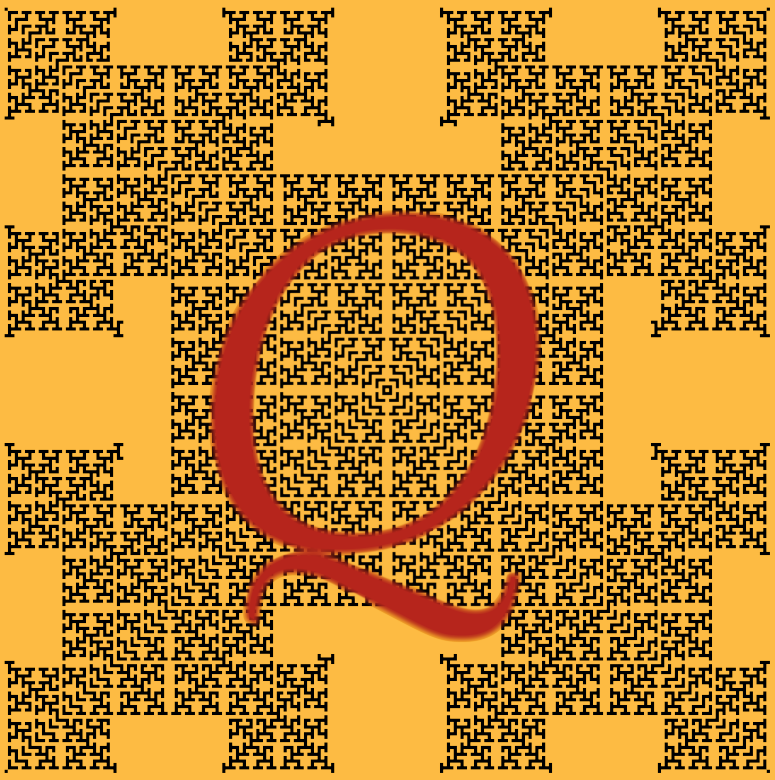
AISB Quarterly

THE NEWSLETTER OF THE SOCIETY FOR THE STUDY OF ARTIFICIAL INTELLIGENCE AND SIMULATION OF BEHAVIOUR



No. XXX

Christmas, 20XX

Do you feel artistic?
Exhibit your artwork on our front covers!
Email us at aisbq15@aisb.org.uk!

Artwork by Mohammad A. Javaheri Javid (Goldsmiths, University of London)

The cover artwork is generated in cellular automata environment having two states (black and yellow) with an eight cell mapping of transition function between states in outer totalistic rules set.The cellular automata are known for their generative capabilities in creating very complex patterns in their global level, sometimes with high aesthetic qualities from simple rules at a local level.The generated pattern has emerged from a single cell as initial configuration and it closely resembles fractal patterns, however the rule generating this pattern is very simple compared to rules generating fractals.

M. A. Javaheri Javid and René te Boekhorst (2006). Cell Dormancy in Cellular Automata. In Proceedings of the *International Conference on Computational Science, LNCS 3993(3)*. Vassil N. Alexandrov, G. Dick van Albada, Peter M. A. Sloot, and Jack Dongarra (Eds.), Springer, pp. 367-374.

M. A. Javaheri Javid, M. Majid Al-Rifaie, and R. Zimmer (2014). Detecting Symmetry in Cellular Automata Generated Patterns using Swarm Intelligence. In Proceedings of *Theory and Practice of Natural Computing, LNCS 8890*. A.-H. Dediu, M. Lozano, and C. Martin-Vide (Eds.), Springer International Publishing, pp. 8394.

AISB 2019 Convention, Falmouth

Swen E. Gaudl **(Falmouth University, *swen.gaudl@gmail.com*)**

The 2019 Convention of the Society for the Study of Artificial Intelligence and Simulation of Behaviour, AISB 2019 will be held from April 16th to April 18th 2019 at Falmouth University, Cornwall. The convention is chaired by Swen E. Gaudl and Edward Powley. Additionally, the organisation committee consists of Tanya Krzywinska, Rob Saunders, Heidi Ball, Kamran Harandy and Michael A. Scott.

