STA 141A Data Analysis Report
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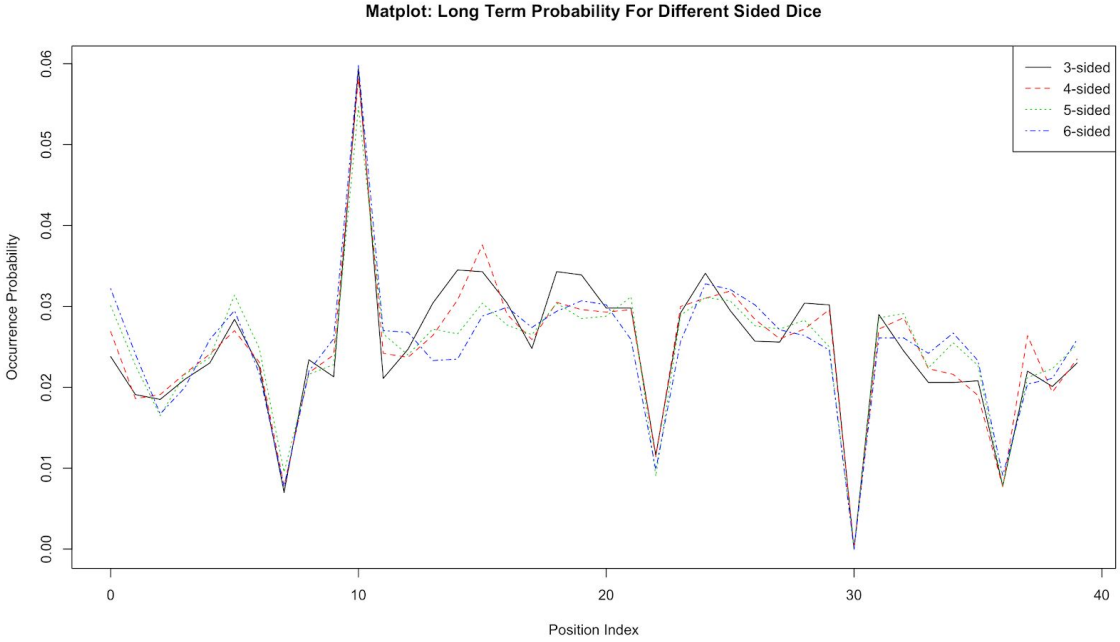
Part 1: Working with the Board

Q1: The function **simulate_monopoly()** which simulates n turns by a player in a game of Monopoly using two d-sided dice is shown as R code in the appendix, under section 1.1. Comments are included to explain codes and usages.

Q2 : The function **estimate_monopoly()** which uses the simulation to estimate the long-term probabilities of ending a turn on each Monopoly square is shown as R code in the appendix, under section 1.2. Comments are included to explain codes and usages.

Statistics indicating the 3 most likely squares to end a turn on with playing different sided dice are shown in the below graph:



As we can see from this graph, the most likely square to land on with all these 4 different kinds of dice is the same, at index 10, where the “JAIL” is, and the least likely square to land on with all these 4 different kinds of dice is the same as well, at index 30, where the “G2J” is, having probability 0. It makes sense because everytime we land on “G2J”, we directly go to “JAIL”. So landing on index 30 should always has probability 0.

By extracting data values from the matrix we used to plot the above graph, we find the index and probability of the top 3 most squares to end a turn on with different sided dice in long term are as follows:

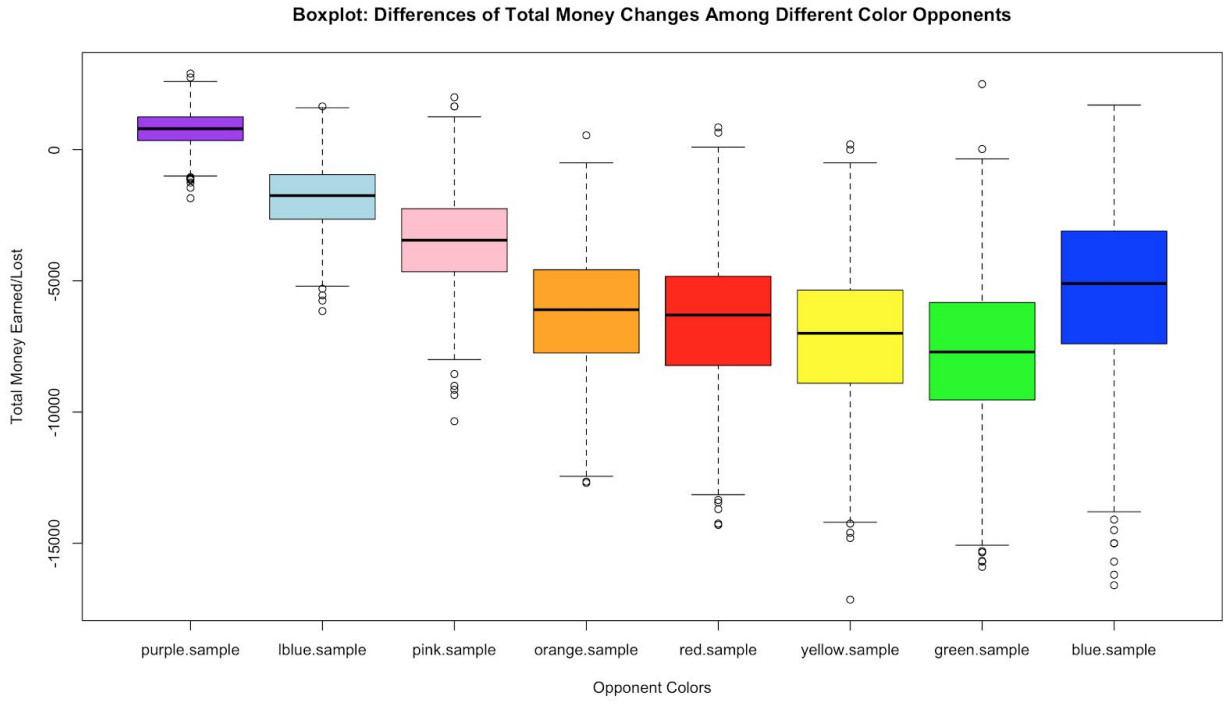
Top 3 Statistics		1st	2nd	3rd
3-sided dice	index	10	14	18
	probability	0.05939406	0.03449655	0.03429657
4-sided dice	index	10	15	25
	probability	0.05819418	0.03759624	0.03189681
5-sided dice	index	10	5	21
	probability	0.05469453	0.03139686	0.03119688
6-sided dice	index	10	24	0
	probability	0.05979402	0.03279672	0.03219678

Q3: Using R to compute the estimated standard error for the long-term probability of ending a turn in jail, with R code attached in the appendix, under section 1.3, we find that the sd = 0.002077305. Comments are included to explain codes. The value of sd indicates that if we use two 6-sided dice to play this Monopoly for 10000 turns 1000 times, the standard deviation of this sampling distribution of ending on jail is very small.

Part 2: Working with Money

Q1: The function **simulate_monopoly2()** which updates money gain and lose on top of the features in **simulate_monopoly()** is shown as R code in the appendix, under section 1.1. Comments are included to explain codes and usages.

Q2: After running simulate_monopoly2() with n=100 dice rolls and k=1000 simulations for all eight colors, we sum the money change at each turn to get the total money gained/lost per simulation. The result is shown with the below graph:



As we can see from this graph, the purple box, which shows the distribution on purple opponent sample, is above Total Money Earned/Lost = 0, while the other color boxes are all below, meaning that among these 8 colors, purple seems to be the least effective when it has hotels on it because mostly it would lose money. Green seems to be the most effective among them because the green box located the lowest negative on the graph, meaning that it gains money all the time and the gain are mostly more than the others.

Q3: Using R to simulate a basic version of a two player game of Monopoly, as shown in R appendix under section 2.3. The below tables show the 28 paired results among colors for each value of n.

n=25:

	p1	p1.winning.num	p1.winning.prop	p2	p2.winning.num	p2.winning.prop
1	Purple	42	0.42	Light Blue	58	0.58
2	Purple	50	0.50	Pink	50	0.50
3	Purple	40	0.40	Orange	60	0.60
4	Purple	41	0.41	Red	59	0.59
5	Purple	34	0.34	Yellow	66	0.66
6	Purple	53	0.53	Green	47	0.47
7	Purple	40	0.40	Blue	60	0.60
8	Light Blue	46	0.46	Pink	54	0.54
9	Light Blue	40	0.40	Orange	60	0.60
10	Light Blue	46	0.46	Red	54	0.54
11	Light Blue	36	0.36	Yellow	64	0.64
12	Light Blue	53	0.53	Green	47	0.47
13	Light Blue	40	0.40	Blue	60	0.60
14	Pink	44	0.44	Orange	56	0.56
15	Pink	44	0.44	Red	56	0.56
16	Pink	38	0.38	Yellow	62	0.62
17	Pink	38	0.38	Green	62	0.62
18	Pink	39	0.39	Blue	61	0.61
19	Orange	40	0.40	Red	60	0.60
20	Orange	41	0.41	Yellow	59	0.59
21	Orange	42	0.42	Green	58	0.58
22	Orange	36	0.36	Blue	64	0.64
23	Red	52	0.52	Yellow	48	0.48
24	Red	33	0.33	Green	67	0.67
25	Red	45	0.45	Blue	55	0.55
26	Yellow	39	0.39	Green	61	0.61
27	Yellow	36	0.36	Blue	64	0.64
28	Green	43	0.43	Blue	57	0.57

n=50:

	p1	p1.winning.num	p1.winning.prop	p2	p2.winning.num	p2.winning.prop
1	Purple	54	0.54	Light Blue	46	0.46
2	Purple	44	0.44	Pink	56	0.56
3	Purple	52	0.52	Orange	48	0.48
4	Purple	46	0.46	Red	54	0.54
5	Purple	44	0.44	Yellow	56	0.56
6	Purple	50	0.50	Green	50	0.50
7	Purple	47	0.47	Blue	53	0.53
8	Light Blue	48	0.48	Pink	52	0.52
9	Light Blue	40	0.40	Orange	60	0.60
10	Light Blue	43	0.43	Red	57	0.57
11	Light Blue	48	0.48	Yellow	52	0.52
12	Light Blue	46	0.46	Green	54	0.54
13	Light Blue	45	0.45	Blue	55	0.55
14	Pink	51	0.51	Orange	49	0.49
15	Pink	48	0.48	Red	52	0.52
16	Pink	51	0.51	Yellow	49	0.49
17	Pink	49	0.49	Green	51	0.51
18	Pink	39	0.39	Blue	61	0.61
19	Orange	43	0.43	Red	57	0.57
20	Orange	34	0.34	Yellow	66	0.66
21	Orange	43	0.43	Green	57	0.57
22	Orange	53	0.53	Blue	47	0.47
23	Red	46	0.46	Yellow	54	0.54
24	Red	43	0.43	Green	57	0.57
25	Red	48	0.48	Blue	52	0.52
26	Yellow	43	0.43	Green	57	0.57
27	Yellow	39	0.39	Blue	61	0.61
28	Green	43	0.43	Blue	57	0.57

n=100:

	p1	p1.winning.num	p1.winning.prop	p2	p2.winning.num	p2.winning.prop
1	Purple	48	0.48	Light Blue	52	0.52
2	Purple	52	0.52	Pink	48	0.48
3	Purple	50	0.50	Orange	50	0.50
4	Purple	43	0.43	Red	57	0.57
5	Purple	44	0.44	Yellow	56	0.56
6	Purple	41	0.41	Green	59	0.59
7	Purple	52	0.52	Blue	48	0.48
8	Light Blue	53	0.53	Pink	47	0.47
9	Light Blue	52	0.52	Orange	48	0.48
10	Light Blue	44	0.44	Red	56	0.56
11	Light Blue	52	0.52	Yellow	48	0.48
12	Light Blue	37	0.37	Green	63	0.63
13	Light Blue	48	0.48	Blue	52	0.52
14	Pink	43	0.43	Orange	57	0.57
15	Pink	45	0.45	Red	55	0.55
16	Pink	44	0.44	Yellow	56	0.56
17	Pink	49	0.49	Green	51	0.51
18	Pink	39	0.39	Blue	61	0.61
19	Orange	44	0.44	Red	56	0.56
20	Orange	48	0.48	Yellow	52	0.52
21	Orange	40	0.40	Green	60	0.60
22	Orange	39	0.39	Blue	61	0.61
23	Red	39	0.39	Yellow	61	0.61
24	Red	45	0.45	Green	55	0.55
25	Red	46	0.46	Blue	54	0.54
26	Yellow	44	0.44	Green	56	0.56
27	Yellow	47	0.47	Blue	53	0.53
28	Green	48	0.48	Blue	52	0.52