

Project 2

Jay Patel

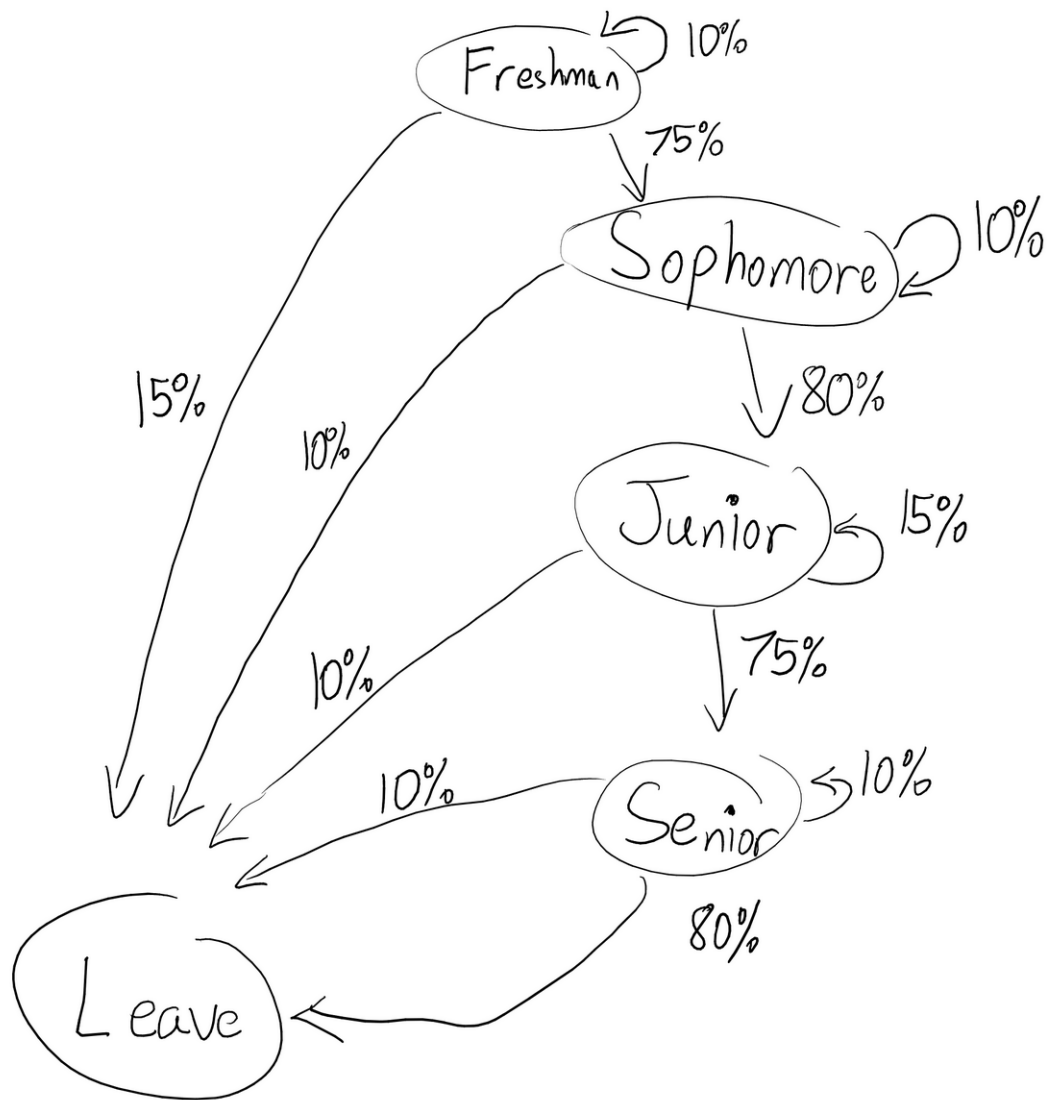
CSE 3504

Project 2

16 April 2020

Problem 1

a.



