General

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Robotics and Biology Laboratory

https://www.tu.berlin/robotics

Prof. Dr. Oliver Brock

Mind, Body, Environment: An Interactive Seminar on Embodied Intelligence (Current Topics in Embodied Intelligence)

Organizer: Aravind Battaje

Type: Seminar
Date: Fri, 14-16 pm
Location: MAR 2.057
Max. number of participants: 25
Credits: 3 ECTS
Course language: English
Attendance: In-person only
Prerequisites: Must be pursuing master's in any branch of study at TU, HU, FU or Charité. Any previous coursework in topics related to intelligence (e.g., machine learning, cognitive science, behavioral biology, philosophy etc.) would be very handy.

First meeting: 25.04.2025

Embodied Intelligence is a research area that challenges conventional views of intelligence as isolated information processing in the brain. This interactive seminar will introduce students to key theories and research highlighting this shift in perspective through invited lectures from experts in the field and interactive sessions. Students will also have the opportunity to interact with the experts outside of the lecture.

Students need to engage with the content recommended by speakers before their talks. The course will involve student groups who present some of the content in a debate format. More details will be announced in the introductory session on April 25.

Announcements 0

Michael Levin

About speaker

Michael Levin
Tufts University

Michael Levin is the Vannevar Bush Chair and Distinguished Professor of Biology at Tufts University, where he directs both the Allen Discovery Center and the Tufts Center for Regenerative and Developmental Biology. Renowned for his pioneering work at the intersection of developmental biology, synthetic biology, and cognitive science, Prof. Levin investigates how cells and tissues process information to control growth, regeneration, and form. His research explores the collective intelligence of cells, bioelectric signaling, and the emergence of cognition in both natural and synthetic organisms, with applications ranging from regenerative medicine to synthetic bioengineering.

Prof. Levin is widely recognized for co-discovering *xenobots*—programmable living machines made from frog cells—and has published over 350 scientific papers. His work has been featured in major scientific and popular media. For more information, visit his lab website.

Lecture

May 2, 14:15 to 15:45

Title: TBA

Abstract: TBA

Recommended reading

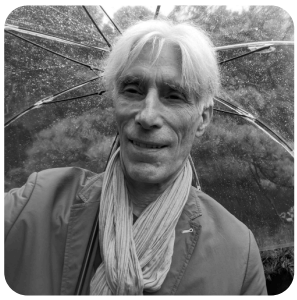
Levin, M. (2025). Living Things Are Not Machines (Also, They Totally Are), Essay Technology & the Human.

Baluška, F., & Levin, M. (2016). On Having No Head: Cognition throughout Biological Systems. Frontiers in Psychology, 7. https://doi.org/10.3389/fpsyg.2016.00902

Fields, C., & Levin, M. (2022). Competency in Navigating Arbitrary Spaces as an Invariant for Analyzing Cognition in Diverse Embodiments. Entropy, 24(6), 819. https://doi.org/10.3390/e24060819

J. Kevin O'Regan

About speaker



J. Kevin O'Regan
Integrative Neuroscience and Cognition Center
Université Paris Cité and CNRS, Paris

Kevin O'Regan is emeritus ex-director of the Laboratoire Psychologie de la Perception, CNRS, Université Paris Descartes. After working on eye movements in reading he became interested in visual stability and discovered the phenomenon of change blindness. His current work concerns the sensorimotor approach to phenomenal consciousness and its applications to child development and robotics. See http://whatfeelingislike.net and http://kevin-oregan.net/.

Lecture

May 9, 14:15 to 15:45

How to make machines that are conscious and really feel.

Despite current advances in artificial intelligence, many people remain convinced that machines are still far from being able to really experience, for example, the redness of a sunset, the pain of a pinprick, or what it's like to be sad. This "phenomenal" or "felt" aspect of consciousness seems outside the realm of science and impossible to implement in machines. Philosophers say phenomenal consciousness is the "hard problem".

