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HW3-Written Problems/READM

1.) Blackjack

On the next page is a table which represents the transition matrix.

P	Start	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	S12	S13	S14	S15	S16	S17	S18	S19	S20	Bust
start	0	$\frac{1}{169}$	$\frac{2}{169}$	$\frac{3}{169}$	$\frac{4}{169}$	$\frac{5}{169}$	$\frac{6}{169}$	$\frac{7}{169}$	$\frac{8}{169}$	$\frac{15}{169}$	$\frac{14}{169}$	$\frac{13}{169}$	$\frac{12}{169}$	$\frac{11}{169}$	$\frac{10}{169}$	$\frac{9}{169}$	$\frac{8}{169}$	$\frac{16}{169}$	$\frac{8}{169}$	$\frac{1}{169}$	$\frac{2}{169}$	$\frac{2}{169}$	$\frac{2}{169}$	$\frac{2}{169}$	$\frac{2}{169}$	$\frac{2}{169}$	$\frac{2}{169}$	$\frac{2}{169}$	0
4	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{4}{13}$	0	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	0	0	0	0	0	0
5	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{4}{13}$	0	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	0	0	0	0	0
6	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{4}{13}$	0	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	0	0	0	0
7	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{4}{13}$	0	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	0	0	0
8	0	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{4}{13}$	0	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	0	0
9	0	0	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{4}{13}$	0	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	0
10	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{4}{13}$	$\frac{1}{13}$	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{4}{13}$	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	0	0	0	0	0	0	0	0	0	$\frac{4}{13}$
13	0	0	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	0	0	0	0	0	0	0	0	0	$\frac{5}{13}$
14	0	0	0	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	0	0	0	0	0	0	0	0	0	$\frac{6}{13}$
15	0	0	0	0	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	0	0	0	0	0	0	0	0	0	$\frac{7}{13}$
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	0	0	0	0	0	0	0	0	0	$\frac{8}{13}$
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	0	0	0	0	0	0	0	0	0	$\frac{9}{13}$
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	0	0	0	0	0	0	0	0	0	$\frac{10}{13}$
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	0	0	0	0	0	0	0	0	0	$\frac{11}{13}$
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	0	0	0	0	0	0	0	0	0	$\frac{12}{13}$
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$\frac{13}{13}$
S12	0	0	0	0	0	0	0	0	0	$\frac{4}{13}$	0	0	0	0	0	0	0	0	$\frac{1}{13}$	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	0
S13	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{4}{13}$	0	0	0	0	0	0	0	$\frac{1}{13}$	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	0
S14	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{4}{13}$	0	0	0	0	0	0	$\frac{1}{13}$	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	0
S15	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{4}{13}$	0	0	0	0	0	$\frac{1}{13}$	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	0
S16	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{4}{13}$	0	0	0	0	$\frac{1}{13}$	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	0
S17	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{4}{13}$	0	0	0	$\frac{1}{13}$	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	0
S18	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{4}{13}$	0	0	$\frac{1}{13}$	0	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	0
S19	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{4}{13}$	0	$\frac{1}{13}$	0	0	0	0	0	0	0	0	$\frac{1}{13}$	0
S20	0	0	0	0	0	0	0	0	0	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{4}{13}$	$\frac{1}{13}$	0	0	0	0	0	0	0	0	0	0
bust	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$\frac{13}{13}$

2.) Whitejack

a.

P	start	1	2	3	4	Bust
Start	0	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	0
1	0	0	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$
2	0	0	0	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{2}$
3	0	0	0	0	$\frac{1}{4}$	$\frac{3}{4}$
4	0	0	0	0	1	0
bust	0	0	0	0	0	1

P^2	start	1	2	3	4	Bust
Start	0	0	$\frac{1}{16}$	$\frac{2}{16}$	$\frac{7}{16}$	$\frac{6}{16}$
1	0	0	0	$\frac{1}{16}$	$\frac{6}{16}$	$\frac{9}{16}$
2	0	0	0	0	$\frac{5}{16}$	$\frac{11}{16}$
3	0	0	0	0	$\frac{4}{16}$	$\frac{12}{16}$
4	0	0	0	0	1	0
bust	0	0	0	0	0	1

