ΔΙΠΑΕ CYQAA

ΦΟΡΕΑΣ ΔΙΑΣΦΑΛΙΣΗΣ ΚΑΙ ΠΙΣΤΟΠΟΙΗΣΗΣ ΤΗΣ ΠΟΙΟΤΗΤΑΣ ΤΗΣ ΑΝΩΤΕΡΗΣ ΕΚΠΑΙΔΕΥΣΗΣ
CYPRUS AGENCY OF QUALITY ASSURANCE AND ACCREDITATION IN HIGHER EDUCATION

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Doc. 300.3.2

Date: 26/10/2020

Higher Education Institution's Response

(Departmental)

- **Higher Education Institution:
  European University Cyprus**
- **Town: Nicosia**
- **School/Faculty: Sciences**
- **Department: Computer Science and Engineering**
- **Programme(s) of study under evaluation Name (Duration, ECTS, Cycle)**

Programme 1
In Greek:
Επιστήμη Υπολογιστών (4 Έτη/240 ECTS, Πτυχίο)
In English:
Computer Science (4 Years FT, 240 ECTS, B.Sc.)

Programme 2
In Greek:
Επιστήμη Υπολογιστών (18 Μήνες / 90 ECTS, Μεταπτυχιακό)
In English:
Computer Science (18 Months FT, 90 ECTS, M.Sc.)

Programme 3
In Greek:
Επιστήμη Υπολογιστών, 3 έτη, 180 ECTS, (Διδακτορικό)
In English:
 Computer Science (3 Years FT, 180 ECTS, Ph.D.)

- **Department's Status: Currently Operating**

A. Guidelines on content and structure of the report

- *The Higher Education Institution (HEI) based on the External Evaluation Committee's (EEC's) evaluation report (Doc.300.3.1) must justify whether actions have been taken in improving the quality of the department in each assessment area.*

- *In particular, under each assessment area, the HEI must respond on, <u>without changing the format of the report</u>:*

  - *the findings, strengths, areas of improvement and recommendations of the EEC*
  - *the deficiencies noted under the quality indicators (criteria)*
  - *the conclusions and final remarks noted by the EEC*

- *The HEI's response must follow below the EEC's comments, which must be copied from the external evaluation report (Doc. 300.3.1).*

- *In case of annexes, those should be attached and sent on a separate document.*

1. Department's academic profile and orientation

> **Sub-areas**
>
> 1.1 **Mission and strategic planning**
> 1.2 **Connecting with society**
> 1.3 **Development processes**

Click to enter text.

The EEC has raised the following issues. The response for issue is shown below each point that is raised.

Comments by the EEC:

Areas of improvement and recommendations

The Department needs a carefully thought out development plan in several dimensions: (i) student growth, (ii) research presence, (iii) external funding, and (iv) permanent academic staff.

The Department needs to think more strategically as to specific areas of specialization within the Computing Science field and/or develop substantial expertise in areas where the Department is offering programs (e.g., Computing Science, Computing Engineering, Information Management, etc.) and/or areas where the Department appears to wish to concentrate in (e.g., AI, Information Systems, etc. as shown in its desired Learning Outcomes of its degrees).

As the Department's net financial contribution to the University appears to be strongly positive and since a stated goal of the University is to invest a large percentage of donations and profits to improve its academic programs, the University is strongly encouraged to support the Department's development/growth and increase the Department's depth and breadth of expertise in key strategic areas (such as AI and Information Systems).

Response by EUC:

We thank the EEC for these important recommendations.

The Department, following the School of Sciences strategic plan, is engaged to provide high quality education using student-centered teaching methods and to prepare graduates for successful employment opportunities. The vision of the School of Sciences is to attain and maintain leadership, locally and regionally, in top-quality education with remarkable research output, beneficial to the society community outreach activities. To achieve this, part of the Department's strategic plan priorities focuses on:

1. *Development of freshmen management plans (academic engagement, monitoring, and tutoring activities, from the 1st year of study).*
2. *Student recruitment policies: national & international*
3. *Development of short and long-term marketing plans per program of study*
4. *Targeted faculty additions to allow sustainable growth*
5. *Introduction of new postgraduate programs of study*

6. *Strengthening of research capacity (establishment of new research centers, merging/collaboration of existing research centers, research infrastructure development, scholarships for Ph.D. students)*
7. *Creation of additional research centers, i.e. Cybersecurity, for promoting interdisciplinary research and attract funding.*

The Department's focus is gradually changing from what it used to be towards a more modern approach, through its master degrees in Cybersecurity and Artificial Intelligence. These innovative degrees are already attracting students (during Fall 2020 semester, 18 new students registered in Cybersecurity and 10 in Artificial intelligence). The Department has announced new internal Ph.D. scholarships for the academic year 2020–2021, through its research centers and M.o.U. collaborations (please see Table 1 below for more details). Currently, for Fall Semester 2020, there are six (6) new students registered for the Ph.D. program in Computer Science. Further efforts for strengthening the research capacity of the Department are also attempted, for instance through an under preparation collaboration with other universities in Europe through Erasmus Mundus joint master degrees under our master in Cybersecurity. Moreover, the Department has launched in September 2020 a new cybersecurity expertise center, the CYBER.CERIDES. This competence center's vision is to become a world-class reference center for cybersecurity risk assessment. The Department, under the School of Sciences has already started developing its 2020-2025 strategic planning, in which extra emphasis is placed on securing the EEC's comments and suggestions so that we can deliver exceptional academic programs for our students and ensure that will become successful engineers and scientists with a well-balanced educational experience.

Academic Year	Scholarship Name	Number of Scholarships	Fees Percentage	Degrees
2015-2016	PhDs Scholarship Scheme	3	100%	All PhDs
2016-2017	CERIDES	2	100%	PCSC, POSH
2019-2020	CERIDES	5	100%	PCSC, POSH
2020-2021	Aristarchus	1	100%	PCSC
	MOU - ENGINO.Net Ltd	1	50%	All PhDs
	MOU - AAI Scientific Cultural Services Ltd (AAISCS)	1	25%	All PhDs

Table 1: Ph.D Scholarships for 2020-2021

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(i)   Student growth

The Department has been growing over the years with respect to research presence, external funding, and permanent staff and has managed to maintain on a stable healthy number of students. Regarding the programs accredited together with the Departmental evaluation, this is clearly indicated in Table 2 below for the past six years. From the same table it can also be observed that the number of students in the Ph.D. program is gradually increasing.

CODE	DEGREE NAME	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	F2020
BCSC	Computer Science (4 years, Bachelor)	96	102	97	111	102	93	88
PCSC	PhD Computing/Computer Science	-	2	2	4	3	6	8

Table 2: Total number of students enrolled per academic year

As a Department, we wish to maintain the size and quality of the undergraduate programs, and increase the size and quality of the graduate programs, as well as to attract and retain a diverse student population. We plan to pursue support for endowed scholarships for our students, especially women and minorities. We believe that with the new programs we are offering (Cybersecurity M.Sc. and Artificial Intelligence M.Sc.) and the new promotion plan of the Marketing Department in collaboration with the Department and the School of Sciences, student numbers will increase further.

(ii)   Research Presence

The Department already maintains a respectable research presence in a number of areas related to its programs. For example, the Department collaborates with the SME AAISCS, the National Technical University of Athens, the National Observatory of Athens, and the University of Hawaii at Manoa under the project GRATOS (Graph Theoretical Tools for Sciences) funded by the Cyprus Research Promotion Foundation. The strategy of the Department is to build on this and concentrate its research activity in areas where there are good prospects for both student growth as well as research funding which will in turn enhance research presence. The Department has recently been successful in securing funding through its research centers CERIDES and Aristarchus Research Center (ARC) in the areas of Artificial Intelligence, Graph Theory and Network Science, High Performance Computing, Decision Sciences.

The Department increases its international visibility by inviting to campus external speakers in areas closely related to research areas of our faculty and topics where multi-disciplinary proposals are being developed. For instance, during the academic year 2019 – 2020 such visitors included Dr Olexandr Prylypko (Associate Professor of Mathematics at Zhytomyr Polytechnic State University, Ukraine) by the Erasmus Mundus Active programme, and Dr Iordanis Koutsopoulos (Associate Professor, Department of Informatics of Athens University of Economics and Business (AUEB), Greece) though the Aristarchus collaboration. The Department has also set as a goal to increase the number of publications in respected peer-reviewed journals and conference proceedings to at least one publication per faculty member per year.

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(iii)   External funding

The strategy of the Department is to pursue opportunities for external research funding in the next few years from Horizon Europe, Research & Innovation Foundation and the European Space Agency (ESA). The Department has been very successful in securing funding from these sources in recent years. For example, it secured the first Marie-Sklodowska Curie Innovative Training Network of the University in the area of Connectivity Science (i-CONN project), which provides full financial support (fees, living expenses, equipment, travel) for two Ph.D. students of the Department. It also coordinates an Excellence Hub awarded by the Research & Innovation Foundation in the area of Graph Theory and its applications in Astrophysics and Neuroscience. Aristarchus Research Center (ARC) also secured the first project of the University from ESA, which will allow it to develop further its expertise in High Performance Computing and Markov Chain Monte Carlo model fitting (CYGNUS project). Moreover, CERIDES is coordinating the first integrated project of the University under the Restart 2016-2020 Program of the Research & Innovation Foundation (ΙδΕΚ) which will implement the use of unmanned aerial vehicles and a series of cutting-edge technologies (OenoWatch project). Furthermore, the Department has launched a new Cyber Security Competence Center CYBER.CERIDES, which aims to provide governments, and businesses its combined wealth of cybersecurity and risk assessment expertise, advance academic research in the field and build trustworthy partnerships in Cyprus and the broader Mediterranean region.

(iv)   Permanent academic staff

Following the EEC recommendations, two new full-time faculty have been hired to support the computer science courses starting on September 1st 2020, namely:

1. Alberto Calzada, Lecturer in Computer Science and Artificial Intelligence
2. Pericles Leng Cheng, Lecturer in Computer Science and Robotics

In addition, in September 2019 a new full-time faculty was hired in Computer Engineering, namely George Hadjichristofi (Associate Professor), and in February 2019 a new full-time faculty was hired in Cybersecurity, namely Yianna Danidou (Lecturer). Provided that there will be a significant increase of the number of students in the respective programs of study or any other program of the Department, more faculty will be recruited.

In addition, aiming at sustainable research progress, in each new faculty vacancy the University prioritises applications from candidates with a strong research record. We believe that initiatives such as these will augment our research efforts, given that successful candidates can benefit from a significant reduction in their teaching load from the first year of their employment.

With regards to the recommendation on specific areas of specialization, the University's main goal is to expand its programs towards the newer fields of Computer Science and Engineering. As part of this, the Computer Science and Engineering Department has a newly offered Master in Artificial Intelligence (currently on its first semester) and a new Master in Cybersecurity (currently in its second year).

Cognisant of the suggestion of the EEC to increase the Department's depth and breadth of expertise in key strategic areas, we firmly believe that these newly hired faculty along with

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the current faculty will significantly enhance the Department's research efforts. Finally, we are positive that this will strengthen our commitment to support focused research in strategic areas and enhance our relevant publication output.

2. Quality Assurance

> **Sub-areas**
>
> **2.1   System and quality assurance strategy**
> **2.2   Quality assurance for the programmes of study**

Click to enter text.

Comments by the EEC:

Areas of improvement and recommendations

Lack of annual monitoring report.

Response by EUC:

We would like to thank the Committee for commenting about the monitoring procedures. This has been a concern, not only of the Department but the University as a whole, hence a new monitoring system is currently under development, which can be tailored to our University needs. The new software system named U4SM, is expected to be launched with the beginning of the academic year 2021-2022 (currently being piloted). The use of this system will allow data analysis and reporting regarding students' progress in each course as well as in each program of study. This annually produced monitoring report will be much more efficient and comprehensive, and will provide information including, but not restricted to, the following:

Student information:

- *Student progress based on their G.P.A.*
- *Student progress based on their completed courses*
- *Courses enrolled per semester*
- *Withdraw from classes*
- *Resit examination rights*
- *Student transcript*

Program information:

- *Student turnover and attrition rates per program*
- *Total number of students enrolled per semester per program*
- *Number of graduating students per program*
- *Average duration for completion of studies*
- *Low G.P.A. student within each program*

This system also includes an instructor's portal where instructors will be able to insert information about the students, as for example:

- *Absences*
- *Assessment details*

In addition to the above, the University monitors, evaluates and revises its programs of study through an established Program Evaluation Review (PER) procedure. PER encourages excellence in academic programs by aligning teaching and learning, curriculum, and other academic processes and activities with the mission of individual programs. The PER process is a continuous process. It is expected that each Department implements the PER procedure and prepares the PER report every five years (the latest). The School Council appoints a Program Committee that monitors the academic and other issues of each program. The Program Committee can initiate a PER procedure at any time within the five year period suggesting documented program changes (please see Appendix 1 for more details on PER procedure).

Additionally, students are annually monitored based on their GPA (Grade Point Average). Taking into consideration the ECTS load of each student and the annual GPA, academic advisors come into communication with students to address issues and assist those with low GPA, by monitoring their academic path and discussing ways to improve performance (see for more details of the procedure in the respective EUC Internal Regulation as appears in Appendix 2). The same list of students with low GPA's reaches the Schools' program coordinators, Chairpersons, and Dean for their perusal. The Department closely monitors and supports students with low GPA by following these procedures for supporting students with low GPA. These actions are additional to the efforts/support that each individual instructor of the Department provides to each student and aim for a timely and early enough diagnosis of the phenomenon in order to facilitate an effective, early intervention. Moreover, high achievers are rewarded annually with Academic Excellence Scholarships and Certificates of Excellence (Deans' List).

3. Administration

Comments by the EEC:

Areas of improvement and recommendations

None

4. Learning and Teaching

Sub-areas
4.1 Planning the programmes of study 4.2 Organisation of teaching

Click to enter text.

Comments by the EEC:

Areas of improvement and recommendations

The thematic choices seem rather disconnected. They need to be better linked in order to form a coherent program which follows specific educational goals. The offering of classes is rather broad, but the offerings should be linked with each other in order to be in line with a well-articulated strategic plan for growth including specific focus areas, and timelines for hiring new faculty in the department.

Response by EUC:

We are in agreement with the EEC's observations and endorse our own understanding as to the variety of the thematic choices.

EUC was established in 2007 and it is a 13-year old university that is building on its academic and research culture every year. The Department of Computer Science and Engineering has been pivotal in the development of EUC. Although currently the Department has a clear focus on IT related subjects, in the near past it hosted a variety of pure engineering degrees (civil, computer, electrical, telecommunication). The establishment in 2014 of the M.Sc. in Occupational Safety and Health (and later in 2015 of the Ph.D. in Occupational Safety and Health) complimented this offer. During the past few years the University's main goal is to expand the Department's programs towards the newer fields of Computer Science and Engineering. Therefore the Department's focus is gradually changing to a more modern approach, through its newest master degrees in Cybersecurity (currently in its second year) and Artificial Intelligence (currently on its first semester).

The M.Sc. in Occupational Safety and Health connects to the existing courses in the Department in a number of interfaces. At its current design the M.Sc. offers courses in Safety Technology (where the use and development of technical solutions is discussed), Risk Assessment (with explicit links with emerging risks in Cybersecurity and Artificial Intelligence) and Critical Infrastructure Protection (with reference to Networks and Cybersecurity). We prefer to see the existing variety of courses as a developmental tool rather than a limiting factor. Already, there are new courses of the M.Sc. in Occupational Safety and Health, that are currently under re-accreditation by CY.Q.A.A. that build upon this variety (e.g. Emergency and Security Management, etc.).

A major connecting factor for all the courses of the Department is the Department's centre of excellence CERIDES – Excellence in Innovation and Technology, one of the few centre of excellences in the country. CERIDES has amassed over €4Mn in EU and National highly competitive funds and currently employs almost 30 researchers in its areas of focus (Risk and Decision Sciences). CERIDES's success has led to the establishment of CYBER.CERIDES that will focus specifically on risks in Cybersecurity. CYBER.CERIDES,

both through CERIDES and the Department, provides an academic framework for cyber-risk sciences and creates a career path for emerging researchers. High-quality teaching will challenge our international students and help them develop skills in critical thinking, research and problem-solving that can be applied to a career in either research or the broader business community. Through its taught programs we foster dissemination of ideas, theories and methods to its students. It is anticipated that the experience gained through research will be fed back to existing courses and it is also anticipated that new courses will spin off from CYBER.CERIDES.

It is worthwhile mentioning, as previously mentioned in this document in section 1 '(iv) Permanent academic staff', that over the past two years four new full-time faculty were hired in the Department; one in Cybersecurity, one in Computer Engineering, and two in Computer Science - Artificial Intelligence. It is expected that in the next three years, provided that there will be a significant increase of the number of students in the respective programs of study, especially the new master degrees in Cybersecurity and Artificial Intelligence, more faculty will be recruited.

5. Teaching Staff

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Comments by the EEC:

Areas of improvement and recommendations

High ratio of visiting collaborators.

Response by EUC*:*

In order to address the abovementioned issue, the Department of Computer Science and Engineering has addressed these issues as follows:

Scientific collaborators contribute to the smooth running of the programs, especially for courses where specialized areas are covered. As we wish for our students to be offered the best possible experience in learning, these scientists are needed to provide deep knowledge of the material as well as expert support and feedback. These collaborators are professionals hired after a position is advertised and an interview and demo lecture is given in front of a selection committee of at least three faculty members in related areas. The ratio of scientific collaborator versus full-time faculty varies from semester to semester depending on the demand of such courses. This ratio also depends on the teaching hour reduction of a research active Faculty permitted and granted by the University's Research Policy (please see Appendix 3). More specifically, this allows the teaching hour reduction of a research active Faculty from twelve (12) hours per week to six (6) or nine (9) based on the research record application of each Faculty member. Currently, there are seven (7) (out of 17) full-time faculty members of the Department taking advantage of this teaching load reduction, forcing the ratio of scientific collaborators to increase. As we already mentioned earlier, during the past two years two new programs on Cybersecurity and Artificial Intelligence where offered and four new full-time faculty were hired in the Department; one in Cybersecurity, one in Computer Engineering, and two in Artificial Intelligence. Additionally, scientific collaborators where hired to further support the new programs with the prospective that once the number of students registered to these programs is increased, more permanent academic staff may be hired. During the current semester of Fall 2020 the Department hired only twenty seven (27) scientific collaborators and the ratio of scientific collaborators versus full-time faculty is now 27/17 or 1.588. This means for each full-time faculty the Department is using 1.588 collaborators, which is a very favourable ratio.

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6. Research

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Comments by the EEC:

Areas of improvement and recommendations

The mission of the department needs to be a bit more precisely articulated in terms of processes for success in order to fine-tune research policy.

Response by EUC*:*

We thank the EEC for their guidance.

The Department follows its Research strategic plan as well at the Research Policy of the University. Following this strategic plan, and in accordance with the EUC Research Policy, the Department has set some goals as described below:

- *Increased Engagement of Undergraduate Students in Research Output: encourage research participation by undergraduate students.*
- *Students, through their senior projects: e.g. two students in 2019 – 2020 were involved in faculty's research projects (please see Appendix 4 and Appendix 5), a trend that will be continued.*
- *New laboratory facilities for research:*
  - o *Establishment of a new research laboratory for developing prototypes: A new research lab is being developed to support the new competence center on cybersecurity risks (CYBER.CERIDES).*
- *All academic staff to participate research activity: Participation in research funding projects and Publication in peer-review conferences and journals: as mentioned before, 7 out 17 (15 faculty and 2 special teaching personnel) is already engaged in external funding during the academic year 2019 – 2020.*
- *Improved Research output:*
  - o *Increase Scopus peer-reviewed publications per faculty per year*
  - o *Increase presentations in national/global conferences per faculty per year*
  - o *Establishment of new multidisciplinary Research Centers in the Department*

The above goals are supported by the Research policy as well as the budget of the Department in the following sense. The funding for research is being rewarded by the Research policy and through the teaching load reduction scheme. The budget includes a special funding for publications fees, thus encourages publications in recognized and high-impact journals. Additionally, it covers the expenses for conference presentations. The budget also covers purchases of new equipment or maintenance of existing ones of new or longstanding laboratories.

The Department also runs two research centers, as previously mentioned in this document which are very active as well as a newly launched competence center in cybersecurity risks.

1. CERIDES – Excellence in Innovation and Technology is the first cross-disciplinary, Center of Excellence to be established at European University Cyprus. The Center implements horizontal research activities in scientific areas related to the fields of Risk and Decision Sciences. CERIDES has put in place an intensive talent management program for their Ph.D.

students. Selected Ph.D. students in Computer Science and Occupational Safety and Health are offered a tailor made training program in association with their Ph.D. supervisor. To facilitate the process, those Ph.D. students are offered a dedicated space in the CERIDES – Excellence in Innovation and Technology _working space_ and where possible are provided with either a scholarship and / or a bursary. The aim of this intense talent management program with CERIDES–Excellence in Innovation and Technology is to equip Ph.D. candidates with a mentor, that will assist them in preparing high quality (Q1, Scopus indexed) publications, internationalization exposure and networking opportunities.

In addition to the above, CERIDES–Excellence in Innovation and Technology organizes on an annual basis _Nicosia Risk Forum_ which has been established as Regional outpost for dissemination and networking in SE Europe. A dedicated Ph.D. candidate track takes place every year, which gives students the opportunity to present findings of their work as well as be part of the organization of the event.

2. _Aristarchus Research Center (ARC)_ is a multi-disciplinary research and innovation center, which aims primarily to address the challenges of analysis and interpretation of the large and complex data sets of the modern era. The center currently focuses on the application of advanced methods in Computer Science, Mathematics and Statistics for exploring data in Astrophysics and Neuroscience. The interests of members of ARC also encompass technology-enhanced education. The center has a prestigious network of international collaborators.

3. _CYBER.CERIDES_ is a new cybersecurity expertise center seeking to enhance academic understanding and strengthen strategic and practical capability of its clients to handle cyber-risks. CYBER.CERIDES aims to provide to governments and businesses its combined cybersecurity and risk assessment expertise in for cyber-risk assessment. The participation in National, EU and private research projects of CERIDES and the Department has created a vibrant ecosystem for research in Cyprus and SE Mediterranean. CYBER.CERIDES will build upon this, working with Research Associates and Postdoctoral Research Fellows in projects relevant to the Centre's thematic pillars, creating an inspiring and productive environment, which is primarily focused on delivering high quality research output and stimulating scientific debate.

In addition, to comment of the EEC committee on research development, the University's Research Policy (please see Appendix 3) aims to provide a framework that allows academics and researchers of the University to contribute towards its mission to "develop a pioneering and innovative research infrastructure with the objective of generating new knowledge". As can be seen in the document, this is to be achieved in various ways and policy provisions including among others:

- _Procedures for the award of Teaching Hours Reductions to faculty on the basis of participation in projects, authoring of books or by accumulation of research points (pp. 24)_
- _Rules governing Internal Research Awards (pp. 23)_
- _A framework for the establishment of Research Centers and Laboratories (pp. 20)_
- _Rules governing External Research Programs (pp. 20)_
- _Procedures for acquiring equipment purchased through external or internal research funding (pp. 25)_
- _Procedures for research appointments and affiliations (pp. 27)_

7. Resources

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Comments by the EEC:

Areas of improvement and recommendations

More investment is needed to support the depth and breadth of the Department's programs.

More investment is needed for develop the Research and PhD programs. As it stands, said programs are only provided at a rudimentary basis.

_Response by EUC__:_

As far as these two important points raised by the EEC, we have attempted to take into account effectively, as indicated below:

The Department has grown over the last year. Should the number of students increases, the University, as in all similar cases, hires more permanent Faculty to cover the teaching, as well as other needs of the Department. As previously mentioned in this document in Section 1 above, the Department has announced new Ph.D. scholarships for the academic year 2020–2021, through its research centers and M.o.U. collaborations (please refer to Table 1 in pp. 5 of this document). Moreover, the number of new Ph.D. students for Fall 2020 has increased to six (6) for Ph.D. in Computer Science and seven (7) for Ph.D. in Occupational Safety and Health. A third of the enrolled students is supported with full-time scholarships, two (2) of them from the prestigious and highly competitive Innovative Training Networks of the Marie Skłodowska-Curie Actions (MCSA ITN).

With regards to research development, currently the Department facilitates two very well established and profitable research groups, CERIDES and Aristarchus. CERIDES has amassed over €4Mn in EU and National highly competitive funds and currently employs almost 30 researchers in its areas of focus (Risk and Decision Sciences). CERIDES– Excellence in Innovation and Technology has a clear national and regional expansion strategy. The areas of focus of CERIDES revolve around the development, use and evaluation of primarily quantitative and to a lesser degree qualitative methods in order to measure, assess, manage and communicate risk, and to analyze, design and implement decision-making mechanisms and systems. CERIDES's development strategy follows an organic growth model with a continuous effort for more research funds, more researchers and a clear research talent management strategy.

CERIDES aims to create high quality output and build a high caliber reputation along three main areas:

- **_Research: CERIDES aspires to create a vibrant research community within Cyprus and the region._**
- **_Education/Training: CERIDES intends to provide an academic framework for risk science and create a career path for researchers emerging from the University. The Centre will provide high-quality teaching that will challenge students and help them develop skills in critical thinking, research and problem-solving._**

- *Consultancy: One of the key aims of the CERIDES is to assist organizations to effectively manage risk and uncertainty and assist decision making in the fields of occupational, industrial, natural and environmental hazards.*

Furthermore, aiming at sustainable research progress, in each new Faculty vacancy the University prioritizes applications from candidates with a strong research record. In achieving this, as the Artificial Intelligence vacancy proclamation noted: "Successful candidates can benefit from a significant reduction in their teaching load from the first year of their employment. The reduction in teaching load will depend on the quantity and the quality of Scopus publications they (co-)authored in the last five (5) years". We believe that initiatives such as these will augment our research efforts, given that successful candidates can benefit from a significant reduction in their teaching load from the first year of their employment.

It is also important to mention that a percentage of the money earned from research projects is re-invested in the Department's Research Laboratories (in terms of providing Ph.D. scholarships) and Research Centers, or even the creation of a new one (like in the case of CYBER.CERIDES). The School's budget also covers purchases of new equipment or maintenance of existing ones of new or longstanding laboratories. It also includes a special funding for publications fees (up to 35000 euros), thus encourages publications in recognized and high-impact journals. Additionally, it covers the expenses for all full-time faculty conference presentations.

B. Conclusions and final remarks

Click to enter text.

Comments by the EEC:

Areas of improvement and recommendations

- The Department needs a carefully thought out development plan in several dimensions: (i) student growth, (ii) research presence, (iii) external funding, and (iv) permanent academic staff.
- Lack of annual monitoring report.
- The thematic choices seem rather disconnected. They need to be better linked in order to form a coherent program which follows specific educational goals.
- The research mission of the department needs to be a bit more precisely articulated in terms of processes for success in order to fine-tune research policy.
- More investment is needed for develop the Research and PhD programs. As it stands, said programs are only provided at a rudimentary basis.

Response by EUC:

We would like to thank the EEC for the positive feedback and its constructive recommendations.

As presented in the previous sections of the report, the Department of Computer Science and Engineering has made a focused effort to address each one of the EEC's recommendations. As such, we believe that these actions enhance the contribution and performance of the Department.

The Department's mission and strategic planning includes growth in terms of students, research presence, external funding, and permanent academic staff. The Department already has good research presence in a number of areas related to its programs (e.g. GRATOS funded by the Cyprus Research Promotion Foundation, i-CONN a Marie Skłodowska-Curie ITN project funded by the European Commission, under H2020 programme). Following the EEC's recommendation, the Department's strategy is to build on this and concentrate its research activity in areas where there are good prospects for both student growth as well as research funding which will in turn enhance research presence.

Cognisant of the current lack of annual reporting system, a new monitoring system is currently under development, which can be tailored to our University needs. The new system is going to be launched with the beginning of the academic year 2021-2022. In addition to the above, the Department uses the available resources to monitor its programs and students through the established Program Evaluation Review (PER) procedure of the University and the annual monitoring based on the GPA, respectively.

The Department of Computer Science and Engineering offers a variety of degrees; this is something that is slowly changing and focuses more on IT degrees.

The Department follows its Research strategic plan as well at the Research Policy of the University with main goals to encourage research participation by undergraduate students, increase the number of full-time faculty who are involved in research funding projects,

increase the publications in peer-review as well as the presentations in national and international conferences per year.

Finally, the Department has grown over the last years and is more active in research. The total number of Ph.D. students has increased this Fall Semester 2020 to a total of 13 and Ph.D. scholarships have been awarded. Currently the Department facilitates two very well established and profitable research groups, CERIDES and Aristarchus, both engaging Ph.D. students.

In closing, we would like to say that the Department of Computer Science and Engineering found the EEC's candid discussions, a constructive learning process. We all believe that this review was a positive experience and feel that we were provided with important input on how to move effectively forward. In addition, we have thoroughly reviewed the findings, strengths and areas of improvement clearly indicated by the EEC following their review and attempted to respond to each item specifically and succinctly, indicating our actions. By embracing the EEC's comments and suggestions, we are convinced that the Department will be able to more effectively ensure the learning outcomes of its students. In this regards, we are grateful to the EEC for their recommendations regarding our Department and the insightful comments and suggestions throughout their report.

C. Higher Education Institution academic representatives

Name	Position	Signature
Marina Appiou Nikiforou	Chairperson, Department of Computer Science and Engineering	
Panagiotis Papageorgis	Dean, School of Sciences	
FullName	Position	
FullName	Position	
FullName	Position	
FullName	Position	

Date: **27.10.2020**

European University Cyprus

INTERNAL REGULATION ON

EUC's PROGRAM EVALUATION REVIEW (P.E.R.) PROCEDURES AND TEMPLATE

62nd Senate Decision: 28 January 2019

Program Evaluation Review (PER) Procedures

1. Rationale and Scope

The Program Evaluation Review (PER) encourages excellence in academic programs by aligning teaching and learning, curriculum, and other academic processes and activities with the mission of individual programs. The process is an essential part of EUC's continued effort to ensure that its mission is met through the delivery of its programs, that EUC programs of study comply, on institutional level, with Standards and Guidelines in the European Higher Education Area, and that EUC programs' structure, content and delivery mode meet stakeholders expectations and needs.

More specifically, the PER's goal is to provide a framework for developing, implementing, and maintaining an ongoing effective program evaluation review process that will:

- Result in the improvement of the program experience of students;
- Follow the standards of the EUC policies and align to accreditation bodies' decisions (e.g. CY.Q.A.A. The Cyprus Agency of Quality Assurance and Accreditation in Higher Education/ΔΙ.Π.Α.Ε. Φορέας Διασφάλισης και Πιστοποίησης της Ποιότητας της Ανώτερης Εκπαίδευσης);
- Assess the quality and enhance the overall effectiveness of the Programs, Departments, Schools and University as a whole;
- Identify the strengths and weaknesses in each program under evaluation review and offer opportunities for improvement;
- Establish program action plans and strategies for continuous and ongoing improvement;
- Utilize the information collected through the PER process to better plan and set priorities at the University level.

2. Sources of Information

The aim of every program is to satisfy the needs and expectations of its stakeholders. As a result, continuous monitoring of needs and expectations is essential. The table below shows the way by which the PER process monitors and collects information from the program stakeholders.

STAKEHOLDER	SOURCES OF INFORMATION	DOCUMENTATION
Students	Course Evaluation Questionnaires	Full report of questionnaires output shall be available at the end of each semester
	Program Committee	Students' representation in the Program Committee. Minutes of meetings
Alumni	Alumni Questionnaires (e.g. Έρευνα Αποφοίτων)	Full report of questionnaires output should be available
	Advisory Board	Alumni representation on the Advisory Board. Minutes of meetings.
	Graduate Employment Reports	Reports
Faculty Members	Program Committee	All faculty members teaching in the program are members of the Committee. Minutes of meetings
		Students' representatives in the Committee. Minutes of meetings
Professionals – Industrialists	Advisory Board	Professional Bodies, Industrialists representation on the Advisory Board. Minutes of meetings
	National & International Professional Bodies Curriculum Guidelines	Established guidelines
	National & International Legislative Directives on Program Curricula	Directives on program curricula
University Management	University Strategic Plan	University strategic plan document
	School/Departmental Strategic Plan	School/Dept. Strategic Plan.
Other		

In order to facilitate the collection of information from the stakeholders and the development of the PER report, the following Committees/Bodies need to be in place (additional to those described in the EUC Charter):

(a) Program Committee:

The School Council appoints a Program Committee (*as EUC Charter: Annex 12, Article VII, Section 2,*) that monitors the academic and other issues of each program. The Program

Committee can appoint sub-committee(s) to handle specific thematic areas and/or collect information.

(i) Terms of reference: The Program Committee shall report to the Department and/or School Council accordingly. For the purposes of the PER procedure the Committee meets at least once per semester. It shall have the following specific responsibilities:

- To oversee and monitor the implementation of the Senate policies and guidelines;
- To monitor curriculum development, delivery and assessment; and make recommendations to the School Council for proposed changes in regulations through the development of the PER report;
- To monitor students' admission and progress;
- To monitor the career path of the Alumni and maintain strong ties between the Alumni and the University;
- To receive and consider the minutes of meetings of the Sub-Committee for the program;
- To receive and consider the summary results of students evaluation questionnaires, as available;
- To provide a forum for discussion of general matters relating to the program;
- To submit the PER report of the program to the Department and School Council through the program coordinator.

The Program Committee Chair comprises the following members:

- The Program Coordinator (*as EUC Charter: Annex 12, Appendix B*);
- The Program's full time teaching personnel, plus selective part time teaching personnel, if necessary;
- Representative of the Administration personnel according to the specific administrative needs, if required;
- Student representatives.

(b) School or Department or Program Advisory Board:

Each program sets up an Advisory Board with the following broad terms of reference and membership.

(a) Terms of reference: The aim of the Advisory Board is to support the Undergraduate and Postgraduate Programs of each Department and School of the European University Cyprus through an independent evaluation of its activities, feedback and constructive criticism. Overall, the Advisory Board will review and contribute in several areas, including the following:
1. Improvement(s) on academic teaching;
2. Evaluation and provision of suggestions regarding the Undergraduate and Postgraduate Programs of the Department and School structure and content; thus providing students with an enhanced learning experience and a high quality educational program;
3. Proposition of courses that link the Department's/School's programs with the needs of the local and global industries, promote internationalization, academic and professional qualification and foremost employability of graduates;

4. Develop mutually beneficial relationships between the faculty, the industry, stakeholders and authorities, aiming to facilitate constructive exchange of ideas, as well as strengthen the links between them;

5. Contribution of unique and innovative ideas for research and its implementation;

6. Promotion of the faculty's work profile outside the University.

(b) Membership: C/o School and Departments.

(c) Expert Review Panel (ERP):

The PER process refers to the evaluation of the report by an Experts' panel with the following terms of reference and membership:

(i)   Membership

The Program Review Panel comprises of academic and subject experts, namely:

• Two External Faculty members who are experts on the program thematic areas.

The Program Coordinator (on behalf of the Program Committee) appoints the two external experts.

(ii)   Terms of reference

The Expert Review Panel provides a written review report by commenting and evaluating the findings and implementation plan presented in the PER, as well as by providing relevant recommendations. The role of the Expert Review Panel is to provide feedback only on the academic elements of the Program Evaluation Review. Decisions about the viability and other aspects of the program remain within the remit of the School and University.

3. The PER Process

The PER process to be followed is illustrated in the diagram below. The PER process is a continuous process. It is expected that each Department implements the PER procedure and prepares the PER report (see Template attached) every five (5) years. The Program Committee can initiate a PER procedure at any time within the five year period suggesting documented program changes.

