



**Foundations of Trustworthy AI –
Integrating Reasoning, Learning and Optimization
TAILOR
Grant Agreement Number 952215**

**Report on Third TAILOR Summer School,
D9.9**

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1. Introduction

1.1. Executive summary

The present deliverable reports on the Third TAILOR Summer School on Artificial Intelligence, held in Ljubljana, Slovenia in the week of July 24-28, 2023. The school comprised the First European Summer School on AI (ESSAI), with six parallel tracks. It also comprised the 20th Advanced Course on Artificial Intelligence (ACAI), as a seventh track of ESSAI & ACAI 2023.

ESSAI included 24 courses, each comprising five 90-minute sessions (a total of 10 school hours), given at the same time on each of the five days of the week. Selected from roughly twice as many (46) course proposals by the ESSAI program chairs and committee, the courses covered a broad spectrum of topics within the field of artificial intelligence. They included many courses given by TAILOR lectures and/or covering TAILOR-relevant topics.

ACAI included 12 tutorials, eight consisting of two 90-minute sessions (a half day, a total of 4 school hours) and four comprising a single 90-minute session (two school hours). Situated in the broader area of Artificial Intelligence and Science, the tutorial speakers were hand-picked and invited by the ACAI program chairs. They covered a broad range of topics, ranging from more traditional topics, such as equation discovery and symbolic regression, through knowledge representation and ontologies for science, to cutting edge topics like language models for science and quantum machine learning.

The event was a great success. It attracted over 500 participants from over 40 countries. The lectures were of high quality and very well received by the participants. The social events contributed to a lively, relaxed and friendly atmosphere and greatly facilitated interactions and networking among the event participants.

The event achieved its major objective, i.e., to establish the European Summer School on Artificial Intelligence (ESSAI) as a major event that attracts young researchers and brings to them the latest development in AI. ESSAI, which is supported by EurAI, The European Association for Artificial Intelligence, has now become a yearly event and is a lasting legacy of TAILOR. The next edition of the event, which will last for two weeks, will be held in Athens, 15-26 July 2024.

1.2. Objectives

The European Summer School in Artificial Intelligence (ESSAI) is a new annual summer school held under the auspices of the European Association for Artificial Intelligence (EurAI). The ambition of ESSAI is to become the central meeting place for students and young researchers in Artificial Intelligence to discuss current research, share knowledge and stay up-to-date with advances in the field. It also aspires to provide an easy entry point into AI for researchers entering the field, as it provides an interdisciplinary setting in which courses are offered in all areas of Artificial Intelligence, also from a wider scientific, historical, and philosophical perspective.

The format of ESSAI is analogous to the European Summer School in Logic, Language and Information (ESSLLI) which has been running since 1989. ESSAI courses consist of five 90 minute sessions, offered daily (Monday-Friday) in a single week, to allow students to develop in-depth knowledge of a topic. Courses can be at three levels: foundational, introductory and advanced.

While a major topic of ESSAI was Trustworthy AI, a topic of central interest in the TAILOR project, an important goal of ESSAI-2023 was to broaden the school's scope and cover a variety of topics from all areas of artificial intelligence. ESSAI will hopefully become a tradition and will be organized annually, becoming the ESSLI equivalent for AI, lasting for two weeks. It will represent a major legacy of the TAILOR project that will last well beyond the project lifetime.

1.3. History

The European Summer School on Artificial Intelligence (ESSAI) is a direct product of European AI research being increasingly coordinated and scaled up across projects, research organizations and countries. ESSAI's immediate predecessors are the Advanced Course on AI (ACAI), organized since 1985 under the auspices of the European Association for Artificial Intelligence (EurAI), and the TAILOR Summer School on Trustworthy AI organized since 2021 by the European ICT-48 Network of Excellence on Trustworthy AI through Integrating Learning, Optimisation and Reasoning. In 2022, these two schools were already co-located in Barcelona with parallel tracks as well as joint events.

In 2023, EurAI and TAILOR continued their collaboration, aiming to deliver a significantly larger event: ESSAI & ACAI-2023. The two were organized together as the third TAILOR Summer School, and comprised 24 courses, 12 tutorials, a keynote talk, two panels and three social events.

After the 2nd TAILOR conference, which took place in Prague, 12-14 September 2022, a call was issued by EurAI for bids to organize jointly ESSAI and ACAI. While ACAI has a long tradition and is organized bi-annually, the 2023 edition was to be the first edition of ESSAI, modeled largely after ESSLi (the European Summer School in Language, Logic and Information). Given the relatively short notice, the first edition of ESSAI was to last for one week (ESSLi typically lasts two weeks).

A bid was placed for organizing ESSAI and ACAI in Ljubljana, Slovenia, July 24-28, 2023 (Appendix A). Note that ESSLi-2023 was set to be organized in Ljubljana in the first two weeks of August. JSI (as represented by Sašo Džeroski, the TAILOR PI of JSI) took the initiative in recruiting a local team, headed by Vida Groznik and Aleksander Sadikov. On the program side, coordinated by Giuseppe De Giacomo (ESSAI standing committee chair), a team was recruited with Magdalena Ortiz as chair, and Brian Logan, Sašo Džeroski, as co-chairs: For details on the teams, see Section 3.5.



The president of the Republic of Slovenia attended the course on AI Fairness & Privacy

1.4. Scientific Content Highlights

ESSAI & ACAI 2023 were organized jointly as the third TAILOR Summer School on AI. The event comprised 36 courses and tutorials presented in seven parallel tracks. It also comprised one keynote talk, two panel discussions and three social events (a reception, a gala dinner and a concert). ESSAI & ACAI-2023 took place at the Faculty of Computer and Information Science, University of Ljubljana, Slovenia. Organized also under the auspices of SLAIS, the Slovenian AI society, the event marked 50 years of AI research in Slovenia and 30 years of SLAIS (in the landmark year of 2022).

ESSAI offered 24 courses (of 5x90min each) on all topics of AI, selected by an international program committee from 46 proposals solicited through an open call for course proposals (the call for course proposals is given as Appendix B). The most popular courses included the following:

- *Large Language Models: Background & Applications*. Michael Roth & Ivan Vulic.
- *AutoML: Accelerating research on and development of AI applications*. Marius Lindauer & Katharina Eggensperger.
- *AI fairness and privacy: Fundamentals, synergies and conflicts*. Tijl de Bie & Maarten Buyl

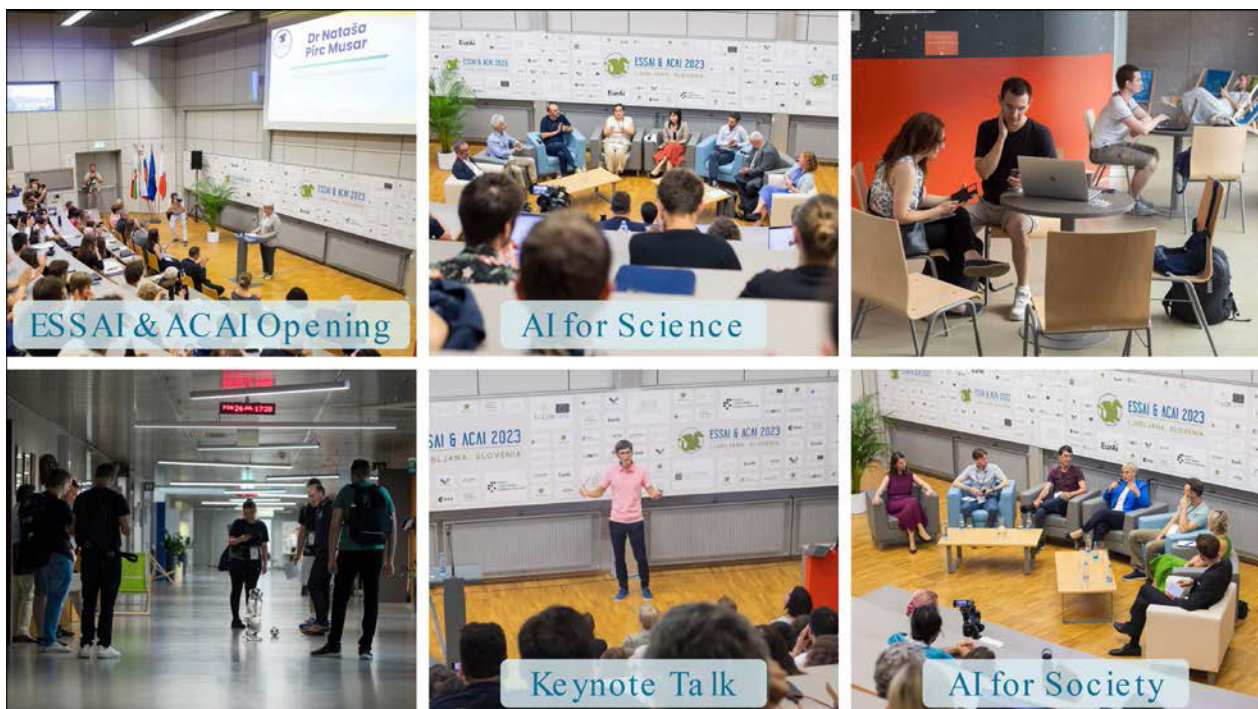
The latter was also attended by The President of the Republic of Slovenia, dr. Nataša Pirc Musar, who was the honorary patron of the event, took part in the opening ceremony and participated in the roundtable on *AI & Society*.

ACAI included 12 tutorials, eight consisting of two 90-minute sessions (a half day, a total of 4 school hours) and four comprising a single 90-minute session (two school hours). Nine were delivered in person and three were delivered remotely. The tutorials covered the topic of Artificial Intelligence and Science, and were given by speakers that were hand-picked and invited by the ACAI program chairs. The lecturers were all renowned experts in the field of AI, comprising a mixture of young up-and-coming researchers, as well as established researchers in the area.

Example tutorials include the following:

- *AI for Biology and Science* (Ziga Avsec/Claire Bycroft)
- *Basic Ideas in Quantum Machine Learning* (Vedran Dunjko)
- *Closed-loop automation of scientific research* (Ross King)

The lecturers at ACAI included researchers from Cambridge, Stanford and Yale Universities, as well as Google Deepmind and Microsoft research, to name a few of the most prominent institutions.



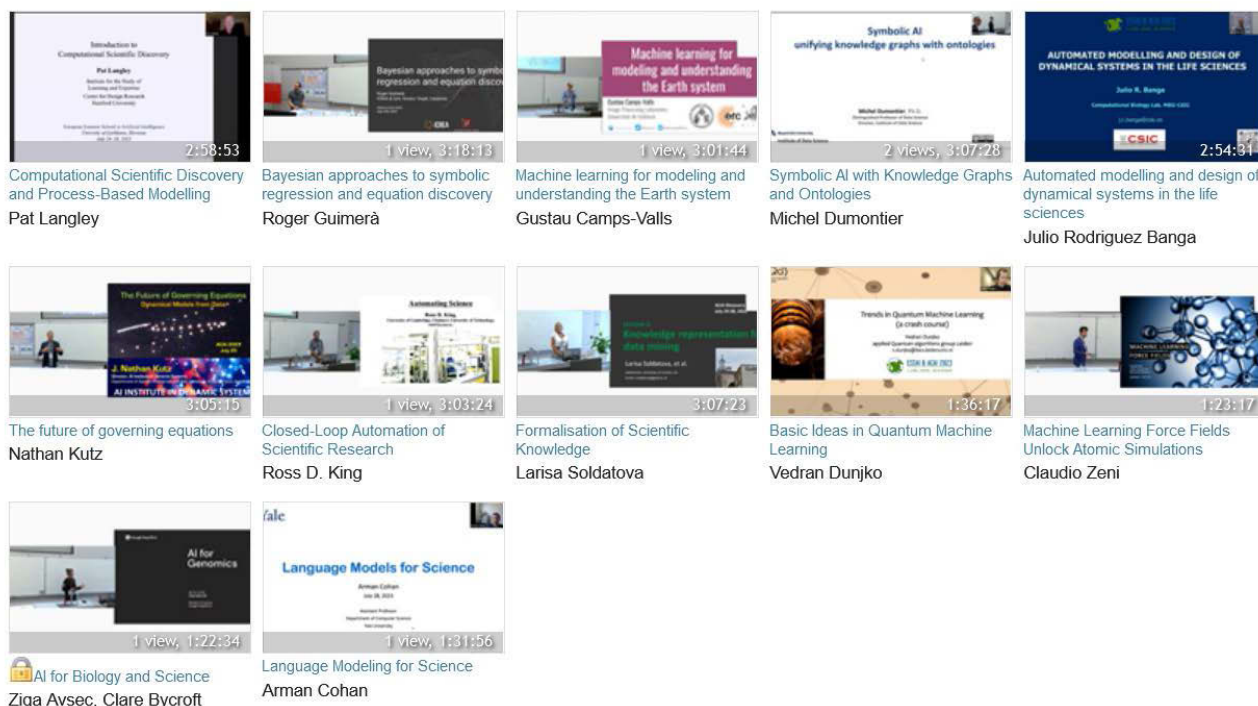
Images from the different parts of the ESSAI & ACAI-2023 event.

The event also included a keynote talk by Jure Leskovec from Stanford University, titled *Foundation Models*. It was delivered at the end of the first day, after a full program of lectures and the opening session. The latter included an address by the honorary patron, the President of the Republic of Slovenia, the president of SLAIS (the Slovenian AI society), and representatives of the three institutional organizers. Last, but not least, the program chairs of ESSAI (Magdalena Ortiz) and ACAI (Sašo Džeroski), as well as the local chair (Vida Groznik) addressed the audience. The event also included two panel (round table) discussions on the topics of *AI and Society* and *AI in Science*, held on Tuesday and Thursday. The event was preceded by a smaller event organized by the CLAIRE R2Rnet (Raising Researchers Network). The closing session was on Friday afternoon.

The school was attended by over 500 participants, in addition to the 60 lecturers. Registrations for in-person attendance had to be capped at 500, as the venue capacity was reached. Of these, exactly 100 were TAILOR student registrations. After closing in-person registrations, registration for on-line participation was open. However, the arrangements for streaming and recording the lectures were made quite late and announced even later, so few participants attended online (around 20).

More importantly, however, the recorded lectures were post-processed and made publicly available via the videolectures.net platform (provided the lecturers gave consent for this). Of the 12 ACAI tutorials, only one is not publicly available. Of the 24 ESSAI courses, only three are not publicly available. The opening, keynote talk and the two panel discussions are publicly available. All can be found at https://videolectures.net/ESSAIandACAIschool2023_ljubljana/

20th Advanced Course on Artificial Intelligence (ACAI)



The ACAI tutorial recordings as available from the videolectures.net platform.

Overall, ESSAI & ACAI-2023 was a great success. ESSAI comprised a wide variety of courses at different levels of complexity, covering a broad range of topics from the area of AI. ACAI included twelve tutorials, systematically covering the field of Artificial Intelligence and Science.

The event attracted a large number of participants. Through the lectures, they were able to get up to speed with the latest and greatest research and researchers in AI. Through the social events, they were able to network with topmost researchers in AI, as well as their peers.

ESSAI and ACAI successfully paved the way for future editions of the event, opening the road for it to become a tradition. They certainly made an impact on both the attendees and the lecturers. Through the publicly available recordings of the lectures, they will make an even larger and lasting impact to a much broader circle and the AI community, in Europe and worldwide.

Following the success of ESSAI & ACAI-2023, EurAI issued public calls for candidates to organize the 2024 and 2025 editions of the event. ESSAI & ACAI-2024 will be held in Athens, 15-26 July 2024: Its main organizer will be Manolis Koubarakis. We wish him best of luck & success!

We would like to thank all participants, everybody who submitted a course proposal to ESSAI, and the lecturers of both ESSAI and ACAI. We would also like to thank the institutions that supported the event (listed in Section 3), incl. EurAI and SLAIS, TAILOR, U of Ljubljana, JSI, U of Primorska, ESA, and CLAIRE. Finally, we would like to thank the people who contributed to the organization, incl. the volunteers, the (co)chairs and program committee of ESSAI, the chairs of ACAI, and the local organizers team, chaired by Vida Groznik and Aleksander Sadikov.

2. Scientific Content Details

2.1. Overview of the schedule and programme of ESSAI&ACAI-2023

ESSAI and ACAI 2023 was originally planned as a single event with six parallel tracks. Five of these were meant to be ESSAI tracks and one of these was meant to be ACAI, The Advanced Course on Artificial Intelligence. It was planned to last for a full week, July 24-28, 2023. A schema of the planned program structure of the event is given below.

Monday, 24. 7. 2023	Tuesday, 25. 7. 2023	Wednesday, 26. 7. 2023	Thursday, 27. 7. 2023	Friday, 28. 7. 2023
ACAI	ACAI	ACAI	ACAI	ACAI
ESSAI - Track 1	ESSAI - Track 1	ESSAI - Track 1	ESSAI - Track 1	ESSAI - Track 1
ESSAI - Track 2	ESSAI - Track 2	ESSAI - Track 2	ESSAI - Track 2	ESSAI - Track 2
ESSAI - Track 3	ESSAI - Track 3	ESSAI - Track 3	ESSAI - Track 3	ESSAI - Track 3
ESSAI - Track 4	ESSAI - Track 4	ESSAI - Track 4	ESSAI - Track 4	ESSAI - Track 4
ESSAI - Track 5	ESSAI - Track 5	ESSAI - Track 5	ESSAI - Track 5	ESSAI - Track 5

The schema of the planned program structure of the ESSAI & ACAI-2023 event.

The ACAI track was originally planned to comprise 10 tutorials, two per day. Each tutorial would include two 90-minute sessions. The tutorials were planned to cover the topic of Artificial Intelligence and Science.

The ACAI speakers were hand-picked and invited by the ACAI program chairs, Sašo Džeroski and Ljupčo Todorovski. Eventually, ACAI included 12 tutorials, eight consisting of two 90-minute sessions (a half day, a total of 4 school hours) and four comprising a single 90-minute session (two school hours). Of these, nine were delivered in person and three remotely.

	Monday	Tuesday	Wednesday	Thursday	Friday
9:00 to 10:30	Pat Langley - Computational Scientific Discovery and Process-Based Modelling Room: PB	Roger Guimerà - Bayesian Approaches to Symbolic Regression and Equation Discovery Room: PB	Gustau Camps-Valls - Machine Learning for Modeling and Understanding the Earth System Room: PB	Michel Dumontier - Symbolic AI with Knowledge Graphs and Ontologies Room: PB	Vedran Dunjko - Basic Ideas in Quantum Machine Learning Room: PB
Coffee break					
11:00 to 12:30	Pat Langley - Computational Scientific Discovery and Process-Based Modelling Room: PB	Roger Guimerà - Bayesian Approaches to Symbolic Regression and Equation Discovery Room: PB	Gustau Camps-Valls - Machine Learning for Modeling and Understanding the Earth System Room: PB	Michel Dumontier - The Promise and Perils of FAIR Data Room: PB	Claudio Zeni - Machine Learning Force Fields Unlock Atomic Simulations Room: PB
Lunch					
14:00 to 15:30	Julio Rodriguez Banga - Automated Modelling and Design of Dynamical Systems in the Life Sciences Room: PB	Nathan Kutz - The Future of Governing Equations Room: PB	Ross King - Closed-Loop Automation of Scientific Research Room: PB	Larisa Soldatova - Formalisation of Scientific Knowledge Room: PB	Ziga Avsec & Clare Bycroft - AI for Biology and Science Room: PB
Coffee Break					
16:00 to 17:30	Julio Rodriguez Banga - Automated Modelling and Design of Dynamical Systems in the Life Sciences Room: PB	Nathan Kutz - The Future of Governing Equations Room: PB	Ross King - Closed-Loop Automation of Scientific Research Room: PB	Larisa Soldatova - Formalisation of Scientific Knowledge Room: PB	Arman Cohan - Language Modeling for Science Room: PB

The final program of the ACAI track on AI and Science of the ESSAI & ACAI-2023 event.

ESSAI offered 24 courses (of 5x90min each) on all topics of AI. All but one (23) were selected from twice as many (46) proposals solicited through an open call for course proposals (the call for course proposals is given as Appendix B). The selection was made by an international program committee, chaired by Magdalena Ortiz (and co-chaired by Brian Logan and Sašo Džeroski). A proposal was solicited by the chairs from Michael Roth and Ivan Vulic on the topic of large language models. This turned out to be one of the most popular courses in the end. The 24 courses were organized in six parallel tracks, so the event consisted of a total of 7 tracks.