As in the past years, AISB 2019 will provide a unique forum for presenting cutting-edge research and burning issues around all areas of AI.

> The theme for this year is Artificial Intelligence, Imagination and Invention.

The annual convention is a unique place for presenting and discussing research as well. The convention provides a forum fostering trans-disciplinary exchange and bringing together researchers, practitioners, artists and scholars from various backgrounds and countries. After this year's selection process, we accepted a total of nine symposia and two workshops with topics ranging from machine learning and language acquisition to robotic dance performance, creativity and games. We are also excited that the proposals came both from national and international groups, demonstrating that research is not and should not be bound by borders.

Further on, we give a brief introduction to the events both workshops & symposia that will be held during AISB2019. For more information and for details on keynotes, exhibitions, travel and other social events which will complement the programme, as well as the full call for papers of the various symposia, please visit our website at `http://aisb2019.falmouthgamesacademy.com/`

6th Computational Creativity Symposium

Organised by Maximilian Droog-Hayes and Juan Manuel Alvarado López (Queen Mary University of London, UK)

Over the last few decades, computational creativity has attracted an increasing number of researchers from both arts and science backgrounds.

This symposium aims at bringing together researchers to discuss recent technical and philosophical developments in the field, and the impact of this research on the future of our relationship with computers and the way we perceive them: at the individual level where we interact with the machines, the social level where we interact with each other via computers, or even with machines interacting with each other. We invite submissions related to both theoretical and technical work on modelling creative systems which produce musical, pictorial or linguistic works that represent imaginative concepts. Relevant topics might include discussions about creativity as a source of imagination in relation to

multiple domains, or how a creative process can produce a novel and interesting result.

More general topics of interest:

- Novel systems and theories in computational creativity
- Evaluating computational creative systems, processes & artefacts
- Computational aesthetics theory
- Representational issues in creativity, including visual & perceptual representations
- Social aspects of computational creativity & IP issues
- Creative autonomy & constraint
- Computational appreciation of artifacts, including human artwork

We welcome participants to submit their work as a paper of up to 8 pages, or as a demo. As is the tradition of the Computational Creativity symposium, the best paper and the best presentation would each be awarded a prize.

10th AI & Games Symposium

Organised by Daniela Romano, David Moffat & Swen E. Gaudl (University College London, Glasgow Caledonian University, Falmouth University, UK)

The AISB AI & Games symposium celebrates 11 years since it first started in 2008 as AI & Narrative Games for Education. In the past years the symposium has been acting as a meeting place for researchers and practitioners from academia and industry who are involved with the design, development and evaluation of AI in the context of games. In particular, the Symposium focuses on the application of artificial intelligence or intelligent-like techniques, frameworks and theories to the creation of intelligent games. AI can be used in any manner suitable in a game, from algorithms to making it more engaging, personalised, and/or interactive.

Example topics (research & practice) of the symposium; these can be applied to X (a game, or VR, or design process, or any form of experience):

- Use of AI techniques (e.g. planning, learning, evolution etc.)
- Design & engineering of AI components
- (Semi-)Automatic PCG
- Intelligent or adaptive player interaction
- AI for user analytics and/or player-modelling
- Agent path-finding and/or decision-making
- Games (or simulations) as a platform for building agents
- Environmental simulations
- Interactive narrative generation
- Intelligent Narrative Technologies
- Experimental AI

Authors could be specialised in: AI, machine learning, planning, narrative, education and training, media, multimedia, virtual reality and virtual experiences, game design and development, game interaction design, charac-

ters design, interaction design and evaluation for children and/or adults, and any other relevant area.

A poster and demo session is also held usually over coffee time. In all past years we had one invited speaker.

