DS&AI

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Curriculum Development in Data Science and Artificial Intelligence

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D2.4 - Description of methodology and tools

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DISCLAIMER

Contents

Abstract

This report refers to the deliverable D2.4 from WP2 “D2.4 Description of methodologies and tools” that must be selected for the efficient delivery of the DS&AI MSc programme. The methodologies and tools were carefully selected considering:

(1) the outcomes from the Questionnaire on Methodologies and Tools prepared by the University of Minho (UMI) and set available online to all DS&AI partners, which have contributed with their teaching experience and areas of expertise;
(2) The outcomes from the study visits to Athens and Leiden (D2.1);
(3) and the outputs generated by WP1.

Introduction

The Data Science and Artificial Intelligence (DS&AI) Erasmus + KA2 Project aims at creating a new MSc programme in Data Science and Artificial Intelligence in Asia, focusing on MSc's level training, providing advanced courses and guidance in developing research skills necessary to develop innovative new data-driven technologies. For the effective delivery of the MSc programme, each higher education institution (HEI) partner must employ a set of pedagogical tools and methodologies that best fit each curricular course, following modern teaching practices and approaches with high-level teaching standards.

This document refers to the deliverable D2.4 (report) of work package (WP) 2 "D2.4 Description of methodologies and tools". The tools and methodology were carefully chosen under the consideration of the outcomes from the Questionnaire on Methodologies and Tools prepared by the University of Minho (UMI) and set available online to all DS&AI partners. This report also considered the outcomes from the study visits to Athens and Leiden (D2.1), as well as the outputs generated by WP1.

The remainder of this report is divided as follows: Section ***"Teaching Methodologies & Tools***" describes different teaching methodology and tools that can be adopted by each course; Section ***"Online Questionnaire on Teaching Methodology & Tools"*** outlines the online survey and collected data; Sections ***"Programme Core Courses"***, ***"Programme Elective Courses"***, and ***"Internship and thesis"*** refers to the methodology that should be applied to each curricular course; and finally, Section ***"Conclusions"*** concludes this document.

Teaching Methodologies & Tools

For the effective delivery of the MSc programme, each course must adopt the methodology and teaching tools that best fits its outline and meets the expected learning outcomes.

A. In-class lectures

In-class lectures, or simply lectures, are one of the oldest teaching methods, and still the most widely used method of instruction on colleges and universities. Lecturing is not simply a matter of standing in front of a class and teaching the students what is known. An in-class lecture is a special form of communication in which voice, gesture, movement, facial expression, and eye contact can either complement or detract from the content. No matter what the topic is, the way professionals deliver and the manner of speaking immeasurably influence the students' attentiveness and learning.

B. Lab/practical classes

In many Engineering and Science courses students spend considerable parts of their time doing practical or laboratory work. Laboratory classes provide students with first-hand experience with course concepts and with the opportunity to explore methods used by experts in their discipline. Here the learning is very 'hands on' and classes are designed to allow students to practise and develop a wide range of discipline-based techniques and personal skills. In many courses, lectures and practical sessions are integrated with the view that theory can be explained in the lecture and then applied and tested in the practical class.

C. E-learning/Offline Lectures

E-learning lectures, which take advantage of the modern IT infrastructure, can be considered a teaching methodology but simultaneously or a tool (when contents are available online for being consulted by students, at any time). The main advantage of this methodology is that students can prepare themselves with topics before any lab or in-class session. This method is very handy as students can attend a virtual/offline lecture everywhere and anywhere, allowing them to manage their own schedule. On the other hand, there is no interaction with the lecturer, which may difficult the learning task.

D. Individual/Group Project

It is widely known that projects are a great way to mix up instruction and get students thinking outside the box. Projects can also allow students to learn more about something they are interested in. While students have their preference for group or individual projects, there are mutual benefits for both types of projects. Students will need some skills both working in a team and solving problems independently. Group projects encourage teamwork and collaboration, both of which are incredibly important skills that students will need long after they graduate from high school. On the other side, groups may allocate work unevenly based on students grades or knowledge of a subject, leaving some people to do far more work than others.

E. CDIO-based approach

Nowadays, traditional teaching methods that rely on lecturing and rote testing may not always apply to every course, which can neither convince students to stay in the classroom, nor provide them with the proper requirements from the current industry scenario. Therefore, the MSc may also adopt, when needed, a CDIO approach. Originally conceived at the Massachusetts Institute of Technology (MIT) in the late 90s, the CDIO promotes an authentic learning environment by replicating the whole product lifecycle of technological corporations. This model requires students to Conceive, Design, Implement, and Operate, complex, value-added engineering products, processes and systems in teams, simulating every-day challenges as if they were already inside the enterprise. The outcomes from this strategy include well-prepared students that are able to face real challenges in the company and societal contexts.

F. Engineering and Analysis Tools

In the data science and artificial intelligence field, students need to be proficient with a set of tools and programming languages. These tools are of utmost importance to analyse, process, clean, and visualize data. There is an extensive list of “weapons” that students can find among the ecosystem. Among the programming languages, Python and R are extremely used for data analysis. “R” is especially used mostly for statistics (and data modelling) and is purely made for analysis purposes, while Python is a language that is widely used not only for Data Analysis but also as a scripting language, coding algorithms, writing backend tasks and many more. For data collection and ingestion, Cassandra, Hadoop, and Apache are widely used tools. For data cleaning and mining, apart from R and Python, Apache Spark or simply Spark is an all-powerful analytics engine. Other important tools for data analytics and visualization are Jupyter and Pandas.

Online Questionnaire on *Teaching Methodology & Tools*

The online survey was divided into three distinct parts: part 1 consists in the questionnaire on materials and tools for the five core courses (outcomes from D2.1, study visits to AUEB in Athens); part 2 concerns the questionnaire on materials and tools for the eleven elective courses (outcomes from D2.1, produced in the study visits to Leiden); and part 3 is mainly focused in the Internship (when applicable) and Thesis. The full course list targeted by this questionnaire can be found in Table 1. The questionnaire targeted all DS&AI partners and resulted in eighteen valid responses (at least one response from each partner institution has completed the survey), which reflects, along with the outputs from D2.1, the proposed methodology and tools that each course should employ.

Table 1 - List of DS&AI Core and Elective Courses.

Core	1. Business Intelligence and Analytics (BIA)
	2. Data Modelling and Management (DMM)
	3. Machine Learning (ML)
	4. Artificial Intelligence (AI)
	5. Computer Programming for Data Science & AI (CPDS)
Elective	1. Nature-Inspired Computing (NIC)
	2. Computational Linguistics (CL)
	3. Knowledge Representation (KR)
	4. Computer Vision (CV)
	5. Social Network Analysis (SNA)
	6. Recent Trends in Machine Learning (RTML)
	7. Multicriteria Optimization and Decision Analysis (MODA)
	8. Spatio-Temporal Data Analysis (STDA)
	9. Software Development and Project Management (SDPM)
	10. Human Computing Interaction and Information Visualization (HCI)
	11. Distributed Systems (DS)

Programme Core Courses

1. Business Intelligence and Analytics (BIA)

Course Description: Business intelligence (BI) is a process of analysing business data to obtain business insights and actionable intelligence and knowledge, in order to support better business decision making and capture new business opportunities. This course will give students an understanding of the principles and practices of BI and data analytics to support organizations in conducting their business in a competitive environment.

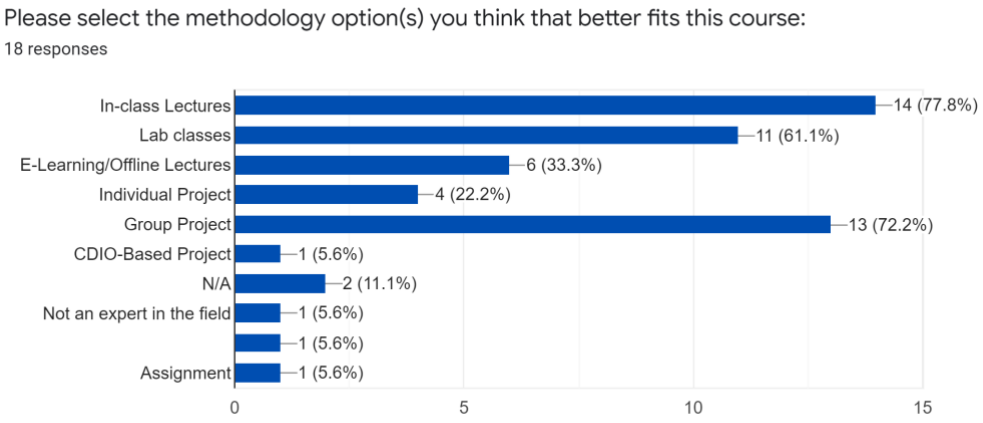
Expected Outcomes: Students, on successful completion of the course, will be able to:

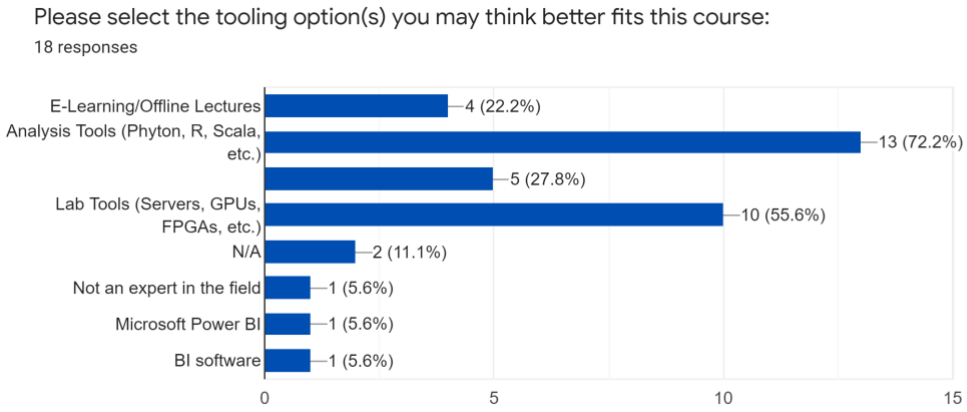
1. Explain the concepts characteristics of BI and data analytics;
2. Describe multiple business problem/decision making domains requiring BI and data analytics;
3. Apply BI and data analytic tools and technologies to develop BI applications;
4. Integrate BI applications with other information systems as part of a business process;
5. Define a BI strategy for an organization;
6. Manage a BI project for an organization;
7. Describe big data analytics and applications.

