INSTITUTE 2024
SCHLOSS DAGSTUHL
(GERMANY • SEP 23-27)

ARTIFICIAL AND HUMAN INTELLIGENCE

FORMAL AND COGNITIVE FOUNDATIONS FOR HUMAN-CENTRED COMPUTING

/ LECTURES. TUTORIALS. PANEL DISCUSSION.
DOCTORAL COLLOQUIUM. /

ARTIFICIAL INTELLIGENCE. MACHINE LEARNING. COGNITIVE SCIENCE.
COGNITIVE PSYCHOLOGY. VISUAL COGNITION AND COMPUTATION.
COGNITIVE NEUROSCIENCE. HUMAN-COMPUTER INTERACTION. DESIGN COGNITION.

CODESIGN LAB EU > COGNITION. AI. INTERACTION. DESIGN.
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INSTITUTE 2024 / ARTIFICIAL AND HUMAN INTELLIGENCE

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SCHLOSS DAGSTUHL / LEIBNIZ CENTER FOR INFORMATICS

www.dagstuhl.de

STEERING AND ORGANISATION

Institute 2024 on Artificial and Human Intelligence is an initiative of **CoDesign Lab EU**.

INSTITUTE 2024 CHAIRS

- MEHUL BHATT - Örebro University, Sweden
- ÁRNI KRISTJÁNSSON - University of Iceland, Iceland
- PAUL HEMEREN - University of Skövde, SE
- JAKOB SUCHAN - Constructor University, Germany
- VASILIKI KONDYLI - Jagiellonian University, Poland

MEDIA AND COMMUNICATIONS

- ANDRES ACEVEDO - THE MARKET EXIT AB, Sweden
- GABRIELE SACCO - VOLUNTEER - UniBz & FBK, Italy

ADMINISTRATIVE SUPPORT (SCHLOSS DAGSTUHL, GERMANY)

- HEIKE CLEMENS - Logistics and Administration
- CHRISTINA SCHWARTZ - Publishing and Seminar Management

ABOUT INSTITUTE 2024

INSTITUTE 2024 / ARTIFICIAL AND HUMAN INTELLIGENCE

The INSTITUTE 2024 on **Artificial and Human Intelligence** is an advanced training forum positioning research methodologies and perspectives from Artificial Intelligence, Cognitive Science, Neuroscience, Psychology & Human Development, Human-Computer Interaction, and Design Science. Institute 2024 is held at Schloss Dagstuhl (Germany) during September 23-27, 2024.

The institute consists of an integrated school, panel discussion, and young researcher forum; the institute is primarily (but not exclusively) aimed at early stage doctoral researchers and research-inclined students enrolled in a bachelors or masters programme. Institute participants include professional academics, doctoral candidates, industry professionals, and research-driven students. The institute hosts an invited faculty delivering lectures, intensive tutorials, and keynotes; opportunities also exist for young researchers to position ongoing / early stage research, discuss, and network with institute faculty and participants.

CONFLUENCE / COGNITION. AI. INTERACTION. DESIGN.

Research in Artificial and Human Intelligence aims to bring together and advance a novel & unique combination of research methodologies, academics and communities encompassing artificial intelligence, cognitive science, neuroscience, psychology & human development, human-computer interaction, and design science. In addition to pursuing its core scientific agenda, this line of inquiry also creates a discussion point for the development of interdisciplinary research, projects, collaborations, and other international people-exchange initiatives addressing CoDesign, the confluence of Cognition, AI, Interaction, and Design (https://www.codesign-lab.org/).

HUMAN-CENTRED AI & COGNITIVE TECHNOLOGIES.

The Institute addresses the formal & cognitive foundations for human-centred computing (for AI), and the human-centred design, development, and usability of cognitive technologies aimed at human-in-the-loop assistance & empowerment in decision-making, planning, creative-technical problem-solving, and automation.

The scientific agenda of the Institute emphasises development of novel foundational methods for human-centred AI keeping in mind interpretability & explainability, generality / domain-independence and elaboration tolerance (of methods), community benchmarking, and re-usability.

MINDS. EXPERIENCES. TECHNOLOGIES.

Of special interest to Institute 2024 is the design and development of artificial cognitive technologies where the human-centred modelling, interpretation, simulation, and synthesis of **embodied cognitive experiences** encompassing, for instance, multimodal perception and interaction is critical. Example application areas in focus include:

- Autonomous Driving
- Cognitive Robotics - Social Robotics
- Cognitive Design Assistance Technologies
- Creative Media Design Tech
- Clinical Diagnostic Assistance Technologies
- Technology-Assisted Education / Learning

TECHNICAL FOCUS.

INSTITUTE 2024 courses encompass:

- the formal and computational foundations of AI and Cognitive Technologies with a principal emphasis on human-centred knowledge representation, semantics, commonsense reasoning, integration of reasoning & learning, and visuospatial representation and reasoning. A particular focus is on *integrated commonsense reasoning & learning about space and motion in human-scale embodied multimodal interaction.*
- behavioural / empirical methods in cognitive science & psychology and neuroscience aimed at investigating human intelligence from the viewpoints of embodiment, multimodal interaction, and visuospatial thinking. A special emphasis is on visuospatial cognition and computation, e.g., in the backdrop of aspects pertaining to *visual perception, high-level event perception, motion, and narrative-driven (episodic) perceptual sensemaking.*

Emerging research-driven themes of high interest to be addresses in the institute include:

- knowledge representation - semantics - commonsense - declarative methods
- semantic interpretation of multimodal human behaviour data
- integration of reasoning and learning - explainability - neurosymbolism
- synergy of computational and behavioural / empirical methods
- data-centred methods for psychology - psychology-driven AI "in the wild" experimentation
- embodiment - visuospatial thinking - motion & interaction - visuospatial perception and cognition
- design science - design cognition and computation - designing embodied cognitive experiences

HUMAN BEHAVIOUR. EMBODIMENT. VISUOSPATIAL THINKING.

The insititute emphasises: (i). **"In-the-wild"** ecologically valid naturalistic (embodied multimodal interaction) settings; (ii). Bottom-up **interdisciplinary**, e.g., combining methods in AI and cognitive psychology; and (iii). **Design-thinking** as a human-centred perspective for engineering ("usable") cognitive technologies aiming to assist, empower, and augment human capability.