I will show that the "hard problem" dissolves if we think about experiences using a "sensorimotor" approach. Like the abandonment of the "ether hypothesis" and the "vital spirit" at the beginning of the 20th century, the sensorimotor approach requires making a metaphysical shift. Instead of thinking of experiences as "happening to us", we should think of experiences as "things we do". I will illustrate the idea by taking concrete examples from the study of vision and touch. With this approach it becomes potentially possible to explain everything that can be explained from a scientific point of view about what it's like to have sensory, bodily, emotional and mental experiences.

Phenomenal consciousness loses its mystery. There is no obstacle to making machines that really feel. They are coming very soon.

Recommended reading

O'Regan, J. K. (1992). Solving the "real" mysteries of visual perception: The world as an outside memory. Canadian Journal of Psychology / Revue Canadienne de Psychologie, 46(3), 461–488. https://doi.org/10.1037/h0084327

O'Regan, J. K. (2012). How to Build a Robot that is Conscious and Feels. Minds and Machines, 22(2), 117–136. https://doi.org/10.1007/s11023-012-9279-x

O'Regan, J. K. (2023). How voluntary control over information and body movements determines "what it's like" to have perceptual, bodily, emotional and mental experiences. Frontiers in Psychology, 13, 1108279. https://doi.org/10.3389/fpsyg.2022.1108279

Cornelia Fermüller

About speaker

Cornelia Fermüller
University of Maryland

Cornelia Fermüller is a Research Scientist at the University of Maryland's Institute for Advanced Computer Studies (UMIACS), where she co-founded the Autonomy Cognition and Robotics (ARC) Lab and co-leads the Perception and Robotics Group. Her research lies at the intersection of computer vision, robotics, and human vision, with a focus on biologically inspired solutions for active vision systems. She has made significant contributions to the understanding of visual perception by developing computational models for visual motion analysis, 3D motion and shape estimation, texture analysis, and action recognition, as well as integrating perception, action, and reasoning to enable cognitive robots to learn and interpret human manipulation actions.

Dr. Fermüller holds an M.S. from the University of Technology, Graz, and a Ph.D. in Applied Mathematics from the Technical University of Vienna. Her recent work emphasizes the use of event-based, bio-inspired sensors for robust motion perception in challenging environments, with applications ranging from fast motion perception for drones to autonomous driving in diverse lighting conditions. She is the principal investigator of an NSF-sponsored Science of Learning Center Network for Neuromorphic Engineering, co-organizes the Neuromorphic Engineering and Cognition Workshop, and has been recognized for her leadership in interdisciplinary research bridging computational modeling and psychophysical studies of human vision.

Lecture

May 30, 14:15 to 15:45

Title: TBA

Abstract: TBA

Recommended reading

Maynord, M., Dessalene, E., Fermuller, C., Aloimonos, Y. (2023). ICLR Poster Mid-Vision Feedback. https://iclr.cc/virtual/2023/poster/10754

Sanket, N. J., Singh, C. D., Fermüller, C., & Aloimonos, Y. (2023). Ajna: Generalized deep uncertainty for minimal perception on parsimonious robots. Science Robotics, 8(81), eadd5139. https://doi.org/10.1126/scirobotics.add5139

Burner, L., Fermüller, C., & Aloimonos, Y. (2024). Embodied Visuomotor Representation (No. arXiv:2410.00287). arXiv. https://doi.org/10.48550/arXiv.2410.00287

Tony Prescott

About speaker

Tony J. Prescott
University of Sheffield

Tony Prescott (him/his) is a Professor of Robotics at the University of Sheffield who develops robots that resemble animals including humans. His goal is both to advance the understanding of natural intelligence and to create useful new technologies such as assistive, educational and entertainment robots. Tony has published over 250 refereed articles and journal papers at the intersection of robotics and psychology (Google h-factor 52) and has received over £10M in funding from UK and European research agencies. He is the author of the book The Psychology of Artificial Intelligence (Routledge, 2024) and lead editor of Living Machines: A Handbook of Research in Biomimetic and Biohybrid Systems (OUP, 2018). With collaborators he has developed the MiRo-e robot and the MiRoCloud robotics e-learning platform. His research has been covered by the major news and scientific media including the BBC, CNN, Discovery Channel, The Guardian and New Scientist. Tony regularly writes and speaks on societal and ethical issues in robotics and artificial intelligence. For more information see his blog page or follow @tonyjprescott on BlueSky.

