Foundations of Trustworthy AI – Integrating Reasoning, Learning and Optimization
TAILOR
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Author(s)	George Stamoulis, Despina-Athanasia Pantazi and Manolis Koubarakis
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1. Introduction

1.1. Executive Summary

This deliverable presents the report on the Fourth TAILOR Summer School on Artificial Intelligence, held in Athens, Greece, from July 15-26, 2024. This summer school combined the TAILOR summer school with the Second European Summer School on AI (ESSAI) and the 21st Advanced Course on Artificial Intelligence (ACAI).

ESSAI provided 27 courses, each comprising five 90-minute sessions held concurrently over the five days of the week. These courses were selected from 51 proposals by the ESSAI program chairs and committee, ensuring coverage of a wide range of topics within Artificial Intelligence. ACAI featured 15 tutorials, each consisting of a single 90-minute session. The tutorial speakers, selected and invited by the organising committee, covered diverse topics within the broader domain of Artificial Intelligence.

1.2. Objectives

The European Summer School in Artificial Intelligence (ESSAI) is an emerging annual event instigated and supported by the TAILOR project and organized under the auspices of the European Association for Artificial Intelligence (EurAI). ESSAI aims to establish itself as a premier gathering for students and early-career researchers in AI, fostering discussions on contemporary research, knowledge exchange, and staying abreast of advancements in the field. It also serves as an accessible entry point for new AI researchers, offering an interdisciplinary environment with courses spanning all aspects of Artificial Intelligence, including broader scientific, historical, and philosophical contexts.

ESSAI's structure is modelled after the European Summer School in Logic, Language, and Information (ESSLLI), which has been conducted since 1989. ESSAI courses include five 90-minute sessions held daily from Monday to Friday over one week, enabling students to gain comprehensive knowledge in specific topics. The courses are available at introductory and advanced levels.

A significant objective of ESSAI 2024 was to expand the school's scope to encompass a wide range of AI topics. ESSAI aspires to become a lasting tradition, akin to ESSLLI for AI, and will be organized annually. This initiative is expected to be a major legacy of the TAILOR project, enduring well beyond TAILOR's conclusion.

1.3. Summer School Highlights

ESSAI & ACAI 2024 were jointly organized as the fourth TAILOR Summer School on AI. The school covered all three dimensions of research in TAILOR: learning, optimization and reasoning, featuring 27 courses and 15 tutorials across five parallel tracks, along with two keynote lectures and two social events. ESSAI & ACAI 2024 took place at the premises of the National Centre for Scientific Research "Demokritos".

ESSAI offered 27 courses (each 5x90 minutes) on various AI topics, selected by an international program committee from 51 proposals solicited through an open call. Notable courses included "Large Language Models, Societal Harms, and their Mitigation" by Antonios Anastasopoulos, "The Legislation Game: Introduction to Legal Issues in Artificial Intelligence and Large Language Models" by Pawel Kamocki, and "Fairness and Explainability: Models, measurements, and mitigation strategies" by Evaggelia Pitoura, Panayiotis Tsaparas, Eirini Ntoutsi and Kostas Stefanidis. The Deputy Minister Mrs. Zoi Rapti and the General Secretary for Research and Innovation Prof. Athanasios Kyriazis attended the opening ceremony and participated in the Opening remarks speech.

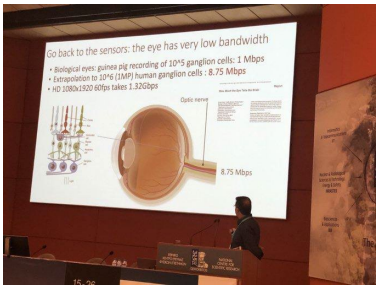
ESSAI & ACAI 2024 Opening remarks

ACAI featured 15 tutorials, each consisting of a single 90-minute session, covering topics within Artificial Intelligence. Examples included "Self-designing AI Systems" by Stratos Idreos, "Can Large Language Models Reason and Plant?" by Subbarao Kambhampati, and "Generative Models for Robot Control" by Katerina Fragkiadaki.

Two keynote lectures by Kostas Daniilidis on "Efficient Perception And Learning With Symmetry And Active Sensing" and Katerina Fragkiadaki on "Perception For Robotics" concluded the first day of each week. The opening session featured addresses from the Deputy Minister of Development Mrs. Zoe Rapti, along with Local Chair Manolis Koubarakis and Program Chair Brian Logan.

Manolis Koubarakis, Zoe Rapti, George Nounesis, Giannis Mylonakis (left to right)

The Summer School attracted 261 participants and 60 lecturers. Among these were 104 TAILOR student registrations whose registration fee was covered by the TAILOR project. We also offered online participation, with about 50 participants attending online. All presentations, course material and the recorded lectures are publicly available on the website of the school[1], to ensure accessibility to a broader audience.



[1] https://essai2024.di.uoa.gr/recordings-presentations.html

Overall, ESSAI & ACAI 2024 was a success, offering diverse courses and tutorials that covered a wide range of AI topics. The event facilitated networking opportunities through social events and paved the way for future editions, significantly impacting both attendees and lecturers. The publicly available lecture recordings further extend this impact and all the feedback that was received by participants (lecturers, tutors and students) was very positive.

2. Scientific Content Details

2.1. Overview of the schedule and programme of ESSAI & ACAI 2024

The Summer School programme was coordinated by a programme committee with representatives from all relevant parties including TAILOR. Submitted course proposals were evaluated on quality and relevance. This led to an attractive programme covering all aspects of AI with a focus on trustworthiness.

The schedule of ESSAI & ACAI 2024 was designed to span over two weeks in parallel sessions. Each day was divided in four 90 minute slots, and three of them were allocated to ESSAI courses, with the fourth designated for the ACAI tutorials. The planned date was July 15-26, 2024 and the overview of the schedule is shown below.

ESSAI offered 27 courses (each 5x90 minutes) covering a broad range of AI topics, that were selected from 51 proposals solicited through an open call for course proposals. The selection process was overseen by an international program committee chaired by Brian Logan, with co-chair Magdalena Ortiz. The courses were organized into five parallel tracks, and assigned to one of the three available time slots each day.

ESSAI & ACAI 2024					
Week 1 ~ July 15-19					
09:00 - 10:30	Tensor Computations for Machine Learning (A) CANCELLED	Introduction to Constraint Satisfaction (I) Auditorium - Building 12	Integrated Knowledge-based and Data-driven Reasoning, Control, and Learning in Robotics: Robustness, Rationality, and Explainable Agency (A) Conference Hall - Building 12	Self-Governing Multi-Agent Systems (I) Library - Building 15	Agent-Based Simulation in Complex Networks (I) INN - Building 8
10:30 - 11:00	**Coffee Break**				
11:00 - 12:30	Formal Aspects of Strategic Reasoning and Game Playing (I) Conference Hall - Building 12	Unlocking Data Insights: Introduction to Data-Centric AI (I) Library - Building 15	Logic-based specification and verification of multi-agent systems (A) INN - Building 8	Logic-Based Explainable Artificial Intelligence (A) Auditorium - Building 12	Large Language Models, Societal Harms, and their Mitigation (I) IBA - Building 20
12:30 - 14:00	**Lunch Break**				
14:00 - 15:30	Fairness and Explainability: Models, measurements, and mitigation strategies (A) Auditorium - Building 12	The Legislation Game: Introduction to Legal Issues in Artificial Intelligence and Large Language Models (I) Conference Hall - Building 12	Game-Theoretic Approach to Temporal Synthesis (A) Library - Building 15	Probabilistic Circuits: Tractable Representations for Learning and Reasoning (A) INN - Building 8	
15:30 - 16:00	**Coffee Break**				
16:00 - 17:30	**ACAI Tutorials**				
	Monday (15/07)	Deep Learning and Computer Vision for Surface Anomaly Detection		Auditorium - Building 12	
	Tuesday (16/07)	Equivariance in Learning for Perception		Auditorium - Building 12	
	Wednesday (17/07)	Complex Event Recognition		Conference Hall - Building 12	
	Wednesday (17/07)	Diffusion Models in Medical Imaging and Analysis		Auditorium - Building 12	
	Thursday (18/07)	Computationally Efficient Learning under Noisy Data		Conference Hall - Building 12	
	Thursday (18/07)	Advancements in Self-Supervised Learning for Speech Technologies		Auditorium - Building 12	
	Friday (19/07)	The Self-Supervised Learning Paradigm in Computer Vision		Auditorium - Building 12	
	Friday (19/07)	Artificial Intelligence for Earth Observation - ESA Φ-lab		Conference Hall - Building 12	
Monday July 15					
17:45 - 19:30	**Opening and Keynote** Opening remarks *Manolis Koubarakis, Brian Logan, Representative of the Greek Government* Efficient Perception and Learning with Symmetry and Active Sensing *Kostas Daniilidis*			Auditorium - Building 12	
20:00	**Opening Reception**			Foyer - Building 12	

ESSAI & ACAI 2024 Schedule for the first week

ESSAI & ACAI 2024						
Week 2 ~ July 22-26						
09:00 - 10:30	Deep Reasoning in AI with Answer Set Programming (I) Auditorium - Building 12	Universal Models and the Chase Procedure (A) Conference Hall - Building 12	From Quantity to Quality: The Role of Large Datasets in Language AI Evolution (I) CANCELLED	Learning Paradigms for Hybrid Decision-Making (I) INN - Building 8	Multi-Agent Systems and Evolution (I) IBA - Building 20	
10:30 - 11:00	**Coffee Break**					
11:00 - 12:30	Explainable Machine Learning (I) CANCELLED	Neural-symbolic Knowledge Representation and Reasoning (I) Auditorium - Building 12	Introduction to computational argumentation semantics (I) Conference Hall - Building 12	AI Governance in Europe: Navigating the AI Act, Establishing AI Offices and Upholding European Principles (I) Library - Building 15	Algorithms for Causal Probabilistic Graphical Models (I) INN - Building 8	Learning to behave via imitation (A) IBA - Building 20
12:30 - 14:00	**Lunch Break**					
14:00 - 15:30	Quantification: Predicting Class Frequencies via Supervised Learning (I) Library - Building 15	Harnessing Scientific AI for Knowledge Discovery in the Open Research Knowledge Graph (A) INN - Building 8	Practical AI for Autonomous Robots (I) Auditorium - Building 12	Machines Climbing Pearl's Ladder of Causation (I) Conference Hall - Building 12	Explainable AI via Argumentation: Theory & Practice (I) IBA - Building 20	
15:30 - 16:00	**Coffee Break**					
16:00 - 17:30	**ACAI Tutorials**					
	Monday (22/07)	Generative Models for Robot Control			Auditorium - Building 12	
	Tuesday (23/07)	Exploring the Intersection of Voting Theory and AI			Auditorium - Building 12	
	Wednesday (24/07)	Can Large Language Models Reason and Plan?			Auditorium - Building 12	
	Thursday (25/07)	The Power of Graph Learning			Auditorium - Building 12	
	Thursday (25/07)	The European AI-on-Demand Platform for AI Researchers			Conference Hall - Building 12	
	Friday (26/07)	Self-designing AI Systems			Auditorium - Building 12	
	Friday (26/07)	Generative AI in Computer Vision			Conference Hall - Building 12	
Monday July 22						
17:45 - 19:00	**Opening and Keynote** Opening remarks *Manolis Koubarakis* Perception for Robotics *Katerina Fragkiadaki*				Auditorium - Building 12	
Thursday July 25						
20:30	**Social Event ~ Skyfall bar**					
Friday July 26						
17:45 - 18:00	**Closing**				Auditorium - Building 12	

ESSAI & ACAI 2024 Schedule for the second week

The ACAI track was designed to cover the fourth time slot each day, with 90 minute sessions. The tutorials were planned to cover the broad theme “AI, Data Science and Algorithms”. All ACAI tutors were selected and invited by our Local Chair Manolis Koubarakis in collaboration with George Vouros (Hellenic Artificial Intelligence Society), Timos Sellis (Archimedes Research Unit) and Vangelis Karkaletsis (National Centre of Scientific Research "Demokritos"). All tutors are top researchers in AI worldwide. ACAI featured 15 tutorials, each consisting of a single 90-minute session in two parallel tracks.