The institute particularly addressees key topics of interest from formal, cognitive, computational, engineering, empirical, psychological, and philosophical perspectives. Indicative topics and applications in focus include:

- knowledge representation - semantics
- reasoning about space, actions
- commonsense reasoning
- computational cognitive systems
- deep (visuo-spatial) semantics
- declarative spatial reasoning
- integrated reasoning and learning
- non-monotonic reasoning
- visual computing computing
- cognitive vision and perception]

INSTITUTE 2024 / ARTIFICIAL AND HUMAN INTELLIGENCE

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SCHLOSS DAGSTUHL / LEIBNIZ CENTER FOR INFORMATICS

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FACULTY

INSTITUTE 2024 / FACULTY

LECTURERS

- Cindy Xiong Bearfield (Georgia Institute of Technology)
- Mehul Bhatt (Örebro University)
- Emmanuelle Dietz (Airbus Hamburg)
- Thomas Eiter (Vienna University of Technology)
- Paul Hemeren (University of Skövde)
- Árni Kristjánsson (University of Iceland)
- Vasiliki Kondyli (Jagiellonian University)
- Clayton Lewis (University of Colorado - Boulder)
- Oliver Kutz (Free University of Bozen-Bolzano)
- Antonio Lieto (University of Salerno & ICAR-CNR)
- Alessandra Russo (Imperial College London)
- Jakob Suchan (Constructor University)
- Ilaria Tiddi (Vrije Universiteit Amsterdam)
- Barbara Tversky (Stanford University & Columbia University)

TUTORIAL PRESENTERS

- Mehul Bhatt (Örebro University)
- Emmanuelle Dietz (Airbus Hamburg)
- Vasiliki Kondyli (Jagiellonian University)
- Jakob Suchan (Constructor University)

CINDY XIONG BEARFIELD

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BIOGRAPHY

Cindy Xiong Bearfield is an Assistant Professor in the School of Interactive Computing at Georgia Institute of Technology. Bridging the fields of psychology and data visualization, Professor Bearfield aims to understand the cognitive and perceptual processes that underlie visual data interpretation and communication. Her research informs the design and development of visualizations and visualization tools that elicit calibrated trust in complex data to facilitate more effective visual data analysis and communication.

She received her Ph.D. in Cognitive Psychology and her MS in Statistics from Northwestern University. Her research at the intersection of human perception, cognition, and data visualization has been recognized with an NSF CAREER award. She has received awards at premier psychology and data visualization venues, including Psychonomics, ACM CHI, IEEE PacificVis, and IEEE VIS. She is also one of the founding leaders of VISxVISION (visxvision.com), an initiative dedicated to increasing collaboration between visualization researchers and perceptual and cognitive psychologists.

MEHUL BHATT

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BIOGRAPHY

Mehul Bhatt is Professor within the School of Science and Technology at Orebro University (Sweden), and a Guest Professor at the University of Skövde (Sweden). His basic research focusses on formal, cognitive, and computational foundations for AI technologies with a principal emphasis on knowledge representation, semantics, integration of commonsense reasoning & learning, explainability, and spatial representation and reasoning. Mehul Bhatt steers CoDesign Lab (www.codesign-lab.org), an initiative aimed at addressing the confluence of Cognition, Artificial Intelligence, Interaction, and Design Science for the development of human-centred cognitive assistive technologies and interaction systems. Since 2014, he directs the research and consulting group DesignSpace (www.design-space.org) and pursues ongoing research in Cognitive Vision (www.codesign-lab.org/cognitive-vision) and Spatial Reasoning (www.spatial-reasoning.com).

Mehul Bhatt obtained a bachelors in economics (India), masters in information technology (Australia), and a PhD in computer science (Australia). He has been a recipient of an Alexander von Humboldt Fellowship, a German Academic Exchange Service award (DAAD), and an Australian Post-graduate Award (APA). He was the University of Bremen nominee for the German Research Foundation (DFG) Award: Heinz Maier-Leibnitz-Preis 2014. Prior to moving to Sweden, Mehul Bhatt was Professor at the University of Bremen (Germany). Further details are available via: www.mehulbhatt.org.

» Research Statement (Artificial and Human Intelligence) / http://codesign-lab.org/hcc/agenda.html

EMMANUELLE DIETZ

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BIOGRAPHY

Emmanuelle Dietz is a human-centered technology scientist at Airbus Central R&T in Hamburg, Germany. Previously, she was a postdoctoral researcher at the Knowledge Representation and Reasoning group at TU Dresden. After completing her master's degree in Computer Science at Utrecht University, she registered in the European PhD Program in Computational Logic at TU Dresden where she received a joint PhD Degree. During and after her PhD studies she was a visiting researcher at UNL in Portugal, SFU in Canada and UCY in Cyprus. Her research interest covers areas from Cognitive Science, Computational Argumentation and Logic Programming, in particular the formalization of human reasoning and benchmarking cognitive models.

THOMAS EITER

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BIOGRAPHY

Thomas Eiter is a professor in the Faculty of Informatics of Vienna University of Technology (TU Wien), where is the head of the Knowledge-Based Systems Group and the Institute for Logic and Computation. He has been working in different fields of Computer Science and AI, with special interest in knowledge representation and reasoning, logic and computation, and declarative problem solving. Eiter is a fellow of the ACM, of the European Association for Artificial Intelligence (EurAI), and of the Asia-Pacific Artificial Intelligence Association (AAIA), as well as member of the Austrian Academy of Sciences and of Academia Europea (London). Furthermore, he is president of the Association for Logic Programming and past president of KR Inc., the organization behind the Conference on Principles of Knowledge Representation and Reasoning.

PAUL HEMEREN

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BIOGRAPHY

Paul Hemeren is an associate professor in informatics at the University of Skövde and was recruited as a cognitive scientist to the University of Skövde where the subject area of informatics includes cognitive science for the development of computational models of intelligence and to improve the interaction between humans and different kinds of technology. His Ph.D. in Cognitive Science is from Lund University. In his research, he looks at how we form concepts for things. More specifically, he examines how we perceive other people's movements in the form of different actions. Humans and other creatures have an amazing ability to quickly perceive what others are doing. How does this happen? What information is used to perceive another person's intentions in an action or movement? One side of his research is about how we organize our knowledge of other people's and our own actions. The other side is on how movement information in connection with the actions of others is processed in the human brain. An important aim of his research is to integrate these two sides to gain a broader and deeper understanding of how we perceive our interaction with others. These questions turn out to be important inputs for more applied projects about how we can create safer situations for cyclists and how we can achieve a better interaction between humans and robots.