Decolonising the computational imagination: Human & machine creativity as situated practice

Organised by Eleanor Dare,ăEleni Ikoniadou,ăClaudia DutsonăandăLaura Ferrarello (Royal College of Art London, UK)

Projects such as the Leverhulme's CFI (Centre for the Future of Intelligence) Value Alignment (2018) aim to prevent AI from acting in ways which are irreconcilable with our explicit moral values, but what about our unconscious values, our implicit assumptions and inherited ideas about what constitutes imagination and invention?

This four-part workshop will address the complex theme of how we can we model an artificial, or even a natural inventive intelligence, until we've understood our own assumptions about what that means to imagine something new, if, indeed, "newness"(Lim & Oyama, 2014) is an inevitable component of human and machine creativity. The practical goal(s) of this workshop will be to generate collaborative insights, creative performances and design methodologies addressing the theme of decolonising AI, the workshops are a positive opportunity to re-think commonly held assumptions about human and machine creativity, to engage with broader practices and to understand the situated nature of all computation. We will make the case for decolonising human-machine creativity - as both an ethical and a pragmatic imperative.

The 4-part workshop will use practical exercise to uncover the assumptions, processes and structures embedded in all computational processes which claim to emulate human inventiveness. The workshop will explore the extent to which those models and processes are culturally specific, bringing to the surface our historically situated notions of what constitutes human intelligence, and, by extension, what constitutes human subjectivity and creativity.

This workshop will present a series of calibration exercises, performative engagements, dialogue and speculation, designed to reveal to participants their implicit and explicit notions of creative intelligence and inventive insight. Each RCA academic (who has a research specialism addressing aspects of AI), will present a 45-minute interactive/collaborative exercises.

Philosophy after AI: language, imagination and creativity Symposium

Organised by Giusy Gallo and Claudia Stancati (University of Calabria, Italy)

This symposium aims for a philosophical approach to the latest issues about the study of human mind developed in the field of Artificial Intelligence. The goal of the second symposium Philosophy after AI is to investigate the philosophical roots of imagination and creativity and the role they play in AI researches and/or, con-

versely, how much they have changed (and are changing) after AI developments.

The first edition of the symposium has been devoted to themes such as mind and knowledge. Among the issues to be investigated the mind-body problem and the category of subject need to be deeply explored, from the ethical perspective encouraged last year till a new light given by the philosophical stance on imagination and creativity. The mind-body problem can be read again involving the neuroscientific research, including the provocative theory of the extended mind. The second question is about the philosophical category of subject: how to set out the boundaries of the self? How is the concept of subject together with the concept of imagination involved in AI researches? Is human imagination due to be replicated? Are technological developments affecting human creativity in long term? The third issue concerns the nature of learning and creativity and the current research in the field of machine learning. The development of AI asks for the role of the advancement in such field plays in studies devoted to language, including the helpful effect on people with disabilities. Moreover, we should follow the way machines implement human language (e.g. Siri, Cortana, ...): could machines and human beings understand each other?

Recently AI researchers are developing autonomous machines which can exhibit behaviours such as prejudice, identifying, copying and learning them from a big amount of data. This kind of understanding and simulation requires a philosophical attitude on the power of imaginative dimension of prefiguration of behaviour.

We invite talks on the following topics (non-exclusive):

- Linguistics and AI
- AI research on language
- The role of imagination in AI research
- Philosophy, science and AI
- Mind-body problem and AI
- Truth, post-truth and AI
- Language & cognition
- Learning, creativity & AI
- Creativity, machine-learning & language
- Social media, devices & human sociality

Social Interactions in Complex Intelligent Systems (SICIS)

Organised by Stefania Monica and Federico Bergenti (UNIVERSITÀ DI PARMA, Italy)

A complex intelligent system (CIS) is a large network of interacting agents where non-trivial global patterns and behaviours emerge, normally without a central control, from the combination of simple behaviours of individual units. Social interactions in CIS give rise to collective properties that hold at the macroscopic level, such as the formation of polarised opinions or the appearance of trends and subcultures, whose emergence cannot be easily inferred from the analysis of the behaviour of single agents at the micro-

scopic level. The study of complex intelligent systems represents a novel approach to investigate how social interactions among agents lead to emergent behaviours which exhibit some sort of intelligence.