The event also included two keynote lectures that concluded the first day of each week. The first one by Kostas Daniilidis from the University of Pennsylvania, titled "Efficient Perception And Learning With Symmetry And Active Sensing" and a second one by Katerina Fragkiadaki from Carnegie Mellon University, titled "Perception For Robotics".

The day before ESSAI & ACAI 2024 started, CLAIRE Rising Researchers Network was organizing a workshop for the attendees. The first part was focused on mental health in academia and started with a panel discussion aimed at addressing the mental health challenges faced by Ph.D. students and young researchers. The full schedule of the workshop is shown below.

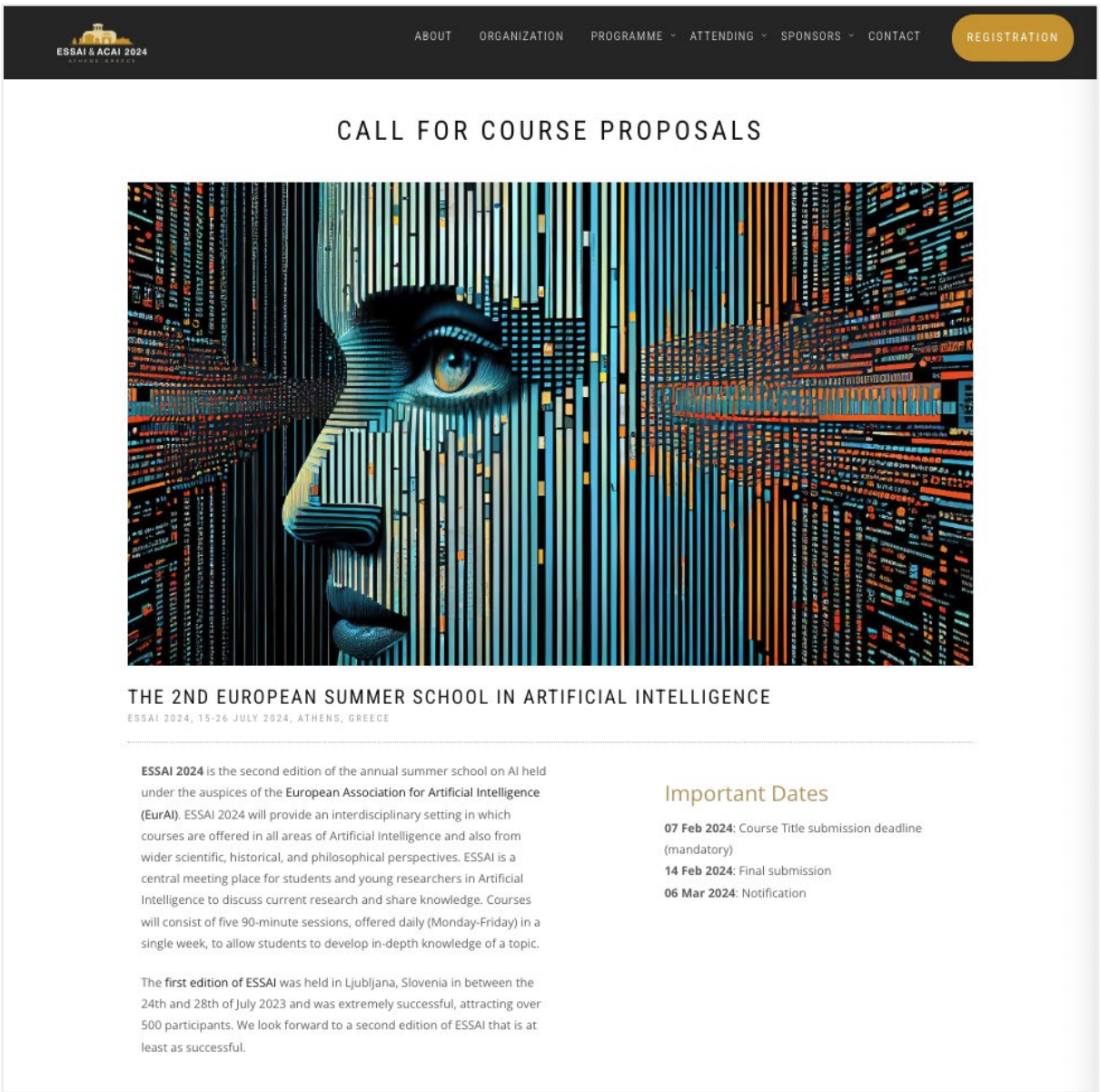
CLAIRE Rising Researchers Network Workshop	
July 14 ~ Auditorium (Building 12)	
09:45 - 10:00	**Opening**
10:00 - 11:00	**Panel discussion ~ Ph.D life** Discussion about common challenges and struggles during your Ph.D
11:00 - 11:15	**Coffee Break**
11:15 - 12:45	**Workshop**
12:45 - 14:45	**Lunch Break**
14:45 - 15:30	**Invited talk** Advancing Generative and Trustworthy AI: Key Projects at Fraunhofer IAIS *Nicolo' Brandizzi*
15:30 - 16:15	**Invited talk** helvia.ai: Anatomy of GenAI Chatbots and Cost-effective LLM Use *Lefteris Loukas*
16:15 - 16:30	**Coffee Break**
16:30 - 17:15	**Invited talk** ESA Φ-lab: Current Projects and Future Perspectives – Earth Observation, Artificial Intelligence, and Quantum Computing *Nikolaos Dionelis*
17:15	**Closing words and Dinner**

CLAIRE Rising Researchers Network Workshop Schedule

Finally, the Summer School included two social events, a reception and an open bar. The reception took place at the Foyer of the event venue on Monday July 15th, after the *Opening and Keynote* session. The open bar took place at Skyfall bar, on Thursday 25th of July. Skyfall bar is close to the historic center of Athens, next to the Kallimarmaro stadium. The venue provided an amazing terrace with a breathtaking view over some of the city's most famous landmarks, the Acropolis, the Lycabettus Hill and the Zappeion Hall.

2.2. The courses of ESSAI 2024

ESSAI 2024 offered 27 courses selected out of 51 applications through the “Call for Course Proposals” that was published on the Summer School website[2]. Applicants could select from a variety of topics and formats and propose a category for their course. A full set of guidelines was presented to them in order to prepare their application and submit it through EasyChair.



[2] https://essai2024.di.uoa.gr/call-for-course-proposals.html

Call for Course Proposals Webpage

Each course could fall under the categories Introductory or Advanced. After the selection process, the final schedule consisted of 18 introductory and 9 advanced courses listed below. Originally we selected 30 courses, but we had three last minute cancellations. Unfortunately, the advanced course "Tensor Computations for Machine Learning" had to be canceled because the lecturer could not obtain his visa on time and the introductory courses “Explainable Machine Learning” and “From Quantity to Quality: The Role of Large Datasets in Language AI Evolution” were canceled due to an urgent medical issue of the lecturers.

ESSAI 2024 - Introductory Courses	Lecturers
Agent-Based Simulation in Complex Networks	Miguel Rebollo
AI Governance in Europe: Navigating the AI Act, Establishing AI Offices and Upholding European Principles	Dr. Maria-Oraiozili Koutsoupia
Algorithms for Causal Probabilistic Graphical Models	Rina Dechter, Alexander Ihler
Deep Reasoning in AI with Answer Set Programming	Mario Alviano, Francesco Ricca
Explainable AI via Argumentation: Theory & Practice	Antonis Kakas, Nikolaos Spanoudakis
Formal Aspects of Strategic Reasoning and Game Playing	Munyque Mittelmann, Aniello Murano, Laurent Perrussel
Introduction to computational argumentation semantics	Srdjan Vesic, Dragan Doder
Introduction to Constraint Satisfaction	Roman Barták
Large Language Models, Societal Harms, and their Mitigation	Antonios Anastasopoulos
Learning Paradigms for Hybrid Decision-Making	Clara Punzi, Mattia Setzu, Roberto Pellungrini, Andrea Beretta, Fosca Giannotti, Dino Pedreschi
Machines Climbing Pearl’s Ladder of Causation	Matej Zečević, Devendra Dhami, Adèle Ribeiro
Multi-Agent Systems and Evolution	Elias Fernández Domingos, Marco Saponara, Tom Lenaerts
Neural-symbolic Knowledge Representation and Reasoning	Jiaoyan Chen, Uli Sattler
Practical AI for Autonomous Robots	Timothy Wiley
Quantification: Predicting Class Frequencies via Supervised Learning	Alejandro Moreo, Fabrizio Sebastiani
Self-Governing Multi-Agent Systems	Jeremy Pitt, Asimina Mertzani
The Legislation Game: Introduction to Legal Issues in Artificial Intelligence and Large Language Models	Pawel Kamocki
Unlocking Data Insights: Introduction to Data-Centric AI	Vincenzo Pasquadibisceglie

ESSAI 2024 - Advanced Courses	Lecturers
Fairness and Explainability: Models, measurements, and mitigation strategies	Evaggelia Pitoura, Panayiotis Tsaparas, Eirini Ntoutsi, Kostas Stefanidis
Game-Theoretic Approach to Temporal Synthesis	Antonio Di Stasio, Giuseppe Perelli, Shufang Zhu
Harnessing Scientific AI for Knowledge Discovery in the Open Research Knowledge Graph	Jennifer D'Souza, Allard Oelen
Integrated Knowledge-based and Data-driven Reasoning, Control, and Learning in Robotics: Robustness, Rationality, and Explainable Agency	Mohan Sridharan
Learning to behave via imitation	George Vouros
Logic-Based Explainable Artificial Intelligence	Joao Marques-Silva
Logic-based specification and verification of multi-agent systems	Valentin Goranko
Probabilistic Circuits: Tractable Representations for Learning and Reasoning	Robert Peharz, Antonio Vergari
Universal Models and the Chase Procedure	Phokion Kolaitis, Andreas Pieris

2.3. The tutorials of ACAI 2024

ACAI 2024 featured 15 tutorials, consisting of one 90-minute session. These tutorials focused on modern topics of Artificial Intelligence and were delivered by a carefully selected group of speakers. The tutors were all esteemed experts in AI, including both emerging researchers and established leaders in the field. Below is the full list of the given tutorials.

ACAI 2024 - Tutorials	Tutors
The Self-Supervised Learning Paradigm In Computer Vision	Nikos Komodakis
Equivariance In Learning For Perception	Kostas Daniilidis
Deep Learning And Computer Vision For Surface Anomaly Detection	Danijel Skočaj
Can Large Language Models Reason And Plan?	Subbarao Kambhampati
The Power Of Graph Learning	Floris Geerts
Complex Event Recognition	Alexander Artikis
Generative Ai In Computer Vision	Vicky Kalogeiton
Computationally Efficient Learning Under Noisy Data	Christos Tzamos
Self-Designing Ai Systems	Stratos Idreos
Exploring The Intersection Of Voting Theory And Ai	Zoi Terzopoulou
Generative Models For Robot Control	Katerina Fragkiadaki
Advancements In Self-Supervised Learning For Speech Technologies	Themos Stafylakis
Diffusion Models In Medical Imaging And Analysis	Sotirios Tsaftaris, Nefeli Gkouti
Artificial Intelligence for Earth Observation - ESA Φ-lab	Nikolaos Dionelis
The European Ai-On-Demand Platform For Ai Researchers	Iraklis-Angelos Klampanos

2.4. Keynote lectures of ESSAI & ACAI 2024

ESSAI & ACAI 2024 featured two keynote lectures that concluded the first day of each week.

The first one by Kostas Daniilidis who is the Ruth Yalom Stone Professor of Computer and Information Science at the University of Pennsylvania, titled "Efficient Perception And Learning With Symmetry And Active Sensing". In this keynote he presented an active approach to view selection based on information-theoretic principles, and a new sensor paradigm that senses only visual events rather than whole scenes, and how it can solve basic tasks fundamental to embodied intelligence.

The second one by Katerina Fragkiadaki who is the JPMorgan Chase Associate Professor in the Machine Learning Department in Carnegie Mellon University, titled "Perception For Robotics". In this keynote, she discussed her work on Computer Vision for Robotics, such as, perception methods used in autonomous vehicles, robot manipulation, video tracking and learning from videos, instruction following and social navigation.