ÁRNI KRISTJÁNSSON

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BIOGRAPHY

My research focuses on various aspects of human visual perception, such as visual attention and eye movements, how representations of the visual world are formed, visual foraging, and the influence of perceptual history on perception in the present. I mainly use psychophysical methods to answer these questions, but members of my lab and I are also involved in eye-tracking studies, neuroimaging, neuropsychological work, cognitive development studies, and clinical psychology. I received my Ph.D. from Harvard University in 2002, and worked as Honorary Research Fellow at the Institute of Cognitive Neuroscience at UCL from 2002-2004. From 2004 I have had a position at the University of Iceland.

VASILIKI KONDYLI

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BIOGRAPHY

Vasiliki Kondyli obtained her PhD in Computer Science at Örebro University (Sweden) as part of the Marie Skłodowska-Curie Grant, and she is currently a postdoctoral researcher at the Center for Cognitive Science, Jagiellonian University (Poland). Vasiliki is a trained architect (University of Patras, Greece) with specific expertise in parametric systems and environmental psychology and a member of the DesignSpace Group (www.design-space.org) and the CoDesign Lab EU (https://codesign-lab.org/). Her research interests involve embodied multimodal interactions between humans and their surrounding environment, specifically aspects of visual perception and spatial cognition studied under naturalistic conditions. A special focus has been on the development of a cognitive technological framework for human-centred assistive technologies and autonomous systems such as autonomous driving and design assistive technologies.

CLAYTON LEWIS

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BIOGRAPHY

Clayton Lewis is Emeritus Professor of Computer Science at the University of Colorado Boulder. Lewis served previously as Co-Director for Technology for the Coleman Institute for Cognitive Disabilities, and Fellow of the Institute of Cognitive Science, at CU, and as technology advisor to the director of the National Institute for Disability and Rehabilitation Research, US Department of Education. Lewis' recent research explores the implications of the success of predictive models, such as Large Language Models, for theories of human cognition. Other recent work addresses the implications of the same technology for programming, including especially programming in educational settings. He has also investigated the potential of machine learning to contribute to the develoment of supports for people with cognitive disabilities, including artificial personal assistants. Before joining the University of Colorado, Lewis was Manager of Human Factors at IBM's Watson Research Center, where he was a member of the research staff from 1970 to 1973 and 1979 to 1984. He holds degrees from Princeton, MIT, and the University of Michigan. He has been honored by appointment to the ACM SIGCHI Academy, by the SIGCHI Social Impact Award, by the Strache Leadership Award (CSUN Assistive Technology Conference), and by the ACM SIGACCESS Outstanding Contribution Award.

OLIVER KUTZ

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BIOGRAPHY

Oliver Kutz research focus lies at the intersections of computational and philosophical logic, knowledge representation, cognitive artificial intelligence, computational creativity, and applied ontology. More specifically, I work in the areas of Modal and Description Logics, ontologies and the logical foundations of the Semantic Web, non-monotonic reasoning and abduction, spatial reasoning, combination techniques for logics, models for conceptual blending, and the formalisation of core concepts in cognition such as 'affordances' and 'image schemas'. I investigate how formal models of logical reasoning and concept formation reflect common sense concepts of everyday reasoning, how such formal approaches can be informed through computational cognitive models, and how combined hybrid approaches bridging machine learning and symbolic AI can lead to new approaches in explainable AI, computational creativity, and human-machine interaction. I received a PhD from the University of Liverpool in 2005, held research positions in Manchester, Bremen, and Magdeburg, and am now Associate Professor at the Free University of Bozen-Bolzano, Italy, where I was recently the chief organiser and scientific chair of the 2020/21 Bolzano Summer of Knowledge. In 2023, I was elected President of the International Association for Ontology and its Applications (IAOA.org).

ANTONIO LIETO

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BIOGRAPHY

Antonio Lieto is an Associate Professor in Computer Science at the University of Salerno (Italy) and a research associate at the ICAR-CNR Institute in Palermo (Italy). He does research in Artificial Intelligence, Computational Cognitive Science and Human-Machine Interaction (and their intersections) with a focus on the following areas: knowledge representation and reasoning, semantic/language technologies, cognitive architectures for intelligent agents (embodied or not), persuasive technologies. Since January 2024, he is an elected member of the Scientific Board of the Italian Association for Artificial Intelligence (AI*IA). Previously, he has been Vice-President of the Italian Association of Cognitive Sciences (AISC, 2017-2022), the recipient of the "Outstanding BICA Research Award" from the Biologically Inspired Cognitive Architecture Society (USA) and, since 2020, is an ACM Distinguished Speaker. He has authored the book "Cognitive Design for Artificial Minds" (Routledge/Taylor & Francis, 2021) and over 100 scientific publications.

ALESSANDRA RUSSO

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BIOGRAPHY

Alessandra Russo is a Professor on Applied Computational Logic, at the Department of Computing, Imperial College London, Deputy director of the UKRI Centre for Doctoral Training in "Safe and Trusted AI", and promoter of the Imperial-X inter-disciplinary research initiative "Intelligible AI" on explainable, safe and trustworthy AI. She leads the "Structured and Probabilistic Intelligent Knowledge Engineering (SPIKE)" research group at the Department of Computing. She has pioneered several state-of-the-art symbolic machine learning systems, including the recent state-of-the-art LAS (Learning from Answer Sets) system for learning interpretable knowledge from labelled data. More recently she has explored novel methodologies for neuro-symbolic learning that integrate machine learning and probabilistic inference with symbolic learning to support generalisation and transfer learning from multimodal unstructured data. She has published over 200 articles in flagship conferences and high impact journals in Artificial Intelligence and Software Engineering, and led various projects funded by the EPSRC, the EU and Industry.

JAKOB SUCHAN

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BIOGRAPHY

Jakob Suchan is Assistant Professor at the Constructor University, Germany. My research is in the area of Cognitive Vision, particularly focussing on the integration of Vision and AI (specifically, KR) from the viewpoint of computational cognitive systems where integrated (embodied) perception and interaction are involved. My publications lie at the intersection of AI, Computer Vision, and Human-Centred Computing. In particular, I am interested in how we can develop general methods and tools that enable autonomous systems to abstract, understand, reason about, and learn from multimodal (human) Interactions, with the aim to assist humans in their everyday personal and professional tasks. From a technical point of view this includes for instance: – Commonsense Abstractions of Space and Motion – Declarative Reasoning and Learning about Visuospatial Dynamics - Neurosymbolic Integration of AI and Vision - Visual Perception (e.g., involving eye-tracking)

ILARIA TIDDI

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BIOGRAPHY

Ilaria Tiddi is an Assistant Professor in Hybrid Intelligence at the Knowledge in AI (KAI) group of the Vrije Universiteit Amsterdam (NL). Her research focuses on creating systems that generate complex narratives through a combination of semantic technologies, open data and machine learning, applied mostly in scientific and robotics scenarios. She is Editor-in-Chief of the CEUR-WS publication, part of the Steering Committee for the Hybrid Human-AI Conference, and Coordinator of the international Staff Exchange for the Dutch Hybrid Intelligence consortium. Since 2014, she is regularly active in the OCs/PCs of the major venues in the KR field (ISWC/ESWC, HHAI, WWW, CIKM, IJCAI/ECAI).

