David Silver

“David Silver is a neural network whisperer”. I was recently listening to Lex Fridman’s podcast with Michael Littman, a reinforcement learning researcher, as the guest speaker, and this was what Littman had to say about David Silver. I have a deep interest in machine learning, and reinforcement learning has fascinated me over the past few years, and it is the area in which I would like to research as an academic down the line. Littman was referring to Silver’s contributions to AlphaGo, the first computer program to beat a Go master, a feat achieved only as recently as 2016, an astonishing thought compared to how Garry Kasparov was beaten in chess by DeepBlue in 1997. David Silver has been central to many of the advances in reinforcement learning in the past decade, and it is for this reason that I deeply admire him as a software engineer.

Silver’s interest in computers began around the age of 7, when his parents brought home their first computer, a BBC Model B microcomputer. Silver, like many of us, was fascinated by this machine and eventually decided to learn how it worked, which lead him to programming. He initially began programming in Basic. According the Silver, his father was so interested in the technology that he left his career to return to school and earn a Master’s degree in Artificial Intelligence. Silver’s father taught him Prolog, and Silver gained an interest in teaching machines to learn like a human, and to “solve intelligence”, which according to DeepMind (where Silver currently works), will be achieved through the creation of artificial general intelligence.

Silver studied computer science at Cambridge University and graduated in 1997. Upon graduation, Silver founded the video game company Elixir Studios, where he worked as CTO and lead programmer on the game Republic: the Revolution. Silver states that he has always had a deep love and passion for games, both of the board and video variety. In university, he became obsessed with the game of Go, an ancient Chinese game. Go has been of great importance to the artificial intelligence community over the years, as such a simple game has many advanced layers to it, involving pattern recognition, long term planning and deep strategic thinking. The number of possible board positions is approximately 2.1×10^{170}, a number that would be impossible for a computer to simulate, therefore making it incredibly difficult, if not impossible to “solve”. To paraphrase Silver himself “If we ever meet aliens, we may not be able to communicate with them, but there’s a good chance we could play Go with them, as they too have likely created such a game since the rules are so basic.” Silver eventually left Elixir Studios in 2004 to return to academia and pursue a PhD in reinforcement learning at the University of Alberta under the supervision of Richard Sutton, a pioneer in reinforcement learning. Silver achieved his PhD in 2009 with a thesis called “Reinforcement Learning and Simulation-Based Search”, which was mainly focused on reinforcement learning agents playing Go. Silver is now a professor at University College London, after being awarded a Royal Society University Research Fellowship in 2011, though he is on indefinite leave from teaching so that he can focus on his research at DeepMind.

Silver currently leads the reinforcement learning research group at DeepMind, an artificial intelligence research company based in London and owned by Google. Founded by Demis Hassabis in 2010, DeepMind has been one of the leading contributors to research into the

field of artificial general intelligence. Silver met Hassabis while studying at Cambridge, and Hassabis was the founder of Elixir Studios. DeepMind made news headlines in 2015 when they combined deep learning and reinforcement learning on Atari games, to train agents that could perform well in a large number of these games, rather than just one. Silver co-led this project, after joining DeepMind full-time in 2013, though he has been involved with the company since its founding.

After working on the Atari agent, Silver focused his efforts on the work he had always been pursuing: teaching an AI how to master Go. Silver led the AlphaGo project, which was the first computer program to ever defeat a professional Go player (9 dan). In 2016, the match between Go prodigy and world champion Lee Sedol and AlphaGo took place in South Korea. This match was broadcast across the world and the story behind it can be viewed on the documentary AlphaGo - The Movie on Youtube. It is estimated that about 60 million people watched this match in China alone. It's also widely speculated that it was this match in particular that sparked China's large investment in AI and its goal to be the world leader in artificial intelligence by 2030. AlphaGo shocked the world when it defeated Lee Sedol 4-1, and, in my opinion, this is one of the most influential breakthroughs in the history of artificial intelligence. Watching the documentary inspired me to begin my own journey into reinforcement learning. I feel that enough credit cannot be given to Sedol, however, for managing to beat AlphaGo in one of the games. It's an incredible achievement and truly shows that we still have something that machines do not in terms of thinking and creativity.