Teaching/learning methodology and tools: Despite the output from D2.1 not considering lab sessions, this course should mainly adopt a teaching methodology that includes in-class lectures combined with lab sessions, and a group project. Lab sessions shall include computer-based tools for business data analysis.

Progress and final evaluations will be based on the group project and final exam. Regular assignments may also be required.

Results from the online survey:





2. Data Modelling and Management (DMM)

Course Description: The course emphasizes emerging data models and technologies, suitable for managing different types and characteristics of data. Students will develop skills for analysing, evaluating, modelling and developing database applications with concerns on both technical and business requirements.

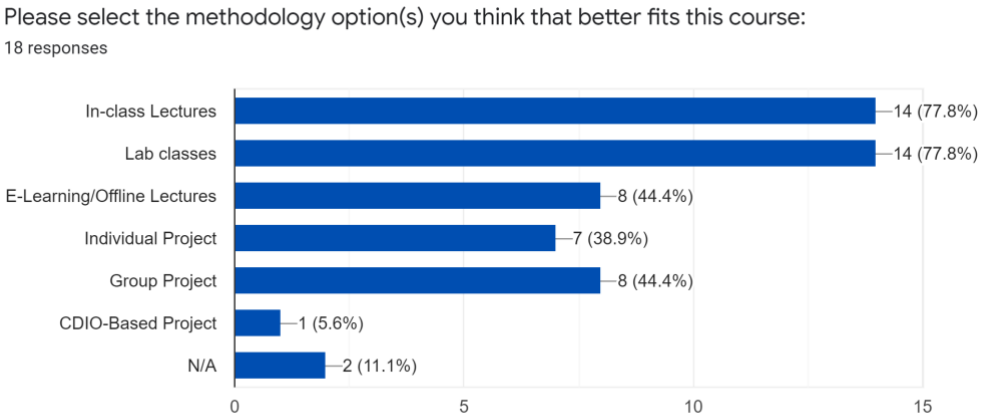
Expected Learning Outcomes: Students, on successful completion of the course, will be able to:

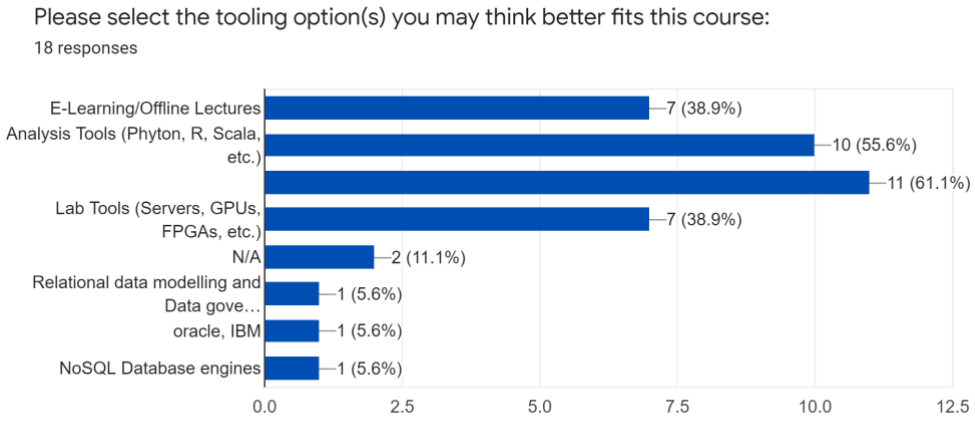
1. Explain data modelling and management concepts;
2. Design and organize various types of data using a relational and non-relational data models;
3. Analyse the characteristics and requirements of data and select an appropriate data model;
4. Identify, implement and perform frequent data operations (CRUD: create, read, update and delete) on relational and NoSQL databases,
5. Describe the concepts and the importance of big data, data security, privacy and governance;
6. Describe the concepts and the importance of data engineering and data visualization.

Teaching/learning methodology and tools: This core course should adopt a teaching methodology that includes both in-class lectures and lab sessions. Lab sessions must include CRUD operations over NoSQL data sets, utilization of specific engineering tools for big data handling, etc.

Progress and final evaluations will be based on the group project and final exam.

Results from the online survey:





3. Machine Learning (ML)

Course Description: This course introduces students from a variety of science and engineering backgrounds to the fundamentals of machine learning and prepares them to perform R&D, involving machine learning techniques and applications. Students will learn to design, implement, and evaluate intelligent systems incorporating models learned from data.

Expected Learning Outcomes: Students, on successful completion of the course, will be able to:

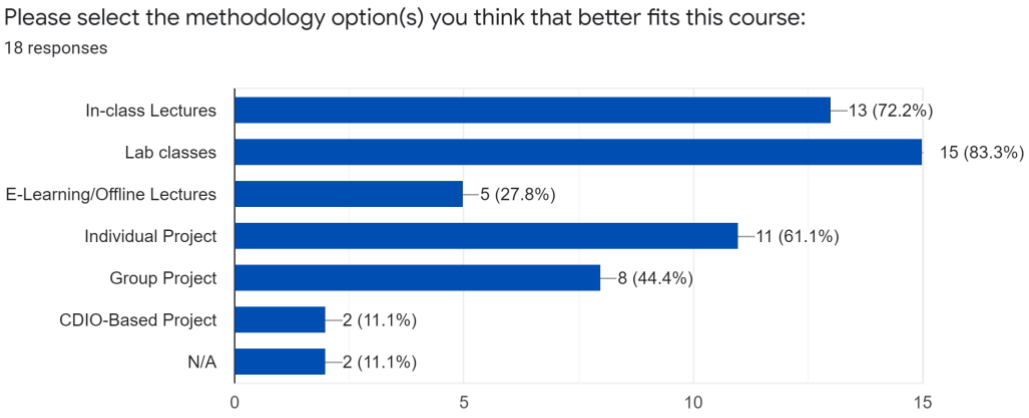
1. Formulate a practical data analysis and prediction problem as a machine learning problem;
2. Identify the characteristics of the data set required for a particular machine learning problem;
3. Train and test supervised regression and classification models, unsupervised learning and density estimation models, and reinforcement learning models;

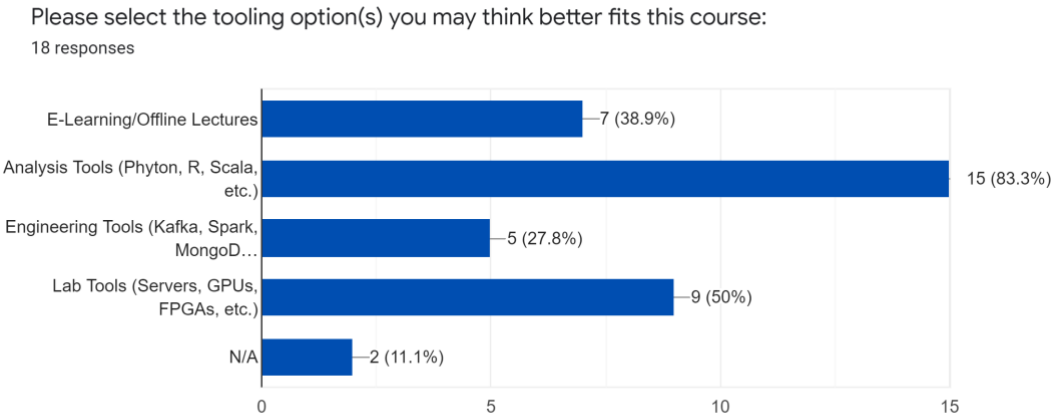
4. Integrate a trained machine learning model into an online software system.

Teaching/learning methodology and tools: This core course should adopt a teaching methodology that includes in-class lectures balanced with lab sessions, and an individual or group project. Lab sessions shall include computer-based tools for data analysis.

Progress and final evaluations will be based on examinations, assignments/reports, and group projects.

Results from the online survey:





4. Artificial Intelligence (AI)

Course Description: The main goal of this course is to introduce students to fundamentals of Artificial Intelligence. Students will be exposed to several techniques on planning and decision procedures, ranging from precise to uncertain and temporal reasoning with applications to intelligent agents.

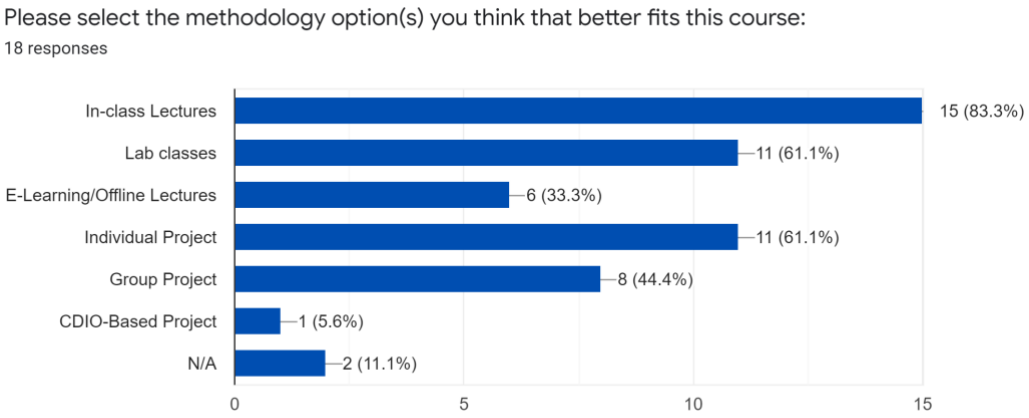
Expected Learning Outcomes: Students, on successful completion of the course, will be able to:

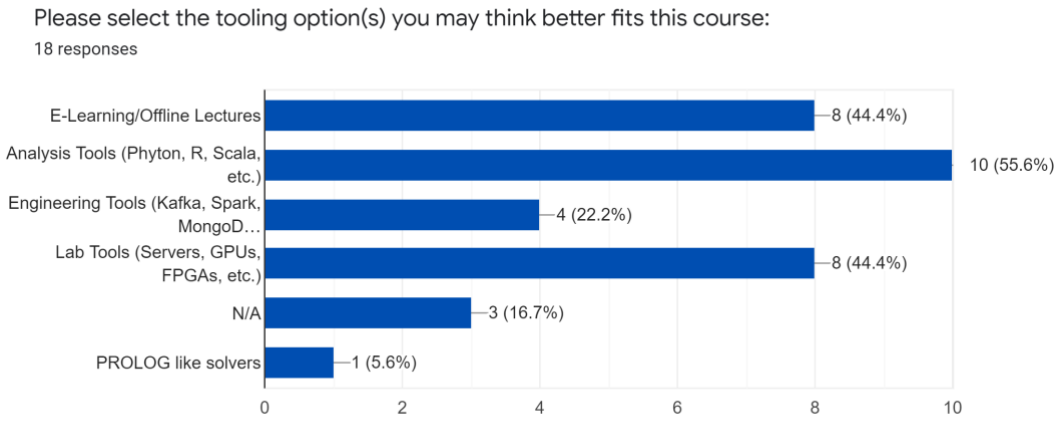
1. Demonstrate fundamental insights into practical planning and decision procedures;
2. Reason under uncertainty;
3. Apply planning techniques into intelligent agents.