Diagram: PER Procedure
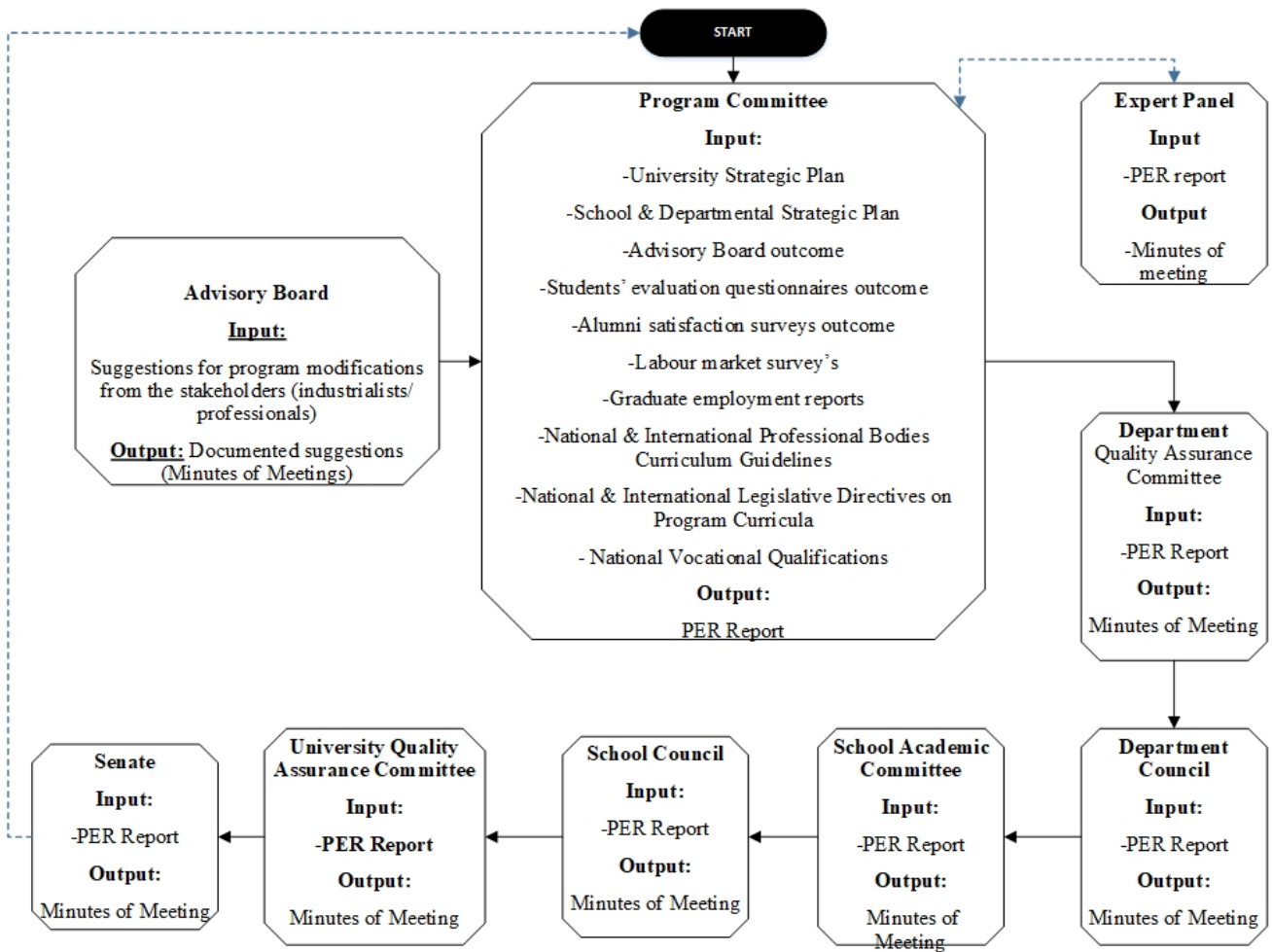
4. Timeframe

Program Evaluation Review is a continuous process. It is expected that every program should complete a PER process every five (5) years. However, the Program Committee is not restricted with regards to the exact time, as it can initiate a PER report at any time within the five year period suggesting documented program changes.

Schools with a program to be reviewed for the 5 years PER process will be notified by the Office of the Vice-Rector of Academic Affairs *in early July.* Since the review process is an ongoing process, the School shall follow all procedures so that the report with the associated documentation is approved by the Senate in its first meeting of the following calendar year.

Program Evaluation Review (PER) Template

"Program Title"

School of X

Department of X

Last Review Date: DD/MM/YY

1. Background/Contextual Information

Briefly describe the **status** of the Program in review (provide **headline** information in terms of student numbers, profiles and accreditations). Focus on any significant developments since the last program review.

Briefly present the actions taken since the **last Program Review**, and the progress of the suggested Program Action Plan (if any).

 (*Provide references wherever this is applicable / appropriate, see Section ….*)

2. PER methodology

Briefly describe the **methodology** used for the implementation of this review. Refer to how this review is related to the overall University's QA process.

(*Provide references wherever this is applicable/appropriate, see Section …*)

3. PER Data Sets & Other Sources of Information

List the **data sets** and **other sources of information**, which were used for the implementation of this review. Provide as appendix all the documentation.

4. Curriculum Structure, Objectives, and Learning Outcomes

Briefly describe and review the **general structure**/**content** and **rationale** of the Program Curriculum in Review. Possible review tasks, which may be undertaken, are the following:

− Review the relevance and adequacy of the **current Objectives / Learning Outcomes** of the Program in review in relation to the latest research, professional and technological developments (wherever applicable).
− Review how the Curriculum structure and content **satisfies the current Objectives and Learning Outcomes** of the Program in review (cross-reference matrices of 'Courses vs Learning Outcomes' can be designed / used for this purpose).
− Review how the Curriculum's structure / learning outcomes **satisfy the requirements of international standards and professional organisations, as well as any legislative requirements** (if applicable).
− Review how the Curriculum structure / learning outcomes **address stakeholders'** (students, alumni, professionals) **considerations and expectations**.

Feel free to implement any additional / alternative review task you consider appropriate for the Program in review.

(*Provide references this is applicable / appropriate, see Section 2*)

5. Teaching and Learning

Briefly describe and review the **teaching and learning methods, teaching and learning materials, academic personnel, resources, and academic support**, which are provided for the Program in review. Possible review tasks, which may be undertaken, are the following:

− Review the relevance and adequacy of the **current teaching, learning, and assessment methods followed**, in relation to international standards, stakeholders' feedback, and current educational trends.
− Review the adequacy of the **Program's current academic personnel** in relation to the teaching and learning needs of the Program Curriculum, international standards, stakeholders' feedback, School and University Strategy, and requirements from professional bodies.
− Review the relevance and adequacy of the Program's current teaching **resources and academic support** in relation to international standards, stakeholders' feedback, and current educational trends.

Feel free to implement any additional / alternative review task you might feel is appropriate for the Program in review.

(Provide references wherever this is applicable / appropriate, see Section 2)

6. Sustainability

Briefly describe and review the **Sustainability** aspects of the Program in review. Possible review tasks, which may be undertaken, are the following:

− Review the **student recruitment / retention policy**, which is followed for the Program in review, in relation to the latest enrolment, retention, and marketing data.
− Review the **employability dimension** of the Program in review, in relation to the latest alumni satisfaction and graduate employment reports, and in relation to the feedback provided by industrial stakeholders.
− Review how the Program in review fits and contributes to the satisfaction of **the School's and University's long-term strategic plans**.
− Review how the Program in review addresses the latest **national and international professional needs and trends**.

Feel free to implement any additional / alternative review task you consider as appropriate for the Program in review.

(Provide references wherever this is applicable / appropriate, see Section 2)

7. SWOT Analysis

Based on your review, please provide a Strengths/Weaknesses/Opportunity/ Threats Analysis for the Program in Review:

Strengths	Weaknesses
1. Strength x 2. Strength y	1. Weakness x 2. Weakness y
Opportunities	**Threats**
1. Opportunity x 2. Opportunity y	1. Threat x 2. Threat y

8. Proposed Program Modifications

Identify the proposed program modifications by providing the necessary documentation on the following areas:

I. Program modifications:

    (a) Title
    (b) Aim and Objectives
    (c) Learning Outcome(s)
    (d) Curriculum/Program structure
    (e) Entry requirements/criteria

II. Course(s) modifications

    (a) Title
    (b) Aim and Objectives
    (c) Learning Outcomes
    (d) Course Content
    (e) Teaching Methodology
    (f) Assessment Methods
    (g) Recommended Textbook(s)
    (h) Other (ECTS, hours, etc.)

III. Program quality control mechanisms

IV. Other (Specify)

9. Implementation Plan

Describe the proposed action plan for the proposed modifications/changes in a timetable or Gantt Chart.

INTERNAL REGULATION ON

"EUC"s PROCEDURES FOR SUPPORTING STUDENTS WITH LOW GRADE POINT AVERAGE (GPA)"

71st Senate Decision: 7 February 2020

Aiming to develop a proposal/framework on the process and actions to be taken, in order to address and reduce the phenomenon of students' low G.P.A. and its effects, the actions to be taken in order to help reduce the phenomenon, are:
- the provision of correct information to all students, namely undergraduate, postgraduate, Conventional and Distance Learning;
- ensure that students are aware of the role of GPA and the impact of low GPA on the progress of their studies;
- increase of the support provided at the Program, Department and School level;
- proper implementation of procedures by the Student Advising Centre.

These actions are additional to the efforts/support that each individual instructor provides to each student and aim for a timely and early enough diagnosis of the phenomenon in order to facilitate an effective, early intervention.

The following steps will be followed for all students (both conventional and distance education):
1. **The Department of Enrollment** provides the Schools at the beginning of each academic semester (e.g. third week of October and February, respectively) with a list of their students with a low GPA (for undergraduate courses: below 1.80 except for the School of Medicine where the threshold has been set to 2.0; for postgraduate courses: below 2.5; for Ph.D. courses the issues concern late progress in completing the Ph.D-see sample letter attached).

2. **The School** (this concerns all undergraduate and postgraduate Conventional and Distance Learning Programs of Study)**:**
   (1) *For first year students at the end of the 1st semester of their studies or for students included in the list for the first time:*
   Each affected student is called by the Program Coordinator, in order to ensure that, students are aware of the concern of the Department and School, and that students are indeed properly informed that the Department is available to provide support (e.g. Specifically, students are informed about the role and

importance of the GPA, the possible reasons and causes of the low GPA, and ways for improvement of the situation, which may either involve the student (e.g. further effort) or the Department and School).

(2) ***For new students, which continue to be in the same situation at the end of the second semester of their studies or for students appearing in the list for a second time***:
The process presented in Item 1 above is repeated in the presence of the Chairperson of the Department, for further discussion and enhancement of the process, aiming at the most tangible academic targets and the procedures involved. If needed, the Chairperson of the Department and the Program Coordinator will request the presence of the Dean.

(3) ***For students who exhibit the phenomenon on a continuous basis***:
The possibility of sending a letter from the Dean <u>to the student</u> (registered, in the home address) is considered (see attached "Sample" letters).

<u>For the School of Medicine (undergraduate degrees) in more specific</u>: The students with a GPA lower than 2.0 receive a "Letter of Probation" before the beginning of the second academic year of their studies (September). Students who received a "Letter of Probation" and still maintain an unacceptably low GPA will be given only one last opportunity to correct their GPA during the coming semester (Spring). At the end of the Spring semester of their second year of studies,, these students (e.g. those who have already received a letter of warning in the past), and continue to maintain a very low GPA will receive a "Letter of Dismissal", with the option to either change their program of study (e.g. transfer to biology) or to withdraw from the School. Those students who, on the other hand, have not yet received a "Letter of Probation" in the past, but perform unsatisfactorily, will receive a "Letter of Probation" at the end of the Spring semester of their second year of studies, with subsequent consequences should their performance not improve. This option will be provided this one and only time to those students with failures; no other opportunity will be provided to improve "F" grades. Each student will be notified accordingly, depending on their status.

3. The Department of Enrollment:
Each Student Advisor:
(1) Contacts/communicates with students and ensures that each student is well informed and advised about the University's grading system and the role of GPA ;
(2) In the case of students not passing a course, the advisor re-registers them to the same course in order to immediately delete the received F, and thus avoid accumulation of F's. This takes places in the exact following semester in case the affected course is a prerequisite to other courses, in order to avoid accumulation of F's;
(3) Student advisors are in constant communication with the Program Coordinators in order to secure this process.

Encl.: (1) Sample Letters (Greek and English version)
      (2) Sample Letter of Probation (School of Medicine)
      (3) Sample Letter of Dismissal (School of Medicine)
      (4) Sample Letter for Ph.D. Students (Department of Enrollement)

.... 2020

Προς
....

Θέμα: Χαμηλός Μέσος Όρος Βαθμολογίας (G.P.A.)

Αγαπητή/έ...................,

Σε συνέχεια της αναφοράς του/της Προέδρου του Τμήματος και του/της Συντονιστή/τριας του Προγράμματος που παρακολουθείτε κατά το περασμένο ακαδημαϊκό εξάμηνο, παρακαλώ σημειώστε ότι ο μέχρι τώρα μέσος όρος της βαθμολογίας σας (G.P.A.) είναι ....

Θα ήθελα να σας υπενθυμίσω, επί του προκειμένου, τους κανονισμούς του Πανεπιστημίου μας αναφορικά με τις προϋποθέσεις απόκτησης πτυχίου, οι οποίοι προβλέπουν μέσο όρο βαθμολογίας (G.P.A.) 2.00 και άνω.

Ο/η Πρόεδρος του Τμήματος και ο/η Συντονιστής/τρια του Προγράμματος που παρακολουθείτε μπορούν να σας δώσουν περισσότερες πληροφορίες και σχετική υποστήριξη.

Ελπίζω ότι, κυρίως με την αναβάθμιση των δικών σας προσπαθειών, θα καταστεί δυνατή τόσο μια ποιοτική συνέχιση των σπουδών σας, όσο και η τελική επίτευξη των στόχων σας.

Με εκτίμηση,

....
Κοσμήτορας,
Σχολή ....

Κοιν.:
-Συντονιστής/τρια Προγράμματος Σπουδών
-Πρόεδρος Τμήματος

European University Cyprus
6 Diogenous str, 2404 Engomi,
P.O.Box 22006, 1516 Nicosia, Cyprus
Telephone: +35722559514
Fax: +357 22559515

Date XXX

Student's Name: xxxxx
ID: xxxx
Program: Doctor of Medicine, MD

Re: Letter of Probation for G.P.A. of less than 2.0

Dear [Name of Student],

I regret to inform you that, due to your low cumulative Grade Point Average (GPA), you are being placed on academic probation. You will remain on probation and will be subject to dismissal until your cumulative GPA reaches or exceeds 2.00.

Academic Probation status is serious. You must raise your cumulative GPA to 2.00 to return to good standing and to receive your degree. According to European University Cyprus bylaws and the decision outlined by the EUC 48th Senate, students with a GPA lower than 1.7 at the end of their second year (year 2) are subject to dismissal (termination).

The School of Medicine is committed to helping you improve your academic performance so that you can return to good standing and make progress toward your degree. We will provide you with the services and activities to help you achieve academic success. In return, you must commit yourself to work diligently. It is my sincere hope that you will be successful next semester.

Sincerely,

Professor Elizabeth O. Johnson
Acting Dean
School of Medicine
European University Cyprus

CC: Professor Ioannis Patrikios, Chair, Department of Medicine
      Professor Loizos Symeou,Vice-Rector of Academic Affairs
      Dr. Christos Tsiappas, Director of Enrollment

Date XXX

Student's Name: xxxxx
ID: xxxx
Program: Doctor of Medicine, MD

Re: Letter of Dismissal
Dear [Name of Student],

As you are aware, on [date of probation letter] you were placed on academic probation because your cumulative Grade Point Average (GPA) was below 2.00.

After careful review of your academic performance, the School of Medicine must regrettably inform the Rectorate and Director of Admissions that you have not made satisfactory progress and are recommended for dismissal from the Doctor of Medicine, MD, program.

According to European University Cyprus bylaws and the decision outlined by the EUC 48th Senate, students with a GPA lower than 2.0 will not be eligible for graduation.

While you are being dismissed from the program of Doctor of Medicine, you may wish to explore your options of transferring to another program in Life Sciences, such as Biology, offered by European University Cyprus. We will be happy to assist you in this process. We wish you the best in your future endeavors.

Sincerely,

Professor Elizabeth O. Johnson
Acting Dean
School of Medicine
European University Cyprus

CC: Professor Ioannis Patrikios, Chair, Department of Medicine
    Professor Loizos Symeou,Vice-Rector of Academic Affairs
    Dr. Christos Tsiappas, Director of Enrollment

.... 2020

Προς
....

Αγαπητή κα,

Με την παρούσα επιστολή θα ήθελα να σας ενημερώσουμε για τα παρακάτω:

Η διάρκεια των διδακτορικών σπουδών του Πανεπιστημίου είναι 3-6 χρόνια με τη δυνατότητα χορήγησης αναστολής φοίτησης μέχρι και ένα (1) ακαδημαϊκό έτος.

Είστε εγγεγραμμένη στο πρόγραμμα διδακτορικών σπουδών στις ……… από το Φθινοπωρινό Εξάμηνο 201…., και συνεπώς αναμένεται να ολοκληρώσετε τις σπουδές σας μέχρι το τέλος του Εαρινού Εξαμήνου 202….. Αυτό σας δίνει περιθώριο ακόμη τεσσάρων (4) εξαμήνων φοίτησης. Δείτε αναλυτικά τη σχετική αναλυτική σας βαθμολογία στο συνημμένα.

Επιπρόσθετα, θα ήθελα να σημειώσω ότι είστε εγγεγραμμένη στάδιο υποστήριξης πρότασης διατριβής (PHD801) για έξι (6) συνεχή εξάμηνα (από το S20….).

Με βάση τα πιο πάνω δεδομένα, και επειδή μας προβληματίζει η καθυστέρηση που παρατηρείται στην πρόοδό σας στο Πρόγραμμα, σας ενημερώνω ότι για την εντός του εναπομείναντα χρόνου ολοκλήρωση των διδακτορικών σας σπουδών, απομένουν οι εξής επιλογές:

(α) Μέχρι το επίσημο τέλος του τρέχοντος εξαμήνου (Φθινοπωρινό 20…), θα πρέπει να ολοκληρώσετε επιτυχώς το μάθημα PHD801. Στη συνέχεια θα έχετε στη διάθεσή σας ακόμη τρία (3) εξάμηνα για να ολοκληρώσετε το στάδιο συλλογή και ανάλυση δεδομένων (PHD802) και συγγραφή και υποστήριξη διδακτορικής διατριβής (PHD803).

β) Εάν τυχόν δεν ολοκληρώσετε επιτυχώς το μάθημα PHD801 μέχρι το τέλους του Φθινοπωρινού Εξαμήνου 20…, το Πανεπιστήμιο θα προχωρήσει στην καταχώρηση βαθμολογίας F. Θα μπορείτε να επανεγγραφείτε στον ίδιο κωδικό μαθήματος το επόμενο εξάμηνο με επιπρόσθετο κόστος 1.500 ευρώ. Στη συνέχεια θα έχετε ακόμη τρία (3) εξάμηνα για να ολοκληρώσετε τα μαθήματα PHD801, PHD802, PHD803.

Τέλος, σε περίπτωση που τα πιο πάνω δεν μπορούν να εφαρμοστούν, θα σας δοθεί η δυνατότητα, μετά από υποβολή αίτησης στο Τμήμα Εγγραφών και κοινοποίηση στο/την Πρόεδρο του Τμήματος ……., να επιλέξετε να μετεγγραφείτε από το διδακτορικό στο οποίο φοιτάτε σε ένα μεταπτυχιακό του Ευρωπαϊκού Πανεπιστημίου Κύπρου με αντιστοίχιση μαθημάτων που έχετε ήδη παρακολουθήσει και παρακολούθηση των μαθημάτων που υπολείπονται.

Βασική επιδίωξη του Πανεπιστημίου είναι η στήριξη των φοιτητών και φοιτητριών μας με απώτερο σκοπό την ακαδημαϊκή τους πρόοδο και επιτυχή αποπεράτωση των σπουδών τους.

Τόσο εγώ, όσο και η επόπτριά σας, ο συντονιστής του διδακτορικού προγράμματος και ο/η Πρόεδρος του Τμήματος ….. παραμένουμε στη διάθεσή σας για οτιδήποτε περαιτέρω.

Χρίστος Τσιάππας

Διευθυντής Τμήματος Εγγραφών

European University Cyprus

INTERNAL REGULATION ON

RESEARCH POLICY

54th Senate Decision: 21 December 2017
60th Senate Decision: 2 October 2018
70th Senate Decision: 13 December 2019

Table of Contents

Introduction

Within the framework of further contribution to the research community, the mission of the European University Cyprus (from now on referred to as the University or EUC) is to develop a pioneering and innovative research infrastructure with the objective of generating new knowledge. The university focuses on both fundamental and applied research and wherever possible the commercial application or exploitation of the research results.

The policy is guided by the following broad objectives:

1) The establishment of an interdisciplinary approach for researchers with attractive conditions for accessible movement among institutions, disciplines, sectors and countries, without financial and administrative obstacles.

2) The creation of state of the art research infrastructures, including research centres, foundations, units and/or laboratories, which are integrated and networked and accessible to research teams from across the EUC.

3) Introduction of a simple and harmonized regime for intellectual property rights in order to enhance the efficiency of knowledge transfer, in particular between public research and industry.

4) Optimization of research programs and priorities, for example by developing joint principles for the administration of European, national and regional funding programs.

5) The strengthening of international cooperation enabling faculty and other scholars in the world to participate in various research areas, with special emphasis on developing multilateral initiatives to address global challenges.

6) The transfer of research-based knowledge to EUC students

Research is conducted by faculty members, research associates/research personnel and PhD students either on their own or within the framework of external (national, European, international) and internal funding programs that are launched by the University.

The Research Policy provides a code of conduct for research and is intended for all staff, including people with honorary positions, faculty members, special teaching personnel, scientific collaborators, special scientists, research associates, and students carrying out research at or on behalf of the University.

All groups mentioned above must familiarize themselves with the Research Policy to ensure that its provisions are observed.

1. EUC Research Ethics Policy

1.1 Scope and Purpose

1. The aim of the EUC Research Ethics policy is to promote and encourage a high quality research and enterprise culture, with the highest possible standards of integrity and practice. The policy applies to all academic, contract research and administrative staff, all research students, as well as undergraduate and masters students who are undertaking research. In short, the policy applies to all disciplines and research activities within the University, or sub-contracted on its behalf.

2. All staff and students are expected to act ethically when engaged in University business. Any research involving animals, human participants, human tissue or the collection of data on individuals requires ethical consideration. While particular attention must be paid to the interests of potentially vulnerable groups, such as children, the University recognises that it has a duty of care towards all members of the wider community affected by its activities. The University also recognises that it has a duty of care to its own staff, and that this includes the avoidance of harm to those undertaking research.

3. The University will establish a framework for research ethics governance in which its Research Ethics Committee will have a central approval, monitoring and training role. The University will establish a Research Ethics Committee with representatives from all the Schools. The Research Ethics Committee will put in place the procedures needed to obtain approval.

   It is, however, recognised that it may not always be appropriate or practicable for ethical approval to be sought from the Research Ethics Committee especially when it comes to short or undergraduate projects. Normally undergraduate or taught projects will not require clearance from the Research Ethics Committee and the matter can be dealt with at School and/or Department level. However, when active intervention is involved whether physically invasive or psychologically intrusive the Research Ethics Committee will need to be consulted. In particular, university staff has an obligation to ensure that not only their own research but any undergraduate or masters student research conducted under their supervision is ethically sound. Where research projects are subject to external approval, the School or Department responsible must ensure that this approval is sought and given. Where approval for a project has been given by a Research Ethics Committee at another university, as may be the case with a collaborative project, the EUC Research Ethics Committee must be provided with proof of this.

4. For some research projects it may be necessary to obtain the approval of the Cyprus National Bioethics Committee. Researchers should consult directly with the Cyprus National Bioethics Committee. Contact details and more information on the approval process can be found on http://www.bioethics.gov.cy .

1.2 General Principles

1. The EUC Research Ethics Policy is based on widely accepted principles and practices governing research involving human participants. The key elements are:
   - Minimal risk of harm to participants and researchers;
   - Potential for benefit to the society;
   - Maintenance of the dignity of participants:
   - Minimal risk of harm to the environment;
   - Voluntary informed consent by participants, or special safeguards where this is not possible;
   - Transparency in declaring funding sources;
   - Confidentiality of information supplied by research participants and anonymity of respondents;
   - Acknowledgement of assistance;
   - Appropriate publication and dissemination of research results;
   - Independence and impartiality of researchers.

1.3 The Definition of Human-Related Research

1. All human-related research which includes one or more of the following require ethical assessment and approval at the appropriate level:
   - Direct involvement through physically invasive procedures, such as the taking of blood samples
   - Direct involvement through non-invasive procedures, such as laboratory-based experiments, interviews, questionnaires, surveys, observation
   - Indirect involvement through access to personal information and/or tissue
   - Involvement requiring consent on behalf of others, such as by parents for a child participant

1.4 Vulnerable Participants

1. Some participants may be particularly vulnerable to harm and may require special safeguards for their welfare. In general, it may be inappropriate for undergraduates to undertake research projects involving such participants.
2. Particularly vulnerable participants might be:
   - Infants and children under the age of eighteen

- People with physiological and/or psychological impairments and/or learning difficulties.
- People in poverty
- Relatives of sick, or recently–deceased, people

1.5 The Legal Framework, the Role of Professional Associations and Research Councils

1. All research undertaken under the auspices of EUC must meet statutory requirements. Of particular relevance is the Bioethics Law (N.150 (I)/2001 and 53 (I)/2010), the Data Protection Law (2001), the Patients Protection Law (2005), and all those laws that create the legal framework for the Cyprus National Bioethics Committee.
2. Researchers in particular disciplines should comply with any research ethics guidelines set out by their professional associations.
3. Research Councils, charitable trusts and other research funding bodies in most cases require an undertaking from grant applicants that research proposals involving human participants have been approved by the University Research Ethics Committee or another appropriate body. Some also require audited compliance with their guidelines.

2. Good Research Practices / Code of Ethical Conduct in Research

2.1 Code of ethical conduct in research
Scholarly inquiry and the dissemination of knowledge are central functions of the University. They can be carried out only if faculty and research personnel abide by certain rules of conduct and accept responsibilities stemming from their research. And they can only be carried out if faculty and research personnel are guaranteed certain freedoms. The University expects that faculty and research personnel will be bound by the following research practices:

All faculty and research personnel are free to choose any research matter, to receive support from any legitimate source, and to create, analyse and derive their own findings and conclusions.

Research methods, techniques, and practices should not violate any established professional ethics, or infringe on health, safety, privacy and other personal rights of human beings and/or animals.

The above principles define the university's role with respect to research carried out on its premises. They are set forth to reinforce, and not diminish each faculty and research personnel's personal responsibilities toward their research, and to assure that each faculty and research personnel's source of funding and research applications are consistent with moral and societal conscience.

2.2 Openness in research

The University recognizes and supports the need for faculty and research personnel to protect their own rights, be they academic or intellectual property rights. Even so, the University encourages all faculty and research personnel to be as open as possible when discussing their research with other researchers and the public. This aims at the dissemination of research performed in the University to enhance the international research community's knowledge and understanding.

2.3 Integrity

Faculty and research personnel must be honest about their research and in their review of research coming from other researchers. This applies to all types of research work, including, but not limited to, analysing data, applying for funding, and publishing findings. The contributions of all involved parties should be acknowledged in all published forms of findings.

Faculty and research personnel are liable to the society, their professions, the University, their students and any funding agency that may fund their research. For this reason, faculty and research personnel are expected to understand that any form of plagiarism, deception, fabrication or falsification of research results are regarded as grave disciplinary offences managed by procedures described in detail in Section 2.4.

Any real or potential conflict of interest should be reported by faculty and research personnel to any affected party in a timely manner in all matters concerning research and peer review. According to the United States National Institute of Health "Conflict of interest occurs when individuals involved with the conduct, reporting, oversight, or review of research also have financial or other interests, from which they can benefit, depending on the results of the research." (http://www.nih.gov).

2.4 Misconduct in research

Misconduct in research may involve Fabrication, Falsification, or Plagiarism in proposing, performing, or reviewing research, or in reporting research results. To prove that there has been misconduct in research, the following conditions must be met: The performance of said research has significantly deviated from accepted practices used in the field that the research was performed, and there was intention in the misconduct by the researcher(s).

Any allegations about misconduct in research will be investigated by the University thoroughly, through a special committee formed as described in the University Charter, Annex 11, Article VII.

3. Intellectual Property Policy

3.1 Introduction

The EUC is dedicated to teaching, research, and the extension of knowledge to the public. Faculty, research personnel, and students at the University, hereafter referred to as "University Employees," recognize as two of their major objectives the production of new knowledge and the dissemination of both old and new knowledge. Because of these objectives, the need is created to encourage the production of creative and scholarly works and to develop new and useful materials, devices, processes, and other inventions, some of which may have potential for commercialization.

The University acknowledges the need for an Intellectual Property Rights (IPR) policy, which will promote the University's reputation as socially relevant, leading research and teaching organisation and will directly contribute to the financial position of the EUC if its commercial value is realised.

The policy is based on the principles that will govern the ownership rights emanating from research of and/or materials produced by the EUC's members of staff and students, and to establish objectively fair and equitable criteria for the transfer of knowledge. The EUC thus aims to provide support services to promote the creation of Intellectual Property (IP) whilst seeking to maximise the commercial exploitation of the resulting IPR.

Intellectual Property includes, but is not limited to, patents, registered designs, registered trademarks and applications and the right to apply for any of the foregoing, copyright, design rights, topography rights, database rights, brands, trademarks, utility model rights, rights in the nature of copyright, knowhow, rights in proprietary and confidential information and any other rights in inventions.

The EUC acknowledges that registration and commercial exploitation of Intellectual Property is often a long and costly process that is justified once it is ascertained that there exists a business case for such registration and exploitation. It is known that in practice, only a small number of works can be commercially exploited in a viable manner, depending on the nature and marketability of the work in question.

3.2 Definitions

For the purposes of this Policy:

Creator - "Creator" shall mean, employees of EUC, a student, non-employees contracted to EUC for contracts and services, or a member of a Visiting Teaching Staff involved in the production of Disclosable Work.

Disclosable Work – "Disclosable Work" shall mean such work that is novel, original, and/or important and is likely to bring impact and enhance the Creator's reputation. This work is characterised by the IP rights it generates.

Intellectual Property Policy – "IP Policy" is the name of the policy described here that outlines the regulations of the EUC in regard to disclosure and exploitation of Intellectual Property Rights (IPR).

Organisation – "Organisation" for the purpose of this document is the European University Cyprus (EUC).

Intellectual Property Adjudication Committee – is the name of the committee established to resolve disputes over interpretation or claims arising out of or relating to this policy, or dispute as to ownership rights of Intellectual Property under this policy.

Office of the Vice Rector for Research and External Affairs – is the office within the EUC responsible for the development of and enacting this IP Policy and is the interface between the EUC and the Technology Transfer Facility.

Technology Transfer Facility – "TTF" for the purpose of this policy, is the relevant body responsible for Technology Transfer support in Cyprus.

3.3 Intellectual Property Regulations

3.3.1 Responsibility

1. The IP Policy acknowledges that all members of staff and students have responsibilities with regard to IPR arising from and/or used by them in the course of their teaching/employment.
2. The IP Policy also recognises that all members of staff and students require support and assistance to help them to meet their responsibilities and this will be provided by the Office of the Vice Rector for Research and External Affairs and, subsequently, by the Technology Transfer Facility.

3.3.2 Identification of IP (including duty of confidentiality)

1. It is expected that identification will take place when employees, students, or members of staff are involved in creating and developing IP. Much of the IP which will be created by the EUC's employees may be anticipated prior to its creation depending on the nature of the project in question and outputs and results that are expected to be generated. Examples of such outputs which are likely to have potential IP rights arising include (but are not limited to):
   • Inventions (whether or not patentable);
   • Methodologies;
   • Software;
   • Databases;
   • Educational/training materials and tools;
   • Modelling tools;
   • Solutions to technical problems; and
   • Design/artistic products.

2. A Summary of the main classes of IPR is listed below:

Patent

A registered patent provides a time-defined (up to 20 years) geographically defined monopoly right to exploit a new commercially valuable invention or process. The basis of the permission to exploit is that the invention's working is disclosed, although patenting is not possible if there has been ANY prior disclosure of the invention. Patents are governed by Cyprus Law or EU Law such as the New Patent Law of Cyprus (Law No. 16(I)/1998).

Copyright

This time-limited right (which varies between 25 and 70 years according to the material) arises automatically on the physical creation (not the idea) of software, original literary, dramatic, artistic or musical work, and in recorded (e.g. film) or published (e.g. layout) derivations. Use of the © mark and owner's name and date is the internationally recognised way of alerting the public to the copyright ownership but the protection (the right to preventing unauthorised copying) exists regardless. Copyright is governed by the Copyright Law, 59/76.

Copyright may be assigned to a third party, but until that point or until a licence is agreed it remains the property of the Creator, unless s/he creates the work 'in the course of his/her employment', in which case it is the property of the employer.

Moral rights

All European countries recognise an author's moral rights. In Cyprus, there are two moral rights: the right of paternity and the right of integrity. These rights relate to the reputation or standing of the creator in the eyes of fellow human beings. To infringe a moral right involves denigrating or harming the author's reputation. The right of integrity means the creator has the right to object to derogatory treatment of his/her work. Basically, this means changing it in a way that affects the nature of the work without permission. Moral rights can be waived (i.e. the author chooses not to exercise the rights) or they can be bequeathed. They cannot be assigned.

Performing rights

Creators of copyright works have the right to protect the physical form in which those works are created – words on the page, pigment on a canvas, or the clay or metal of a sculpture. Performers such as teachers, actors, musicians and dancers also enjoy protection of their performance, especially when recorded on film, video, tape, CD, or in other form.

Performing rights may affect the multimedia elements of online courseware, as well as the Creator's copyright in the material itself.

<u>Database Right</u>

This time-limited (15 years) right arises without registration to protect the compilers of non-original information from losing the benefit of their work through unauthorised copying or re-use.

<u>Industrial Designs</u>

There is automatic time-limited (15 years) protection (the right to prevent unauthorised copying) for unregistered designs, provided authorship can be proved, under the Legal Protection of Industrial Designs and Models Law 4(I)/2002 This design right covers "the appearance of the whole or a part of a product resulting from the features of, in particular, the lines, contours, colours, shape, texture and/or materials of the product itself and/or its ornamentation" on condition of novelty of the design.

On registration under Legal Protection of Industrial Designs and Models Law, the designer of the new pattern or shape which has aesthetic appeal (can be 2 or 3 dimensional) acquires a monopoly right of commercialisation for a maximum of 25 years from the filing of the application, divided into 5 periods of 5 years.

An unregistered community design (UCD) gives its owner the right to prevent unauthorised copying of their design throughout the European Union. It is not a monopoly right and lasts for 3 years from the date on which the design was first made available to the public within the Community.

<u>Domain Names</u>

Registering a domain name for Internet use gives a right to use the domain name typically for a period of two years, registered with bodies like ICANN internationally and the University of Cyprus in Cyprus. Owners of trademarks can have established rights to domain names.

<u>Trade Marks</u>

Registering a trade mark under the Cyprus Trade Marks Law, Chapter 268, gives a monopoly right for the use of graphically distinct trading identification signs. Unregistered trade marks have some protection through court actions against "passing off" (piracy), provided that their use has not lapsed for a period of 5 years. Cyprus legislation is fully harmonised with EU Standards applicable in trade mark protection.

3. EUC's members of staff and students undertake to keep confidential and not disclose any confidential information, data, materials, knowhow, trade secrets or any other IP, to any unauthorised third party and shall also undertake to keep such information secure and strictly confidential both during the course of research activity, be it of an Academic or Collaborative/Contract nature, and also on and following completion thereof.

4. Any breach of this confidentiality and non-disclosure obligation constitutes a serious breach and may lead to disciplinary action and does not prejudice the rights of the EUC to file any action for damages or any other rights available at law.

3.3.3 Coverage of the Regulations

1. Whom does this IP Policy apply to?
   - Employees:
     By persons employed by the EUC in the course of their employment.
   - Students:
     By student members in the course of or incidentally to their studies at EUC.
   - Non-employees contracted to the EUC:
     By persons engaged by EUC under contracts for services during the course of or incidentally to that engagement.

2. Sabbatical, Seconded, Visiting Academics and others:

   By other persons engaged in study or research in the University who, as a condition of their being granted access to the EUC's premises or facilities, have agreed in writing that this Part shall apply to them.

3. Participation of the EUC members of staff/employees and or students in Collaborative and/or Contracted Research.

   The preparation and negotiation of any IP agreements or contracts involving the allocation of rights in and to IP will be undertaken by a competent person authorised for this purpose by the EUC.

   Issues that will be addressed in such agreements include, but will not always be limited to:
   - ownership of Foreground IP;
   - licences to Foreground IP for uses outside the project;
   - ownership of Background IP;
   - licences to use Background IP in the project or activity in question and in relation to the use of the Foreground IP arising from such project or activity;
   - allocation of rights to use or commercialise IP arising from any such project or activity and the sharing of revenues; and
   - publications arising from the relevant project or activity and the rights arising from such projects or activities.

   The terms of such agreements may be subject to negotiation.

3.3.4 Exceptions to the Regulations

1. Unless specifically commissioned, typically the EUC will NOT claim ownership of copyright in certain types of Disclosable Work described in this policy as "Creator Copyright Works":
   - artistic works;
   - text and artwork for publication in books;
   - articles written for publication in journals;
   - papers to be presented at conferences;
   - theses and dissertations;
   - oral presentations at conferences;
   - posters for presentation at conferences; and
   - musical scores.

2. Where IP has been generated under the exception clause of this regulation, the EUC may assign the copyright to the Creator.
3. Students – undergraduate and/or postgraduate.

3.3.5 Disclosure of IP

1. All persons bound by these Regulations are required to make reasonably prompt written disclosure to the EUC's Office of the Vice Rector for Research and External Affairs at the outset of the work or as soon as they become aware of it (by completion of the Invention Disclosure Form, the information required for which is provided in Appendix B):
   - any IP of potential commercial value arising from their work;
   - the ownership by a third party of any IP referred to or used for their work;
   - any use to be made of existing EUC IP during their work;
   - any IP which they themselves own which is proposed to be used by the EUC.
2. Creators shall keep all Disclosable Work confidential and avoid disclosing this prematurely and without consent;
3. Only disclose any Disclosable Work and the IP relating to it in accordance with the EUC's policy and instructions;
4. Seek EUC's consent to any publication of information relating to any Disclosable Work;
5. Creators must NOT:
   i. apply for patents or other protection in relation to the Disclosable Work; and
   ii. use any Disclosable Work for their own personal and/or business purposes and/or on their own account.