Lecture

June 6, 14:15 to 15:45

The Psychology of Artificial Intelligence

Artificial intelligence and robotics have been making great progress in recent years but how close are we to emulating human intelligence? This talk will explore the similarities and differences between humans and AIs and discuss the development of biomimetic cognitive systems that more directly think and behave like us. A key focus will be on layered control architectures for robots inspired by the mammalian brain. The talk will be illustrated with work from my lab on active sensing, memory, and sense of self for animal-like and humanoid robots.

Recommended reading

Material	Comments from the speaker
Prescott, T. J. (2024). The Psychology of Artificial Intelligence. Routledge & CRC Press, https://www.routledge.com/The-Psychology-of-Artificial-Intelligence/Prescott/p/book/9780367543112	Best single reference for the talk
Prescott, T. J., & Wilson, S. P. (2023). Understanding brain functional architecture through robotics. Science Robotics, 8(78), eadg6014. https://doi.org/10.1126/scirobotics.adg6014	
Wilson, S. P., & Prescott, T. J. (2021). Scaffolding layered control architectures through constraint closure: Insights into brain evolution and development. Philosophical Transactions of the Royal Society B: Biological Sciences, 377(1844), 20200519. https://doi.org/10.1098/rstb.2020.0519	
Prescott, T. J., & Robillard, J. M. (2021). Are friends electric? The benefits and risks of human-robot relationships. iScience, 24(1). https://doi.org/10.1016/j.isci.2020.101993	

Fumiya Iida

About speaker

Fumiya Iida
University of Cambridge

Fumiya Iida is Professor of Robotics at the Department of Engineering, University of Cambridge. Previously he was an assistant professor for bio-inspired robotics at ETH Zurich (2009-2014) and a lecturer at Cambridge (2014-2018). He received his bachelor and master degrees in mechanical engineering at Tokyo University of Science (Japan, 1999), and Dr. sc. nat. in Informatics at University of Zurich (2006). In 2004 and 2005 he was also engaged in biomechanics research of human locomotion at Locomotion Laboratory, University of Jena (Germany). From 2006 to 2009 he worked as a postdoctoral associate at the Computer Science and Artificial Intelligence Laboratory, Massachusetts Institute of Technology in USA. In 2006 he was awarded the Fellowship for Prospective Researchers from the Swiss National Science Foundation and, in 2009, the Swiss National Science Foundation Professorship. He was a recipient of the IROS2016 Fukuda Young Professional Award, Royal Society Translation Award in 2017, Tokyo University of Science Award in 2021. His research interests include biologically inspired robotics, embodied artificial intelligence, and biomechanics of human locomotion and manipulation, where he was involved in a number of research projects related to dynamic legged locomotion, navigation of autonomous robots, and human-machine interactions. For more information, visit the Bio-Inspired Robotics Laboratory website.

Lecture

June 13, 14:15 to 15:45

Title: TBA

Abstract: TBA

Recommended reading

Iida, F., & Giardina, F. (2023). On the Timescales of Embodied Intelligence for Autonomous Adaptive Systems. Annual Review of Control, Robotics, and Autonomous Systems, 6(Volume 6, 2023), 95–122. https://doi.org/10.1146/annurev-control-063022-094301

Iida, F., & Ijspeert, A. J. (2016). Biologically Inspired Robotics. In B. Siciliano & O. Khatib (Eds.), Springer Handbook of Robotics (pp. 2015–2034). Springer International Publishing. https://doi.org/10.1007/978-3-319-32552-1_75

Brodbeck, L., Hauser, S., & Iida, F. (2015). Morphological Evolution of Physical Robots through Model-Free Phenotype Development. PLOS ONE, 10(6), e0128444. https://doi.org/10.1371/journal.pone.0128444

Fumiya Iida also recommends going through the following proceedings. No need to read everything, but skim through to gain an understanding of what we are generally discussing in the field of Embodied Intelligence.