Teaching/learning methodology and tools: This core course should adopt a teaching methodology that includes in-class lectures along with lab sessions. Individual and/or group projects may also be required. Lab sessions shall include computer-based tools for running algorithms and analysis tools (Prolog, Python, R, Java, TensorFlow, etc.). The course may be complemented with e-learning lectures and activities.

Progress and final evaluations will be based on examinations, assignments, and group projects.

Results from the online survey:





5. Computer Programming for Data Science & AI (CPDS)

Course Description: This course consists of a laboratory-based course that provides students with the computer programming background required for success in data science and artificial intelligence.

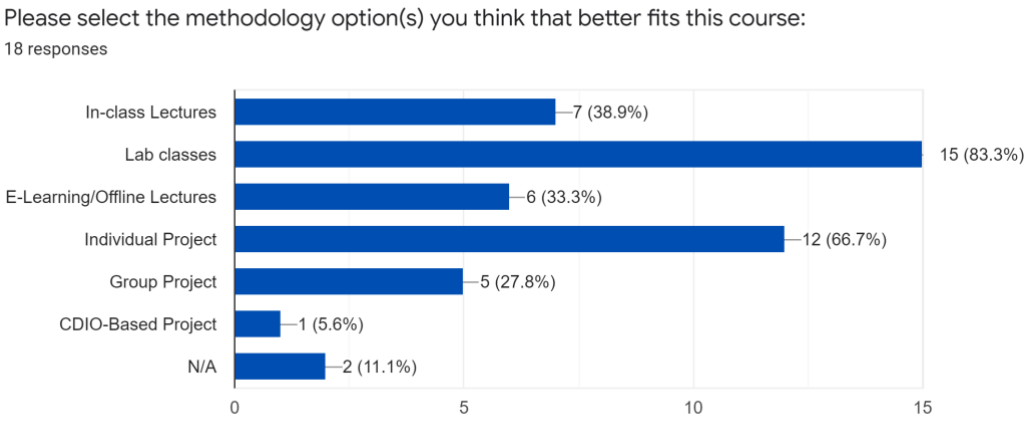
Expected Learning Outcomes: Students, on successful completion of the course, will be able to:

1. Prepare data for further analysis using data analytic tools;
2. Manipulate data sets programmatically;
3. Perform exploratory data analysis programmatically;
4. Apply basic text processing techniques to unstructured data sets;
5. Visualize data sets effectively;
6. Perform basic statistical analyses programmatically;
7. Build data-driven predictive models;

Teaching/learning methodology and tools: This core course highly relies on lab-based sessions assisted by in-class lectures. Each course topic must have a set of lab sessions, aided by several computer-based analysis tools. Individual and/or group projects are also highly encouraged. Offline lectures may also be provided.

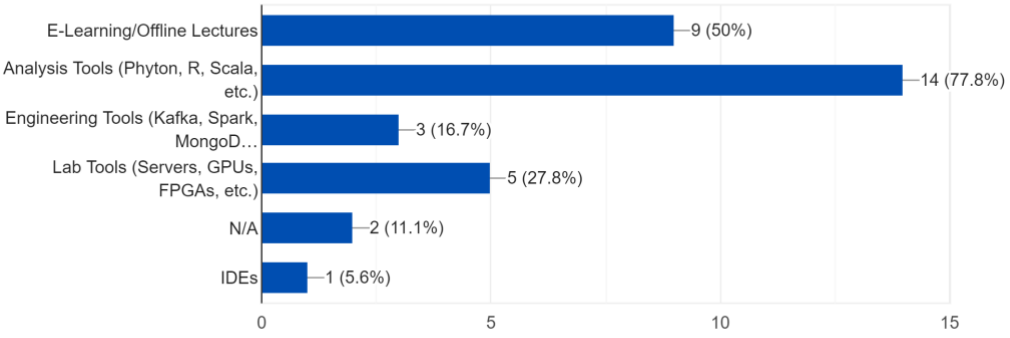
Progress and final evaluations will be based on final exam, periodic assignments/reports, and group projects.

Results from the online survey:



Please select the tooling option(s) you may think better fits this course:

18 responses



Programme Elective Courses

1. Nature-Inspired Computing (NIC)

Course Description: This course aims at Introducing students to the field of nature-inspired metaheuristic methods for search and optimization, including the latest trends in nature-inspired algorithms and other forms of natural computing. The students will be exposed not only to paradigms of nature-inspired metaheuristic methods (originating from, for example, biology, living thing behaviour and natural phenomena), but also to their applications.

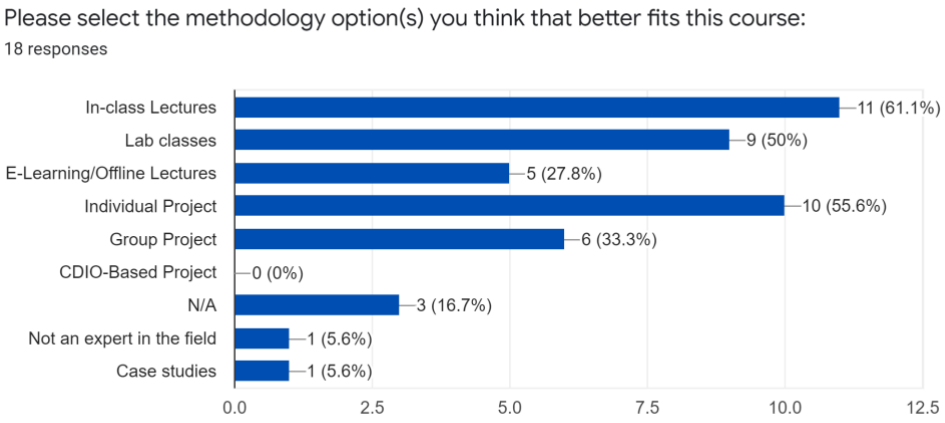
Learning Outcomes: Students, on successful completion of the course, will be able to:

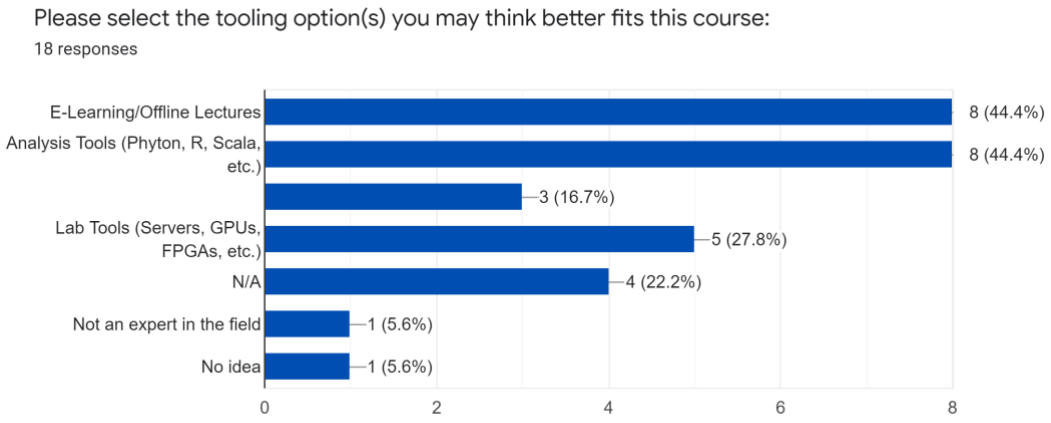
1. Demonstrate fundamental insights of nature-inspired computation;
2. Implement nature-inspired methods into concrete algorithms;
3. Apply nature-inspired algorithms to some search and optimization applications.

Teaching/learning methodology and tools: This elective course should adopt a teaching methodology that includes in-class lectures along with individual and/or group projects. Lab sessions are also highly recommended. Offline materials for student's self-learning may also be provided.

Progress and final evaluations will be based on final examination, and group projects and assignments evaluation.

