Chapter 9: Game On - Questions

1. Name the two founders of the computer age who wrote programs to play chess before there were even computers that could run their code.

They are Alan Turing and Claude Shannon, (145).

2. He is the "face" of DeepMind Technologies, a company that has also been responsible for significant technical advancements in machine learning, having produced a number of award-winning papers. In particular, the company has made significant advances in deep learning and reinforcement learning, and pioneered the field of deep reinforcement learning which combines these two methods. Who is he? ((Thanks to Wikipedia for helping me to frame the question.))

The "face" of DeepMind Technologies is Demis Hassabis (146).

3. The video game *Breakout* was the result of Atari's effort to create a single-player version of its successful game *Pong*. To whom was the design and implementation of *Breakout* originally assigned in 1975?

Mitchell writes, "The design and implementation of *Breakout* were originally assigned in 1975 to a twenty-year-old employee named Steve Jobs," (147).

4. TRUE/FALSE - In 2013, a group of Canadian AI researchers released a software platform called the Arcade Learning Environment that made it easy to test machine-learning systems on forty-nine Atari video games. This was the platform used by the DeepMind group in their work on reinforcement learning.
5. TRUE/FALSE - The DeepMind group combined reinforcement learning–in particular Q-learning–with deep neural networks to create a system that could learn to play Atari video games. The group called their approach deep Q-learning.
6. What game did Melanie Mitchell use as a running example to explain how deep Q-learning works?

Melanie Mitchell uses *Breakout* as a running example to explain how deep Q-learning works (148).

7. TRUE/FALSE - DeepMind first presented its work on computational methods for learning to play Atari video games in 2013 at an international machine-learning

conference. The audience was dazzled. Less than a year later, Google announced that it was acquiring DeepMind for about 650 million dollars, presumably as a result of its work on the machine learning of Atari video games.

8. TRUE/FALSE - With a lot of money in their pockets and the resources of Google behind them, DeepMind–now called Google DeepMind–moved onto a bigger challenge, one that had in fact long been considered one of AI's "grand challenges": creating a program that learns to play the game Go better than any human.
9. In the very early years of the computer age, Arthur Samuel joined IBM's laboratory in Poughkeepsie, New York and immediately set about programming an early version of IBM's 701 computer to play checkers. In what language did he do this early work?

Samuel programmed on the IBM 701 computer using op codes and address (152).

10. TRUE/FALSE - Samuel's checkers-playing program was among the earliest machine-learning programs; indeed, it was Samuel who coined the term *machine learning*.
11. Samuel's checkers player was based on a method of searching a game tree, which is essentially the same method used by Deep Blue to play chess and AlphaGo to play Go. What is the name of this method of searching a game tree?

Samuel's checkers player used minimaxing to evaluate the game tree (155).

12. TRUE/FALSE - What Samuel's program learned was *which* features of the board should be included in the static evaluation function at a given turn, as well as how to weight these different features when summing their points.
13. TRUE/FALSE - In the most interesting version of Samuel's program, the system learned while playing itself!
14. What are the three main concepts Samuel's checkers player illustrates?

The three main concepts that Samuel's checkers player illustrates are "the game tree, the evaluation function, and learning by self-play," (155).

15. TRUE/FALSE - In 1958, Alan Newell and Herb Simon wrote, "If one could devise a successful chess machine, one would seem to have penetrated to the core of human intellectual endeavor."

16. TRUE/FALSE - In 1997, IBM had its second big game-playing triumph with Deep Blue, a chess-playing program that beat the world champion Garry Kasparov in a widely broadcast multi-game match.
17. Other than the difference of game specific knowledge (checkers vs chess), what were the major differences between Samuel's chess machine and the Deep Blue chess machine?

Mitchell writes, "The major differences between Samuel's program and Deep Blue were Deep Blue's deeper look-ahead in its game tree, its more complex (chess-specific) evaluation function, hand-programmed chess knowledge, and specialized parallel hardware to make it run very fast," (156). Machine learning was not the focal point of Deep Blue, unlike Samuel's chess machine.

18. After Deep Blue defeated Kasparov, how did most people in AI view Newell and Simon's famous 1958 statement about a successful chess-playing machine?

After Kasparov's defeat, the media questioned whether the rise of superhuman intelligence was a threat. However, the general public grew to disregard Deep Blue as intelligent, due to the fact that it lacks "general intelligence," (157).

19. TRUE/FALSE - According to the great Go champion Lee Sedol, Go is incomparably more subtle and intellectual than chess.
20. TRUE/FALSE - Go is a game that has fairly simple rules but produces what you might call emergent complexity. At each turn, a player places a piece of his or her color (black or white) on a 19-by-19 square board, following rules for where pieces may be placed and how to capture one's opponent's pieces. Unlike chess, with its hierarchy of pawns, bishops, queens, and so on, pieces in Go ("stones") are all equal. It's the configuration of stones on the board that a player must quickly analyze to decide on a move.
21. TRUE/FALSE - In 2016, DeepMind's AlphaGo program spectacularly defeated Lee Sedol in a very high profile 5 game match.
22. TRUE/FALSE - Demis Hassabis following the AlphaGo-Sedol match, noted that "the thing that separates out top Go players is their intuition," and suggested that "what we've done with AlphaGo is to introduce with neural networks this aspect of intuition."
23. DeepMind built several different versions of AlphaGo, so to keep them straight, DeepMind started naming them after the human Go champions the programs had defeated–AlphaGo Fan and AlphaGo Lee. What image did this naming convention evoke in MM's mind?

Mitchell writes that the naming convention evokes images of "the skulls of vanquished enemies in the collection of a digital Viking," (160).

24. A year after the Lee Sedol match, DeepMind developed a version of the Go machine, called AlphaGo Zero, that was both simpler than and superior to the previous versions. Why was the program given this name?

AlphaGo Zero's name is representative of the fact that it starts off knowing nothing besides the rules of Go (160).

25. TRUE/FALSE - The word *intuition* has an aura of mystery, but AlphaGo's "intuition" arises from its combination of deep Q-learning with a clever method called Monte Carlo tree search.
26. Describe "Monte Carlo tree search" in just one paragraph.

The Monte Carlo Tree search method addresses the issue of being unable to do a full-search of a game tree in a reasonable amount of time. It does this by introducing randomness in its search: the Monte Carlo method has the machine look at some possible moves and play out a game by picking moves randomly (at first) or probabilistically and scoring the results. It essentially collects statistics and uses probability to determine winning moves. Selection of moves is referred to as "roll-outs." The more roll-outs performed, the more successful the machine is (162-163).

27. TRUE/FALSE - The scientists at DeepMind invented Monte Carlo tree search.
28. TRUE/FALSE - Imagine that you are AlphaGo staring at a board position: before you start the Monte Carlo process of performing roll-outs from that position, the ConvNet is whispering in your ear which of the possible moves from your current position are probably the best ones.
29. TRUE/FALSE - Imagine yourself as AlphaGo after a Monte Carlo tree search. The results of your search are new probabilities assigned to all your possible moves, based on how many times those moves led to wins or losses during the roll-outs you performed. These new probabilities are now used to correct your ConvNet's output, via back-propagation.
30. TRUE/FALSE - Once AlphaGo "matures," its ConvNet, informed by a huge number of Monte Carlo tree search applications over a huge number of plays of the game against itself, will play the role of the program's "intuition."

31. TRUE/FALSE - With its AlphaGo project, DeepMind demonstrated that one of AI's longtime grand challenges could be conquered by an inventive combination of reinforcement learning, convolutional neural networks, and Monte Carlo tree search (and adding powerful modern computing hardware to the mix).