3. Organizational Details

3.1. Organizing institutions

European Association for Artificial Intelligence

The European Association for Artificial Intelligence EurAI (formerly ECCAI) was established in July 1982 as a representative body for the European Artificial Intelligence community. Its aim is to promote the study, research and application of Artificial Intelligence in Europe.

TAILOR – Network of Research Excellence Centres

The purpose of the EU Project TAILOR is to build the capacity to provide the scientific foundations for Trustworthy AI in Europe by developing a network of research excellence centers leveraging and combining learning, optimisation, and reasoning. These systems are meant to provide descriptive, predictive, and prescriptive systems integrating data-driven and knowledge-based approaches.

Hellenic Artificial Intelligence Society

Founded in 1988, the Hellenic Artificial Intelligence Society (EETN) is a non profit scientific organization devoted to organizing and promoting AI (Artificial Intelligence) research in Greece and abroad. Since its establishment, EETN has participated in the organization of various national and international events related to AI and its subfields. EETN is also interested in promoting AI in higher education and in exploiting AI research results by commercial organizations. The recent, rapid growth of the Internet and the World Wide Web has intensified the need for intelligent information systems and increased commercial interest in the area of AI.

**National and Kapodistrian University of Athens,
Department of Informatics and Telecommunications**

The Department of Informatics and Telecommunications originated as a cross-departmental undergraduate program between the Departments of Physics and Mathematics in 1986 and it evolved into an independent department in 1989. It belongs to the Faculty of Science of the National and Kapodistrian University of Athens. Prof. Manolis Koubarakis, who leads the Artificial Intelligence team of the Department of Informatics and Telecommunications, was the local chair of ESSAI & ACAI 2024.

Archimedes Research Unit

ARCHIMEDES is a vibrant research hub connecting the global AI and Data Science research community fostering groundbreaking research in Greece and beyond. Its dedicated core team, comprising lead researchers, affiliated researchers, Post-Docs, PhDs and interns, is committed to advancing basic and applied research in Artificial Intelligence and its supporting disciplines, including Algorithms, Statistics, Learning Theory, and Game Theory organized around 6 core research areas. By collaborating with Greek and Foreign Universities and Research Institutes, ARCHIMEDES disseminates its research findings fostering knowledge exchange and providing enriching opportunities for students. Leveraging AI to address real-world challenges, ARCHIMEDES promotes innovation within the Greek ecosystem and extends its societal impact. Established in January 2022, as a research unit of the Athena

Research Center with support from the Committee Greece 2021, ARCHIMEDES is funded for its first four years by the EU Recovery and Resilience Facility (RRF).

National Centre for Scientific Research "Demokritos"
Founded in July 1961 as a Research Centre for Nuclear Research, Demokritos is today the largest multidisciplinary Research Centre of Greece with approximately 180 Researchers in tenured and tenure-track positions and over 500 Research Personnel working in projects funded mainly by grants from State Funds, the European Union and Private Industries. The Centre consists of five independent Institutes focusing on different scientific fields. It is governed by the Board of Directors and is supervised by the General Secretariat of Research and Innovation, which is in the Ministry of Development.

3.2. Under the Auspices

The school is organized under the auspices of the General Secretariat for Research and Innovation of the Greek Ministry of Development. The Deputy Minister Mrs. Zoi Rapti and the General Secretary for Research and Innovation Prof. Athanasios Kyriazis gave a speech at the Opening Ceremony.

3.3. Sponsors

The support of TAILOR and Archimedes was very critical for the financial viability of ESSAI and ACAI 2024. TAILOR sponsored the registration of 104 students (66.000 euros) and Archimedes covered travel and accommodation for the ACAI tutors (13.000 euros).

TAILOR – Network of Research Excellence Centres
TAILOR is an EU project dedicated to establishing the scientific foundations for Trustworthy AI in Europe. It aims to build a network of research excellence centres by combining learning, optimization, and reasoning to develop systems offering descriptive, predictive, and prescriptive solutions that integrate data-driven and knowledge-based approaches. The idea for ESSAI emerged from TAILOR's collaboration with EurAI. ESSAI & ACAI 2024, organized together as the 4th TAILOR Summer School in AI, received significant financial support from TAILOR. TAILOR sponsored the registration of 104 students (66.000 euros).

Archimedes Research Unit
ARCHIMEDES is a vibrant research hub connecting the global AI and Data Science research community fostering groundbreaking research in Greece and beyond. Its dedicated core team, comprising lead researchers, affiliated researchers, Post-Docs, PhDs and interns, is committed to advancing basic and applied research in Artificial Intelligence and its supporting disciplines, including Algorithms, Statistics, Learning Theory, and Game Theory organized around 6 core research areas. By collaborating with Greek and Foreign Universities and Research Institutes, ARCHIMEDES disseminates its research findings fostering knowledge

exchange and providing enriching opportunities for students. Archimedes covered travel and accommodation for the ACAI tutors (13.000 euros).

European Association for Artificial Intelligence

The European Association for Artificial Intelligence EurAI (formerly ECCAI) was established in July 1982 as a representative body for the European Artificial Intelligence community. Its aim is to promote the study, research and application of Artificial Intelligence in Europe. EurAI covered 14 travel grants of 450 euro each (6.300 euro in total).

Artificial Intelligence Journal

The Artificial Intelligence journal (AIJ) is the longstanding premier journal on Artificial Intelligence broadly conceived. Since it was founded in 1970, it has published many of the key papers in the field. AIJ publishes original papers on all aspects of AI, whether they describe proposals for new ways of looking at AI problems and the results achieved, or novel AI methods advancing performance in application areas. AIJ will provide 1.500 euro as financial support for the event.

Hellenic Artificial Intelligence Society

Founded in 1988, the Hellenic Artificial Intelligence Society (EETN) is a non profit scientific organization devoted to organizing and promoting AI (Artificial Intelligence) research in Greece and abroad. Since its establishment, EETN has participated in the organization of various national and international events related to AI and its subfields. EETN sponsored the registration of two graduate students selected after a call with 450 euro each (900 euro in total).

National and Kapodistrian University of Athens, Department of Informatics and Telecommunications

The Department of Informatics and Telecommunications originated as a cross-departmental undergraduate program between the Departments of Physics and Mathematics in 1986 and it evolved into an independent department in 1989. It belongs to the Faculty of Science of the National and Kapodistrian University of Athens. Prof. Manolis Koubarakis, who leads the Artificial Intelligence team of the Department of Informatics and Telecommunications, was the local chair of ESSAI & ACAI 2024. The department offered 790 euro as sponsorship for technical assistance during the event.

National and Kapodistrian University of Athens, School of Science

The School of Science consists of the following Departments: Biology, Chemistry, Geology and Geoenvironment, History and Philosophy of Science, Informatics and Telecommunications, Mathematics, Physics and Digital Industry Technologies. The School of Science offered 1.545 euro as a sponsorship for catering during the event.

3.4. Advertisement and registration fees

The event was visually branded with a distinctive logo featured on the event website and all promotional materials. This logo appeared on posters advertising the schools and individual lectures, as well as on the promotional items provided to participants.

ESSAI & ACAI 2024 Logo

A comprehensive and systematic effort was undertaken to advertise the event. Initially, EurAI fellows and member societies were engaged, with contacts (presidents, secretaries) asked to promote the event within their memberships. Another major promotional avenue involved contacts from the TAILOR project, including industrial partners. Advertisement through CLAIRE's mailing lists was also crucial.

The call for course proposals and participation was distributed via these channels. Additionally, numerous mailing lists within the artificial intelligence and machine learning communities were utilized. Special efforts were made to disseminate the calls through local mailing lists, scientific institutions, and the organizers' collaboration networks to enhance local participation.

The event website (https://essai2024.di.uoa.gr/) served as the primary information hub to attract participants. Local organizers also actively promoted the event on social media platform X. Posters were created, starting with an overall event poster. Special posters for each ESSAI

course were also designed and gradually released through social media posts. All posters are available in the APPENDIX of this deliverable.

ESSAI & ACAI 2024 Posters

The registration fees for online participation (for both weeks) were set at €350. For in-person attendance, fees were categorized into three groups: Students, Academics and Industry. Additionally, three different pricing tiers were applied based on the timing of registration: Early Fee, Late Fee, and Onsite Fee. Participants could also select if they would like to participate only for one week or for both weeks of the Summer School. All different options are presented in the tables below.

Physical Participation			
ESSAI/ACAI 2024 - One Week Registration Fee			
Registration Category	**Early Fee** April 20 - June 16	**Late Fee** June 17 - July 12	**Onsite Fee** July 15 - July 26
Students	450,00 €	550,00 €	650,00 €
Academics	550,00 €	650,00 €	750,00 €
Participants from industry	650,00 €	750,00 €	850,00 €
Delegate Registration includes:			
Access to Summer School Courses & Tutorials (week one or two)			
Lunch and Coffee Breaks			
Welcome Reception			
Social Event			

Physical Participation			
ESSAI/ACAI 2024 - Two Weeks Registration Fee			
Registration Category	Early Fee April 20 - June 16	Late Fee June 17 - July 12	Onsite Fee July 15 - July 26
Students	770,00 €	870,00 €	970,00 €
Academics	950,00 €	1.050,00 €	1.150,00 €
Participants from industry	1.050,00 €	1.150,00 €	1.250,00 €
Delegate Registration includes:			
Access to all Summer School Courses & Tutorials (both weeks)			
Lunch and Coffee Breaks			
Welcome Reception			
Social Event			

Virtual Participation	
ESSAI/ACAI 2024 - Two Weeks Registration Fee	
Registration Category	April 20 - July 26
Virtual - All Categories	350,00 €
Delegate Registration includes:	
Virtual access to all Summer School Courses & Tutorials (both weeks)	

ESSAI & ACAI 2024 Registration Fees

Finally, a call for volunteers was issued by the Local Chair Prof. Manolis Koubarakis for which 32 applications were received. From these applications, 10 volunteers were selected who helped with various aspects of the school both weeks.

3.5. Organizers

The team that contributed to organizing ESSAI & ACAI 2024 includes the people listed below.

ESSAI Programme Chairs

- Brian Logan, Utrecht University (chair)
- Magdalena Ortiz, Umeå University (co-chair)

ESSAI Programme Committee

- Natasha Alechina, Utrecht University
- Francesco Amigoni, Politecnico di Milano
- Antonis Argyros, University of Crete & ICS-FORTH
- Yannis Avrithis, Institute of Advanced Research in Artificial Intelligence
- Tijl De Bie, Ghent University
- Luc De Raedt, KU Leuven
- Sašo Džeroski, Jozef Stefan Institute
- Katharina Eggensperger, University of Tübingen
- Peter Flach, University of Bristol
- Matti Järvisalo, University of Helsinki
- Bernardo Magnini, Fondazone Bruno Kessler
- Martin Mundt, Technical University of Darmstadt
- Ann Nowe, Vrije Universiteit Brussel
- Marija Slavkovik, University of Bergen
- Ivan Vulic, University of Cambridge & PolyAI

Local Organization and ACAI Programme Chair

- Manolis Koubarakis, National and Kapodistrian University of Athens

Local Organization Committee

- Manolis Koubarakis, National and Kapodistrian University of Athens (Chair)
- George Vouros, Hellenic Artificial Intelligence Society
- Timos Sellis, Archimedes Research Unit
- Vangelis Karkaletsis, National Centre of Scientific Research "Demokritos"

Local Organization Chair 2023

- Vida Groznik, University of Ljubljana

ESSAI Steering Committee Chair

- Giuseppe De Giacomo, University of Oxford

Web and Social Media Chair

- George Stamoulis, National and Kapodistrian University of Athens

Communications

- Martina Bacaro and Lena Tasse, TAILOR
- Alexa Codde, CLAIRE

TAILOR representative

- Peter Flach

4. Participants

4.1. Lecturers and Tutors

We had 60 lecturers and tutors that presented at the school. Their names and affiliations are listed below.