b.
P =

	Freshman	Sophomore	Junior	Senior	Leave
Freshman	0.1	0.75	0	0	0.15
Sophomore	0	0.1	0.8	0	0.1
Junior	0	0	0.15	0.75	0.1
Senior	0	0	0	0.1	0.9
Leave	0	0	0	0	1

Q = (No absorbing states)

	Freshman	Sophomore	Junior	Senior
Freshman	0.1	0.75	0	0
Sophomore	0	0.1	0.8	0
Junior	0	0	0.15	0.75
Senior	0	0	0	0.1

I - Q =

	Freshman	Sophomore	Junior	Senior
Freshman	0.9	-0.75	0	0
Sophomore	0	0.9	-0.8	0
Junior	0	0	0.85	-0.75
Senior	0	0	0	0.9

$(I - Q)^{-1}$ =

	Freshman	Sophomore	Junior	Senior
Freshman	1.11111	0.92592	0.87145	0.72621
Sophomore	0	1.11111	1.04565	0.87145

Junior	0	0	1.17647	0.98039
Senior	0	0	0	1.11111

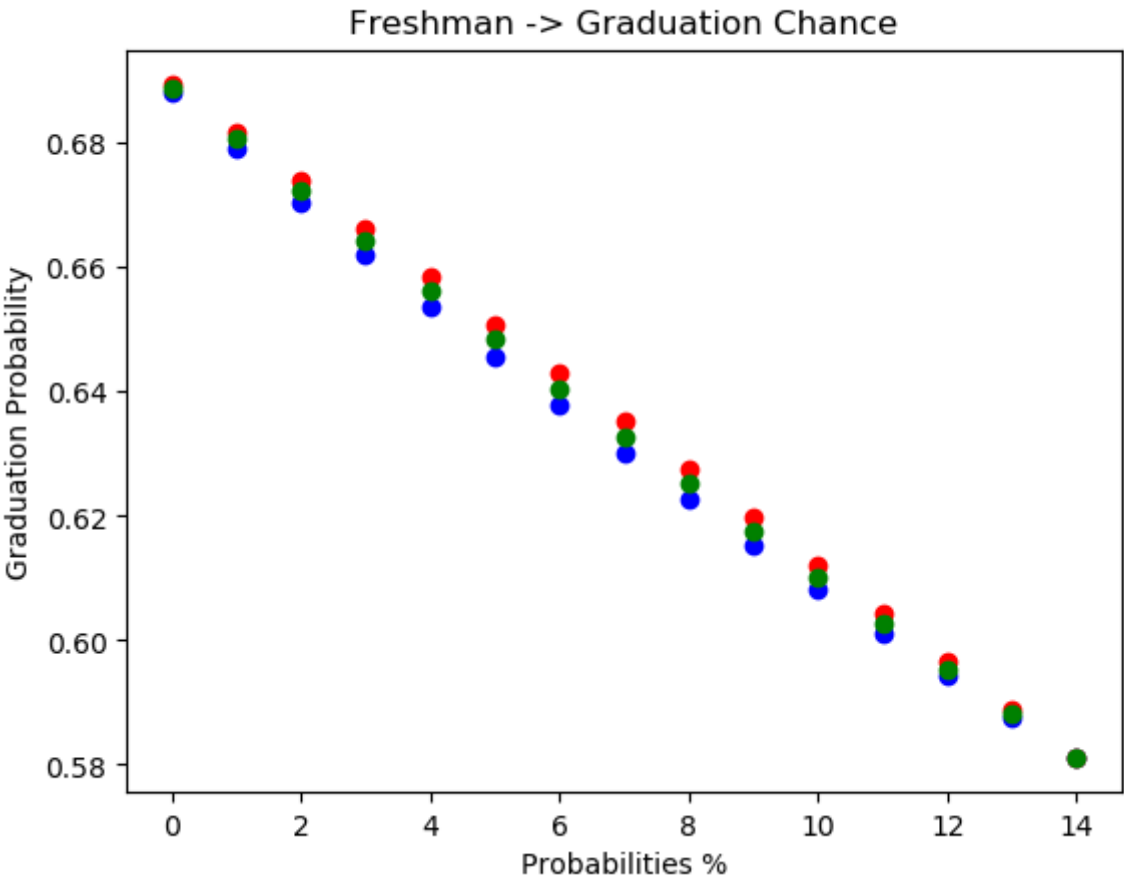
1.1111+0.92592+.87145+.72621 = 3.63468 expectation

c.
Repeating years doesn't affect your chance of graduation or graduating, due to memoryless property. The chance of repeating will be subtracted from the total probability at each step.