Methodologically, social interactions in CIS accommodate both local and global phenomena, and therefore they are a key concept to understand the behaviour of a complex intelligent system. Social interactions are also the key concept to explain how real and artificial societies behave. The models used to study interactions among agents may derive from various fields, such as statistical physics, information theory, and non-linear dynamics. They are used to describe the effects of interactions among agents from a microscopic point of view, and the derivation of observable behaviours of the system may be addressed using various approaches, such as analytic and simulative tools, statistical methods, and empirical observations. Sophisticated research methodologies are being developed and used in the analysis of social complex intelligent systems, including graph theory, bifurcation diagrams, network analysis, agent-based modelling, theoretical physics, non-linear modelling, and computational models including cellular automata, and multi-agent systems.

Complex intelligent systems (CIS) and models of social interactions are used to describe processes in various fields, such as Artificial Intelligence, Computer Science, Mathematics, Biology, Economics, Physics, Sociology, Economy, and many others. Hence, they represent a promising multi-disciplinary research field. The symposium is meant to offer an interdisciplinary forum on all aspects related to social interactions in complex intelligent systems. It aims to stimulate discussions and synergies among participants, which are expected to have diverse and complementary research backgrounds.

This will be the third edition of the symposium. The structure of the symposium involves talks given by authors of accepted papers.

Topics of interest to the symposium include, but are not limited to:

- Collective intelligence and cooperation
- Interacting agents and emergent behaviours
- Self-adaptiveness and self-organization in CIS
- Opinion dynamics in CIS
- Cultural dynamics
- Social consensus and agreement
- Social simulation and agent-based simulation
- Social networks analysis and simulation
- Mathematical analysis of CIS
- Mathematical and physical models of CIS
- Bio-inspired analysis of CIS
- Game theoretic and economical models of CIS
- Emergent properties and behaviours in CIS

Symposium on Analytics-based (Cognitively-enabled) Social Systems

Organised by Aladdin Ayesh, Indrani Lahiri, Miguel Arevalillo-Herráez andăJohn Bishop (De Montfort University, Goldsmiths, UK, University of Valencia, Spain)

Several technological advances in recent years make the presence of systems in our life persistent and ubiquitous, whether in hardware form such as phones or software form such as social media that is embedded in the various devices we use, e.g. TV. This was driven by and equally drove further the advances in cognitive systems research. This enabled two things to happen: greater amount of data to be generated and new ways of socialising. These two events feed back into the development of cognitive systems in the forms of Data Analytics and Social Systems, providing a full loop of interaction between technological development and daily societal impact. Terms such as cyberbullying, personalised ads, analytics, and many others are becoming part of the daily language and news bulletins. Whilst technology gives rise to social issues and anxieties, e.g. meddling into elections, these social issues impose challenges and expectations especially from Artificial Intelligence, to resolve these issues, e.g. identifying fake news or unlawful content in social media platforms.

This symposium aims to look at this new breed of systems from a multidisciplinary viewpoint, examining, amongst others, the social impact and its effects on pushing the boundaries of developing such systems.

Topics include but are not limited to:

- Personalisation, Machine learning and AI
- Quantified self and data cultures
- Mobile and locative services
- Social media, politics & big data
- Cyberpsychology
- Ethics & Privacy in Social Systems
- Data-system sustainability
- Cybersurveillance & IoT
- Social & cognitive theories testbeds
- Social bots and the management of sociality
- Social data collection and mining
- Social recommender systems and social robots
- Analytics applications
- Text analytics and language development
- Smart cities and smart services

Explainable Artificial Intelligence

Organised by Serge Thill and Maria Riveiro (Radboud University, NL, University of Skövde, SE)

AI systems are increasingly present in everyday society, from simple computer systems to agents such as autonomous vehicles or social robots. In this context, several researchers have noted that it is critical to understand how human users perceive such systems - in

particular, the degree to which they understand how the system works, and what mental models they build of the underlying algorithms. "Explainable AI" (XAI) thus refers to AI systems that behave or provide the necessary information so that their working becomes comprehensible to the human user. The need for transparency and explanations in AI-based systems to support interpretability, understandability, and trust has been highlighted recently by multiple authors from disparate disciplines in both AI and HCI communities, and is, for example, the focus of Google's People & AI research initiative.