BARBARA TVERSKY

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BIOGRAPHY

Barbara Tversky studied cognitive psychology at the University of Michigan, where she focused on the then neglected topic of spatial memory and imagery. The work continued and expanded at the Hebrew University in Jerusalem and Stanford University to include categorization, memory, cognitive maps, spatial mental models, spatial language and memory, eyewitness testimony, biased visual and verbal memory, HCI, design, diagrammatic thinking, gesture, event perception and cognition, and creativity. She is currently Professor of Psychology at Columbia Teachers College and Professor Emerita of Psychology at Stanford. She has received awards for teaching and for a computer laboratory for teaching cognitive psychology, is a fellow of the American Academy of Arts and Sciences, the American Psychological Society, the Cognitive Science Society, and the Russell Sage Foundation, and was elected to the Society of Experimental Psychology. She has served on the governing boards of many professional organizations, on the editorial boards of many journals, and on the organizing committees of nearly 100 international interdisciplinary conferences. She has enjoyed collaborations with linguists, philosophers, computer scientists, neuroscientists, biologists, chemists, engineers, architects, designers, and artists.

LECTURES

INSTITUTE 2024 / LECTURES

DESIGNS TO SUPPORT BETTER VISUAL DATA COMMUNICATION

CINDY XIONG BEARFIELD

GEORGIA INSTITUTE OF TECHNOLOGY, UNITED STATES

VISUOSPATIAL COMMONSENSE: ON NEUROSYMBOLIC REASONING AND LEARNING ABOUT SPACE AND MOTION

MEHUL BHATT

ÖREBRO UNIVERSITY, SWEDEN

HYBRID ANSWER SET PROGRAMMING AND ITS USE FOR VISUAL QUESTION ANSWERING

THOMAS EITER

VIENNA UNIVERSITY OF TECHNOLOGY, AUSTRIA

HUMAN ACTION RECOGNITION, COGNITION, AND COMPUTATIONAL MODELS IN RELATION TO FORMAL AND COGNITIVE FOUNDATIONS FOR HUMAN-CENTERED COMPUTING

PAUL HEMEREN

UNIVERSITY OF SKÖVDE, SWEDEN

PRIMING OF PROBABILISTIC VISUAL TEMPLATES

ÁRNI KRISTJÁNSSON

UNIVERSITY OF ICELAND, ICELAND

THE EFFECT OF ENVIRONMENTAL COMPLEXITY ON EVERYDAY VISUAL ATTENTION

VASILIKI KONDYLI

JAGIELLONIAN UNIVERSITY, POLAND

PREDICTIVE MODELING AND HUMAN COGNITION: THEORY AND APPLICATION

CLAYTON LEWIS

UNIVERSITY OF COLORADO - BOULDER, USA

USING LOGIC TO REPRESENT AND COMBINE CONCEPTS

OLIVER KUTZ

FREE UNIVERSITY OF BOZEN-BOLZANO, ITALY

COGNITIVE DESIGN FOR AI SYSTEMS WITH HUMAN-LIKE REASONING

ANTONIO LIETO

UNIVERSITY OF SALERNO & ICAR-CNR, ITALY

NEURO-SYMBOLIC AI AND ITS ROLE IN ROBUST AND INTERPRETABLE AI-DRIVEN DECISION-MAKING

ALESSANDRA RUSSO

IMPERIAL COLLEGE LONDON, UNITED KINGDOM

NEUROSYMBOLIC LEARNING: ON GENERALISING RELATIONAL VISUOSPATIAL AND TEMPORAL STRUCTURE

JAKOB SUCHAN

CONSTRUCTOR UNIVERSITY, GERMANY

KNOWLEDGE ENGINEERING METHODS FOR HYBRID HUMAN-ARTIFICIAL INTELLIGENCE

ILARIA TIDDI

VRIJE UNIVERSITEIT AMSTERDAM, THE NETHERLANDS

USING SPACE TO THINK AND COMMUNICATE

BARBARA TVERSKY

COLUMBIA TEACHERS COLLEGE, USA

DESIGNS TO SUPPORT BETTER VISUAL DATA COMMUNICATION

CINDY XIONG BEARFIELD

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ABSTRACT.

Well-chosen data visualizations can lead to powerful and intuitive processing by a viewer, both for visual analytics and data storytelling. When badly chosen, visualizations leave important patterns opaque or misunderstood. So how can we design an effective visualization? I will share several empirical studies demonstrating that visualization design can influence viewer perception and interpretation of data, referencing methods and insights from cognitive psychology. I leverage these study results to design natural language interfaces that recommend the most effective visualization to answer user queries and help them extract the 'right' message from data. I then identify two challenges in developing such an interface. First, human perception and interpretation of visualizations is riddled with biases, so we need to understand how people extract information from data. Second, natural language queries describing takeaways from visualizations can be ambiguous and thus difficult to interpret and model, so we need to investigate how people use natural language to describe a specific message. I will discuss ongoing and future efforts to address these challenges in the real world, providing concrete guidelines for visualization tools that help people more effectively explore and communicate data.

SELECT PUBLICATIONS

Gaba, A., Kaufman, Z., Cheung, J., Shvakel, M., Hall, K. W., Brun, Y., & Bearfield, C. X. (2023). My Model is Unfair, Do People Even Care? Visual Design Affects Trust and Perceived Bias in Machine Learning. IEEE transactions on visualization and computer graphics.

Elhamdadi, H., Stefkovics, A., Beyer, J., Moerth, E., Pfister, H., Bearfield, C. X., & Nobre, C. (2023). Vistrust: A multidimensional framework and empirical study of trust in data visualizations. IEEE Transactions on Visualization and Computer Graphics.