3.3.6　Ownership of IP

1. Ownership of IP created by an individual who is an employee is generally determined by considering:
   - Who created the IP?
   - Was the IP created in the course of the Creator's employment?
   - Are there any contractual conditions that affect ownership?
2. Assignment of ownership rights

   Generally, the Creator of IP is its legal owner. From the EUC's point of view, the most important exception to this is the general rule that IP is owned by a person's employer where the IP is created as part of, or through the auspices of, the person's employment.
3. The EUC claims ownership of all the Intellectual Property specified in section 2.2, which is devised, made or created by those specified in section 3 and under the exceptions to the regulations in Section 4. It also includes but is not limited to the following:
   i. Any work generated by computer hardware/software owned/operated by the EUC.
   ii. Any work generated that is patentable or non-patentable.
   iii. Any work generated with the aid of the EUC's resources and facilities including but not limited to films, videos, field and laboratory notebooks, multimedia works, photographs, typographic arrangements.
   iv. Any work that is registered and any unregistered designs, plant varieties and topographies.
   v. Any University commissioned work generated. Commissioned work is defined as work which the EUC has specifically employed or requested the person concerned to produce, whether in return of special payment or not and whether solely for the University or as part of a consortium.
   vi. Know-how and information related to the above
   vii. Any work generated as a result of the teaching process including but not limited to teaching materials, methodologies and course outlines.
   viii. Material produced for the purposes of the design, content and delivery of an EUC course or other teaching on behalf of the school, whether used at the school's premises or used in relation to a distance learning and/or e-learning project. This type of material includes slides, examination papers, questions, case studies, and assignments ("course materials").
   ix. Material for projects specifically commissioned by the EUC
   x. All administrative materials and official EUC documents, e.g. software, finance records, administration reports, results and data.

3.3.7　Modus Operandi for Commercial Exploitation of the IPR

1. The EUC is entitled to commercially exploit any result obtained under its aegis (unless this entitlement is relinquished). The Office of the Vice Rector for Research and External Affairs has the responsibility for administration of Disclosures and will work with the TTF of Cyprus, which has responsibility for

commercialisation of Disclosures. As guidance to the commercialisation process, the EUC/TTF will follow a standard process, graphically presented in Appendix A.

2. The Creator/s shall notify the Office of the Vice Rector for Research and External Affairs of all IP which might be commercially exploitable and of any associated materials, including research results, as early as possible in the research project. This notification shall be effected by means of an Invention Disclosure Form (contents as noted in Appendix B). In case of doubt as to whether research is commercially exploitable or otherwise, the Creator/s undertake/s to seek the advice of Cyprus Central TTF.

3. The Office of the Vice Rector for Research and External Affairs shall immediately acknowledge receipt of the Disclosure Form. In consultation with the TTF and the Creator/s, shall decide whether the EUC and the TTF has an interest to protect and exploit the relevant IPR.

4. The TTF shall communicate the decision in writing to the Office of the Vice Rector and the Creator/s by not later than three months from the date of receipt of the Invention Disclosure Form. If the EUC and TTF decide to protect and exploit the IPR, it is understood that:

- the Creator/s shall collaborate with the EUC and the TTF, to develop an action plan for the protection and commercial exploitation of the IP;
- the TTF in collaboration with the Creator/s shall ensure that third party rights are not infringed in any way through the process; and
- the EUC/TTF shall seek to protect the right of the Creator/s to use the said IP for strictly non-commercial purposes.

5. Should the EUC and TTF decide that there is no interest in protecting and exploiting the relevant IPR, or should it fail to inform the Creator/s about its decision within the stipulated time, the EUC may assign all its rights, title and interest in such IP to the Creator/s concerned, whilst the EUC retains the right to use the said IP in whichever manifestation for strictly non-commercial purposes.

6. The Creator/s SHALL NOT enter into any sponsorships or commercial agreements with
third parties related to their research at EUC without prior written authorisation by the Office of the Vice Rector for Research and External Affairs. This said, it is understood that consent shall generally be granted to Creator/s for such requests as long as the IPRs of the EUC are safeguarded; otherwise the claims on IPR expected by the third party must be agreed upon explicitly upfront.

3.3.8 IPR protection

1. Some forms of IP require active steps to be taken to obtain protection (e.g.: patents, registered trademarks and registered designs). Other forms of IP rights are protected on creation (e.g. Copyright, EU Database Rights) but still require appropriate management in order to maximise the protection available. Best practices in patent protection require that all materials made publicly available by any employees, members of staff and/or students should include a copyright notice.

2. Any decisions relating to the registration of any IP rights such as making an application for a patent or a registered trade mark or a registered design (including any decisions to continue or discontinue any such application) should be made in consultation with the Office of the Vice Rector for Research and External Affairs and the TTF. The IP registration process can be very expensive and IP protection costs should not be incurred without appropriate consideration of how such costs will be recovered.

3.3.9 Revenue Sharing Mechanism

The EUC's employees and students can benefit from the Revenue Sharing Scheme if their work generates income for the EUC. The scheme is presented in Appendix C. Note that such revenue to be shared is typically calculated after deduction of all costs incurred by the EUC and TTF in developing, protecting, exploiting, and marketing the Disclosable Work and the Intellectual Property it contains.

3.3.10 Leaving the EUC

Cessation of employment, under normal circumstances, will not affect an individual's right to receive a share of revenue. Exceptions to this rule include: cessation of employment due to disciplinary actions.

3.3.11 Applications to use the EUC's IP

1. The EUC may be willing to consider requests from its staff and/or students for a licence to use specific IP, owned by EUC for their use although the terms and decision to grant any such licences is a decision wholly made by the EUC.
2. Applications for such licence should be made in writing to the Office of the Vice Rector for Research and External Affairs.

3.3.12 Breach of the Regulations

1. Breach of the regulations listed in this Policy may be a disciplinary matter for the EUC's staff and students under the normal procedures.
2. The EUC shall consider all avenues available to it, including legal action if necessary, in respect to persons bound by these regulations who acted in breach of them.

3.3.13 Discretion to assign/licence back

1. If the EUC does not wish to pursue the commercialisation of any Intellectual Property or does not wish to maintain an interest in the IPR, it has the right to assign such IPR rights to the Creator/s of the IPR by entering into an agreement to enable the IP to be used by the Creators. This will generally only be granted where there is clear evidence that the IP provides no other benefit to the EUC and is not related to other IP, which the EUC has an interest in.
    However, the EUC shall not assign its IP if they consider that the commercialisation of the IP could potentially bring harm to the name of the EUC. Decisions regarding potential harm will be taken by the Research Ethics Committee of EUC.

2. Requests for any transfer of rights from the EUC to another party with rights should be made in the first instance to the Vice Rector for Research and External Affairs.

3.3.14 Amendments to the Regulations

These Regulations may be amended by the Senate of the EUC on the recommendation of the Vice Rector for Research and External Affairs.

3.3.15 Death

In the event of a researcher's death, the entitlement shall continue for the benefit of his or her estate.

3.3.16 Disputes

1. Any question of interpretation or claim arising out of or relating to this policy, or dispute as to ownership rights of intellectual property under this policy, will be settled by submitting to the EUC's Intellectual Property Adjudication Committee a letter setting forth the grievance or issue to be resolved. The committee will review the matter and then advise the parties of its decision within 60 days of submission of the letter.
2. The Intellectual Property Adjudication Committee will consist of a chair who is a member of the tenured faculty, at the rank of either a Professor or an Associate Professor, one member of the faculty from each School, at the rank of either Assistant Professor or Associate Professor or Professor, an individual from the EUC with knowledge of Intellectual Property and experience in commercialisation of Intellectual Property, and two other members representing, respectively, the EUC administration, and the student body. The chair will be appointed by the Vice Rector for Research and External Affairs, with the advice and consent of the Senate Research Committee, and the remaining members of the committee will be appointed: the faculty members, each by their School's Council, the administration representative by the University Council or its designee, and the student representative by the Student Union.
The committee will use the guidelines set forth in this policy to decide upon a fair resolution of any dispute.
3. Any disputes regarding the revenue distribution from the exploitation of Disclosable Works will be dealt with in accordance with the EUC's normal member of staff or student dispute procedures as outlined in the contractual terms of conditions.
4. The Parties shall attempt to settle any claim, dispute or controversy arising in connection with this Policy, including without limitation any controversy regarding the interpretation of this Policy, through consultation and negotiation in good faith and spirit of mutual cooperation. Where such claims or disputes cannot be settled amicably, they may be taken to court.
5. This Agreement shall be governed by, and construed in accordance with the laws of Cyprus.

4. Offices, Committees and Centres for Research

4.1 Vice Rector for Research and External Affairs

The Vice Rector for Research and External Affairs (from now on referred to as the Vice Rector) is the person responsible for representing the University on research matters and enhancing activities related to research within the University. Moreover the Vice Rector facilitates and supports, when asked by faculty or research members, all research activities, including the implementation of research projects, the organization of scientific conferences and the establishment of research units/labs. In addition, the Vice Rector is responsible for the smooth implementation of the University's Research Policy.

4.2 Senate Research Committee

The administration of the research activity is facilitated by the Senate Research Committee of the University. The Committee composition is prescribed in the University Charter and the Committee is accountable to the Senate of the University.

4.3 Research Foundations and Centres

Research is carried out in university departments, research foundations, and centres. The Senate suggests to the University Council the formation of new foundations and research centres or the discontinuation of existing ones, if necessary.

The University Council approves the establishment of these foundations and research centres. Separate regulations are issued for the establishment of University research centres. Detailed description of the mission, area of specialization, and operation of each foundation or research centre is given in a separate document.

4.4 Research Office

Detailed description of the mission, area of specialization, and operation of the Research Office is given in a separate document.

5. Rules Governing External Research Programmes

5.1 Suggested procedure for submitting and implementing a funded research project

The following rules apply for externally funded research projects:

5.1.1 Submission of research proposals:

Faculty and research personnel that are interested in submitting a proposal or participate in a proposal for ANY kind of externally funded research project

(commercial, consultancy, RPF, European etc) should consult and get the approval of the EUC Research Office. The formal procedures developed by the Research Office pertaining to the development of a research proposal and to participation in a research project should be followed in all cases. Given that in all research and consulting application forms a budget also needs to be prepared, the budget will be developed in collaboration with the EUC Research Office, sharing their expertise with the faculty and research personnel and advising them accordingly about the cost models and cost categories used in each case. This procedure should make sure that the proposal satisfies all the necessary criteria of the particular research call.

The final approval for financial and administrative issues of proposals or projects will be signed by the legal representative of EUC.

5.1.2 Project implementation

The formal procedures developed by the Research Office pertaining to the administration of a research project should be followed in all cases.

In the case where a project is awarded, a copy of the contract and all the original receipts, invoices, contracts and other accounting documents regarding expenses of the project will be maintained by the EUC Research Office without any additional remuneration or personnel costs added to the budget of a project. The researcher/s involved in an externally funded project are responsible for submitting all receipts, invoices, contracts and other accounting documents relevant to their project to this department. No payment will be processed before the submission of the aforementioned documents to the Research Office.

Timesheets should be kept for all projects. These will be used as the basis for calculating the money to be paid to researchers for all types of projects. The EUC Research Office will assist researchers to calculate the hourly and daily rate for each staff member.

The researcher must also inform the Chief Financial Officer of the University, through the EUC Research Office, in order to create a separate ledger (account) in the University's Accounts Department. After completion of the project, the Accounts Department will keep the file on record for 5 years or more if needed by the contractual agreement.

The EUC Research Office should keep a file with all the details concerning the project. The file must be made available to the Senate Research Committee upon request.

5.1.3 Financial issues concerning externally funded research projects

All incoming funds for the execution of a project are deposited in a separate account (ledger) of the University and all necessary expenses with their receipts relating to the project are paid/signed by the Vice Rector for Research and External Affairs, the CFO and the CEO of the University.

The time spent by faculty and research personnel on national, European or international research projects is, with rare exceptions, an eligible cost for inclusion in a project budget at a level which reflects the time to be spent by faculty and research personnel on the project and the employer's cost. These are real project costs and their inclusion in project budgets is strongly required.

Salary payments to faculty and research personnel will be paid out regularly by the Accounts department upon the project coordinator's request to the Research Office and provided that the allocated amount for the previous period has been received from the funding agency and all reporting requirements for the previous period to the funding agency have been met.

In cases of delay in receiving the predetermined instalment, the University will grant to the researcher the required funds (not his/her compensation/remuneration but costs such as equipment, consumables, traveling) to initiate the research, provided that a copy of the contract and all necessary documentation had been submitted to the Research Office.

Employment of additional temporary staff, budgeted for completion of the research project, will be the responsibility of the project coordinator. The remuneration for temporary staff will depend on the corresponding budget of the project and the possible allocation of funds for this purpose.

Subcontracting activities within the framework of a research project will be the responsibility of the project coordinator. These activities should be in alignment with the corresponding budget of the project, the grant rules, and the EUC subcontracting policy.

In the case where a faculty or research personnel fails to complete a research project due to failure to meet his/her contractual obligations, or if it is clear that there was an intention of misconduct and there are financial damages laid upon the University relating to this event, the faculty or research personnel is liable to pay these damages. This will not be applied in cases such as health problem, etc, where there is clearly not an intention of misconduct.

5.1.4 University research fund

All funds allocated for research from externally-funded research projects, the University as well as funds offered for research purposes from third parties will be deposited in the University Research Fund. Recommendations for the allocation of funds are made by the Senate Research Committee and are subject

to the final approval of the Management of the University. These funds can be used to finance such activities as:

(a)   Participation of academic researchers in conferences, seminars, and meetings to co-ordinate activities, which are needed for submission of external programmes.

(b)   The administration costs associated with providing support services to academic researchers.

(c)   Organisation of training seminars for the faculty and research personnel of the University; these seminars shall be organized if and only will help/assist and/or facilitate researchers to enhance and further develop their knowledge in subjects related to their research fields and help them design and implement research projects.

(d)   Purchase of software, hardware and equipment that are needed by faculty and research personnel for research projects.

(e)   The funding for the University's Internal Research Awards such as PhD scholarships

(f)   Development of Infrastructure related to the research activity of the University.

(g)   Funding of the activities of the Research Office of the University.

6.   Rules Governing Internal Research Awards

The University's "Internal Research Awards" (IRA) are launched on an annual basis by the Senate Research Committee, are announced by the Vice Rector for Research & External Affairs and financed by the University Research Fund and external sponsors as described in Section 5.1.4 above.

6.1   Purpose
IRAs are awarded to EUC faculty in order to pursue research and other creative work. IRAs provide support for exploratory research projects which might result in proposals submitted for external funding or in creative work that is likely to enhance the recognition of the faculty and research personnel and the University at large. IRAs may be used for funding travel, equipment, supplies, PhD student assistants' scholarships, student assistants, research assistants and other expenses. Funding for this programme comes from the University Research Fund.

6.2   Eligibility for the awards
All full-time faculty members of the University who have the rank of Assistant Professor or higher are eligible to apply for the awards. Specific eligibility criteria may apply for each type of award.

6.3 Application Procedure

The Vice Rector for Research and External Affairs initiates the selection process by issuing a call for proposals. The deadline for the submission of proposals will be announced. Application materials will be available from the office of the Vice Rector for Research and External Affairs and the proposals will be submitted electronically to the office of the Vice Rector.

7. Teaching Hours Reduction for Research Purposes

The University rewards members of staff who excel in research by awarding them Teaching Hours Reduction (THR). A THR may be awarded if the member of staff fulfils the conditions in one or more of the three schemes outlined below.

A member of staff may be awarded a THR under more than one of the schemes described below if he/she is eligible. The minimum teaching per semester can be reduced down to 6 hours per week based on the accumulated research load reduction hours. An exemption may be considered for Deans and Chairs.

All allocations of THR under the three schemes outlined below will be made after a recommendation of an ad-hoc committee chaired by the Vice Rector for Research and External Affairs. The committee will take into account scheduling constraints and other considerations for the sustainable development of research activity at the university. The committee will meet at an appropriate time in each semester in order to make the THR allocations in time for the preparation of the schedule of classes for the next semester.

7.1 Award of a THR for participation in research projects

Members of staff are eligible to apply for a Teaching Hours Reduction (THR) when conducting funded research for the full duration and until the completion of relevant funded projects. Should their application meets with success, funded project coordinators are entitled to a three-hour teaching reduction per semester for the whole duration of the project, whereas research partners are eligible for a THR equivalent to at least one third of the duration of the project.

Based on the policy of the University with regard to THR requests, Faculty, research and Other Teaching Personnel (OTP) members are expected to submit a written request to the Chairperson of his/her Department before the beginning of the academic year/semester. The Chairperson will process the THR request by way of making a relevant recommendation to the Dean of School. The Dean will then forward his/her recommendation to the Vice Rector for final approval. After the deadline expires, applications for teaching hours reduction will not be accepted.

The deadlines for submitting a request for teaching load reduction per semester are the following:

For the Fall Semester: 1st of May
For the Spring Semester: 31st of October

If a research proposal was awarded a grant after the special case of approval of a research/grant proposal (i.e. RPF, EU etc) while an academic year is in progress, a THR request should be submitted and be approved prior to the beginning of the next semester, during which the teaching load reduction will be applied. The research project should commence at least one month before the beginning of the next semester for the THR to be awarded.

7.2 Award of a THR for writing a book

A three-hour teaching reduction per semester will be awarded for the purpose of writing a book upon submission of a publishing contract by a reputable publisher. A total of two THR allocations (maximum 6 credits) will be made under the scheme for each book contract. The same deadlines and application procedure apply as in the scheme described in section 7.1.

7.3 Award of a THR by accumulation of points

A third scheme for the award of a THR takes into account the research activity of members of staff and the points they have accumulated according to the tables given in Appendix D. A THR of 3 hours per week is awarded to faculty members once they accumulate 100 (one hundred) points and the same number of points are automatically deducted from his/her accumulated total. Points accumulated over time but not utilized by a member of staff will simply remain at his/her disposal.

Note that members of staff may consider the year 2016 as the starting point for calculating points accumulated through research. The calculation of points will be valid after it has been approved by the Dean of the School and the Vice Rector for Research and External Affairs.

New faculty members can also get THRs under this scheme from the first semester of their employment. The points accumulated from their publications in the five (5) years prior to their appointment will be taken into account.

8. Equipment Acquired through Internal and External Funding

8.1 Equipment acquired through University funds

All equipment that has been acquired through funds that come directly through the university's funds (internal research grants, university research funds) will belong solely to the University and will be used by the faculty and research personnel's affiliated department or lab, according to the affiliation used by said faculty and research personnel in the funded research proposal and/or project. The faculty and research member is entitled to use the equipment throughout the duration of the funded project and this remains within the research unit/laboratory once the project

is completed, or within the faculty member's department, under his/her direct supervision if s/he does not belong to a unit / lab. Any required maintenance of the equipment should be undertaken by the University.

8.2 Equipment purchased through external funding

Equipment (software and hardware) is often provided in full or partly in the budget of proposals for external funding to enable the faculty and research member to carry out research effectively. This kind of equipment (computers, projectors, software programmes, fax and printing machines, etc.) is the property of the University but remains in the faculty or research personnel's research unit/laboratory or when this is not applicable in his/her department, under his/her supervision. The faculty member is entitled to use the equipment throughout the duration of the externally funded project. When faculty or research personnel who have had externally funded research projects leave the University, the status of any equipment purchased remains a property of the unit/lab or department that the faculty or research personnel belonged.

Any required maintenance of the equipment should again be undertaken by the University.

In the unlikely event that a faculty or research personnel obtains equipment via external funding that is not processed through the University's budget, the status of the equipment should be negotiated with the Vice Rector to determine ownership and responsibility for repair and replacement. Faculty or research personnel are encouraged to seek outside funding to upgrade, or replace their research equipment.

The Research Office is committed to working with faculty or research personnel to develop proposals for research and teaching equipment. Equipment grants usually require an institutional match, and faculty or research members are advised to consult with the Research Office and the Director of MIS early in the process about this matter. The MIS should be able to help faculty or research personnel to identify the best hardware and software products and estimate costs for proposal budgets.

8.3 Provision of computing equipment by MIS

The MIS department supplies desktop office computers, computer teaching labs, copy and printing machines and other types of equipment needed for research (software and hardware). The Director of the MIS department is responsible for keeping the University's inventory records and adjust these in the case of equipment purchases or wearing out of equipment (being fully depreciated).

9. Policy on Research Staff

9.1   Introduction

Academic Research Staff are EUC contract employees hired to work on EUC research activities as defined below. As EUC employees, Academic Research Staff are subject to all policies and procedures related to EUC employment, and receive all benefits implied by the employment law.

9.2   Definitions of Roles

The following positions for research staff are being described in the following sections:

- Research Associate
- Research Fellow
- Senior Research Fellow
- Honorary Research Staff

9.2.1 Job Description for the Position of Research Associate

9.2.1.1 Overall Role

For researchers who are educated to first degree level (and Master's degree) and who possess sufficient breadth or depth of knowledge in the discipline of research methods and techniques to work within their own area. Role holders who gain their doctorate during the course of employment will normally be recommended for promotion to Research Fellow, if this is appropriate for the duties and responsibilities of the post.

As a team member of the Research Laboratory/Programme the Research Associate will contribute quality research outputs and conceptual support to projects. With the guidance of the supervisor/programme leader, and within the bounds of the Research Laboratory/Programme mandate, the Research Associate will:

9.2.1.2 Key Responsibilities

• Conceptualize and conduct short-term experiments and research activities in support of broadbased/longitudinal research projects, ensuring consistency with established methodological approaches and models, adherence to project timelines, and completeness of documentation;
• Conduct studies of related literature and research to support the design and implementation of projects and development of reports, ensuring conceptual relevance, comprehensiveness, and currency of information;

• Write and publish articles in peer-reviewed journals that highlight findings from research and experimental activities ensuring consistency with the highest standards of academic publication and showcasing the Centre's/Programme's scientific leadership;

• Communicate to Programme/Project team developments/progress and results of research activities ensuring that relevant information and issues in the implementation of projects/experiments are captured in as comprehensive and timely manner as possible;

• Develop collaborative links with core scientific personnel in related programme areas to gain exposure to, and build knowledge on experimental/research activities and approaches, in order to subsequently improve conceptual development and implementation of existing programmes;

• Utilize appropriate and current techniques/protocols in experimental laboratory management to ensure integrity and security of experimental process, comprehensive documentation, and replicability of experimental procedures;

• Design and organize databases along project frameworks and experimental research design that support overall research management, including the monitoring and evaluation of project inputs, actions, and outcomes, as well as the subsequent integration of these databases to other databanks;

• Identify areas of improvement within the research structure using integrated management approaches in pursuit of capacity building/strengthening and the preservation of scientific rigor in research studies.

• To contribute to the design of a range of experiments/fieldwork/research methodologies in relation to the specific project that they are working on

• To set up and run experiments/fieldwork in consultation with the Principal Investigator, ensuring that the experiments/fieldwork are appropriately supervised and supported. To record, analyse and write up the results of these experiments/fieldwork.

• To prepare and present findings of research activity to colleagues for review purposes.

• To contribute to the drafting and submitting of papers to appropriate peer reviewed journals.

• To prepare progress reports on research for funding bodies when required.

• To contribute to the preparation and drafting of research bids and proposals.

• To contribute to the overall activities of the research team and department as required.

• To analyse and interpret the results of their own research

9.2.1.3 Skills and Qualifications

Education: Level Bachelor and/or Master's in the Programme Area
Experience and Skills:
Basic research skills and knowledge of research techniques
Ability to analyse and write up data
Ability to present and communicate research results effectively to a range of audiences

9.2.1.4 EUC Pertaining Benefits

Researchers will have access to facilities which are necessary and appropriate for the performance of their duties.
- Desk, Telephone line and PC
- MS Office, SPSS, Email and Printing Rights
- Business Cards with the University Emblem and the Research Laboratory they belong to
- Full access to the library
All researchers must receive the same forms of employment documentation as other academic-related staff of the University:
- a formal contract signed by the relevant appointing authority;
- written confirmation of any changes in the terms of employment;
- job description or the generic description of the role and, where appropriate, a list of expected research goals;
- further to the completion of the contract, researchers are responsible for returning in good condition all the equipment as well as business cards that have been provided to them.

9.2.2 Job Description for the Position of Research Fellow

9.2.2.1 Overall Role

A Research Fellow is a researcher with some research experience and who has typically been awarded a doctoral degree. A Research Fellow will often have supervisory responsibilities for more junior researchers and will often lead a team of researchers to achieve a research project's aims. They will initiate, develop, design and be responsible for the delivery of a programme of high quality research and may have full authority over several phases of project work.

9.2.2.2 Key Responsibilities
• Design, Conceptualize and conduct short-term experiments and research activities in support of broadbased/longitudinal research projects, ensuring consistency with established methodological approaches and models, adherence to project timelines, and completeness of documentation;
• Supervise and Conduct studies of related literature and research to support the design and implementation of projects and development of reports, ensuring conceptual relevance, comprehensiveness, and currency of information;
• Write and publish articles in peer-reviewed journals that highlight findings from research and experimental activities ensuring consistency with the highest standards of academic publication and showcasing the Centre's/Programme's scientific leadership;
• Take the lead within the team and communicate to Programme/Project team developments/progress and results of research activities ensuring that relevant

information and issues in the implementation of projects/experiments are captured in as comprehensive and timely manner as possible;
• Develop collaborative links with core scientific personnel in related programme areas to gain exposure to, and build knowledge on experimental/research activities and approaches, in order to subsequently improve conceptual development and implementation of existing programmes;
• Utilize appropriate and current techniques/protocols in experimental laboratory management to ensure integrity and security of experimental process, comprehensive documentation, and replicability of experimental procedures;
• Design and organize databases along project frameworks and experimental research design that support overall research management, including the monitoring and evaluation of project inputs, actions, and outcomes, as well as the subsequent integration of these databases to other databanks;
• Identify areas of improvement within the research structure using integrated management approaches in pursuit of capacity building/strengthening and the preservation of scientific rigor in research studies.
• Develop research objectives, projects and proposals.
• Conduct individual or collaborative research projects.
• Identify sources of funding and contribute to the process of securing funds.

• Act as principal investigator on research projects.
• Manage and lead a team of researchers to achieve the aims of a research project.
• Oversee and appropriately supervise and support the research activities (experiments, fieldwork etc.) of a research programme/project.
• Ensure that research results are recorded, analysed and written up in a timely fashion.
• Manage research grants in accordance with EUC Financial Regulations and the conditions of the funding body (e.g. EU, RPF etc.)
• Prepare and present findings of research activity to colleagues for review purposes.
• Submit papers to relevant peer reviewed journals and attend and present findings at relevant conferences.
• Prepare progress reports on research for funding bodies when required
• Participate in and develop external networks, for example to identify sources of funding or to build relationships for future research activities

9.2.2.3 Skills and Qualifications

Education: Level PhD in the Programme Area
Experience: at least 1-3 years relevant experience.
The candidate must possess sufficient specialist knowledge in the specific discipline to develop research programmes and methodologies*.*

9.2.2.4 EUC Pertaining Benefits

Researchers will have access to facilities which are necessary and appropriate for the performance of their duties.

- Desk, Telephone line and PC
- MS Office, SPSS, Email and Printing Rights
- Business Cards with the University Emblem and the Research Laboratory they belong to
- Full access to the library

All researchers must receive the same forms of employment documentation as other academic-related staff of the University:

• a formal contract signed by the relevant appointing authority;

• written confirmation of any changes in the terms of employment;

• job description or the generic description of the role and, where appropriate, a list of expected research goals;

• further to the completion of the contract, researchers are responsible for returning in good condition all the equipment as well as business cards that have been provided to them

9.2.3 Job Description for the Position of Senior Research Fellow

9.2.3.1 Overall Role

A Senior Research Fellow is an experienced researcher holding a leadership role in a research group/centre/institute. Post-holders are expected to undertake the role of Principal Investigator on major research projects, exhibit a strong reputation for independent research, and provide academic leadership. They are also expected to support the management activity of the relevant School/Research Centre, and contribute to the delivery of the School's/ Centre's/Laboratory's research strategy.

9.2.3.2 Key Responsibilities

- Supervise postgraduate research students
- Contribute to the development of research strategies for the relevant School/Centre/Laboratory.
- Define research objectives and questions
- Develop proposals for research projects which will make a significant impact by leading to an increase in knowledge and understanding
- Actively seek research funding and secure it as far as it is reasonably possible
- Generate new research approaches
- Review and synthesise the outcomes of research studies
- Interpret findings obtained from research projects and develop new insights
- Contribute generally to the development of thought and practice in the field
- Provide academic leadership to those working within research areas - for example, by co-ordinating the work of others to ensure that research projects are delivered effectively and to time
- Contribute to the development of teams and individuals through the appraisal system and providing advice on personal development

- Act as line manager (e.g. of research teams)
- Act as a personal mentor to peers and colleagues
- Provide advice on issues such as ensuring the appropriate balance of research projects, appointment of researchers and other performance related issues
- Identify opportunities for strategic development of new projects or other areas of research activity and contribute to the development of such ideas

9.2.3.3 Skills and Qualifications

Education: Level PhD in the Programme Area
Experience: at least 7-10 years relevant experience. Significant post-qualification research experience with a track record of high-quality publications.
Experience of successful supervision of students
Experience in a leadership role in a Research Group/Centre or Laboratory

9.2.3.4 EUC Pertaining Benefits

Researchers will have access to facilities which are necessary and appropriate for the performance of their duties.
- Desk, Telephone line and PC
- MS Office, SPSS, Email and Printing Rights
- Business Cards with the University Emblem and the Research Laboratory they belong to
- Full access to the library
All researchers must receive the same forms of employment documentation as other academic-related staff of the University:
• a formal contract signed by the relevant appointing authority;
• written confirmation of any changes in the terms of employment;
• job description or the generic description of the role and, where appropriate, a list of expected research goals;
• further to the completion of the contract, researchers are responsible for returning in good condition all the equipment as well as business cards that have been provided to them

9.3   Procedures for Appointment

9.3.1   Selection and Search Procedures

As a general rule, an appointment to the Academic Research Staff requires a search for a suitable candidate. Searches are initiated with a written vacancy announcement, such as in relevant professional journals or other publications.

The text for the announcement should be sent to the Office of the Vice Rector of Research and External Affairs and the Office of the Director of Human Resources, clearly describing the terms of employment, length of employment, identity and duration of funding sources contributing to his or her salary and line manager (the person the researcher will be reporting to). The text should be advertised for a reasonable amount of time. A copy of a current CV, a cover letter and at least one recommendation should be sought for. A short list of the potential candidates will be created based on merit and the top part of the list will be called for a structured interview with the line manager. At the end of the procedure, the line manager will report back to the Office of the Vice Rector of Research and External Affairs and the Office of the Director of Human Resources, the name(s) of the proposed Researcher.

9.3.2 Criteria for the Appointment to Rank of Research Associate

Minimum qualifications as described in Section 9.2.1.

9.3.3 Criteria and Procedures for the Promotion to the Rank of Research Fellow

A Research Associate may, during the course of his/her appointment obtain, his/her PhD. In such cases, the employee (provided that he/she fulfills the work experience as described in Section 9.2.2) is promoted to the rank of Research Fellow. If the funding source that sponsors the program the researcher is assigned to accounts for a pay rise this is immediately applied.

9.4 Honorary Research Staff

The work of Research Centers is enhanced by the involvement and collaboration in the Research Centers' activities of personnel who are not employees of the University. To recognise the association, EUC may confer an honorary title to such individuals during the period of their association. An honorary title may not be conferred on an employee of EUC.

The title to be conferred will depend on the level of distinction and qualification of the candidate. Applications should come from the Dean of the School with:
- a copy of the person's CV
- a citation that should include:
    - a description of contributions to teaching
    - research being undertaken with academic staff as evidenced by joint publications/research projects and research grants or contracts being held jointly or a significant involvement in industry/academic joint activities within the College
    - rationale for offering the association
    - the start date and end date of the association

Honorary titles are intended to recognise ongoing attachments and are awarded for a fixed term, normally up to three years in the first instance. No monetary honorarium is associated with the offer.

The honorary research titles that can be awarded are:

9.4.1 Honorary Principal Research Fellow

Will have made an outstanding contribution to teaching and research

9.4.2 Honorary Senior Research Fellow

Extensive research experience required, the quality of which is determined by refereed publications, invitations to speak at conferences, hold an established national reputation and a known or developing international reputation. Have the ability to attract significant external research funding. Will usually lead a team of other research staff, possibly drawn from several disciplines

9.4.3 Honorary Research Fellow

Proven ability of high quality research, evidenced by authorship of a range of publications. Capable of attracting external research funding. May be required to undertake project management and/or supervise teams and other research staff; expected to provide expert advice and guidance to others

9.4.4 Honorary Research Associate

Required to produce independent original research and to take initiatives in planning of research.

9.5   Intellectual Property Rights

All IP generated throughout the employment of an Academic Research Staff Member belongs to EUC. In such cases that the Researcher is employed in a project that assigns explicit IP rights (e.g. an EU funded project) then the rules as set out by the funding agency are followed.

Honorary Research Staff may be required to assign the rights to any IP they create in the course of their academic activities to EUC. EUC may have obligations to organisations which are funding the research (e.g. an EU funded project) in question which it will not be able to honour without such an assignment of rights being in place.

Associates are treated as if they were EUC Employees for the purposes of revenue sharing.

9.6 Involvement of Research Staff

Wherever possible, Academic Research staff should be encouraged to take part in university decision making processes, for example by inclusion in relevant departmental committees. Where appropriate, researchers should be included at University level, for example as representatives in working groups and staff consultation exercises.

Appendix A:

A Technology Transfer Process Map – to be completed when the TTF has been established.
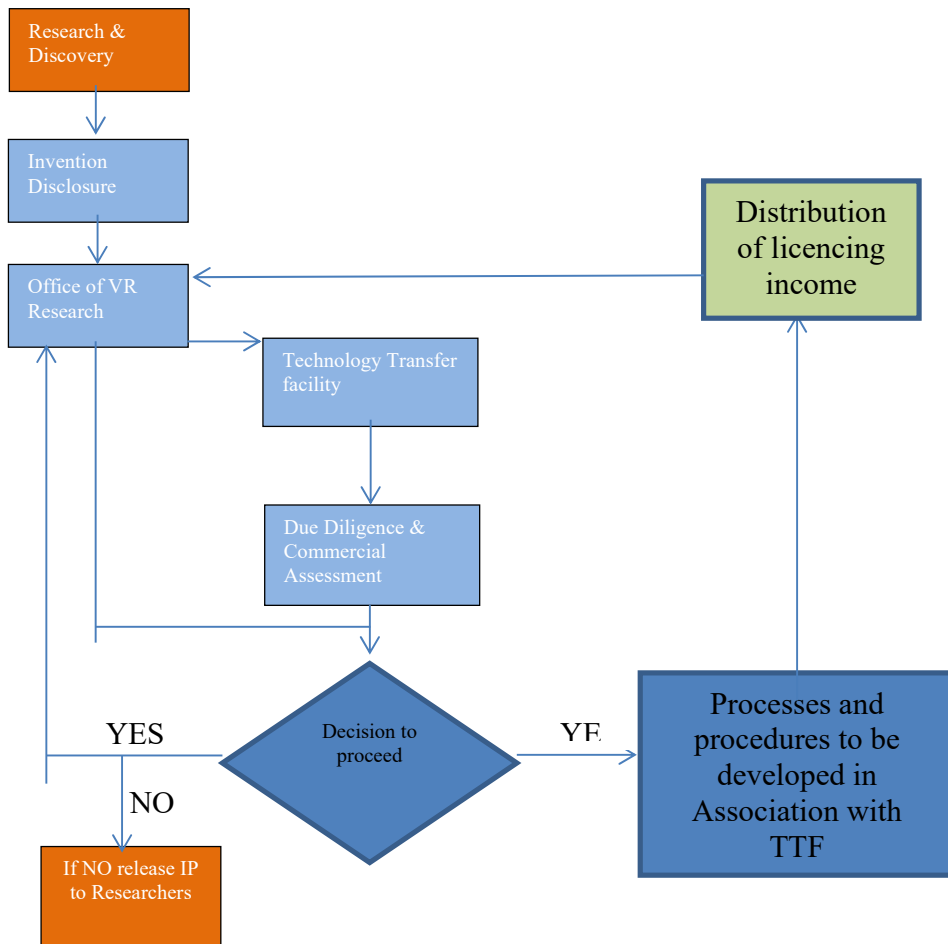
Appendix B:

Invention Disclosure Guidelines

Invention Disclosure Form - Example

An Invention Disclosure Form (IDF) is designed to determine the basic facts relating to an invention, design, or copyright material. It is a way of capturing an invention and establishing who the inventors are, what the invention is, who is funding it, what the anticipated product/ market is and initiate Intellectual Property (IP) due diligence. Information on the following aspects of an invention should be included in an Invention Disclosure Form.

1. Descriptive Title of the Invention.
2. Who was involved? Please specify for each individual who contributed, invented or authored (if software):
   a. Their names and if any are foreign nationals;
   b. Who their employer is; are any contracts or arrangements in place?
   c. What they contributed to the development of the technology (e.g. came up with the original idea; designed experiments; carried out experimental work; wrote code)
3. Detail of your invention:
   a. What do you think your invention is?
   b. What will your invention be used for?
   c. What are the advantages of your invention and how does it improve on the present situation?
   d. What is new about your invention?
   e. How and why does it work? What is the science behind the invention
   f. Are there any other uses of the invention?
4. Interest from external organisations and their details.
5. Information on published literature (including patents) relevant to your invention?
6. When and where the invention was first conceived?
7. What are your future plans for developing the technology?
8. Who have you told about the invention, when and where?
9. When did you first describe the invention in writing or electronically?
10. Publications, abstracts, conferences to date.
11. Publication and conference plans.
12. Funding information (comprehensive), e.g including third party support, Material Sales or Transfers, patient consents.