Results from the online survey:





2. Computational Linguistics (CL)

Course Description: Students will understand knowledge on computational linguistics, especially text processing. Students would learn the fundamentals of language, text mining, natural language processing and its applications. Students should be able to apply the pre-processing and parsing methods for natural languages. Students could employ techniques and models for NLP problem scenarios, design, and implement some scenarios of NLP applications

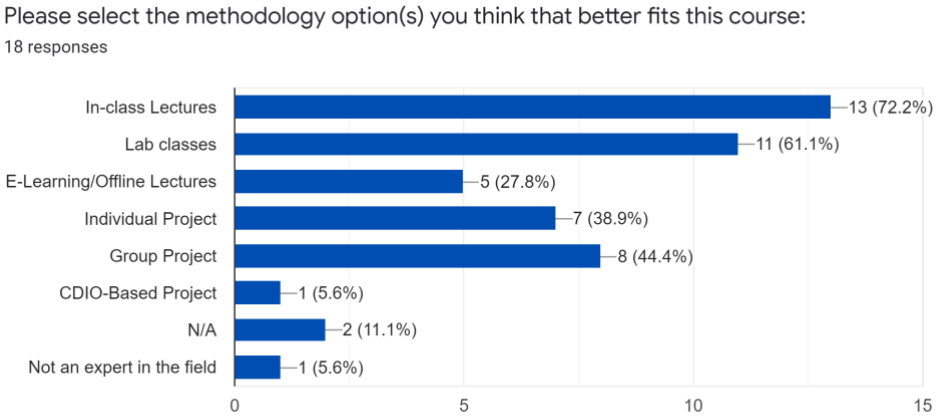
Learning Outcomes: Students, on successful completion of the course, will be able to:

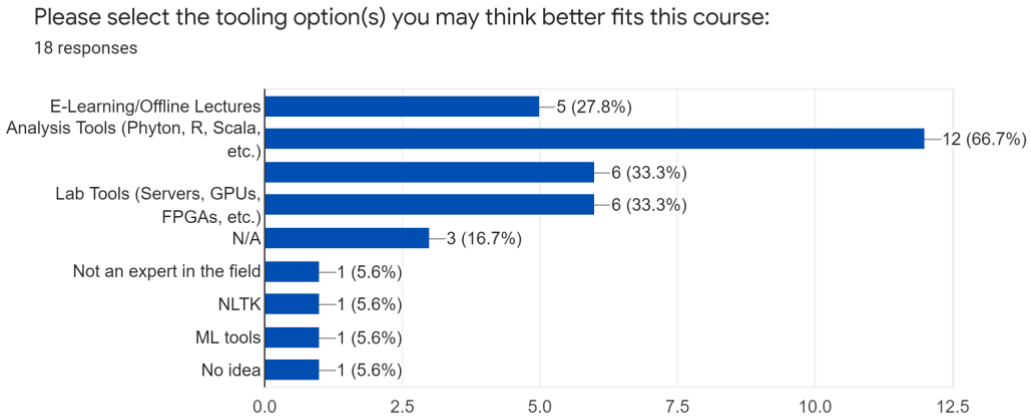
1. Explain the fundamentals of language, text mining, natural language processing, and its applications;
2. Apply the pre-processing and parsing methods for natural languages;
3. Describe and employ suitable techniques and models for NLP problem scenarios;
4. Design and implement NLP applications.

Teaching/learning methodology and tools: This elective course should rely on lab-based sessions assisted by in-class lectures. Each core topic must have a set of lab sessions, where students will learn and create analysis tools aided by the NLP tool kit. Individual and/or group projects will also be required.

Progress and final evaluations will be based on final exam, periodic assignments/reports, and group lab project.

Results from the online survey:





3. Knowledge Representation (KR)

Course Description: Introduce the students to the field of knowledge representation, with the goal of reasoning about knowledge. The students will be exposed to specialized knowledge representations stemming from applications in different domains, such as, semantic web and cognitive robotics.

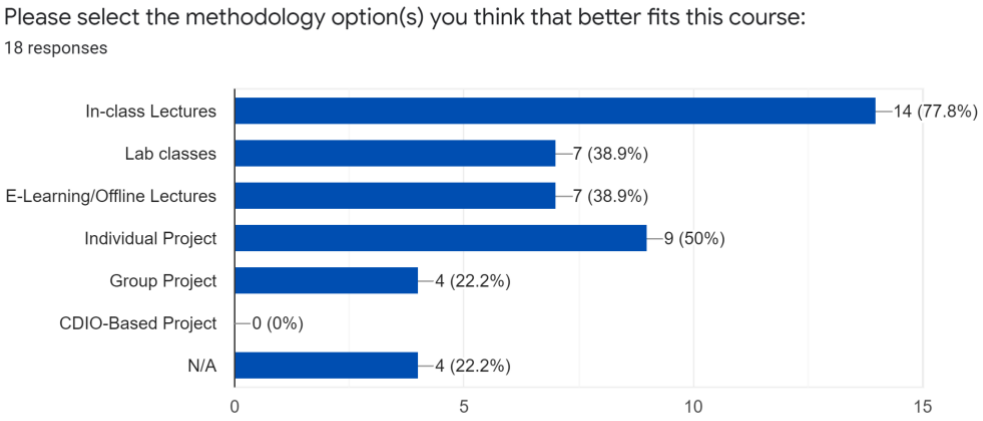
Expected Learning Outcomes: Students, on successful completion of the course, will be able to:

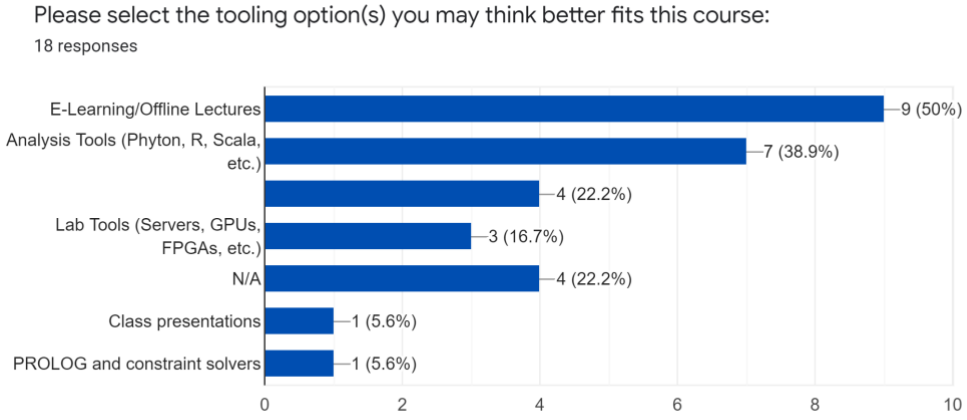
1. Use logical formalisms to effectively describe knowledge, belief, events, and situation;
2. Identify the components of non-monotonic reasoning and its usefulness as representation mechanism for knowledge systems;
3. Design real world knowledge-based systems.

Teaching/learning methodology and tools: This elective course should rely on in-class lectures assisted by practical la sessions. Individual projects may also be of utmost importance.

Progress and final evaluations will be based on final exam and practical group assignments.

Results from the online survey:





4. Computer Vision (CV)

Course Description: The main objective of this course is to introduce the concepts of computer vision with emphasis on state-of-the-art methods used in vision applications.

Learning Outcomes: Students, on successful completion of the course, will be able to:

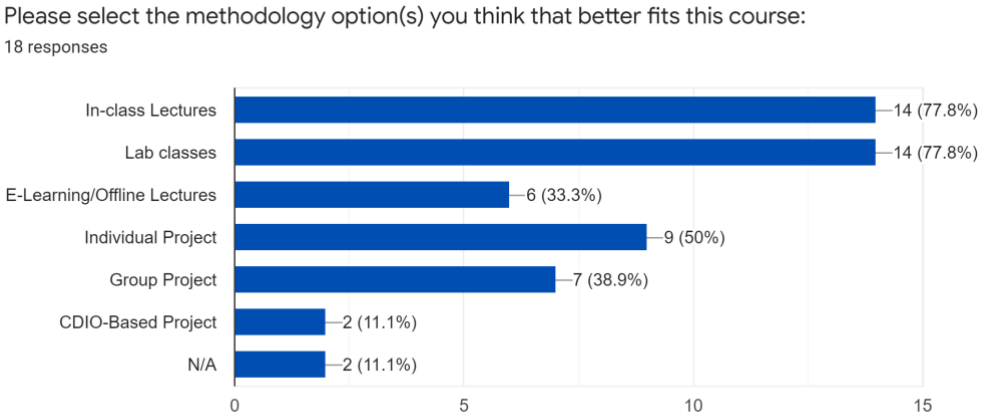
1. Explain key concepts of computer vision;
2. Extract discriminative features from image/video data and use them for pattern classification;
3. Analyse, examine, and evaluate existing practical computer vision systems;

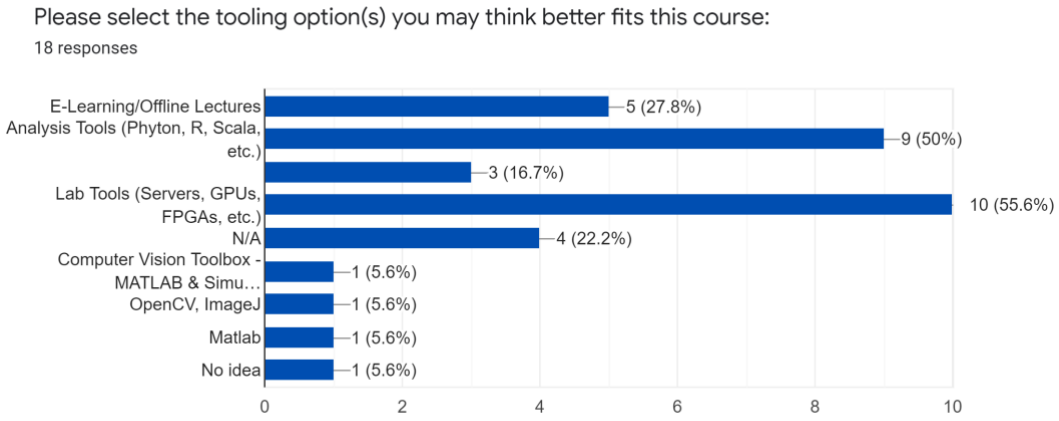
4. Apply computer vision algorithms from standard libraries and tools to build prototype computer vision systems for real scenarios.

Teaching/learning methodology and tools: This elective course should mainly rely on lab-based sessions assisted by in-class lectures. Each core topic must have a set of lab sessions, where students will learn and manipulate computer vision tools such as OpenCV and Python-based frameworks. Individual homework and one group project will also be required. Offline lectures/tutorials may also be required, prior to each in-class lecture.

Progress and final evaluations will be based on final exam, periodic assignments/reports, and group lab projects.

Results from the online survey:





5. Social Network Analysis (SNA)

Course Description: With the growth and popularity of social networks, the analysis of large datasets of networks is becoming more important. This course will give the students an understanding of methods of social networks analysis and applications of social network analysis.