Given the breadth of fields in which the notion of explainable AI turns up in one form or another, there are varying interpretations of what the concept really entails. To a traditional AI researcher, for example, explainable AI is often the opposite of a black box system. Similarly, in the situation awareness literature, the term "system awareness" (or sometimes system transparency) is used to describe to what degree a user understands, that is to say, has a reasonable model, of the inner working of the decision support system they interact with.

In the cognitive sciences, meanwhile, the interest is two-fold, covering both how humans understand other humans, and how these mechanisms can be mapped onto machines. In particular, Theory of Mind (ToM) refers to the human ability to infer the (internal) mental states of other human beings. Insights from the cognitive sciences have then be used in, for example, robotics, to argue that it is necessary for machine systems to tap into the human ability to understand other agents through such simulation mechanisms. This is similar to long traditions of research in, for example, Human-Computer Interaction, which asks how humans perceive their environment in order to provide effective interfaces for computer programs.

Similarly, the application range is varied. In the automotive domain, it can lead to appropriately calibrated trust in an autonomous vehicle's abilities, similar to how appropriate system awareness can manage trust and also cognitive load in the domain of decision support systems. For a cognitive scientist, understanding how to design intuitively understandable AI systems can lead to a better understanding of the human mind itself. It is clear from the description above, that XAI research is a very varied field whose precise meaning and core missions are interpreted differently by different researchers.

The purpose of the present symposium is to bring together researchers from all aspects of XAI, and to foster an exchange of the current state of the art while facilitating the development of synergetic connections between different sub-fields of XAI.

We are interested in a diverse symposium that can cover several aspects of XAI outlined above. We particularly encourage submissions around the themes of human expectations of intelligent systems, and, conversely, how such systems can create explanations that are relevant, and in line with those expectations. Additionally, work concerned with the evaluation of such systems is also relevant to this symposium.

Movement that Shapes Behaviour: Rethinking how we can form relationships with non-humanlike embodied agents

Organised by Petra Gemeinboeck, Rob Saunders and Elizabeth Jochum (Falmouth University, UK, University of NSW, The University of Sydney, AUS, Aalborg University, DK)

This symposium is a transdisciplinary forum for exploring the potential of movement for shaping the expressive and relational capacities of non-humanlike robots and how we perceive them as social agents. Social robots are expected to affect every aspect of our lives in the near future. Currently, the design of social robots in research labs often mimic humanlike or animal-like features, both in terms of how they look and how they behave. We believe, however, that movement and its expressive, relation-making qualities hold the key to widening the spectrum of how we can interact with robots, without relying on a human- or animal-like veneer.

The importance of movement in the simulation of behaviour can be traced back to early cybernetic experiments and artworks, such as, Grey Walters tortoises and Gordon Pask's conversational systems. Similarly, Heider and Simmel's classic cognitive psychology experiments using simple animated geometric figures, demonstrated the potential of movement to generate social meaning. This symposium emphasises the importance of methods and practices from the fields of animation, choreography, dance, puppetry and theatre. Grounded in embodied knowledge, they offer valuable insights for embodied AI, e.g., working with movement as a material, embodying bodies, relation-making through movement dynamics, embodied perception, and kinaesthetic empathy.