- https://iopscience.iop.org/issue/1757-899X/1261/1
- https://iopscience.iop.org/issue/1757-899X/1292/1
- https://iopscience.iop.org/issue/1757-899X/1321/1

You may also breeze through some video lectures at https://embodied-intelligence.org/past-conferences/

John K. Tsotsos

About speaker

John K. Tsotsos
York University

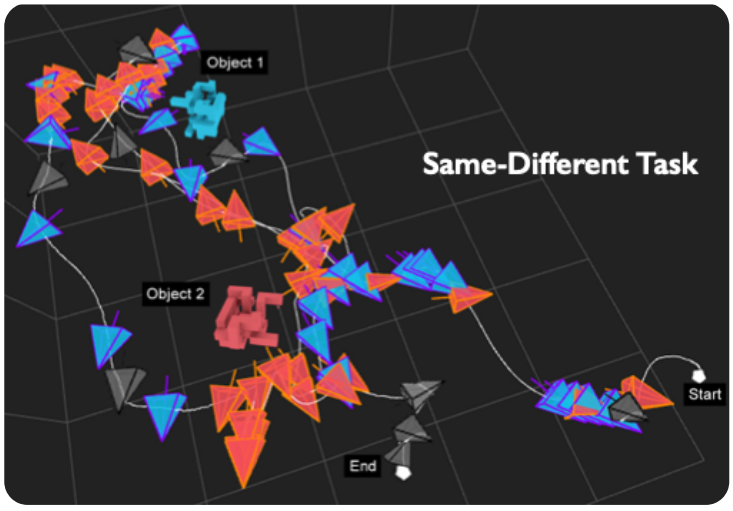
John Tsotsos (he/him) is Distinguished Research Professor of Vision Science at York University and also holds an Adjunct Professorship in Ophthalmology and Vision Sciences at the University of Toronto. Internationally recognized for his pioneering work on visual attention and active vision, Prof. Tsotsos developed the influential Selective Tuning theory, which has shaped understanding of both human and computational vision. His research spans computer vision, computational neuroscience, robotics, and artificial intelligence, with over 300 refereed publications and major contributions to areas such as motion interpretation, visual search, and medical image analysis.

Prof. Tsotsos has received numerous honors, including Fellowships in the Royal Society of Canada, IEEE, and the Canadian Academy of Engineering, as well as the Sir John William Dawson Medal for sustained excellence in interdisciplinary research—the first computer scientist to receive this distinction. He has held the NSERC Tier I Canada Research Chair in Computational Vision since 2003 and was the founding Director of York's Centre for Vision Research, which he led to international prominence.