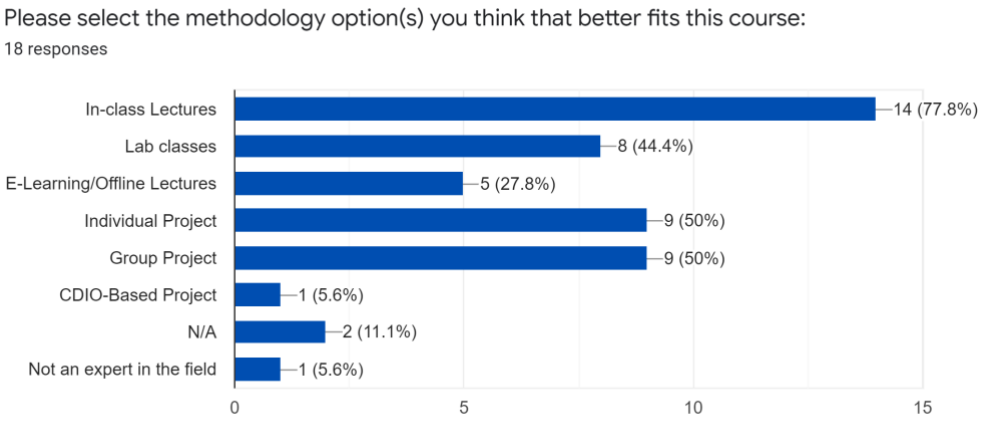
Learning Outcomes: Students, on successful completion of the course, will be able to:

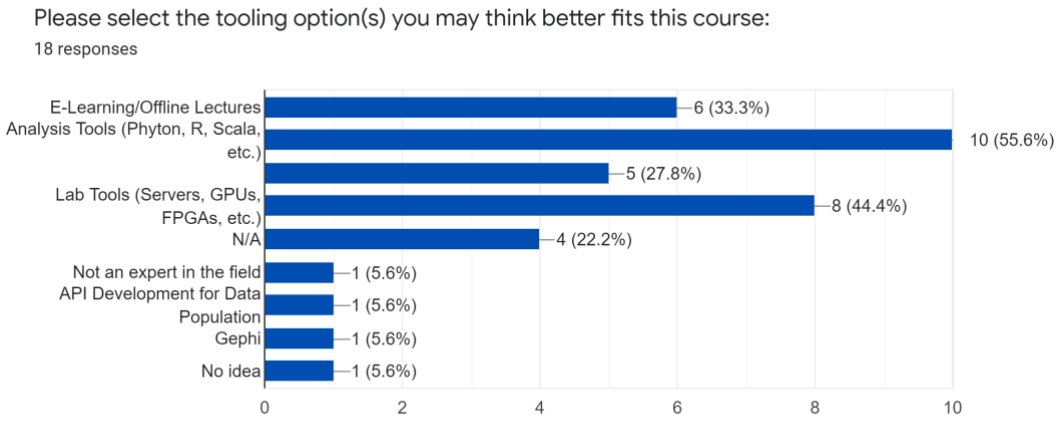
1. Describe different algorithms and methods of social network analysis;
2. Know the evolution of social network;
3. Use SNA for studying the social behaviour or social structure to making decisions;
4. Develop applications of SNA.

Teaching/learning methodology and tools: This elective course should mainly rely on in-class lectures. Individual homework and a group project on real-world case studies will also be required. Offline lectures/tutorials may also be a good complement to promote self-learning sessions.

Progress and final evaluations will be based on final exam, periodic assignments/reports, and the course project.

Results from the online survey:





6. Recent Trends in Machine Learning (RTML)

Course Description: The course builds on the content of Machine Learning, providing students with a deeper understanding of machine learning techniques and a wider variety of extant learning models. Students will be prepared to develop advanced machine learning applications and perform research at a state-of-the-art level.

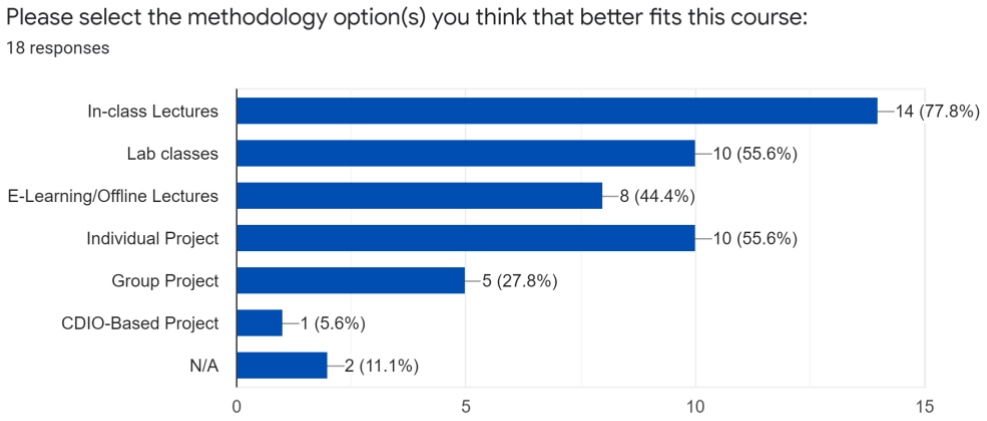
Learning Outcomes: Students, on successful completion of the course, will be able to:

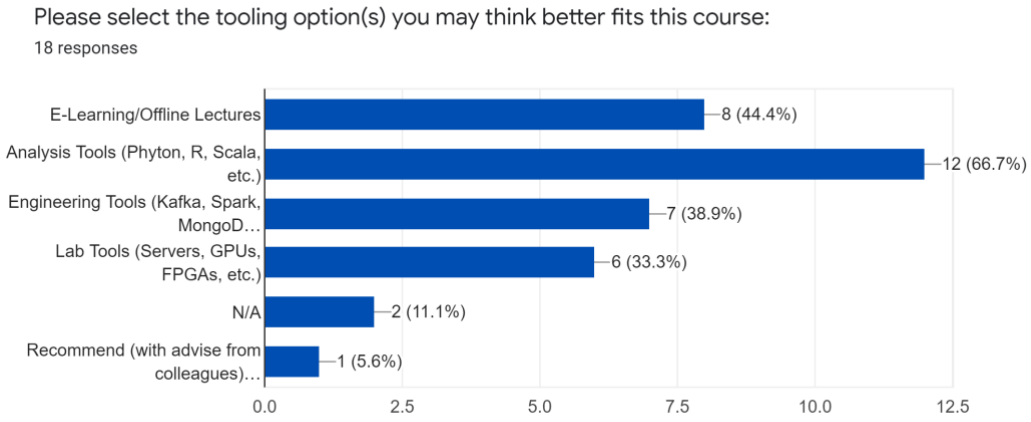
1. Design, train, test, and deploy modern convolutional neural networks (CNNs);
2. Utilize the principles of adversarial learning to increase the robustness of a machine learning model;
3. Design, train, test, and deploy generative adversarial networks (GANs);
4. Utilize recurrent neural networks (RNNs) to model and predict time series;
5. Utilize deep neural networks to solve difficult tabula rasa reinforcement learning problems;
6. Apply state-of-the-art machine learning methods to solve problems in speech processing, speech synthesis, natural language understanding, natural language synthesis, computer vision, and intelligent agent design.

Teaching/learning methodology and tools: This elective course should adopt a teaching methodology that includes in-class lectures balanced with lab sessions. Additionally, prior to each in-class lecture, students must prepare themselves with e-learning resources. This course must also include individual homework assignments and a group project. Lab sessions shall include a set of exercises in data analysis with respective reports.

Progress and final evaluations will be based on examinations, individual homework, lab reports, and the course project.

Results from the online survey:





7. Multi-criteria Optimization and Decision Analysis (MODA)

Course Description: This course will give students an understanding of the decision making process and multi-criteria decision analysis methods and optimization processes for finding optimal solutions to problems with multiple decision alternatives and conflicting objectives.

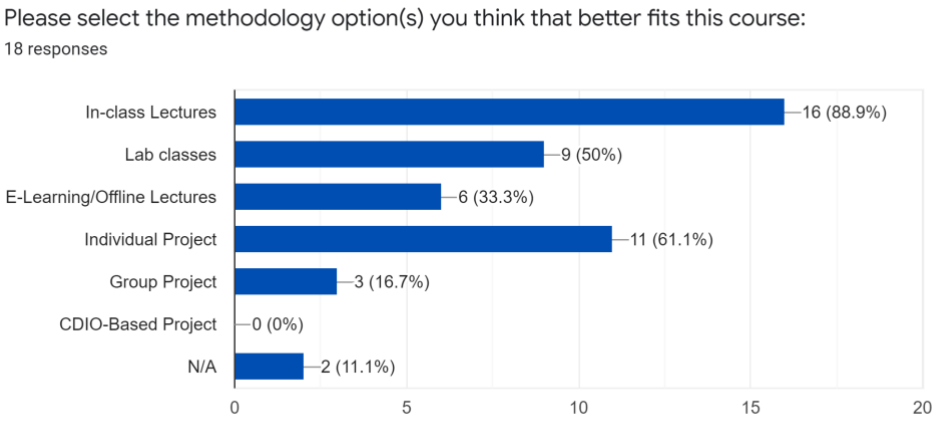
Learning Outcomes: Students, on successful completion of the course, will be able to:

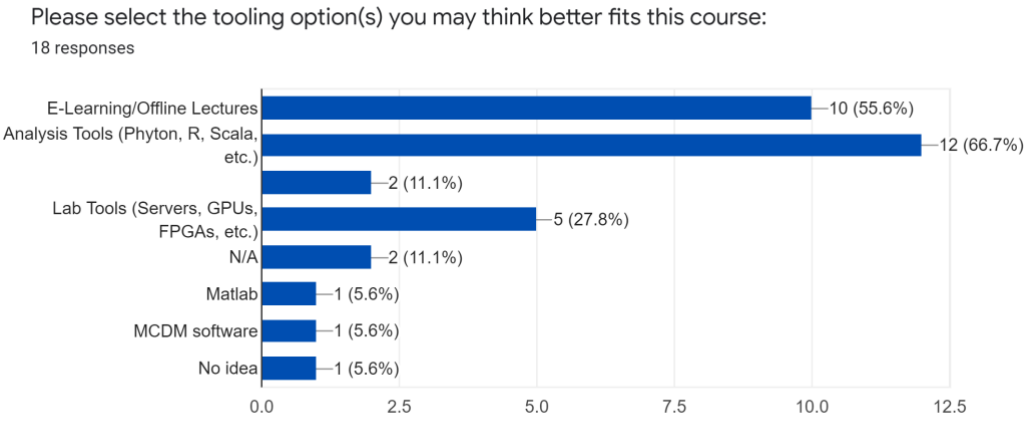
1. Describe the decision making processes typically used by organizations;
2. Formulate a decision making scenario as a multi-criteria decision analysis problem;
3. Identify and formulate different types of mathematical programming problems including formulations with constraints and multiple objectives;
4. Analytically solve simple Pareto optimization problems that are special cases for the application of Karush-Kuhn-Tucker conditions and the Lagrange multiplier theorem;
5. Apply methods of multi-criteria optimization and decision analysis to real world problem domains.