    For inventions that include software, please provide the following additional information.

13. Application name and version number.

14. For source code developed by the researchers identified in question 2 above, include: source files used, programming languages, development tools, copyright protection in source code.

15. For new versions, include: source files changed, added or removed since the previous version, documentation required for others to use, if the source files have been distributed outside the university, and in what form, and are the source files available as a web-download – inc. URL and terms under which the download is available.

16. For other source files or libraries that are required to build the software application (external software), list the following: all external software required to use the application; who owns that software, how was the software obtained, licence terms or FOSS – name of the licence.

Appendix C:

Suggested Revenue Sharing Scheme

The EUC will share royalty income with employees and/or students involved in producing Disclosable Work whose exploitation generates revenue for the EUC. Payments are made at the Organisation's sole discretion, but the EUC will normally share royalty income in accordance with the table below. This may be either as a lump sum or as royalty income over a period of time.

Table C1

Net Revenue	Allocated to the Creator/s	Allocated to the EUC Central Budget	Allocated to the Creator'/s School of Study or Department Budget	Allocated to Support the TTF
100%	50%	20%	20%	10%

Appendix D

D1. Points accumulation from Research

Table D1 details the evaluation categories which will be used for the calculation of research points allocated to EUC researchers. The table has been constructed taking into account the following:

1. The points awarded are based on the evaluation of research accomplishments, not on the estimation / calculation of hours spent during the implementation of a research activity.
2. A research accomplishment is any research-related activity which strengthens the research portfolio and enhances the research esteem of a researcher in particular, and the EUC in general
3. It is apparent that specific research accomplishments cannot be evaluated in a similar manner across the range of research disciplines. Therefore, the following table is implicitly "averaging" the weight of these accomplishments, so that the scheme can be operational and fair.
4. The term "national", when used in association with a conference, refers to one which is local in nature (i.e. only researchers from Cypriot Universities and other Cypriot research establishments participated in it).
5. The term "international", when used in association with a conference, refers to one which is international in nature (i.e. researchers from Universities and other research establishments from at least two countries participated in it).
6. The term "national", when used in association with a publication refers to one published by a Cypriot university or other Cypriot academic publishing house.
7. The term "international", when used in association with a publication refers to one published by an international university or other international academic publishing house.

Where a publication of any type (conference, journal, book chapter, monograph, textbook, book, or other) concerns two or more authors, the following points' calculation rules will apply: For cases up to (and including) two (2) authors, full points are awarded to the author in consideration. For each additional co-author (three (3) authors or more), a deduction of 2 points will be implemented on the full points' allocation for the category considered. The minimum points that an author will be awarded cannot be smaller than 50% of the full points' allocation for the category considered.

Table D1

Points	Conferences	Journals	Books	Research Projects	Other*
5	1. Presentation of poster / article in national conference (refereed) 2. Presentation as invited keynote speaker (refereed national conference)			1. Unsuccessful submission of funded research proposal in national / international organization (research partner)	Member of scientific / conference organizing committee (national / international)
10	1. Presentation of refereed poster / article in international conference (refereed) 2. Presentation as invited keynote speaker (refereed international conference) 3. Editor of national conference proceedings (refereed)	1. Publication of refereed journal article (journal not in ISI / Scopus / ACM / IEEE/etc.) 2. Editor of refereed journal special issue (journal not in ISI / Scopus / ACM / IEEE/etc.)	Publication of refereed book chapter (national)	1. Unsuccessful submission of funded research proposal in national organisation (project coordinator)	General Chair or Program Chair of refereed national conference
15	1. Editor of international conference proceedings (refereed)		Publication of refereed book chapter (international)	1. Unsuccessful submission of funded research proposal in international organization (project coordinator)	General Chair or Program Chair of refereed international conference

Table D1 (continues)

Points	Conferences	Journals	Book Chapters / Editors	Research Projects	Other*
20		1. Editor of refereed journal special issue (journal in ISI / Scopus / ACM / IEEE/etc.)	Editor of refereed book / book series		
25		1. Publication of refereed journal article (journal in ISI / Scopus / ACM / IEEE/etc.)			

* For these categories only 50% of the points will be accumulated

D2. Points accumulation from Research / Department of Arts

Points	Other		
	Performance /Exhibition (Artist	Creative works	Workshop/Seminars/Festivals

Due to the nature of the research conducted in the Department of Arts, Table D2 has been produced to address the research output of the Department. For all other research outputs such as journal papers, conferences, books, etc. the European University Cyprus' "Points' accumulation" table given in section D1 must be followed.

Table D2

					/Competitions/ Broadcasts/Residencies
	Music	Graphic Design	Music	Graphic Design	
5	Performance - National level (partial performance)	Participation in local group exhibition	Composition for up to 4 musicians		• National Performance or Broadcast of a composition/arrangement • Adjudication of Competition • Invited workshop / art lecture in national conference/festival
10	Performance - International level (partial performance)	Participation in international group exhibition	Composition from 5-10 musicians	Publication design (national/international) - booklets covers	• International Performance or Broadcast of a composition/arrangement • Competition Finalist • Invited workshop / art lecture in international conference/festival • Invited Artist (Workshop)
15	Performance - National level (entire concert) Performance with Large Ensemble	Editor of exhibition catalogue (national/international)	Composition for 10 musicians and above	Publication design (international) - books and exhibition catalogues	• Competition Winner • Invited Artist (Festival – duration more than three days)
20	Performer – International level (entire concert)	Participation in national solo exhibition	Composition for Symphonic Orchestra	Commissioned work by government/museum/ other cultural institution	Participation in funded international residency
25		Participation in international solo exhibition	Publication of a composition (Score/CD) by an		

			International Music Publishing House		

School of Sciences | Department of Computer Science and Engineering

Investigating Community Detection Algorithms for Real Networks using igraph

An R implementation

Bachelor of Science
Computer Science

Ioannis Apostolidis

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Ioannis Apostolidis

Abstract

This thesis is an attempt to prove the concept of applying graph theory and clustering methodologies into analyses for scientific fields such as astrophysics and neuroscience which were used in this project. In addition, a number of R scripts where created for this purpose, in order to lay the foundations for more advance and accurate analyses but also to be used in similar project datasets. For this purpose, the R scripts have been designed with generality in mind so that to be portable and easy to make the necessary changes in order to get the appropriate results for all kinds of research.

Furthermore, in this document, readers will be taken in a path where, first, the theoretical material used in the analysis will be provided with the goal of receiving the appropriate knowledge to understand the analyses conducted and the chapters to come. Then, theoretical material regarding the clustering methodologies will be given to get familiar with the notion of clustering and display some useful tools that can assist in the clustering analysis and extract useful information regarding the graphs generated.

Next, the core of the implementation side will be introduced, the igraph package under R, which is a powerful tool for creating all types of graphs and has a high degree of customization freedom. Finally, the two analyses of the neuroscience and the astrophysics datasets are displayed along with technical information used for the two analyses and the results generated by the R scripts which were created for the project.

Table of Contents

1 Graph Theory Basics

In this section, the theoretical background of graphs is presented with the goal of introducing the readers with the basic definitions, the "jargon" and tools of graph theory, so that to understand the following chapters discussed below but also to acquire knowledge regarding the topic; this chapter will show the fundamental parts of graphs, their properties and types.

1.1 Graph Properties

1.1.1 Vertices

To begin with, in order to define a graph, we need two fundamental elements to represent them in a finite space, vertices and edges. Vertices or nodes (as otherwise called) are basically points in an area that represent an entity, either a person or object.

1.1.2 Edges

The second fundamental element of graph, along with vertices are the edges. Edges represent connections between vertices and shows a relationship that we define and want to study up close. In order to define an edge, an individual must connect one vertex with another, the two vertices which the edge connects are called the endpoints of the edge. Edges can have a direction or be directionless (discussed further in section 1.2). In addition, there can be multiple edges connecting two vertices.
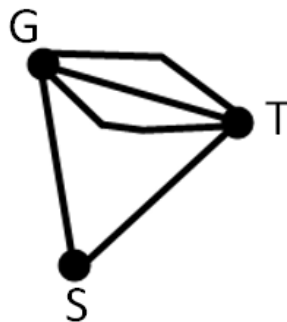
Figure 1: Multiple Edges in a Graph

1.1.3 Graph Definition

Now that the elements of a graphs where defined, the informal definition of a graph is that a graph is a whole diagram that includes the vertices and the edges for a given scenario. To put it more formally:

A graph G is a collection of vertices V and edges E and is denoted by G = (V , E). Edges are said to belong in E, if each edge e joins two vertices of the graph which are called the end
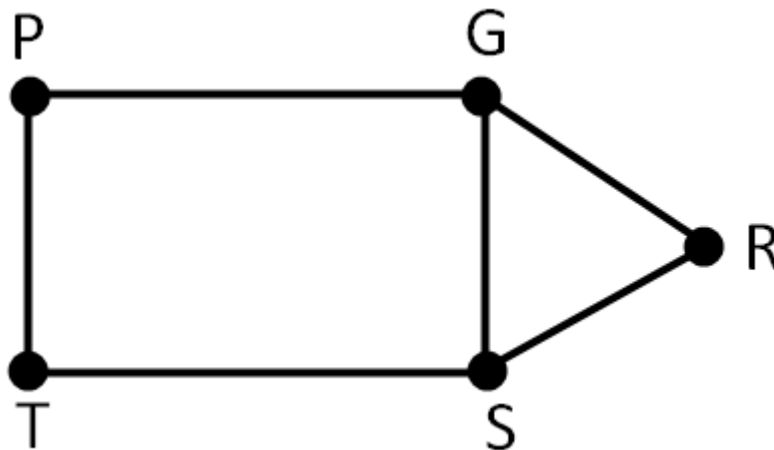
Figure 2: A randomly created graph

points of the edge e. In addition, if e has endpoints vertices u, v which belong to V (denoted as u, v ∈ V), we write that e = (u , v). There are two types of graphs, directional graphs (also names digraphs) and undirected graphs. Furthermore, vertices such as u, v are said to be adjacent when an edge e links the two together and the edge e is said to be incident with the two vertices u and v [1]. Moreover, two edges e_1 and e_2 are said to be adjacent if they are connected via the same vertex (edges PG and GR is an example in figure 1) [2].

Moreover, graphs can be categorized into several categories according to particular features displayed in each graph. These types are the following:

Simple Graphs:

Graphs with no loops or multiple edges. In Figure 3, the subgraphs ABC and EFGD are simple graphs.

Connected Graph:

A graph where any two vertices chosen are connected by a path; all vertices can be visited. In Figure 2, the graph is a connected graph.

Disconnected Graph:

A graph that contains two or more subgraphs, where some vertices cannot be accessed by another vertex via a path.
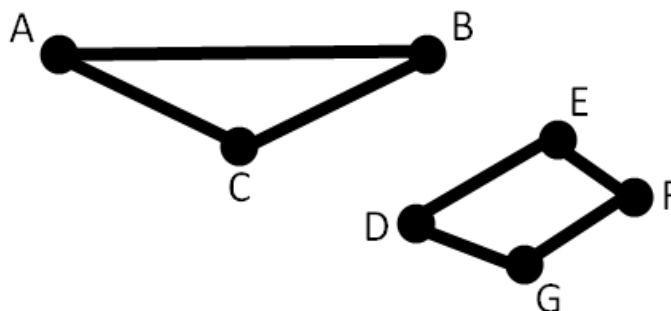
Figure 3: A Disconnected Graph

Planar Graph:

A graph drawn in a plane without any of the edges crossing (ex. Figure 2).

Regular Graph:

A graph where all its vertices has the same degree (total degree).

1.1.4 Degree

The degree property of a vertex v of a graph G is the number of incident edges in v and is denoted by deg(v) or δ(v). For the case of loops, edges that go to the same vertex, we count them twice. An important aspect of the degree of vertices in graph G, is that the sum of all vertex degrees is twice the number of edges of G [1]. Also, when referring to the degree of a vertex, there are two cases:

1. The "degree" in undirected graphs

The general term of the "degree" in an undirected graph means the sum of all the incident edges of a vertex.

2. The "degree" in directed graphs

When the graph given is a directed graph then there are two cases, the indegree is the number of edges coming in the vertex (have direction towards the vertex) and the outdegree is the number of edges coming out of the vertex (have direction outgoing from the vertex) [1].

1.1.5 Additional Properties

Graphs have a number of properties, its one helps us view specific information or represent a specific problem using graph theory that has particular restrictions. Those properties and shown below:

Walks:

Going from one vertex to another.

$$P \longrightarrow Q \longrightarrow R \; || \; \text{Walk of length 2}$$

Figure 4: Displaying a Walk in the graph shown in Figure 2

Path:

We say that we have a path when a vertex does not appear more than once in a walk

Cycle:

A walk of the form: $Q \rightarrow S \rightarrow T \rightarrow Q$

Hamiltonian Path:

We have a Hamiltonian path when we pass from every vertex only once in a given graph.

Euler Path:

We have an Euler path when we pass from every edge only once in a given graph.

Shortest Path:

The act of locating the shortest path in a graph means, finding the path with the smallest possible distance needed in order to go from vertex v to vertex u; the edge weights represent the distance from one vertex to the other and are used to determine the shortest path between v and u.

1.2 Graph Clustering

In this section, after introducing some basic information about the theoretical aspects of graph theory, we move on to introduce the next set of tools that readers will need to get themselves familiar with in order to understand the analysis conducted and learn all the necessary terminology required for the clustering analysis. More specifically, the theoretical material of

clusters are presented, known algorithms that help users to perform clustering analysis in all kinds of datasets in order to find similarities and distances between vertices, view the various types of clustering and see some other scientific fields that might benefit from such analysis beside neuroscience and astrophysics.

1.2.1 Definition

Although a formal definition of clustering does not exist, clustering is basically defined as the act of processing, detecting and organizing the vertices of a graph, according to similar features and properties between those vertices; we say two vertices belong to the some cluster/community if their characteristics are very in common to each other depending on the clustering algorithm run. Clustering can be performed using various methodologies that are used to determine the vertex allocation to the clusters discovered.

1.2.2 Clustering Properties

Each cluster found, has particular characteristics which tells us some information regarding the clustered graph or the individual clusters. There is a number of such characteristics that, for example, help us determine how "good" a cluster is depending on the connections created, how important are some vertex that act as central nodes to the graph, the density of edges in the graph and many other useful that are out of the scope of this analysis; below, we introduce some basic properties of clusters that will assist the understanding of the clustering algorithms and provide a way to see the quality of the clusters produced from the analysis' R scripts created for this project.

1.2.2.1 Closeness Centrality

The Closeness centrality property is a useful characteristic of a vertex in a cluster or a graph in general, where, as the name suggests, it is a measure of centrality or importance of a vertex and is defined as the inverse of the sum of the shortest path distances from the vertex examining to all other vertices in the graph; the property was first described by Alex Bavelas in 1948. Using this property, individuals can locate vertices of utmost importance in applications, such as electrical grids in order to find electric stations that can get overload or weak points of the grid's infrastructure, can assist telecommunication companies to install internet cables in the most optimal way etc. The mathematical representation of the closeness centrality can be defined as:

$$C(v) = \frac{N - 1}{\sum_{u \in V} d(u, v)}$$

Where:

C(): closeness centrality function name

N: the number of vertices in the graph

v: the vertex of which the closeness centrality is computed

u: a vertex belonging to the vertex set V of the graph

In order to better understand the procedure needed to follow so that to get a correct result, here is an example. Suppose the following graph is to be examined:
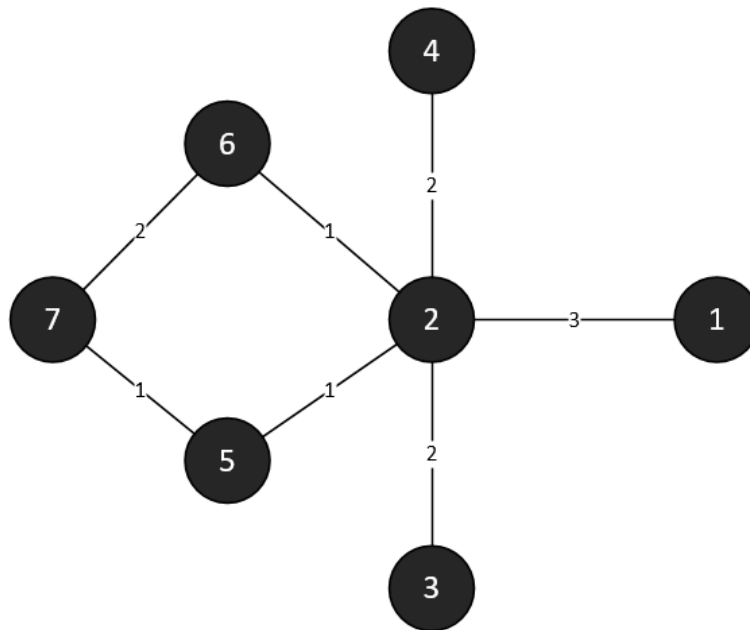
Figure 5: A random graph to compute the Closeness centrality of vertex 2

Suppose that the Closeness Centrality of vertex 2 is to be computed using the methodology described above. To simplify things and be able to have a better visual representation of the shortest paths from vertex 2 to all other vertices, a matrix is created that shows the shortest distances from one vertex to the other. Such a matrix can be created using a variety of algorithms that compute the shortest paths from vertices of a graph, for example, Dijkstra's algorithm, Floyd-Warshall Algorithm and Bell-ford algorithm, the Dijkstra's algorithm is going to be used as it is simple and the best candidate for the case examined. Applying Dijkstra's algorithm to the graph produces the following matrix:

Dijkstra's Result	V1	V2	V3	V4	V5	V6	V7
V1	-	3	5	5	4	4	5
V2	3	-	2	2	1	1	2
V3	5	2	-	4	3	3	4
V4	5	2	4	-	3	3	4
V5	4	1	3	3	-	2	1
V6	4	1	3	3	2	-	2
V7	5	2	4	4	1	2	-

Now, the summation of the shortest paths of vertex 2 (V2) is the addition of all the values in the V2 row in the above matrix:

$$\sum_{v \in V} d(V2, v) = 3 + 2 + 2 + 1 + 1 + 2 = 11$$

Our N in this case is 7, thus:

$$C(V2) = \frac{7 - 1}{11} = \frac{6}{11} \approx 0.54$$

[12].

Furthermore, there is also the case where the average length of the shortest paths can be used apart from the summation of them. This approach will produce a normalized form of the formula which can be beneficial to the analysis conducted.

1.2.2.2 Modularity

Now that we have seen a way to determine how important a vertex in a given graph is, other important questions arise, how we determine that the clusters located in a given graph are "good" clusters? How we know that the results taken from our clustering algorithm has grouped our vertices in the most optimal way possible? With this in mind, a new type of measurement was defined in order to describe the quality of the division of a particular graph into clusters [13]. The modularity measure of a graph describes how good the division of the graph is and is denoted by having many edges within and few edges between each cluster found in the graph,

the higher the modularity number is (the interval of the values is between 0 and 1 and can be both positive and negative), the higher isolation exists between clusters with only few inter-cluster edges connecting them. In order to calculate the modularity property, we need to see the mathematical background of such property and the procedure followed to find it:

Suppose we have a graph G of N vertices and an adjacency matrix M of $N \times N$ size where 1 denotes the existence of a connection between vertices i, j and 0 otherwise; each element chosen from M is denoted by E_{ij}. In addition, suppose that community detection is performed into a given graph and an output of k clusters is found, we denote the membership of a vertex i to a cluster as C_i. To find the fraction of edges that exist in the same cluster, we find the density of edges, we do the following [14],

$$F_{ij} = \frac{\sum_{ij} E_{ij} \times \delta(C_i, C_j)}{\sum_{ij} E_{ij}} = \frac{1}{2m} \sum_{ij} \left[E_{ij} \times \delta(C_i, C_j) \right] \quad (1)$$

Where:

$\delta()$: a function that outputs 1 if $i = j$, or 0 otherwise. This function shows that the edge picked is in the cluster examining.

m: is the number of edges in the graph, where $m = \frac{1}{2} \sum_{ij} E_{ij}$, we divide by 2 to remove the double count of edges in M.

The information taken by the above calculation can be a possible candidate for showing that each cluster is isolated from each other, but it can backfire in some cases like when detecting only one cluster in the graph examining; the result will be 1, which by simple observation is not an ideal result for a particular analysis. To solve the above problem the following idea is utilized, if we recreate the same fraction F_{ij} for the case of a graph with random edges created, then it will add meaning to the result. So, the probability of having an edge between vertices i, j is dependent on the degree d of i, j and is defined as [14],

$$P_{ij} = \frac{d_i d_j}{2m} \quad (2)$$

Where:

$d_i = \sum_w E_{iw}$, and w being any other vertex that i is connected with.

Thus, the modularity q for a chosen cluster in a given graph is calculated by [14]:

$$q = \frac{1}{2m} \sum_{ij} [E_{ij} - P_{ij}] \times \delta(C_i, C_j) \quad (3)$$

Now, in order to find a global modularity Q, we need to find the fraction of all edges in our graph that connect vertices in a cluster w to vertices in cluster z. For this case, suppose that our graph has k clusters. A matrix H of $k \times k$ size is defined, where its element e_{ij} stored in each cell of the H, contains the fractions described. For the calculation of e_{ij} we will use equation (1) with an additional parameter and a small modification [13]:

$$e_{wz} = \frac{1}{2m} \sum_{ij} [E_{ij} \times \delta(C_i, w) \times \delta(C_j, z)] \quad (4)$$

Where:

$\delta(C_i, w)$ & $\delta(C_i, z)$: as previously defined, the $\delta()$ function will show if the cluster that i belongs to is the w and if the cluster that j belong to is the z, respectively.

Finally, we need one more term to come up with the modularity of the whole graph. We need to find the fraction of edges is a particular cluster s. For this we define a_w as [13]:

$$a_w = \sum_z e_{wz} \quad (5)$$

Thus, the modularity Q of a graph is defined as:

$$Q = \sum_w (e_{ww} - a_w^2) \quad (6)$$

An alternative approach for the calculation will be to computing the trace of the matrix H (the trace is the sum of the diagonal) denoted by $Tr(H)$ and subtracting it by the square of the sum of the elements in H. So, this makes Q [13]:

$$Q = \sum_w Tr(H) - \|H^2\| \quad (6)$$

Where:

$\|H^2\|$: it denotes the sum of the cells of H squared

1.2.2.3 Vertex & Edge Betweenness Centrality

Another important property of clustering is the vertex and edge betweenness centrality detection in a clustered graph. This property provides us with an important tool to be able to distinguish the most central vertices that are vital to the integrity of a connected graph; the removal of such vertices which might act as bridges will result in a disconnected graph in the worst case or the paths from one vertex to the other will have to take longer routes to reach each other, thus, affecting the communication between them.

The vertex betweenness centrality is defined according to H. A. Newman et al. [15] as "The betweenness centrality of a vertex v is the ratio of the number of shortest paths between two other vertices u and w which contain v to the total number of shortest paths between u and w, summed over all ordered pairs of vertices (u, w)." Similarly, the edge betweenness centrality of an edge e is defined as, suppose we have a graph G, then the betweenness centrality of e is the number of shortest paths between two vertices i and j that contain e, denoted as $\sigma_{ij}(e)$, divided by the total number of shortest paths between i and j, denoted as σ_{ij}. Thus, for all vertices i and j, the edge betweenness centrality denoted by $B_G(e)$ is calculated by:

$$B_G(e) = \sum_{ij} \frac{\sigma_{ij}(e)}{\sigma_{ij}}$$

And for the vertex betweenness centrality we have:

$$B_G(v) = \sum_{uw} \frac{\sigma_{uw}(v)}{\sigma_{uw}}$$

[15].

1.2.3 Types of Clustering

Apart from clustering properties, cluster algorithms can follow a specific clustering methodology with the purpose of finding the clusters existing in the graph examined. In this section we are going to discuss these types of clustering methods, how they work, procedure

followed etc. There are a number of clustering types, here we are going to examine five well known types, the partitioning method, the hierarchical, the fuzzy, the density-based and the model-based clustering methodologies. In addition, in section 1.2.5, we are going to discuss some clustering algorithms that follow this approaches for identifying the clusters in a graph.

1.2.3.1 Partition Clustering

The partitioning method used by known clustering algorithms like the K-means (discussed in section 1.2.5.1), K-medoids clustering (an alternative algorithm to K-means which is more resilient to outliers), the CLARA algorithm which is an extension of K-medoids clustering algorithm etc. This technique divides the graph created by a dataset, in k groups where the k must be defined by the user/analyst before the execution of the clustering algorithm used, thus, these algorithms need a supervising by the user/analyst, they do not perform automatic detection of the clusters in graphs [16, 17].

1.2.3.2 Hierarchical Clustering

Hierarchical clustering is another clustering paradigm that does not require a pre-defined number of clusters to be given be the user/analysist but performs the cluster detection automatically. The way the final result is achieved, is by creating a dendrogram, a tree representation of the vertices in the graph. It is important to note that the dendrogram created does not show the number of clusters by itself, as it has many hierarchical levels where its level is a join of the clusters in the level below it. This feature allows to choose which level to "cut" the tree and retrieve the appropriate number of clusters in the graph. For this type of clustering algorithms, there are two approaches of clustering algorithms that the hierarchical clustering methodology is used, the agglomerative clustering, a bottom-up approach for creating the dendrogram, and the divise clustering, the inverse of the agglomerative, a top-down approach [16, 18].
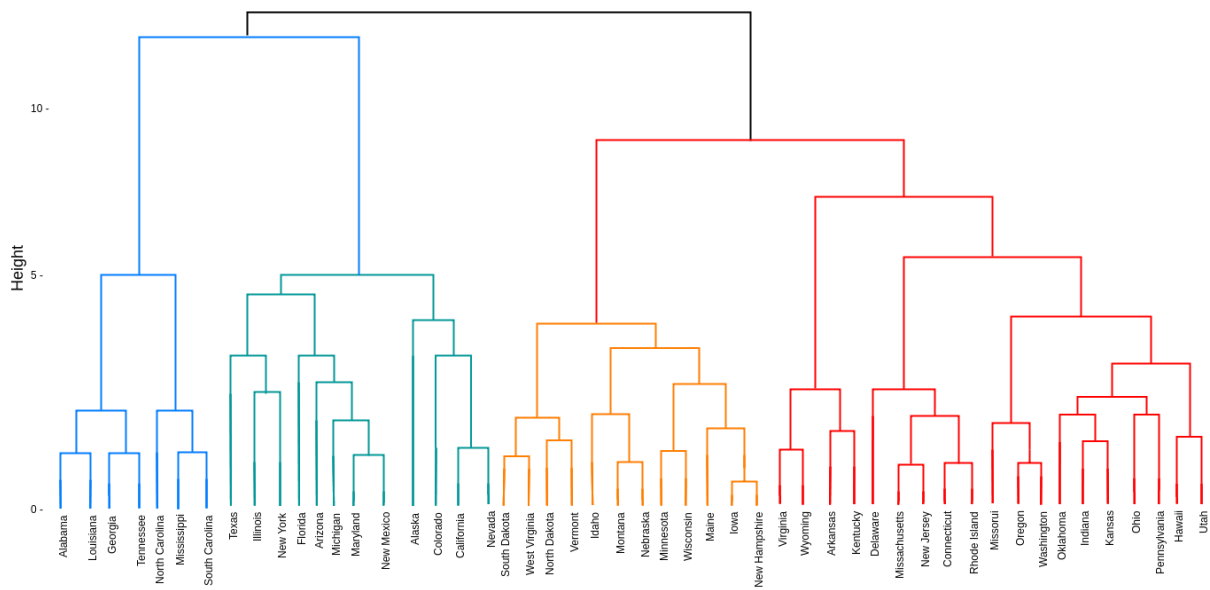
Figure 6: A dendrogram sample (taken from https://online.visual-paradigm.com/repository/images/0fe81efd-c6f6-41af-98d5-d9b1f0d33f2f.png)

1.2.3.3 Fuzzy Clustering

The way the fuzzy clustering type works differs from the above clustering types because we now do not locate to which particular cluster a vertex belongs to, also known as hard clustering, the fuzzy clustering type follows a soft approach where each vertex has a set of membership coefficients that represents the degree to which cluster the particular vertex belongs to. In other words, each vertex can have membership to multiple clusters in a given graph, depending of the probability, an example of such algorithm is the fuzzy C-means clustering algorithm. Clustering algorithms that do not follow this paradigm, for instance, the K-means algorithm, are called non-fuzzy. The degree of the membership coefficients can take values between 0 and 1 [16, 19].

1.2.3.4 Density-based Clustering

The density-based clustering type is capable of detecting clusters of complex shapes and sizes in datasets containing noise and outliers. This is accomplished through detecting all the regions with high vertex density, which are separated by lower vertex density. In order for the algorithm to progress in the addition of new vertices in a cluster, the radius from each vertex of a cluster needs to have a minimum number of other vertices in a given radius. Because of the fact that

the method descripted resembles the cluster detection patterns of a human, it is also called a human intuitive clustering methodology [16, 22].

Figure 7: An example of a cluster detection result from a density-based clustering algorithm (taken from [22])

1.2.3.5 Model-based Clustering

This methodology uses a soft clustering approach, similar to the fuzzy clustering type, the data taken from a given dataset are thought as coming from a distribution created by the mixture of two or more clusters, with each vertex in each cluster having a probabilistic membership in these clusters and not a discrete one. The clusters are modelled according to the normal or Gaussian distribution but can adopt any probability model in general and each cluster is described by a density function along with the probabilistic membership, also, called associated probability [16, 20, 21].

1.2.4 Clustering Applications

Clustering is becoming a standard these past few years along with data mining and artificial intelligence and finds many applications in real world problems. As it is shown in the below sections, for this analysis, the clustering methodologies where used to apply neuroscience and astrophysics datasets with the goal of determining similarities between pupils and galaxies alike. Apart from these two, clustering finds applications in many other fields, for example, it can be used by civil engineers and electrical engineers to determine the status of the electricity

grid with the goal of adding electricity stations or reinforcing a current "weak" station as the need arises.

Another interesting application of clustering, although not so strait forward, is the usage of clustering in image segmentation and compression. In this case, clustering can be used to determine the colours existing in an image and group it together with the neighbouring colours in order to find a general colour that describes the cluster's colours, thus, the final result will be a type of lossy compression but the image size will be reduced. Other applications for clustering include biology, where researchers can use it to find cancerous samples in a given dataset, clustering is basically the backbone of search engines such as Google, Bing etc., can be used in academia for monitoring the progress of both students and instructors depending on their performance, the list goes on.

1.2.5 Clustering Algorithms

Various well known and important clustering algorithms are shown below; all of which are used in the analyses done to the two datasets, others were implemented to work under the R igraph package (see section 2) standards and others are frequently used by the scientific community are discussed in the following lines.

1.2.5.1 K-means Algorithm

Characterized as one of the simplest and popular clustering algorithms used in data science and machine learning, the K-means algorithm, is used to perform community detection to a set of data by utilizing a number of centroids K, points as small as possible, which the users define and each vertex (or point) in the dataset is classified depending on the distance they have from each centroid which in the beginning are placed randomly in the working two-dimensional space. After calculating the distances, the algorithm performs a repositioning calculation that recomputes the clusters' centres by taking the mean of all the distances of the particular clusters and adjusts the position of the centres.

The algorithm will continue to execute the above two operations until two cases occur, the centroids became stable, no changes in the centres of the K clusters are made and secondly, when the number of iterations, which can be specified as parameters along with the centroids number, has been reached. Compared to other clustering algorithms, the K-means algorithm is a very fast and simple to implement algorithm because the only calculation needed to adjust the clusters is the distances from the centroids to the vertices.

Thus, that makes it having a time complexity of O(n). As with all things, the K-means algorithms comes with some disadvantages, in this specific algorithm the user/researcher needs to take a good look at his/her dataset and find after various attempts the number of clusters to specify in the algorithm. In addition, the fact that the centroids are placed randomly leaves the margin that for different executions of the algorithm, it might yield different results, thus, making them difficult or even not replicable by other users/researchers and as a result making it inconsistent [5, 6].

1.2.5.2 Louvain Algorithm

The Louvain algorithm is another well-known algorithm used by the scientific community that in comparison with other clustering algorithms such as the K-means algorithm we discussed above, it does not require any user "intervention" regarding the number of clusters to specify, number of iterations or any other similar parameter to execute beforehand. The way the Louvain algorithm works is executed in two phases, the first been the modularity optimization analysis and the second part is the community aggregation analysis. In the modularity optimization phase, the vertices of the dataset are randomly ordered in the graph created and initially each vertex is one cluster/community. Then, the algorithm will start re-assigning vertices by adding and removing them from a cluster with the ultimate goal been to achieve the highest modularity possible in each cluster (the number of cluster will change dynamically after the above operation).

In the second phase, when the modularity optimization finishes for this pass, all nodes belonging to the same cluster are merged into a single vertex; all edges that connect the clusters internally are summed, which will act as the edge weights of self-loops, and all external edges that connect a vertex of a cluster to another will also be summed up and will act as the weight of the edge connection of the two merged vertices. This procedure act as a simplification of the original graph and it will be now used to repeat the execution of the algorithm until no increase in modularity is observed in the clusters remaining or the whole graph has merged into a single vertex [7, 8, 9]. The below figure shows a sample of the procedure discussed above.
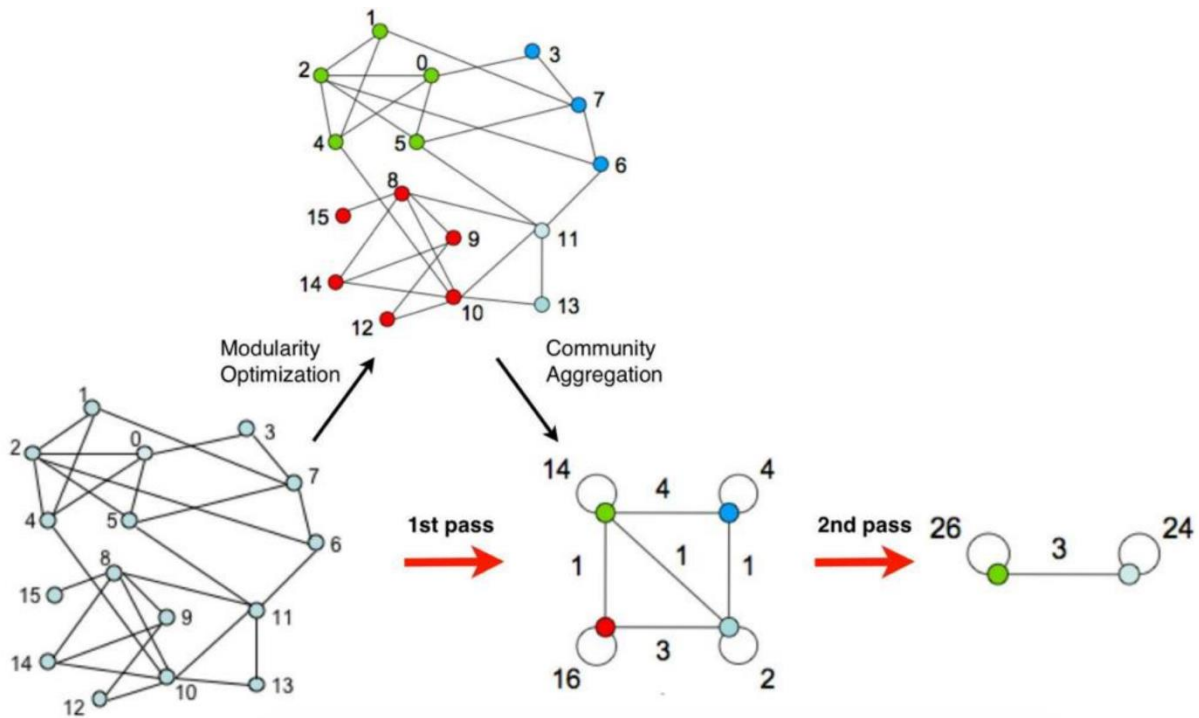
Figure 8: The Modularity Optimization & Community Aggregation in practice (image taken from [9])

1.2.5.3 Edge Betweenness Algorithm

The edge betweenness clustering algorithm utilizes the notion described in section 1.2.2.3 of the edge betweenness centrality to achieve the community detection of the given graph. The idea behind this clustering algorithm is that by first locating the edges with the highest score of edge betweenness centrality, we get to find the edges that most shortest paths are going through them, making them a candidate for being an edge connecting two clusters together. In order to detect the clusters in a graph using this clustering algorithm, the following procedure is followed:

- Find the edge betweenness centrality score for all edges in the graph
- Remove the edge with the highest edge betweenness centrality score
- Recalculate the new edge betweenness centrality score for all edges
- Keep removing the edges until no edge is left

In the end, a dendrogram is created containing a series of possible clusters with the leaves of this dendrogram been the vertices of the graph. The level of the clusters with the highest modularity is selected to be the final result of the clustering algorithm [23, 13].

1.2.5.4 Leading Eigenvector Algorithm

Another clustering algorithm that has the modularity notion at its core, similar to the Louvain clustering algorithm, is the leading eigenvector, where it divides a given graph into clusters by first computing the modularity matrix of the graph and then proceed with calculating the leading non-negative eigenvector of that modularity matrix, which will detected the most densely connected sections of the graph examined [24, 25].