Bearfield, C. X., van Weelden, L., Waytz, A., & Franconeri, S. (2024). Same Data, Diverging Perspectives: The Power of Visualizations to Elicit Competing Interpretations. IEEE Transactions on Visualization and Computer Graphics.

VISUOSPATIAL COMMONSENSE: ON NEUROSYMBOLIC REASONING AND LEARNING ABOUT SPACE AND MOTION

MEHUL BHATT

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ABSTRACT.

This talk addresses computational cognitive vision and perception at the interface of (spatial) language, (spatial) logic, (spatial) cognition, and artificial intelligence. Summarising recent works, I present general methods for the semantic interpretation of dynamic visuospatial imagery with an emphasis on the ability to (neurosymbolically) perform abstraction, reasoning, and learning with cognitively rooted structured characterisations of commonsense knowledge pertaining to space and motion. I will particularly highlight:

- explainable models of computational visuospatial commonsense at the interface of symbolic and neural techniques;
- deep semantics, entailing systematically formalised declarative (neurosymbolic) reasoning and learning with aspects pertaining to space, space-time, motion, actions & events, spatio-linguistic conceptual knowledge;
- general foundational commonsense abstractions of space, time, and motion needed for representation mediated (grounded) reasoning and learning with dynamic visuospatial stimuli.

The presented works -demonstrated in the backdrop of applications in autonomous driving, cognitive robotics, visuoauditory media, and cognitive psychology- are intended to serve as a systematic model and general methodology integrating diverse, multi-faceted AI methods pertaining Knowledge Representation and Reasoning, Computer Vision, and Machine Learning towards realising practical, human-centred, computational visual intelligence. I will conclude by highlighting a bottom-up interdisciplinary approach -at the confluence of Cognition, AI, Interaction, and Design Science- necessary to better appreciate the complexity and spectrum of varied human-centred challenges for the design and (usable) implementation of (explainable) artificial visual intelligence solutions in diverse human-system interaction contexts.

SELECT PUBLICATIONS

Bhatt, M., and Suchan, J. (2023). Artificial Visual Intelligence: Perceptual Commonsense for Human-Centred Cognitive Technologies. In Human-Centered Artificial Intelligence: Advanced Lectures. Springer-Verlag, Berlin, Heidelberg, 216–242. https://doi.org/10.1007/978-3-031-24349-3_12

Bhatt, M., Schultz, C. (2017). People-Centered Visuospatial Cognition: Next-generation Architectural Design Systems and their Role in Conception, Computing, and Communication. In: The Active Image: Architecture and Engineering in the Age of Modelling. Editors: Ammon, S. and Capdevila-Werning, R. Pages: 291, Volume 28 of Philosophy of Engineering and Technology, Springer International Publishing., ISBN: 331956465X, 9783319564654, 2017.

Bhatt, M., Schultz, C., Freksa, C. (2013). The 'Space' in Spatial Assistance Systems: Conception, Formalisation and Computation. In: Representing space in cognition: Interrelations of behaviour, language, and formal models. Series: Explorations in Language and Space. 978-0-19-967991-1, Oxford University Press (2013).

HYBRID ANSWER SET PROGRAMMING AND ITS USE FOR VISUAL QUESTION ANSWERING

THOMAS EITER

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ABSTRACT.

Visual Question Answering (VQA) is concerned with answering a question, posed in natural language, about a visual scene shown in an image or possibly also in a video sequence. It is challenging task that requires processing multi-modal input and reasoning capabilities to obtain the correct answer, and it enables applications in a range of areas such as medicine, assistance for blind people, surveillance, and education. Neuro-symbolic approaches tackle the problem by employing a modular architecture in which components based on subsymbolic and symbolic AI take care of different subtasks such as object recognition, language parsing, scene representation, and inference, respectively, which may be accomplished by deep neural networks and symbolic reasoning components. Answer Set Programming (ASP), a well-known approach to declarative problem solving, is a versatile formalism for realizing the latter. In this lecture, we consider ASP for addressing VQA. To this end we discuss extensions of ASP towards subsymbolic AI, so called hybrid AI, comprising both reasoning and learning, for this purpose. Furthermore, we dscuss challenges that VQA poses to ASP for future research, in order to unleash its potential for developing transparent and explainable VQA.

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Thomas Eiter, Markus Hecher, Rafael Kiesel, aspmc: New frontiers of algebraic answer set counting, Artificial Intelligence, Volume 330, 2024, 104109, ISSN 0004-3702.

Bauer, J. J., Eiter, T., Ruiz, N. H., & Oetsch, J. (2023). Neuro-symbolic Visual Graph Question Answering with LLMs for language parsing. Presented at the TAASP 2023. Workshop on Trends and Applications of Answer Set Programming, November 20-21, 2023, Potsdam, Germany.

HUMAN ACTION RECOGNITION, COGNITION, AND COMPUTATIONAL MODELS IN RELATION TO FORMAL AND COGNITIVE FOUNDATIONS FOR HUMAN-CENTERED COMPUTING

PAUL HEMEREN

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ABSTRACT.

This lecture will describe the key questions and results of the human attention of visual point-light action displays that include hand movement, walking, and social movement. The major factor of local and global movement processing is demonstrated to show the clear differences between low-level kinematics and global form features. This will also explain the necessity of using different kinds of stimuli to affect human action attention in relation to kinematics and semantics. In theoretical fields, contributions of visual familiarity and visual orientation towards action recognition and discrimination have implications in fields like cognitive neuroscience, cognitive psychology, and neurophysiology. In practical approaches, this knowledge of distinction could contribute to computational models of biological motion, like models for visual learning and action recognition, familiarity-based attention models, and action recognition for human-robot interaction. It can also help to make better interface designs for interactive games and augmented and virtual reality-based systems.

Understanding human action recognition by using point-light displays of biological motion allows us to then compare the accuracy of computational models in relation to human cognitive and perceptual factors. This area can be used to demonstrate some of the modality factors in human action recognition as well as the possible relationship between modality factors and levels of action and event perception. This lecture will present findings about different levels of action and event perception as well as direct comparisons between computational models and human cognition and perception using point-light displays of biological motion. A key question is then to evaluate the similarities and differences between human processing and computational models. To what extent should AI-development using multimodality computation in human-machine interaction be concerned about the relation between processes and results? What role should this comparison (computational models and human cognition) have in understanding human cognition?

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Hemeren, P. E., & Thill, S. (2011). Deriving motor primitives through action segmentation. Frontiers in Psychology, 1, 243.

Hemeren, P., Veto, P., Thill, S., Li, C., & Sun, J. (2021). Kinematic-based classification of social gestures and grasping by humans and machine learning techniques. Frontiers in Robotics and AI, 308.