Teaching/learning methodology and tools: This course should mainly rely on in-class lectures; however, lab tutorials can be provided, upon request. Individual homework and an individual course project on real-world case studies are required. Offline lectures/tutorials may also be provided in order to promote self-learning sessions.

Progress and final evaluations will be based on final exam, periodic assignments/reports, and the course project.

Results from the online survey:





8. Spatio-Temporal Data Analysis (STDA)

Course Description: Students should understand problems, methods, algorithms, and novel computational techniques in the analysis of spatio-temporal databases. Students will apply these understanding in spatio-temporal data projects.

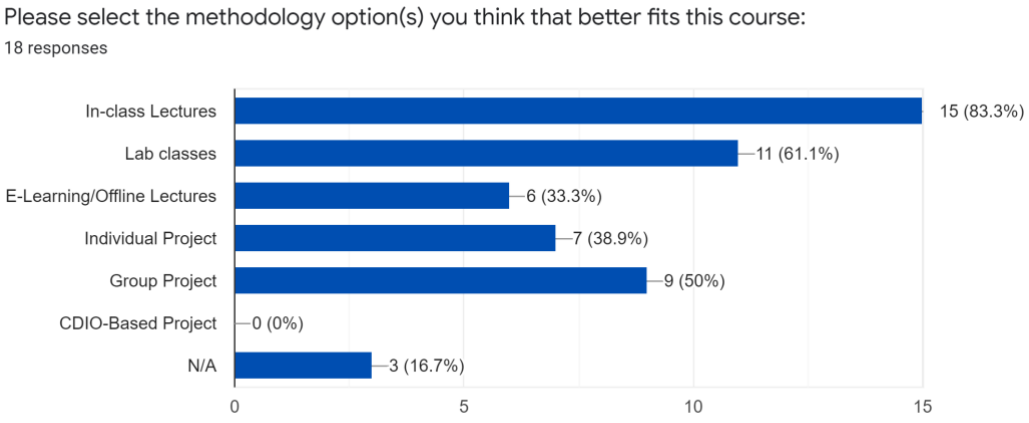
Learning Outcomes: Students, on successful completion of the course, will be able to:

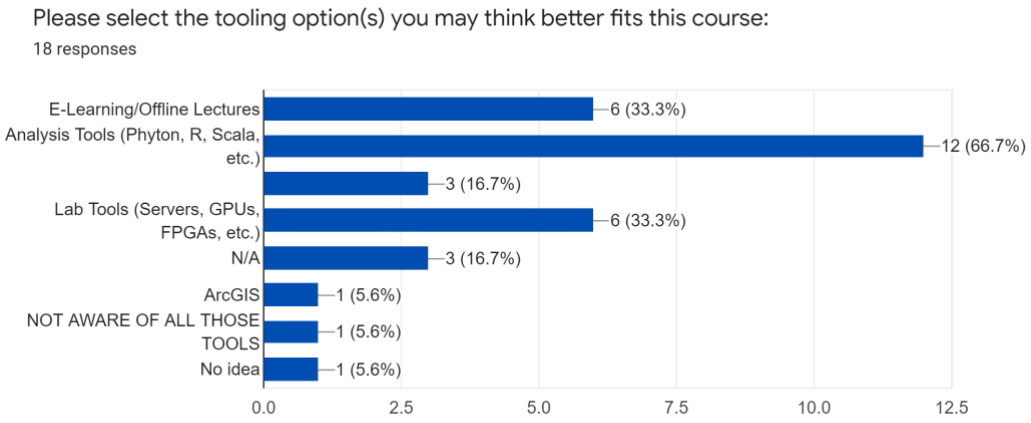
1. Explain the problems and methods (minimum methods are clustering and predictive learning) on the spatio-temporal data mining;
2. Apply modelling skill for realizing spatio-temporal data projects;
3. Apply integration skill for realizing spatio-temporal data projects;
4. Apply visualization skill for realizing spatio-temporal data projects.

Teaching/learning methodology and tools: This elective course should adopt a teaching methodology that includes in-class lectures balanced with lab sessions. Additionally, prior to each in-class lecture, students must prepare themselves with off-line elearn-based lectures. This course must also include individual homework assignments and a group project on spatio-temporal data mining.

Progress and final evaluations will be based on final examination, individual assignments, and the course project.

Results from the online survey:





9. Software Development and Project Management (SDPM)

Course Description: The course emphasizes modern and important software development, software process, and project management. Students will tailor the software development process and project management for DS&AI projects, including planning, iterative development, test driven development, continuous integration/continuous delivery, versioning, and deliverables. Students learn to apply knowledge to the problems in DS&AI domains.

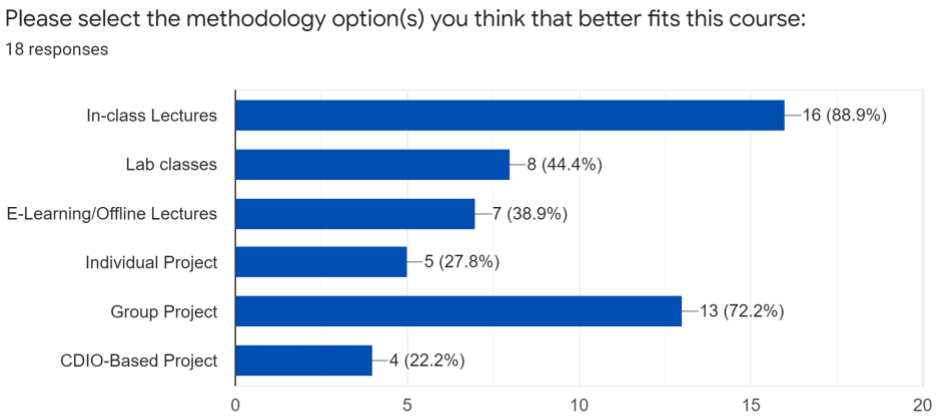
Learning Outcomes: Students, on successful completion of the course, will be able to:

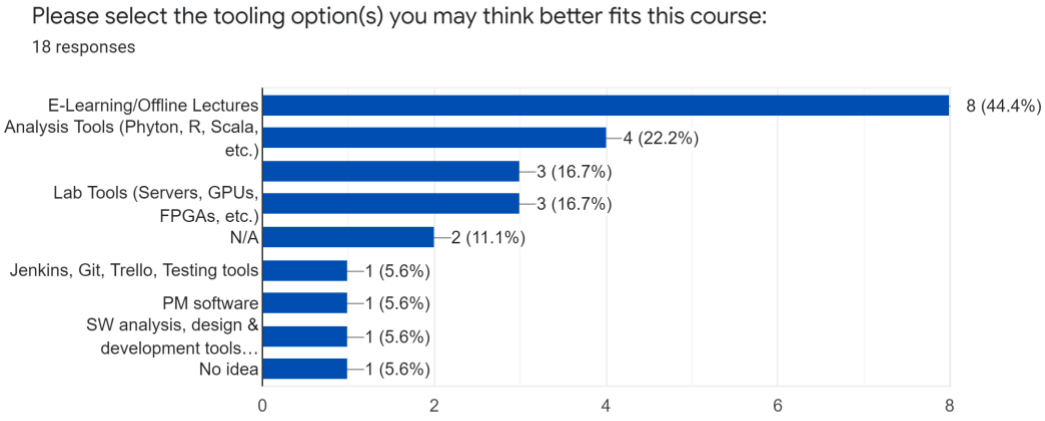
1. Explain the importance of software development and project management;
2. Explain how model-driven development works in a DevOps and agile environments;
3. Create model and data versioning;
4. Apply the principles of project management to DS&AI project.

Teaching/learning methodology and tools: This elective course should mainly rely on in-class lectures. Additionally, prior to each in-class lecture, students must prepare themselves with off-line elearn-based lectures. It is also required that students perform individual projects along with a group project (3-4 people) on a real-world case scenario for an application of DS&AI.

Progress and final evaluations will be based on periodic examinations, individual projects, and the course group project.

Results from the online survey:





10. Human Computing Interaction and Information Visualization (HCI)

Course Description: Throughout this course, students should understand the principles, processes and techniques for design, implementation and evaluation of interactive systems to maximize usability and to enhance user experience of data-driven systems. Students would learn the methods and techniques to present information to enhance the understanding of data.