ESSAI Lecturers		
Last Name	**First Name**	**Affiliation**
Alviano	Mario	University Of Calabria

Anastasopoulos	Antonios	George Mason University
Bartak	Roman	Charles University
Beretta	Andrea	ISTI-CNR
Chen	Jiaoyan	The University of Manchester
Dechter	Rina	University of California, Irvine
D'Souza	Jennifer	Technische Informationsbibliothek
Dhami	Devendra	Eindhoven University Of Technology
Di Stasio	Antoni	University of Oxford
Fernandez Domingos	Elias	Universite Libre De Bruxelles
Goranko	Valentin	Stockholm University
Ihler	Alexander	Uc Irvine
Kakas	Antonis	University Of Cyprus
Kamocki	Pawel	CLARIN ERIC / IDS Mannheim
Kolaitis	Phokion	UC Santa Cruz and IBM Research
Marques-silva	Joao	Icrea, University Of Lleida
Mertzani	Asimina	Imperial College London
Mittelmann	Munyque	University Of Naples Federico Ii
Moreo	Alejandro	ISTI-CNR
Ntoutsi	Eirini	Bundeswehr University Munich
Oelen	Allard	Technische Informationsbibliothek
Pasquadibisceglie	Vincenzo	University Of Bari Aldo Moro
Peharz	Robert	TU Graz
Pellungrini	Roberto	Scuola Normale Superiore
Perelli	Giuseppe	Sapienza University Of Rome
Perrussel	Laurent	Universite Toulouse Capitole
Pieris	Andreas	University of Edinburgh

Pitoura	Evaggelia	University of Ioannina
Pitt	Jeremy	Imperial College London
Rebollo	Miguel	Technical Univ of Valencia
Ribeiro	Adele Helena	Philipps-university Marburg
Ricca	Francesco	University Of Calabria
Saponara	Marco	Universite Libre De Bruxelles
Sattler	Uli	University Of Manchester
Setzu	Mattia	University Of Pisa
Spanoudakis	Nikolaos	Technical University of Crete
Sridharan	Mohan	University Of Edinburgh
Stefanidis	Kostas	Tampere University
Tsaparas	Panayiotis	University Of Ioannina
Vergari	Antonio	University Of Edinburgh
Vesic	Srdjan	Cril Cnrs University Artois
Wiley	Timothy	RMIT University
Zhu	Shufang	University Of Oxford

ACAI Tutors		
Last Name	**First Name**	**Affiliation**
Artikis	Alexander	University Of Piraeus
Fragkiadaki	Aikaterini	Carnegie Mellon University
Geerts	Floris	University Of Antwerp
Kalogeiton	Vicky	Ecole Polytechnique, Ip Paris
Komodakis	Nikos	University Of Crete
Skocaj	Danijel	University Of Ljubljana
Daniilidis	Kostas	University Of Pennsylvania

Terzopoulou	Zoi	GATE|SE²
Kambhampati	Subbarao	Arizona State University
Kalogeiton	Vicky	École Polytechnique
Tzamos	Christos	University of Athens
Idreos	Stratos	Harvard John A. Paulson School of Engineering and Applied Sciences
Stafylakis	Themos	Athens University of Economics and Business
Tsaftaris	Sotirios	University of Edinburgh
Gkouti	Nefeli	National and Kapodistrian University of Athens
Dionelis	Nikolaos	ESA Φ-lab
Klampanos	Iraklis	National Centre for Scientific Research "Demokritos"

Keynote Speakers		
Last Name	**First Name**	**Affiliation**
Daniilidis	Kostas	University Of Pennsylvania
Fragkiadaki	Aikaterini	Carnegie Mellon University

4.2. TAILOR students

Free registration was offered to PhD students from TAILOR partners, in recognition of the major sponsorship provided by TAILOR. We had 104 TAILOR students registered for the event (13 online, 91 on-site).

Last Name	First Name	Affiliation
Asadi	Mehrdad	Vrije Universiteit Brussel
Barbin	Aymeric	Sapienza University of Rome
Barrachina	Pol	University College Cork
Bendjeddou	Asma	University Degli Studi Di Siena

Borelli	valerio	Sapienza University of Rome
Canha	Dulce	Luxembourg Institute of Health
Castellano Ontiveros	Rodrigo	University of Siena
Castillo Jimenez	Roberto	NEO: Networking and Emerging Optimisation
Charitos	George	National and Kapodistrian University of Athens
Cavallo	Andrea	TU Delft
Chakraborty	Sanjay	Linkoping University
Chatzifoti	Olga	National and Kapodistrian University of Athens
Chepeleva	Maryna	Luxembourg Institute of Health
Chicano	Francisco	University of Malaga
Cibula	Miroslav	Comenius University
Closson	Louis	Université Grenoble Alpes - Adeunis
Contet	Clement	Centre National de la Recherche Scientifique
Correa	Augusto B.	University Of Basel
Cosci	Cristian	Universita Di Bologna
Curcio	Riccardo	Sapienza University of Rome
Dahi	Zakaria Abdelmoiz	Institut national de recherche en informatique et en automatique
Delfino	Roberto Maria	Sapienza University of Rome
Deligiannis	Kimon	University Of Patras
Di Panfilo	Marco	Sapienza University of Rome
Dorgiakis	Michail	National and Kapodistrian University of Athens
Dudyrev	Egor	Institut national de recherche en informatique et en automatique, Loria
Durand	Serge	Commissariat à l'Energie Atomique et aux

		Energies Alternatives
Dusi	Michele	Sapienza University of Rome
Fiani	Francesca	Sapienza University of Rome
Filosa	Matteo	Sapienza University of Rome
Gardos Reid	Reuben	Delft University Of Technology
Geisler	Nadja	TU Darmstadt
Gentili	Elisabetta	Siena Artificial Intelligence Lab, University of Siena
George	Ashwin	Delft University of Technology
Gkatsis	Vasilis	National and Kapodistrian University of Athens
Grekas	George	National and Kapodistrian University of Athens
He	Gaole	Delft University Of Technology
Iacobelli	Emanuele	Sapienza University of Rome
Innocente	Simone	University College Of Cork
Ioannidis	Theofilos	National and Kapodistrian University of Athens
Jamshidi	Neda	University Of Siena
Karpontinis	Dimitris	National and Kapodistrian University of Athens
Katare	Dewant	Delft University Of Technology
Katikaridi	Mariza	National and Kapodistrian University of Athens
Kefalidis	Sergios-anestis	National and Kapodistrian University of Athens
Kocak	Husnu Murat	Ku Leuven
Koloveas	Paris	National and Kapodistrian University of Athens
Lastrucci	Giacomo	Delft University Of Technology

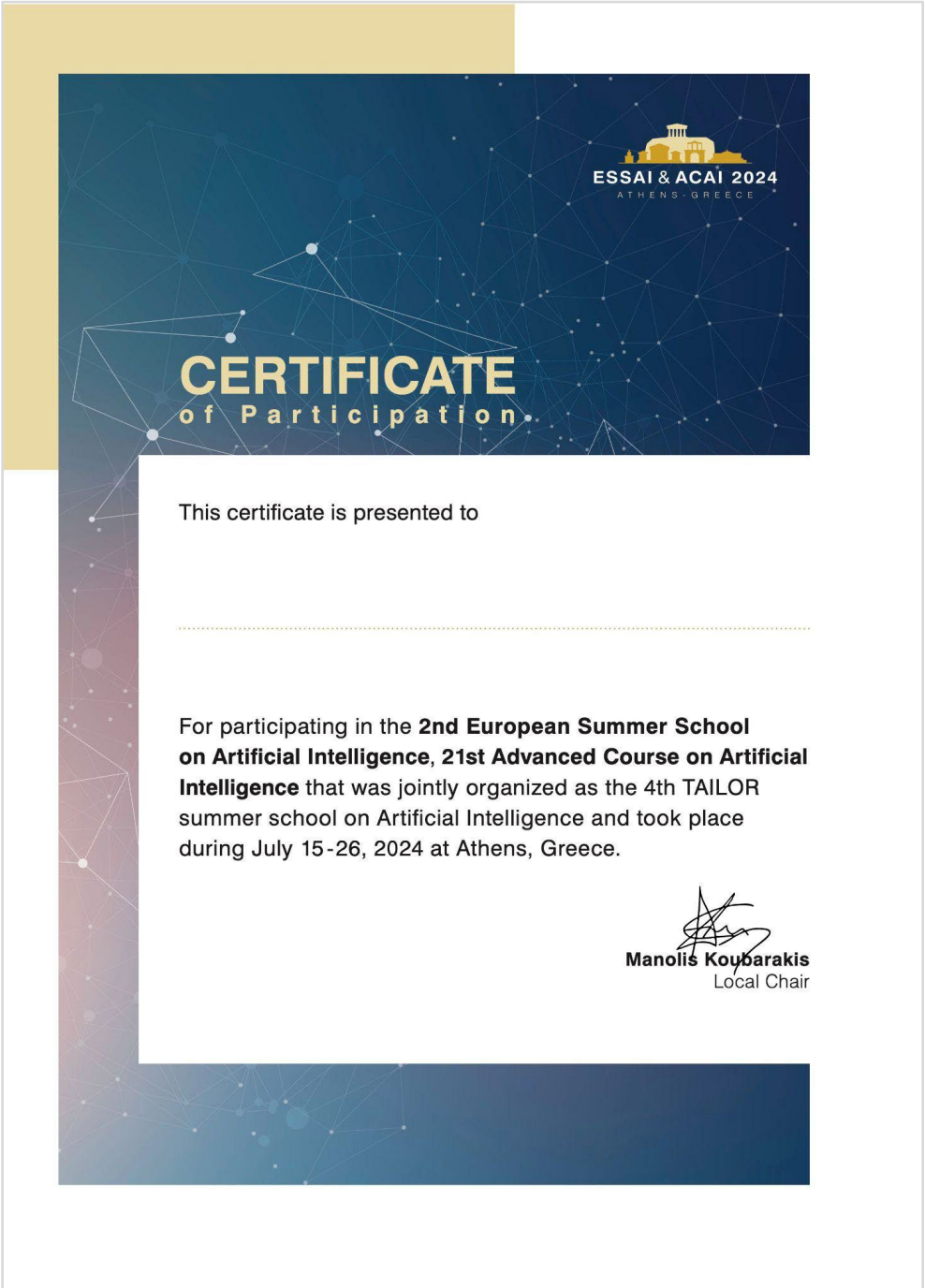
Lefebre Lobaina	Jairo Alejandro	Institut d'Investigació en Intel·ligència Artificial – Consejo Superior de Investigaciones Científicas
Lessa	Nayari Marie	DFKI
Liu	Chengen	Delft University of Technology
Lougiakis	Christos	National and Kapodistrian University of Athens
Loulas	Iridanos	National and Kapodistrian University of Athens
Lynn	Matthew James	RWTH Aachen University
Mailis	Theofilos	National and Kapodistrian University of Athens
Malvicini	Stephanie Anneris	Institut d'Investigació en Intel·ligència Artificial – Consejo Superior de Investigaciones Científicas
Mancanelli	Matteo	Sapienza University of Rome
Mantas	Anastasios	National and Kapodistrian University of Athens
Margoula	Georgia	National and Kapodistrian University of Athens
Markou	Kleopatra	National and Kapodistrian University of Athens
Mattar	Maykel	Commissariat à l'Energie Atomique et aux Energies Alternatives
Mestek	Jakub	Charles University
Metaxa	Konstantina	National and Kapodistrian University of Athens
Minculescu	Andra Cristiana	Netherlands Organisation for applied scientific research
Nikoletos	Konstantinos	National and Kapodistrian University of Athens
Oruc	Deniz Can	Ku Leuven
Panou	Dimitra	National and Kapodistrian University of Athens

Papadakis	George	National and Kapodistrian University of Athens
Parretti	Gianmarco	Sapienza University of Rome
Peri	Aristotelis	National and Kapodistrian University of Athens
Plas	Konstantinos	National and Kapodistrian University of Athens
Poulis	Aggelos	National and Kapodistrian University of Athens
Qosja	Agresa	Université Grenoble Alpes
Recio Abad	Juan Carlos	Universidad De Malaga
Reppas	Smaragda	National and Kapodistrian University of Athens
Rossberg	Nicola	University College Cork
Rovetta	Alberto	Universita Degli Studi Di Brescia
Sabbella	Sandeep Reddy	Sapienza University of Rome
Scionis	Luca	Sapienza University of Rome
Sikder	Md Fahim	Linkoping University
Silo	Luciana	Sapienza University of Rome
Simon	Mathieu	ICTEAM UCLouvain
Soria	Jules	Commissariat à l'Energie Atomique et aux Energies Alternatives
Spiegel	Michal	Kempelen Institute of Intelligent Technologies
Stamoulis	George	National and Kapodistrian University of Athens
Stradiotti	Luca	KU Leuven
Tabbakh	Danial	Luxembourg Institute of Health
Terremoto	Giovanni	Sapienza University of Rome
Tomaras	Dimitrios	National and Kapodistrian University of Athens

Trevorrow	Joseph	University Of Bristol
Tsalapati	Eleni	National and Kapodistrian University of Athens
Tsokanaridou	Myrto	National and Kapodistrian University of Athens
Tsourma	Maria	National and Kapodistrian University of Athens
Vayanou	Maria	National and Kapodistrian University of Athens
von Meijenfeldt	Bart	Eindhoven University Of Technology
Walker	Jake	Delft University Of Technology
Yang	Yi	KU Leuven
Yang	Nana	Uclouvain/icteam
Yfantis	Filippos	National and Kapodistrian University of Athens
Yorsh	Uladzislau	Charles University In Prague
Yuan	Yining	University Of Bristol
Zeakis	Alexandros	National and Kapodistrian University of Athens
Zeinalipour	Kamyar	University Of Siena, Sailab
Zhang	Ruiqi	TU Delft

4.3. Certificates of participation

All registered participants that attended the event received a certificate of participation. The certificate was signed by the Local Chair, Prof. Manolis Koubarakis. An example certificate is included below.