Lecture

June 20, 14:15 to 15:45

Attentional Mechanisms Bridge Seeing to Looking



David Marr wrote 'What does it mean, to see? The plain man's answer (and Aristotle's, too) would be, to know what is where by looking'. Modern vision science has moved beyond Aristotle's view as well as Marr's, although it certainly would not have advanced without the influence of both. Seeing and Looking are different and although related in a plain manner, at a deeper mechanistic level it is not plain at all: they are spatially, temporally and causally connected. We examine Looking and Seeing and the roles they play in a rational visual agent that functions purposefully in a real three-dimensional world, as a plain person, Marr, or Aristotle would behave during their lifetimes. The vast bulk of theoretical, experimental and empirical research has focussed on how an agent views and perceives an image, singly or in video sequence. We add to the small but growing literature that addresses how an agent chooses how to view a three-dimensional world in the context of a real world task. Looking is the result of a change of gaze while Seeing is what occurs during the analysis of what is being looked at and causes a particular next Looking act. Gaze change ranges over a full 6 degrees-of-freedom for head pose and 3 degrees-of-freedom for each of two eyes within that head. Although our past research has shown that sensor viewpoint planning has provably exponential complexity properties, we propose that an array of attentional mechanisms, as found in our Selective Tuning model, tame the complexity of such behaviour and provides the bridge between Seeing and Looking. Through extensive human experiment (one of these is the pictured Same-Different Task) and foraging through the history of computational vision, we are gradually constructing a picture of a complex blend of orchestrated attentional, visual, reasoning, planning and motor behaviours required for real-world 3D visual tasks.

Recommended reading

Tsotsos, J. K. (2017). Complexity Level Analysis Revisited: What Can 30 Years of Hindsight Tell Us about How the Brain Might Represent Visual Information? Frontiers in Psychology, 8, 1216. https://doi.org/10.3389/fpsyg.2017.01216

Wu, T. C., & Tsotsos, J. K. (2025). Real-world visual search goes beyond eye movements: Active searchers select 3D scene viewpoints too. Neuroscience. https://doi.org/10.1101/2025.02.08.637269

Solbach, M. D., & Tsotsos, J. K. (2023). The psychophysics of human three-dimensional active visuospatial problem-solving. Scientific Reports, 13(1), 19967. https://doi.org/10.1038/s41598-023-47188-4

Tsotsos, J. (2022). When We Study the Ability to Attend, What Exactly Are We Trying to Understand? Journal of Imaging, 8(8), 212. https://doi.org/10.3390/jimaging8080212

Dario Floreano

About speaker

Dario Floreano
Swiss Federal Institute of Technology Lausanne (EPFL)

Prof. Dario Floreano is director of the Laboratory of Intelligent Systems at the Swiss Federal Institute of Technology Lausanne (EPFL). Between 2010 and 2022, he was the founding director of the Swiss National Center of Competence in Robotics, a research program that graduated almost 200 PhD students and more than 100 postdocs, funded two professorships at EPFL and University of Zurich, created the EPFL Master's program in Robotics and the annual Swiss Robotics Day, helped launch Cybathlon, and generated more than 15 robotics spinoffs that created several hundred jobs.

Prof. Floreano holds an M.A. in Vision, an M.S. in Neural Computation, and a PhD in Robotics. He has held research positions at Sony Computer Science Laboratory, at Caltech/JPL, and at Harvard University. His research interests are Robotics and A.I. at the convergence of biology and engineering. Prof. Floreano made pioneering contributions to the fields of evolutionary robotics, aerial robotics, and soft robotics. He served in numerous advisory boards and committees, including the Future and Emerging Technologies division of the European Commission, the World Economic Forum Agenda Council, the International Society of Artificial Life, the International Neural Network Society, and in the editorial committee of several scientific journals. In addition, he helped spinning off three drone companies (senseFly.com, Flyability.com, Elythor.com) and a non-for-profit portal on robotics and A.I. (RoboHub.org). For more information, visit his EPFL profile or Google Scholar page.

Lecture

June 27, 14:15 to 15:45

Title: TBA

Abstract: TBA

Recommended reading

Ajanic, E., Feroskhan, M., Mintchev, S., Noca, F., & Floreano, D. (2020). Bioinspired wing and tail morphing extends drone flight capabilities. Science Robotics, 5(47), eabc2897. https://doi.org/10.1126/scirobotics.abc2897

Phan, H.-V., & Floreano, D. (2024). A twist of the tail in turning maneuvers of bird-inspired drones. Science Robotics, 9(96), eado3890. https://doi.org/10.1126/scirobotics.ado3890

Wüest, V., Jeger, S., Feroskhan, M., Ajanic, E., Bergonti, F., & Floreano, D. (2024). Agile perching maneuvers in birds and morphing-wing drones. Nature Communications, 15(1), 8330. https://doi.org/10.1038/s41467-024-52369-4