PRIMING OF PROBABILISTIC VISUAL TEMPLATES

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ABSTRACT.

Attentional priming has a dominating influence on vision, speeding visual search, releasing items from crowding, reducing masking effects, and during free-choice, primed targets are chosen over unprimed ones. Many accounts postulate that templates stored in working memory control what we attend to and mediate the priming. But what is the nature of these templates (or representations)? Analyses of real-world visual scenes suggest that tuning templates to exact color or luminance values would be impractical since those can vary greatly because of changes in environmental circumstances and perceptual interpretation. Tuning templates to a range of the most probable values would be more efficient. Recent evidence does indeed suggest that the visual system represents such probability, gradually encoding statistical variation in the environment through repeated exposure to input statistics. This is consistent with evidence from neurophysiology and theoretical neuroscience as well as computational evidence of probabilistic representations in visual perception. I argue that such probabilistic representations are the unit of attentional priming and that priming of, say, a repeated single-color value simply involves priming of a distribution with no variance. This "priming of probability" view can be modelled within a Bayesian framework where priming provides contextual priors. Priming can therefore be thought of as learning of the underlying probability density function of the target or distractor sets in a given continuous task.

SELECT PUBLICATIONS

Kristjánsson, Á. Priming of probabilistic attentional templates. Psychon Bull Rev 30, 22–39 (2023).

Kristjánsson, Á, and Kristjánsson, T. Attentional priming in Go No-Go search tasks. Vision Research, Volume 213, 2023.

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THE EFFECT OF ENVIRONMENTAL COMPLEXITY ON EVERYDAY VISUAL ATTENTION

VASILIKI KONDYLI

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ABSTRACT.

Visuospatial attention is critical in many everyday activities, especially those involving embodied multimodal interaction between humans and their surrounding environment. Driving, cycling, or navigating an urban environment, are some of these complex activities which require maintenance of situational awareness of the surrounding environment while at the same time, people need to perform planning and execution of control actions (steering, braking). To investigate the dynamic environment where these everyday activities take place, we extract visuospatial characteristics including clutter, geometry, motion, etc. and construct a cognitive model of visuospatial complexity. In a series of behavioral studies, conducted in the real world and virtual environments, we combine qualitative and quantitive methods to explore the effect of visuospatial complexity on visual attention along these continuous everyday activities. The findings reveal a critical effect of visuospatial complexity on high-level visual processing, where an increase in complexity leads to a substantial increase in change blindness performance. However, the results also show mitigation strategies employed as a response to the load, by adjusting their focus and avoiding non-productive forms of attentional elaboration. These outcomes uncover implications for driving education, driving assistance technologies, as well as the design of immersive media.

SELECT PUBLICATIONS

Kondyli, V., Bhatt, M., Levin, D. & Suchan, J. (2023). How do drivers mitigate the effects of naturalistic visual complexity? On attentional strategies and their implications under a change blindness protocol. Cognitive Research: Principles and Implications, 8 (I).

Kondyli, V., & Bhatt, M. (2021). Visuo-Locomotive Update in the Wild: The Role of (Un)Familiarity in Choice of Navigation Strategy, and its Application in Computational Spatial Design. Proceedings of the Annual Conference of the Cognitive Science Society, 43, 2017-2023.

Kondyli, V., Bhatt, M. & Hartmann, T. (2018). Precedent Based Design Foundations for Parametric Design: The Case of Navigation and Wayfinding. Advances in Computational Design, 3 (4), 339-366.

PREDICTIVE MODELING AND HUMAN COGNITION: THEORY AND APPLICATION

CLAYTON LEWIS

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ABSTRACT.

The unexpected success of predictive Large Language Models on a wide range of tasks adds support to the idea that prediction is a fundamental cognitive process. The fact that these models have no in-built structures, or even intended provisions for creating structures as we think of them, suggests that Harold Garfinkel's skeptical rejection of structures and rules in communication and cognition can be seen a new constructive light. On the other hand, the possibility that structures of more or less familiar kinds emerge during training also needs consideration. Possible applications of LLMs and allied technologies in supporting new interaction techniques, including enhanced support for people with disabilities, also deserve attention.

SELECT PUBLICATIONS

Lewis, C. 2023. Large Language Models and the Psychology of Programming. In Proceedings of the 34th Annual Workshop of the Psychology of Programming Interest Group (pp.77-95) (to appear).

Lewis, C. 2022. Challenges and opportunities in technology for inclusion. In Proceedings of the 24th International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS '22). Association for Computing Machinery, New York, NY, USA.

Seeman, L., Lewis, C. (2019). Cognitive and Learning Disabilities. In: Yesilada, Y., Harper, S. (eds) Web Accessibility. Human–Computer Interaction Series. Springer, London.

USING LOGIC TO REPRESENT AND COMBINE CONCEPTS

OLIVER KUTZ

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ABSTRACT.

We will discuss a number of approaches to model concepts with the help of logic, and illustrate how such modelling approaches are capable (or not) of modelling certain psychological effects as they are displayed in the use of concepts by humans. We will then introduce in some more detail the recent framework of weighted description logics, also called perceptron or 'tooth' logic, and illustrate some of the features and benefits of such logics in modelling and reasoning with concepts and prototype concepts.

SELECT PUBLICATIONS

Romanenko, E., Kutz, O., Calvanese, D., Guizzardi, G. (2023). Towards Semantics for Abstractions in Ontology-Driven Conceptual Modeling. In: Sales, T.P., Araújo, J., Borbinha, J., Guizzardi, G. (eds) Advances in Conceptual Modeling. ER 2023. Lecture Notes in Computer Science, vol 14319. Springer, Cham.

Kutz, O., Lutz, C., Wolter, F., & Zakharyaschev, M. E-connections of abstract description systems, Artificial Intelligence, Volume 156, Issue 1, 2004, Pages 1-73.

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COGNITIVE DESIGN FOR AI SYSTEMS WITH HUMAN-LIKE REASONING

ANTONIO LIETO

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ABSTRACT.

Commonsense reasoning is one of the main open problems in the field of Artificial Intelligence (AI) while, on the other hand, seems to be a very intuitive and default reasoning mode in humans and other animals. In this lecture, I will show - via two different case studies concerning commonsense categorization and knowledge invention tasks - how cognitively inspired heuristics can help (both in terms of efficiency and efficacy) in the realization of intelligent artificial systems able to reason in a human-like fashion, with results comparable to human-level performances.