ESSAI & ACAI 2024 Certificate of Participation

4.4. ESSAI & ACAI 2025

During the closing ceremony, Viera Borðoy from the Slovak University of Technology gave a presentation to disseminate the summer school for 2025, which will take place in Bratislava, Slovakia. We also shared their poster in the discord server of the event.

ESSAI & ACAI 2025 poster

APPENDIX


ESSAI & ACAI 2024
ATHENS - GREECE
European Summer School on Artificial Intelligence
Advanced Course on Artificial Intelligence
15 - 26
JULY 2024
ATHENS, GREECE
Organized Jointly
as 4th Tailor Summer School
on Artificial Intelligence
https://essai2024.di.uoa.gr/
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ESSAI & ACAI 2024
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REGISTER NOW
LARGE LANGUAGE MODELS, SOCIETAL HARMS, AND THEIR MITIGATION
Antonios Anastasopoulos
George Mason University
Numerous recent studies have highlighted societal harms that can be caused by language technologies deployed in the wild. In fact, several surveys, tutorials, and workshops have discussed the risks of harms in specific contexts (e.g., detecting and mitigating gender bias in NLP models). This course will present a unified typology of technical approaches for mitigating harms of language generation models. The course is based on an extensive survey that proposes such a typology. The course will provide an overview of potential social issues in language generation, including toxicity, social biases, misinformation, factual inconsistency, and privacy violations. Our primary focus will be on how to systematically identify risks, and how to eliminate them at various stages of model development, from data collection, to model development, to inference/language generation. Through this tutorial, we aim to equip AI and NLP researchers and engineers with a suite of practical tools for mitigating safety risks from pretrained language generation models.
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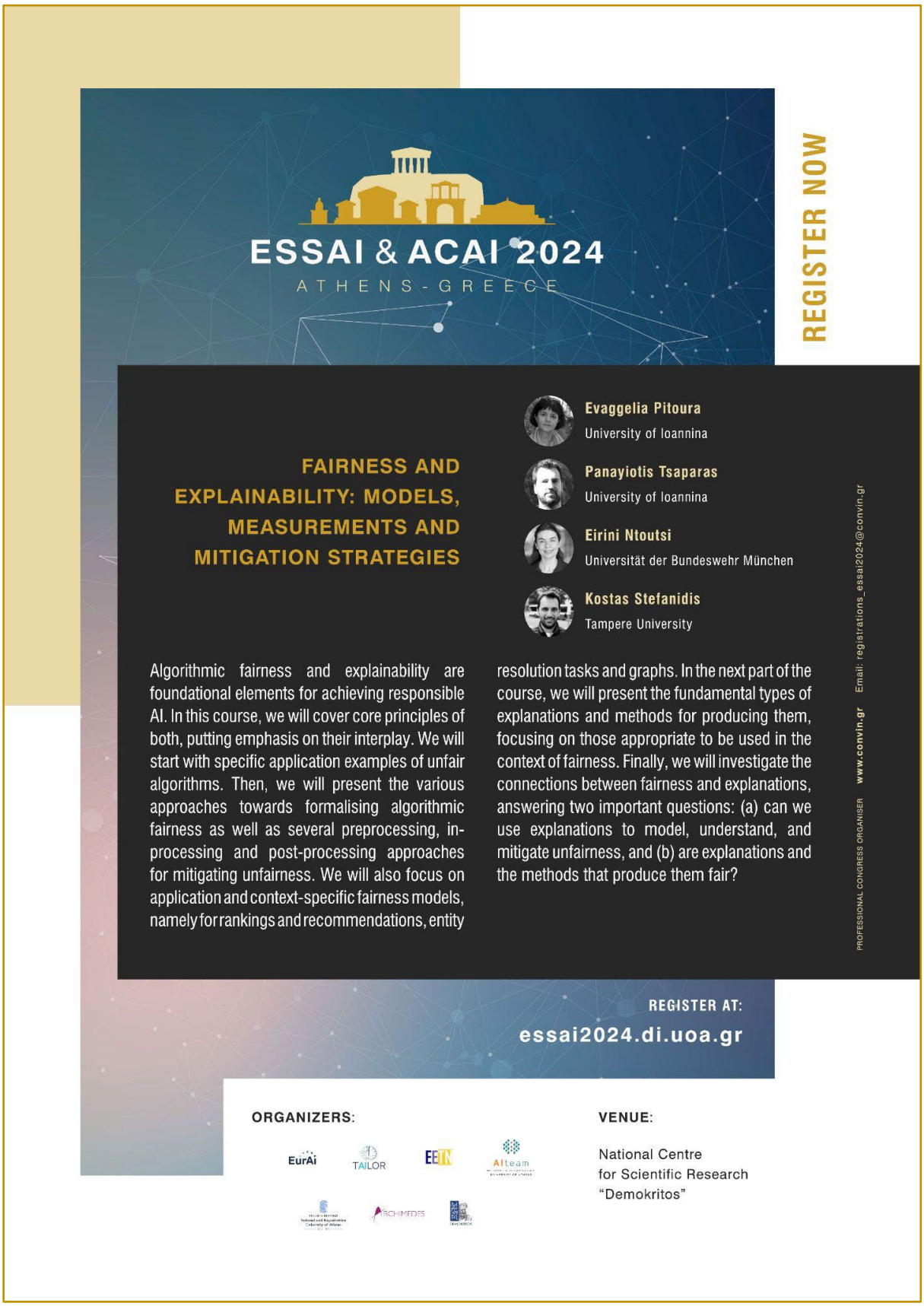
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FAIRNESS AND EXPLAINABILITY: MODELS, MEASUREMENTS AND MITIGATION STRATEGIES
Evaggelia Pitoura
University of Ioannina
Panayiotis Tsaparas
University of Ioannina
Eirini Ntoutsi
Universität der Bundeswehr München
Kostas Stefanidis
Tampere University
Algorithmic fairness and explainability are foundational elements for achieving responsible AI. In this course, we will cover core principles of both, putting emphasis on their interplay. We will start with specific application examples of unfair algorithms. Then, we will present the various approaches towards formalising algorithmic fairness as well as several preprocessing, in-processing and post-processing approaches for mitigating unfairness. We will also focus on application and context-specific fairness models, namely for rankings and recommendations, entity resolution tasks and graphs. In the next part of the course, we will present the fundamental types of explanations and methods for producing them, focusing on those appropriate to be used in the context of fairness. Finally, we will investigate the connections between fairness and explanations, answering two important questions: (a) can we use explanations to model, understand, and mitigate unfairness, and (b) are explanations and the methods that produce them fair?
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LOGIC-BASED EXPLAINABLE ARTIFICIAL INTELLIGENCE
Alexey Ignatiev
Monash University
Joao Marques-Silva
University of Lleida
The last decade witnessed remarkable advances in machine learning (ML), that are having far-reaching societal impact. By all accounts, such impact is expected to become even more prominent in the future. Nevertheless, a threat to the widespread deployment of ML models is their complexity. Human decision-makers are unable to fathom the decisions made by ML models. This not only makes debugging a challenge, but it is also a source of distrust in those models. Explainable artificial intelligence (XAI) aims to help human decision-makers to understand the decisions made by ML models. However, the best-known XAI approaches do not provide formal guarantees of rigor, and this can cast distrust instead of building trust. As a result, recent years have witnessed the emergence of formal approaches for explaining the operation of ML models, being referred to as formal explainability in AI (FXAI). The explanations obtained with FXAI are logic-based and offer guarantees of rigor that are unmatched by other XAI approaches. This course offers an in-depth contact with the underpinnings of formal explainability in AI.
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THE LEGISLATION GAME: INTRODUCTION TO LEGAL ISSUES IN ARTIFICIAL INTELLIGENCE AND LARGE LANGUAGE MODELS
Pawel Kamocki
IDS Mannheim
This course will introduce the participants to the dynamic legal discourse surrounding Artificial Intelligence (AI), with a particular focus on Large Language Models (LLM). Through a blend of interactive theoretical discussions and case studies from EU and US law, the audience will discover how legal frameworks such as Intellectual Property (and especially Copyright), Data Protection or Civil Liability (Tort Law) are affected by technological developments, and to what extent AI and LLMs are already regulated by law. An important part of the course will be devoted to the most recent developments in EU law, such as the Data Act and the long-awaited Artificial Intelligence Act. The course is intended for people with no background in law, but lawyers who want to learn more about the subject are also welcome.
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EXPLAINABLE
MACHINE LEARNING
Nikos Nikolaou
London's Global University
Machine learning models are often perceived as 'black boxes'. Explainable machine learning (XML) a.k.a. Explainable artificial intelligence (XAI) methods allow us to inspect their inner workings and understand their predictions to reveal new insights about the data, but also hidden biases, increase transparency, trust and safety of ML applications and promote their adoption by domain experts and general public alike. In high stakes applications (e.g. medical, safety) XAI is becoming a regulatory requirement. The course will provide an overview of principles, methods, applications, limitations and challenges of XAI. We will cover the more inherently interpretable 'white box' methods as well as methods tailored to the more opaque deep neural networks and general purpose methods applicable to any model. We will give examples of successful applications, discuss advantages and disadvantages of each approach, but also limitations and open problems of XAI as a field. The course will be accompanied by Python tutorials.
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NEURAL-SYMBOLIC KNOWLEDGE REPRESENTATION AND REASONING
Jiaoyan Chen
University of Manchester
Uli Sattler
University of Manchester
Ontologies and Knowledge Graphs (KGs) have been extensively explored as means of symbolic knowledge representation and reasoning (KRR), leading to a wide range of insights, formalisms, tools, and applications in information systems, AI, life sciences and so on. More recently, ontology and KG embeddings have been designed and investigated: they aim to represent entities (concepts, relationships) in a sub-symbolic (vector) space while preserving (some) of their semantics, and promise to transfer the encapsulated knowledge to deep learning models and to enable the integration of statistical methods. In this course, we will mainly (i) introduce symbolic KRR using ontologies and KGs with technologies such as Resource Description Framework (RDF), RDF Schema (RDFS), Web Ontology Language (OWL) and Description Logic, and (ii) present the development of ontology and KG embeddings with their concepts, methods and usage in knowledge engineering, for augmenting machine learning, and for addressing link prediction problems.
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EXPLAINABLE AI VIA ARGUMENTATION: THEORY & PRACTICE
Antonis Kakas
University of Cyprus
Nikolaos Spanoudakis
Technical University of Crete
Explanations play a central role in AI either in providing some form of transparency to black-box machine learning systems or more generally in supporting the results of an AI system in order to help users to understand, accept and trust the operation of the system. The course will present how Argumentation can serve as a basis for Explainable AI (XAI) and how this can be applied to Decision Making and Machine Learning for AI applications. It will present the role and basic quality requirements of explanations of AI systems and how these can be met in argumentation-based systems. It will cover the necessary theory of argumentation, a software methodology for argumentation-based explainable systems and the use of practical tools in argumentation for realizing such systems. Students will have hands on experience on using these tools and the development of a realistic XAI decision making system.