P^3	start	1	2	3	4	Bust
Start	0	0	0	$\frac{1}{64}$	$\frac{31}{64}$	$\frac{32}{64}$
1	0	0	0	0	$\frac{25}{64}$	$\frac{39}{64}$
2	0	0	0	0	$\frac{20}{64}$	$\frac{44}{64}$
3	0	0	0	0	$\frac{16}{64}$	$\frac{48}{64}$
4	0	0	0	0	1	0
bust	0	0	0	0	0	1

P^4	start	1	2	3	4	Bust
Start	0	0	0	0	$\frac{125}{256}$	$\frac{131}{256}$
1	0	0	0	0	$\frac{100}{256}$	$\frac{156}{256}$
2	0	0	0	0	$\frac{80}{256}$	$\frac{176}{256}$
3	0	0	0	0	$\frac{64}{256}$	$\frac{192}{256}$
4	0	0	0	0	1	0
bust	0	0	0	0	0	1

b.

$P_{START\ 1}{}^{\infty}$, the probability our dealer ends in state 1 given we are at the start of a game = 0

$P_{START\ 2}{}^{\infty}$, the probability our dealer ends in state 2 given we are at the start of a game = 0

$P_{START\ 3}{}^{\infty}$, the probability our dealer ends in state 3 given we are at the start of a game = 0

$P_{START\ 4}{}^{\infty}$, the probability our dealer ends in state 4 given we are at the start of a game = $\frac{125}{256}$

$P_{START\ BUST}{}^{\infty}$, the probability our dealer ends in the Bust state given we are at the start of a game = $\frac{131}{256}$

c. Stand on 3/4 hit on ½ (cannot bust when a 3 or 4 is drawn first)

P	start	1	2	3	4	Bust
Start	0	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	0
1	0	0	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$
2	0	0	0	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{2}$
3	0	0	0	1	0	0
4	0	0	0	0	1	0
bust	0	0	0	0	0	1

P^2	start	1	2	3	4	Bust
Start	0	0	$\frac{1}{16}$	$\frac{6}{16}$	$\frac{6}{16}$	$\frac{3}{16}$
1	0	0	0	$\frac{5}{16}$	$\frac{6}{16}$	$\frac{5}{16}$
2	0	0	0	$\frac{4}{16}$	$\frac{4}{16}$	$\frac{8}{16}$
3	0	0	0	1	0	0
4	0	0	0	0	1	0
bust	0	0	0	0	0	1

P^3	start	1	2	3	4	Bust
Start	0	0	0	$\frac{25}{64}$	$\frac{25}{64}$	$\frac{14}{64}$
1	0	0	0	$\frac{20}{64}$	$\frac{20}{64}$	$\frac{24}{64}$
2	0	0	0	$\frac{16}{64}$	$\frac{16}{64}$	$\frac{32}{64}$
3	0	0	0	1	0	0
4	0	0	0	0	1	0
bust	0	0	0	0	0	1

P^4	start	1	2	3	4	Bust
Start	0	0	0	$\frac{100}{256}$	$\frac{120}{256}$	$\frac{32}{256}$
1	0	0	0	$\frac{36}{256}$	$\frac{24}{256}$	$\frac{196}{256}$
2	0	0	0	$\frac{16}{256}$	$\frac{16}{256}$	$\frac{224}{256}$
3	0	0	0	1	0	0
4	0	0	0	0	1	0
bust	0	0	0	0	0	1

This policy is better than the original which is made obvious upon observation of the data.

C. Grayjack

P(winning)	1	2	3	4
stand	56/256	56/256	56/256	156/256
hit	19/48	5/16	3/16	0

If you stand against the grayjack at states 1,2,or 3 the only way to win is if your opponent busts.
Therefore, P(winning when you stand for 1,2,3) = P(dealer busting) P(winning when you stand at 4) is the probability of the dealer busting PLUS the probability that the dealer has a 3 since his only options are 3,4,or bust.

README
I began to execute the coding portion of the homework but unfortunately ran out of time. I will be sure to allot for time for myself in the future to prevent this from happening again. I began making the pieces to simulate the two different dealers which I completed, but I was a bit hung-up on the sampling portion. There are 2 py files that show the beginnings of both of my approaches. As it does not say anything in the syllabus about submitting incomplete programs I am hoping I can get some partial credit for this.