9:00 to 10:30						
ESSAI courses						ACAI courses
Foundational	Introductory			Advanced		Monday - Friday See the ACAI schedule below (Room: PB)
Nicola Gigante - Temporal Reasoning in AI: an introduction	Marius Lindauer & Katharina Eggensperger - AutoML: Accelerating Research on and Development of AI Applications	Sebastijan Dumancic, Robin Manhaeve & Giuseppe Marra - From Statistical Relational to Neural Symbolic Artificial Intelligence	Mario Alviano & Francesco Ricca - Pills of Answer Set Programming	Alexey Ignatiev, Nina Narodytska & Joao Marques-Silva - Formal Explainability in Artificial Intelligence	Franz Baader, Patrick Koopmann & Francesco Kriegel - Explaining and Repairing Description Logic Ontologies	
Room: PC	Room: PA	Room: P22	Room: PD	Room: P1	Room: P19	
10:30 to 11:00						
Coffee break						
11:00 to 12:30						
Foundational	Introductory			Advanced		Monday - Friday See the ACAI schedule below (Room: PB)
Martin Mundi - Machine Learning Beyond Static Datasets	Srdjan Vesic & Dragan Doder - Introduction to computational argumentation semantics	Tome Eftimov & Peter Karašec - Smart-sized Benchmarking for Black-Box Optimization	Robert Peharz & Antonio Vergari - Probabilistic Circuits: Deep Probabilistic Models with Reliable Reasoning	Michael Roth & Ivan Vulic - Large Language Models: Background and Applications	Bloi Bonet & Hector Geffner - Learning to act and plan	
Room: P1	Room: P19	Room: PD	Room: PC	Room: PA	Room: P22	
12:30 to 14:00						
Lunch						
14:00 to 15:30						
Foundational	Introductory		Advanced			Monday - Friday See the ACAI schedule below (Room: PB)
Roman Barták - Foundations of Automated Planning	Bruno Lacerda, Nick Hawes & David Parker - Model Uncertainty in Sequential Decision Making	Matias Valdenegro Toro & Marco Zullo - Uncertainty Quantification in Machine Learning	Catalin Dima & Wojtek Jamroz - Automated Verification of Multi-Agent Systems. Why, What, and Especially: How?	Adrian Popescu - Continual Learning for Image Classification	Roxana Radulescu - Multi-Objective Reinforcement Learning	
Room: PD (Monday P19)	Room: P22	Room: PA	Room: P19 (Monday P20)	Room: PC	Room: P1 (Monday PD)	
15:30 to 16:00						
Coffee break						
16:00 to 17:30						
Foundational	Introductory			Advanced		Monday - Friday See the ACAI schedule below (Room: PB)
Richard Dinga - Statistical Evaluation of The Performance of Machine Learning Models	Tijl De Bie & Maarten Buyt - AI Fairness and Privacy: Fundamentals, Synergies and Conflicts	Pance Panov - Knowledge Representation and Reasoning with Ontologies	Timothy Wile - Practical Applications of Artificial Intelligence for Robotics	Devendra Dhami, Matej Zecevic & Adele Ribeiro - Machines Climbing Pearl's Ladder of Causation	Antonio Di Stasio, Giuseppe Perelli & Shufang Zhu - Game-Theoretic Approach to Planning and Synthesis	
Room: PA	Room: P1 (Monday PD)	Room: P22	Room: PC	Room: PD (Monday P20)	Room: P19	

The final program of the six ESSAI tracks of the ESSAI & ACAI-2023 event.

The event also included a keynote talk by Jure Leskovec from Stanford University, titled *Foundation Models*. It was delivered at the end of the first day, after a full program of lectures and the opening session. The event also included two panel (round table) discussions on the topics of *AI and Society* and *AI in Science*, held on Tuesday and Thursday.

The event was preceded by a smaller event organized by the CLAIRE R2Rnet (Raising Researchers Network). The topic of the R2Rnet event was AI research and mental wellbeing. The closing session of ESSAI & ACAI-2023 was on Friday afternoon.

ESSAI & ACAI-2023 also included three social events: a reception, a gala dinner and a concert. The reception took place at the event venue on Monday, after the opening session, and included a music program by a renowned violin player (who also performed two pieces during the opening session). The gala dinner took place on Wednesday at the Grand Hotel Union and included music and dancing. The final social event, which took place on Friday evening was an open-air jazz concert, which took place in the old town center and featured the jazz band MatJazz II.

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
9:00 to 10:30		Lectures & Tutorials (7 parallel tracks)				
		Coffee break				
11:00 to 12:30		Lectures & Tutorials (7 parallel tracks)				
		Lunch				
14:00 to 15:30		Lectures & Tutorials (7 parallel tracks)				
		Coffee Break				
16:00 to 17:30	(14:45) CLAIRE R2Net – AI Research & Mental Well-Being Workshop	Lectures & Tutorials (7 parallel tracks)				
		Break				
18:00		ESSAI and ACAI Opening	Round Table: <i>AI for Society</i>		Round Table: <i>AI for Science</i>	Closing Ceremony
18:45		Keynote Lecture: <i>Jure Leskovec</i>				
20:00		Welcome Reception @ FRI		Social Dinner @ Grand Hotel Union		(20:30) Jazz Concert: MATJAZZ II @ Gornji trg

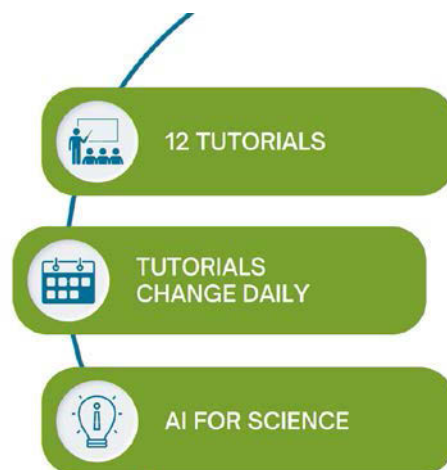
The final overall schedule of the ESSAI & ACAI-2023 event, including science and social program.

2.2 The tutorials of the ACAI-2023 on AI and Science

As mentioned above, ACAI included 12 tutorials, eight consisting of two 90-minute sessions (a half day, a total of 4 school hours) and four comprising a single 90-minute session (two school hours). The tutorials focused on the topic of Artificial Intelligence and Science, and were given by a select group of speakers. The lecturers were all renowned experts in the field of AI, comprising a mixture of young up-and-coming researchers, as well as established researchers in the area. The full list of ACAI tutorials is given below, together with the lectures and their institutions.



ADVANCED COURSE ON ARTIFICIAL INTELLIGENCE (ACAI)



The 12 tutorials presented at ACAI-2023 are listed below in the order in which they were presented:

- *Computational Scientific Discovery and Process-Based Modelling* (Pat Langley, Stanford University, US)
- *Automated modelling and design of dynamical systems in the life sciences* (Julio Rodriguez Banga, MBG-CSIC, Pontevedra, Spain)
- *Bayesian approaches to symbolic regression and equation discovery* (Roger Guimerà, Universitat Rovira i Virgili, Spain)
- *The future of governing equations* (Nathan Kutz, University of Washington, US)
- *Machine learning for modeling and understanding the Earth system* (Gustau Camps-Valls, University of Valencia, Spain)
- *Closed-loop automation of scientific research* (Ross King, Chalmers University, Sweden & Cambridge University, UK)
- *Symbolic AI with Knowledge Graphs and Ontologies* (Michel Dumontier, Maastricht University, The Netherlands)
- *Formalisation of Scientific Knowledge* (Larisa Soldatova, Goldsmiths University of London, UK)
- *Basic Ideas in Quantum Machine Learning* (Vedran Dunjko, Leiden University, The Netherlands)
- *Machine Learning Force Fields Unlock Atomic Simulations* (Claudio Zeni, Microsoft Research, UK)
- *AI for Biology and Science* (Ziga Avsec & Claire Bycroft, DeepMind, London, UK)
- *Language Modeling for Science* (Arman Cohan, Yale University, US)

Appendix C gives more details on the tutorials. For each tutorial, a one page description, presented in landscape format is given. The description includes the tutorial title; names, affiliations and photos of the lecturers; and the abstracts of their tutorials. In some cases a single abstract is available for the two 90min lectures, while in others separate abstracts are available for each.

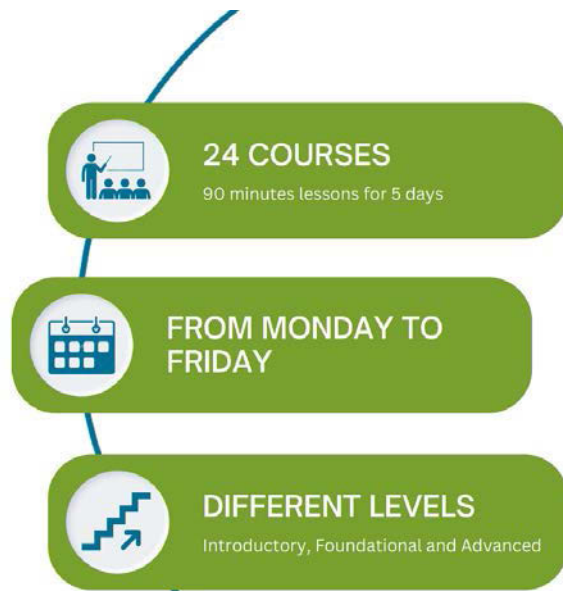
2.3 The courses of ESSAI-2023

ESSAI offered 24 courses, which were selected as explained above (23 out of 46 submitted course proposals + 1 solicited course on large language models). The courses could be at three different levels: foundational, introductory and advanced. Of the 24 courses, four were foundational and seven were advanced. The remaining 13 courses were at an introductory level.

Appendix D gives more details on the courses. For each course, a one page description, presented in landscape format is given. The description includes the course title; names, affiliations and photos of the lecturers; and the abstracts of their courses. As for the ACAI tutorials, the full list of ESSAI courses is given below, together with the lectures and their institutions/affiliations. The category of each course is listed as well (foundational, introductory or advanced).



EUROPEAN SUMMER SCHOOL ON ARTIFICIAL INTELLIGENCE (ESSAI)



The 24 courses presented at ESSAI-2023 are listed below (title, lecturers and affiliations), for each level separately. Those where at least one lecturer is affiliated with a TAILOR partner are marked TAILOR. The affiliations of the lecturers can be found in Section 3, which lists the lecturers and their institutions in Section 4. More than one third of the courses (9 out of 24) are TAILOR courses.

Foundational ESSAI courses

- *Temporal Reasoning in AI: an introduction.* Nicola Gigante.
- *Machine Learning Beyond Static Datasets.* Martin Mundt.
- *Foundations of Automated Planning.* Roman Barták (**TAILOR**).
- *Statistical Evaluation of the Performance of Machine Learning Models.* Richard Dinga.

Introductory ESSAI courses

- *AutoML: Accelerating Research on and Development of AI Applications.* Marius Lindauer, Katharina Eggensperger.
- *From Statistical Relational to Neural Symbolic Artificial Intelligence.* Sebastijan Dumancic, Robin Manhaeve, Giuseppe Marra (**TAILOR**).
- *Pills of Answer Set Programming.* Mario Alviano, Francesco Ricca.
- *Introduction to computational argumentation semantics.* Srdjan Vesic, Dragan Doder (**TAILOR**).
- *Smart-sized Benchmarking for Black-Box Optimization.* Tome Eftimov, Peter Korošec (**TAILOR**).
- *Probabilistic Circuits: Deep Probabilistic Models with Reliable Reasoning.* Robert Peharz, Antonio Vergari.
- *Large Language Models: Background and Applications.* Michael Roth, Ivan Vulic.
- *Model Uncertainty in Sequential Decision Making.* Bruno Lacerda, Nick Hawes, David Parker.
- *Uncertainty Quantification in Machine Learning.* Matias Valdenegro Toro, Marco Zullich.
- *AI Fairness and Privacy: Fundamentals, Synergies and Conflicts.* Tijl De Bie, Maarten Buyt.
- *Knowledge Representation and Reasoning with Ontologies.* Pance Panov (**TAILOR**).
- *Practical Applications of Artificial Intelligence for Robotics.* Timothy Wiley.
- *Machines Climbing Pearl's Ladder of Causation.* Devendra Dhami, Matej Zecevic, Adele Ribeiro (**TAILOR**).

Advanced ESSAI courses

- *Formal Explainability in Artificial Intelligence*. Alexey Ignatiev, Nina Narodytska, Joao Marques Sliva (**TAILOR**).
- *Explaining and Repairing Description Logic Ontologies*. Franz Baader, Patric Koopmann, Francesco Kriegel.
- *Learning to act and plan*. Blain Bonet, Hector Geffner (**TAILOR**).
- *Automated Verification of Multi-Agent Systems. Why, What, and Especially: How?* Catalin Dima, Wojtek Jamroga.
- *Continual Learning for Image Classification*. Adrian Popescu.
- *Multi-Objective Reinforcement Learning*. Roxana Radulescu.
- Antonio Di Stasio, Guiseppe Perelli, Shufang Zhu (**TAILOR**). *Game-Theoretic Approach to Planning and Synthesis*.

2.4 The keynote talk and the roundtables at ESSAI & ACAI-2023

As mentioned above a keynote talk was delivered by Jure Leskovec from Stanford University. It took place at the end of the first day, after a full program of lectures and the opening session.



Originally, Jure was invited to give a full-length tutorial at ACAI-2023. The planned topic was *Deep Learning from Relational Data: Graph Neural Networks and Beyond*. However, once the organizers decided that Jure should give a plenary keynote talk, Jure chose the very hot topic of *Foundation Models*.

The first panel (round table) discussion was devoted to the topic of *AI and Society*. It took place on Tuesday. It was moderated by Dino Subašić. The list of the six panellists included the President of the Republic of Slovenia, the local chair and three lecturers of ESSAI & ACAI-2023 and is given below.

- *Nataša Pirc Musar*, President of the Republic of Slovenia
- *Michel Dumontier*, Professor at Maastricht University
- *Tijl De Bie*, Professor at Ghent University
- *Žiga Avsec*, Research scientist at DeepMind
- *Špela Vintar*, Professor at the University of Ljubljana
- *Vida Groznik*, Assistant professor at the University of Primorska, researcher at the University of Ljubljana

The second panel (round table) discussion was devoted to the topic of *AI and Science* and took place on Thursday. It was moderated by Sašo Džeroski and Ljupčo Todorovski, the ACAI chairs. The list of panellists includes the program chair of ESSAI and two lecturers from ACAI, two prominent scientists from Slovenia and the director of the Slovenian funding agency.

- *Julio Banga*, Consejo Superior de Investigaciones Científicas, Pontevedra, Spain
- *Barbara Breznik*, National Institute of Biology, Slovenia
- *Gustau Camps Valls*, University of Valencia, Spain
- *Jernej Fesl Kamenik*, Jožef Stefan Institute and University of Ljubljana, Slovenia
- *Magdalena Ortiz*, Umea University, Sweden
- *Špela Stres*, Slovenian Research and Innovation Agency, Slovenia

3. Organizational Details

3.1. Under the auspices of



ESSAI & ACAI-2023 were organized under the auspices of EurAI and SLAIS. EurAI is the European Association for Artificial Intelligence (formerly ECCAI). It 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. The president of EurAI in the period of organizing the school was Carles Sierra from Spain.



Slovenian AI researchers and practitioners are associated in SLAIS (SLovenian Artificial Intelligence Society). SLAIS was founded in 1992 and is a member society of EurAI. Currently, SLAIS has about 150 members (note that Slovenia has a population of about 2.1 million). At the time of submitting the bid for organizing ESSAI & ACAI-2023, the president of SLAIS was Sašo Džeroski. In the spring of 2024, Aleksander Sadikov became the president of SLAIS.

EurAI and SLAIS shared the financial responsibility for organizing the event. EurAI reserved some funds for financially supporting the school directly. On the other hand, it also provided some travel grants for students from member societies to attend. Applications for these grants were processed by the ESSAI programme committee (chair). Travel support was provided directly to participants.

3.2. Organizing institutions



University of Ljubljana, Faculty of Computer and Information Science. The University of Ljubljana (UL) is the oldest Slovenian university, established in 1919, and celebrated its centenary four years ago. UL has 23 member faculties and three academies with approximately 40,000 students. The Faculty of Computer and Information Science (UL FRI), the host for ESSAI & ACAI 2023, has about 170 personnel and enrolls 1,400 students. Artificial intelligence is by far its strongest research field with 5 active laboratories employing about 60 researchers.

The University of Ljubljana supported the event in many ways. Most importantly, it provided the venue of the event, free of charge. Given the large number of participants, this was extremely important. No less important was the support provided through the work of the members of the local organizing committee.

The University of Ljubljana received support for the event by the TAILOR project. This was provided by TAILORs connectivity fund. Namely, the University of Ljubljana is not a partner of the TAILOR project.

The Jožef Stefan Institute (JSI), host to SLAIS, is the leading Slovenian scientific research institute, covering a broad spectrum of basic and applied research. The staff of more than 1,000 specializes in natural sciences, life sciences and engineering. At JSI, artificial intelligence is represented by three departments with almost 100 researchers between them. These departments have played a major role in organizing many scientific and educational events in AI. JSI is also home to VideoLectures.NET.

JSI supported the school via the work invested in the programme and local organization of the event. It also channeled the originally planned support from the TAILOR project. This allowed for free registrations of 100 TAILOR students.

Finally, JSI also provided financial support for the school, via its Development pillar of financing. It covered the costs of the streaming, recording, postprocessing and hosting of the recorded lectures at VideoLectures.net. It also covered some costs of the PCO, notably costs of handling registrations and travel arrangements of the invited speakers and program chairs.



The University of Primorska is a relatively young and dynamic university, headquartered in Koper, Slovenia. Its Faculty of Mathematics, Natural Sciences, and Information Technologies (UP FAMNIT) is most well known for its mathematics department, but also has a young and ambitious computer science department, where AI is the dominant research field. In 2021 UP FAMNIT hosted The 8th European Congress in Mathematics with over 1,500 attendees.

3.3. Sponsors

The school received support, both financial and in kind, from a number of sponsors, in addition to support from the organizing institutions. The descriptions of the sponsors taken from the school website are given below, with descriptions of the type of sponsorship where appropriate.



TAILOR is an EU project with the aim to build the capacity to provide the scientific foundations for Trustworthy AI in Europe. TAILOR develops a network of research excellence centres,

leveraging and combining learning, optimisation, and reasoning. These will develop systems that are meant to provide descriptive, predictive, and prescriptive approaches to integrating data-driven and knowledge-based approaches.

The idea for ESSAI originated from TAILOR and its interactions with EurAI. Given that EESAI & ACAI-2023 were organized jointly as the Third TAILOR summer school in AI, TAILOR was the major source of financial support for the event. It supported the event via JSI, through the budget planned for the activity of organizing the school. It also supported the event via The University of Ljubljana, which received support from TAILOR's connectivity fund, aimed at growing the network.



The Artificial Intelligence journal (AIJ) is the long-standing 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 provided financial support for the event.



CLAIRE. Launched in 2018 and with over 450 members from across AI research and innovation in Europe, CLAIRE (Confederation of Laboratories for Artificial Intelligence Research in Europe, claire-ai.org) is an organization created by the European AI community that seeks to strengthen European excellence in AI research and innovation, with a strong focus on human-centred AI. CLAIRE aims to establish a world-wide brand recognition for "AI made in Europe" (at the level of CERN), and to position Europe in control of its own future. CLAIRE provided financial support for the event.



The European Space Agency (ESA) is Europe's gateway to space. Its mission is to shape the development of Europe's space capability and ensure that investment in space continues to deliver benefits to the citizens of Europe and the world. ESA provided financial support for the event.



AIDA, the international AI Doctoral Academy has been created for offering access to knowledge and expertise and attracting PhD talents in Europe. It is a joint instrument of five EU projects/networks, aiming to support a world-level AI education and research programme. Its goals are: 1) Coordination of the PhD/postdoc educational and training activities on AI of AIDA partners.

2) Aiming high to become a world-level reference for anything related to AI education (and research). 3) Defining mechanisms to create inter-university sharing of educational assets in the area of PhD-level AI. 4) Envisage future efforts towards a charter for European universities to share, accredit, and recognise, PhD education credits in the area of AI. AIDA supported the event by advertising it through its network of students (potential participants of ESSAI & ACAI-2023).



Ljubljana Tourism is a destination management organization established by the City of Ljubljana. Ljubljana Tourism fosters the development and undertakes the promotion of tourism in Ljubljana and the Ljubljana region in conjunction with tourism providers. It provided in-kind support for the event.



Ljubljanski potniški promet d.o.o. The most important task of the public company Ljubljanski potniški promet d.o.o. is to provide safe, reliable and smooth-running public transport in the area of the entire City Municipality of Ljubljana and sixteen suburban municipalities. Their wish and goal is to make sure that buses become the best alternative to private cars since in this way we can remove private vehicles from urban areas to ensure a healthy environment for future generations. It provided in-kind support for the event (free public transport for all event participants).



SPIRIT Slovenia is a Slovenian public agency. Its chief tasks include promotion of Slovenia's companies abroad as well as promoting Slovenia's advantages as an FDI location. SPIRIT Slovenia helps both Slovenian companies to increase their exports and international companies to invest and expand in Slovenia and beyond. It provided in-kind support for the event.

3.4. Advertisement and registration fees

The event was visually branded through a logo that appeared on the website of the event and all advertisement materials. It was used on posters promoting the schools and individual lectures. It was also used on the promotional materials that participants received (T-shirts, bags, notepads, water bottles, ...).



ESSAI & ACAI 2023
LJUBLJANA, SLOVENIA

A broad and systematic effort was made to advertise the event. The first line followed EurAI fellows and member societies. The contacts of the member societies (presidents, secretaries) were asked to advertise the event to their memberships.