1.2.5.5 Walktrap Algorithm

The main idea for the walktrap algorithm is that short random walks between vertices, are more likely to be achieved when vertices are located in the same cluster; the distance of such walk between vertices in the same cluster should be small and large for vertices belonging to different clusters. At each time frame the algorithm runs, a walk is created so that to visit each vertex and move on the next one, thus, creating a randomly and uniformly path. The sequence of the vertices is modelled as a Markov chain, a probabilistic model representing the sequence of possible events that the outcome of an event depends on the state of the previous event. With these ideas in mind, the algorithm will perform the following to accomplish the cluster detection phase:

- The graph is partitioned to N clusters with each cluster contained one vertex (so the N is the number of vertices)
- The distance of all adjacent vertices is computed
- The procedure continues by choosing two clusters based on a distance criterion for the partition
- The two clusters are merged, and a new cluster is created
- A new partition is also created that holds the vertices of the new cluster
- The distances are recalculated

After the algorithm finishes, the partitions generated by this procedure are represented as a hierarchical structure like a dendrogram. At this point, based on further operations the ideal partition of the dendrogram is selected which contains the particular number of clusters [26, 24].

2 Igraph under R

In this section the igraph package under the R programming language will be introduced. The igraph package for this analysis contacted, acts as the fundamental pillar that was used to create all the following results for the neuroscience and astrophysics analysis.

2.1 Introduction

The igraph package is an open source software implemented in the C programming language and can be used in a variety of other programming languages such as R, which is the version used in this analysis, python, mathematica and its native languages of C and C++. This package is basically a collection of networking analysis tools that are easy to work with and create complex graph structures using the built is functions available from its library. The initial release of the package was in 2006 which was developed by Gábor Csárdi and Tamás Nepusz. The package is used widely in academic research and especially in network sciences.

2.2 Features

The igraph package contains appropriate functions which can assists the user to create interactive or non-interactive graphs. For both analyses created for this project, the non-interactive approach is used which creates static image outputs. For the case of the interactive approach, the user is able to view the graph as an executable program and in this, he/she will be able to interact with the node of the graph created. The main features of igraph include:

- Create graph images (plots) in various file formats (png, jpeg etc.)
- A number of build-in clustering algorithms exist to use
- The ability to add (not under igraph) external clustering algorithms and plot them
- Graph and clustering properties can be found using built-in functions like degree, shortest path etc.
- High degree of graph customization for visual purposes

2.2.1 Clustering Algorithms under igraph

The igraph package has a number of clustering algorithms, some of them mentions in the above sections. These include:

- Louvain
- Leading eigenvector
- Edge betweenness
- Walktrap
- Optimal Modularity
- Fast-greedy
- Multi-Level
- Label Propagation

2.2.2 Adding External Clustering Algorithms to igraph

The most beneficial feature of igraph package, is to allow the user to introduce their own clustering algorithms for the package and create the desired clustered graphs and manipulate

them with the igraph standards. In this particular analysis, specifically for the astrophysics dataset, The K-means clustering algorithm was introduced and the appropriate clustered graphs were created.

2.3 Requirements

In order to setup the igraph package under R, the computer used **<u>MUST</u>** fulfil the below requirements:

1. Windows or Linux (Unix-like systems) Operating System (OS), in Mac OS it is **<u>NOT</u>** supported
2. Install Java 8 & Java JDK 8 (build 1.8.X)
3. Install R (latest version)
4. (Optional) Install Rstudio (useful IDE for R)
5. Install igraph package for R
    a. The command to do so is: **install.packages("igraph")**
    b. run the above command in the R console

3 Analysis and Design

Using all previous material covered, from graph theory basics to performing clustering analysis in graphs, along with the programming language R and the igraph package, two separate analysis were performed in two scientific fields, in neuroscience and in astrophysics. The goal of this section is to introduce to readers a real-life analysis and provide results that can be used by researchers, but also show the capabilities of using such tools in for scientific research.

3.1 Neuroscience Analysis

For the neuroscience analysis, the initial script structures and methods for both analysis were created and improved throughout the months taken to create the R scripts needed in order to acquire the appropriate results in both neuroscience and astrophysics sections shown in this document. In the below sections, the internal structure of the scripts used and the steps needed are displayed to the reader, so that to get familiar with the procedures followed to accomplish the specific analysis but also to see the capabilities of the R scripts created in terms of results and usefulness to a user that can utilize the methodologies used. A brief introduction of the below sections is, the reader will see the steps taken in order to pre-process the dataset used for the neuroscience analysis, the output structure taken after the execution of the analysis in a particular dataset and information extracted from the clusters found along with other information useful to the user.

3.1.1 Data Pre-processing

The R script used for processing the neuroscience dataset includes two pre-processing features, the first one refers to the users input that will determine the output of the script, the parameters that can be specified are, the dataset, a weight filtering threshold, delete nodes with underscore (basically test only the first test of students), a new node to be added after the clustering and a node to monitor each path. The other pre-processing feature is capable of performing pre-processing analysis and excluding particular nodes that are thought to be "bad data". More specifically, the algorithm responsible for this feature will exclude any node that fulfills the below criteria stated in the "CIIA Project" document [27]:

a) The data are entirely composed of No Responses
b) The data are roughly equally divided between correct and wrong responses with roughly the same RT and with few or none "No responses".
c) The data are composed of fast responses, with very fast wrong responses etc.

```
if((((Current_Node_Correct_Value < 60 && Current_Node_Correct_Value > 40) ||
    (Current_Node_Wrong_Value < 60 && Current_Node_Wrong_Value > 40)) &&
    (Current_Node_No_Response_Value >= 0 && Current_Node_No_Response_Value <= 8) &&
    (abs(Current_Node_Mean_Correct_Value - Current_Node_Mean_Wrong_Value) <= 100)) ||
    (Current_Node_No_Response_Value == 100) ||
    (Current_Node_Wrong_Value < Mean_of_Wrong_Responses &&
    Current_Node_Mean_Time_Value < Mean_of_Response_Time && Current_Node_Wrong_Value > 40)
)
```

Figure 9: Pre-Processing Condition for Excluding Nodes

The above code will do the following, it will detect if the Correct & Wrong answer of the student are between 40 and 60 percentage (the answers are nearly distributed) with roughly same reaction time and the threshold for no responses is between 0 and 8, the student provided no responses throughout the test and finally, the last condition will check if the student's response time and wrong response times are faster than the mean time (below the average/mean responses) of the other students; a threshold of 40 percent wrong responses is included in the equation so that to not exclude pupils that did roughly good in the test with fast times.

3.1.2 Computer organization and data structures

For a graph object to be created, data frames are mostly used to store information when the R script is executing and numeric vectors to perform mathematical operations such as to calculate the edge weights of the graph or find the mean/median of a cluster; in some parts, data frames act as adjacency matrices that store all the edge weights previously calculated using the Euclidian distance methodology. The way that nodes and data are transformed into a graph is,

be reading the dataset, creating all the edges and their weights, perform clustering using four igraph algorithms and finally plotting the resulting communities object to get the visual data. In addition, a core resource for reading, storing, and manipulating the dataset in the xlsx package in R. This package is used as a standalone generalized R script to export results given by the analysis of the clustering algorithms run in the dataset. More specifically, the package is used to save a summary report that included the results of the mean and the median calculated for all the clusters generated from the edge betweenness, leading eigen, Louvain and the walktrap algorithms. Also, the same properties of a particular cluster can be viewed from an algorithm's folder that the user want to investigate along with all the node that belong to that cluster. Furthermore, another report is generated from the script that includes the results of the embedding feature, a report that shows in which cluster a new node will have been placed if it was to be added in the graph for every algorithm used for the clustering procedures.
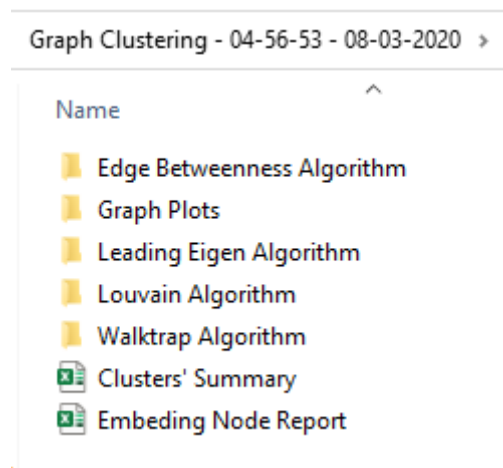
Figure 10: Folder Structure with all Data extracted from the analysis
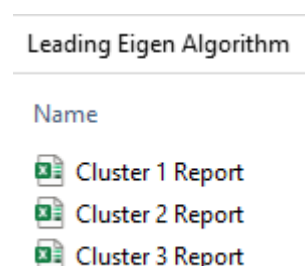
Figure 11: Example of reports generated for the Leading Eigen Algorithm

3.1.3 Full Data Matrices and operations to Define processed Data Matrices

In order to perform the remove operation in the pre-processing feature mentioned above, vector operations are used to remove the "bad" nodes from our working dataset. Apart from the pre-

processing operations used to locate and then remove from the dataset, a number of other matrix operations are done to give us the desired results. First things first, a normalization procedure is performed on the dataset's values to help us make our results more accurate and unhide important aspects of our analysis. The way the normalization is done is by finding the maximum value existing in the particular column of the dataset that we want to normalize and divide all values of that column with that maximum value. Then, when the dataset is now in the normalized form, it will be used to create the edge list, along with the edge weights mentioned above.

```
#------------------------------------ Applying Normalization -------------------------------------------

Dataset_Columns_Number = ncol(Dataset_Table)

Current_Column = 2
Current_Row = 1

for(Current_Column in 2:Dataset_Columns_Number)
{
  # Finding the maximum number in the each column of the dataset
  NormalizationSeed = max(Dataset_Table[,Current_Column] , na.rm = TRUE)

  # Dividing each column's attributes with the maximum number (NormalizationSeed) of that column
  Normalized_Dataset_Column = apply(Dataset_Table[, Current_Column , drop = F] , 2 , function(x) x / NormalizationSeed)
  Normalized_Dataset_Column = data.frame(Normalized_Dataset_Column)

  # Saving the new  normalized column to the dataset
  for(Current_Row in 1:nrow(Dataset_Table))
  {
    Dataset_Table[Current_Row , Current_Column] = Normalized_Dataset_Column[Current_Row , 1]
  }
}
```

Figure 12: Algorithm that performs the Normalization

3.1.4 Operations on processed Data Matrices

When we finish with the normalization phase of the script, we begin creating the data needed to create our similarity graphs using different clustering algorithms. In order to be able to check which pupil is closer in their characteristics with another pupil, the edge list of the graph will include edges between all nodes with each other and calculate a corresponding weight for each edge. The weight of each edge is calculated using the equation of the Euclidean distance; its node's attributes (Correct %, Wrong %, Mean Time etc.) are taken as a vector and used accordingly to perform the necessary operation to get the edge weights.

```
Temp_Distance1 = Dataset_Values[counter,]
Temp_Distance2 = Dataset_Values[counter_2,]

Temp_Distance1 = lapply(Temp_Distance1, function(x) as.numeric(as.character(x)))
Temp_Distance2 = lapply(Temp_Distance2, function(x) as.numeric(as.character(x)))

Temp_Distance1 = as.data.frame(Temp_Distance1 , stringsAsFactors = FALSE)
Temp_Distance2 = as.data.frame(Temp_Distance2 , stringsAsFactors = FALSE)

# finding the Eucledian Distance for the calculation of the edge weight
Overall_Distance =  sqrt(sum((Temp_Distance1 - Temp_Distance2) * (Temp_Distance1 - Temp_Distance2)))

if(Overall_Distance != 0.0)
{
  Edge_Weight = 1 / Overall_Distance
}
else
{
  Edge_Weight = 1
}
```

Figure 13: Calculating the Euclidian Distance between two Nodes

In the above image, all columns of the dataset are used except the "Subject" and the "Test_Date" columns. Then, based on the particular edge list generated, the graph G0 that will be used for plotting is created. At this stage, the program is able to delete all underscore vertices if the user requested it in the beginning for visualization or other reasons. Moreover, the G0 graph object will be passed to the clustering algorithms, walktrap, leading eigen, Louvain and edge betweenness to create the communities objects and finally the plotting will take place. The script will also perform a filtering of the edges based on user's input, the one used in the below visuals is 1.5.

```
# Filtering the nodes with underscope if user wants to
if(Delete_Underscope_Vertices == TRUE)
{
  G0 = delete_vertices(G0 , grep("_" , Graph_Nodes$GraphNodes))
}

#------------------------ Clustering Algorithms ------------------------

ClusteredGraph0 = cluster_walktrap(G0)
ClusteredGraph1 = cluster_leading_eigen(G0)
ClusteredGraph2 = cluster_louvain(G0)
ClusteredGraph3 = cluster_edge_betweenness(G0)
```

Figure 14: Clustering Algorithms

3.1.5 Computing data clusters

The above clustering algorithms will be plotting and produce 4 graph images (one for each clustering algorithm) that show the communities detected by the algorithm used (with random generated colours) and the nodes that are contained in the communities; a legend is also included in each graph that shows to which cluster the community colour corresponds to. In addition, 4 other graph images are also created which are referred to as "simplified" that instead

of having the node's name above the node, a number is displayed to remove the chaotic overlapping of labels when the clusters are very close; a match table file is included in the graphs' folder so that the user can see which one is which.

3.1.6 Clusters revealed

As shown in figures 10 and 11, the script will create 4 folders for each clustering algorithm and will create reports that will have the nodes of the cluster and a properties table that displayed the median and the mean properties (other can be displayed for different analyses) of the cluster. Also, as mention above, a clusters' summary file will include all clusters created from all algorithms along with the properties table that the user can view in collaboration with the graphs to have a better picture of the output generated. Furthermore, all graphs generated are as such so that to keep the position of the nodes the same in order for the user to see more easily the differences between clustering algorithms used, for example the number of clusters created. For this case, the seed value used to keep everything in place is 500. Below, the graphs and a sample of the reports created are displayed:
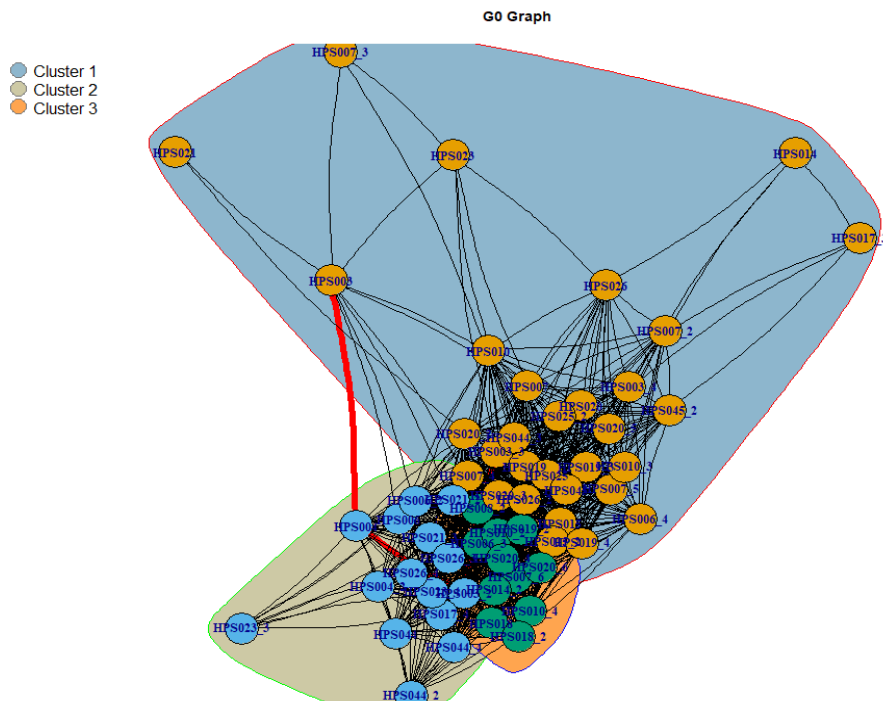
Figure 15: Louvain Algorithm Graph
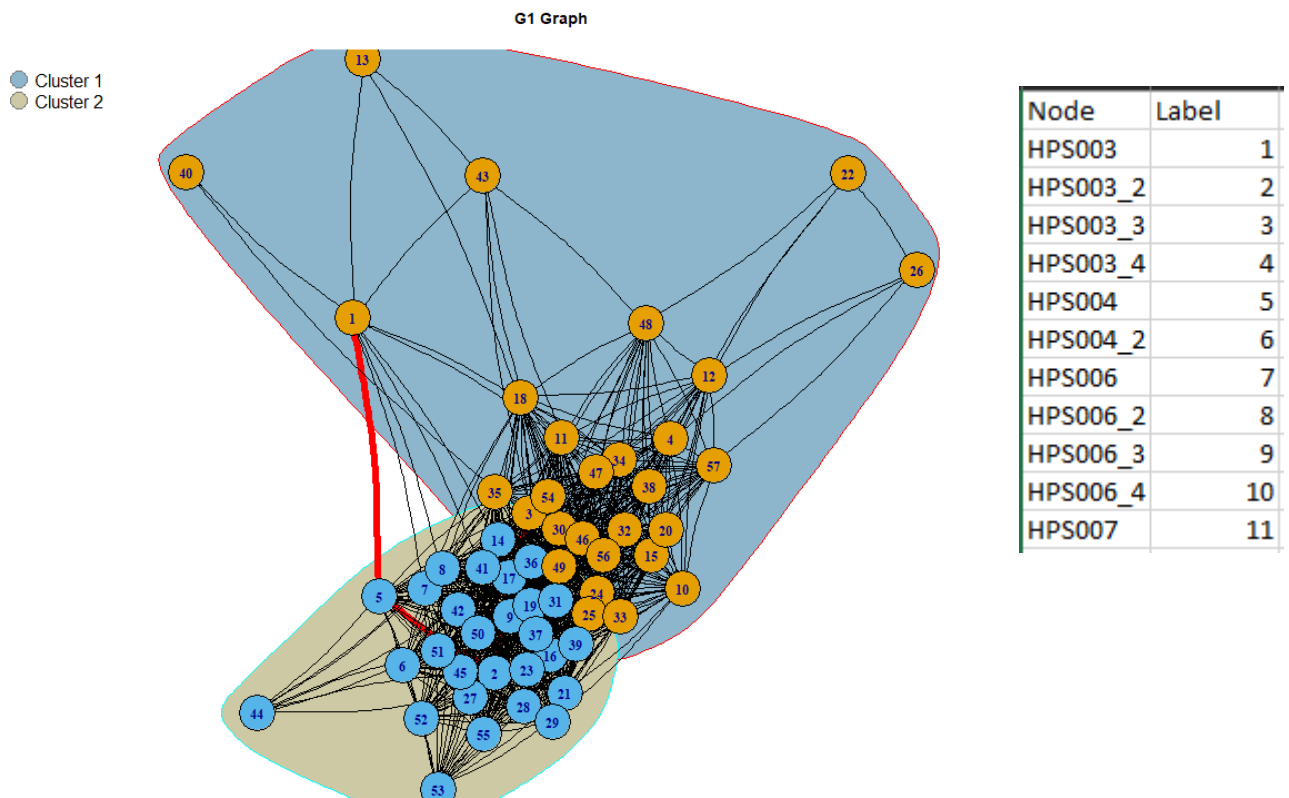
Figure 16: Walktrap Algorithm Graph - Simplified

The table in the figure:

Node	Label
HPS003	1
HPS003_2	2
HPS003_3	3
HPS003_4	4
HPS004	5
HPS004_2	6
HPS006	7
HPS006_2	8
HPS006_3	9
HPS006_4	10
HPS007	11

Note: Although the clusters' colours in the Louvain and Leading Eigen algorithms are the same in the legend, the clusters are just numbered differently (can be verified by seeing the algorithm reports).

3.1.7 Features Extraction of Clusters obtained

All in all, the extraction features that are included in the generalized R script are getting the clusters detected along with their nodes and a property table that shows the median and the

Embedding Node Result

New Node Attributes

	Correct (%)	Wrong (%)	No Response (%)	Mean Time	Mean Time Correct	Mean Time Wrong
Values	0,032607332	0,00919694	0	0,39043606	0,396341499	0,339254212

New Node Cluster Placement Table

	Walktrap Algorithm	Leading Eigen Algorithm	Louvain Algorithm	Edge Betweenness Algorithm	
Cluster Number	1	1	3	31	

mean of the particular cluster, clusters' summary report, graphs for all clustering algorithms applied, graph charts and an embedding node report. The below image displayed the report output for the embedding feature:

Clustering Summary using Walktrap Algorithm

Cluster 1

Cluster Properties Table	Correct (%)	Wrong (%)	No Response (%)	Mean Time	Mean Time Correct	Mean Time Wrong
Median	0,5	0,448275363	0,16666675	0,494850284	0,376145544	0,234600932
Mean	0,462068959	0,450653923	0,255746948	0,51619571	0,377858321	0,249949736

Cluster 2

Cluster Properties Table	Correct (%)	Wrong (%)	No Response (%)	Mean Time	Mean Time Correct	Mean Time Wrong
Median	0,8	0,137930642	0	0,72095704	0,52775063	0,328956425
Mean	0,833333332	0,139162489	0,080357045	0,738007791	0,536013019	0,346633361

Clustering Summary using Leading Eigen Algorithm

Figure 17: Clusters' Summary Report

Clustering Summary using Louvain Algorithm

Median Properties Table						
Cluster Number	Correct	Wrong	No_Response	Mean_Time	Mean_Time_Correct	Mean_Time_Wrong
1	0,8	0,20689648	0	0,63976576	0,458081304	0,262321809
2	0,866667	0,06896553	0,08333325	0,80770748	0,585579374	0,379248359
3	0,5	0,44827536	0,16666675	0,49485028	0,376145544	0,234600932

Louvain Algorithm Chart
Median of Correct & Mean Time Correct

Figure 18: Graph Chart Sample

Cluster Number	Median Distances from Each Cluster			
	Walktrap Algorithm	Leading Eigen Algorithm	Louvain Algorithm	Edge Betweenness Algorithm
1	0,679180453	0,660631928	0,836583716	1,082343241
2	0,855618136	0,957965389	0,957965389	0,838686686
3	-	0,829420407	0,679180453	0,767555893
4	-	-	-	0,716297207
5	-	-	-	1,056525791
6	-	-	-	1,060778496
7	-	-	-	0,830057552
8	-	-	-	0,7710791
9	-	-	-	0,721811959
10	-	-	-	0,801746104
11	-	-	-	1,159866426
12	-	-	-	0,702894574
13	-	-	-	0,81829187
14	-	-	-	0,802951545

Figure 18: Displaying Median Distances used for the Embedding

21	-	-	-	0,710146801
22	-	-	-	0,771701654
23	-	-	-	0,714555051
24	-	-	-	1,110475279
25	-	-	-	0,966695939
26	-	-	-	1,209367081
27	-	-	-	0,706484147
28	-	-	-	0,819718319
29	-	-	-	1,119824988
30	-	-	-	1,222918351
31	-	-	-	0,698165619
32	-	-	-	0,761561315
Minimum Distance From Clusters	0,679180453	0,660631928	0,679180453	0,698165619

Figure 19: Displaying Minimum Distances used to determine the cluster to insert the new node

For the feature of graph charting (figure 8) it must be noted that it is the **ONLY** feature included that was performed with a manual operation, all other feature discussed on this document are created dynamically depending on the dataset input.

3.1.8 Computing the path between clusters for a pupil

The R script has also a basic functionality of monitoring a specific node's path in order for the user to see the progress of the pupil after taking the test again. The way this path is highlighted in the graph (see red lines displayed in the images) is by finding the shortest path (using the shortest_path built-in function of the igraph package) between two nodes (the one monitoring and its next node (NODE_#).
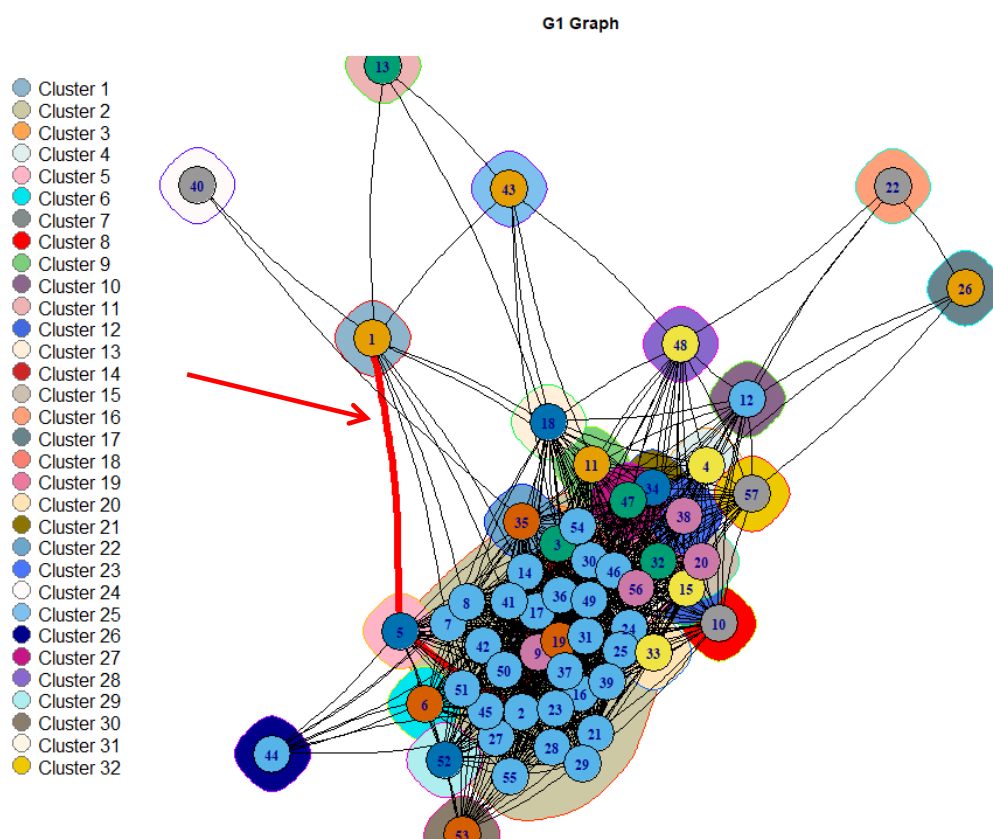
3.1.9 Embedding Feature

In order to determine where the new node should be added, we need to know some characteristics that the clusters in the graph created have. One such characteristic of a given cluster created from a graph is the Median; a Median vector can be created that will include all the Medians of each column of the nodes that are included in that particular cluster. With this methodology we will be able to calculate the Euclidean distance between the Median values of

the Median vector with the values that the new node has in that particular column and determine to which cluster the new node is closer in distance. More specifically:

Suppose we have a clustered graph with two clusters generated, called C1 and C2. Then, because we have 6 columns in our dataset, we will have 2 vectors (one for each cluster) which will contain 6 items (one for each column), this items will be the Medians of all the nodes that are included in that particular cluster.

Median vector of C1: $C_1 (M_1^{(1)}, M_2^{(1)}, M_3^{(1)}, M_4^{(1)}, M_5^{(1)}, M_6^{(1)}) = U_1$

Median vector of C2: $C_1 (M_1^{(2)}, M_2^{(2)}, M_3^{(2)}, M_4^{(2)}, M_5^{(2)}, M_6^{(2)}) = U_2$

New node's attributes: V $(V_1, V_2, V_3, V_4, V_5, V_6)$

Now, we will compare the Euclidean distances (d) of the Median vectors with the new node's attributes vector (a vector with all the values that the new node has in each column) to determine to which cluster the new node is closer too.

$$d(U_1, V) \leq d(U_2, V)$$

The above methodology determined the new node placement and the Euclidean distances can be viewed in figure 19.

3.2 Astrophysics Analysis

For the astrophysics analysis, similar R scripts with the neuroscience analysis where used to create the results that will be displayed below. In the particular analysis, individuals will view results taken when applied to a particular dataset regarding galaxies with specific properties similar to the analysis done by Farrah et al. [4]. In the below sections, readers will see the approaches used to find clusters in the dataset which were applied, the output structure and information extraction features similar to the neuroscience analysis, view graph plots taken via the R scripts created, the steps needed to configure and see how the scripts used work.

3.2.1 Astrophysics Clustering Approaches

The clustering analysis for the astrophysics dataset is broken up into two separate approach paradigms, the exponential distance approach [3] and the Euclidean distance approach. For the

first approach, in order to perform the clustering into our dataset, the following methodology is followed:

- The algorithm receives two parameters, the Epsilon ε threshold and the Sigma σ parameter
  - The ε parameter is a threshold that filters the edges of the graph
  - The σ parameter is a parametric value in the exponential equation for normalization purposes
- The Euclidean distance (EUD) is calculated for all possible combinations of node edges
- The edge existence is filtered based on the ε threshold, if the edge weight (EW) found with EUD is: $EW < ε$
- The result of the above operation will output an adjacency matrix that will have a 0 or 1 to denote that the edge should exist or not
- This adjacency matrix is then used so that for the edges that exist, the exponential weights of the edge is calculated using the below equation:

$$exponential\ weight\ =\ exp\left(-\frac{(N_1\ -\ N_2)^2}{2\ \sigma^2}\right)$$

Where:

N_1: a selected node

N_2: the node to find the distance

σ: the sigma parameter

Note: the above equation is applied to all combinations of nodes

- The graph object is created using the weights found with the above methodology and clustering algorithms are applied (Louvain, Leading eigenvector and Walktrap)
- The Kmeans algorithm is also used by calculating the embed Laplacian matrix and passing it to the Kmeans algorithm as parameter (Kmeans does not exist as a ready-made function of igraph)
- Finally, all the clustering graph outputs are plotted

In the second approach, the Euclidean methodology, only the first part of the exponential is basically used to find the distance of each node to the another:

- The algorithm receives one parameter, a filtering weight parameter that deletes edges **<u>after</u>** the clustering has occurred
- The Euclidean distance is calculated for all possible combinations of node edges

- The graph object is created with weights and the edge list found in the above steps
- The clustering algorithms (Louvain, Leading eigenvector and Walktrap) are applied to the graph object
- Finally, all the clustering graph outputs are plotted

3.2.2 Astrophysics R Scripts Architecture

To address the requirements of the above approaches and extract useful information from the clustering data analysis in the astrophysics dataset, three (3) individual (main) scripts were created. The first one, creates graphs based on the Exponential approach and plots
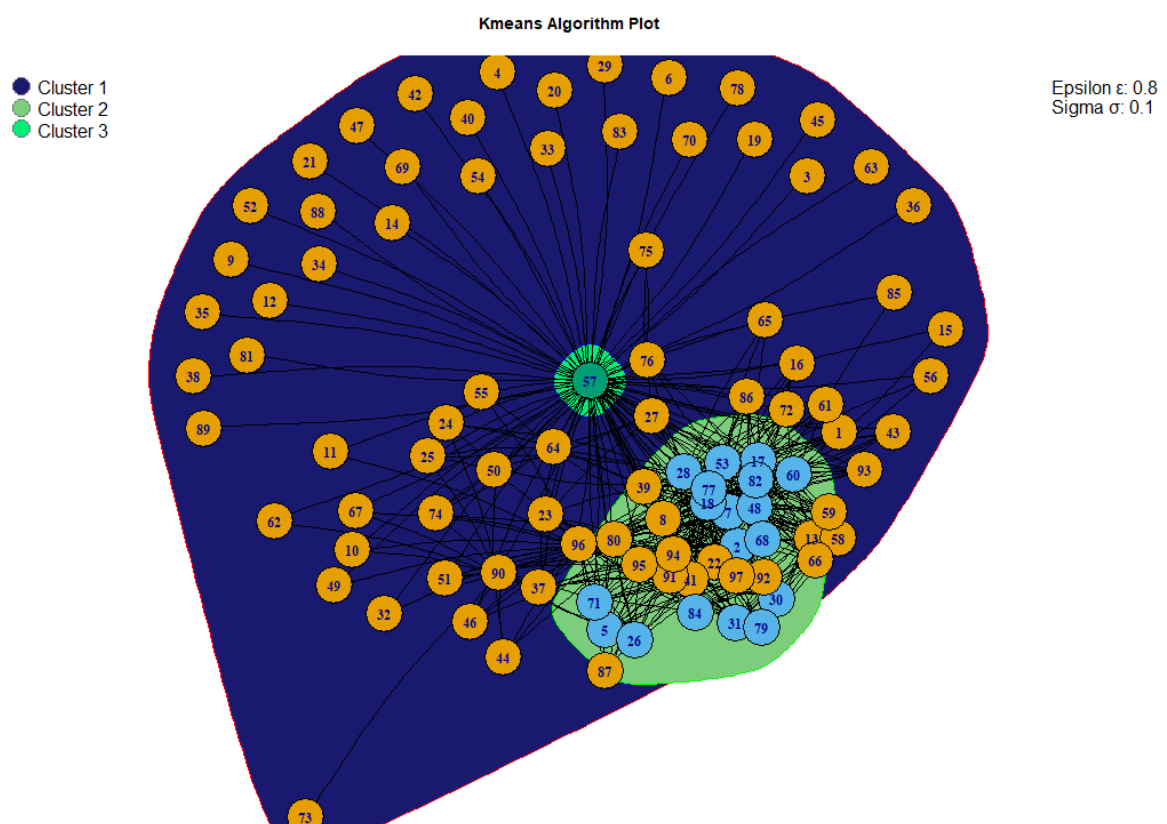
Figure 20: Kmeans algorithm implementation (not under igraph)

them; it also uses the feature extraction R script to create reports that contains information regarding the clusters found for each algorithm run.