Ex. Freshman = $.75/(1 - .1) = .8333$

$.83333 * .89 * .88 * .89 = 58.09\%$

- d.
- a



Scenario A

+-----+-----+-----+-----+-----+						
	Freshman	Sophomore	Junior	Senior	Leave	
+-----+-----+-----+-----+-----+						
	Freshman	0.24	0.75	0.0	0.0	0.01

	Sophomore	0.0	0.1	0.8	0.0	0.1
	Junior	0.0	0.0	0.15	0.75	0.1
	Senior	0.0	0.0	0.0	0.1	0.9
	Leave	0.0	0.0	0.0	0.0	1.0
+-----+-----+-----+-----+-----+-----+						
+-----+-----+-----+-----+-----+-----+						
	Freshman	Sophomore	Junior	Senior	Leave	
+-----+-----+-----+-----+-----+-----+						
	Freshman	0.23	0.75	0.0	0.0	0.02
	Sophomore	0.0	0.1	0.8	0.0	0.1
	Junior	0.0	0.0	0.15	0.75	0.1
	Senior	0.0	0.0	0.0	0.1	0.9
	Leave	0.0	0.0	0.0	0.0	1.0
+-----+-----+-----+-----+-----+-----+						
+-----+-----+-----+-----+-----+-----+						
	Freshman	Sophomore	Junior	Senior	Leave	
+-----+-----+-----+-----+-----+-----+						
	Freshman	0.22	0.75	0.0	0.0	0.03
	Sophomore	0.0	0.1	0.8	0.0	0.1
	Junior	0.0	0.0	0.15	0.75	0.1
	Senior	0.0	0.0	0.0	0.1	0.9
	Leave	0.0	0.0	0.0	0.0	1.0
+-----+-----+-----+-----+-----+-----+						
+-----+-----+-----+-----+-----+-----+						
	Freshman	Sophomore	Junior	Senior	Leave	
+-----+-----+-----+-----+-----+-----+						
	Freshman	0.21	0.75	0.0	0.0	0.04
	Sophomore	0.0	0.1	0.8	0.0	0.1
	Junior	0.0	0.0	0.15	0.75	0.1
	Senior	0.0	0.0	0.0	0.1	0.9
	Leave	0.0	0.0	0.0	0.0	1.0
+-----+-----+-----+-----+-----+-----+						
+-----+-----+-----+-----+-----+-----+						
	Freshman	Sophomore	Junior	Senior	Leave	
+-----+-----+-----+-----+-----+-----+						
	Freshman	0.2	0.75	0.0	0.0	0.05
	Sophomore	0.0	0.1	0.8	0.0	0.1
	Junior	0.0	0.0	0.15	0.75	0.1
	Senior	0.0	0.0	0.0	0.1	0.9
	Leave	0.0	0.0	0.0	0.0	1.0

	Freshman	Sophomore	Junior	Senior	Leave	
Freshman	0.19	0.75	0.0	0.0	0.06	
Sophomore	0.0	0.1	0.8	0.0	0.1	
Junior	0.0	0.0	0.15	0.75	0.1	
Senior	0.0	0.0	0.0	0.1	0.9	
Leave	0.0	0.0	0.0	0.0	1.0	

	Freshman	Sophomore	Junior	Senior	Leave	
Freshman	0.18	0.75	0.0	0.0	0.07	
Sophomore	0.0	0.1	0.8	0.0	0.1	
Junior	0.0	0.0	0.15	0.75	0.1	
Senior	0.0	0.0	0.0	0.1	0.9	
Leave	0.0	0.0	0.0	0.0	1.0	