Another major avenue followed contacts from the TAILOR project (e.g. industrial partners). Of high importance was also advertisement to CLAIRE via its mailing lists. Representatives of TAILOR and CLAIRE (Lena Tasse, Alexa Kodde) were included in the organization committee as persons in charge of communication.

The call for course proposals and call for participation were distributed through the above channels. In addition, many mailing lists in the areas of artificial intelligence and machine learning were used to distribute them. Special effort was made to distribute the calls through local mailing lists, scientific institutions and the collaboration networks of the organizers and the organizing institutions, in order to boost local participation.

The website (essai.si) was a primary medium of providing information about the school and attracting participants. In addition, the local organizers made special efforts to promote the event via social media. Facebook and LinkedIn were primarily used for this purpose. Posters were created, starting with an overall poster of the event. However, special posters were created for each lecture of ESSAI & ACAI and these were gradually released through posts on social networks.

REGISTER NOW

1st European Summer School on Artificial Intelligence (ESSAI) & 20th Advanced Course on Artificial Intelligence (ACAI)

Organised jointly as 3rd TAILOR Summer School on AI

24 - 28 July 2023 in LJUBLJANA, SLOVENIA

34 courses & tutorials at different levels (introductory, foundational & advanced)

7 parallel sessions on various topics of AI

200+ attendees - great opportunity for networking with your peers from around the world.

50+ leading experts from top international universities and research institutes, e.g. **Stanford, Yale, Cambridge, Oxford, CNRS, KU Leuven, Washington, Sapienza, TU Darmstadt**, and companies, e.g. **Google Deep Mind, Microsoft, VMware**, etc.

3 social events

Register at: <https://essai.si>

Register at: essai.si

LARGE LANGUAGE MODELS: BACKGROUND AND APPLICATIONS

MICHAEL ROTH
DFG Emmy Noether

IVAN VULIĆ
University of Cambridge

24 - 28 July 2023 at 11 am - 12.30 pm

Large language models (LLMs) have revolutionized the field of natural language processing in recent years, enabling machines to produce human-like language and perform tasks such as translation, sentiment analysis, and question answering. However, understanding the inner workings of LLMs and their implementation can be intimidating for beginners. In this course, we will explore different variants of LLMs, focusing on transformer-based models such as BERT, GPT, and RoBERTa, and their specific use cases. We will cover the basic components of these LLMs and their architecture, the pre-training and fine-tuning process, as well as applications. The course will provide step-by-step guidance on how to use different LLMs, based on implementations in Python and existing libraries. Along the way, we will also discuss ethical considerations and limitations. Finally, a tutorial on Friday will cover more advanced topics such as modularity and parameter efficiency, as well as the use of LLMs in multilingual and multimodal setups.

1st European Summer School on Artificial Intelligence (ESSAI)

3rd TAILOR Summer School on Artificial Intelligence

The overall poster of the ESSAI & ACAI-2023 event and a poster advertising one of the ESSAI courses (on large language models).

The registration fees for on-line participation was set to 220 € The registration fees for in-person participation at the event were divided into three categories: Student, Academia and Other. Three different scales were applied, according to when the registration was made: Early bird, Regular and Late fee. This resulted in nine different prices for registration.

The registration rates for students were as follows.

- Early bird: 400 €
- Regular: 500 €
- Late fee: 600 €

The registration fees for academia were as follows.

- Early bird: 550 €
- Regular: 650 €
- Late fee: 750 €

The registration fees for other participants (e.g. from industry) were as follows.

- Early bird: 900 €
- Regular 1000 €
- Late fee: 1100 €

To promote cross-fertilization with ESSLI, which was the role model for ESSAI, and boost local participation (from Slovenia), we offered the following discounts:

- 50€ for ESSLI attendees
- 10% for University of Primorska students and employees
- 10% University of Ljubljana students and employees
- 20% Faculty of Computer and Information Science students and employees
- 20% Jozef Stefan Institute employees

The discounts were very effective and more than 100 participants from Slovenia attended the event. Participation from the University of Ljubljana reached cca 40 persons. Participation from the Jozef Stefan Institute exceeded 50 persons.

3.5. Organizers

The team that contributed to organizing ESSAI & ACAI-2023 includes the people listed below.

ESSAI Programme Chairs

- *Magdalena Ortiz*, Umeå University (chair)
- *Brian Logan*, Utrecht University (co-chair)
- *Sašo Džeroski*, Jožef Stefan Institute (co-chair)

ESSAI Programme Committee (Area chairs)

- *Natasha Alechina*, Utrecht University
- *Kristian Kersting*, TU Darmstadt
- *Peter Flach*, University of Bristol
- *Ioannis Kompatsiaris*, CERTH-ITI
- *Roberto Navigli*, Sapienza University of Rome
- *Ann Nowé*, Vrije Universiteit Brussel
- *Alessandro Saffiotti*, University of Örebro
- *Sungho Sun*, DFKI

ACAI Programme Chairs

- *Sašo Džeroski*, Jožef Stefan Institute
- *Ljupčo Todorovski*, University of Ljubljana

Local Organization Chairs:

- *Vida Groznik*, University of Primorska, University of Ljubljana (chair)
- *Aleksander Sadikov*, University of Ljubljana (co-chair)

Local Organization Committee:

- *Sašo Džeroski*, Jožef Stefan Institute
- *Jure Žabkar*, University of Ljubljana
- *Marta Malavolta*, University of Ljubljana
- *Andrea De Gobbi*, NEUS Diagnostics d.o.o.

Communications

- *Lena Tasse*, TAILOR
- *Alexa Kodde*, CLAIRE

ESSAI Standing Committee Chair

- *Giuseppe De Giacomo*, Sapienza University of Rome

TAILOR representative

- *Peter Flach*, University of Bristol

4. Participants

4.1. Lecturers

Exactly 60 lecturers gave presentations at the school. Their names and affiliations are listed below.

ACAI lecturers:

1. Nathan Kutz, University of Washington
2. Julio Rodriguez Banga, MBG-CSIC
3. Roger Guimerà, Universitat Rovira i Virgili
4. Gustau Camps-Valls, Universitat de Valencia
5. Ross King, University of Cambridge and Chalmers University
6. Ziga Avsec, DeepMind
7. Clare Bycroft, DeepMind
8. Pat Langley, Stanford University
9. Arman Cohan, Yale University
10. Claudio Zeni, Microsoft Research
11. Vedran Dunjko, Leiden University
12. Larisa Soldatova, University of London
13. Michel Dumontier, Maastricht University

ESSAI lecturers:

14. Michael Roth, DFG Emmy Noether
15. Ivan Vulic, University of Cambridge
16. Devendra Dhami, TU Darmstadt
17. Matej Zečević, TU Darmstadt
18. Adèle Helena Ribeiro, University of Marburg

19. Alexey Ignatiev, Monash University
20. Nina Narodytska, VMware Research
21. Joao Marques-Silva, CNRS
22. Srdjan Vesic, Computer Science Research Institute of Lens
23. Dragan Doder, Utrecht University
24. Richard Dinga, Tilburg University
25. Adrian Popescu, CEA LIST
26. Catalin Dima, Université Paris-Est Créteil
27. Wojtek Jamroga, Polish Academy of Sciences
28. Antonio Di Stasio, University of Oxford
29. Giuseppe Perelli, La Sapienza
30. Shufang Zhu, University of Oxford
31. Tijl De Bie, Ghent University
32. Maarten Buyt, Ghent University
33. Nicola Gigante, Free University of Bozen-Bolzano
34. Bruno Lacerda, University of Oxford
35. Nick Hawes, University of Oxford
36. Dave Parker, University of Oxford
37. Marius Lindauer, Leibniz University Hannover
38. Katharina Eggersperger, University of Tübingen
39. Roxana Rădulescu, Vrije Universiteit Brussel
40. Sebastijan Dumančić, TU Delft
41. Robin Manhaeve, KU Leuven
42. Giuseppe Marra, KU Leuven
43. Robert Peharz, Graz University of Technology
44. Antonio Vergari, University of Edinburgh
45. Panče Panov, Jožef Stefan Institute
46. Martin Mundt, Technical University of Darmstadt
47. Roman Barták, Charles University
48. Franz Baader, Technische Universität Dresden
49. Patrick Koopmann, Vrije Universiteit Amsterdam
50. Francesco Kriegel, Technische Universität Dresden
51. Mario Alviano, University of Calabria
52. Francesco Ricca, University of Calabria
53. Tome Eftimov, Jožef Stefan Institute
54. Peter Korošec, Jožef Stefan Institute
55. Timothy Wile, RMIT University
56. Blai Bonet, Pompeu Fabra University
57. Hector Geffner, RWTH Aachen University
58. Marco Zullo, University of Groningen
59. Matias Valdenegro-Toro, University of Groningen

Keynote lecturer:

60. Jure Leskovec, University of Stanford

4.2. TAILOR students

Free registration was offered to PhD students from TAILOR partners, in recognition of the major sponsorship provided by TAILOR. Exactly 100 TAILOR students registered for the event. Below we give the numbers of such students grouped by the TAILOR partners that supported their attendance at the school.

1. LiU: Linköping University, Sweden: 1 student
2. CNR: Consiglio Nazionale delle Ricerche, Italy: 1 student
3. INRIA: Institut national de recherche en informatique et en automatique, France: 3 students
4. UCC: University College Cork, Ireland: 2 students
5. KUL: KU Leuven, Belgium: 5 students
6. UOR: University of Rome, Italy: 5 students
7. LEU: Leiden University, The Netherlands: 2 students
8. IST-UL: Instituto Superior Técnico, University of Lisbon, Portugal: 5 students
9. UPF: Universitat Pompeu Fabra, Spain: 2 students
10. UNIBO: Università di Bologna, Italy: 2 students
12. TUE: Eindhoven University of Technology, The Netherlands: 5 students
13. CNRS-IRIT: Centre national de la recherche scientifique, Institut de Recherche en Informatique de Toulouse, France: 3 students
14. JSI: Jožef Stefan Institute, Slovenia: 5 students
15. TUDA: Technische Universität Darmstadt, Germany: 4 students
16. UNIBRIS: University of Bristol, United Kingdom: 4 students
20. VUB: Vrije Universiteit Brussel, Belgium: 2 students
21. CUNI: Charles University, Czech Republic: 3 students
24. CVUT: Czech Technical University, Czech Republic: 3 students
25. TUD: Delft University of Technology, The Netherlands: 5 students
26. DFKI: Deutsches Forschungszentrum für Künstliche Intelligenz, Germany: 5 students
28. FBK: Fondazione Bruno Kessler, Italy: 1 student
31. IIIA-CSIC: Institut d'Investigació en Intel·ligència Artificial, Consejo Superior de Investigaciones Científicas, Spain: 2 students
33. UOA: University of Athens, Greece: 3 students
34. NEO-UMA: Networking and Emerging Optimization, University of Malaga, Spain: 1 student
35. PUT: Poznan University of Technology, Poland: 2 students

36. RWTH: RWTH Aachen University, Germany: 2 students
37. CINI: Consorzio Interuniversitario Nazionale per l'Informatica, Italy: 4 students
38. slovak.AI, Slovakia: 5 students
40. UniPI: Università di Pisa, Italy: 3 students
41. UGA: Université Grenoble Alpes, France: 3 students
43. UPV: Universitat Politècnica de València, Spain: 5 students
50. ICL: Imperial College London, United Kingdom: 1 student
54. Bosch: 1 student

4.3. Certificates of attendance

All registered participants that attended the event received a certificate of participation. The certificate was signed by the ESSAI programme chair, ACAI programme chair and the chair of the Local organizing committee. An example attendance certificate is included below.



An example certificate of attendance, completed and signed by the chairs of the event.

Appendices

- A. The Ljubljana bid for organizing ESSAI & ACAI-2023
- B. The ESSAI – 2023 call for course proposals
- C. The ACAI tutorials (Lecturers, Titles & Abstracts)
- D. The ESSAI courses (Lecturers, Titles & Abstracts)

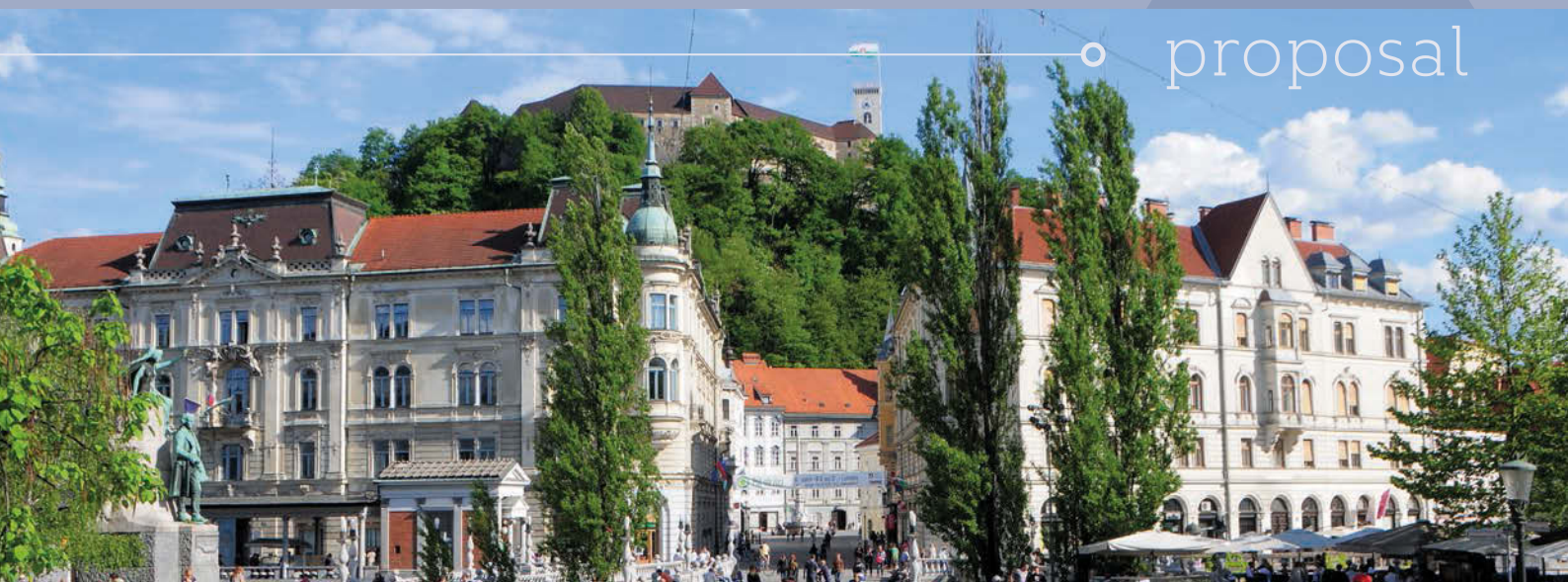


ESSAI & ACAI 2023

Ljubljana, Slovenia



proposal





○ ESSAI & ACAI 2023 in Ljubljana, Slovenia

Why should ESSAI & ACAI 2023 take place in Slovenia?

By **Vida Groznik & Aleksander Sadikov**,
Co-Chairs of the Organizing Committee

This is an official proposal for hosting ESSAI & ACAI 2023, the very first edition of the European Summer School on Artificial Intelligence and the 20th edition of the Advanced Course on Artificial Intelligence in Ljubljana, Slovenia. **Why should this landmark event take place in Slovenia?**

- 1** We make this bid in 2022, a year that represents two important milestones for AI research in Slovenia. The more important one is the **50th anniversary of AI research in Slovenia**, which began in 1972 at the Computer Science Department of the Jožef Stefan Institute (JSI) in Ljubljana. An additional milestone is the **30th anniversary of the Slovenian Artificial Intelligence Society (SLAIS)**.
- 2** This presents **a great opportunity for the junior European AI community to visit and get to know Slovenia** and its AI community. Although small in size, Slovenia has hosted ACAI 2005 and many other renowned AI conferences, such as IFIP 1971, EWSL 1987 (predecessor of ECML), ICML 1999, ILP 1999, ECML PKDD 2009, AIME 2011, Discovery Science 2014, LREC 2016, and a number of smaller conferences and workshops.
- 3** ESSAI & ACAI 2023 will be **co-located with** the well established **34th European Summer School in Logic, Language and Information (ESSLLI)** which will take place at the same location right after the ESSAI & ACAI school. This will be a great opportunity for the attendees of both schools to extend their stay in Ljubljana and also attend the co-located event.
- 4** Slovenia resides at the **heart of Europe**, where diverse cultures intertwine. Its character is influenced by its position amidst the Pannonian plains, the Julian Alps, and the Mediterranean coast. The intersections of culture and geography make Slovenia a welcoming host to visitors from anywhere in the world.
- 5** We propose to organise ESSAI & ACAI 2023 in Ljubljana, the charming capital city of Slovenia, where **everything is within walking distance**. This would be a unique opportunity to convert Ljubljana into a youth artificial intelligence capital for a week.

SLOVENIAN ARTIFICIAL INTELLIGENCE COMMUNITY

This bid is put forward by **the Slovenian Artificial Intelligence Society (SLAIS)**, a member society of EurAI. The bid is seconded by the **University of Ljubljana** (Faculty of Computer and Information Science), the **University of Primorska** (Faculty of Mathematics, Natural Sciences, and Information Technologies), and the **Jožef Stefan Institute**.

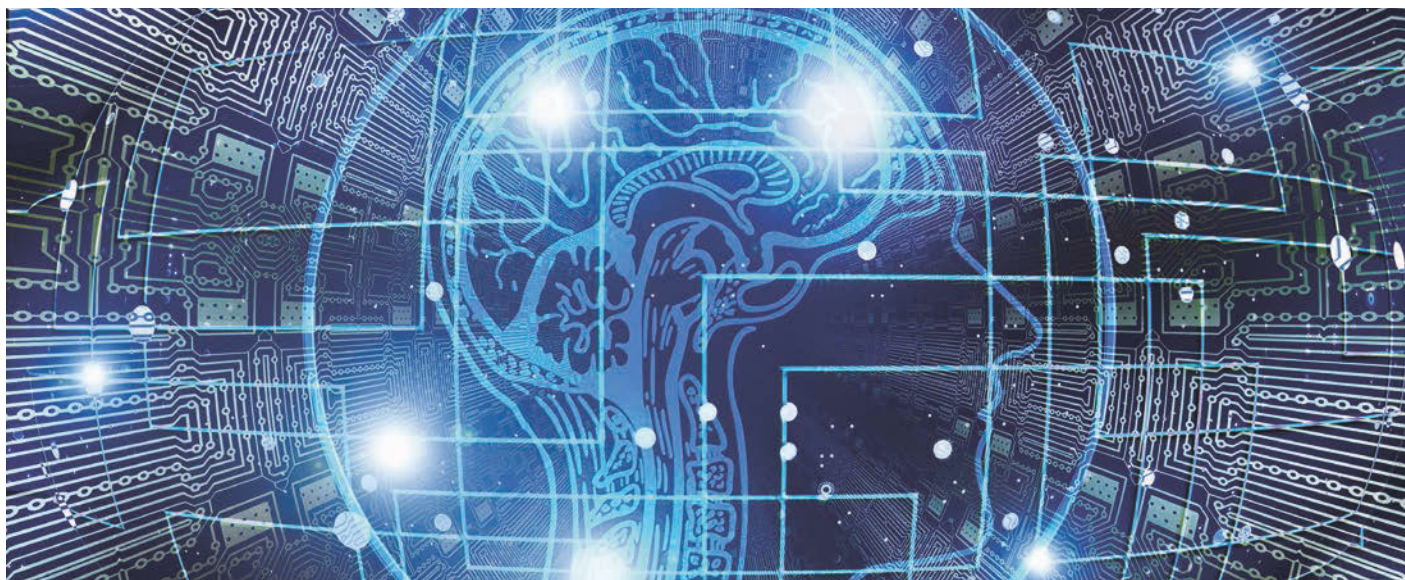


Artificial intelligence **research in Slovenia started in 1972** at the Jožef Stefan Institute (JSI) after the 5th IFIP (International Federation for Information Processing) Congress that was also held in Ljubljana. A few years later, first the AI Group was established at JSI, and soon after the AI Laboratory was founded at the University of Ljubljana, Faculty of Computer and Information Science. Both research groups were **led by Professor Ivan Bratko**. Since these early days, AI research in Slovenia has steadily grown over the years. According to SICRIS (Slovenian Current Research Information System), there are now **more than 30 research groups** in Slovenia whose research is related to AI.

Slovenian AI researchers and practitioners are associated in SLAIS (Slovenian Artificial Intelligence Society). **SLAIS was founded in 1992** and is a member society of EurAI, The European Association for Artificial Intelligence. Currently, SLAIS has about **150 members**. To put this number in context, note that Slovenia has a population of about 2.1 million.

Slovenian AI researchers are active in diverse fields of AI, and have, along scientific papers, authored many books and AI software over the years. The most important in view of this bid is the organizing experience of the community. Over the years, SLAIS or its members have organized many international events from small workshops and summer schools to major conferences. To date the most important ones have been: EWSL 1987 (predecessor of EMCL), ICML 1999, ECML/PKDD 2009 (organized in Croatia), 2009 (in Bled, Slovenia), and 2017 (in Macedonia).