The second script creates the Euclidean approach graphs which are then also plotted, and the feature extraction can also be used. In the main plots (the ones that **do not** have the word "Comparison" on them), the graphs that are created using the Euclidean distance include in the calculation columns 5,6,7,8,10,11 and 13 of the dataset (left side of image) along with another

graph that was created using **only** column 13 (IR Luminosity, right side of image); the two plots are combined in one image for comparison purposes; three (3) such images, one for each clustering algorithm is created (names end with the word "Plot").
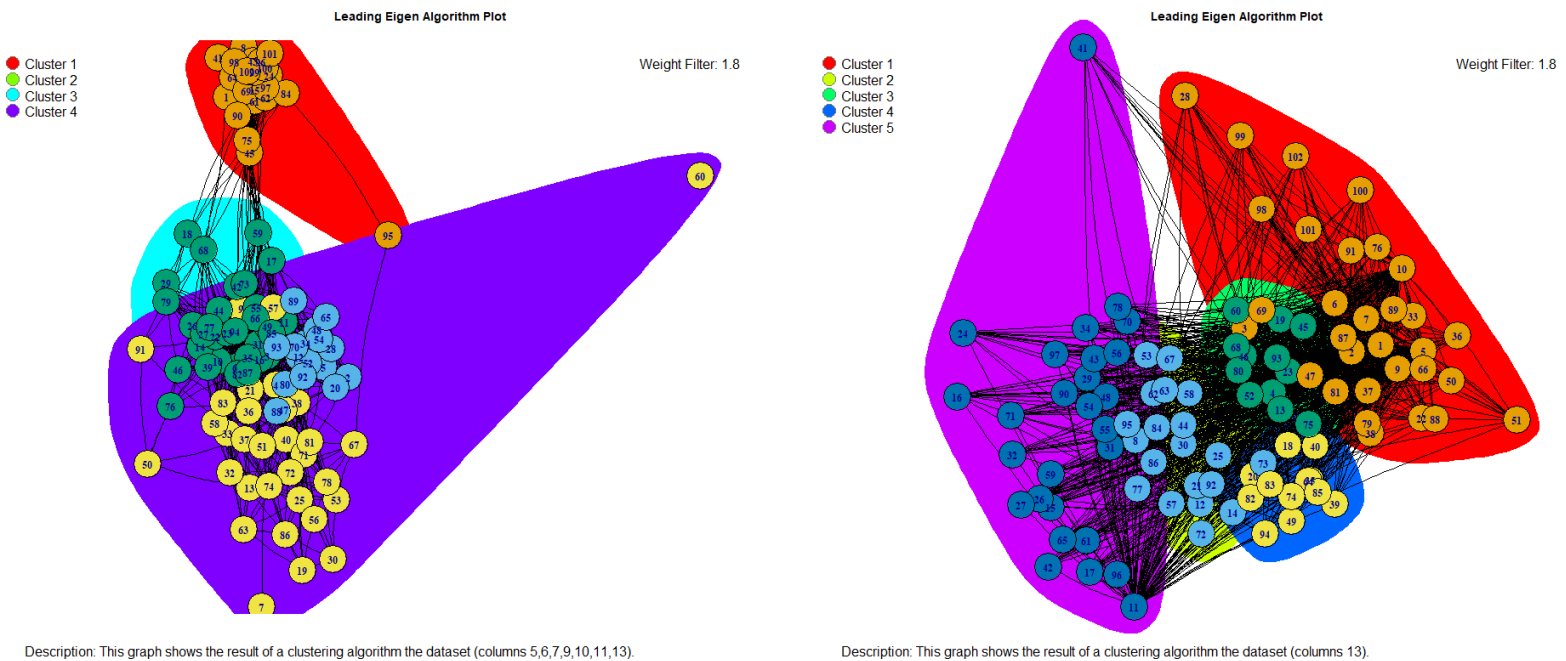
Figure 21: Main Plots of the Clustering Analysis with the Euclidean Approach

In addition, this script creates comparison (secondary) plots that include in a single image the clustered graph displayed in the main plots (with columns 5,6,7,8,10,11 and 13) along with graphs that display similar graphs as Farrah et al. [4] Figures 6 and 7; the graph nodes' sizes are determined based on the value that they have in the dataset. The method to break down the dataset column to determine the colors (displayed in the bottom-right corner of the right image) is the following:

- The dataset column selected for the analysis is broken down into 4 intervals:

Figure 22: Determining Color Intervals

- The case of the value being zero is treated as another color case from the above 4 (thus having 5 coloring classes)
- The nodes are colored according to which interval their column value belongs too

These comparisons are implemented for columns IR Luminosity, Optical Spectral Type, Nuclear Separation and Black Hole Mass. In total, these comparison images are 12 (4 for each clustering algorithm run) and show the clustered graph along with the graphs created with the
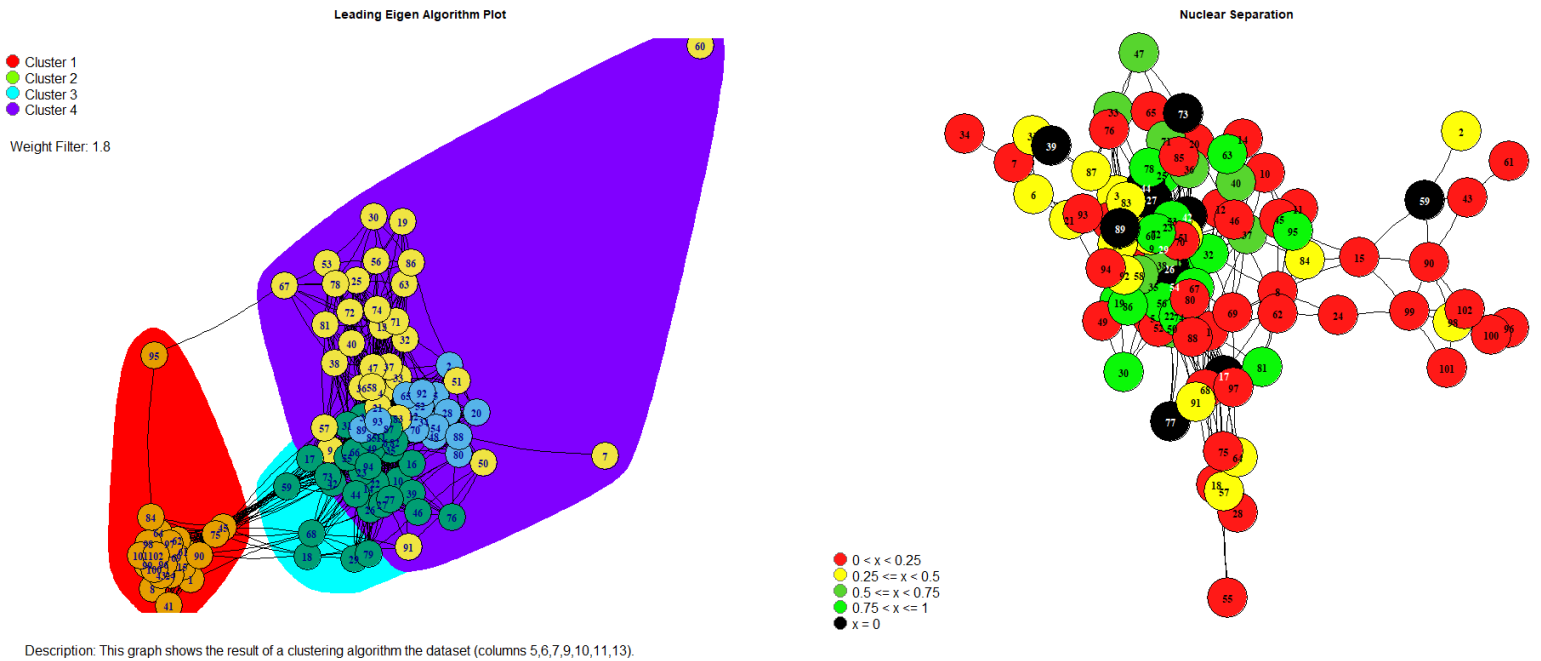
Figure 23: Displaying a comparison plot that shows the Waltrap algorithm along with the Nuclear Separation attribute
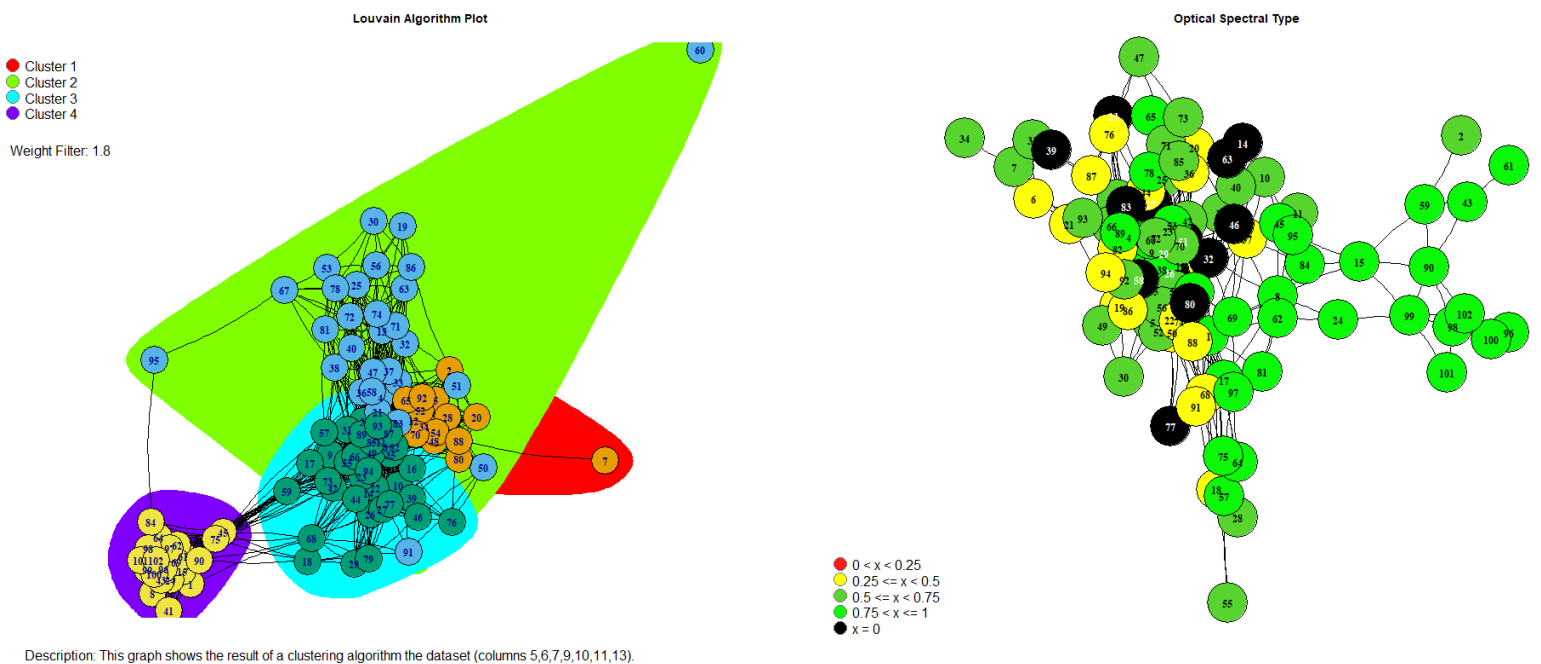
Figure 24: Displaying a comparison plot that shows the Louvain algorithm along with the Optical Spectral Type attribute

above methodology so that to determine the particular characteristics of a node and find in which cluster the node belongs too with ease.

Finally, the third (and last) individual script follows the Farrah et al. [4] approach, meaning, the script recreates the original graph of Farrah's document using the degree (the ncons column basically) of each node in order to color, and sets the node sizing in the graph. The following table shows these categories:

Color	Node Degree Case	Interval	Mapping Values
	0	< 4	0
	1	4 − 7	0.25
	2	7 − 14	0.5
	3	14 − 20	0.75
	4	> 20	1

Figure 25: Coloring & Values Mapping Table

Then, the 3 clustering algorithms used in the previous scripts are utilized to apply once more the clustering analysis to the graph of Farrah's and determine to which cluster its node belong too. Furthermore, the node sizing can also be displaying in the plots with the clustered graphs. The clustered graphs are displayed in the left side and the Farrah's graphs are displayed in the right side of the images ending with the word "ncos Comparison".
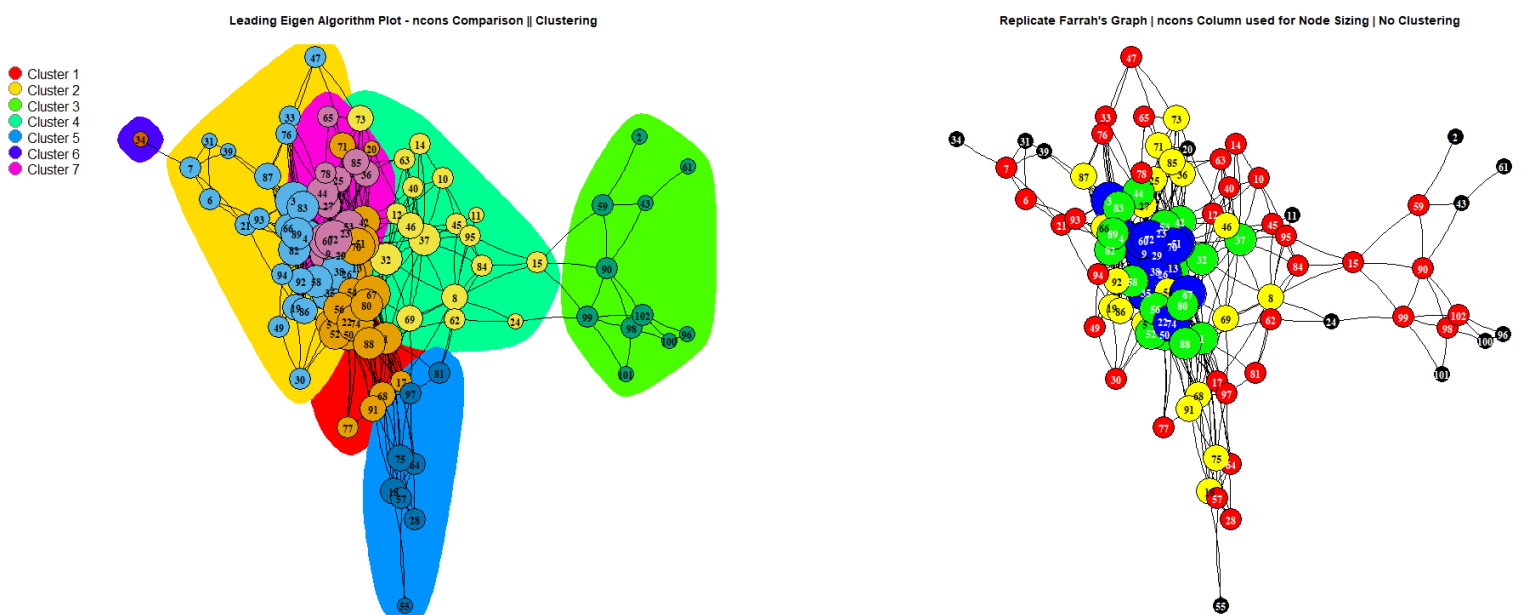
Description: This graph contains nodes sized according to ncons column (node class) with clustering applied to it (areas marked).

Figure 26: Displaying the clustered graph (left) with a replicate of Farrah et al. [4] graph, colored & sized based on the degree

Moreover, a similar procedure is followed in order to produce analogous to the ncons column comparison plots with the Optical Spectral Type (optc) column; the values of the optc column
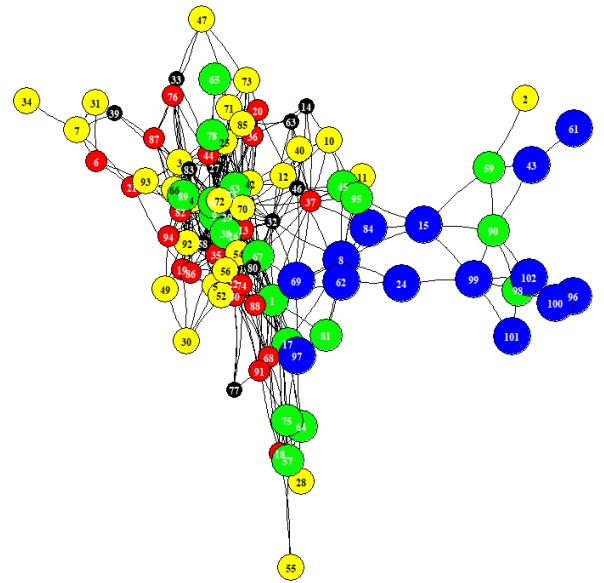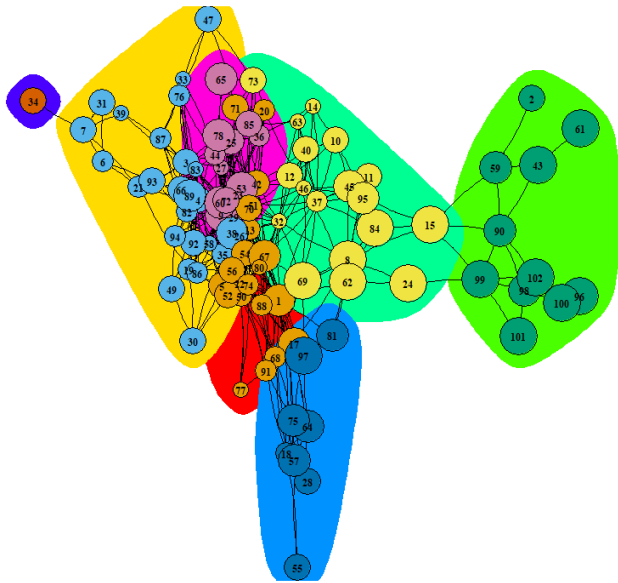
Description: This graph contains nodes sized according to optc column (node class) with clustering applied to it (areas marked).

Figure 27: Displaying the clustered graph (left) with Farrah et al. [4] graph, colored & sized based on the optc column

are distinct and thus the same value mapping is used.

3.2.3 R Scripts' Parameters & Outputs

The parameters needed for each R script to run are the following:

EXPONENTIAL ANALYSIS SCRIPT

```
#-------------------------------------------- Script Parameters ----------------------------------------
# The output files will be saved in the below folder specified
OutputDirectory = "C:                        strophysics Outputs"

# Reading the dataset file
Dataset_Table = na.omit(read.xlsx(paste(FilesDirectory , "Farrah_original_data_normalized.xlsx" , sep = "") , sheetIndex = 1))

# Epsilon variable is used to filter the edge in the euclidean distance filtering
EpsilonThreshold = 0.8

# Sigma variable is used in the exponential distance between nodes so that to find the edge weights
SigmaParameter = 0.1

# The user can choose if he/she wants to have feature extraction reports
GetReports = F
```

Figure 28: Exponential approach Script Parameters

EUCLIDEAN ANALYSIS SCRIPT

```
#------------------------------------------ Script Parameters ----------------------------------------

# The output files will be saved in the below folder specified
OutputDirectory = "                    /Astrophysics Outputs"

# Reading the dataset file
Dataset_Table = na.omit(read.xlsx(paste(FilesDirectory , "Farrah_original_data_normalized.xlsx" , sep = "") , sheetIndex = 1))

#Edges' Filter in order to see the similarities above a certain thresshold
GOFilthering_Weight = 1.8

# The user can choose if he/she wants to have feature extraction reports
GetReports = F
```

Figure 29: Euclidean Approach Script parameters

FARRAH REPLICATE SCRIPT

The third script has no extra parameters other than the output folder, the dataset, edge list files and whether to get cluster reports or not.

```
#------------------------------------------ Script Parameters ----------------------------------------

# The output files will be saved in the below folder specified
OutputDirectory = "C                    strophysics Outputs"

# Reading the dataset file
Dataset_Table = na.omit(read.xlsx(paste(FilesDirectory , "Farrah_original_data_normalized.xlsx" , sep = "") , sheetIndex = 1))

# Reading the edge list file
Dataset_Edges = na.omit(read.xlsx(paste(FilesDirectory , "Edge_List_Optimized.xlsx" , sep = "") , sheetIndex = 1))

# The user can choose if he/she wants to have feature extraction reports
GetReports = F
```

Figure 30: Exponential approach Script Parameters

Each script, when the appropriate parameters are passed will create a folder with the below files structure:
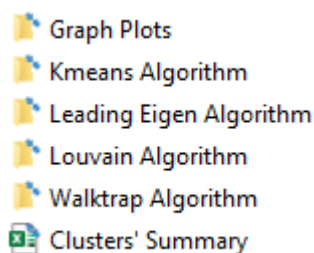
Figure 31: Astrophysics Output with Reports
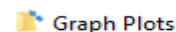
Figure 32: Astrophysics Output without Reports

For each script run, the user will receive a folder with the output files requested and the appropriate graph plots. More specifically, the "Graph Plots" folder will contain for each script run:
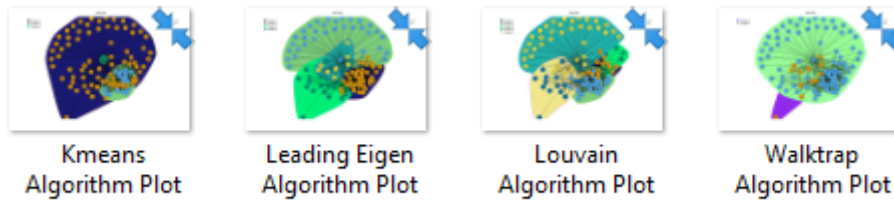
EXPONENTIAL ANALYSIS SCRIPT

Figure 33: Exponential Script Plots
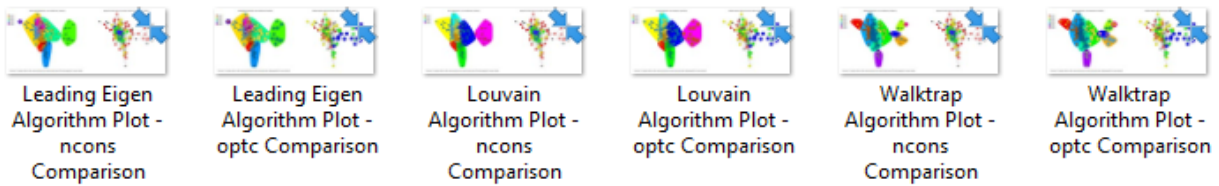
EUCLIDEAN ANALYSIS SCRIPT

Figure 34: Euclidean Script Plots

FARRAH REPLICATE SCRIPT

Figure 35: Farrah's Replicate Script Plots

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Additional User Manual

Neuroscience Analysis R Script Manual

In order for users to be able to utilize the neuroscience analysis scripts they need to have in mind some information regarding the setup and the internal processes of the script so that to produce results that fit their needs and expectations. With the above goal as a reference, a user manual is displayed below, aiming at providing the appropriate insights, script parameters guidelines, output expectations, some information to have in mind when passing script parameters and some comments regarding the format of the dataset when passed into the script.

Script Architecture

The R script is broken into two R script files, one containing all the functions used for the report creation, the pre-processing analysis, the weight filtering etc., called **NeuroscienceClusteringUtilityFunctions.R** and the second one (the main file) called **NeuroscienceClusteringScript.R** which contains all the necessary code used to create the graph object that will be used to perform the clustering analysis and the plotting of the graph.

Figure 36: R script Files

Script Parameters

The R script (when referring to the R script, we refer the **NeuroscienceClusteringScript.R**) needs to receive six (6) parameters from the user in order to run and all can be given between lines 15 and 37.

```
15 ▾ #------------------------------------------- Script Parameters -----------------------------------------
16   # The output files will be saved in the below folder specified
17   OutputDirectory = "C:/Users/Giannis/Desktop/Neuroscience Outputs/"
18
19   # Specifying the dataset file that the script will take as input
20   Dataset_Table = na.omit(read.xlsx(paste(FilesDirectory , "results_REC_selected.xlsx" , sep = "") , colIndex = c(1 , 3:8) ,
21
22   #Edges' Filter in order to see the similarities above a certain threshold
23   GOFilthering_Weight = 1.5
24
25   # Delete Underscore Vertices
26   Delete_Underscope_Vertices = F
27
28   # New Node Definition for Embeding Feature (Random node created)
29   NewNodeVector = c(78 ,  22 ,  0 , 933.9621 ,  948.0885 ,  811.53)
30
31   # Node to select to see how it changes clusters
32   MonitorNode = "HPS003"
33
34   GetReports = F
35
36   # Clustering algorithms used
37   # cluster_walktrap || cluster_leading_eigen || cluster_louvain || cluster_edge_betweenness
38
39 ▾ #----------------------------------------- Script Parameters End -----------------------------------------
```
Figure 37: Parameters Section of the Script

More specifically, the above image shows that the user can change the following:

- The folder where the output will be saved
    - (**Output Directory**: Windows Path in string format)
- The dataset file
    - (**Dataset_Table**: XLSX file)
- A weight threshold were all the edges below that threshold of the graph will not be visible in the final plots
    - (G0Filthering_Weight: Float Number)
- To either delete or not all the tries except the first of each node
    - (**Delete_Underscope_Vertices**: TRUE or FALSE)
- A numeric vector that contains 6 scalars (one value for each columns of the dataset)
    - (**NewNodeVector**: c(# , # , # , # , # , #))
- A string that contains the name of the node to monitor in the plots; a red line will be drawn that shows how the monitor node changes clusters with each try of the test
    - (**MonitorNode**: String)
- Can choose to get reports or not regarding the clusters produces (feature extraction)
    - (**GetReports**: TRUE or FALSE)

Script Capabilities & Output

Once a user sets up the above parameters for the script to use, after about 1-4 minutes the user will receive a folder named with the format **"Graph Clustering – TIME – DATE"**. That folder will contain the following files:

- A folder with all the plots created for each clustering algorithm run
- One folder for each clustering algorithm run containing cluster reports that have in them the data of all the nodes that belong to that cluster along with a properties table that shows the median and the mean of that cluster
- A **"Cluster's Summary"** file that has the properties tables of all the clusters created for each of the algorithm run
- An **"Embeding Node Report"** file that contains information regarding the insertion of the new node (specified in the **NewNodeVector** parameter); the cluster the new node should have been placed and the median distances from the clusters to the node
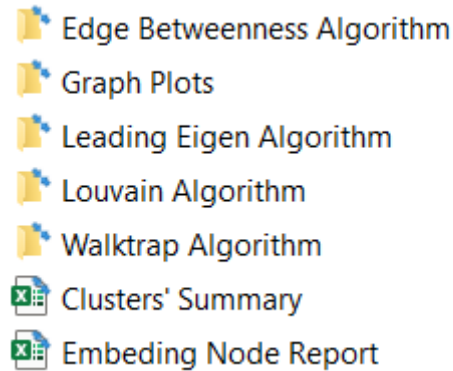
Figure 18: Output Folder

Figure 39: Output Files

Note that if the user chooses to not get reports from the analysis, he/she will **only** get the **"Graph Plots"** folder that will contain only the plots created (This will take a few seconds to produce).

Figure 40: Output Without Reports

Final Comments

In order for the user to use another dataset to perform the data analysis and produce the above output format in the current version the R script is in (it can expand to more columns), the dataset **MUST** be an excel file (xlsx or xls file type) and be populated with 8 columns in the order and naming displayed in figure 6.

Subject	Test_Date	Correct(%)	Wrong(%)	No_Response(%)	Mean_Time	Mean_Time_Correct	Mean_Time_Wrong

Figure 19: Columns needed for the R Script to work

All in all, the R script is partitioned using comment areas so that the user can understand what the R script is doing at that particular section and perform modifications with ease.

```
#-------------------------------------------------- End --------------------------------------------------
#------------------------- Calculating the Weights of the edges of the graph -------------------------
```

Figure 41: Code Sections are partitioned with comments

European University Cyprus

School of Sciences | Department of Computer Science and Engineering

Be-com Instructional Video Production

Bachelor of Science
in Computer Science

Michael Kourtellis

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Abstract

For the successful completion of the Be-com project the EUC research team and I began the investigation of online collaboration tools for educational purposes, the investigation was split in criteria's we thought were necessary to achieve this goal. We began by clarifying what exactly "online collaboration" is, then we proceed to unveil the types of online collaboration tools that would partially give an advantage to our cause. Although we know how the online collaboration works as a system our focus was on the educational aspect and what were the requirements for it to succeed, furthermore we deconstructed it and arrived at the levels in which although they are intertwined, as a whole make online collaboration easier for everyone. We discuss about Security and Privacy matters associated with online collaboration and we begin a thorough investigation on online collaboration tools to see if they fit the requirements, by comparing them we arrived to the best online collaboration tools for our needs. In the end we showcase what was the process for deciding what the videos will be about and how we created them.

Table of Contents

1 Introduction

1.1 Overview

We live in a day and age in which the development of our technology has made immense progress. In fact the evolution is happening with such great speed that our learning capabilities are stretched. Sometimes, mistakenly so, we take for granted that people all around the world had the time to learn how our progressive technology works, especially in the area of education. Since the appearance of the Internet until now we saw the development of Cloud collaboration which gave the world the ability to share information with other members without the hindrance of distance or unavailability. Internet and cloud technologies also make it possible to work simultaneously on a project with real time editing from all the involved parties, no matter where they are in the world. The possibilities offered by technology are far greater of what we thought, especially in our education. Through Cloud Collaboration we managed to have a virtual classroom in which the instructor can teach the class in the same (or at least a very similar) manner to what they would normally do in an actual classroom. Via online collaboration it is possible to conduct assignment, reviews, as well as examinations in a manner that did not degrade the quality of the study.

This project was conducted in order to fulfil the requirement for my bachelor's in computer science at the European University Cyprus. This project is part of and concerns a bigger research project that researchers in the Department of Computer Science and Engineering are participating. The research project is called Be-com and has a general objective to try and cover this gap created by the ever evolving technology and the interactions of people (and more specifically educators) trying to take advantage of this digital world. This project's objective (briefly) is to provide instructional material relating to: 1) working on the cloud, 2) sending large files and 3) secure communications in the era of web. The material will be in the form of short instructional videos, which will be used to supplement the deliverable of EUC for the Be-com project.

1.2 Aims and objectives

Even through the Be-com project concerns three areas of interest, the senior project focused on primarily on the 'working on the cloud' aspect.

A first aim of the senior project is to introduce the Be-com project and present what it is trying to achieve. As part of this, a first objective would be to explain the project and the participating partners. A second objective would be to explain what the research team at EUC is responsible for and clarify what are the required outputs and deliverables for the project.

Secondly presented, is the primary aim of this work. To fulfil the 'working on the cloud' aspect of the research team at European University Cyprus. The first objective for this aim is to define and explain what is 'working on the cloud'. A second objective is to identify for are the requirements for an organisation using cloud services and more specifically an educational organisation. A third objective is to perform an investigation of the available cloud services that can be used and realise if they satisfy the requirements. A fourth objective would be to identify the most appropriate cloud service to use for the videos. A fifth objective is to select what videos to create that will demonstrate various aspects of working on the cloud. A final (and the most time-consuming) objective would be the creation of the videos. This last objective involves learning to use the video editing software that has been selected from the partners of the project.

1.3 Structure of thesis

Chapter 2 provides overview information related to the Be-com project and the partners. The chapter also includes details of the European University Cyprus research team responsibilities and any deliverables, as well as the plan of action for this project.

Chapter 3 describes the work performed for the 'working on the cloud' aspect of the project. First we explain certain concepts in more detail, then we derive requirements. Following that we present the investigation of available options and then try to identify the best suited service to use.

Chapter 4 starts by presenting a list of videos that will be created and a brief overview of each video. The chapter then gives details of guidelines and video requirements. The main body of the chapter presents the steps of creating a video for the Be-com project.

Chapter 5 offers an overall account of the work completed for this project. The chapter gives details of results and/or outputs as well as some suggestions for future work.

1.4 Summary

We talked about the project and the reason as to why there is a need in creating such a project, the aims and objectives of said project and a brief explanation of the process and lastly the structure of the thesis and what it will include.

In the next chapter you will be presented with a more detailed explanation of what the Be-com project is.

2 The Be-com project

2.1 The project

Digital competence is the ability to use the technology in the best way possible for information gathering, communication and also be able to come up with solutions to problems that arise in our daily life. At the same time, there is also the skillset of Digital Literacy, which means that when you are presented with a new or an unknown existing technology, you have the knowledge to navigate, evaluate and create information with the help of what you believe is best suited from the existing range of digital technologies.

Through the advancement of digital technologies, came an overwhelming amount of possibilities and applications. Unfortunately, the education system lacks the ability to incorporate the fast evolvement of technology and as a result we see that the youth lacks the ability of Digital Competence and Digital Literacy.

The project's main objective is to strengthen communication skills through educational tools and good practises, promote the idea of open resources and ICTs in higher education level, enhance the student's knowledge that will take part in a testing & evaluation from 3 European universities and equip teachers in the academic section with didactic tools to be used on students that will help the teacher and the student to adapt easier in the changes of the modern market.

2.2 The partners

The Be-com project partners are:

The University of Silesia in Katowice (Poland),
"*one of the largest and most dynamically developing public universities in Poland. Founded in 1968, the University of Silesia quickly established a reputation as a vibrant academic institution and an important interdisciplinary research hub. With a tradition of launching new programmes to best meet the needs of rapidly changing labor markets, the University of Silesia offers students a variety of programs and specialized fields of study. With outstanding research teams and well-equipped laboratories, we are an important player on the global research arena. We actively participate in European Commission initiatives focused both on educational*

and scientific development, and realize projects within the frame of programmes such as Erasmus+ and Horizon 2020." (Slaski, 2020)

The Kazimieras Simonovičius University (Lithuania),

" Kazimieras Simonavičius University (KSU), founded in 2003, is an accredited private institution of higher education with campuses in Vilnius and Klaipeda, Lithuania. KSU stands out for its innovative approach to learning and its entrepreneurial values.

The studies cover major areas of Social Sciences – Business and Management, Public Administration, Law, Communication, Political Sciences. The University offers 11 Bachelor's, 5 Master's and 1 Integrated programmes, as well as life-long learning studies and courses. "
(KSU, 2020)

The University of Malta (Malta)

" Lying at the cross-roads of the Mediterranean, UM has been, over its 400-year history, the hub for international academic exchange on the island. UM is the leading higher education institution in Malta and its structures are in line with the Bologna Process and the European Higher Education area.

At UM we to carry out academic research and provide a vibrant higher education setting in the arts, sciences and the humanities as required for Malta's economic, social and cultural development. Our courses are designed to produce highly-qualified professionals in multiple disciplines. Our alumni community is growing exponentially: well over 3,500 students graduate in various disciplines annually.

We are committed to high standards of research and teaching and every member of staff at UM plays an important role and contributes to an outstanding student experience. "
(Malta, 2020)

The Agere Aude Foundation for Knowledge and Social Dialogue (Poland)

" Despite being so different according to our knowledge, professional experiences and interests we seem to be connected by eagerness for constant and positive changes in the reality we are exposed to.

That's why our foundation's name – Agere Aude – means: Be brave to be active!

We deeply believe in the power of joining different potentials as well as the power of a team varieties. We are sure our commitment, helping passion and sharing the knowledge are the keys to achieve the goals. "
(Aude, 2020)

The European University Cyprus (Cyprus)
" Emphasizing high-level, student-centered academics, a diverse and inclusive student body and powerful corporate, community and government links, EUC is a trustworthy and reliable partner in your pursuit of higher education

Rising in the rankings, European University Cyprus has been gaining local, regional and global acknowledgement of our efforts to be a student-focused and innovative institution, with an emphasis on an international orientation, sustainability and industry/community engagement.

With a history of more than 60 years, European University Cyprus has grown into a leading academic and research institution in the region with Schools of Medicine, Sciences, Business, Law, and Humanities, Social & Education Sciences and a Distance Education Unit.

Though numbers do not tell the whole story, they are concrete evidence of our commitment to be a trusted and thriving partner in your education and future. Impressive data show expanding enrollment, richer program offerings, increasing graduate employability numbers and a wider network of alumni and partnerships.

Responsible for upholding the academic mission and vision of the university, the leadership team is made up of dedicated professionals who work to create an environment of innovation, entrepreneurship, collaboration and support for all members of the university community.

Every day, our faculty, students, researchers and scholars are exploring the frontiers of new knowledge and best practices both on campus and in the field.

Our greatest asset is our people. Each individual plays an important role in contributing to learning, teaching, research and support across the university to serve students' needs and impact society as a leading international university. "
(EUC, 2020)

2.3 Expected project outputs

The first output would be an educational tool which will include, scenarios and instructional videos to be used by students and educators from all fields of study. For the preparation of the toolkit partners would examine these areas: communication in digital environments, sharing resources using online tools, connection and contact with others, cooperation through digital tools, interaction and participation in social activities. The table below presents an account of the areas that will be included in the toolbox.

Table 2-1 Digital toolbox effective communication areas

Private communication through email	Gathering emails in one place	Sending large files	Creating groups of people as a distribution list
Creating custom made templates to use with emails	Managing one or more mailboxes	Use planning tools (calendars, etc)	Use real-time exchanges
Work on the cloud with a group of people	Explain how to use, the cloud application	Sharing resources, that are available on the cloud	How real time editing can happen

The second deliverable (or output) would be an educational tool which will include, scenarios and instructional videos to be used by students and educators from all fields of study and focusing on 'Secure communication'. For the preparation of the toolkit partners would examine how a user can protect their communication, understanding the risks and threats that occur in the digital world and become aware on how to protect/secure the resources from unwanted people, understand why the existence of password policy is needed and why there are multi-step verification systems. Furthermore the toolbox will acknowledge the terms of use for each application, protection of personal data, respect other people's privacy and avoid scams and

threats. It will explain how to use encryption while sending an email to protect the data, how to encrypt data using the cloud or phone or personal computer and how to prevent data loss.

The third deliverable is an electronic handbook providing instructional material on how to communicate in the era of web 2.0. The focus of this handbook is to help 'digital immigrant' teachers become familiar on how to communicate with today's pupils and students who are 'digital natives'.

The fourth (and final) deliverable of the project is an 'educational strategic game based on the action mapping concept and idea of gamification'. This action mapping model focuses on the interaction of the learning with knowledge – mapping possible choices and solving problems. The idea of gamification allows students to acquire skills, ensures greater activation, enhance competitiveness as well as team building skills and also motivates students in asking questions, finding answers and learning (Be-com, 2019)

2.4 European University Cyprus responsibilities

The research team at European University is involved in the project in output 1 and output 2. This means that the team would investigate and report on digital online secure communication. More specifically the methodology to be used is:

Output 1: digital online collaboration and communication. This would entail
- Data collection of guidelines related to usable digital tools
- Preparation of a description of a set of digital tools for communication along with a brief explanation of their operation
- Preparation of instruction film scenarios to understand the need for using digital tools and shaping digital competences in the context of effective communication with the recording of instructional videos

Output 2: data protection, secure communication / collaboration. This would entail:
- Diagnosing digital space necessary for security in the contact of secure communications and providing guidelines in this topic
- Intellectual work using the above guidelines to prepare scenarios for intellectual results taking into account the perceptual abilities of people with low digital competences

- Preparation of screenplays of instructional videos presenting digital tools necessary for safe communication in the virtual world prepared according to the guidelines developed earlier.

The primary focus areas of the local research team are:

- **Working on the cloud**. Online collaboration can be characterized as an innovation that utilizes some collaboration software to permit a gathering of individuals to cooperate with the goal of accomplishing a similar objective. The individuals form a collaborating team and can utilize the collaboration software to organize, communicate, coordinate, share, arrange and take care of issues.
- **Sending large files**: It is the nature of any collaborative environment to want to exchange files. Most of the times the files are transferred asynchronously via email but an email system (and its associated servers) has limitations in dealing with large files. The team will investigate digital tools to be used to either compress the files so that they are smaller in size or use an online transfer service whereby you upload the file on an online server and the eventual recipient(s) can download the file from there.
- **Data protection**: Data is a valuable commodity and should be protected. Protection relates to a)authentication: for messages or online exchanges to ensure that the sender or exchanging entities are in fact who they say they are; b)data access: relating to the ability to control access to systems or resources; c) confidentiality: protection for passive attacks and released of various level of data; and finally d)data integrity: to protect all of part of a steam of data from deletion or alteration.

Plan of Action for EUC research team

The teams of researchers planned the following steps:

1. Data collection related to usable digital tools for online collaboration, large file transfers and secure communication
2. Description of operation of the tools
3. Using the above descriptions preparing guidelines for scenarios of intellectual results taking in to account the perception of people with low digital competences.
4. Preparing of instruction film scenarios and recording of instructional videos

It should be noted once again that for the purposes on this senior project the focus of the work is on 'online collaboration' or 'working on the cloud'. The plan is to collect data on digital tools,

characterise the needs of the users, identify the best fit-for-the-purpose tool and then generate the videos to demonstrate effective usage of the tools.

2.5 Summary

We talked about what the project is about in detail, what are the expected outputs of the project, the responsibilities that the EUC was given and how the research team had planned to tackle the requirements. In the next chapter we will talk about the three major aspects of the research team responsibilities which were, online/cloud collaboration, large file-size transfer approaches and secure communications

3 Digital tools, online collaboration

In this chapter we present work completed that has focused on the 'online collaboration' or 'working on cloud' aspect of the tasks assigned to the research teach at European University Cyprus.

More specifically we attempted to investigate and used criteria that we believed were a must for cloud collaboration tool to be effective for our needs (and by extension to an online educator needs). These criteria were:

1. **What features are made available through the collaboration tool?** We were looking for something that had many ways in which it could be used and not be limiting,
2. **Pricing**. Since it will be used by the universities, we tried to minimize the cost of usage.
3. **Ease of use**. The target audience is for educators of all disciplines so that mostly includes academic not very familiar with the latest technology trends. Any tool to be selected must be easy to use, intuitive and not require extensive training.

