Playing blackjack

Portfolio assignment 4

MAL2 Autumn 2024

In this assignment, you are tasked with solving the problem of training a model to effectively play the classic casino game blackjack (explained on the next page) using reinforcement learning techniques. The environment for simulation is provided by Gym, which you can learn more about here: https://www.gymlibrary.dev/environments/toy_text/blackjack/.

Blackjack's simplicity, with only two actions and short game durations, makes it an ideal candidate for rapid training on standard computers. This allows you to experiment with different policies, training methodologies, neural network architectures, and more.

You will implement a basic policy where the player sticks whenever their card value is 17 or higher, which should give you a win rate of approximately 39 %. Then train a neural network to play blackjack and surpass the 39 % win rate achieved by the basic policy. Simulate 1,000 games and report the win rate of your model. If your model wins more often than it loses, you might want to board the next plane to Las Vegas! In any case, **the best blackjack player in the class receives a prize**.

You are to hand in a notebook with

- output (all cells must be run)
- relevant comments describing your approach, experiments, and findings
- your basic policy and neural network implementation as well as their win rates
- at least two interesting figures or animations

The game of blackjack

This section offers an explanation of the game Blackjack. There are probably better explanations out there.

Blackjack, also known as 21, is a popular card game played in casinos with the objective of having a hand value closer to 21 than the dealer's hand without exceeding 21.

The game uses standard playing cards where number cards (2-10) are worth their face value, face cards (King, Queen, Jack) are worth 10 points each, and Aces can be worth either 1 or 11 points, depending on which value benefits the hand more.

Gameplay begins with each player, including the dealer, being dealt two cards. The players' cards are typically dealt face up, while the dealer has one card face up (the upcard) and one card face down (the hole card). Players then take turns deciding whether to "hit" (take another card) or "stick" (keep their current hand). Players can hit as many times as they want, but if their hand value exceeds 21, they "bust" and lose the round.

After all players have completed their turns, the dealer reveals the hole card. The dealer must hit until their hand value is 17 or higher and must stick on all 17s.

To win the game, a player's hand must be closer to 21 than the dealer's hand without busting. If both the player and dealer have the same hand value, it results in a "push," and the player's bet is returned. If the player busts, they lose regardless of the dealer's hand. If the dealer busts, all remaining players win.

A special winning condition occurs if a player's initial two cards are an Ace and a 10-value card (10, Jack, Queen, or King), known as "blackjack," which typically pays out at 3:2 odds.

For example, if a player’s initial hand is an 8 and a 7, totaling 15, and the dealer's upcard is a 6, the player might choose to hit and receive a 5, bringing the total to 20, at which point the player sticks. If the dealer reveals a 10, bringing their total to 16, and then hits and gets a 5, reaching a total of 21, the dealer wins since 21 is closer to 21 than the player’s 20. Alternatively, if the player sticks with 20 and the dealer busts by exceeding 21, the player wins.