This year (2022) is a very significant **double milestone for artificial intelligence research** in Slovenia. It marks **half a century since 1972, when AI research in Slovenia started**, and is the **30th anniversary of SLAIS**. The Slovenian AI community would be immensely honoured to welcome the European and global AI community at ESSAI & ACAI 2023 in Ljubljana!



ABOUT THE ORGANIZERS

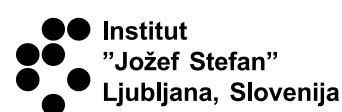
Participating institutions

The University of Ljubljana (UL) is the oldest Slovenian university, established in 1919, and celebrated its centenary three years ago. UL has 23 member faculties and three academies with approximately 40,000 students. The Faculty of Computer and Information Science (UL FRI), the proposed host for ESSAI & ACAI in this bid, has about 170 personnel and enrolls 1,400 students. Artificial intelligence is by far its strongest research field with 5 active laboratories employing about 60 researchers.

The Jožef Stefan Institute (JSI), host to SLAIS, is the leading Slovenian scientific research institute, covering a broad spectrum of basic and applied research. The staff of more than 1,000 specializes in natural sciences, life sciences and engineering. Artificial intelligence is represented by three departments with almost 100 researchers between them. These departments have played a major role in organizing many scientific and educational events in AI. JSI is also home to **VideoLectures.NET**.

The University of Primorska is a relatively young and dynamic university, headquartered in Koper, Slovenia. Its Faculty of Mathematics, Natural Sciences, and Information Technologies (UP FAMNIT) is most well known for its mathematics department, but also has a young and ambitious computer science department, where AI is the dominant research field. In 2021 UP FAMNIT hosted The 8th European Congress in Mathematics with over 1,500 attendees.

Univerza v Ljubljani



Core local organizing committee

Aleksander Sadikov (University of Ljubljana)

Vida Groznik (University of Primorska, University of Ljubljana)

Sašo Džeroski (Jožef Stefan Institute)

Jure Žabkar (University of Ljubljana)

The core organizing committee is a **mixture of youth and experience**. Its members come from all three involved organizations and all are members of SLAIS. In the past they were either **in charge or helped organize** the following events: ECML-PKDD 2017 (600 delegates), CAiSE 2016 (Conference on Advanced Information Systems Engineering; approx. 300 delegates, held at UL FRI), Encompassing Computer Science Workshop 2015 (held at UP FAMNIT), Discovery Science 2014, Qualitative Reasoning Workshop 2009, ECEM/EAML 2004 (European Conference on Ecological Modelling), and Information Society Multiconference (annual Slovenian conference with international attendance held at IJS). Vida Groznik **was head of UL FRI's public relations and event organization office** with a yearly budget of approximately 100,000 EUR. She also helped organizing the 8th European Congress in Mathematics with over 1,500 delegates in 2021 at UP FAMNIT.

The local organizing committee will be **extended with active SLAIS members** in case the bid is successful. The committee has also enlisted the **professional support** of their colleague, Mr. Janoš Kern, director of Imago Sloveniae Foundation. Mr. Kern has more than 30 years of experience in organizing free public cultural events and large international conferences.



○ Ljubljana, Slovenia



LOCATION

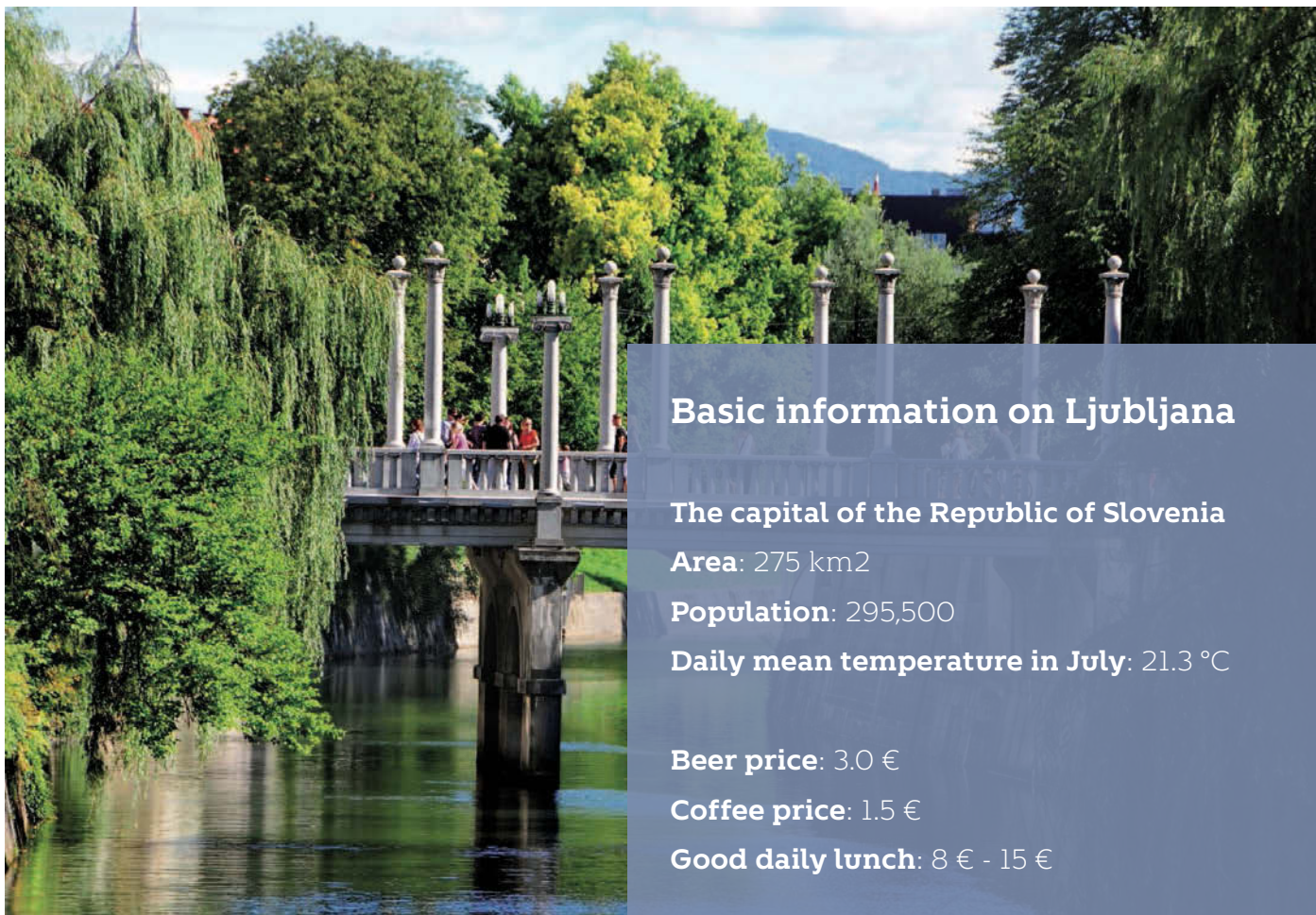
The Republic of Slovenia is located in southern Central Europe. It is part of the European Union. Ljubljana, the proposed host city lies in the center of Slovenia, which is known for its diverse landscape and nature.

Both its residents and numerous visitors perceive Ljubljana as a city built on a human scale. Despite the fact that it ranks among the mid-sized European cities, it has preserved its small-town friendliness and, at the same time, has everything that all the larger capitals have.



European Green Capital

Ljubljana was the **European Green Capital 2016**. It is a city with a green soul and a sustainable vision of development. It has excellently preserved green spaces and nature even in the heart of the city centre.



Basic information on Ljubljana

The capital of the Republic of Slovenia

Area: 275 km²

Population: 295,500

Daily mean temperature in July: 21.3 °C

Beer price: 3.0 €

Coffee price: 1.5 €

Good daily lunch: 8 € - 15 €

Modern services

- The **WiFree Ljubljana** wireless network allows visitors to Ljubljana city centre to use **free wireless internet for up to 60 minutes a day**. The holders of the Ljubljana Tourist Card can enjoy 24-hour free access to the WiFree Ljubljana network.
- The **BicikeLJ bicycle-sharing system** offers hiring bikes from self-service terminals located across the wider Ljubljana city center. Hiring of BicikeLJ bikes is **free of charge** if you return a hired bicycle to the nearest docking station within an hour..
- Ljubljana's four **electric-powered vehicles named "Kavalir" (eng. gentleman) are a free city centre public transport option** friendly both to people and the environment. Kavalirs run around the pedestrianized historical city center at a speed slow enough to allow you to hail them anywhere on the street.
- Ljubljana is a city which can be proud of its clean drinking water. While rambling the streets of Ljubljana, you can **quench your thirst for free at public drinking fountains**, which operate from April to October.
- **Several car sharing systems** with their vast fleet of electrical vehicles is available throughout Ljubljana. Some also have a drop-off/pick-up location at the Ljubljana airport.
- **Electric scooters and electric bicycle hiring systems** are becoming very popular in Ljubljana as an affordable and green transportation around the city.

Safety

Slovenia is **one of the safest countries in the world**. It is safe to walk anywhere in Ljubljana at any time of the day and night. At worst, there are occasional incidents of purse snatching and pickpocketing in the tourist areas, but even these occur at a much lower rate than in other capital cities.



Summer festivals

Ljubljana is well known for its **rich offering of festivals**, which contribute significantly to the cultural life of Ljubljana in the summer. The festivals offer a rich program of concert, opera, and ballet events, featuring internationally renowned artists, including some of the world's most recognised names in music and performing arts. Festival events are held at a number of venues in Ljubljana and its surrounding areas and the majority of them are **free to attend**.

We have already arranged with one of the concert organizers to hold the **majority of its free concerts to coincide with the ESSAI & ACAI school**. This will provide our attendees with additional opportunities for cultural experiences.

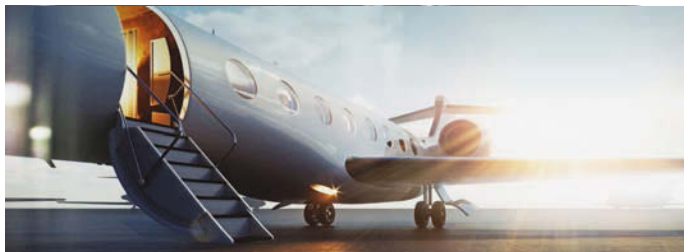
Tours

Slovenia, albeit only spanning 20,273 sq. km, is very geographically varied, from the **seaside** in the south, the **Karst region with vast UNESCO-protected underground caves**, the **Alps** (highest peak Triglav; 2,864m) and idyllic **mountainous lakes** in the north, to the **Pannonian plains** in the northwest. Ljubljana is located in the very middle of the country and tours from Ljubljana offer different and interesting possibilities, at most an hour's drive away. The country has a rich history and boasts an array of **medieval castles** scattered across it.

A list of recommended tours can be found on page 22.

TRAVEL

Ljubljana has good connections with foreign countries. It is served by its own **airport, located 20 minutes from Ljubljana**, as well as by trains and buses. Travellers from the east or west coast of the USA usually need to make **one plane transfer**, whereas travellers from Australia or Asia need to change planes twice (to get to the Ljubljana airport) or once (to get to nearby airports in Venice or Vienna).



By air

The Ljubljana airport at Brnik (Jože Pučnik Airport) is about 25 km North-West from the center of Ljubljana. It has good connections with other European airports and is serviced by **major European and other international airlines** (Air France, Lufthansa, Swiss, LOT, Turkish Airlines), and **low-fare carriers** (Fly Dubai).

Ljubljana airport has **direct flights to:** Amsterdam, Belgrade, Brussels, Dubai, Frankfurt, Istanbul, London, Munich, Niš, Paris, Podgorica, Warsaw, Zurich (*more destinations available in the summer months).

Several airports within reasonable distance to Ljubljana are served by low-fare carriers. Favourably priced scheduled transfers from these airports and Ljubljana Jože Pučnik Airport can be booked through the website at GoOpti.com.

More info: www.lju-airport.si/en

Distance from Ljubljana to other airports

Airport Klagenfurt, Austria: 85 km
Airport Trieste, Italy: 130 km
Airport Zagreb, Croatia: 140 km
Airport Graz, Austria: 187 km
Airport Venice, Italy: 230 km



By road

Ljubljana is located at the **crossroads of Slovenia's most important road routes**. Motorway access from any of the neighbouring countries is very easy. Ljubljana is located **2.5 hours drive from Venice, Italy and 3.5 hours drive from Vienna, Austria**.

Road tax vignettes must be purchased for the use of Slovenian motorways, including the Ljubljana bypass/ringroad. The roads where the vignette is required are marked by special vignette signs. Vignettes can be purchased at petrol stations located in the border areas of Slovenia's neighbouring countries, at petrol stations, post offices and most newspaper kiosks in Slovenia, at branch offices of the Automobile Association of Slovenia (AMZS) and online at <https://evinjeta.dars.si/en>.



By bus

The Ljubljana Bus Station has regular services to all of Slovenia's **neighbouring countries**, as well as to the most popular **tourist destinations within the country**. Bus tickets can be purchased at the counter of the Ljubljana Bus Station or online from its website.

European cities served by direct bus routes from Ljubljana: Trieste, Venice (Mestre, Marco Polo Airport), Florence, Milan, Klagenfurt, Vienna, Munich, Dortmund, Paris, Budapest, Zagreb, Sarajevo, Belgrade, Niš, Sofia, and more.

Major Slovenian tourist destinations served by direct bus routes from Ljubljana: Bled and Bohinj lake resorts, Postojna cave, the coastal towns of Portorož and Piran.



By rail

Ljubljana has good railway links with all large European cities. The railway station is **in the center of Ljubljana**. Train travel within Slovenia is convenient and inexpensive.

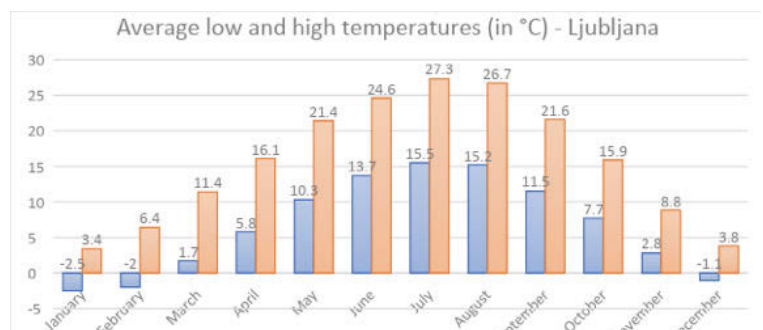
More info: www.slo-zeleznice.si/en/

PROPOSED DATES OF THE SCHOOL

We propose to hold the ESSAI & ACAI 2023 between **24 July and 28 July 2023**. In this way, the school will be **co-located with ESSLLI 2023** school which will be held at the same location between 31 July and 11 August 2023. We are in contact with the organiser of the ESSLLI 2023. There are no special or local holidays at that time. There will be cultural and concert activities in Ljubljana as is usual for the summer. These do not conflict with the school, but rather add to the general vibrant mood of the city.

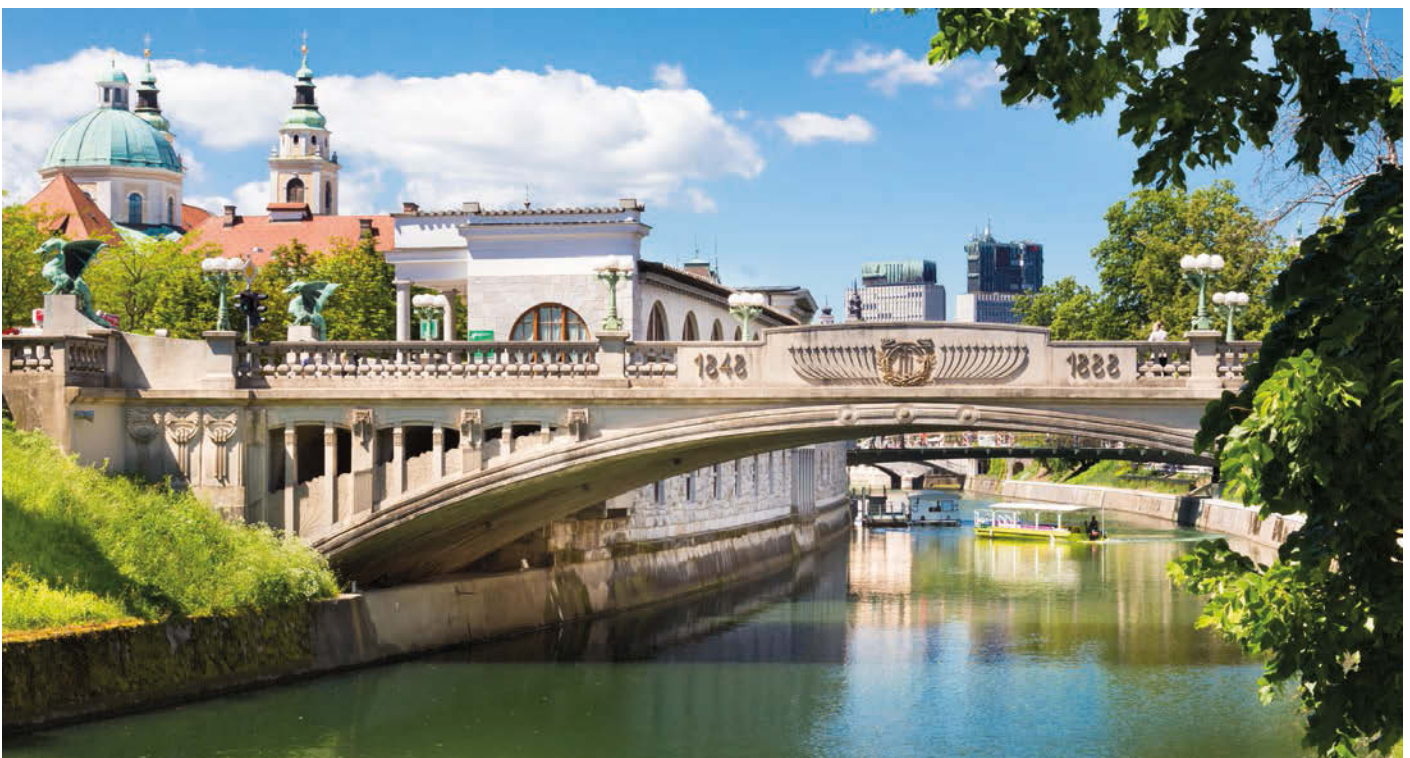
CLIMATE/SEASON

The climate in Ljubljana in mid-July is **warm**. It is especially nice in the evening along the river in the old city centre. The **average high temperature is 27.3°C** and the **average low temperature is 15.5°C**; **daily mean is 21.3°C**. In summer, the weather in the city is under the influence of Mediterranean air currents, so summers are sunny and warm. In July the average sunrise is at 5.30am and the sunset just before 9pm.



Ljubljana is a **one hour drive from the seaside**.

The average **sea temperature** in July and August is **25°C**.



ESSAI & ACAI VENUE

We propose to host the ESSAI & ACAI 2023 **at the University of Ljubljana's Faculty of Computer and Information Science (UL FRI)** which has already approved its support.

Workshops and tutorials venue

The faculty (UL FRI) enrolls about 1,400 students. It has just recently (2014/2015) built its own **modern building**. It offers a wide variety of air conditioned classrooms, all equipped with **state-of-the-art AV equipment**, including at least **two overhead projectors, wireless internet (eduroam), whiteboards, and plenty of electricity sockets for notebook computers**. The faculty has two large lobbies where the participants can mingle and network, interspersed with a plenty of small cosy workspaces equipped with electricity, and a spacious terrace with benches just outside the main entrance.



UL FRI in numbers:

- **three large auditoriums** (300, 200, and 100 seats, respectively),
- **five medium size classrooms** (50-60 seats),
- **four smaller classrooms** (30-40 seats),
- **12 computerized classrooms** (18-30 computers each, one to two seats per working space; can be emptied if necessary), and
- **cafeteria which can sit 400 people** and will be offering lunch to the attendees.

All classrooms are **located on the ground floor and are disabled-friendly**. The other two floors contain mainly laboratory space, offices, and some smaller meeting rooms. The cafeteria can be reached also using an elevator.

The faculty's Governing Board has approved the use of all facilities free of charge.

The floor plans of the faculty can be found in the appendix.

If necessary the **adjoining Faculty of Chemistry and Chemical Engineering (UL FKKT) would offer additional modern classrooms**. UL FRI and UL FKKT share the glass middle building, containing the joined entrance, cafeteria, two-story library, and a large auditorium. The two faculties are connected with a wide glass bridge through the middle building and architecturally act as a single unit.

UL FKKT in numbers; excluding the shared facilities with UL FRI:

- **one large auditorium** (200 seats),
- **four large classrooms** (100 seats),
- **four medium sized classrooms** (60 seats), and
- **nine small classrooms** (35-45 seats).

All the classrooms have the **same level of AV equipment as UL FRI**.

SOCIAL EVENTS

Welcome reception

The welcome reception will be held in front of the school's main venue on its big open-air platform. The location is ideal for hanging out in a relaxed atmosphere in the summer evenings from where the attendees can observe the colorful sunset. We will offer fingerfood to present local cuisine along with local wines and non-alcoholic beverages.