3.1 Introduction

What makes online collaboration effective is the ability to share information through different devices no matter your location. As long as you have an internet connection, a colleague of yours can see information that you want him to see at the push of a button. This gives an immense advantage from the old days when employees had to actually look for information that either they had or someone else made available to them through some sort of facility.

For example "Someone emailed you a file some days ago and while in meeting you need that file; you search your inbox only to realise that the inbox has been cleared of old emails and the file is no longer available. Now you have to go through the process of requesting the file, receiving it and using it." Stressful and in the long run time-consuming. Here comes online collaboration to provide a solution for sending, sharing, and using information.

3.2 Working on the cloud

3.2.1 What is online collaboration?

Online collaboration can be characterized as an innovation that utilizes some collaboration software to permit a gathering of individuals to cooperate with the goal of accomplishing a

similar objective. The individuals form a collaborating team and can utilize the collaboration software to organize, communicate, coordinate, share, arrange and take care of issues.

Collaboration has a big impact in the process that we learn. Particularly collaborative learning has proven highly influential in the areas of medical education and many other educational areas showing that when there is collaboration there is a higher chance for success.
(Warren G. , 2019)

3.2.2 Types of clouds

Based on Cloud location

Private cloud basically means that a cloud framework is exclusively used for solitary organisations, regardless of the way they are overseen, either internally or by an outsider, or facilitated either internally or remotely. Exploiting a private cloud might require the organization to undertake a huge burden to virtualize the environment, and also rethink strategies about already existing resources. Would advance the organisation, yet each step in the undertaking increments security problems that must be conveyed to forestall serious vulnerabilities to one's organization. Autonomous server farms are usually capital focused. They have the need for a lot of physical impression, requiring allotments of room, equipment, and ecological controls. These benefits need to be reviewed occasionally, creating extra capital expenses**.**
(Foley, 2008) (govconnection, 2020) (Wikipedia, 2020)

A cloud is known as a Public cloud when the administrations are rendered over a system that is allowed to be used by the public. Public cloud administrations might be free of charge. In fact there might be almost no distinction among public and private cloud engineering, nonetheless, security might be significantly opposed for services (applications, storage, and different assets) that are made accessible by a specialist provider for an open crowd and when correspondence is affected over a non-confided network. For the most part, open cloud specialist organizations like Amazon Web Services (AWS), IBM Cloud, Oracle, Microsoft, Google, and Alibaba claim and work the foundation at their server farm and access is by the Internet. AWS, Oracle, Microsoft, and Google additionally offer direct associate administrations called "AWS Direct Connect", "Prophet FastConnect", "Azure ExpressRoute",

and "Cloud Interconnect" separately, such associations expect clients to buy or rent a private association with a peering point offered by the cloud supplier.

(Rouse, 2019) (Gens, 2008) (Oracle, 2020) (Wikipedia, 2020)

Hybrid cloud uses the combination of public and private as seen fit by the circumstances. Basically, you keep crucial applications or information's at your own servers to make sure that they are as safe as possible, applications that are irrelevant for privacy reasons can be kept at facilities which you do not own.

(ESDS, 2020)

Based on services they provide

IaaS (Infrastructure as a Service) which is the most common type of cloud service, it gives you the ability to rent infrastructures from a service provider

PaaS (Platform as a Service) supplying an on-request environment for creating, testing, conveying and overseeing applications. It is intended to rapidly make web or portable applications, without handling servers, storage, networks and databases.

SaaS (Software as a Service), it's a way to convey programming applications over the Internet according to the interest and on a membership premise. SaaS encourages you to have and deal with the product application and basic framework and handle the maintenance

FaaS (Function as a Service) which is an add on to the PaaS, it allows you to reduce expenses as the application in which you wish to deploy will consume IaaS only when it is deployed.

(ESDS, 2020)

If we want to be successful we don't only take into consideration the fact that there is a higher chance of improvement but also the development of other skills such as social understanding of when not to interrupt someone and taking turn and engaging in active listening, Looking at the bigger picture of what collaboration is we can see that there is a mean to develop belief in your ability to take decisions and influence other participants.

This environment of teaching or learning provides with questions and problems to work together, giving way for many ideas on how they can be solved. It also gives problem solving

strategies. However, as with everything there would be flaws or just not giving a straight forward solution. Some of these problems arise because the actual interaction with humans is removed from the equation and in more detail, some key challenges in the environment of teaching were context, content, educator and learner, there was a lack of individual assessment of each of the students; because it is very different to assess a group of people than an individual. Social skills would have to be taught and not be taken for granted that students already acquired this basic notion of skill.

3.2.3 Online collaboration requirements

The part of establishing social presence is to bring a climate of trust and belonging into existence that will help with interaction. Social presence is a must for us to create a sense of community. For cognitive presence, there is evidence to suggest that a link exists between design and bringing into existence social presence, showing that courses that initiate in creating social presence are associated with high interaction among students. So, in our case, we need to take into consideration that for an online collaboration to be successful it has to revolve around the idea of giving opportunities to students to interact as they would normally with their peers.

(Garrison, 2006)

When designing instructions to be used for online collaboration one should be aware that social presence in online collaboration is less frequent and more forced while in a face-to-face environment, there is also the physical presence that can stimulate social presence in a more easy and efficient way and it also creates pathological politeness.

(Garrison, 2006)

The way in which you can actually achieve this type of environment, is by creating a comfort zone and willingness to collaborate with the community. Some basic concepts of achieving this is by having the participants in the collaborative environment to introduce themselves and offer information about themselves. To create this atmosphere, creating forums and chats with the community will prove beneficial towards the accomplishment of said goal of social presence and willingness towards cooperation and collaboration.

(Garrison, 2006)

For the online collaboration environment to be effective in the teaching area there are some additional requirements. The teachers must have a good understanding of how the students become part of a community and how that community is structured, while the link between social presence and sense of community is undeniably correlated. There is also a correlation between community and learning, and based on how the activities are being created and designed we see that there is an impact on how each student will approach these learning designs. While building a community of people eager to learn, it is also important to incorporate justified tasks with the focus not to be personal or social issues that need to be resolved. (Garrison, 2006)

The cognitive presence is established through the progression of the course content in a structured and significant way. From our design prospective, there is the issue of making the decision as which learning activities are eligible for each phase that students will be operating. The main challenge is how to ensure that in the collaborating learning, students will progress through the phases as planned, with the ultimate goal being to encourage the flow from awareness to knowledge construction, the environment of online learning offers. (Garrison, 2006)

In early phases it appears that online learning through the online collaboration means to offer an advantage in the area of ideas through brainstorming. This proved more efficient than the counterpart of face-to-face context, giving results to a finer quality of ideas especially when providing some sort of solution. As a result, online discussions have a deeper more complex critical thinking while the counterpart of face-to-face lacked the complexity of what was discussed before.

One other distinct requirement that online collaboration has with online learning is that it gives the ability of coming up with a permanent record of the session (recordings), in which students can use to have revisions or just to refresh what they learned.

Being able to discourse is the essence of the online collaboration learning process for teaching and learning. To manage this discourse of the students engaging and participating, there should be an initiative to create a feeling of belonging in a community. The tricky part of this, while it is fairly easy to initiate, is to actually maintain it. There seems to be a lack of understanding on how this could be maintained; of course this can be managed by having a strong teaching

method in which you know how and when to challenge the students with questions to guide the discussion. To be able to guide the discussion, one should be able to transition from social to cognitive when finding it appropriate and apparently learners find it very pleasing and successful when instructors are capable of such transitions.

(Garrison, 2006)

In summary, the requirements would be: establishing social presence, instruction creation should be based on the social presence within the online collaboration environment, creating a comfort zone and willingness, understand how cognitive presence in online collaboration is initiated.

Education aspects identified from the EUC research team

From an educational perspective, the local team identified some aspects of online collaboration that must be considered and provided for when talking about introducing online collaboration to instructors that are not digitally competent. The table below provides a these areas with a brief explanation of each one

Table 3-1 online collaboration aspects identified by the EUC research team

Break-out groups	When in an online meeting the instructor has the ability to create (on demand) groups of students so that they can work in groups about something
Asynchronous communication	Having the ability to send email or platform-based messages and files in an asynchronous fashion.
Synchronous communication	Audio, video, text sharing, application sharing. Teleconferencing (teleworking)
Sharing documents	Being able to give access to resources (files) and the ability to view download
Real-time shared editing	Being able to give access to resources (files) and the ability to edit real-time (wiki)
Online data collection	Being able to create questionnaires to collect information for assignment or other related tasks (google forms)

Remote automated or manual assessment of work	Online assignment setting and collecting and correcting (manual or automatic)
Attendees participation	Tools for measuring the participation of attended (or students) for activities and/or material
Online classes	Tools for successfully delivering online classes – how to create an online classroom

3.2.4 Aspects of online collaboration

The online collaboration takes the layers in which a collaboration exists. Although there are countless layers in which collaboration focuses, to make everything easier there are some layers that we will discuss. First we will discuss the team level which sits at the core of collaboration because it is the core of collaboration and it describes the team in which the collaboration takes effect in minimizing working time while maximizing output in terms of quality. The next step would be that you pass to a community level in which has a wider range of working, it involves people across your social community, to manage and improve large scale situations, a conjoint amount of activities. Then we will move to the network level, in which you do not focus only on your organization but you extend to a global approach as there is interaction form also the outside of your community. Moving past the levels in which the collaboration focuses in terms with the area of effect, we then see who make this process effective and so much desirable. The most crucial element would be the human force in the collaboration environment with which it would cease to exist if the people stop using it to provide the innovation and the ideas and knowledge through the online collaboration tools. Of course, there are sub levels in the human force environment for it to be efficient; there is always the need of a skilled leader in which to guide the team to the correct destination, then comes the team which will have to be competent and have the ability to adapt their work style without issue and provide with information and ideas to keep the team moving forward with the shared goal in mind to work as fast as possible and having trust to one another in the sense that their information is reliable. (Strickland, 2020) (Smartsheet, 2020)

3.2.5 Security and privacy on cloud

Distributed computing presents protection concerns on the grounds that the specialist organization can get to the information that is in the cloud. It could unintentionally or purposely change or erase data. Cloud suppliers will release data to the proper authorities when law-related circumstances require it. A client is made aware of this before commencing operation. Solutions for security incorporate strategy and enactment just as end-clients' decisions for how information is put away. Clients can protect access to their data (on the cloud) by using encryption. Identity management frameworks can likewise give functional answers for protection issues in distributed computing. These frameworks recognize approved and unapproved clients and decide the measure of information that is available to every element. The frameworks work by making and portraying identities, recording activities, and disposing of unused identities.

3.2.6 What is needed for "cloud working"

Based on everything discussed above, the following table summarises what is required from a cloud service provider

Table 3-2 Cloud service provider requirements

Synchronisation	File Sharing	Productivity
- Sync Folder - Block-Level Sync - Selective Sync - Bandwidth management - Sync any folder	- File link sharing - Link passwords - Link Expiry - Folder Sharing - Folder Permissions - Link download limit - Upload links	- File previews - Edit Files - In-App collaboration - Office online - Google docs - Deleted File retention - Versioning
Security	**Support**	**Miscellaneous**
- At-Rest Encryption - In-Transit Encryption - Encryption Protocol	24/7 Support - Live chat Support - Telephone Support	Free plan

• Zero Knowledge • Two-Factor Authentication	• Email Support • User Forum • Knowledgebase	

(Gildred, 2018) (Kochovski, 2020) (Stockton, Cloudwards: Dropbox Review, 2020) (Stockton, Cloudwards: OneDrive Review, 2020)

3.3 Digital tools investigation

Google Drive

Straightforward, simple to utilize and focused on home clients, Google Drive flaunts 800 million clients, in no little part on account of the joining with Google's profitability suite, Google Docs.

The Docs suite incorporates applications for document handling, spreadsheet and presentation. With those, it's anything but difficult to team up progressively with others. You can recommend edits, offer remarks, rollback to past variants of the archive and see what changes others made. Google has an immense network of engineers thus its third-party library has a great deal of utilizations.

When signing up for an account with Google (usually for G-mail), you automatically get the Google Drive (G-Drive). It is a common storage for all the files in your Google presence (email messages, documents, pictures, contacts and anything else). G-drive works consistently with all of Google's apps and tools.
(Kochovski, 2020) (Google, 2020)

Dropbox

In Dropbox you can use MS Office or Google Docs. Folders can be shared with a group of people and any work anyone does is saved on the Dropbox folder, making group joint effort becomes a breeze.

In the event that you need to make another archive, you can do that, as well. You can utilize any program to make Office records

In case you are stressed over document changes, you may discover the "rewind" device helpful. This document forming highlight permits you to reign in record changes. On the off chance that you choose to move back a record edit, re-establish an erased document or retrieve your documents back after a hack assault, this what you will need.

In Dropbox (depending on your account and service) you can back-track to work completed from 30 to 180 days before. You can see a rundown of every one of your progressions so you might settle on an educated choice, and Dropbox will make sure to send you an email to tell you that the documents are re-established.

In the event that you require common space to store your records, in Dropbox you can use the 'Spaces' feature which transforms a folder in a group shared folder creating a common working space.
(Stockton, Cloudwards: Dropbox Review, 2020)

Jumpshare

While it very well may be utilized for distributed storage, offloading records to the cloud to clear up space on your work area is a very common reason to use cloud storage, Jumpshare is best utilized as a document sharing assistance. While, we cannot think about a distributed storage service that doesn't permit document sharing, alongside numerous online backup services, however few do it as perfectly as Jumpshare.

Another bit of leeway of going with Jumpshare over a run of the typical distributed storage service is that it has some extraordinary analytics alternatives to follow document shares and other conduct. It is an incredible instrument for experts to follow how content use for security or different purposes. As with most distributed storage services, erased document recuperation and versioning are both included highlights, as well. Document versioning lets you return to past record states if there should be an occurrence of undesirable changes. Jumpshare keeps a boundless number of record adaptations, however just for 30 days. Additionally, erased records are saved for 30 days before being expelled for all time from your Jumpshare junk bin. While pressed with document sharing highlights that you won't find with most distributed storage services,

Jumpshare doesn't do record sync, another normal distributed storage feature. Despite not having sync capacities, Jumpshare has a work area customer, and a decent one at that. In addition to the fact that it saves you from having to login online to share documents, it incorporates both screen capture and screen-recording features. For a distributed storage service that doesn't sync records, Jumpshare is pressed with highlights both normal and phenomenal, settling on it beneficial decision relying upon your necessities.
(Gildred, 2018)

OneDrive
OneDrive has some one of a kind highlights and alternatives that may make it distinguished from the opposition, however, its most appealing feature is the integration with MS Office and other MS services (Skype etc) which makes sharing effortless.

Its highlights are constrained with free membership, however, you will have to pay to benefit from the administration. Be that as it may, the greatest detriment for OneDrive is its average protection highlights

OneDrive has become a component with rich services, with an attention on Office and Windows combination that puts it in front of a portion of its principle rivals. The diverse evaluating alternatives decide the highlights you can eventually get to, yet you'll presumably require a Microsoft 365 membership to benefit from it.

One word summarizes the greatest advantage to utilizing OneDrive: Office. Microsoft items like Office and OneDrive are a definitive efficiency instrument for understudies and office laborers. As opposed to gambling a lost or tainted drive, you can store, alter and take a shot at your Office archives from your OneDrive storage itself.

You'll require a Microsoft 365 Personal or Home membership to have the option to receive Office and use it with OneDrive on your Personal Computer, however common OneDrive clients have free access to the versatile and web applications. Comparative services are accessible in case you're utilizing another working framework, for example, macOS, with OneDrive for Mac clients getting a comparative encounter.

Security wise, OneDrive provides the 'personal vault' for encrypting and securing any data, which is can be subsequently accessed by providing a unique key to authenticate you. (Stockton, Cloudwards: OneDrive Review, 2020)

3.4 Comparing tools

Having presented some of the most common tools it is now time to comparatively look at them and find out which of the required aspects can be satisfied from which tools.

Table 3-3 Comparing online collaboration tools (G = G-drive, O=One-drive, J = Jumpshare, D = Dropbox)

Requirement	G	O	J	D	Requirement	G	O	J	D
Synchronisation					**Security (continued)**				
Sync Folder	Yes	Yes	Yes	Yes	In-transit encryption	Yes	Yes	Yes	Yes
Block-level sync	No	Yes	Yes	Yes	Encryption protocol	Yes	Yes	Yes	Yes
Bandwidth management	No	Yes	Yes	Yes	Zero knowledge encryption	No	No	No	No
Selective sync	Yes	Yes	Yes	Yes	Two-factor authentication	Yes	Yes	Yes	Yes
Sync any folder	Yes	No	Yes	No	**Support**				
File sharing					24/7 support	Yes	No	Yes	Yes
File link sharing	Yes	Yes	Yes	Yes	Live chat support	Yes	No	No	Yes
Link passwords	No	No	Yes	Yes	Telephone support	Yes	No	No	No
link expiry dates	Yes	Yes	Yes	Yes	Email support	Yes	Yes	Yes	Yes
Folder sharing	Yes	Yes	Yes	Yes	User forum	Yes	Yes	No	Yes
Folder permissions	Yes	Yes	Yes	Yes	Knowledge base	Yes	Yes	Yes	Yes
Link download limit	No	No	Yes	No	**Miscellaneous**				
Upload links	No	No	Yes	Yes	Free plan	Yes	Yes	Yes	Yes
Productivity					**Education related**				
File previews	Yes	Yes	Yes	Yes	Break-out groups	No	No	No	Yes
Edit files	Yes	Yes	Yes	Yes	Asynchronous communication	Yes	Yes	No	Yes
In-app collaboration	Yes	Yes	Yes	Yes	Synchronous communication	Yes	Yes	No	Yes
Office online	No	Yes	Yes	Yes	Sharing documents	Yes	Yes	No	Yes
Google docs	Yes	No	No	No	Real-time shared editing	Yes	Yes	No	Yes
Delete file retention	Yes	Yes	Yes	Yes	Online data collection	Yes	Yes	No	No
Versioning	Yes	Yes	Yes	Yes	Remote automated or manual assessment of work	No	No	No	No
Security					Attendees participation	Yes	No	No	No
At-rest encryption	Yes	Yes	Yes	Yes	Online classes	Yes	No	Yes	No

(Stockton, Cloudwards: OneDrive Review, 2020) (Stockton, Cloudwards: Dropbox Review, 2020) (Gildred, 2018) (Google, 2020)

Verdict

The most competent joint-effort platform is google drive but Dropbox integrates with Google Docs and MS Office, it's a component that is extremely unequalled by the greater part of its significant opponents. We also have OneDrive which has similar potential although it will not allow you to use Google Docs and finally Jumpshare, it's a good platform for sharing files and that's all I have to say for Jumpshare.

In my opinion and as you can see from the above comparison table, when it comes to online collaboration platforms in an educational scenario we can choose from Google Drive, OneDrive and Dropbox, there are some small differences between them but each platform tries to compensate in its own way.
(Gildred, 2018) (Google, 2020) (Kochovski, 2020) (Stockton, Cloudwards: Dropbox Review, 2020)

3.5 Summary

In this chapter we talked about using online collaborations and what it entails, aspects such as what is necessary in order to be successful, how it works as a system and some basic explanation of the 'levels' it contains, some types of cloud architectures and their benefits and how the security of data issue is handled. The next chapter contains the process and requirements for the creation of the instructional videos

4 Implementation

4.1 Introduction

One of the requirements for the Be-com project was the creation of instructional videos in order to show to students and teachers of all academic disciplines how they can use the advancing technology to their benefit.

4.2 Videos to be created

The following table provides a listing of the videos that will be created along with a brief overview of each video. Appendix C, provides the scenarios that have been created for each video

Table 4-1 Brief listing and overview of the videos to be created

Short description	More elaborate description
Using Google Forms	How to create and manage a questionnaire, by viewing all the options available for the questions, styling etc
Linking forms with Sheets	How to link the questionnaire to a spreadsheet in order to use (and analyse) the data without wasting any time
Sharing a form	Demonstration on how to share the questionnaire (for editing or completion)
G-mail message Templates	Demonstrate how to create template message and how to use them for sending emails
Using G-mail instance messenger	Demonstration of the 'instance messenger' which is integrated with the Gmail client.
Sending email using Gmail	Sending a simple email message, using the Cc & Bcc and other functions Gmail
Google groups	How to create, use and manage a google group (for email distributions)
Google Drive basics	How to use the basic features of google drive
Using Google drive	Demonstration of how to share any resource that is available on google drive (Sharing to view, via link Sharing to edit, via account permission)

Using Google Docs	Demonstration of real-time editing of Docs
Using Google Slides	Demonstration of real-time editing of Slides
Using Google Sheets	Demonstration of real-time editing of Sheets

4.3 Software used and videos guidelines

The program that was recommended by the project coordinator was a free film editing tool called DaVinci Resolve 16. (Blackmagicdesign, 2020)

Resolve allows you to import, alter, trim, include transitions, titles, consequently coordinate shading, blend sound and so forth, all in the one area utilizing what they have called "The Cut Page",

The Cut Page provides a set of tools to make operations simpler and performing them quicker. More specifically, it provides

Dual Timeline: letting you rapidly explore the entire edit and trim without sitting around idly zooming and looking over.

Source Tape: Quickly survey all clasps in a container as though it was a solitary "tape".

Devoted Trim Interface: Allows you to see the two sides of an edit and trim in outline precise detail.

Keen Edit Modes: In the course of events the edit modes can shrewdly adjust cuts and edits for you.

Quick Review: Quickly audit a whole course of events or clips with variable speed playback that is consequently set dependent on cut length.

Change, Retime
and Stabilize: Tools for picture in picture impacts, retiming, adjustment, dynamic zoom, text, sound, across the board place.

Speedy Export: Render, transfer and offer your project to online administrations.

Media Import: Import singular files or whole directory structures with subfolders as receptacles.

Versatile Editing: The interface is adaptable on any PC screen.

(Blackmagicdesign, 2020)

The consortium has also suppled requirements and specific guidelines on how certain aspects of the video production process will be. These details are available in Appendix A – Guidelines for video creation

4.4 Creating a video

In planning the cut page, Blackmagic Design (the company that built Resolve) made a stride back and put a great deal of thought into how to develop and make altering quicker. The cut page and the alter page give various interfaces to these two totally different societies of editors. The cut page expels inefficient advances and anything that could otherwise slow you down. Each click or activity you do on the cut page has an immediate outcome. There are no squandered clicks or discretionary settings to set. The page takes a chance at envisioning what you need to do and allows you speed up.

The process of creating a video for Be-com is using a software called DaVinci Resolve 16. The requirements for the videos (about formatting, duration and other details) have been provided by the project partners and have been included in Appendix A. In this chapter we will present how to create an instructional video based on the Be-com characteristics.

Step 1.   Use some screen recording software to capture the whole operation that you want to describe. For the purposes of this demonstration we have used CamStudio Recorder v2.17 (Build on Mercurial release r316) (Software, 2020). This program is free and enabled the capture of the whole screen or a specific rectangular sub-region of the screen. The output of the capture is an .AVI file which will form the basis of the instructional video.

Step 2.   Resolve supports the importing of .MOV file videos so I have used another free application called VSDC Free Video Converter v 2.4.7.339 (Software, nchsoftware, 2020) to convert the .AVI file to a .MOV format. Conversion is fairly straight forward, you select the source file and then the target format and start the conversion. Once finished you have a new .MOV file

Step 3.   Start the Resolve application and either create a 'new project' using the button or simply double-click the 'untitled project' link.
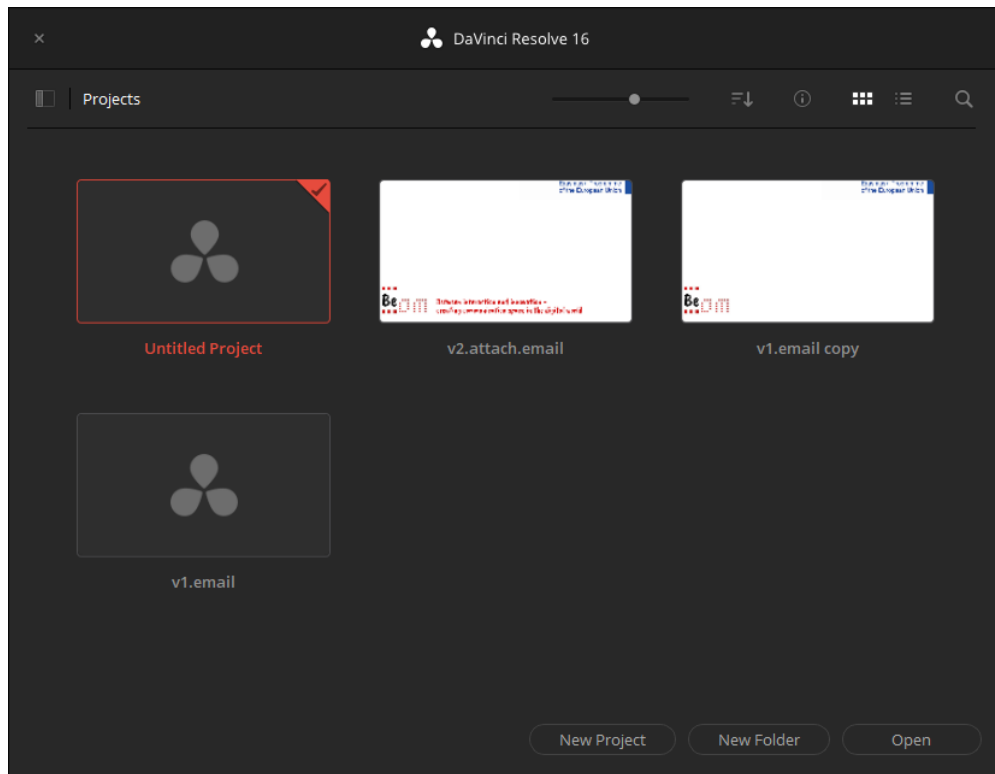
Step 4.   Resolve will open up and you will be presented with a relatively complicated video editing interface containing multiple functionalities and various pages. The capture below illustrates some of the areas
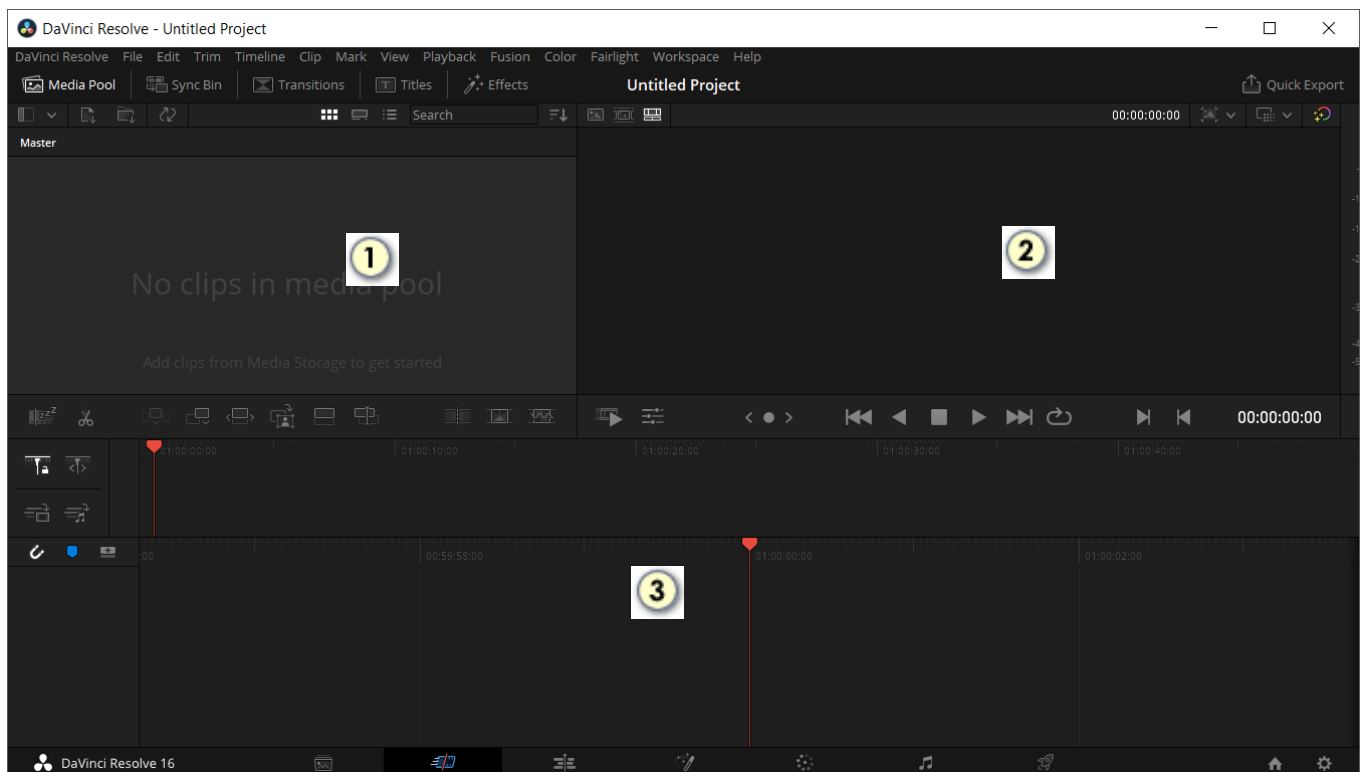
a. Area [1] is where we must include all the clips / media that must be used for the video. This will include the basic .AVI file, any .JPG or .PNG provided by

partners as well as any .WAV (audio) files that need to be used. For every project there is a so-called 'bin' created and in there we must import all the relevant media. The importing is achieved by using the menus of the application and more specifically by following the File → Import File → Import Media, command.

b. Area [2] is the player area, the stage if you wish, where any video that will be created can be previously in there. Notice the bottom of the area where the controls for manipulating play are situated.

c. Area [3] is the timeline area. For every video to be created you are in effect creating a story that will follow a specific sequence of images, videos, sounds etc. The order, in which all of this media are shown, forms the timeline of the video. The main idea is that you will use whatever media you have in the media pool area and drag-and-drop them in the time line in specific locations so as to generate the wanted result.

Step 5.   The capture below demonstrates the window after importing some media using the aforementioned 'import media' command. As you can see, the application is showing a small thumbnail of each file and the name of the file under the thumbnail. Also, depending on the selection on the left-hand-side, the play area (on the right) will update to enable the user to preview the media. a)

a. If is it a still image it can be viewed

b. If it is a video or an audio file, it can be played
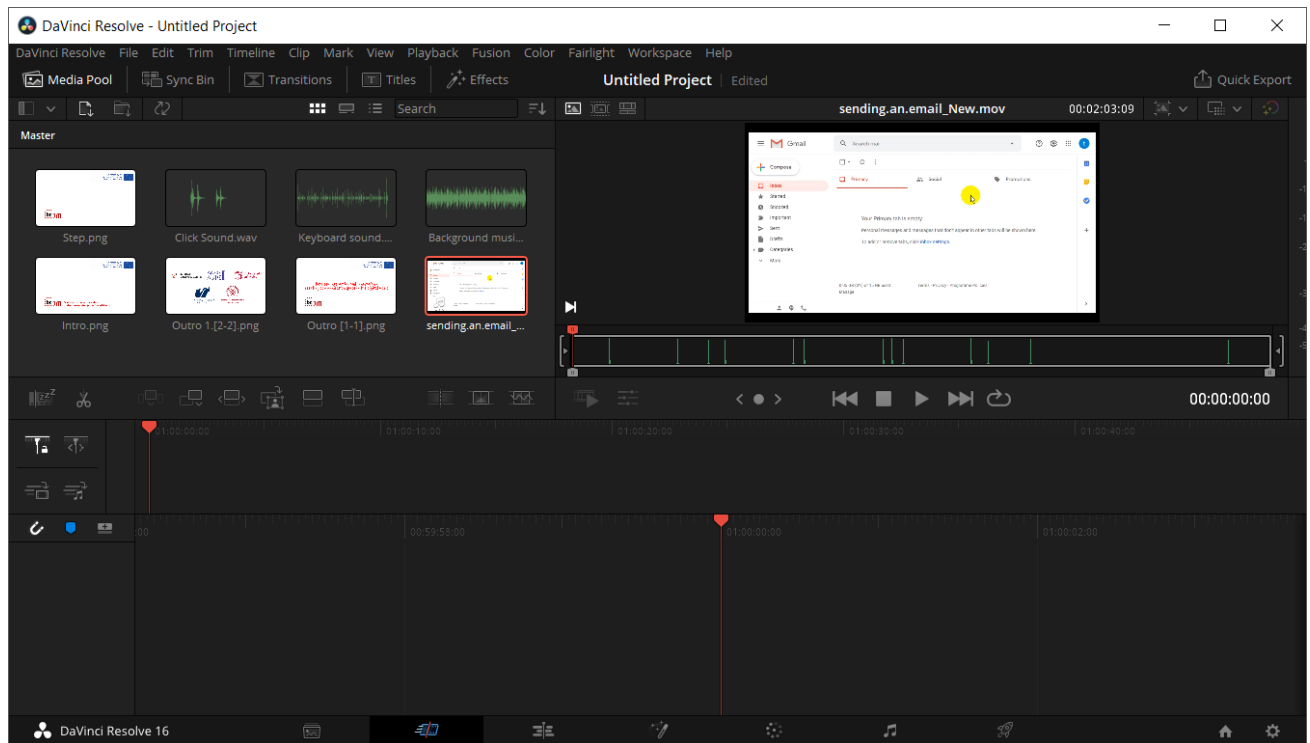
Step 6.   Before we continue we have to present the layout that partners have requested we use. The layout has 3 main items

a. First is a 4 second introductory image providing the title of the video (the file **intro.png** is to be used for this)

b. Second is the main body of the video that contains all the instructional sequences. This must include a limited number of steps that will be clearly showing what is about to happen in the video. For every step

   i. Video play is paused (or at least appears to be) (the main .MOV file to be used for this)

   ii. The 4-second title page is shown (with title and subtitle) (the file called **step.png** is to be used for this and some text to be added indicating the step details)

   iii. Video play resumes to show the next step. (the main .MOV file to be used for this)

c. Third is a two part 4-second each part images showing the logo of the project followed by the partners of the project. (the files **Outro [1-1].png** and **Outro 1.[2-2].png** are to be used for this)

d. Further more

 i. There is a background music that should be played from start to finish (the file **Background music.wav** is to be used for this)

 ii. There are 'keyboard' and 'click' sounds to be used whenever the video is showing typing or a mouse action (the files **keyboard sound.wav** and **click sound.wav** are to be used for this)

 iii. Transitions from a→b, b→step 1→b→step 2→b→step N→b and b→c must appear to be smooth using what is called a 'fade-out' and 'fade-in' effect. This ensures that the transition will appear very much a smooth flow of images and video rather than a sharp change from image to video to image to video and so on.

Step 7. It is now possible to start creating the wanted video by dragging files from the media pool and dropping them on the timeline (staging area) at the bottom. However, we have to be careful to insert the media in the correct order.

