Quantitative Finance

Test 1 - Take Home

April 21, 2024

Instructions

The class part of the test should be solved in the RStudio environment. Please make sure you add comments to your code in each of your steps or else points could be discounted even if your solution is correct. This part of the test can be solved in groups. The due date is Saturday 4^{th} 11:30 p.m. GMT-5. You must send your .Rmd and HTML file to your TAs Gonzalo Fernández and Gerald Campos before the stated time with Subject = Quantitative_Finance_Test1_LastName1_LastName2_LastNa
For each start of the next hour 1 point will be deducted from the final test grade. The test score below will be scaled to base 10. The two remainder points will be assigned based on presentation, execution and neatness of code.
Note: This test has multiple pages.

Functions & Code Efficiency

1 Alto Voltaje

Mercurio is enjoying the success of their game Alto Voltaje. They are thinking of releasing an online version of it but are concerned of some players potentially creating a bot that would give them an unfair advantage versus real players. You have been tasked to simulate a human vs bot gameplay. This card game is simple. There are 73 cards. Each card has a main number from 1 to 10 and a modifier number $\pm$ 1 to 3. On the table's center you will always find a card which holds a main number and modifier.
The first player who finds a card which matches the main number plus or minus the modifier as the main number in his hand will play it on top of the center's card. That will now become the new card. One may play again if they find a match before their opponents. First player that has zero cards in their hand wins.
Example: If the center card is a 3 $\pm$ 2 then the possible cards you can play on top are either 1 or 5.
Additional Rules:

- If the card on top causes an overflow, i.e. 10 $\pm$ 1 then the available options are 9 or 1. Likewise with a negative overflow, i.e. 1 $\pm$ 3 then the available options are 4 or 8.
- If no player has any playable card then a card on the discard pile (the already played cards) are shuffled so a new card comes on top.
- At the start of the game all cards are given to every player so they all have the same amount of cards in their hand. The rest are put on the discard pile with the last card becoming the card on top. If only two players are competing then only 1 card will be on the discard pile and all others will go to the players.

(10 points)

1. Create a function that takes as input the amount of cards on the game with default value 73 and outputs a dataframe with the cards. The dataframe will have two variables: main number and modifier. The main number will have an equal probability of being 1 through 10 and the modifier will have an equal probability of being 1 through 3.

2. Create a function that takes as input the amount of players with default value 2 and outputs a vector with the number of cards that will go to each players hands and the number of cards on the discard pile (discard pile minimum = 1).

3. Creates a function that takes as input the cards dataframe and the vector on item 2. This function will output a list which has 2 items: Players and Discard Pile. Players will be another list which holds one dataframe per player which represents the cards that they have in hand. Discard Pile will be a dataframe which represent the already played cards and the last observation will be the card on top.

4. Create a function that shuffles the discard pile.

5. Create a function which takes as input a player's hand and the discard pile. If there is a playable card then the function should take away that card from the hand and put it on top of the discard pile. Else should output that there is no possible play.

6. Simulate a one player game and track the time which it takes to empty all his hand.

7. Repeat this simulation 1 million times each with a new generated set of cards. Track the time each run takes with a package like tictoc and display how much time it took on average. *Best time will get an additional point.*