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AI GOVERNANCE IN EUROPE: NAVIGATING THE AI ACT, ESTABLISHING AI OFFICES AND UPHOLDING EUROPEAN PRINCIPLES
Maria-Oraiozili Koutsoupia
Rythmisis National Law Institute
This course aims to provide a journey to the heart of AI governance in Europe. Tailored for non-specialists, this program introduces participants to essential legal and regulatory insights while focusing on groundbreaking EU developments, notably the AI Act and the impending launch of the European AI Office. Key objective is fostering a nuanced understanding of the regulation of the AI technologies, the special regime and bans of the AI Act, all while understanding international principles on AI ethics and modern European principles on AI such as transparency, trustworthiness and explainability, as well as the traditional ones, such as the freedom of movement of goods. As an AI legal expert and President of Rythmisis, the Greek Institute for AI Law, I am well-equipped to guide participants through this transformative learning experience, offering both theoretical insights and actionable strategies for navigating the evolving AI governance landscape. The course's ultimate goal is to empower the next generation of AI leaders with the knowledge and skills needed to navigate, innovate, and succeed in the European AI landscape in any sector (health, education, commerce, economics etc.).
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LEARNING TO BEHAVE VIA IMITATION
George Vouros
University of Piraeus
The objective of this course is to transfer knowledge that has been acquired during the last 5 years with regard to modelling the behaviour of moving objects, via deep reinforcement learning and imitation learning. The course will provide background knowledge on deep reinforcement learning and imitation learning and will present challenges and ways to address them, including multimodality (i.e. modelling different patterns of behaviour to perform a task), sparse rewards and long-term horizons, and, maybe very crucially, balancing between optimality and safety, with respect to constraints.
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PRACTICAL AI FOR AUTONOMOUS ROBOTS
Timothy Wiley
RMIT Universityvx
Creating Artificially Intelligent autonomous robots has unique challenges in transferring AI techniques into a practical real-world and real-time domain. The software must handle the limited computation power of autonomous robots along with the uncertainty and noise produced by their sensors and actuators. This software must integrate across algorithms at multiple levels of abstraction, from the low-level information of the sensors to high-level reasoning. This course proposal revises the very successful 2023 ESSAI iteration of the course and focuses on the design and development of the practical AI software architectures for autonomous robotic systems, localisation, mapping, vision and audio processing, and task planning. This course will feature both theoretical aspects of AI in the robotics domain along with practical experiments on a simulated robot platform.
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INTEGRATED KNOWLEDGE-BASED AND DATA-DRIVEN REASONING, CONTROL, AND LEARNING IN ROBOTICS: ROBUSTNESS, RATIONALITY AND EXPLAINABLE AGENCY
Mohan Sridharan
University of Edinburgh
This advanced course seeks to bring participants to the state of the art in integrated systems that sense and interact with the physical world using knowledge-based and data-driven methods for reasoning, control, and learning. In particular, we will explore systems that support: (a) reasoning with prior commonsense domain knowledge and learned models based on non-monotonic logics; (b) leveraging generic knowledge and specific observations using machine learning methods and foundation models; (c) robust and efficient decision-making based on heuristic methods that prioritize adaptive satisficing over optimization; and (d) a methodology to establish that the system's behavior satisfies desired properties, and to provide on-demand relational descriptions as explanations in response to different types of questions. We will use practical examples drawn from robotics, computer vision, and multiagent systems to ground these concepts and discuss how the interplay between representation, reasoning, control, and learning can help address the underlying fundamental challenges.
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TENSOR COMPUTATIONS
FOR MACHINE LEARNING
Yipeng Liu
University of Electronic Science
and Technology of China
This course will first provide a basic coverage of tensor notations, preliminary operations, main tensordecompositionsandtheirproperties.Based on them, a series of tensor learning methods are presented, as the multi-linear extensions of classical sparse learning, missing component analysis, principal component analysis, linear regression, non-negative component analysis, subspace cluster, support vector machine, deep neural network, etc. The experimental results for several data processing applications are given, such as image reconstruction, image quality enhancement, background extraction, multi-view image clustering, weather forecasting, pose estimation, speech source separation, image and speech classification, etc.
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INTRODUCTION TO
CONSTRAINT SATISFACTION
Roman Barták
Charles University
Constraint programming is a technology for declarative description and solving of hard combinatorial problems, such as scheduling. It represents one of the closest approaches to the Holy Grail of automated problem solving: the user states the constraints over the problem variables and the system finds an instantiation of variables satisfying the constraints and representing the solution of the problem. The course overviews major constraint satisfaction techniques and shows how they can be used to solve practical problems.
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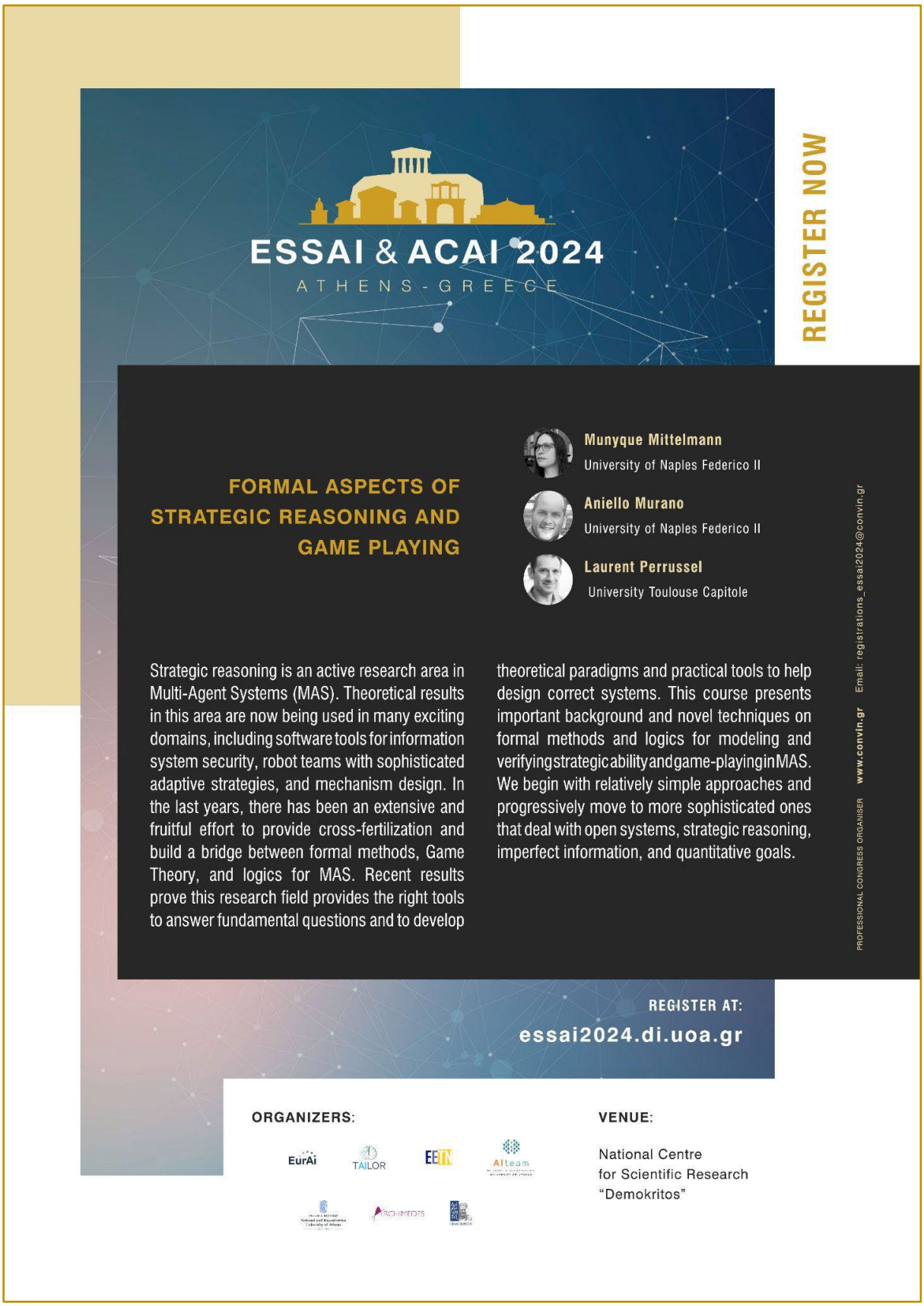
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FORMAL ASPECTS OF STRATEGIC REASONING AND GAME PLAYING
Munyque Mittelmann
University of Naples Federico II
Aniello Murano
University of Naples Federico II
Laurent Perrussel
University Toulouse Capitole
Strategic reasoning is an active research area in Multi-Agent Systems (MAS). Theoretical results in this area are now being used in many exciting domains, including software tools for information system security, robot teams with sophisticated adaptive strategies, and mechanism design. In the last years, there has been an extensive and fruitful effort to provide cross-fertilization and build a bridge between formal methods, Game Theory, and logics for MAS. Recent results prove this research field provides the right tools to answer fundamental questions and to develop theoretical paradigms and practical tools to help design correct systems. This course presents important background and novel techniques on formal methods and logics for modeling and verifying strategic ability and game-playing in MAS. We begin with relatively simple approaches and progressively move to more sophisticated ones that deal with open systems, strategic reasoning, imperfect information, and quantitative goals.
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UNLOCKING DATA INSIGHTS: INTRODUCTION TO DATA-CENTRIC AI
Vincenzo Pasquadibisceglie
University of Bari Aldo Moro
Artificial Intelligence (AI) has historically relied on data and algorithms. However, the traditional model-centric AI paradigm mainly treated data as static entities. Data is collected first, pre-processed, and kept fixed, by spending most of the development time optimizing the learned models. This approach resulted in increasingly complex and opaque models, demanding big training data. In contrast, the emerging data-centric AI is dedicated to systematically and algorithmically generating optimal data to feed Machine Learning (ML) models. The primary objective of data-centric AI approaches is to continually enhance data quality, enabling a level of model accuracy previously deemed unattainable through modelcentric techniques alone. This course aims to delve into the key concepts and open challenges of data-centric AI on the future of AI and ML, providing an overview of the techniques and solutions in the data-centric paradigm.
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LOGIC-BASED SPECIFICATION AND VERIFICATION OF MULTI-AGENT SYSTEMS
Valentin Goranko
Stockholm University