William Warren

About speaker

William H. Warren
Brown University

Bill (he/him) earned his undergraduate degree at Hampshire College (1976), his Ph.D. in Experimental Psychology from the University of Connecticut (1982), did post-doctoral work at the University of Edinburgh, and has been a professor at Brown ever since. He served as Chair of the Department of Cognitive and Linguistic Sciences from 2002-10. Warren is the recipient of a Fulbright Research Fellowship, an NIH Research Career Development Award, and Brown's Elizabeth Leduc Teaching Award for Excellence in the Life Sciences. Warren's research focuses on the visual control of action – in particular, human locomotion and navigation. He seeks to explain how this behavior is adaptively regulated by multi-sensory information, within a dynamical systems framework. Using virtual reality techniques, his research team investigates problems such as the visual control of steering, obstacle avoidance, wayfinding, pedestrian interactions, and the collective behavior of crowds. Experiments in the Virtual Environment Navigation Lab (VENLab) enable his group to manipulate what participants see as they walk through a virtual landscape, and to measure and model their behavior. The aim of this research is to understand how adaptive behavior emerges from the dynamic interaction between an organism and its environment. He believes the answers will not be found only in the brain, but will strongly depend on the physical and informational regularities that the brain exploits. This work contributes to basic knowledge that is needed to understand visual-motor disorders in humans, and to develop mobile robots that can operate in novel environments. For more information, visit his faculty profile or the VENLab website.

Lecture

July 11, 14:15 to 15:45

The Dynamics of Perception and Action: From Pedestrian Interactions to Collective Behavior

Abstract: TBA

Recommended reading

Material	Comments from the speaker
Warren, W. H. (2006). The dynamics of perception and action. Psychological Review, 113(2), 358–389. https://doi.org/10.1037/0033-295X.113.2.358	Theoretical background

Dachner, G. C., Wirth, T. D., Richmond, E., & Warren, W. H. (2022). The visual coupling between neighbours explains local interactions underlying human 'flocking'. Proceedings of the Royal Society B: Biological Sciences, 289(1970), 20212089. https://doi.org/10.1098/rspb.2021.2089	Recent research
Warren, W. H., Falandays, J. B., Yoshida, K., Wirth, T. D., & Free, B. A. (2024). Human Crowds as Social Networks: Collective Dynamics of Consensus and Polarization. Perspectives on Psychological Science, 19(2), 522–537. https://doi.org/10.1177/17456916231186406	An interesting tangent

Jacob Yates

About speaker

Jacob Yates
University of California, Berkeley

Jacob Yates (he/him) is an Assistant Professor of Optometry & Vision Science at UC Berkeley and leads the Active Vision and Neural Computation Lab. His research explores how populations of neurons in the cortex and early visual pathways encode the visual world, with a particular focus on how eye movements generate and utilize information for perception. By combining statistical and machine learning approaches, his lab builds computational models to better understand neural activity and human perception, ultimately aiming to bridge the gap between neural coding and real-world visual behavior.

Lecture

July 18, 14:15 to 15:45

Title: TBA

Abstract: TBA

Recommended reading

Material	Comments from the speaker
Friston, K., Moran, R. J., Nagai, Y., Taniguchi, T., Gomi, H., & Tenenbaum, J. (2021). World model learning and inference. Neural Networks, 144, 573–590. https://doi.org/10.1016/j.neunet.2021.09.011	This articulates the conceptual framework that underlies how I currently think about understanding embodied intelligence.
Land, M. F. (2018). The Evolution of Gaze Shifting Eye Movements. In T. Hodgson (Ed.), Processes of Visuospatial Attention and Working Memory (Vol. 41, pp. 3–11). Springer International Publishing. https://doi.org/10.1007/7854_2018_60	A great reference for how biological systems actively sample with vision (saccade and fixate)