This symposium will bring together researchers and practitioners to explore how movement qualities can enable an embodied agent to communicate non-verbally, take on a social presence, make connections or enact an identity without mimicking living creatures. The topic opens up a number of important questions and challenges for embodied AI: how can we access, apply or learn from the embodied, often tacit knowledge of movement experts? How can we effectively study peoples subjective experiences and ability to connect or interact with such machine-like agents? How does a robots movement abilities integrate with its perceptual and cognitive processes, to make sense of other agents and its environment? How could this embodied emphasis lead to an integrated enactive approach to human-robot interaction? We are particularly interested in contributions from researchers and practitioners developing interdisciplinary theories, concepts and/or approaches that can inform or directly tackle embodied, interactive experiences with machine-like agents.

Language Learning for Artificial Agents (L2A2)

Organised by Stephen McGregor, Katrien Beuls, Stephanie Gross, Brigitte Krenn, Friedrich Neubarth

and Thierry Poibeau (Austrian Research Institute for Artificial Intelligence (OFAI), AU, Vrije Universiteit Brussel, BE, CNRS/École normale supérieure, FR)

Our symposium will be a venue for presenting and discussing recent and ongoing work in the various areas related to the development of artificial linguistic agents. At the heart of this event is the topic of grounded language learning and the host of computational techniques that are being explored as solutions to this socially significant area. As such, we will solicit submissions detailing results, ongoing work, projections, descriptions of data, model learning procedures, and ideas that pertain to artificial linguistic agents and their emerging role in the world. Beyond the core artificial intelligence approaches involved in this area of research, a range of fields, including robotics, computer vision, cognitive science, developmental linguistics, and philosophy are entailed by this ambitious programme.

As members of the artificial intelligence community, we feel we are a part of the spirit of optimism and advancement currently prevalent amongst computational linguists. At the same time, as researchers with an awareness of the theoretical and philosophical issues surrounding computational approaches to language, we are sensitive to concerns regarding the way that some forthcoming technological developments might overlook important questions about the grounded, human aspects of language, and the unforeseen consequences that might arise from pursuing information engineering projects without due regard for the social or environmentally situated aspects of natural language.

Paper topics may include, but are not limited to, the following:

- Representation learning
- Ontology construction
- Construction grammar
- Learning language from multimodal data
- Multi-lingual approaches to grounded language learning
- DL for grounded language learning
- Embodied approaches to NLP
- Modelling non-linguistic components of language learning
- Symbol grounding/ungrounding problems
- Language games
- Embodied conversational agents
- Human interactions with artificial agents
- Computational models of developmental linguistics
- Modelling language on multiple timescales
- Evolutionary computational linguistics
- Social considerations in developing artificial linguistic agents

With this in mind, we intend to offer this symposium as both a platform for the presentation of exciting new results and a forum for engaging with some of the hard questions that emerge at the boundaries of language technology and life in the world.

We anticipate our symposium to be a showcase for research from international authors researching a variety of related topics.

Intelligent Machines & Human Behaviour

Organised by Simon Wells,ăKate Pangbourneăand Hannah Bowden (Edinburgh Napier University, University of Leeds, University College London, UK)

This workshop will primarily take the form of paper presentations around thematic topics in the area of Intelligent machines and human behaviour. Accepted papers will be grouped into thematic sessions that incorporate extensive time for questions and discussion. The session will close following a town-hall discussion session, designed to facilitate the mapping of papers to the interdisciplinary landscape, and the development of future collaborations between participants.

We will solicit contributions from a wide range of relevant topics related to how AI can affect human behaviour. These can include, but are not limited to the use of AI in Captology, digital persuasion, behaviour change, gamification. We are interested not only in focused reports concerning research into the applications of these techniques to specific problems, such as within healthcare and transport behaviour, but also in more general consideration of the risks posed and benefits gained from application of these techniques within human society. Of specific interest are contributions addressing the dark side of these interactions, examining how techniques can be misused and how such misuse can be defended against.