Social dinner

The social dinner will be held at the **Union Pub** where modern Slovenian cuisine meets a selection of more than 10 different **draft beers**. The Union Pub is **located at the Pivovarna Union brewery** and represents the union between the modern world and tradition, brought together by a great pub atmosphere. Different events every month are accompanied by Union Selection - a special weekly brewer's choice of beers, prepared exclusively for the Union Pub.

In case student attendance in-person exceeds 400 participants, we propose the **"Kino Šiška" Center of Urban Culture** as an alternative venue for the social dinner. It can host up to 1,132 standing room or 560 seats (a mixed arrangement would probably be implemented).



ESSAI & ACAI PROGRAM

While ACAI has a long tradition and is organized bi-annually, this would be the first edition of ESSAI. The European Summer School on Artificial Intelligence will hopefully become a tradition and be organized annually. In its organization, ESSAI will follow the model of ESSLLI, the European Summer School in Language, Logic and Information. Note that ESSLLI-2023 would be organized in Ljubljana, immediately after the proposed ESSAI & ACAI 2023 event, and will last for two weeks.

The longer term ambition is that ESSAI would also be a two-week event, with a larger number of courses. However, ESSLLI is an event with a very long tradition (the 2023 edition is the 34th edition of the event). For its first edition, **we propose that ESSAI is a one-week event.**

ESSAI and ACAI 2023 will be organized as a single event with six parallel tracks. One of these tracks will be ACAI-2023, The Advanced Course on Artificial Intelligence. A schema of the program structure of the event is given below.

Monday, 24. 7. 2023	Tuesday, 25. 7. 2023	Wednesday, 26. 7. 2023	Thursday, 27. 7. 2023	Friday, 28. 7. 2023
ACAI	ACAI	ACAI	ACAI	ACAI
ESSAI - Track 1	ESSAI - Track 1	ESSAI - Track 1	ESSAI - Track 1	ESSAI - Track 1
ESSAI - Track 2	ESSAI - Track 2	ESSAI - Track 2	ESSAI - Track 2	ESSAI - Track 2
ESSAI - Track 3	ESSAI - Track 3	ESSAI - Track 3	ESSAI - Track 3	ESSAI - Track 3
ESSAI - Track 4	ESSAI - Track 4	ESSAI - Track 4	ESSAI - Track 4	ESSAI - Track 4
ESSAI - Track 5	ESSAI - Track 5	ESSAI - Track 5	ESSAI - Track 5	ESSAI - Track 5

ESSAI & ACAI 2023 is planned as an in-person event. It is intended that lecturers will be present in-person in Ljubljana, as well as a sizable audience (200-400 attendees). We also intend to live-stream the lectures and allow for a much larger audience to follow the lectures. In the case of unfavorable epidemiological situation, a hybrid or on-line mode can be easily adopted, given that we are making plans for live streaming (as well as recording) of the lectures.

The **topic of ACAI-2023** will be **Artificial Intelligence for Science**. A description of the theme of the Course and a tentative list of topics to be covered is given below. The ACAI-2023 Course will comprise **ten half-day tutorials**, each consisting of two 90 min sessions. One or two tutorials for each of the listed topics will be included. A potential list of lecturers that could give tutorials on each of the topics is also provided. The structure of ACAI-2023 is schematically shown below.

ACAI	Monday	Tuesday	Wednesday	Thursday	Friday
9.00 - 10.30	ACAI T1 - 1/2	ACAI T3 - 1/2	ACAI T5 - 1/2	ACAI T7 - 1/2	ACAI T9 - 1/2
coffee break					
11.00 - 12.30	ACAI T1 - 2/2	ACAI T3 - 2/2	ACAI T5 - 2/2	ACAI T7 - 2/2	ACAI T9 - 2/2
lunch break					
14.00 - 15.30	ACAI T2 - 1/2	ACAI T4 - 1/2	ACAI T6 - 1/2	ACAI T8 - 1/2	ACAI T10 - 1/2
coffee break					
16.00 - 17.30	ACAI T2 - 2/2	ACAI T4 - 2/2	ACAI T6 - 2/2	ACAI T8 - 2/2	ACAI T10 - 2/2

The **ESSAI School will have five parallel tracks. Each will comprise four courses**, each consisting of five 90 min sessions (one on each day during the week). Thus a **total of 20 courses** will be included in ESSAI. The structure of ESSAI-2023 is schematically shown below.

ESSAI Track N	Monday	Tuesday	Wednesday	Thursday	Friday
9.00 - 10.30	ESSAI Track N - C1 - 1/5	ESSAI Track N - C1 - 2/5	ESSAI Track N - C1 - 3/5	ESSAI Track N - C1 - 4/5	ESSAI Track N - C1 - 5/5
coffee break					
11.00 - 12.30	ESSAI Track N - C2 - 1/5	ESSAI Track N - C2 - 2/5	ESSAI Track N - C2 - 3/5	ESSAI Track N - C2 - 4/5	ESSAI Track N - C2 - 5/5
lunch break					
14.00 - 15.30	ESSAI Track N - C3 - 1/5	ESSAI Track N - C3 - 2/5	ESSAI Track N - C3 - 3/5	ESSAI Track N - C3 - 4/5	ESSAI Track N - C3 - 5/5
coffee break					
16.00 - 17.30	ESSAI Track N - C4 - 1/5	ESSAI Track N - C4 - 2/5	ESSAI Track N - C4 - 3/5	ESSAI Track N - C4 - 4/5	ESSAI Track N - C4 - 5/5

The ESSAI program will include courses (introductory or advanced) on different topics from all areas of artificial intelligence. A public call for proposals for courses will be issued, following the ESSLI model. The selection of the courses will be made by the program chairs, together with the program committee that they will form for this purpose. A potential list of topics to be covered and lecturers that could give tutorials on each of the topics is provided below.

Sašo Džeroski (Jožef Stefan Institute, Ljubljana) and **Ljupco Todorovski** (University of Ljubljana) will act as **program chairs** of the event. The topic of ACAI-2023, Artificial Intelligence for Science, is one of the core areas of their scientific research. They will thus select the topics and lecturers for ACAI-2023 themselves. The program committee chairs have extensive experience in organizing prominent and varied scientific events (CVs included below). For ESSAI-2023, they will form a program committee (PC) of prominent scientists from key branches of AI. The PC will issue the call for courses and select among the proposals.

PC Chairs



Sašo Džeroski heads the Department of Knowledge Technologies at the Jozef Stefan Institute (Ljubljana, Slovenia) and a full professor at the Jozef Stefan International Postgraduate School. He is also a visiting professor at the European Space Agency Frascati, Italy). His department develops artificial intelligence methods for machine learning and decision support and uses them to solve practical problems from agriculture and environmental sciences, medicine and life sciences, and space operations/Earth observation. His own research focuses on machine learning from complex data and in the presence of domain knowledge, also in the case of learning models of dynamical systems.

He has conducted many international projects in basic and applied research, including industrial projects for companies and for the European Space Agency. He has participated in numerous EU funded projects and coordinated three of them, most recently the FET Open project MAESTRA (Learning from Massive, Incompletely annotated, and Structured Data). His work is highly cited, with more than 24000 Google scholar citations and an h-index of 71.

He has also been the chair of numerous international conferences, including ICML, the world-

leading conference on machine learning (program chair in 1999, general chair in 2005), and ECML PKDD, the premier European international event on data science (general chair in 2017). He has also organized the conference Discovery Science (program chair in 2014, general chair in 2019) and is chair of the steering committee of this conference.

Sašo Džeroski is currently the chair of the Slovenian Artificial Intelligence Society. He is an EurAI fellow. He is a foreign member of the Macedonian Academy of Sciences and Arts and a member of Academia Europea (European Academy of Humanities, Letters and Sciences).



Ljupco Todorovski is a professor of computer science at the University of Ljubljana, Faculty of Mathematics and Physics, and senior researcher at the Jožef Stefan Institute, Department of Knowledge Technologies. He earned his Ph.D. at the University of Ljubljana, Faculty of Computer and Information Science in 2003, was a postdoctoral fellow at Stanford University from 2004 to 2005 and served as a visiting professor at Stanford in 2011. His research is in computer science and informatics, specifically artificial intelligence and machine learning. His contributions are related to developing machine learning algorithms for the mathematical modeling of dynamical systems from time-series

data and formalized domain knowledge. In collaboration with scientists and experts from other domains, he has applied machine learning to various scientific and engineering problems.

He has been a co-chair of numerous international conferences, including ECML PKDD, the premier European international event on data science (program chair in 2003 and 2017), and Discovery Science, an annual conference with a slant toward computational scientific discovery (program chair in 2006, general chair in 2014). The publication record of Professor Todorovski includes a co-edited book with the title »Computational Discovery of Scientific Knowledge« from 2007 and more than 70 journal articles. His publications have received more than 4,200 Google Scholar citations leading to an h-index of 30. In 2018, the University of Ljubljana awarded him a Golden Plaque for outstanding scientific and pedagogical contributions.

Advanced Course in Artificial Intelligence, ACAI-2023: ARTIFICIAL INTELLIGENCE FOR SCIENCE

In its development, science has gone through several major paradigms. Chronologically ordered from the past to the present, these include (1) the empirical paradigm, focused on describing natural phenomena, (2) the theoretical paradigm that uses models and generalizes over observations, and (3) the computational paradigm that relies on simulating complex phenomena. We are presently witnessing the reign of the fourth paradigm, data-driven science, which heavily uses machine learning to produce novel scientific discoveries.

Machine learning is revolutionizing science by helping to handle the flood of scientific data, reinforcing the reign of data-driven science. Of crucial importance here is the ability to handle large and complex data, at which deep neural networks, including convolutional and graph neural networks, excel. Equally important, however, especially for science, is the ability to explain the models learned from data and their predictions. Explainable AI approaches come to the forefront at this point. Finally, the ability to take into account existing knowledge and relate the newly discovered models to it is also important.

Besides machine learning, other artificial intelligence approaches are important for science. Among these, computational scientific discovery most directly addresses the challenge of automating and providing support to the process of generating new scientific knowledge. In

computational scientific discovery, data, models, and relations between them are considered, with the focus on uncovering these connections. Laws and models constructed by discovery should not only make accurate predictions, but also provide deeper accounts that are consistent with existing scientific theory: They should also be interpretable, ideally being stated in formalisms used by domain scientists. These three points are distinctive features of science that set it apart from other intellectual pursuits. They also impose constraints on the discovery task that mean traditional techniques for machine learning do not suffice to address it.

Representing and storing scientific knowledge, whether we are talking about facts or models, is also of paramount importance for its re-use in different scientific processes, by either human or robot scientists. Here ontologies and semantic technologies (and in general knowledge representation approaches) play a key role. The approaches developed in this area bring us closer to automated science and robot scientists, which not only perform experiments, but go beyond this to automate hypotheses formulation, experiment design and close the loop by forming new hypotheses from experimental results. They also bring us closer to open science, where all products of the scientific process (and not only data) are FAIR (Findable, Accessible, Interoperable, and Reusable).

ACAI-2023 topics, descriptions & tentative speakers

Below are **some topics ACAI-2023 will aim to cover**, descriptions& tentative speakers follow:

- Computational scientific discovery
- Equation discovery and symbolic regression
- Bayesian approaches to computational scientific discovery and systems biology
- Causal, deep and explainable learning for Earth science and remote sensing
- Explainable deep learning/models for computational scientific discovery
- Robots for automating life sciences and material science
- Formalization of scientific knowledge, ontologies, FAIR principles, open science

Computational Scientific Discovery

Pat Langley, Institute for the Study of Learning and Expertise & Stanford University, USA

The development of computational methods that can assist or automatize the process of discovering new scientific knowledge from observations has been studied within the field of computational scientific discovery. The field also aims at understanding how humans carry out the complex activity of scientific discovery and makes use of the analogies and synergies between the processes of understanding and developing computational support for discovery. Pat Langley is among the pioneers of the field of computational scientific discovery. He is the author of an early computational discovery system Bacon for data-driven inference of quantitative laws and co-editor of a seminal volume in the field, "Computational models of scientific discovery and theory formation," published in 1990.

Equation Discovery and Symbolic Regression

Max Tegmark and **Silviu-Marian Udrescu**, Massachusetts Institute of Technology, Cambridge, USA

Nathan Kutz and Steven Brunton, University of Washington, Seattle, USA

Mathematical models are often used in science and engineering to establish laws among observed quantities or explain observed phenomena. Scientific discovery thus often tackles the mathematical modeling task that aims to formulate laws and models from observations

and measurements. The task of inducing mathematical models from data and knowledge is referred to as equation discovery and symbolic regression. Following the pioneering work on Bacon mentioned above, many researchers have been working on developing algorithms for equation discovery. Max Tegmark and Silviu-Marian Udrescu have combined various heuristics and learning paradigms, including deep learning. In contrast, Nathan Kutz and Steven Brunton have developed efficient methods based on sparse regression.

Bayesian Approaches to Computational Scientific Discovery and Systems Biology

Roger Guimera and **Marta Sales Pardo**, ICREA, Catalan Institution for Research and Advanced Studies, Tarragona, Spain

Paul DW Kirk, University of Cambridge, UK

Julio Banga, Computational Biology Lab, Misión Biológica de Galicia, Pontevedra, Spain

Observations and measurements in science are often incomplete, sparse, and noisy. Dealing with such data uncertainties often calls for the development of probabilistic and stochastic computational methods. In their recent work, Roger Guimera and Marta Sales Pardo developed a Bayesian scientist, a computational approach to discovering equations from data based on Bayesian reasoning. The latter also has a long tradition of use in systems biology, where sparse and noisy data are omnipresent. Bayesian inference has been applied for reverse engineering stochastic models of biological processes from noisy measurements and inducing optimal control strategies (related to therapies) in biological systems. Paul Kirk has been working on Bayesian modeling for the reverse engineering of biomedical phenomena. Julio Banga's research is on developing and analyzing global optimization methods for modeling and controlling temporal dynamics in systems biology.

Causal, Deep and Explainable Learning for Earth Science and Remote Sensing

Gustau Camps-Valls, University of Valencia, Spain

Ribana Roscher, Rheinische Friedrich-Wilhelms University, Bonn, Germany

The Earth is a complex dynamic network system. Modelling and understanding the system is at the core of scientific endeavour. These problems can be addressed with machine learning algorithms. Machine learning approaches are indeed increasingly used to extract patterns and insights from the ever-increasing stream of geospatial data. They include advanced Gaussian processes models for bio-geo-physical parameter estimation, which can incorporate physical laws, blend multisensor data while providing credible confidence intervals for the estimates and improved interpretability. They also include nonlinear dimensionality reduction methods to decompose Earth data cubes in spatially-explicit and temporally-resolved modes of variability that summarize the information content of the data and allow for identifying relations with physical processes. Finally, they include methods for causal inference that can uncover cause and effect relations from purely observational data.

The above approaches (and many other) may not be optimal when system behaviour is dominated by spatial or temporal context. Deep learning, and in particular convolutional approaches that are able to extract spatio-temporal features automatically, are naturally suitable to gain understanding of Earth system science problems, improving the predictive ability of seasonal forecasting and modelling of long-range spatial connections across multiple timescales. Deep learning approaches are also particularly suitable for analyzing images obtained via different kind of remote sensing of the Earth. In this context, approaches that can explain the predictions of deep models, e.g., via interpretable latent spaces which allow for generating multiple images and examining/ explaining variability.

Gustau Camps-Valls has developed a variety of approaches for deep and causal learning in the Context of Earth sciences. Ribana Roscher has recently developed approaches to explain the predictions of deep models as applied to remote sensing data.

Explainable Deep Learning/ Models for Computational Scientific Discovery

Marinka Žitnik, Harvard University, Cambridge, USA

Peter Battaglia, DeepMind, London, UK

Jure Leskovec, Stanford University, USA

Following the great success of deep learning methods for building accurate predictive models, they have been recently applied to various scientific tasks. Recent efforts include methods for integrating existing scientific knowledge in appropriate structures of deep neural networks and methods that combine symbolic approaches to AI with statistical and latent representations inferred with deep networks. An obstacle to using deep, nontransparent neural networks in science is their inability to explain their inner workings nor contribute to scientific knowledge. Recently, methods for interpreting deep models and their predictions have been developed that allow their use for explaining scientific phenomena and checking their consistency with existing scientific knowledge. Marinka Žitnik has been developing methods for interpreting and explaining graph neural networks. Peter Battaglia and Jure Leskovec have been working on learning models for computationally efficient simulations in physics.

Robots for Automating Life Sciences and Material Science

Ross King, Chalmers University of Technology, Gothenburg, Sweden

Andrew Cooper, University of Liverpool, UK

A robot scientist can autonomously execute high-throughput hypothesis-led research. Such a robot can: hypothesize to explain observations; devise experiments to test these hypotheses; physically run the experiments using laboratory robotics; interpret the results from the experiments; and repeat the cycle as required. In addition to automating experimentation, a robot scientist is well suited to recording scientific knowledge: as the experiments are conceived and executed automatically, it is possible to completely capture and digitally curate all aspects of the scientific process. Ross King developed the first robot scientist (Adam) in the life sciences/ functional genomics, as well as a second one (Eve) to automate drug discovery and find lead compounds for neglected tropical diseases. Andrew Cooper develops similar high-throughput research approaches for the design of functional materials in materials science.

Formalization of Scientific Knowledge, Ontologies, FAIR Principles, Open Science

Larissa Soldatova, Goldsmith's University of London, UK

Michel Dumontier, Maastricht University

Science refers both to scientific knowledge and the process of acquiring such knowledge: science is about knowledge. Therefore, formalizing scientific knowledge is one of the fundamental interests in computational scientific discovery. The paradigms of open science following the FAIR principles of findable, accessible, interoperable, and reusable can refer to data and knowledge in science. Computational discovery methods can benefit from the FAIR principles that make scientific knowledge readily available for integration in the algorithms and contribute to the principles by producing formalized knowledge in an accessible form ready to be reused. Larissa Soldatova has a long and prominent research record on establishing ontologies of scientific knowledge and applying AI methods in biomedicine. Michel Dumontier is co-founder of the FAIR data principles and aims to unlock the potential of data for scientific research with his work.

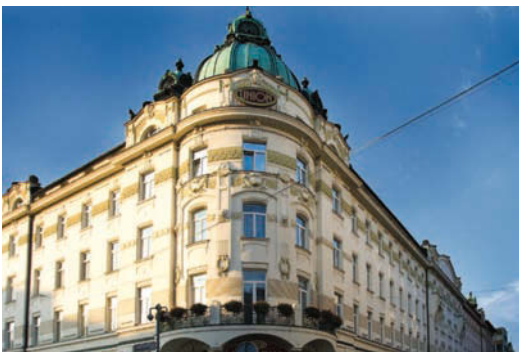


ACCOMMODATION

In recent years, Ljubljana has become a modern European capital, has undergone a major city center overhaul, and has become quite a tourist attraction. This overhaul has also affected its hotels; practically all of them have been either renovated or newly built and offer a very good service.

Ljubljana has over **ten larger** (100-200 rooms), **mostly four star hotels in the city center**, close to the proposed venues of the school and the social events. The current regular prices for four star rooms are **between 80-130 EUR, including breakfast**. The four star rooms away (4-5 km) from the city center start as low as 60 EUR.

The city's transformation has also caused **many smaller (10-40 rooms) hotels and hostels** in the old city center to be opened. They offer more of a family atmosphere; the prices are similar to the larger hotels (lower for hostels, but vary considerably). Ljubljana's **airbnb** market has also become very lively, offering a wide variety of accommodation.



Ljubljana is a major educational hub and has a **large number of dormitories offering affordable student accommodation**. These dormitories mostly operate as hostels during the summer break (July and August). We have received offers **starting at 35 EUR per night** (average 50 EUR) including buffet breakfast. Single accommodation costs 40-55 EUR.