Formal, logic-based approaches and methods are becoming increasingly popular and important in the modeling and analysis of the performance of agents and coalitions in multi-agent systems (MAS). In this course I will first present and discuss some of the most popular and useful logical frameworks for modelling and specification of MAS, including the alternating time temporal logic ATL and some variations and extensions of it. I will then discuss models with perfect and imperfect information as well as the role of agents memory. I will then present some specific topics of recent and ongoing research, including MAS with quantitative and qualitative objectives, homogeneous dynamic MAS, and dynamic resource allocation problems in MAS modelled as generalized dining philosophers games. The emphasis of the course will be on understanding of the logic-based approach for formal specification of MAS and the associated algorithmic model checking methods for formal verification and strategy synthesis.
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GAME-THEORETIC APPROACH TO TEMPORAL SYNTHESIS
Antonio Di Stasio
University of Oxford
Giuseppe Perelli
Università di Roma, La Sapienza
Shufang Zhu
University of Oxford
This course introduces AI reactive synthesis for tasks (goals) expressed over finite traces instead of states. Drawing upon the methodologies of Formal Methods, we will consider tasks and environment specifications expressed in LTL and its finite trace variant LTLf. We will review the main results and algorithmic techniques for solving reactive synthesis. Then, we will draw connections with their game-theoretic solution techniques. The main catch is that working with these logics can be based on devising suitable 2-player games and finding strategies, i.e., plans, to win them. We will cover the following topics: Games on Graphs, Temporal Logics, LTL,LTLf,Game-theoretictechniquesforLTLf objectives,andReactive Synthesis. This course is partially based on the work carried out in ERC Advanced Grant WhiteMech, EU ICT-48 TAILOR, and the PNRR MUR project PE0000013-FAIR.
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SELF-GOVERNING
MULTI-AGENT SYSTEMS
Jeremy Pitt
Imperial College London
Asimina Mertzani
Imperial College London
Self-organising multi-agent systems are a powerful engineering paradigm for developing cyber-physical systems using distributed computational intelligence. Applications include, amongst others, smart grids, ad hoc networks, cloud computing, and information processing. However, basing agent-behaviour on voluntary compliance with conventional rules, that can be re-negotiated and modified at run-time, produces several challenges in self-governance. This includes knowledge management, enforceability, social influence, collective action, and sustainability. There are also some well-known political problems such as the "iron law of oligarchy", the "paradox of self-amendment", and path dependency to be addressed. In this inter-disciplinary course, students will learn the foundations of self-organising multi-agent systems, and understand deep issues concerning self-governance and 'democracy'. They will be able to apply concepts and theories from philosophy, psychology and political science, in order to specify learning and reasoning algorithms, and to code social simulators. The implications for self-governing socio-technical systems combining human and computational intelligence are also discussed.
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AGENT-BASED SIMULATION
IN COMPLEX NETWORKS
Miguel Rebollo
Universitat Politècnica de València
Agent-based models are a promising area to deal with adaptive complex systems, which are characterized by a collective behavior that leads to emergent phenomena. Networks constitute a mathematical framework to study complex, emergent, and self-organized environments, in which the relation among the participant entities plays a central role in the functioning of the community. The aim of this tutorial is to introduce the students to the area of complex networks. The course comprises a combination of theoretical concepts regarding the structure and dynamics of the most known network models, scale-free and small-world phenomena. The second part is a practical one in which these models will be implemented using Netlogo and Python.
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PROBABILISTIC CIRCUITS: TRACTABLE REPRESENTATIONS FOR LEARNING AND REASONING
Robert Peharz
Graz University of Technology
Antonio Vergari
University of Edinburgh
This Advanced Course is the continuation of the successful and well-received Introductory Course "Probabilistic Circuits: Deep Probabilistic Models with Reliable Reasoning" presented at ESSAI'23 in Ljubljana, and will provide in-depth knowledge and skills to treat above challenges with the powerful framework of probabilistic circuits (PCs). PCs have emerged as a "lingua franca" of tractable probabilistic modeling and have strong connections to a wide field of AI disciplines such as logical reasoning, deep learning and other machine learning techniques. Capitalising on these connections in a wide scope is the central goal of the Advanced Course. After an introduction and recap of the PC framework, we will teach algorithms and implementation techniques to actively work with PCs in research and applications. We will then discuss a wide range of hybrid techniques combining PCs with deep learning models and mixing exact and approximate inference. Finally, we will introduce PCs as an excellent tool to implement neurosymbolic systems and highlight further connections between probabilistic circuits, knowledge graphs, decision trees, random forests, causal models and databases.
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QUANTIFICATION: PREDICTING CLASS FREQUENCIES VIA SUPERVISED LEARNING
Alejandro Moreo
Institute of Information Science and Technologies "Alessandro Faedo"
Fabrizio Sebastiani
Institute of Information Science and Technologies "Alessandro Faedo"
Quantification is the task of training predictors of class frequencies via supervised learning, and is interesting in all applications of classification in which the final goal is not determining to which class individual unlabelled datapoints belong, but estimating the distribution of the unlabelled datapoints across the classes of interest. Example disciplines whose interest in labelling datapoints is at the aggregate level (rather than at the individual level) are the social sciences, market research, ecological modelling, and epidemiology. While quantification may be solved by classifying each unlabelled datapoint and counting how many such datapoints have been labelled with each class, it is now undisputed that this "classify and count" (CC) method yields suboptimal quantification accuracy. As a result, quantification is no longer considered a mere byproduct of classification, and has evolved as a task of its own. The goal of this course is introducing young researchers to the methods, algorithms, evaluation measures, and evaluation protocols used in the field of quantification.
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DEEP REASONING IN AI WITH ANSWER SET PROGRAMMING
Mario Alviano
University of Calabria
Francesco Ricca
University of Calabria
Answer Set Programming (ASP) is a logic-based Knowledge Representation and Reasoning (KRR) paradigm easing the fast prototyping of algorithms for complex problems. Indeed, ASP finds a natural application in solving Deep Reasoning problems characterized by search spaces of exponential size, which is the typical case for combinatorial search and combinatorial optimization. However, while moving the first steps in ASP is easy, being proficient with the most advanced linguistic constructs and scaling over realistic size instances is not necessarily a walk in the park. In this course we will show how to use ASP at several levels, from the basic use of ASP systems for computing answer sets of an ASP program, to more sophisticated use cases in which ASP itself is just one (even if of crucial importance) wheel in broader and more complex gears. We will give space to ASP internals, secure coding and explainability concerns (XAI).
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INTRODUCTION TO COMPUTATIONAL ARGUMENTATION SEMANTICS
Srdjan Vesic
Centre National de la Recherche Scientifique
Dragan Doder
Utrecht University
Argumentation is a process of constructing arguments and attacks between them. It drew attention of numerous scholars recently with its features and applications. This course starts with a general introduction to argumentation theory. Then, we study the main motivation and ideas behind extension-based semantics and labellings. After that, we review the quantitative and qualitative approaches for evaluation of individual arguments in an argumentation framework. We analyse and compare all those approaches using the principles from the literature. We conclude the course by providing an overview of multi-disciplinary questions, open problems, possibilities and future challenges.
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UNIVERSAL MODELS AND THE CHASE PROCEDURE
Phokion Kolaitis
University of California, Santa Cruz