Step 8. Insert the **intro.png** file by dragging and drop it in the upper area of the timeline. The window changes as demonstrated below. Read on to see what has happened
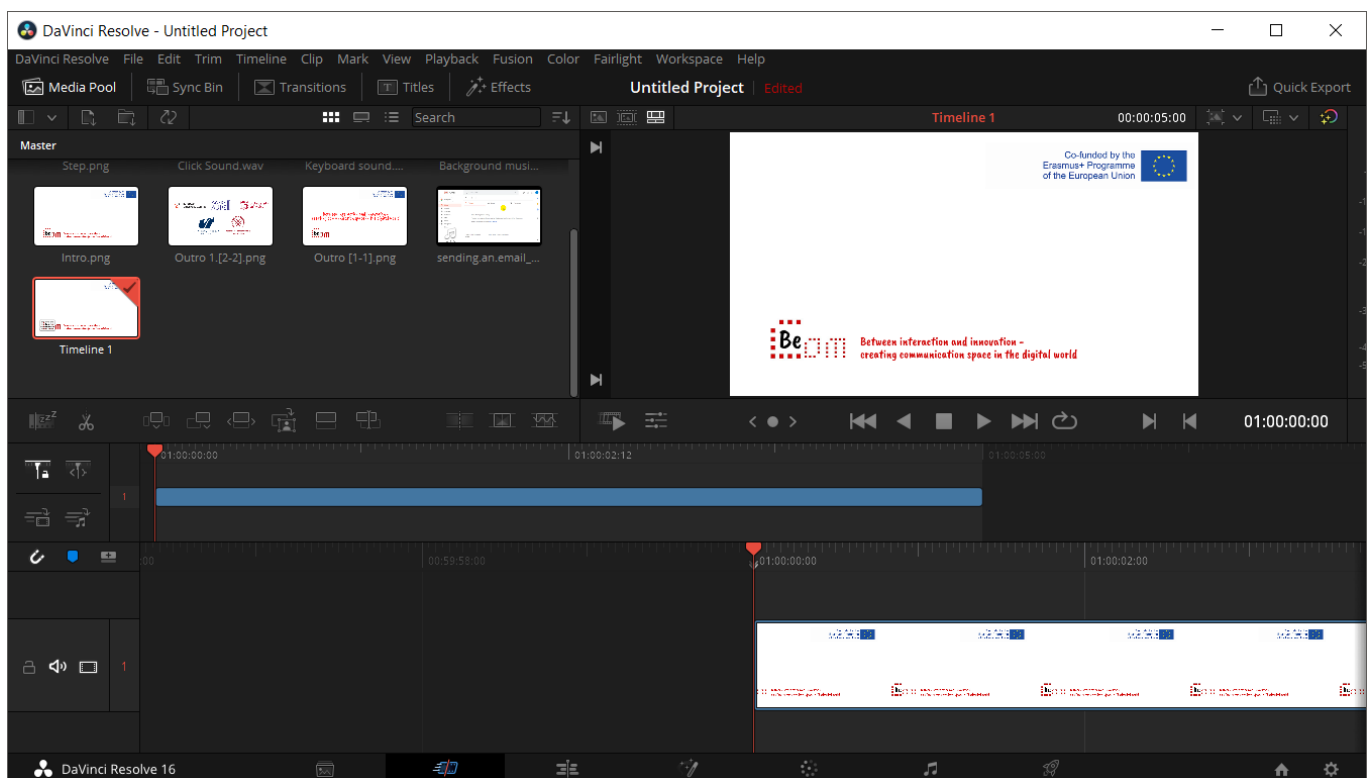
a. In the media pool area a new element has been (created and) added. It is the timeline for the project.

b. In the timeline area (at the bottom) we have two new elements. The blue-ish rectangle at the top is the project timeline (without previewing the content); and the white (image-based) underneath which is the timeline with previewing of the content. Notice how in the previous capture the **play head** (indicated with the little red arrow and line) are the beginning of the clip. If you place your cursor in the ruler-like area with the timed-edges, click-and-drag to the left you can see the **play head** move to the relative positions of the block (above) or the preview (below).
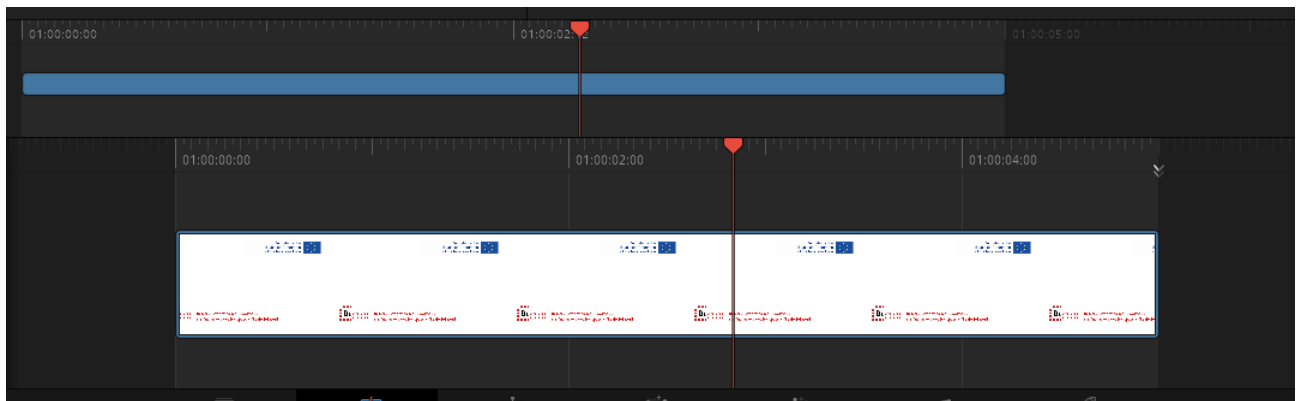
Step 9.   Now, as Intro.png is a still image, by default, Resolve inserts a 5-seconds duration clip in the timeline. Requirements want this to be 4 second so we have to resize it. This can easily be done by grabbing the right edge of the clip and resizing until it goes to 4.00. The capture below demonstrates. Notice how the cursor changes to indicate resizing of the element. What is more helpful is the fact that there is a popup of the exact time indicating the size of the clip. Take that to 4.00 and release the mouse
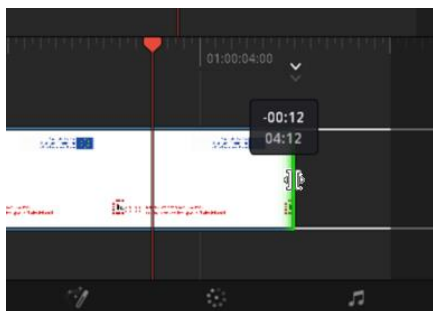
Step 10.   The next step is to insert the main video. In this example we will be using a file called **sending and email.mov** which has been inserted in the media pool. You

can either drag and drop the file or use the 'append clip' command (but make sure that the correct file from the media pool is already selected… indicated with the red border.
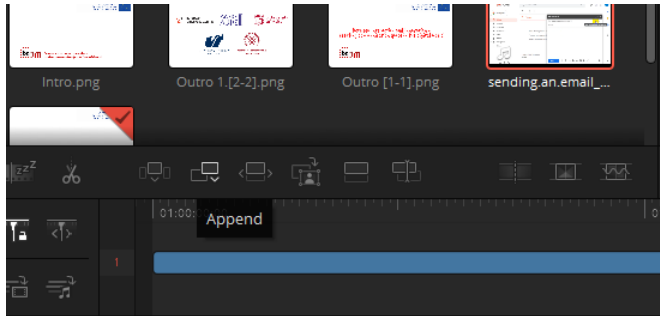
Step 11.　After this appending is completed the timeline looks different. The video clip has been inserted after the intro and the window looks like the capture below. Notice how we now have another 'blue' element in the top timeline and a second video element in the bottom timeline. Once again in the top you just have blue blocks while at the bottom you can preview (in a little detail) what the media includes. In the capture below, we have moved the **play head** in a position that you can that the video is just starting and the difference between the intro and the video is distinct. Also see how the play head (red arrow and line) are indicating the positioning at the beginning of the video just after the intro.
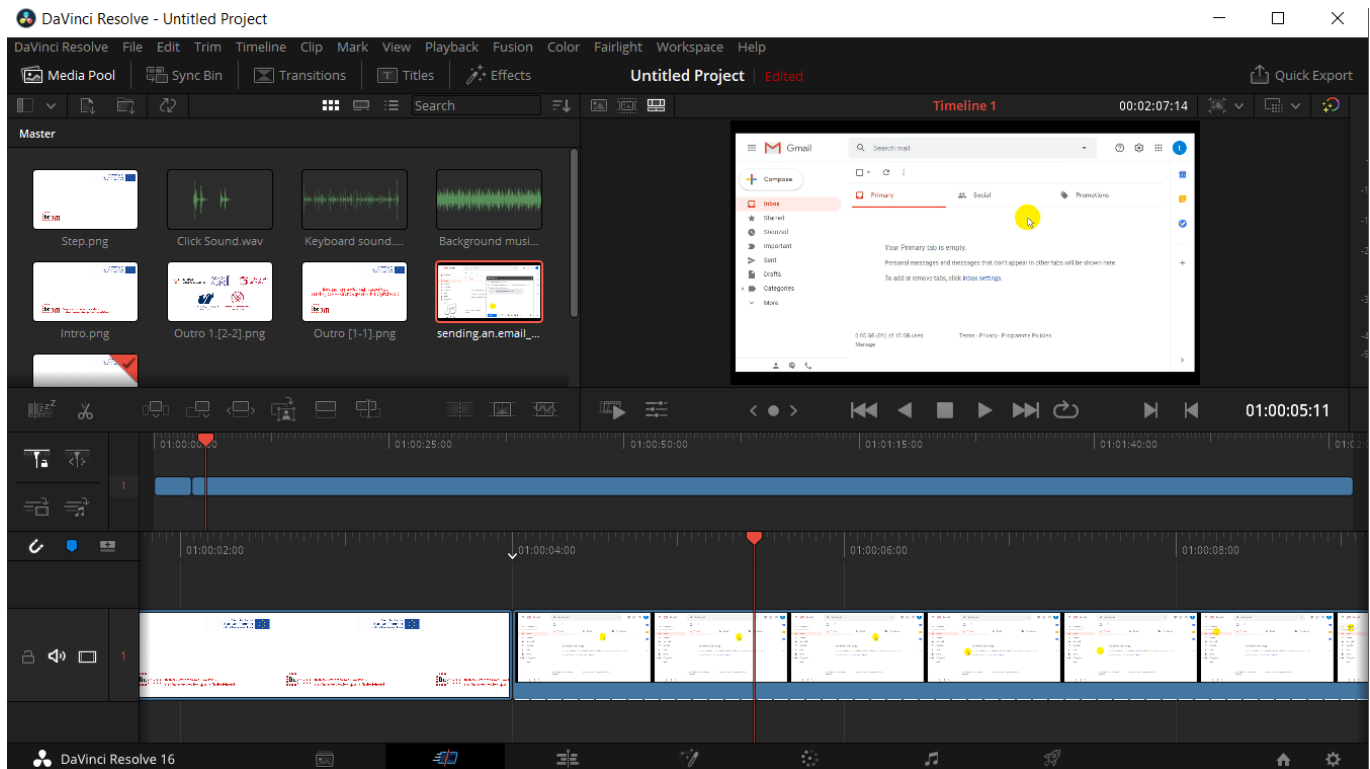
Step 12.   Let us complete the third video requirement by going at the end of the video and appending a 4 second clip of **outro 1-1.png** followed by another 4 seconds of **outro 2-2.png**. The capture below only shows the timeline area. See how the top timeline now includes 2 extra boxes at the end (far right) and how in the bottom timeline you can actually see… the end of the video, the area with the outro 1-1 and then the final outro 2-2.
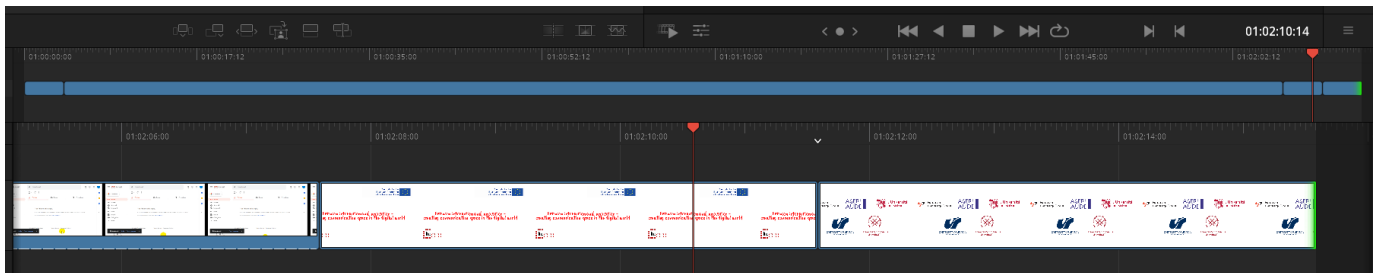
Step 13.   To introduce **Step.png**, after you insert the **Intro.png** you are required to use the Step.png and you can simply drag and drop it in between the Intro and the actual video, but in case you want to insert the Step.png in a specific position in the video then you will have to switch to the **Edit** page of the timeline area.
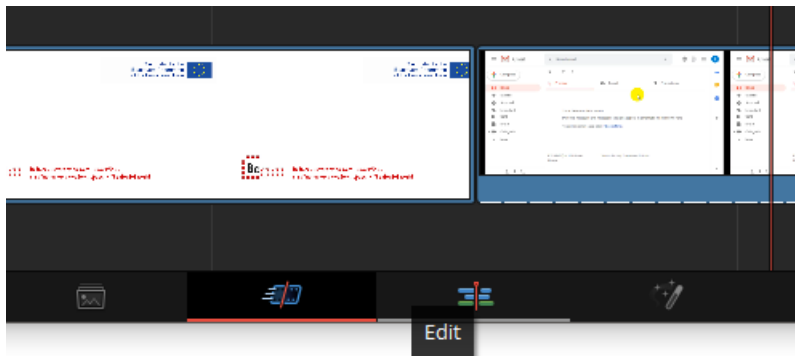
Step 14.   Once in the 'Edit' page the timeline area changes slightly to show the video and audio streams that are incorporated. Notice the capture below and the indicators on the left hand side showing Video 1 and Audio 1.
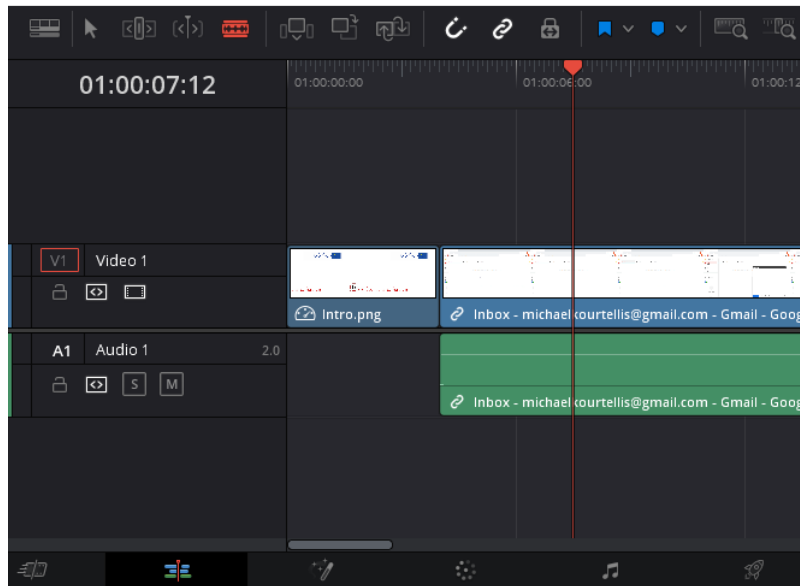
Step 15.   To insert a **Step.png** drag the play head at the required position and then select the Step.png from the media pool and use the **Insert** command. This will automatically split the main video into two places and insert the step clip in the specified position, as the capture below demonstrates. So now we have the sequence of intro → main (part) → step → main (remainder). In this manner we can insert as many steps as the video requires.
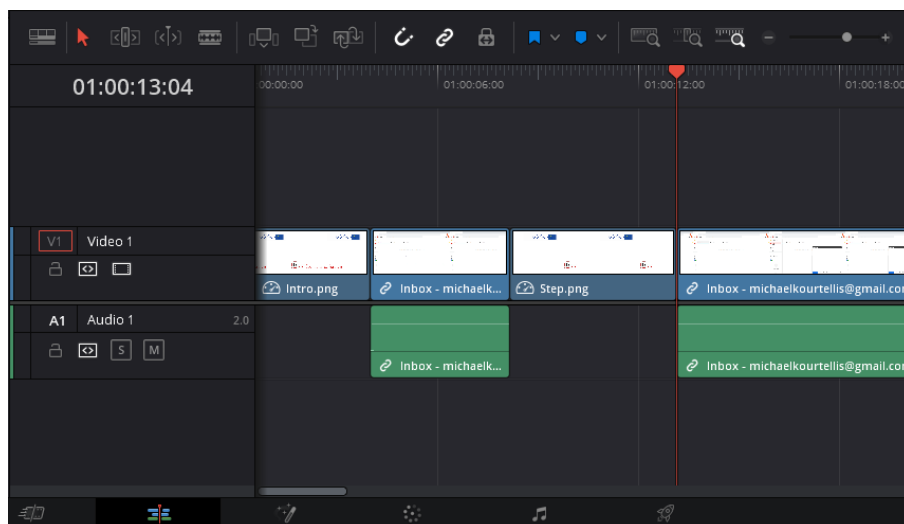

Step 16.   To Insert text in the **Intro.png** you simply go over to the **Toolbox** area and select **Titles**, then from the **Titles → Titles(subsection) → Text** you can drag and drop it directly above the **Intro.png[1]**. After placing it above the Intro you must make sure that it aligns with the margins of the **Intro.png**. The capture below show the toolbox → titles → text.
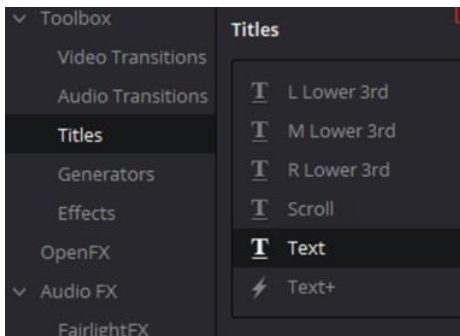
Step 17.   Finally, you double click on the **Text – Title** and the pop-up menu appears near the top right of the window giving access to configuration controls for the text element. Based on the information provided by partners of the project you can customise the text of the 'title' object. To Insert text in the **Step.png** you proceed with the same manner and the only difference is that you will need two **Text-Title**, one above the other.
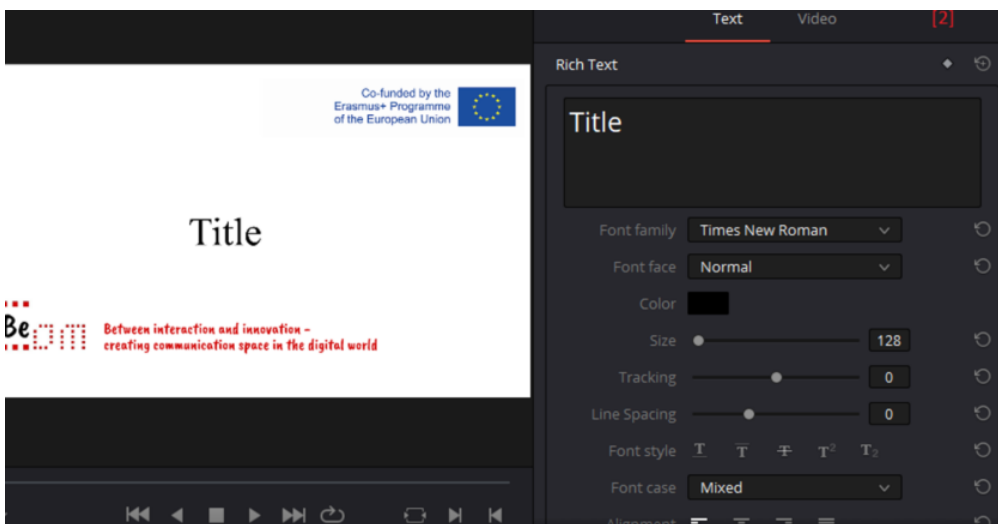
Step 18.   To insert the **Background music.wav** you must select it from the master bin, drag and drop it at the audio section, you can adjust the duration of it in the same manner that was introduced for the **Intro.png**. Notice how the timeline in the capture below now has a Video 2 (for the text) and an Audio 2 track (for the background music)
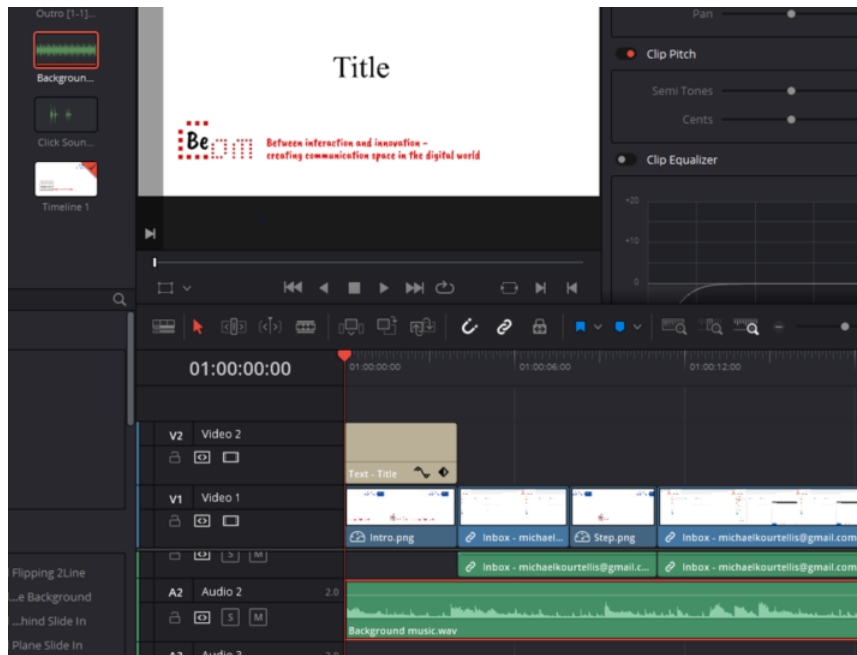
Step 19.   To insert the **Keyboard sound.wav** and the **Click sound.wav** clips you must again select them (individually) from the bin and drag-and-drop them in the bottom of the timeline when area tracks are shown. The screen capture below demonstrates what the timeline looks like after adding a keyboard clip and a click clip.
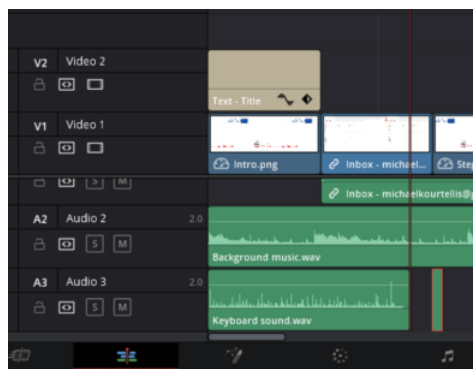

Before moving on the next step an important note has to be made. Inserting keyboard and click sounds cannot simply be inserted anywhere 'we' like. They have to be inserted in all the locations that the actual video is showing either something being typed (for the keyboard) or some interface element being clicked (for the click). This is a tedious process as you have to go back and forth in the video trying to exactly match the typing and clicking.

Step 20.   Fade-out and fade-in are the terms used to achieve a smooth transition from one clip to another, as opposed to a sequence of clips stopping and starting.

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a. To add a fade-out you need perform an action at the end of the clip. In 'Edit' mode (at the timeline area) click to select the block of the main video. As you can see in the capture below a little white indicator appears at the (far right top) end of the video block. You can use that and drag it towards the left in order to apply a fade-out. Partner instructions indicate that the fade-out should last 0.08 sec and while dragging the application shows you the duration. In the capture below (left image) you can see the little white indicator. While dragging (middle image) the indicator becomes red and you can see the duration. Finally, after the mouse is released (right image) in the proper place the video's edge appears a little grey to indicate the fade out.
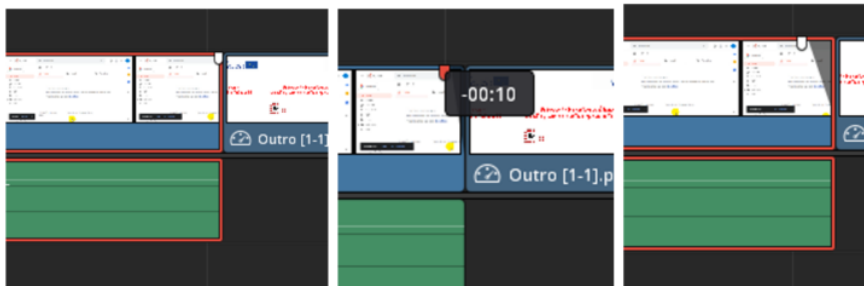

b. In a similar fashion a fade-in must be applied on the clip about to begin. In exactly the same way select the outro clip (left), drag the white indicator to the right (for a 0.08 sec duration) (middle) and release to apply. See the right image in the capture below showing the resulting fade-out → fade-in effect.
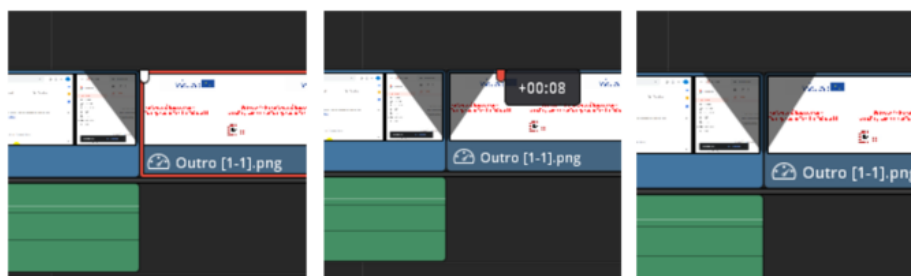
Step 21. The final step will be to generate the MP4 video. To do that you will need to select **Deliver** at the bottom of DaVinci Resolve, once you arrive at the **Deliver** section you will need to select **Format → MP4[1]** then go over to the **Audio** section and make sure that the **Export Audio** is checked[2]. Press **Add to Render Queue [3]** and
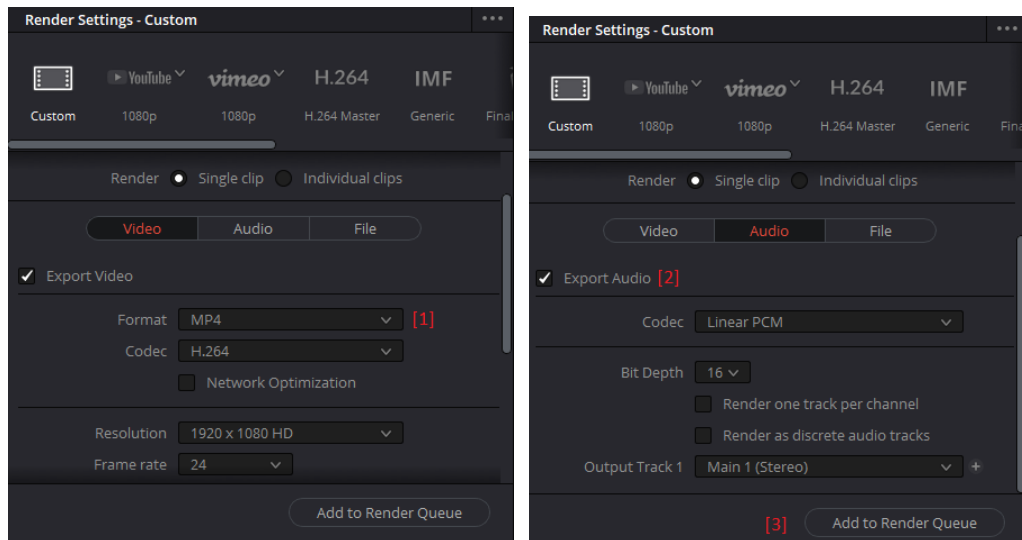
Step 22.   The render queue appears on the top right area of the Resovle window and looks something like the capture below. The final step is to press the **Start Render [4]** and wait for the video to be rendered.
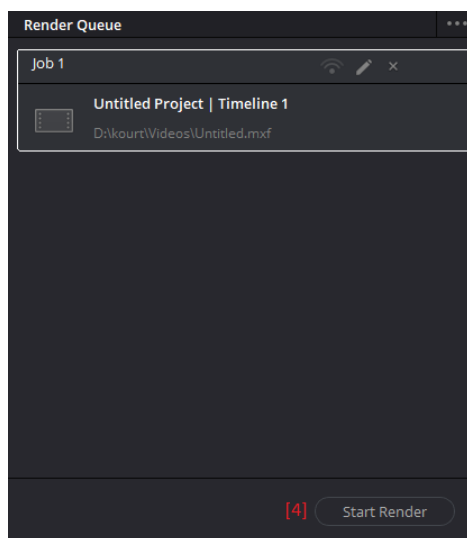
4.5 Summary

In this chapter we demonstrated how to create a Be-com video. Explain the software used along with the files that have been provided by project partners. The chapter worked you through the process of creating a video from scratch to final rendering.

The following chapter concludes the thesis and a presents an account of the work.

5 Discussion

5.1 Overview

The rapid evolution of technology creates a gap of knowledge resulting in people of all ages not having the necessary skill set to 'survive' modern processes and new devices. The main idea for this project was the creation of instructional videos that would help those digitally challenged individuals to understand and help them use the facilities of the tools relating to online collaboration.

This project is part of research project called Be-com which researchers from the department of computer science and engineering are participating. The Be-com project main aim is to provide means to close the gap and provide usage guidance to lower digital capacity audiences. The project has four results: the first is a digital toolbox for effective communication, second is a digital toolbox about secure communications, a handbook on how to communicate on the web and finally a strategic educational game based on gamification. The research team at European is responsible for providing material relating to 'working on the cloud', 'sending large files' and 'data protection'.

My work focused on the 'working on the cloud' aspect of the research. Some of the objectives were to identify what are the requirements so that an educational organisation using cloud services would benefit the educational aspect. Investigate the available cloud services that can be used and realise if they satisfy the requirements. Identify the most appropriate cloud service to use and create the scenario and videos.

5.2 Work performed

Throughout the project there was the need to research cloud service providers that would fulfil the requirements. However, this became quite hard as I started to witness that most of the providers don't really care about the educational environment and its requirements. In the end some service providers; for other reasons; had applications that benefited the educational aspect as well.

Before we began to create the videos we had to come up with suitable requirements that would help us narrow down the list of candidate collaboration tools for educational purposes, with that in mind we managed to make a list of requirements. With the requirement list we compared the online collaboration tool candidates to see which one would be better suited to create most of the videos with. As it become apparent, google had the best suited tools so we choose their products for the creation of most of our videos. Once the tools had been chosen we began the preparation to select what series of features would be showcased in the videos. The next task was to create scenarios that would present the features to get the result that we aimed for. Having the scenarios, we proceeded with the capture of the videos along with the editing on Resolve.

Thankfully, apart from the educational aspect everything else went very smoothly, using the directed software we captured the videos to be included in the end result videos. In my opinion it's a successful and interesting approach to try and resolve the problem at hand.

DaVinci Resolve was a big relief because it was so easy to learn how to create and edit videos and in the end I have learned how to plan and create the videos themselves. Those videos will assist countless people, in many ways and it will make things easier if that person can watch a 2-3 minute video and grasp how to use the tool. This is preferable than spending considerable amount of time trying to understand what any given manual tries to describe.

The output of this project is to help people understand what online collaboration tools are and how they can be used to our benefit. We showcased key elements that must be fulfilled, some of those were standard but we also provided some aspects for the educational aspect. Also, we created scenarios for and edited 12 videos in total that showcase asynchronous communication, synchronous communication, sharing documents, real time-shared editing, and online data collection.

Coming to the end of this project I realise that maybe in my entire lifetime I would have never tried to, in depth understand exactly how an online collaboration tool works and how it could be used for educational purposes.

5.3 Future work

About the future work, I would suggest that we explore even more aspects of online collaborations. I believe we should explore the possibility that no matter where you are in the world you could have the ability to actually be in a meeting or classroom, interact with others as you would in the real world, shake hands, hug etc but you would be at your home. To accomplish such a feat, I would suggest that we use VR (Virtual Reality), not only the VR headset but incorporate the whole human body, with suits that can transmit to the body the sensation of touch. We can already move freely in the virtual reality environment with the use of VR locomotion but it would be best to use the VR treadmill to keep the body active.

For the amount of people that the server would be able to host in the said virtual reality environment is not out of reach but the initial cost is going to be enormous, but building a university is also costly. I would like to propose to consider making the entirety of university study an online experience rather than have physical structures define and limit what a university is. With the same concept as mentioned above.

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Appendices

Appendix A – Guidelines for video creation

These are the guidelines provided by our partners for the creation of the videos:
INTRO

Intro for movies is *intro.png* graphic.
Intro appears on the screen during 4 seconds.
Fade in and fade out effect takes 0,08s.

STEPS

Steps for movies is *Step.png* graphic.
Steps appears on the screen during 4 seconds.
Fade in and fade out effect takes 0,08s

SUBTITLES
The font we use is TIMES NEW ROMAN.
Fade in and fade out effect takes 0,08s.

       Title: Font - Times New Roman
             Color - #000000
             Size - 128
             Position x- 960 y-540
             Fade in - 0,08s
             Fade out 0,08s

       Step: Font - Times New Roman
             Color - #d40007
             Size - 115
             Position x- 335 y-807
             Fade in - 0,08s
             Fade out 0,08s

     Step text:Font - Times New Roman
             Color - #000000
             Size - 90
             Position x- 804 y-540
             Fade in - 0,08s
             Fade out 0,08s

ARROWS
Arrow for movies is *arrow.png* graphic.
Arrow appears on the screen during 3 seconds.
Fade in and fade out effect takes 0,08s.
Arrow Transform: Zoom x - 0.140 y 0.140

SOUNDS
Background for movies is *Background music.wav* music.
Fade in and fade out effect takes 0,08s.
Click sound effect for movies is *Click Sound.wav* music.

Keyboard sound effect for movies is *Keyboard sound.wav* music.
OUTRO
Outro for movies is *Outro 1.png* and *Outro 1.2.png* graphic.
Outro appears on the screen during 8 seconds.
Fade in and fade out effect takes 0,08s.
Any graphic appears on the screen during 4 seconds.
Every graphic must have fade in and fade out effect.
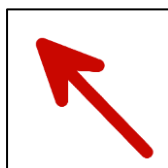First graphic must be *Outro 1.png* , and second graphic must be *Outro 1.2.png*

Appendix B – Media provided by partners

Below are the images that have been provided by the project partners for completing the instructional videos.
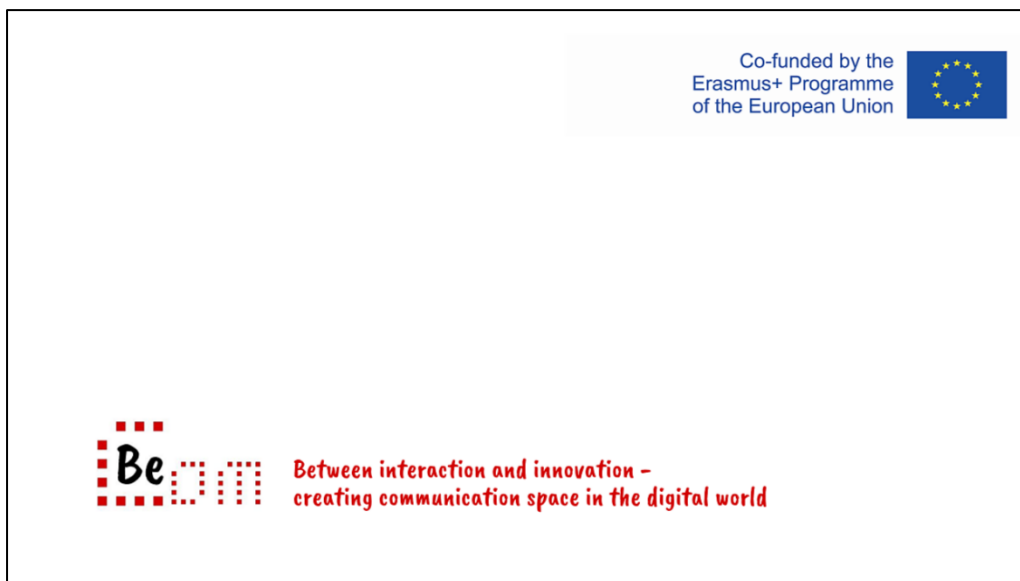
Step.png

Arrow.png

Intro.png

Outro 1.png

Outro 2.png

Appendix C – Video scenarios

In the following table you can find the steps to be used in every video in order to demonstrate the feature begin described:

Short description	Scenario steps
Using Google Forms	1. Enter google drive 2. Click 'New' 3. Hover over 'More' 4. Click google forms 5. Click on first question and at the top right margin of the question there is 'Multiple choice', by clicking it, google forms gives you a variety of choices, showcase all options. 6. Click on the plus logo to add new question 7. Click required 8. Click on the three dots, the 'show' section appears 9. Click the 'delete' to delete question 10. Click the 'Add title and description' 11. Click 'Customize theme' and showcase the options
Linking forms with Sheets	1. Double click on form 2. Click the 'Responses' 3. Click 'View responses in Sheets' 4. Showcase all the options on how to collect data
Sharing a form	1. Double click on form 2. Click the 'Send' which is located at the top right corner 3. Show how to add members 4. Show how to share the form through email 5. Show hot to share the form through link
G-mail message Templates	1. Enter G-mail 2. Show how to enable templates 3. Click on compose 4. Showcase the creation of a template 5. Show how to save the template 6. Show how to use the template to send an email
Using G-mail instance messenger	1. Start by showing were the instance messenger is located 2. Show how to search people to connect with 3. Show how to send a message 4. Show a real time conversation between the two users
Sending email using Gmail	1. Open the email client on the browser 2. click 'Compose' to open the editor 3. enter or select recipient 4. add 'Cc' recipients (enter or select) 5. add 'Bcc' recipients (enter or select) 6. insert a subject 7. insert the message body 8. click 'Send' to send the message
Google groups	1. Enter Google groups 2. Show how to create a group 3. Go through all the options that need to be selected in order to make the group

	4. Show how to create topic
	5. Show how to comment on topics
Google Drive basics	1. Enter Google drive
	2. Click New or click My Drive
	3. Create a folder
	4. Navigate the folder
	5. Show how to connect with more apps
	6. How to share the folder with others and what permissions you can bestow upon them
	7. How to move folders to other sections
	8. How to delete folders
Using Google drive	1. Enter Google drive
	2. Upload a file or folder
	3. How to share the folder with others and what permissions you can bestow upon them
	4. How to download a file or folder
Using Google Docs	1. Open up a browser an click the "Apps"
	2. Open up "Docs" and create a new document
	3. Demonstrate how to enter some indicative text
	4. Demonstrate how to share the document via sending an invitation
	5. Demonstrate how to name a new document, before you share it
	6. Demonstrate the sharing process by entering emails and configuring "editor" option.
	7. Apply sharing
	8. Use another tab and open the same document from the drive of the "shared" user
	9. Have the new user enter some text to demonstrate different cursors
	10. Switch to the first user to show the editing
Using Google Slides	1. Enter google drive
	2. Click New
	3. Click Google Slides
	4. Showcase all the options in creating a google slide
	5. How to share the slide
	6. Show real time editing by utilizing a second account
Using Google Sheets	1. Enter google drive
	2. Click New
	3. Click Google Sheets
	4. Showcase all the options in creating a google sheet
	5. How to share the sheet
	6. Show real time editing by utilizing a second account