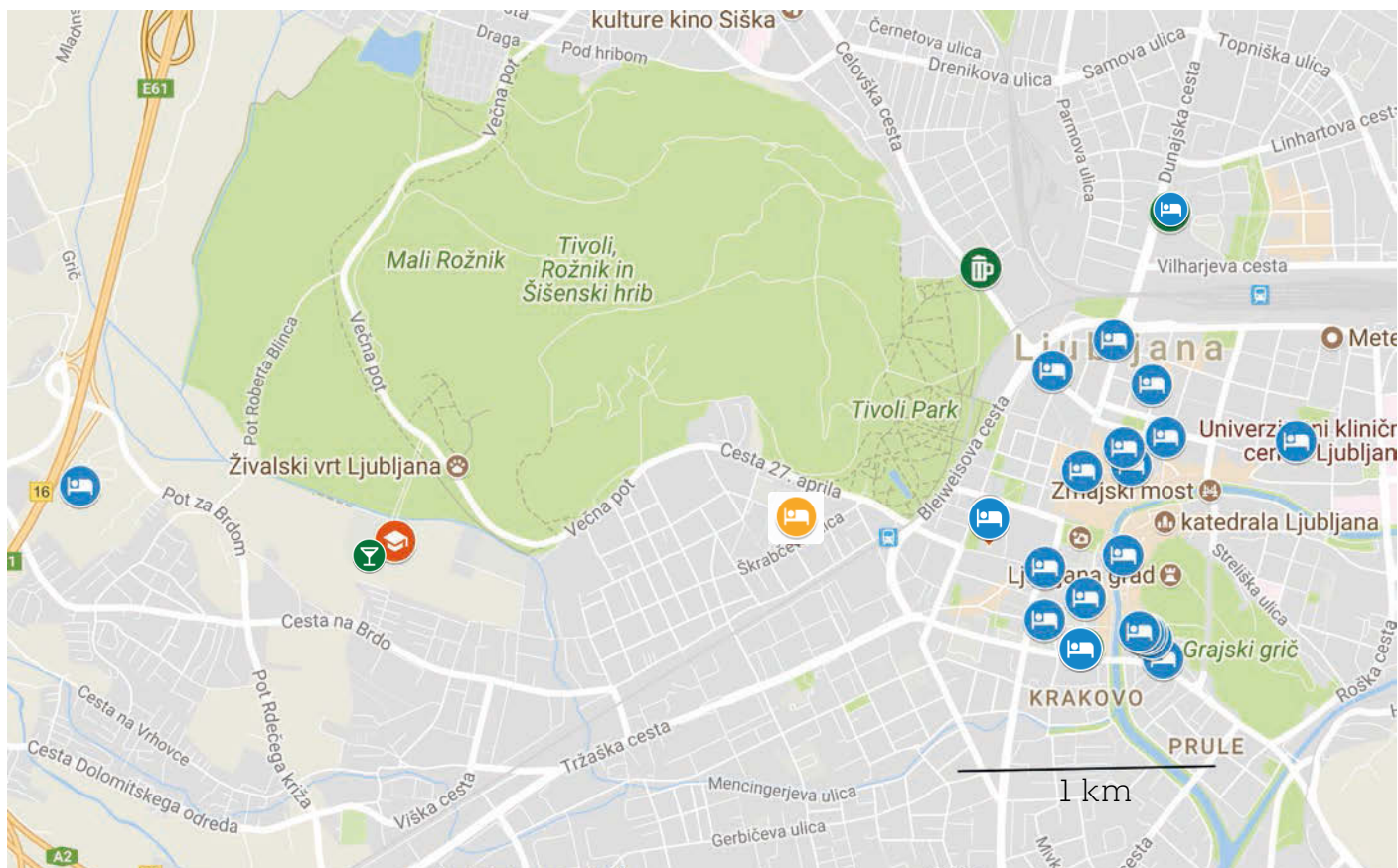
There are also a number of other hostels and dormitories available. It must be noted that the dormitories have been largely **renovated** and offer a very good service for their price.

Almost all of the proposed hotels, hostels, and dormitories are either in the old city center or in its immediate proximity (see map). The walking distance between the two most distant points is about 15-20 minutes. Many of the facilities also offer rental bicycles, and the city has its own one-hour free bicycle rental system.



Please note that the prices mentioned above are regular prices (including dormitories). We intend to negotiate for discounts with selected hotels and dormitories for large block reservations.

ESSAI & ACAI 2023 Venue and hotels



- 🎓 Faculty of Computer and Information Science - school location
 🏠 Student dormitories
 🍷 Pivnica Union - Social dinner
 🏨 Four Points by Sheraton Ljubljana - Hotel Mons
 🏨 InterContinental
 🏨 Best Western Premier Hotel Slon
 🏨 Union Hotels Collection
 🏨 Business Hotel Lev
 🏨 M Hotel
 🏨 Ljubljana Hotel Cubo
 🏨 Antiq Palace Hotel & Spa
 🏨 Central Hotel
 🏨 City Hotel Ljubljana



GOURMET EXPERIENCE



The culinary offering of Ljubljana has always been wide and diverse. Slovenia and Ljubljana are situated at the crossroads of different culinary worlds. **Slovenian cuisine primarily reflects influences from Mediterranean, Alpine, and Pannonian cuisines**, and, in recent years, has also been **influenced by Balkan and some international cuisines**.



The culinary art of Ljubljana is also marked by the diversity of its ingredients. Some of the most notable are vegetables grown in the city's suburban gardens. Meat is also indispensable, particularly beef and poultry produced by the farms of Central Slovenia, while the meat of different game birds can also appear on the table. Since Slovenia is also a Mediterranean country, fish and seafood are always to be found on the menu.



The contemporary approaches of today's chefs have only refined and upgraded the old traditions. If you **pay a visit to the Open Kitchen (Odprta kuhna) or visit one of the quality restaurants in Ljubljana, you might encounter contemporary variations of once popular dishes**.

Even though Central Slovenia is not a wine-growing region, Ljubljana has been awarded the international title of a **"City of Vine and Wine"**. That is no coincidence. Apart from having a large number of wine bars and shops, Ljubljana hosts several wine fairs and events.



Slovenia is a country of good wines valued for their remarkably natural tastes. The choice of Slovenian wines, either sweet or dry, can cater for all tastes and palates. The local wines may not be among the best known in the world, but they often win **prestigious international awards**.



EXCURSIONS

All participants and accompanying persons will be able to enjoy nearby attractions.

Possible destinations for one-day trip are:



Lake Bled & Lake Bohinj

The alpine lake Bled has been a world-renowned paradise for centuries, impressing visitors with its natural beauty, wealth of legend, and special powers to restore well-being. You can visit its island, the only one in Slovenia, on a traditional “pletna” boat. Also in the vicinity is lake Bohinj, the largest freshwater lake in the country. Bohinj and Bled are an excellent starting points for short or long alpine hiking trips to the peaks of the Julian Alps.



Soca River Valley

The Soča river with its distinct emerald green colour, is considered to be one of the most beautiful rivers in Europe. Its water flows across waterfalls, small waterfalls, and cascades as well as through narrow rocky gorges, and along the way it has carved surprising canyons and pools. The river excites the lovers of natural beauty and seekers of adventurous water sports, such as wildwater kayaking, rafting, canyoning etc.



Goriška Brda

Proclaimed the 2015 European Destination of Excellence, the Goriška Brda hills offer countless opportunities to spend a romantic or active vacation. The area is a famous wine region. Slovenian wine makers from this region are considered to be among the world's best wine producers.



Postojna Caves & Predjama Castle

This natural cave extends over 24 km and it is the most visited tourist cave in Europe. The tour starts with a train and is followed by a spectacular walk among the stalagmites and stalactites to the great hall. Predjama Castle is located close to Postojna Cave and is the largest cave castle in the world.



Škocjan Caves

Škocjan Caves have been registered on the UNESCO World Heritage List since 1986. The underground canyon in the Škocjan Caves made by the Reka river is the largest known underground canyon in the world. It consists of a complex system of cave passages, which are 6.2 km in length, and reach a depth of 223 metres at their lowest point.



Lipica Stud Farm

The Lipica Stud Farm is the cradle of all Lipizzaner horses in the world. In the picturesque Karst setting, the breeding and selection of this outstanding and noble breed of horse has been going on for more than 400 years.



Piran

Piran is considered one of the most beautiful historical towns on the Adriatic coast. Picturesque buildings which reflect the influence of the Venetian Republic, the mighty medieval town walls, romantic narrow winding streets and the scent of salt give a unique charm to every corner of the town. This very salt gave Piran its unique mark. Its development was closely related to salt harvesting, and even today Piran salt remains one of the most distinctive symbols of the town.



Golf Courses

The golf courses of Slovenia are among the most beautiful in Europe. They are set in typical landscapes on the edge of the Pannonian Plain, among vineyards and rolling hills, below Alpine summits, and in the idyllic karst landscape.



Natural Spas and Health Resorts

Slovenia is renowned for its natural spas and health resorts. Its thermal and mineral springs are located all over Slovenia, from Pomurje to Dolenjska and from the Alps to the Mediterranean. You will be welcome to fifteen state verified natural spas and thermal spas, which provide comfortable accommodation in hotels, apartments, vacation houses and camps.

VISAS AND GENERAL INFORMATION

Visas

Slovenia is a **member state of the European Union and part of the Schengen area**. The area mostly functions as a single jurisdiction for international travel purposes, with a common visa policy. There is no border control within the area.

The visa policy of the Schengen Area is set by the European Union. If someone other than a European Union, European Economic Area (EEA) or Swiss citizen wishes to enter the Schengen Area, they must have a visa or be a national of a visa-exempt country (see list below). If you need a visa to enter Slovenia, you can obtain one from the Slovenian consular mission in your country. If there is no Slovenian consular mission in your country, contact a consular mission of any Member State of the Schengen Area. A visa issued by one Schengen Member State is also valid for the other Member States. In other words, this means that you can visit several countries which are in the Schengen Area.

The cost of the visa is 60 EUR and it is valid for 90 days. Providing that the visa application is admissible and there are no issues with the application, a decision must be given within 15 calendar days of the date on which the application was lodged.

Nationals of the following 62 countries and territories holding ordinary passports do not need a visa under the visa waiver programs: Albania, Andorra, Antigua and Barbuda, Argentina, Australia, Bahamas, Barbados, Bosnia and Herzegovina, Brazil, Brunei, Canada, Chile, Colombia, Costa Rica, Dominica, El Salvador, Georgia, Grenada, Guatemala, Honduras, Hong Kong, Israel, Japan, Kiribati, Macau, Macedonia, Malaysia, Marshall Islands, Mauritius, Mexico, Micronesia, Moldova, Monaco, Montenegro, New Zealand, Nicaragua, Palau, Panama, Paraguay, Peru, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Samoa, San Marino, Serbia, Seychelles, Singapore, Solomon Islands, South Korea, Taiwan, Timor Leste, Tonga, Trinidad and Tobago, Tuvalu, Ukraine, United Arab Emirates, United States, Uruguay, Vanuatu, Vatican City, Venezuela, and British nationals who are not nationals of the United Kingdom for the purposes of European Union law.

Value added tax

The **value added tax (VAT) in Slovenia is 22% with a reduced rate of 9.5% for food, water, books**, etc. For a VAT refund, the seller must provide the visitors from other countries with a special form, which is completed by the seller. As you exit the EU Member State, you must get the form certified by the customs authorities at the border crossing. At the same time, you must present the original receipt of purchase. You must take the purchased goods out of the country before the end of the third month from the date of purchase. The tax is refunded to you by the institutions indicated on the tax-free purchases form. VAT refund cannot be requested for mineral oils, alcohol and alcoholic beverages, and tobacco products.

Alcoholic beverages

There are no specific restrictions on alcohol purchase and consumption. The general restriction is that alcohol is not served to underage or obviously intoxicated customers. Alcoholic beverages are freely sold in general stores; however, they cannot be sold after 9pm. They can be served in bars, restaurants, and other facilities also after 9pm.



Medical help

Citizens of EEA countries and Switzerland can use their European Health Insurance Card (EHIC), issued free of charge, to receive medical treatment free or at a reduced cost, if that treatment becomes necessary during their visit (for example, due to illness or an accident), or if they have a chronic pre-existing condition which requires care, such as kidney dialysis. For citizens of other countries, tourist health insurance is recommended.

Ambulance transportation is free in emergency cases, so patients do not have to pay any additional amount for the overall cost of transportation.

Ljubljana and major towns in Slovenia have duty pharmacies that provide a 24-hour service.

Language, currency, and prices

The **official currency** in Slovenia is the **Euro (€)** and the official **language is Slovenian**. **Practically everybody speaks at least one foreign language (mostly English)**.

For quick orientation: the price of **a large beer in Ljubljana is 3.0 EUR**, **coffee costs 1.5 EUR**, and a good **meal at lunchtime** in the city center is **between 8 and 15 EUR** (some restaurants offer daily menus). The organisers will take care of coffee breaks and lunch during the school at the premises of UL FRI.



VOLUNTEER LABOR

University of Ljubljana enrolls about 40,000 students, and the hosting Faculty of Computer and Information Science (UL FRI) enrolls about 1,400 students. **The Student Council of UL FRI** is an official body representing students in faculty matters. It has expressed their support for ESSAI & ACAI organization and **will actively help with volunteers**. **SLAIS itself also has a number of junior members prepared to help with the organization.**

LOCAL TOURISM BUREAU SUPPORT

The public institute **Ljubljana Tourism** is a tourist organization under the auspices of the City of Ljubljana. They have expressed their support to this bid. They will provide free-of-charge maps of Ljubljana, brochures, and other promotional material. They will arrange for all the delegates to have **unlimited free public transportation** (city buses) upon showing their ESSAI badges.

Finding your way around FRI



FRI Building

Bridge passage between Central Building and FRI Building

Central Building

Second floor:

Faculty Restaurant and Café, Reading Room (access from the Library)

First floor:

Library

(Opening hours: Mon–Thu, 8:00–19:00;
Fri, 8:00–18:00; Phone: +386 01 479 80 02;
E-mail: knjiznicafkkt@fkkt.uni-lj.si)

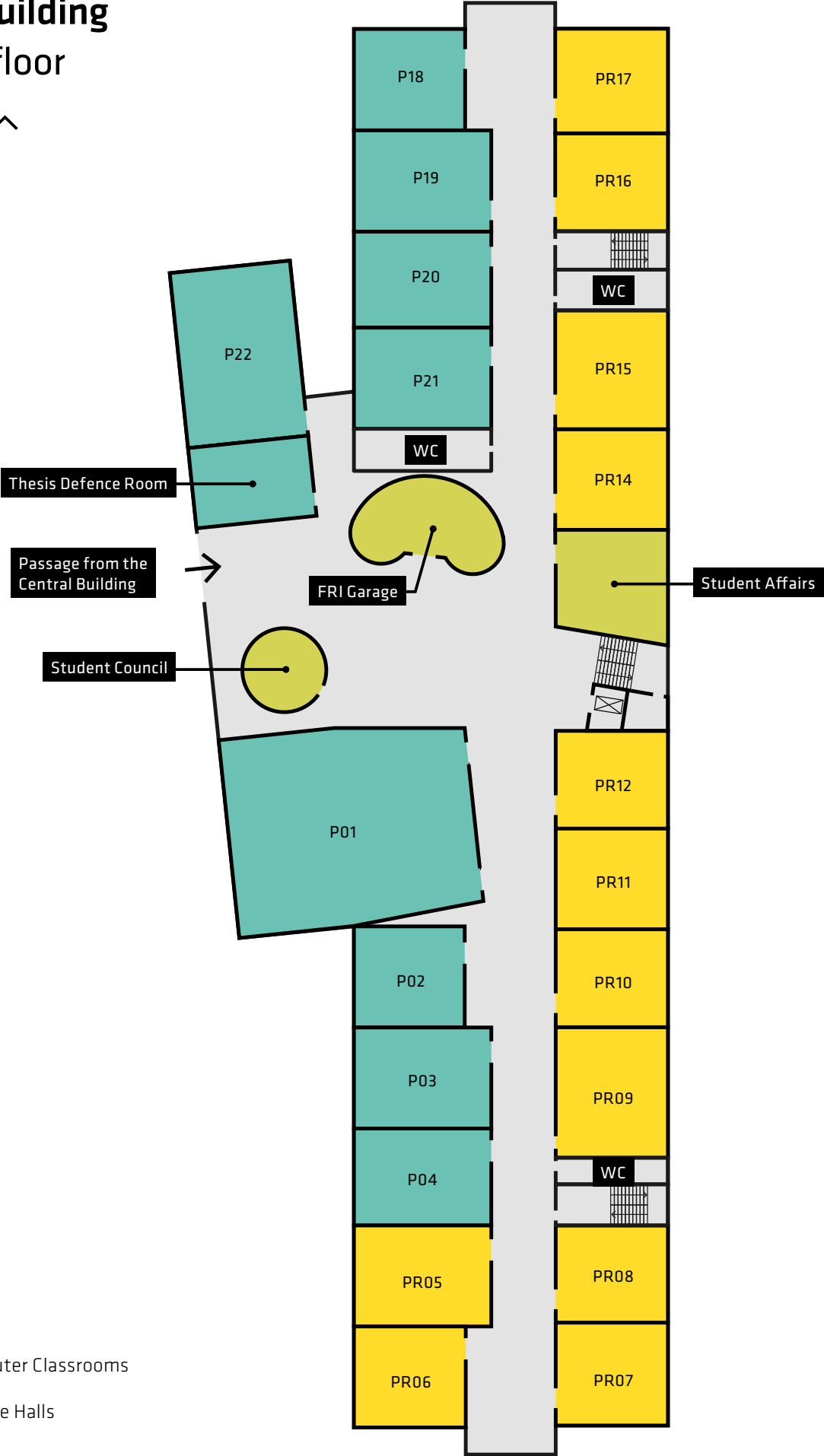
Ground floor:

Main entrance, Reception, Copy Shop and Study Literature Shop, Lecture Room A

Entrance

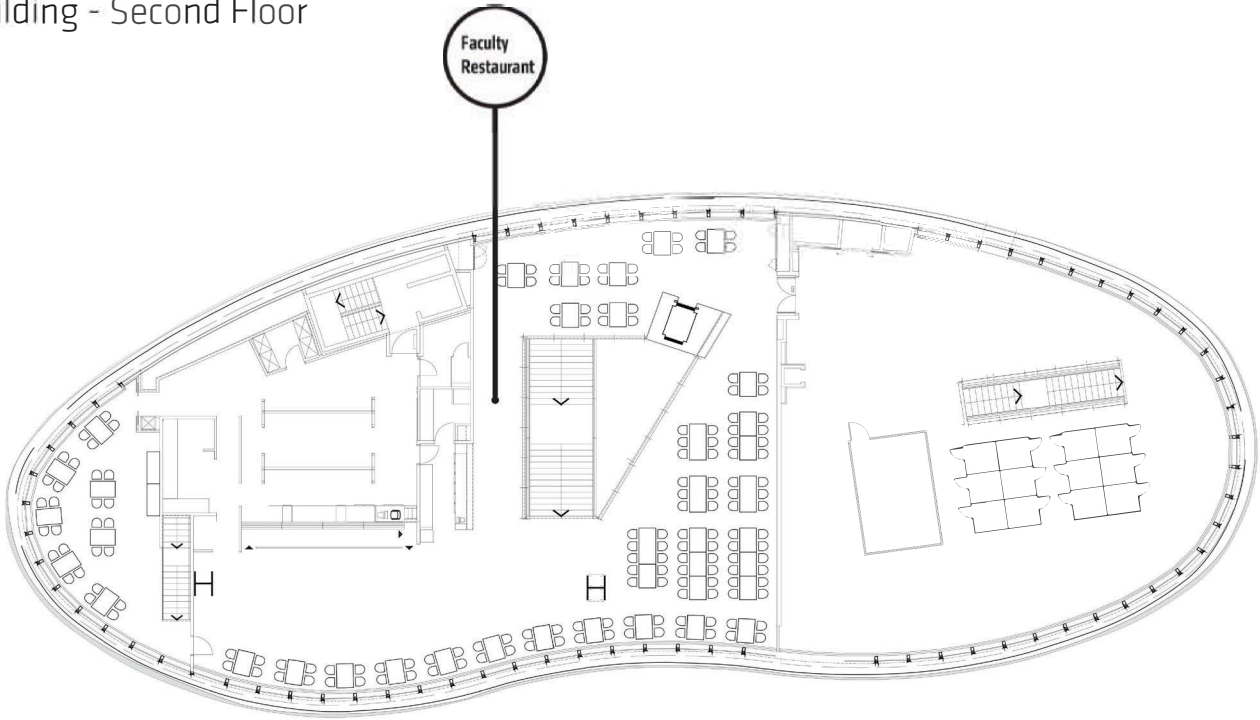
FRI Building

First floor

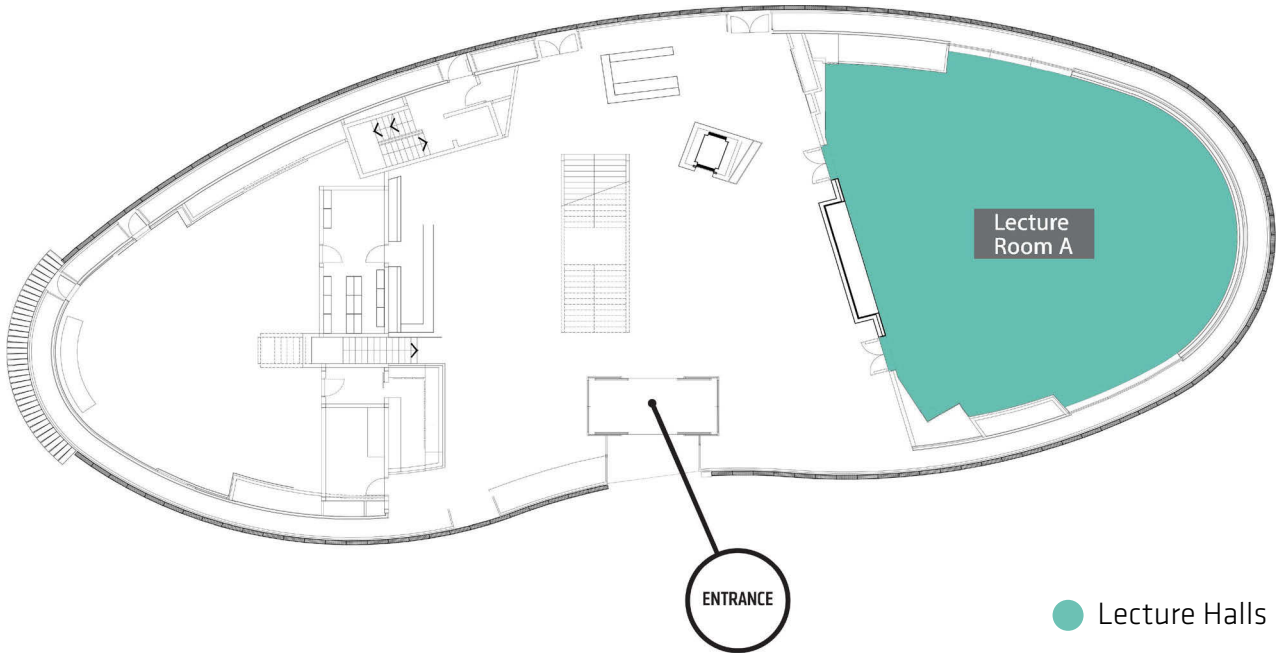


- Computer Classrooms
- Lecture Halls

Central Building - Second Floor



Central Building - Ground Floor



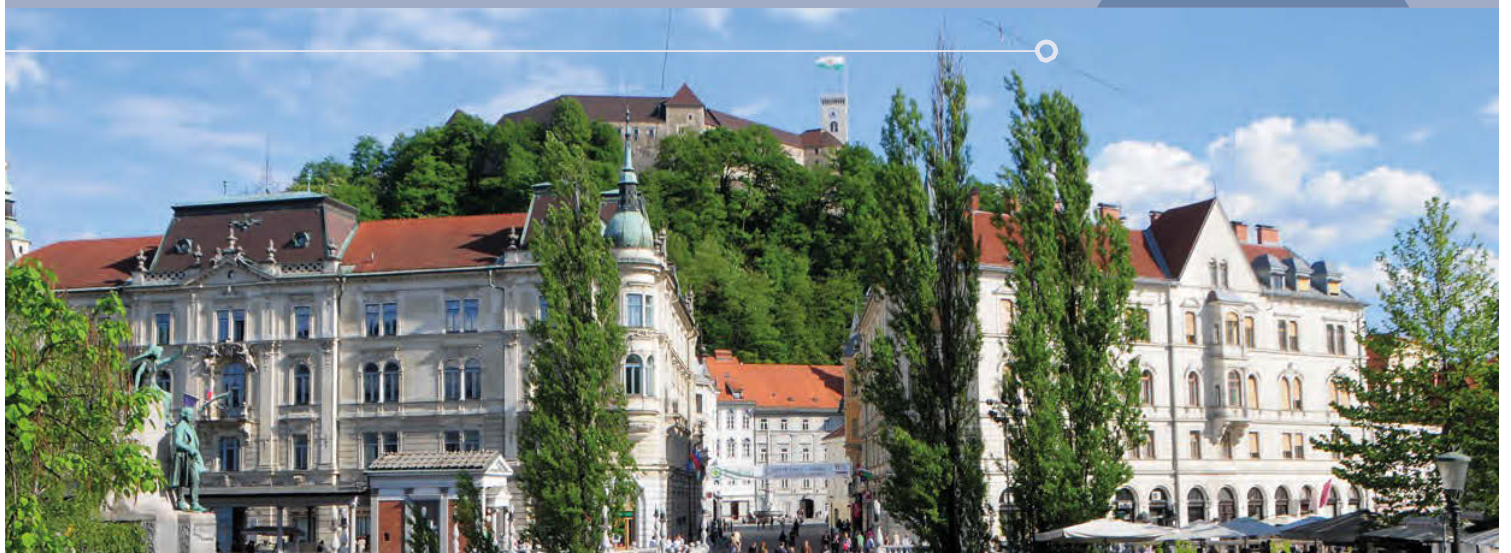
● Lecture Halls



ESSAI & ACAI 2023

24-28 July

Ljubljana, Slovenia



ESSAI CALL FOR COURSE PROPOSALS

The 1st European Summer School in Artificial Intelligence - ESSAI 2023 24-28 July, 2023, Ljubljana, Slovenia

<https://eurai.org/essai2023>

ESSAI-2023 will take place at the Faculty of Computer and Information Science, University of Ljubljana. It **will have five parallel tracks, each comprising four courses**. Each course will consist of five 90 min sessions (one on each day during the week). A **total of 20 courses** will be included in ESSAI, to be selected among the proposals solicited by this call.

Important dates

- **24 Jan 2023:** Course title submission (mandatory) deadline
- **31 Jan 2023:** Final submission
- **28 Feb 2023:** Notification

The European Summer School in Artificial Intelligence (ESSAI) is a new annual summer school held under the auspices of the European Association for Artificial Intelligence (EurAI). The ambition of ESSAI is to become the central meeting place for students and young researchers in Artificial Intelligence to discuss current research and share knowledge.

ESSAI will provide an interdisciplinary setting in which courses are offered in all areas of Artificial Intelligence and also from wider scientific, historical, and philosophical perspectives. The format of ESSAI is analogous to the European Summer School in Logic, Language and Information (ESSLLI) which has been running since 1989. Courses will consist of five 90 minute sessions, offered daily (Monday-Friday) in a single week, to allow students to develop in-depth knowledge of a topic.

The first ESSAI will be held in Ljubljana, Slovenia between the 24th and 28th of July 2023. ESSAI 2023 aims to attract around 400 participants from all parts of Europe, as well as from North and Latin America, and Asia.

Topics and format

Proposals for courses at ESSAI 2023 are invited in all areas of Artificial Intelligence, including but not limited to the following:

- Agent-based and Multi-agent Systems (MAS)
- Ethics, Legal Issues, Explainable and Trustworthy AI (XAI)
- Knowledge Representation and Reasoning (KR)
- Natural Language Processing (NLP)
- Neuro-Symbolic Learning and Reasoning (NeSy)
- Planning & Strategic Reasoning (PLAN)
- Reinforcement Learning (RL)
- Robotics (ROB)
- Search & Optimization (SO)
- Supervised and Unsupervised Learning (ML)
- Vision (VIS)

Each course will consist of five 90 minute lectures, offered daily (Monday-Friday) in a single week.

Categories

Each proposal should fall under one of the following categories: foundational, introductory or advanced course.

* Foundational courses *

Foundational courses present the basics of a research area to the students with no prior knowledge in that area. They should be at an elementary level, without prerequisites in the course's topic, though possibly assuming a level of general scientific maturity in the relevant discipline. They should enable researchers from related disciplines to become comfortable with the fundamental concepts and techniques of the course topic, thereby contributing to the interdisciplinary nature of our research community.

* Introductory courses *

Introductory courses are central to ESSAI's mission. They are intended to introduce a research field to students, young researchers, and other non-specialists, and to foster a sound understanding of its basic methods and techniques. Introductory courses should enable researchers from related disciplines to become competent in the course topic. Introductory courses that are cross-disciplinary may presuppose general knowledge of the relevant disciplines.

* Advanced courses *

Advanced courses are targeted primarily at graduate students who wish to acquire an understanding of current research in a field of Artificial Intelligence.

Proposal guidelines

To be considered, course proposals should closely adhere to the following guidelines:

Course proposals can be submitted by no more than two lecturers, and courses must be presented by lecturers who submitted the proposal. All lecturers must possess a PhD or equivalent degree by the submission deadline for course proposals.

Course proposals should explicitly state the intended course category. Proposals for introductory courses should indicate the intended level, for example, as it relates to standard textbooks and monographs in the area. Proposals for advanced courses should specify the prerequisites in detail.

Proposals must be submitted in PDF format via:

<https://easychair.org/conferences/?conf=essai2023>

and include all of the following:

a. **Personal information for each proposer:** Name, affiliation, contact address, email, homepage (optional)

b. **General proposal information:** Title, category

c. **Information about the course content:**

Abstract of up to 150 words

Motivation and description (up to two pages)

Tentative outline

Expected level and prerequisites

Appropriate references (e.g. textbooks, monographs, proceedings, surveys)

d. Information about the proposer(s) and course:

Whether the course will appeal to students outside of the main discipline of the course

Proposer(s)'s experience of delivering courses in an intensive one-week interdisciplinary setting

Evidence that the proposers are excellent lecturers

To keep participation fees to a minimum, all the instructional and organizational work of ESSAI is performed on a completely voluntary basis. However, the registration fees of organizers and instructors will be waived, and travel and accommodation expenses will be reimbursed up to a level which will be communicated along with the proposal notification. ESSAI can only guarantee reimbursement for at most one course lecturer, and can not guarantee full reimbursement of travel costs for lecturers from outside of Europe. The organizers of ESSAI would appreciate any help in reducing the School's expenses by seeking partial or complete coverage of travel and accommodation expenses from other sources.

Submission information

By Jan 24, 2023:

Proposers must submit on EasyChair at least the name(s) of the lecturers(s), the ESSAI area+course level and a short abstract.

By Jan 31, 2023:

Submission must be completed by uploading a PDF with the actual proposal as detailed above.

Submission portal

Please submit your proposals to

<https://easychair.org/conferences/?conf=essai2023>

Organizing committee

Chair: Vida Groznik (University of Primorska, University of Ljubljana)

Co-chair: Aleksander Sadikov (University of Ljubljana)

Sašo Džeroski (Jožef Stefan Institute)

Jure Žabkar (University of Ljubljana)

Program committee

Chair: Magdalena Ortiz (Umeå University)

Co-chair: Sašo Džeroski (Jožef Stefan Institute)

Co-chair: Brian Logan (University of Aberdeen)

COMPUTATIONAL SCIENTIFIC DISCOVERY AND PROCESS-BASED MODELLING



Speaker



Pat Langley
Stanford University

Lecture 1

Introduction to Computational Scientific Discovery – This lecture will provide an overview of computational approaches to discovering scientific knowledge. It will characterize discovery as heuristic search through a space of laws or models and distinguish it from work on data mining. Discussion will cover six different types of scientific discovery and review systems that address each of them, as well as attempts to unify and integrate them. Examples will include rediscoveries of laws and models from the history of science and new discoveries that have appeared in the scientific literature.

Lecture 2

Computational Discovery of Quantitative Process Models – This lecture discusses the induction of quantitative process models from background knowledge and multivariate time series. A model contains a set of processes, each with one or more differential equations and a set of associated parameters. The effects of processes are additive, so one can compile any such model into a set of differential equations and simulate its behavior over time. Background knowledge includes generic processes that specify types of variables, forms of differential equation, and ranges for parameter values. Inductive process modeling involves constrained search through a discrete space of model structures and a continuous space of model parameters. The lecture will cover different approaches to discovering process model, with examples taken from population dynamics and chemical reaction networks. It will close with a discussion of limitations and directions for future research.

Advanced Course on Artificial Intelligence (ACAI)

AUTOMATED MODELLING AND DESIGN OF DYNAMICAL SYSTEMS IN THE LIFE SCIENCES



Speaker



Julio Rodriguez Banga
MBG-CSIC

Lecture 1

Reverse engineering of biological systems – In this lecture, we will explore the concept of reverse engineering in the context of biological systems, with a focus on mechanistic dynamic modeling using ordinary differential equations (ODEs). We will begin with a brief introduction to the motivation and history of reverse engineering, followed by an overview of various frameworks used in this field. We will discuss the main classes of methods, from knowledge-based to data-driven techniques, with emphasis on recent advances in automatic model discovery. We will also discuss the challenges and difficulties encountered in reverse engineering, addressing perspectives from different areas and key concepts such as identifiability, observability, distinguishability, and interpretability. Lastly, we will delve into model reformulation and the importance of optimal experimental design in overcoming these challenges and advancing our understanding of complex biological systems.

Lecture 2

Optimality and forward engineering of biological systems – This lecture will delve into the concepts of optimality and forward engineering in the context of biological systems. We will first examine the role of optimality principles in biology, exploring how these principles govern the dynamics of biosystems. We will then discuss the inference of optimality principles from data using inverse optimal control and its connection to inverse reinforcement learning. The second half of the lecture will focus on automated design in synthetic biology, with an emphasis on biocircuit design. We will provide an overview of this topic and explore the application of optimal model-based design strategies. The lecture will conclude with a discussion on the inference of biological design principles, shedding light on the underlying rules that guide the development and organization of complex biological systems.

Advanced Course on Artificial Intelligence (ACAI)

BAYESIAN APPROACHES TO SYMBOLIC REGRESSION AND EQUATION DISCOVERY



Speaker



Roger Guimerà
Universitat Rovira i Virgili

Abstract

Closed-form, interpretable mathematical models have been instrumental for advancing our understanding of the world; with the data revolution, we may now be in a position to uncover new such models for many systems from physics to the social sciences. However, to deal with increasing amounts of data, we need “machine scientists” that are able to extract these models automatically from data. Here, we will introduce the main ideas of Bayesian inference and model selection, and discuss a Bayesian machine scientist, which establishes the plausibility of models using explicit approximations to the exact marginal posterior over models and establishes its prior expectations about models by learning from a large empirical corpus of mathematical expressions. Within this approach, the space of models is explored using Markov chain Monte Carlo. We will show that this approach uncovers accurate models for synthetic and real data and provides out-of-sample predictions that are more accurate than those of existing approaches and of other nonparametric methods. We will also use this approach to discuss how models are not always learnable from data and that, in some situations, no algorithm will ever be able to learn the correct model from the data alone.

Advanced Course on Artificial Intelligence (ACAI)

THE FUTURE OF GOVERNING EQUATIONS



Speaker



Nathan Kutz
University of Washington

Abstract

A major challenge in the study of dynamical systems is that of model discovery: turning data into reduced order models that are not just predictive, but provide insight into the nature of the underlying dynamical system that generated the data. We introduce a number of data-driven strategies for discovering nonlinear multiscale dynamical systems and their embeddings from data. We consider two canonical cases: (i) systems for which we have full measurements of the governing variables, and (ii) systems for which we have incomplete measurements. For systems with full state measurements, we show that the recent sparse identification of nonlinear dynamical systems (SINDy) method can discover governing equations with relatively little data and introduce a sampling method that allows SINDy to scale efficiently to problems with multiple time scales, noise and parametric dependencies. For systems with incomplete observations, we show that the Hankel alternative view of Koopman (HAVOK) method, based on time-delay embedding coordinates and the dynamic mode decomposition, can be used to obtain a linear models and Koopman invariant measurement systems that nearly perfectly captures the dynamics of nonlinear quasiperiodic systems. Neural networks are used in targeted ways to aid in the model reduction process. Together, these approaches provide a suite of mathematical strategies for reducing the data required to discover and model nonlinear multiscale systems.

Advanced Course on Artificial Intelligence (ACAI)

MACHINE LEARNING FOR MODELING AND UNDERSTANDING THE EARTH SYSTEM



Speaker



Gustau Camps-Valls
Universitat de València

Abstract

This talk will discuss the use of advanced machine learning (ML) models for understanding and modeling the Earth system. Most problems in Earth sciences aim to do inferences about the system, where accurate predictions are just a tiny part of the whole problem. Inferences mean understanding variables relations, deriving models that are physically plausible, that are simple parsimonious, and mathematically tractable. Machine learning models alone are excellent approximators, but very often do not respect the most elementary laws of physics, like mass or energy conservation, so consistency and confidence are compromised. I will review the main challenges ahead in the field, and introduce several ways to live in the Physics and machine learning interplay. Physics-aware machine learning models are just a step towards understanding the data-generating process, for which causality promises great advances. I'll review some recent methodologies to cope with it too. This is a collective long-term AI agenda towards developing and applying algorithms capable of discovering knowledge in the Earth system.

Advanced Course on Artificial Intelligence (ACAI)

CLOSED-LOOP AUTOMATION OF SCIENTIFIC RESEARCH



Speaker



Ross King
University of Cambridge

Lecture 1

State-of-the-art and roadmap - Recent advances in AI, especially machine learning, are disrupting technological innovation, product development, and ultimately, society. AI is making a significant impact across the sciences, leaving few fields untouched, from material science to drug design, quantum physics to medicine. Indeed, the utilisation of AI is becoming characteristic of early 21st century science. Here we propose a future for AI and science based on scientists collaborating with teams of AI-driven closed-loop discovery laboratories, powered by self-driven hypothesis generation, and open-ended autonomous robotic experimentation. Automation of the very practice of science will increase the efficiency of scientific research, help mitigate the replication crisis, and potentially democratize scientific process. As was the case with AI and games, it is likely that advances in technology and AI will drive the development of ever-smarter AI systems for science. The Nobel Turing Grand Challenge aims to develop: AI systems capable of making Nobel-quality scientific discoveries highly autonomously at a level comparable, and possibly superior, to the best human scientists by 2050. Progress towards this challenge will unleash the deep potential of AI to search for and discover the fundamental structure of our world, and potentially transform the world through accelerated technological development.

Lecture 2

Robot scientists - A Robot Scientist is a physically implemented robotic system that applies techniques from AI to execute cycles of automated scientific experimentation: hypothesis formation, selection of efficient experiments to discriminate between hypotheses, execution of experiments using laboratory automation equipment, and analysis of results. The motivation for Robot Scientists is to both better understand science, and to make science more efficient. Our Robot Scientist 'Adam' was the first machine to autonomously discover novel scientific knowledge. Our Robot Scientist 'Eve' was originally designed to automate drug discovery, with a focus on neglected tropical diseases. We are now developing Genesis, a next-generation Robot Scientist designed to work on yeast systems biology. Genesis will soon be able to run 1,000 cycles of hypothesis-led experiment in parallel per day.

Advanced Course on Artificial Intelligence (ACAI)

SYMBOLIC AI WITH KNOWLEDGE GRAPHS AND ONTOLOGIES; THE PROMISE AND PERILS OF FAIR DATA



Speaker



Michel Dumontier
Maastricht University

Lecture 1

Symbolic AI with Knowledge Graphs and Ontologies - This lecture will introduce foundational elements of symbolic artificial intelligence, namely knowledge graphs and ontologies. In a knowledge graph, entities are represented as nodes, and the relationships between them are represented as edges. Knowledge graphs offer powerful query answering over structured and unstructured data sources, often with a need for high data quality and limited deductive properties. Ontologies complement data-focused knowledge graphs in that they formalise entities and their relations in a manner that is amenable to automated reasoning, so as to make additional inferences and uncover modelling errors. The lecture will cover developments in biomedicine, where substantial efforts have been made to construct and exploit structured knowledge for understanding human health and disease.

Lecture 2

The promise and perils of FAIR Data - FAIR data are data which meet the principles of findability, accessibility, interoperability, and reusability. The lecture will explain the need for FAIR data and the history of the FAIR principles. It will then discuss the FAIR principles themselves and examine guidelines, standards, and repositories for FAIR digital objects. In this context, it will also introduce the TRUST principles for repositories, where TRUST stands for transparency, responsibility, user focus, sustainability and technology. The lecture will also look at methods to automatically assess FAIRness and discuss how we can move towards an Internet of FAIR Data and Services. Finally, the lecture will explore applications of the FAIR principles in biomedicine.

Advanced Course on Artificial Intelligence (ACAI)

FORMALISATION OF SCIENTIFIC KNOWLEDGE



Speaker



Larisa Soldatova
University of London

Abstract

AI systems have super-human ability in making flawless logical conclusions from available data and knowledge. To unleash this power, data and knowledge have to be modelled and encoded in a machine-processable form. In this lecture, we will talk about technologies for knowledge representation, have a look at knowledge representation languages, and discuss examples. We will talk about ontology engineering, it's fascinating history and contemporary applications. You will learn basics principles for designing and using ontologies. We will analyse examples of knowledge modelling, its pitfalls and difficulties. We then will inspect several ontologies for the representation of key scientific processes and its components: hypotheses, experimental protocols, scientific investigations. In particular, we will focus on ontologies for representing and encoding data mining and machine learning studies. We will discuss the role of data and knowledge models for the Open Science framework. Finally, we will have a close look at the case study: formalisation of knowledge for a robot scientist - an AI system for automated scientific discovery. You will learn how knowledge models and ontologies support robot scientists.

Advanced Course on Artificial Intelligence (ACAI)

BASIC IDEAS IN QUANTUM MACHINE LEARNING



Speaker



Vedran Dunjko
Leiden University

Abstract

Quantum computing constitutes a fundamentally different paradigm for the processing of information. While confined to theoretical investigations only for decades, progress in experimental quantum computing has contributed to a dramatic increase in interest in this computational model. One of the more intriguing applications of quantum computers is in the direction of quantum-enhanced machine learning and AI. In this short lecture, we will provide the basic ideas behind quantum computing and quantum machine learning and attempt to provide a critical discussion of their potential and challenges.

Advanced Course on Artificial Intelligence (ACAI)

MACHINE LEARNING FORCE FIELDS UNLOCK ATOMIC SIMULATIONS



Speaker



Claudio Zeni
Microsoft Research

Abstract

This talk delves into the emerging role of machine learning (ML) force fields in materials science and biology, exploring their potential to revolutionize our understanding of complex atomic and molecular interactions. We will discuss the limitations of classical force fields and how ML techniques, such as deep learning and kernel methods, can model potential energy surfaces more accurately and efficiently. By learning from quantum mechanical calculations, ML force fields can provide insights into chemical reactions, protein folding, and material properties, guiding experimental research and accelerating drug discovery. The presentation will emphasize the transformative potential of ML force fields and the importance of continued interdisciplinary research to harness their full capabilities.