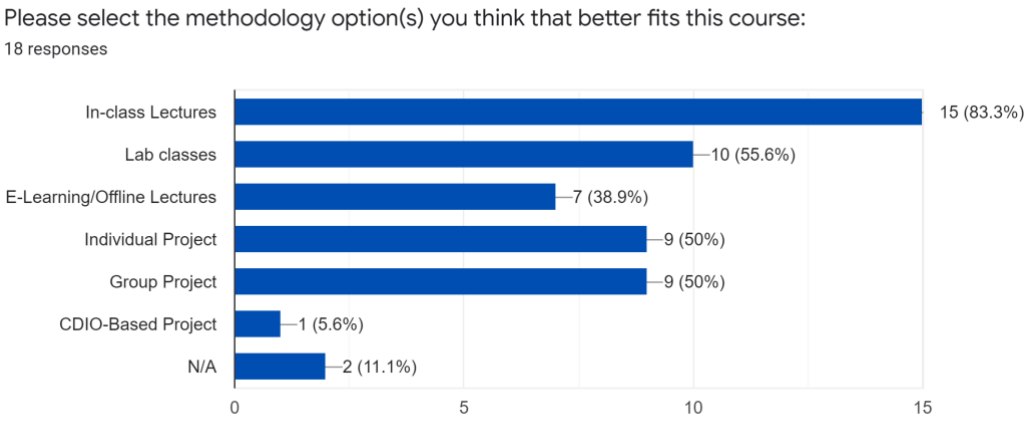
Learning Outcomes: Students, on successful completion of the course, will be able to:

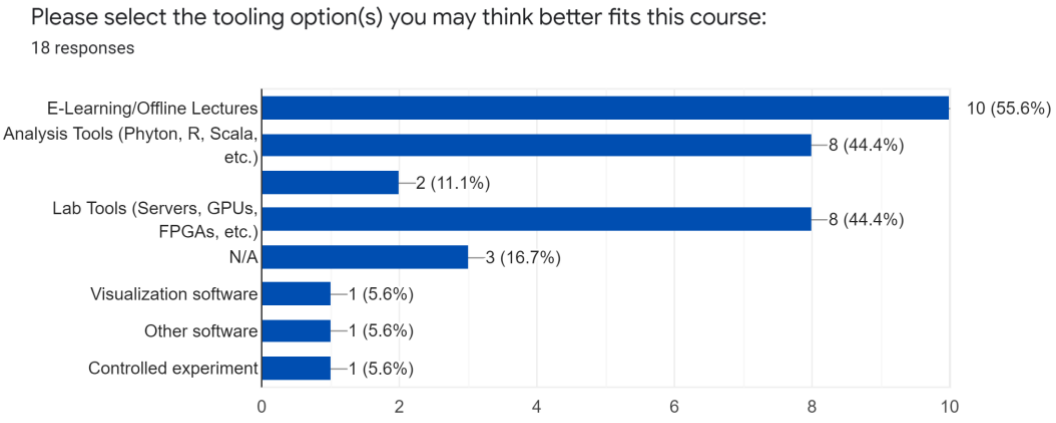
1. Explain capabilities of both humans and computers and the theoretical foundation of human computer interaction (HCI);
2. Adopt the process of design thinking for development of interactive systems;
3. Employ tools in HCI for implementation of systems with maximized usability and enhanced user experience;
4. Explain the fundamentals of information visualization;
5. Summarize dynamic, real-time and spatial datasets across categories, space, and time through visualization tools.

Teaching/learning methodology and tools: This elective course should adopt a teaching methodology that includes in-class lectures balanced with lab sessions on lab tools such as Prolog or R. This course must also include individual homework assignments and individual/group projects.

Progress and final evaluations will be based on a final exam, individual assignments, and course projects.

Results from the online survey:





11. Distributed Systems (DS)

Course Description: The course introduces the concepts of distributed systems, cloud computing, and blockchain. Students learn to create required distributed infrastructure and ecosystems for DS&AI applications. Students earn skills on deployment, monitoring, and management of distributed systems.

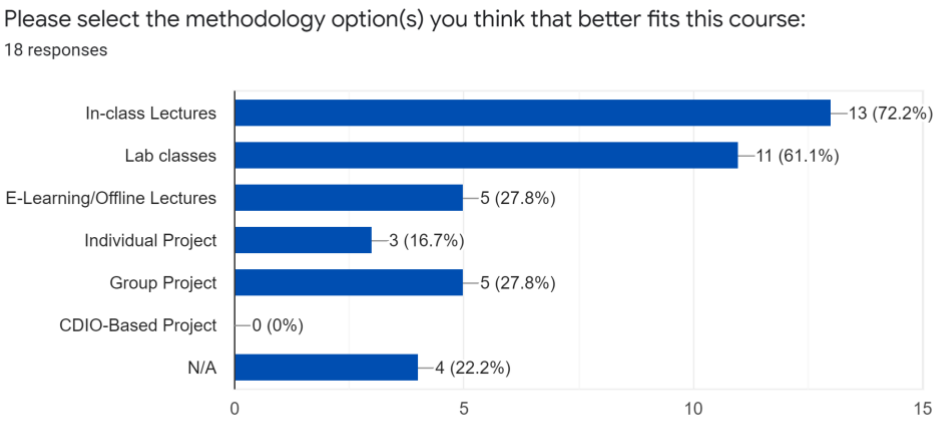
Learning Outcomes: Students, on successful completion of the course, will be able to:

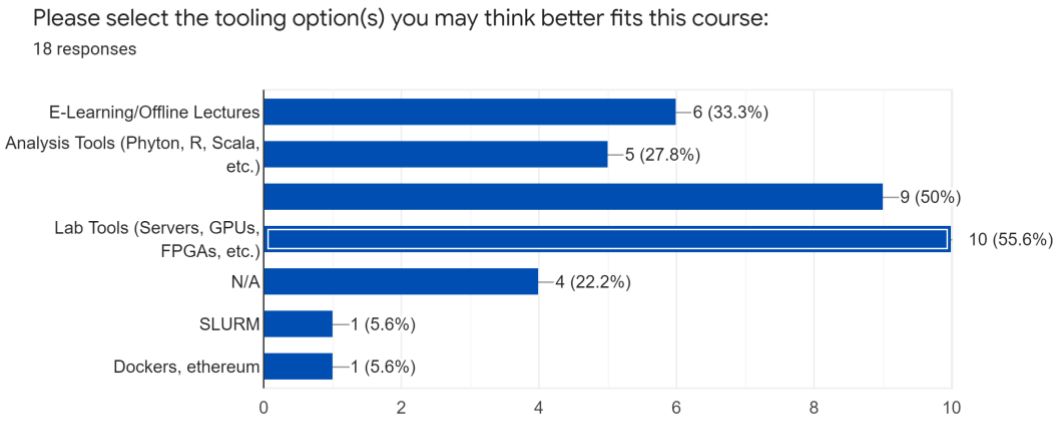
1. Explain the main concepts of distributed systems, cloud computing, and blockchain;
2. Setup distributed environment for DS&AI applications;
3. Utilize distributed file systems;
4. Create the process pipeline and deploy cloud services;
5. Monitor and management the usage of network resources;
6. Implement applications with blockchain/smart contracts.

Teaching/learning methodology and tools: This elective course should adopt a teaching methodology that includes in-class lectures balanced with lab sessions on distributed system's topics such as cloud-based computing. Additionally, prior to each in-class lecture, students must prepare themselves with off-line elearn-based tutorials. This course must also include individual homework assignments, and a group project (blockchain/smart contracts project based on a group of 3-4 students).

Progress and final evaluations will be based on examinations, individual homework, lab sessions, and the course project.

Results from the online survey:





Internship and thesis

A. Internship

An internship is typical of the utmost importance for students to get a first contact with the industry. In traditional Science and Engineering programmes, internships are optional and sometimes an alternative for the Thesis. In the context of a very sophisticated and practical DS&AI programme we believe it should be a good complement to the Thesis. In order to understand the opinion and/or needs of each partner HEI, the following questions were included in the survey.

Q1 - "Do you think the Internship should be elective or mandatory?"
R1 - Regarding this question, 50,0% of the answers consider that it should be "mandatory" and 50,0% "elective". Although there is no consensus among partners, we strongly believe that the Internship is important and recommend HIE partners in Asia to adopt it as mandatory. Results can be found in Figure 1.

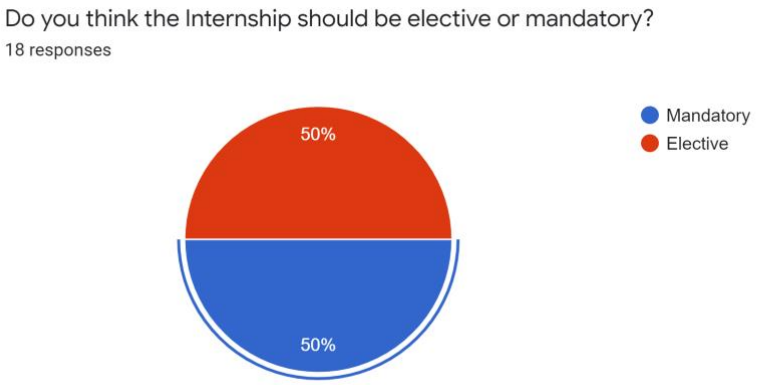


Figure 1 - Responses to Internship Q1.

Q2 - "How/Where/When students will apply for internships?"
R2 - Table 2 shows the received answers to question Q2. Regarding the application period for the internship, students should apply right after they complete the first year of the programme. Students are recommended to apply directly with companies that are partners with the HEIs or eventually through centralized platforms made available by HEIs.

Table 2 - Responses to Internship Q2 - “How/Where/When students will apply for internships?”

1.	With counselling/during the 1st semester
2.	Individually choose a company when he/she in third semester, faculty will help in processing the application
3.	Via the university, in a company, just before their thesis work
4.	At the end of the course work
5.	Companies or organizations having MOU with us might agree to offer internships/Second semester (or when they have a research topic)
6.	Through a central repository of internship projects
7.	Students will apply for internships during the second year of study.
8.	- second year, - at a local company or abroad.
9.	nearby my university, depend on connection and advisor. In my opinion, when they going to the second year and summer period to collect data and get the objective the place where they internship.
10.	Preferably at their own Employment organisation, They should find opportunity on their own, at the end of the taught course.
11.	contact/network, companies, near the end
12.	IST Companies
13.	In the 3rd semester. The internship can be done in the relevant institution either in the home country or abroad.
14.	N/A
15.	How: Faculty should have link to industry where students can apply for internship. Or student may have link to industry, he/she where they can do their internship. Where: in industry When: last three month on their third semester
16.	After completing 1-2 semesters, applying through the program office
17.	Based on personal contacts, Using department contacts
18.	Student initiated/industry/may replace thesis option at their final year

Q3 - "What if there are more students than internship offers?"
R3 – Table 3 shows the received answers to question Q3. If HEIs observe that there are not enough internship offers for the total number of students, they have mainly proposed two options: (i) undergo the internship at the university within R&D projects/Innovation projects; or (ii) approach other national HEIs to use explore partners. There are a minor percentage of HEIs that think that in that case, the Thesis should be extended for the period of the Internship. We believe that Thesis and Internship provide different perspectives and skills for students, and so we strongly advise HEIs to undergo different "marketing" strategies (e.g., dedicated company forum days) for attracting and establishing relations with companies.

