Department of Computer Science
香港城市大學
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COMPUTER SCIENCE COLLOQUIUM

Abstraction hierarchies, human knowledge, and machine learning

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DATE 12 Nov, 2026 (Thu)
TIME 10:30 AM - 11:30 AM
VENUE B5-309, 5/F, Blue Zone, Yeung Kin Man Academic Building, City University of Hong Kong, 83 Tat Chee Avenue, Kowloon Tong

ABSTRACT

Machine learning systems now outperform humans in domains where human expertise took centuries to build, yet what they learn rarely comes back to us as the layered abstractions people use to think, teach and explain. This talk explores that gap. In the game of Go, superhuman engines such as KataGo know which move is best but not how a teacher would explain it. Using LoGos, a language model for Go reasoning co-developed at CUHK, we compare engine analysis, model-generated explanations and human commentary, and ask whether language alone can recover the concepts strong players rely on, such as the size of a move, timing and initiative. In program discovery, we revisit Evolvable Virtual Machines, an evolutionary architecture in which solved programs become building blocks on higher levels, and ask which abstraction hierarchies make program spaces searchable by evolution, reinforcement learning and LLMs. A separate part of the talk turns to cryptocurrency forensics: open problems in de-anonymisation, and graph search for the anonymity sets of transactions in privacy schemes such as CoinJoin. Returning to abstraction hierarchies, we close with broader questions about human knowledge and superhuman machine learning: how the two can coexist, and whether the mechanisms humans use to manage complexity could improve machine learning.

BIOGRAPHY

Mariusz Nowostawski is a Professor in the Department of Computer Science (IDI), NTNU, where he directs the Decentralised Systems Engineering lab and leads the Bachelor programme in Programming. His research centres on decentralised, self-organising computation: systems without central control, and how machines can generate and understand the code that runs on them. His PhD (University of Otago, New Zealand, 2007) introduced Evolvable Virtual Machines, a massively parallel, stack-based architecture for discovering programs through evolution. He continues this work with LLM-guided evolutionary search, reinforcement learning from execution feedback and self-play. His lab studies decentralised systems and public blockchains: it analyses Ethereum smart contracts at the bytecode level (call graphs, trust boundaries between contracts, security) and works with law enforcement on cryptocurrency forensics, including a forensic tool built on CoinJoin heuristics. He has supervised several PhD theses on topics such as blockchain privacy, self-sovereign identity systems and the deployment and operation of blockchain networks, and has contributed to blockchain standardisation in ISO/TC 307. Before joining NTNU in 2013, he was a lecturer at Otago and CTO of two start-ups. He built high-performance networking software for telecom applications on multi-core UltraSPARC servers with Sun Microsystems and Oracle, and optimised the performance of distributed systems, e.g. multiplayer games and Second Life. His 2026–27 research leave takes him to research groups in Europe, Hong Kong, Japan and New Zealand.

All are welcome!

In case of questions, please contact Prof. ZHANG Qingfu at qingfu.zhang@cityu.edu.hk, or visit the CS Departmental Seminar Web at https://www.cs.cityu.edu.hk/events/cs-seminars/recent-cs-colloquiums.