Advanced Course on Artificial Intelligence (ACAI)

AI FOR BIOLOGY AND SCIENCE



Speakers



Clare Bycroft
DeepMind



Žiga Avsec
DeepMind

Abstract

Deep learning approaches are proving to be an important tool for tackling problems in genomics. Specifically, predicting fundamental molecular phenomena, such as gene transcription, or epigenetic marks) from DNA sequence is an important problem in understanding genome function. We will describe DeepMind's approach to leveraging large amounts of epigenetic information to predict gene expression from DNA sequence.

DeepMind is committed to tackling important unsolved problems in biology, and in science more broadly. We will describe a variety of deep learning models developed by DeepMind (such as AlphaFold), which have solved important outstanding scientific problems. We will also discuss the impact these models have had in real-world applications.

Advanced Course on Artificial Intelligence (ACAI)

LANGUAGE MODELING FOR SCIENCE



Speaker



Arman Cohan
Yale University

Abstract

Language models have become indispensable tools for scholars to tackle information overload, enabling them to efficiently discover and comprehend the most relevant research literature. In this talk, we will present a thorough overview of language modeling techniques specifically tailored for the scientific domain. We will begin by delving into the foundations of prevalent language models for science, outlining their essential components and training methodologies. Subsequently, we will explore domain adaptation techniques, which enable these models to be fine-tuned for specialized scientific fields. Next, we will examine evaluation methodologies and investigate specific natural language processing (NLP) tasks pertinent to scientific documents. Furthermore, we will discuss representation learning methods for scientific papers and address the challenges associated with evaluating these methods. To conclude the talk, we will highlight the existing challenges and open problems in the field of scientific language modeling, and suggest promising directions for future research endeavors.

Advanced Course on Artificial Intelligence (ACAI)

TEMPORAL REASONING IN AI: AN INTRODUCTION



Speaker

Abstract



Nicola Gigante
Free University of Bozen-Bolzano

Temporal reasoning, in its most general sense, is a fundamental skill for any kind of autonomous agent, since acting in the world requires to reason about how known facts about the environment change over time. Indeed, temporal reasoning is a cornerstone field of AI which has been studied in different ways for decades. The course aims at introducing the most important concepts, methodologies, and results of the field, including temporal logics, automated planning, reactive synthesis, etc. Students attending the course will obtain a general picture of the field and of its interactions with other fields of AI.

European Summer School on Artificial Intelligence (ESSAI)

AUTOML: ACCELERATING RESEARCH ON AND DEVELOPMENT OF AI APPLICATIONS



Speakers

Abstract



Marius Lindauer
Leibniz University Hannover



Katharina Eggensperger
University of Tübingen

Machine learning (ML) can be frustrating and time-consuming since small design decisions can already make the difference between state-of-the-art performance and no learning progress at all. If one does not have ample experience developing new ML applications, it can take days, weeks or even months to figure out the correct settings for all bells and whistles. Automated Machine Learning (AutoML) supports developers and researchers in efficiently obtaining well-performing predictive models. It helps them determine the best hyperparameters, neural architectures, preprocessing, and even entire data processing pipelines for a dataset and metric at hand. This course will summarize the main principles, ideas and recent progress of AutoML, enabling the attendees to understand how to use AutoML efficiently for their next projects. This includes introductions into Hyperparameter Optimization with Bayesian Optimization, Neural Architecture Search, AutoML systems, and human-centered AutoML.

European Summer School on Artificial Intelligence (ESSAI)

FROM STATISTICAL RELATIONAL TO NEURAL SYMBOLIC ARTIFICIAL INTELLIGENCE



Speakers



Sebastijan Dumančić
TU Delft



Robin Manhaeve
KU Leuven



Giuseppe Marra
KU Leuven

Abstract

The integration of learning and reasoning is one of the key challenges in artificial intelligence and machine learning today. The area neural symbolic computation tackles this challenge by integrating symbolic reasoning with neural networks. This course will provide an introduction to Neural Symbolic Artificial Intelligence (NeSy) by drawing several parallels with another field that has a rich tradition in integrating learning and reasoning, namely Statistical Relational Artificial Intelligence (StarAI). The course will discuss seven dimensions for introducing and categorizing several StarAI and NeSy approaches. By positioning a wide variety of systems along these dimensions, the course makes it possible to underline common patterns and similarities between them. Interesting opportunities for further research will be described, by looking at areas across the dimensions that have not yet been covered.

European Summer School on Artificial Intelligence (ESSAI)

PILLS OF ANSWER SET PROGRAMMING



Speakers



Mario Alviano
University of Calabria



Francesco Ricca
University of Calabria

Abstract

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 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).

European Summer School on Artificial Intelligence (ESSAI)

FORMAL EXPLAINABILITY IN ARTIFICIAL INTELLIGENCE



Speakers



Nina Narodytska
VMware Research



Alexey Ignatiev
Monash University



Joao Marques-Silva
CNRS

Abstract

The last decade witnessed massive advances in machine learning (ML), with far-reaching societal impact. By all accounts, such impact is expected to become even more prominent in the near future. Nevertheless, a threat to the widespread deployment of ML is the lack of trust that arises from decisions made by what are most often inscrutable ML 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 offer essentially no 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.

European Summer School on Artificial Intelligence (ESSAI)

EXPLAINING AND REPAIRING DESCRIPTION LOGIC ONTOLOGIES



Speakers



Francesco Kriegel
Technische Universität Dresden



Alexey Ignatiev
Technische Universität Dresden



Patrick Koopmann
Vrije Universiteit Amsterdam

Abstract

Like all large human-made digital artefacts, ontologies written in the Web Ontology Language OWL may contain errors, which are often detected when reasoning finds an inconsistency or generates consequences that are either unexpected or seem incomplete. In order to decide whether such a reasoning result really points to an error, the users need to be able to understand its derivation. Once they have determined that there is indeed an error in the ontology, they need help in repairing this error. After an introduction into ontology languages based on Description Logics, with an emphasis on the tractable DL EL, the course will describe classical explanation and repair methods employing axiom pinpointing. Then it will consider more sophisticated explanation approaches using proofs to explain consequences and abduction to explain non-consequences. Finally it describes repair methods that preserve more consequences than the classical ones.

European Summer School on Artificial Intelligence (ESSAI)

MACHINE LEARNING BEYOND STATIC DATASETS



Speaker



Martin Mundt
Technical University of
Darmstadt

Abstract

Machine learning studies the design of models and training algorithms in order to learn how to solve tasks from data. Whereas historically machine learning has concentrated primarily on static predefined training datasets and respective test scenarios, recent advances also take into account the fact that the world is constantly evolving. In this course, we will go beyond the train-validate-test phase and explore modern approaches to machines that can learn continually. In addition to a comprehensive overview of the breath of factors to consider in such continual learning, the course will outline the basics of techniques that span mitigation of forgetting across multiple tasks, selection of new data in ongoing training, and robustness with respect to unexpected data inputs.

European Summer School on Artificial Intelligence (ESSAI)

INTRODUCTION TO COMPUTATIONAL ARGUMENTATION SEMANTICS



Speakers



Srdjan Vesic
Computer Science Research
Institute of Lens



Dragan Doder
Utrecht University

Abstract

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.

European Summer School on Artificial Intelligence (ESSAI)

SMART-SIZED BENCHMARKING FOR BLACK-BOX OPTIMIZATION



Speakers



Tome Eftimov
Jožef Stefan Institute



Peter Korošec
Jožef Stefan Institute

Abstract

Moving to the era of explainable AI, a comprehensive comparison of the performance of single- and multi-objective stochastic optimization algorithms has become an increasingly important task. A crucial role in performing a performance assessment is the benchmarking process. This course will focus on providing details for the following parts of the benchmarking process: which optimization problems should be selected for the analysis to decrease the bias in the analysis; which performance measures should be collected and analyzed; and what is the appropriate statistical approach to analyze the performance data that will lead to more robust and reproducible outcomes. This course will provide an overview of the current approaches for analyzing algorithms' performance with special emphasis on caveats that should be more often noticed. The course will end with a demonstration of a web-service-based framework (i.e. DSCTool) for statistical comparison of single- and multi-objective stochastic optimization algorithms.

European Summer School on Artificial Intelligence (ESSAI)

PROBABILISTIC CIRCUITS: DEEP PROBABILISTIC MODELS WITH RELIABLE REASONING



Speakers



Robert Peharz
Graz University of Technology



Antonio Vergari
University of Edinburgh

Abstract

Decision making in the real world involves reasoning in the presence of uncertainty, calling for a probabilistic approach. Often, these reasoning processes can be rather complex and involve background knowledge given by logical or arithmetic constraints. Moreover, in sensitive domains like health-care and economical decision making, the results of these queries are required to be exact, as approximations without guarantees would make the decision making process brittle. Despite all their recent successes, deep probabilistic models, such as VAEs, normalizing flows and diffusion models, are intractable and fall short of the above requirements. In this Introductory Course, we will introduce the research field of Tractable Probabilistic Modeling in general and the framework of Probabilistic Circuits (PCs) in particular, which have recently emerged as a "lingua franca" of tractable probabilistic modeling. We will first introduce the students to the general field of probabilistic machine learning and motivate the use of probabilistic models as rigorous and consistent reasoning tools. We will review classical representations such as probabilistic graphical models and provide a brief introduction to modern deep probabilistic models, illustrating their intractability and the need for tractable representations. We will then introduce the field of tractable probabilistic models, PCs as a universal framework to represent these, as well as learning and inference algorithms for PCs. Finally, we will cover recent developments and applications of PCs, as well as complex reasoning scenarios such as high-dimensional structured output prediction, as used for planning and semantic multi-label prediction.

European Summer School on Artificial Intelligence (ESSAI)

LARGE LANGUAGE MODELS: BACKGROUND AND APPLICATIONS



Speakers



Michael Roth
DFG Emmy Noether



Ivan Vulić
University of Cambridge

Abstract

Large language models (LLMs) have revolutionized the field of natural language processing in recent years, enabling machines to produce human-like language and perform tasks such as translation, sentiment analysis, and question answering. However, understanding the inner workings of LLMs and their implementation can be intimidating for beginners. In this course, we will explore different variants of LLMs, focusing on transformer-based models such as BERT, GPT, and RoBERTa, and their specific use cases. We will cover the basic components of these LLMs and their architecture, the pre-training and fine-tuning process, as well as applications. The course will provide step-by-step guidance on how to use different LLMs, based on implementations in Python and existing libraries. Along the way, we will also discuss ethical considerations and limitations. Finally, a tutorial on Friday will cover more advanced topics such as modularity and parameter efficiency, as well as the use of LLMs in multilingual and multimodal setups.

European Summer School on Artificial Intelligence (ESSAI)

LEARNING TO ACT AND PLAN



Speakers



Blai Bonet
Pompeu Fabra University



Hector Geffner
RWTH Aachen University

Abstract

This is an advanced course on learning to act and plan in different settings: when the action model is known, when it is not known but has to be learned, and when it is not known and doesn't have to be learned at all. The five lectures will be as follows: 1. Intro: models and solvers, model-based solvers vs. model-free learners. Deep learning and stochastic gradient descent as another class of model and solver. 2. Classical planning: languages and algorithms; planning as heuristic search and as SAT, learning planning models. 3. MDPs and RL: the model, basic model-based algorithms; reinforcement learning: model-based and model-free. Policy gradient and policy optimization. 4. General plans: learning policies that generalize across domains. Representing and learning such plans using combinatorial and deep learning approaches. 5. Hierarchies and problem decomposition: width and width-based search; representing problem decomposition in a general language; learning subgoal structure.

European Summer School on Artificial Intelligence (ESSAI)

FOUNDATIONS OF AUTOMATED PLANNING



Speaker



Roman Barták
Charles University, Prague

Abstract

Planning is the reasoning part of acting. It deals with selecting and organizing actions to achieve a given goal. The course introduces automated planning, starting with a formal logical model of planning tasks, through core planning techniques (state-space and plan-space search, planning graph and reduction-based techniques), till exploiting control knowledge and relation to scheduling and execution.

European Summer School on Artificial Intelligence (ESSAI)

MODEL UNCERTAINTY IN SEQUENTIAL DECISION MAKING



Speakers



David Parker
University of Oxford

Bruno Lacerda
University of Oxford



Nick Hawes
University of Oxford

Abstract

The deployment of autonomous systems in the real world presents opportunities to combine model-based reasoning with data-driven models. To approach this in a systematic way, one must acknowledge the inherent inaccuracies and underspecification of data-driven models. Therefore, understanding and reasoning about model uncertainty is crucial. This reasoning can be qualitative, in the form of policies which are robust to variations in the model, or quantitative, in the form of policies that operate on the belief space of models. This introductory course will focus on understanding and reasoning about model uncertainty. We will introduce several extensions of the standard Markov decision process (MDP) framework for planning under uncertainty that enable reasoning over model uncertainty. We will begin by providing the basics of planning for MDPs, and then use the context of long-term autonomy to demonstrate the need for reasoning about model uncertainty. We will then cover three extensions of MDPs designed to do so: interval MDPs, uncertain MDPs, and Bayes-adaptive MDPs.

European Summer School on Artificial Intelligence (ESSAI)

UNCERTAINTY QUANTIFICATION IN MACHINE LEARNING



Speakers



Marco Zullich
University of Groningen



Matias Valdenegro-Toro
University of Groningen

Abstract

What if we train a model to classify dogs and cats, but it is later tested with an image of a human? Generally, the model will output either dog or cat, and has no ability to signal that the image contains no class that it can recognize.

This is because classical neural networks do not contain ways to estimate their own uncertainty, and this has practical consequences for the use of these models, like safety when cooperating with humans, autonomous systems like robots, computer vision systems, and other uses that require reliable uncertainty quantification estimates.

In this short course, we will cover the basic concepts of how to train machine learning models with uncertainty, bayesian neural networks, uncertainty quantification, and related benchmarks and evaluation metrics, and have practical sessions on how to implement/use these techniques using either keras-uncertainty and/or pytorch's pyro, depending on the students' choice.

European Summer School on Artificial Intelligence (ESSAI)

AUTOMATED VERIFICATION OF MULTI-AGENT SYSTEMS. WHY, WHAT, AND ESPECIALLY: HOW?



Speakers



Catalin Dima
Université Paris-Est Créteil



Wojciech Jamroga
Polish Academy of Sciences

Abstract

Automated verification of discrete-state systems has been a hot topic in computer science for over 35 years. The idea found its way into AI and multi-agent systems in late 1990's, and techniques for verification of such systems have been in constant development since then. Model checking of temporal, epistemic, and strategic properties is one of the most prominent and most successful approaches here. In this course, we present a brief introduction to the topic, and mention relevant properties that one might like to verify this way. Then, we describe some very recent results on incomplete model checking algorithms and model reductions, which can potentially lead to practical solutions for the notoriously hard problem. We conclude by a presentation of the experimental tool for verification of strategic ability, being developed by our research group at the Polish Academy of Sciences. [The course features advanced content presented with introductory attitude. If needed, we can change the proposal to a foundational course, focusing on formal semantics and fundamental theoretical results, as discussed with the organizers.]

European Summer School on Artificial Intelligence (ESSAI)

CONTINUAL LEARNING FOR IMAGE CLASSIFICATION



Speaker



Adrian Popescu
CEA LIST

Abstract

Standard machine learning methods assume that: (1) training data are abundant, and available at all times, (2) computational power is sufficient and (3) memory is not constrained. These conditions are often not met in real-life conditions. For instance, use case specific data are often scarce, arrive sequentially, and are non-stationary. Novelty needs to be integrated continuously, while preserving the previously learned knowledge. In these cases, continual learning (CL) methods need to be deployed. This course will focus on continual learning for image classification, and will discuss: (1) the main continual learning challenges (catastrophic forgetting, drift, stability-plasticity compromise, role of memory, scalability), (2) the main families of methods proposed to solve the task, (3) the relation to related areas (transfer learning, few-shot learning, edge learning), (4) the deployment of CL in practice, with examples of applications, and (5) good practices for CL evaluation.

European Summer School on Artificial Intelligence (ESSAI)

MULTI-OBJECTIVE REINFORCEMENT LEARNING



Speaker



Roxana Rădulescu
Vrije Universiteit Brussel

Abstract

Reinforcement learning (RL) is a rapidly growing field in machine learning concerned with agents learning how to act optimally in sequential decision-making settings. Such settings translate to numerous real-world problems, where one has to take a sequence of actions in order to reach a desired goal. Real-world problems are generally complex and require trade-offs between multiple, often conflicting, objectives. Despite this, the majority of research in reinforcement learning either assumes only a single objective, or that multiple objectives can be adequately handled via a simple linear combination. Such approaches may oversimplify the underlying problem and hence produce sub-optimal results. Multi-objective reinforcement learning (MORL) is the more general setting that explicitly allows for multiple objectives to be taken into account during the learning process. The goal of this course is to provide an in-depth overview of multi-objective reinforcement learning and a guide to the application of MORL methods. It identifies the factors that may influence the nature of the desired solution, and illustrates how these should be used to guide the design of multi-objective decision-making systems for complex problems.

European Summer School on Artificial Intelligence (ESSAI)

STATISTICAL EVALUATION OF THE PERFORMANCE OF MACHINE LEARNING MODELS



Speaker



Richard Dinga
Tilburg University

Abstract

Machine learning model validation is essential because any methodological progress cannot be trusted if the results are not properly evaluated using valid and reliable methods. Unfortunately, incorrect methods are common in scientific literature and business, leading to suboptimal model selection and incorrect conclusions. This tutorial will provide a practical guide to a wide range of everyday validation tasks. Namely statistically testing if a model performs better than chance, comparing the performance of two or more models, selecting performance measures with respect to their statistical properties such as reproducibility and statistical power, and model validation in the presence of confounds, validation of feature effects and validation of clustering methods, all with a strong focus on valid statistical inference. Participants will learn how to apply correct statistical tests in various situations.

European Summer School on Artificial Intelligence (ESSAI)

AI FAIRNESS AND PRIVACY: FUNDAMENTALS, SYNERGIES, AND CONFLICTS



Speakers



Tijl De Bie
Ghent University



Maarten Buyt
Ghent University

Abstract

Fairness and privacy are two cornerstones of trustworthy AI. The terms fairness and privacy evoke intuitive associations to familiar concepts, and indeed no technical knowledge appears required to engage in a fruitful discussion on these topics. Yet, people who attempt to formalize these notions, so they can be accounted for by AI systems, find significant obstacles on their path. This course will guide you along this obstacle course. We will discuss both the key concepts and seminal algorithms, point out both fundamental difficulties and practical issues, and survey both the state-of-the-art and the open challenges.

European Summer School on Artificial Intelligence (ESSAI)

KNOWLEDGE REPRESENTATION AND REASONING WITH ONTOLOGIES



Speaker



Panče Panov
Jožef Stefan Institute

Abstract

This course will cover the basics of knowledge representation and reasoning using ontologies as a representational formalism. Ontologies form the basis for the machine-processable formal representation of domain knowledge and play a crucial role in the sharing of information structure by humans or software agents. In this course, we will discuss the specifics of the various knowledge organisation structures that can be used in different use cases. The focus will be on representing and modelling domain knowledge with ontologies. We will also cover the basic concepts of description logic as a basic formalism for representing ontologies. Finally, we will focus on the process of developing a domain ontology in OWL (Ontology Web Language) using an open-source ontology editor Protégé and on querying knowledge bases using the query language SPARQL.

European Summer School on Artificial Intelligence (ESSAI)

PRACTICAL APPLICATIONS OF ARTIFICIAL INTELLIGENCE FOR ROBOTICS



Speaker



Timothy Wiley
RMIT University

Abstract

Creating Artificially Intelligent fully autonomous robots face unique challenges in transferring AI techniques into a practical real-world and real-time domain. Robotic 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 focuses on the design and development of the practical AI software architectures for autonomous robotic systems, including reactive actuator control, 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.

European Summer School on Artificial Intelligence (ESSAI)

MACHINES CLIMBING PEARL'S LADDER OF CAUSATION



Speakers



Matej Zečević
TU Darmstadt



Devendra Dhami
TU Darmstadt



Adèle Ribeiro
University of Marburg

Abstract

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 modelling 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). 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.

European Summer School on Artificial Intelligence (ESSAI)

GAME-THEORETIC APPROACH TO PLANNING AND SYNTHESIS



Speakers



Antonio Di Stasio
University of Oxford



Giuseppe Perelli
La Sapienza



Shufang Zhu
University of Oxford

Abstract

This course introduces AI planning and program synthesis for tasks (goals) expressed over finite traces instead of states. Specifically, borrowing from 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 to handle planning in nondeterministic domains. Then, we will draw connections with verification, and reactive synthesis, together with their game-theoretic solution techniques. The main catch is that working with these logics can be based on devising suitable 2-players games and finding strategies, i.e., plans, to win them. Specifically, we will cover the following topics: Planning in nondeterministic domain, Temporal Logics, LTL, LTLf, Game-theoretic Techniques, Safety Games, Reachability Games, Games for LTL/LTLf objectives, and Reactive Synthesis. This course is partially based on the work carried out in ERC Advanced Grant WhiteMech and EU ICT-48 TAILOR.

European Summer School on Artificial Intelligence (ESSAI)