SELECT PUBLICATIONS

Lieto, A. (2021). Cognitive Design for Artificial Minds (Ist ed.). Routledge.

Lieto, A., Perrone, F., Pozzato, G. L., & Chiodino, E. (2019). Beyond subgoaling: A dynamic knowledge generation framework for creative problem solving in cognitive architectures. Cognitive Systems Research, 58, 305-316.

Lieto, A., Radicioni, D. P., & Rho, V. (2015). A common-sense conceptual categorization system integrating heterogeneous proxytypes and the dual process of reasoning. In Proceedings of IJCAI 2015, Twenty-fourth international joint conference on artificial intelligence, AAAI Press.

NEURO-SYMBOLIC AI AND ITS ROLE IN ROBUST AND INTERPRETABLE AI-DRIVEN DECISION-MAKING

ALESSANDRA RUSSO

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United Kingdom

ABSTRACT.

AI has recently seen rapid advances. But to bring positive transformative change in domains such as healthcare, AI-technologies need to be transparent and interpretable by humans, whilst capable of processing large quantities of (unstructured) data. Learning interpretable models from data is one of the main open challenges of AI. Symbolic Machine Learning, a field of Machine Learning, offers algorithms and systems for learning interpretable models that explain data in the context of a given domain knowledge. In this lecture, I will overview state-of-the-art symbolic machine learning systems capable of learning different classes of interpretable models for solving real-world problems from (structured) data, in a manner that is data efficient, scalable, and robust to noise. I will then present neuro-symbolic architectures that integrate such systems with machine learning to learn complex interpretable knowledge from multi-modal (unstructured) data. Finally, I will present a number of applications including domains such as healthcare and security.

SELECT PUBLICATIONS

Law, M., Russo, A., Bertino, E., Broda, K., & Lobo, J. (2020). FastLAS: Scalable Inductive Logic Programming Incorporating Domain-Specific Optimisation Criteria. Proceedings of the AAAI Conference on Artificial Intelligence, 34(03), 2877-2885.

Belle, V., Fisher, M., Russo, A., Komendantskaya, E., Nottle, A. (2024). Neuro-Symbolic AI + Agent Systems: A First Reflection on Trends, Opportunities and Challenges. In: Amigoni, F., Sinha, A. (eds) Autonomous Agents and Multiagent Systems. Best and Visionary Papers. AAMAS 2023. Lecture Notes in Computer Science(), vol I4456. Springer, Cham.

Aspis, Yaniv et al. Embed2Sym - Scalable Neuro-Symbolic Reasoning via Clustered Embeddings. Proceedings of the Nineteenth International Conference on Principles of Knowledge Representation and Reasoning (2022): n. pag.

NEUROSYMBOLIC LEARNING: ON GENERALISING RELATIONAL VISUOSPATIAL AND TEMPORAL STRUCTURE

JAKOB SUCHAN

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Germany

ABSTRACT.

We present recent and emerging research aimed at developing a general framework for structured spatio-temporal learning from multimodal human behavioural stimuli. The framework and its underlying general, modular methods serve as a model for the application of integrated (neural) visuo-auditory processing and (semantic) relational learning foundations for applications (primarily) in the behavioural sciences. Furthermore, the lecture will situate neurosymbolic learning within the broader context of cognitive vision and perception research aimed developing general methods for commonsense reasoning with cognitively rooted structured characterisations of knowledge pertaining to space and motion.

SELECT PUBLICATIONS

Suchan, J., Bhatt, M., & Varadarajan, S. Commonsense visual sensemaking for autonomous driving – On generalised neurosymbolic online abduction integrating vision and semantics, Artificial Intelligence, Volume 299, 2021.

Suchan, J., Bhatt, M., & Varadarajan, S. 2019. Out of sight but not out of mind: an answer set programming based online abduction framework for visual sensemaking in autonomous driving. In Proceedings of the 28th International Joint Conference on Artificial Intelligence (IJCAI'19). AAAI Press, 1879–1885.

Suchan, J., Bhatt, M., Wałega, P., & Schultz, C. (2018). Visual Explanation by High-Level Abduction: On Answer-Set Programming Driven Reasoning About Moving Objects. Proceedings of the AAAI Conference on Artificial Intelligence, 32(1).

KNOWLEDGE ENGINEERING METHODS FOR HYBRID HUMAN-ARTIFICIAL INTELLIGENCE

ILARIA TIDDI

VRIJE UNIVERSITEIT AMSTERDAM
The Netherlands

ABSTRACT.

Hybrid Human-Artificial Intelligence is a rapidly growing field aiming at creating collaborative systems where humans and intelligent machines cooperate in mixed teams towards shared goals. In this lecture, we will discuss how symbolic AI techniques (knowledge graphs and semantic technologies) can help solving the main challenges for a hybrid human-AI collaboration in combination with the most popular subsymbolic (machine learning) methods. We will start by learning how to model information using the RDF/RDFS/OWL languages and store it as knowledge graphs, then introduce methods to reason over and query such graphs, and finally discuss how ontologies and knowledge engineering methods can be used to design Hybrid Intelligence applications.

SELECT PUBLICATIONS

Tiddi, I., De Boer, V., Schlobach, S., and Meyer-Vitali, A. 2023. Knowledge Engineering for Hybrid Intelligence. In Proceedings of the I2th Knowledge Capture Conference 2023 (K-CAP '23). Association for Computing Machinery, New York, NY, USA, 75–82.

Tiddi, I., and Schlobach, S. Knowledge graphs as tools for explainable machine learning: A survey, Artificial Intelligence, Volume 302, 2022.

Tiddi, I., Lécué, F., and Hitzler, P. Knowledge Graphs for eXplainable Artificial Intelligence: Foundations, Applications and Challenges. 2020 IOS Press.

HOW GRAPHICS AND GESTURE WORK

BARBARA TVERSKY

STANFORD UNIVERSITY, AND COLUMBIA UNIVERSITY
United States

ABSTRACT.

There are many ways to think and communicate. Language is quite popular. But babies gesture before they speak and visualizations of thought predate written language by millennia. We will show the many ways that these media use things in space, actions in space, and place in space spontaneously and naturally to think and communicate.

SELECT PUBLICATIONS

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Emmorey, K., Tversky, B., and Taylor, H. (2000). Using space to describe space: Perspective in speech, sign, and gesture. Spatial Cognition and Computation. 2.

Tversky, B., Lee, P., and Mainwaring, S. (1999). Why speakers mix perspectives. Spatial Cognition and Computation. 1. 399-412.