Silver's work on AlphaGo was influential, and truly shone a new light onto the power of deep reinforcement learning. After the success of AlphaGo, Silver led the team that created AlphaZero, the next level of AlphaGo. AlphaZero taught itself to play Go, Chess and Shogi without any prior knowledge of the games. This was of particular interest to me as I am a big fan of chess, and seeing this agent become one of the strongest computer players in the world purely through self play was incredible. It once again opened my eyes to the exciting advancements being made in this field and reinforced my belief that I wanted to study this field further.

I feel that the work Silver did and the part he played in developing AlphaGo and the algorithms behind it is reflected well in Littman's quote. Littman was comparing Silver to Gerald Tesauro, who developed TD-Gammon, a computer program that achieved near-pro human performance in backgammon in 1992. As Littman says, Silver is a "neural network whisperer", and he continues in the interview stating that he was blown away by the software engineering required to actually make the program work. AI models are incredibly brittle and difficult to get working properly, without converging to a weak solution. Silver's ability to create a program that could become the greatest Go player of all time is no small feat, and despIte Silver being a researcher and the software engineering part may seem trivial to the whole process, it should be stated that the entire system is incredibly complex and creating such a program required a large team working in sync to develop and improve the final solution.

Silver has been a huge contributor to many more innovations at DeepMind. He also co-led the AlphaStar project, which defeated professional StarCraft players, a game that was seen as the "next-stage" in AI game bots, as the game is even more complex than Go. The program was limited to being allowed to play only at the human level physically, as in it could

not press more buttons or see more than a real human player. Silver has over 67,000 citations on his research work, and has an h-index of 66. Some particularly influential work is the AlphaFold paper, which is an algorithm that predicts how a protein will fold based on its unfolded structure. This is an incredible feat, as it has huge potential to change the medical industry and help develop new drugs and medication to fight diseases. Looking into the architecture of this model, we can see the complexities and the deep level of thought required to create such a complex algorithm. The different aspects to be considered, and the modules that fit together and feed information into each other is fascinating to see from a software engineering perspective, and the knowledge that this kind of work has the potential to genuinely change the world and help people in a positive way is fantastic.

David Silver is a software engineer and a researcher who I really admire, as he has developed truly incredible and revolutionary software. I am excited by the advancements in reinforcement learning, artificial intelligence and the future of technology. I feel that in the field of artificial intelligence, the software engineering aspect is often overlooked in favour of the algorithms and ideas being used in the programs, but without the large amount of software engineering done to create these applications, none of what I have discussed would have been realised. Theory is important and is of course required, but without the software engineers and modules that build the systems that apply the theory, we would not be seeing the results we have been seeing these past few years. I hope to someday be part of a team that develops something as influential and awe-inspiring as AlphaFold or AlphaGo, and it's important to remember that it was a team that developed these. Software engineering is a collaborative process, and despite this biography being about David Silver, without his team at DeepMind he would not have been able to make the contributions to the field that he has. Silver has truly brought deep reinforcement learning to the forefront of artificial intelligence research, and has personally inspired me to push myself into the field.

Sources:
Podcast featuring Michael Littman:
https://www.youtube.com/watch?v=c9AbECvRt20&ab_channel=LexFridman
Podcast featuring David Silver:
https://www.youtube.com/watch?v=uPUEq8d73JI&ab_channel=LexFridman
Silver's website: https://www.davidsilver.uk/
AlphaGo documentary:
https://www.youtube.com/watch?v=WXuK6gekU1Y&ab_channel=DeepMind
Silver PhD thesis: https://www.davidsilver.uk/wp-content/uploads/2020/03/thesis-min.pdf
AlphaStar video:
https://www.youtube.com/watch?v=UuhECwm31dM&ab_channel=DeepMind
Wikipedia:
https://en.wikipedia.org/wiki/David_Silver_(computer_scientist)
https://en.wikipedia.org/wiki/Elixir_Studios
https://en.wikipedia.org/wiki/AlphaGo
https://en.wikipedia.org/wiki/AlphaGo_versus_Lee_Sedol