Improving Robot and Deep Reinforcement Learning via Quality Diversity and Open-Ended Algorithms

Abstract: Quality Diversity (QD) algorithms are those that seek to produce a diverse set of high-performing solutions to problems. I will describe them and a number of their positive attributes. I will then summarize our Nature paper on how they, when combined with Bayesian Optimization, produce a learning algorithm that enables robots, after being damaged, to adapt in 1-2 minutes in order to continue performing their mission, yielding state-of-the-art robot damage recovery. I will next describe our QD-based Go-Explore algorithm, which dramatically improves the ability of deep reinforcement learning algorithms to solve previously unsolvable problems wherein reward signals are sparse, meaning that intelligent exploration is required. Go-Explore solves Montezuma’s Revenge, considered by many to be a major AI research challenge. Finally, I will motivate research into open-ended algorithms, which seek to innovate endlessly, and introduce our POET algorithm, which generates its own training challenges while learning to solve them, automatically creating a curricula for robots to learn an expanding set of diverse skills. POET creates and solves challenges that are unsolvable with traditional deep reinforcement learning techniques.

Brief Bio: Jeff Clune is the Loy and Edith Harris Associate Professor in Computer Science at the University of Wyoming and a Senior Research Manager and founding member of Uber AI Labs, which was formed after Uber acquired a startup he helped lead. Jeff focuses on robotics and training deep neural networks via deep learning, including deep reinforcement learning. Since 2015, he won the Presidential Early Career Award for Scientists and Engineers from the White House, had papers on the cover of Nature and PNAS, won an NSF CAREER award, received an Outstanding Paper of the Decade award, and had best paper awards, oral presentations, and invited talks at the top machine learning conferences (NeurIPS, CVPR, ICLR, and ICML). His research is regularly covered in the press, including the New York Times, NPR, NBC, Wired, the BBC, the Economist, Science, Nature, National Geographic, the Atlantic, and the New Scientist. Prior to becoming a professor, he was a Research Scientist at Cornell University and received degrees from Michigan State University (PhD, master’s) and the University of Michigan (bachelor’s). More on Jeff’s research can be found at JeffClune.com.