Our rationale for focusing upon this topic is as follows: Artificially intelligent machines are becoming increasingly prevalent in modern society and are likely to play an important, even ubiquitous, role in future everyday decision making. This is a trend that is likely to accelerate as new techniques for automated-reasoning and machine-learning are applied to decision making within real-world domains. That these machines will have a great impact upon human society is beyond doubt. There is the potential for such machines to improve nearly every aspect of human life, particularly when artificial intelligence can overcome the well known shortcomings in human decision making such as those identified by behavioural economists. Insights from behavioural economics are behind the rise of "nudge" initiatives, and are in themselves subject to a critique of their ethics. However there is also the potential for AI machines to act to the detriment of people. For every cancer successfully detected at an early stage, there could be a bank computer denying (or approving) a mortgage, or the consequences of an autonomous vehicle that makes a poor decision about whether to evade an obstacle or emergency brake. This is not to ascribe explicitly malicious intent, but merely to recognise that most current, and likely future, machine systems will be as imperfect as those who have created them. Additional complexities can stem from the interplay between intelligent machines and human society. A further layer of risk and complexity is added once humans with

malicious intent are included. Whilst a machine can be used to help recognise poor behaviours, for example eating excess junk food, and can in turn help manage that person's behaviour in order to form better habits, such an approach could be used in the absence of informed consent.

Thus the study of how machines, in particular intelligent machines that can learn to recognise behaviours and respond accordingly, interact with humans, and how the behaviour of humans can be directly or indirectly affected as a result, is a topic of timely and deep importance.

AI and Robotics Normative Spheres: Towards a Sustainable Society and Technology.

Organised by Dr Aurora Voiculescu, Dr. Jack Stilgoe, Prof. Alan Winfield, Prof. Susumu Hirato, and Prof. Norihiro Hagita (University of Westminster, University College London, UWE Bristol, UK, Chuo University Tokyo, Advanced Telecommunications Research Institute International, JP)

In the past decades, an increasing number of human intellectual activities, such as perception, recognition, decision-making, inference have been replicated through Artificial Intelligence (AI) technologies. AI actions, based on these intellectual processes, have led to such technologies being used in a multitude of support activities in businesses and services throughout the economy and society. Big data and machine learning have led to increased progress in machines offering "cognitive insight", classifying information, identifying patterns, processing of natural language, to mention just a few. Moreover, intelligent machines share now physically, more and more, the same space as humans, with automated vehicles, care robots, surgical robots, hotel receptionists, becoming a common encounter. While the support that such AI and robotics technologies can bring to human activities is expanding at an ever-increasing rate, the normative ethical and regulatory - environment needed for welcoming such technologies is evolving at a much slower pace and, with few exceptions, mostly in a reactive rather than a proactive manner.

The symposium sets out to create a platform of debate, as a regular recurring feature of the AISB Convention, inviting AI and robotics scientists as well as social scientists to engage critically in dialogue within a multidisciplinary environment.

The symposium organisers invite submissions on all aspect of the ethical and/or regulatory issues encountered within or outside AI and robotics labs, on issues including but not limited to:

- ethical codes and guidelines in AI R&D environments
- signals of the emergence of a new sense of ethics at the human/machine interface
- relevant dimensions in considering the balance between human decisions and AI-based decisions
- technologies for cyber security and privacy protection
- ELS implications of autonomous robots

- challenges derived from the AI enhancing of human senses and abilities
- the challenges of re-distributing responsibility for accidents involving physical or digital AIs
- access and exploitation of big data in relation to privacy and/or social justice
- rights and incentives in developing socially-mindful AIs
- from moral, to legal, to electronic personhood: ethical, legal and conceptual challenges
- types of responsibility at the human/machine interface
- machine ethics and law-abiding algorithms
- transparency the white box/black box conundrum normative implications
- ethical dimensions of stakeholder consultation in AI and robotics
- creating the social space for discussing alternative visions of the societytechnology dynamics
- governance and regulation of new technologies who does the shaping, owning, benefiting from it, accessing it and making decisions about it
- reflecting on the impact of AI technologies on society where should we start? A top-down or bottom-up approach?

Participants in the workshop will be invited to submit contributions to a special issue of an interdisciplinary journal (Ethics and Information Technology; AI and Society and Connection Science are under consideration for SI publication in 2019).