Table 3 - Responses to Internship Q3 - "What if there are more students than internship offers?"

1.	Perform internship at university within R&D&I projects/Innovation projects
2.	Some students could do internship in their our university lab, analyzing real-time problem using on-line data sets found in certain domain area.
3.	Create internal internships with real life projects at the University
4.	If so, there is no issue.
5.	Students having experiences working in the DS&AI fields are exempted from internship. Details of their work experience should be given for a committee to review and approve.
6.	First come first serve
7.	.
8.	- sharing with other HEIs, - preparing in advance
9.	if our network has the students apply less than company who are able to exchange and going to aboard within partner's university be company instead coz some advisor might be project under funds/scholarship at least it should be internship in Research Assistant as well.
10.	Student should have to do a considerable project under supervisor from Academic and Industry staff.
11.	good selection process
12.	Other countries-niternational internships
13.	The internship can be done in the relevant company abroad.
14.	N/A
15.	they can work in lab to solve a (real) problem offered by their supervisors.

16.	Some placement criteria (such as background knowledge and types of work) should be considered to best fit the right students with the right companies
17.	Some work maybe assigned within the university or students may have to take extra courses.
18.	Student initiate the efforts - but we provide thesis option as alternative

Q4 - "What you have in mind regarding the co-advising strategy?"
R4 – Table 4 shows the obtained responses. For this question, it is clear that the co-advising strategy shall include a model where there is an advisor from both the university and the partner company. Furthermore, some HEIs suggest that the main advisor should be from the university and the co-advisor from the company.

Table 4 - Responses to Internship Q4 - "What you have in mind regarding the co-advising strategy?"

1.	N/A
2.	Strongly advise
3.	Not very clear with this term, but if it is allowing student to have outside advisor from an industry with specific expertise, it is a good idea.
4.	Always involve at least one staff member of the University to guarantee quality
5.	Need to study the organization and work to be done before engaging with the organization.
6.	Co-advising is a great opportunity for students for students to work on integrated topics or wide variety of topics. They can also gain experiences from more than one experts.
7.	First supervisor at the university, second supervisor at the company
8.	.
9.	take care of them and be consultant till successful.
10.	It should be as academic and industry should collaborate in modelling students according to academic and industry requirements.
11.	good but rather difficult to arrange
12.	commitee
13.	This strategy would be good - also good for expanding the networking
14.	it's good for students. they can more adapt with the industry

15.	I support the idea since both academia and industry can collaborate closely and complement the strengths of each other.
16.	No idea
17.	-
18.	-

Q5 - "Please provide a list of non-academic partners you may have for internship offers."

R5 - Table 5 presents the received answers to question Q3. In general, the majority of HEIs have presented a list of companies for different sectors, i.e. IT, banking, administration. For a full picture of the names of the companies, we suggest a deeper analysis of Table 5. Notwithstanding, around 20% of the Asian HEIs seem to not have, as of now, a list of target companies for internships. We strongly encourage those HEIs to start some marketing activities as well as to start an alternative plan with the help of other national HEIs involved in the consortium.

Table 5 - Responses to Internship Q5 - "Please provide a list of non-academic partners you may have for internship offers."

1.	Only in Portugal
2.	National telecom companies, networking/data service providers, banks, plantation companies, insurance companies, national stock-exchange companies, hospitals, etc
3.	n.a.
4.	99X Technologies, Dialog Axiata, CodeGen
5.	INET, university's hospital, NECTEC
6.	I only have contacts in the Netherlands
7.	Internet Thailand Public Company Limited.
8.	- Provincial Electricity Authority - Provincial Administration Organization - Companies that provide Social Media Analyzing service
9.	inet company
10.	IFS, Axiata, Sysco Labs, LIRNEAsia, Zone24x7
11.	N/A

12.	n/a
13.	Google Office
14.	We could provide some options, but in a later stage
15.	state-own companies, such as, Telecom, Power Supply company, Hospital, start-up companies, hotels,
16.	KBank, SCB, Bank of Thailand, TOT, IBM, Start Up Companies
17.	We have a list companies currently providing internships for Computer Science students.
18.	-

B. Thesis

A thesis, typically used to sum up learned knowledge in a master's program in the form of a scholarly paper (usually as a result of a project), should be mandatory in the DS&AI programme. Usually, it goes for one academic year (two-semester period), but in some cases it is adopted a one-semester approach. In order to understand the needs from each partner HEI, the following questions were included in the survey.

Q1 - "Do you think a one-semester period for the Thesis may be enough?" R1 - Regarding this question, 16,7% of the answers consider that yes, it should be enough, 44.4% "maybe", and 38.9% correspond to "no". Since the MSc Thesis should be mandatory, and Internships are also possible, it should take a one-semester period during the 2nd year of the MSc programme (before or after the internship, when applicable). When Internships are not possible, maybe a two-semester period should be considered.

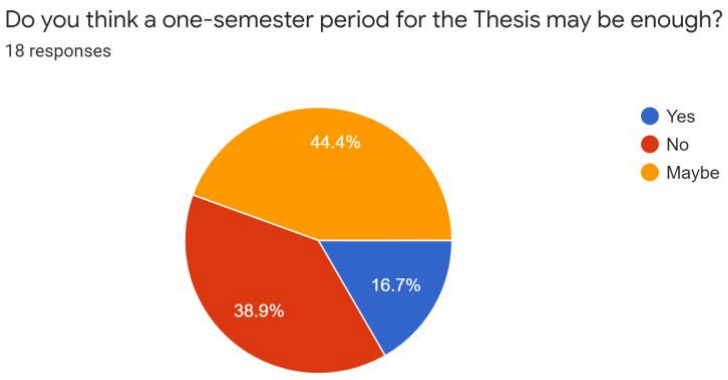


Figure 2 - Responses to Thesis Q1.

Q2 - "How/Where/When students will apply for a Thesis?"
R2 - Table 6 shows the received answers to question Q2. Regarding the application period, and for the success of the thesis project, students should apply as soon as possible, right after they complete the first year of the programme (or after completing the core courses if they are only distributed over the first year).

Table 6 - Responses to Thesis Q2 - "How/Where/When students will apply for a Thesis?"

1.	Application for the offers/by the end of the 2nd semester
2.	Applying for thesis' topic could be initiate as early as the student apply for the Master Degree by submitting a draft thesis proposal, so the head of the program could discuss the advisor assignment in a formal faculty meeting after the admission process is completed.
3.	Via a responsible group of staff members who assign students to projects, at the University during the last semester of the student study programme
4.	At the end of the semester 1.
5.	When they complete all core courses.
6.	Teachers provide thesis topics, the students choose
7.	Students will apply for a thesis after completed all core courses.
8.	- Second year - Last semester
9.	the second year
10.	Starting of the second year
11.	Common interest/HEI/at the end
12.	In the last semester of the Master
13.	either at the beginning or at the end of the 3rd semester
14.	N/A
15.	after completing they internship
16.	After completing the core courses which should be around 1 year.
17.	At the beginning or in the middle of third semester [out of four-semester system]
18.	Matt probably has answered this question already

Q3 - "Do you think Thesis topics offered by non-academic partners may be fruitful?"
R3 - Regarding this question, it is clear that it is important to provide students with topics offered by non-academic partners. Partnerships with companies are crucial, so apart from possible internships, students can also be prepared with real-world problems that industry is facing, endowing them with enough problem-solving skills. Figure 3 shows the obtained results for this question.

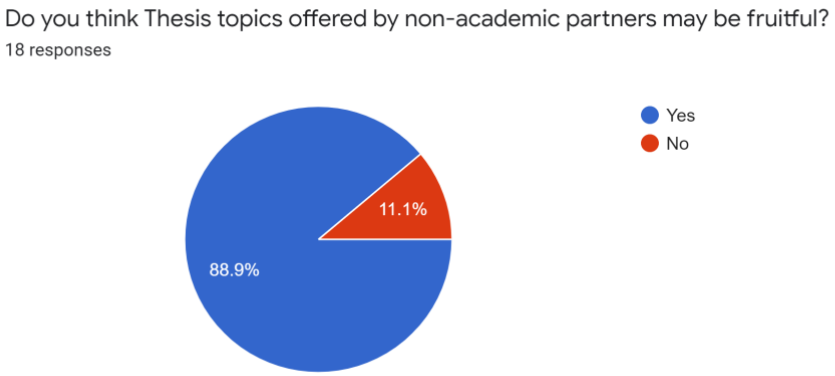


Figure 3 - Responses to Thesis Q3.

Q4 - What you have in mind regarding the (co-)advising strategy?
R4 - For this question, it is clear that a co-advising strategy can be fruitful both for students and industrial partners, resulting in a win-win relationship. However, finding industrial partners may not always be easy, and it is recommended that the supervisor belongs to the HEI, while the project idea can be proposed by the industrial partner. Table 5 shows the obtained responses.

Table 7 - Responses to Thesis Q4 - "What you have in mind regarding the (co-)advising strategy?"

1.	N/A
2.	Strongly advise
3.	A good idea
4.	The supervisor should be from the scientific staff, and possibly with a PhD.
5.	This course content is very useful for any person has basic background knowledge.
6.	Is this a duplicated question from the previous section?
7.	First supervisor from the university, second supervisor from the company

8.	.
9.	tuning work together. win-win
10.	Ideal a real world problem from the industry with co-supervison by an academic and industry partner
11.	good but rather difficult to arrange
12.	It might be useful
13.	will add color and broaden student insight
14.	good for the student, they can get more knowledge of real problem in industry
15.	I support the idea because it would enhance the close collaboration between academia and business partners. In addition, students will be able to apply the knowledge to solve real-world, practical and challenging problems.
16.	Nothing special
17.	-
18.	-

Conclusion

This document refers to the deliverable D2.4 (report) of WP2 “D2.4 Description of methodologies and tools”. The tools and methodology were carefully chosen under the consideration of the outcomes from the Questionnaire on Methodologies and Tools prepared by the University of Minho (UMI) and set available online to all DS&AI partners. This report also considered the outcomes from the study visits to Athens and Leiden (D2.1), as well as the outputs generated by WP1. The efficient delivery of the MSc programme must take into good consideration the outputs from this report, as they reflect the thoughts from all project partners, according to their experience and expertise in their respective course subjects.