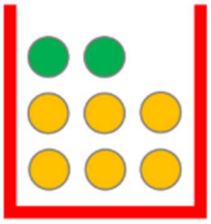
Exercise 8.1 (May 25, 2020)

-B9TB1707

Question:

- Calculate a Monte Carlo estimate of $p(F=o)$ using logical indexing of matrices explained in a previous slide
- Try this code 10 times under different trial numbers (i=10,100,1000,10000).
- Summarize the variation of probability for each trial numbers.



2 apples, 6 oranges

3 apples, 1 orange

Solution:

My code for the solution is as follows:

CAPS_08_B9TB1707_8.1.m

```
1  trial =10;
2  for i =3:13
3  Box = rand(1,trial) < 0.4;
4  F_rand = rand(1,trial);
5  F(Box==1) = F_rand(Box==1) < 3/4;
6  F(Box==0) = F_rand(Box==0) < 1/4;
7  printf("The probability is %f for %d trials\n",(sum((F==1))/(trial)),trial);
8  trial = floor(10^(i/2));
9  clear Box;
10 clear F_rand;
11 clear F;
12 end
```

And the output is as follows:

Command Window

```
>> The probability is 0.200000 for 10 trials
The probability is 0.580645 for 31 trials
The probability is 0.390000 for 100 trials
The probability is 0.446203 for 316 trials
The probability is 0.463000 for 1000 trials
The probability is 0.448134 for 3162 trials
The probability is 0.448400 for 10000 trials
The probability is 0.450572 for 31622 trials
The probability is 0.451230 for 100000 trials
The probability is 0.449769 for 316227 trials
The probability is 0.449991 for 1000000 trials
```

How it works:

1. Line 1 initializes the variable for number of trials.
2. Line 2 sets up the for loop to iterate through multiple trials.
3. Line 3 creates an array to store the outcome of the choice of box. A random number between 1 and 0 is generated and if this number is below 0.4 it is assigned 1 to denote a red box and zero to denote a blue box by using a simple less than logical operator.
4. Line 4 creates an array of random numbers between 0 and 1.
5. Line 5 and 6 stores the fruit choice as 1 for oranges and 0 for apples by using the same method described in step 3 but this time there is an extra input of the state of B. The probability to be check in the logical operation is changed according to the value of B.
6. Line 7 displays the results.
7. Line 8 updates the number of trials. I have chosen to increase by powers of 0.5 because otherwise the numbers will become too large.
8. Line 9 to 11 clears the data stored in the variables for a fresh set of values.
9. Line 12 closes the for loop.

Conclusion:

And thus I have calculated the Monte Carlo estimate of probabilities by using the logical indexing method, a method that uses binary arrays to process a large amount of data. In my opinion logical indexing is far superior to the regular iterative method. I have also calculated probabilities for various number of trials, and as expected, the larger the number of trials the closer the calculated probability got to the actual theoretical value of 0.45.