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TUTORIALS

INSTITUTE 2024 TUTORIALS »
SPATIAL COGNITION AND ARTIFICIAL INTELLIGENCE

by Jakob Suchan, Vasiliki Kondyli, and Mehul Bhatt – CoDesign Lab EU (DE, PL, SE)

The tutorial on Spatial Cognition and Artificial Intelligence addresses the confluence of empirically-based behavioural research in the cognitive and psychological sciences with computationally-driven analytical methods rooted in artificial intelligence and machine learning. This confluence is addressed in the backdrop of human behavioural research concerned with naturalistic, in-the-wild, embodied multimodal interaction. The tutorial presents:

- an interdisciplinary perspective on conducting evidence-based human behaviour research from the viewpoints of visual perception, environmental psychology, and spatial cognition.
- AI methods for the semantic interpretation of embodied multimodal interactions (e.g., rooted in behavioural data), and the (empirically-driven) synthesis of interactive embodied cognitive experiences in real-world settings relevant to both everyday life as well to professional creative-technical spatial thinking
- the relevance and impact of research in cognitive human-factors in spatial cognition for the design and implementation of human-centred AI technologies

The main technical focus of the tutorial is to provide a high-level demonstration of general AI-based computational methods and tools that can be used for multimodal human behavioural studies. Of special focus are visuospatial, visuo-locomotive, and visuo-auditory cognitive experiences in the context of application areas such as architecture and built environment design, narrative media design, product design, cognitive media studies, and autonomous cognitive systems (e.g., robotics, autonomous vehicles). Presented methods are rooted in foundational research in artificial intelligence, spatial cognition and computation, spatial informatics, human-computer interaction, and design science. The tutorial utilises case-studies to demonstrate the application of the foundational practical methods and tools. This will also involve practical examples from large-scale experiments in domains such as evidence-based architecture design, communication and media studies, and cognitive film studies.

INSTITUTE 2024 TUTORIALS »

REASONING IN COGNITIVE ARGUMENTATION

by Emmanuelle Dietz – Airbus Hamburg (DE)

Cognitive Argumentation is a computational framework for dialectic argumentation-based reasoning, built from a theoretical framework of argumentation in AI and grounded via cognitive principles from Cognitive Science. Starting from the observation that humans often deviate from classical logic when reasoning in everyday life, these extra-logical patterns will be formalized as cognitive principles in Cognitive Argumentation. We will also show an integration of Cognitive Argumentation into ACT-R, a cognitive architecture, where the argumentation process is guided by the context through the spreading activation of chunks, bridging to lower levels of cognition.

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INSTITUTE 2024 DOCTORAL COLLOQUIUM »
DOCTORAL PARTICIPANTS

The Doctoral Colloquium (DC) at the Institute on Artificial and Human Intelligence 2024 is an opportunity primarily (but not exclusively) for early stage doctoral researchers to present ongoing or planned research in one or more of the key themes in scope of the Institute. Participating DC members engage with institute faculty and participants throughout the Institute through planned lectures, as well as in dedicated poster sessions and a final presentation event devoted solely for DC members.

Contributing doctoral colloquium participants and the topics of their interest are:

BODY OF IDEAS: INSIGHTS INTO AN ARTISTIC RESEARCH PROJECT RELATED TO PRIMARY METAPHORS AND IMAGE CONTROLLER SCHEMES

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DECIDING WHEN TO STOP EXPLORING: AN EXPERIMENTAL AND COMPUTATIONAL INVESTIGATION OF SEQUENTIAL SEARCH IN HUMANS AND MACHINES.

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VISUAL PERCEPTION PATTERNS FOR AUTONOMOUS BOTS ON THE WEB.

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QUANTIFYING PERCEPTIONS OF VISUAL COMPLEXITY WITH DATA VISUALIZATION DESIGN FEATURES.

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PROBABILISTIC KNOWLEDGE REPRESENTATION FOR MONITORING AI SYSTEMS.

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AUGMENTING QUANTUM MACHINE LEARNING WITH NEURAL DIFFERENTIAL EQUATIONS.

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LIVING WITH EXCEPTIONS: HUMAN-INSPIRED AUTOMATED REASONING.

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DEEP NETWORK PRUNING FOR HUMAN-MACHINE ALIGNMENTS.

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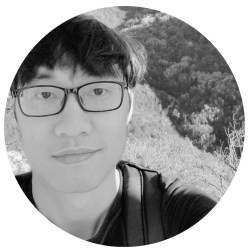

HOW MANY LINGUISTS DOES IT TAKE FOR AI TO TELL A GOOD JOKE? THE CHALLENGES OF CULTURAL ASPECTS FOR AI.

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VISUAL CUES FOR CONCEPTUALISING CATEGORIES.

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AUTONOMOUS RESEARCH ASSISTANTS IN HYBRID INTELLIGENCE: CURRENT LANDSCAPE AND FUTURE CHALLENGES.

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A CONCEPTUAL COMBINATION APPROACH TO METAPHORS

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POST-DOCTORAL PARTICIPANTS

TANTAMOUNT TO A THOUSAND BRIDGES: EXPLAINABILITY IN BETWEEN ARTIFICIAL AND HUMAN INTELLIGENCE.

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AALBORG UNIVERSITY – DENMARK

DECLARATIVE SPATIAL REASONING IN QUANTIFIED EQUILIBRIUM LOGIC WITH EVALUABLE FUNCTIONS.

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PANEL DISCUSSION

INSTITUTE 2024 » PANEL DISCUSSION

HUMAN-CENTRED AI: MULTIDISCIPLINARY CONTOURS AND CHALLENGES OF NEXT-GENERATION AI RESEARCH AND APPLICATIONS

The panel discussion on Human-Centred Artificial Intelligence will focus on the multidisciplinary contours and challenges of next-Generation AI research and applications, particularly in view of emerging AI regulation. The panel will discuss the need for a multi-faceted perspective on approaching next-generation (human-centric) AI research primarily, but not exclusively, at the confluence of formal, computational, and cognitive aspects on the one hand, and social, cultural, and legal dimensions influencing next-generation AI research on the other hand.

INVITED PANELISTS

- Prof. Thomas Eiter (Austria)
- Prof. Árni Kristjánsson (Iceland)
- Prof. Clayton Lewis (United States)
- Prof. Alessandra Russo (United Kingdom)

PANEL CONVENOR & MODERATOR

- Prof. Mehul Bhatt (Sweden)

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