Andreas Pieris
University of Edinburgh
Many database problems that involve rule-like constraints, e.g., containment of queries under constraints, checking logical implication of constraints, computing data exchange solutions, and ontological query answering, to name a few, can be solved by simply exhibiting a universal model of the given database D and set of constraints Σ. Intuitively, a universal model is a representative of all the models of D and Σ. A fundamental tool that allow us to build universal models is the so-called chase procedure, which takes as input a database D and a set of rule-like constraints Σ, and adds new tuples to D as dictated by the rules of Σ. After discussing the central notion of universal model, we will introduce the main variants of the chase procedure (oblivious and restricted) focussing on tuple-generating dependencies, discuss their key differences, and show that they indeed build universal models. We will then focus on the challenge of non-termination of the chase procedure under tuple-generating dependencies.
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FROM QUANTITY TO QUALITY: THE ROLE OF LARGE DATASETS IN LANGUAGE AI EVOLUTION
Jennifer D'Souza
Technische Informationsbibliothek
This talk will explore the transformative impact of large pre-training datasets on the evolution and efficiency of Large Language Models (LLMs). By examining a series of breakthrough models, such as T5, BERT, and the GPT series through GPT-3, GPT-J, LLaMA, and Falcon, the presentation aims to highlight how the scale and quality of datasets have been pivotal in enhancing language capabilities. It will delve into various architectures, from Encoder-Decoder and Encoder-only to Decoder-only frameworks, and discuss the critical role of foundational datasets like C4, BooksCorpus, WebText, the Pile, and the RefinedWeb. These datasets underscore technological milestones and the importance of data diversity, volume, and quality in achieving significant advances in model performance. The talk will provide insights into the interplay between data and algorithmic innovation, charting the journey of LLMs towards more sophisticated language understanding and generation capabilities.
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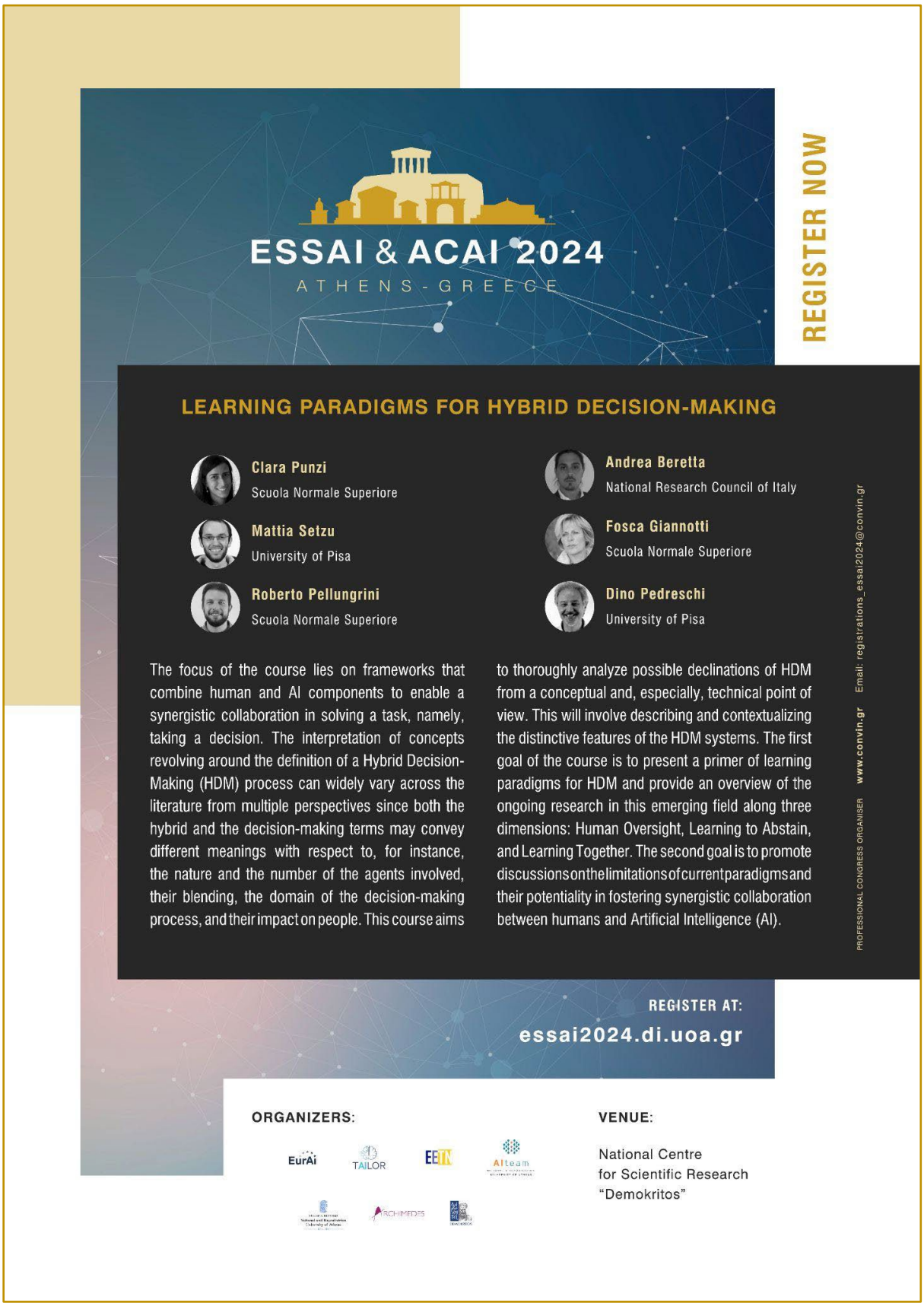
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LEARNING PARADIGMS FOR HYBRID DECISION-MAKING
Clara Punzi
Scuola Normale Superiore
Mattia Setzu
University of Pisa
Roberto Pellungrini
Scuola Normale Superiore
Andrea Beretta
National Research Council of Italy
Fosca Giannotti
Scuola Normale Superiore
Dino Pedreschi
University of Pisa
The focus of the course lies on frameworks that combine human and AI components to enable a synergistic collaboration in solving a task, namely, taking a decision. The interpretation of concepts revolving around the definition of a Hybrid Decision-Making (HDM) process can widely vary across the literature from multiple perspectives since both the hybrid and the decision-making terms may convey different meanings with respect to, for instance, the nature and the number of the agents involved, their blending, the domain of the decision-making process, and their impact on people. This course aims to thoroughly analyze possible declinations of HDM from a conceptual and, especially, technical point of view. This will involve describing and contextualizing the distinctive features of the HDM systems. The first goal of the course is to present a primer of learning paradigms for HDM and provide an overview of the ongoing research in this emerging field along three dimensions: Human Oversight, Learning to Abstain, and Learning Together. The second goal is to promote discussions on the limitations of current paradigms and their potentiality in fostering synergistic collaboration between humans and Artificial Intelligence (AI).
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HARNESSING SCIENTIFIC AI FOR KNOWLEDGE DISCOVERY IN THE OPEN RESEARCH KNOWLEDGE GRAPH
Jennifer D'Souza
Technische Informationsbibliothek
Allard Oelen
Technische Informationsbibliothek
This course delves into the transformative potential of the Open Research Knowledge Graph (ORKG) in redefining scholarly communication through structured descriptions of research contributions and comparative analysis based on salient research properties. By integrating scientific AI, specifically domain-specific information extraction services and Large Language Models (LLMs), the ORKG facilitates the creation of semantically rich, machine-readable data that enhances research discoverability and comparison. We explore how we intertwine search engines, LLMs and knowledge to provide researchers better targeted information extraction from scholarly articles. Furthermore, we discuss how the extracted data is integrated in the ORKG by leveraging human knowledge to ensure the accuracy and relevance of the information added to the graph. This session aims to equip researchers with the knowledge to leverage these advancements for effective knowledge discovery and management in the digital age of scholarly research.
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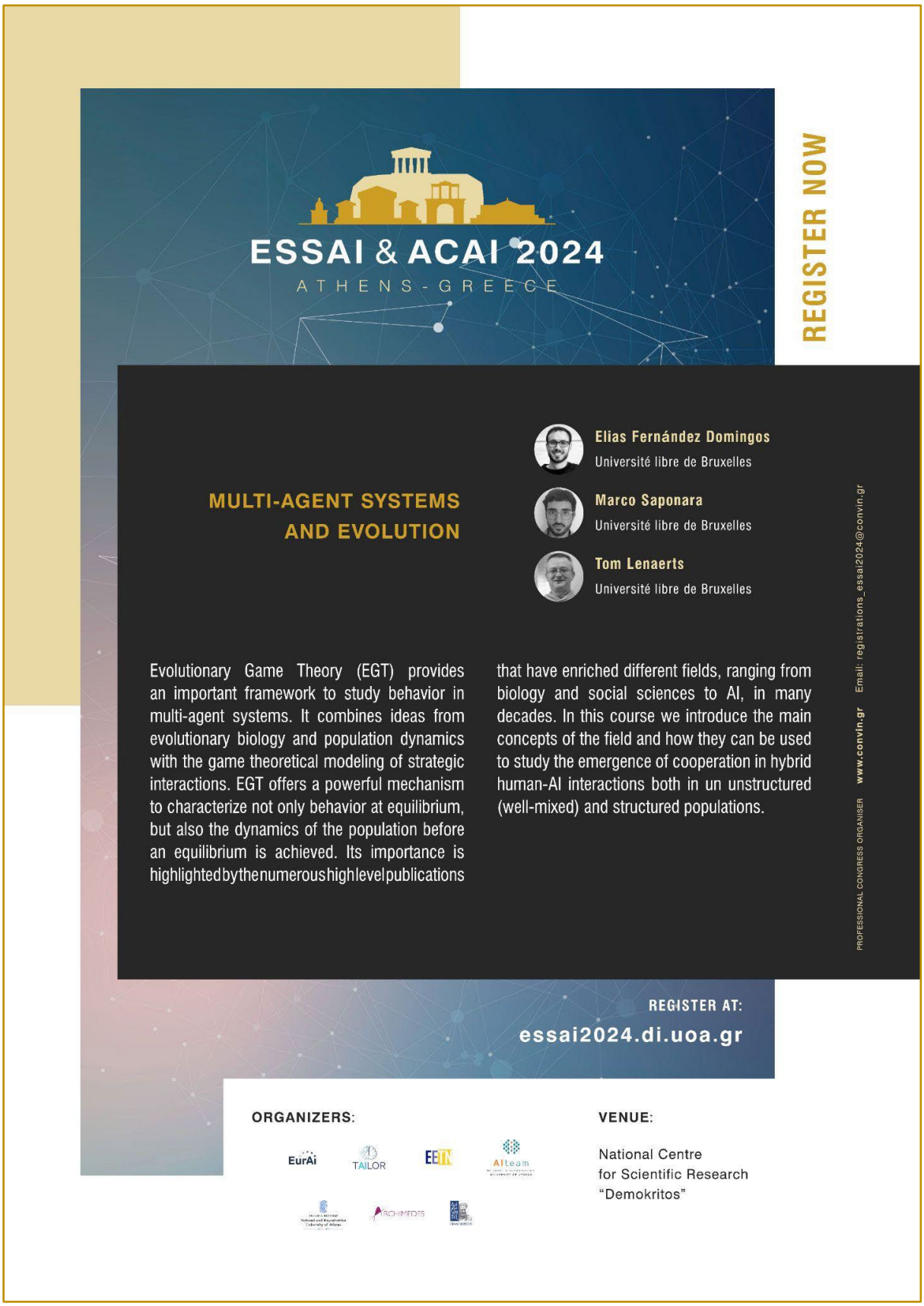
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MULTI-AGENT SYSTEMS AND EVOLUTION
Elias Fernández Domingos
Université libre de Bruxelles
Marco Saponara
Université libre de Bruxelles
Tom Lenaerts
Université libre de Bruxelles
Evolutionary Game Theory (EGT) provides an important framework to study behavior in multi-agent systems. It combines ideas from evolutionary biology and population dynamics with the game theoretical modeling of strategic interactions. EGT offers a powerful mechanism to characterize not only behavior at equilibrium, but also the dynamics of the population before an equilibrium is achieved. Its importance is highlighted by the numerous high level publications that have enriched different fields, ranging from biology and social sciences to AI, in many decades. In this course we introduce the main concepts of the field and how they can be used to study the emergence of cooperation in hybrid human-AI interactions both in un unstructured (well-mixed) and structured populations.
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MACHINES CLIMBING PEARL'S LADDER OF CAUSATION
Matej Zečević
Technische Universität Darmstadt
Devendra Dhami
Eindhoven University of Technology
Adèle Ribeiro
Philipps-Universität Marburg
Artificial intelligence's primary engine, deep learning, has several issues with regard to its data-hungry nature along with a lack of interpretability and explainability. A principled approach to overcome these weaknesses is causal modeling and inference, a mathematical framework well aligned with human-like cognition. In this course, we will show how causality can help machine learning models ascend the ladder of causation, moving beyond mere identification of statistical associations (rung 1 inferences) to provide more insightful and valuable interventional and counterfactual explanations (rung 2 and 3 inferences). We propose to start with the very basic notions of causality, then moving to the question of how to discover and represent causal knowledge in machine learning models. Then after covering the identification and estimation of causal effects we will present the current state of research in causality, eventually concluding with a hands-on session where the participants can do a practical deep dive into causal models.
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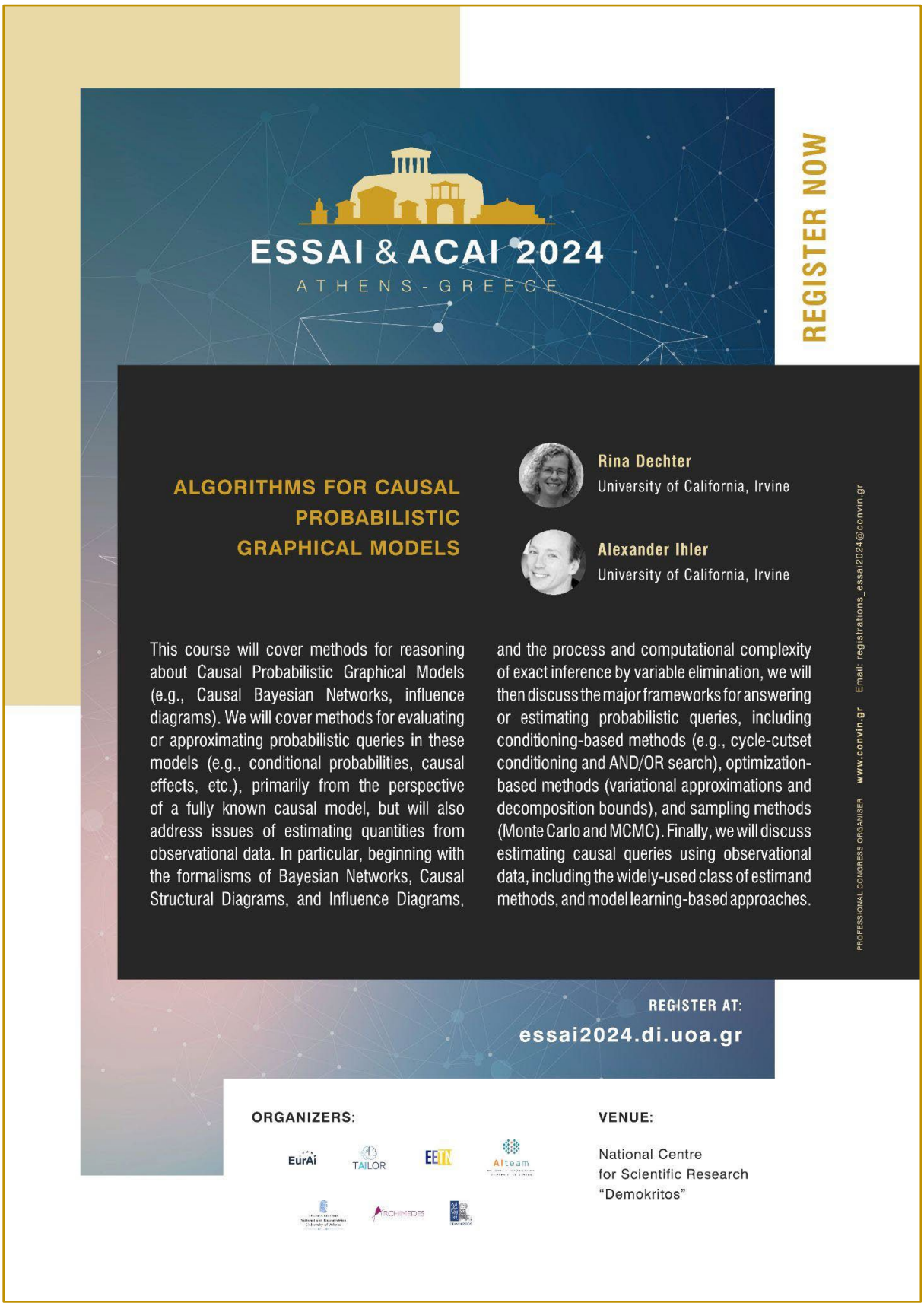
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ALGORITHMS FOR CAUSAL PROBABILISTIC GRAPHICAL MODELS
Rina Dechter
University of California, Irvine
Alexander Ihler
University of California, Irvine
This course will cover methods for reasoning about Causal Probabilistic Graphical Models (e.g., Causal Bayesian Networks, influence diagrams). We will cover methods for evaluating or approximating probabilistic queries in these models (e.g., conditional probabilities, causal effects, etc.), primarily from the perspective of a fully known causal model, but will also address issues of estimating quantities from observational data. In particular, beginning with the formalisms of Bayesian Networks, Causal Structural Diagrams, and Influence Diagrams, and the process and computational complexity of exact inference by variable elimination, we will then discuss the major frameworks for answering or estimating probabilistic queries, including conditioning-based methods (e.g., cycle-cutset conditioning and AND/OR search), optimization-based methods (variational approximations and decomposition bounds), and sampling methods (Monte Carlo and MCMC). Finally, we will discuss estimating causal queries using observational data, including the widely-used class of estimand methods, and model learning-based approaches.
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