	Freshman		Sophomore	Junior	Senior	Leave	
Freshman	0.16999999999999998		0.75	0.0	0.0	0.08	
Sophomore	0.0		0.1	0.8	0.0	0.1	
Junior	0.0		0.0	0.15	0.75	0.1	
Senior	0.0		0.0	0.0	0.1	0.9	
Leave	0.0		0.0	0.0	0.0	1.0	

	Freshman	Sophomore	Junior	Senior	Leave	
Freshman	0.16	0.75	0.0	0.0	0.09	
Sophomore	0.0	0.1	0.8	0.0	0.1	
Junior	0.0	0.0	0.15	0.75	0.1	
Senior	0.0	0.0	0.0	0.1	0.9	
Leave	0.0	0.0	0.0	0.0	1.0	

	Freshman	Sophomore	Junior	Senior	Leave	

Freshman	0.15	0.75	0.0	0.0	0.1
Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9
Leave	0.0	0.0	0.0	0.0	1.0

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	Freshman	Sophomore	Junior	Senior	Leave
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Freshman	0.14	0.75	0.0	0.0	0.11
Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9
Leave	0.0	0.0	0.0	0.0	1.0

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	Freshman	Sophomore	Junior	Senior	Leave
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Freshman	0.13	0.75	0.0	0.0	0.12
Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9
Leave	0.0	0.0	0.0	0.0	1.0

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	Freshman	Sophomore	Junior	Senior	Leave
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Freshman	0.12	0.75	0.0	0.0	0.13
Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9
Leave	0.0	0.0	0.0	0.0	1.0

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	Freshman	Sophomore	Junior	Senior	Leave
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Freshman	0.10999999999999999	0.75	0.0	0.0	0.14
Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9

Leave	0.0	0.0	0.0	0.0	1.0
Freshman	0.1	0.75	0.0	0.0	0.15
Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9
Leave	0.0	0.0	0.0	0.0	1.0

Scenario B

Freshman	0.1	0.89	0.0	0.0	0.01
Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9
Leave	0.0	0.0	0.0	0.0	1.0
Freshman	0.1	0.88	0.0	0.0	0.02
Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9
Leave	0.0	0.0	0.0	0.0	1.0
Freshman	0.1	0.87	0.0	0.0	0.03
Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9
Leave	0.0	0.0	0.0	0.0	1.0

	Freshman	Sophomore	Junior	Senior	Leave
Freshman	0.1	0.86	0.0	0.0	0.04
Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9
Leave	0.0	0.0	0.0	0.0	1.0

	Freshman	Sophomore	Junior	Senior	Leave
Freshman	0.1	0.85	0.0	0.0	0.05
Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9
Leave	0.0	0.0	0.0	0.0	1.0

	Freshman	Sophomore	Junior	Senior	Leave
Freshman	0.1	0.84	0.0	0.0	0.06
Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9
Leave	0.0	0.0	0.0	0.0	1.0

	Freshman	Sophomore	Junior	Senior	Leave
Freshman	0.1	0.83	0.0	0.0	0.07
Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9
Leave	0.0	0.0	0.0	0.0	1.0

	Freshman	Sophomore	Junior	Senior	Leave
Freshman	0.1	0.82	0.0	0.0	0.08

	Sophomore	0.0	0.1	0.8	0.0	0.1
	Junior	0.0	0.0	0.15	0.75	0.1
	Senior	0.0	0.0	0.0	0.1	0.9
	Leave	0.0	0.0	0.0	0.0	1.0
+-----+-----+-----+-----+-----+-----+						
+-----+-----+-----+-----+-----+-----+						
	Freshman	Sophomore	Junior	Senior	Leave	
+-----+-----+-----+-----+-----+-----+						
	Freshman	0.1	0.81	0.0	0.0	0.09
	Sophomore	0.0	0.1	0.8	0.0	0.1
	Junior	0.0	0.0	0.15	0.75	0.1
	Senior	0.0	0.0	0.0	0.1	0.9
	Leave	0.0	0.0	0.0	0.0	1.0
+-----+-----+-----+-----+-----+-----+						
+-----+-----+-----+-----+-----+-----+						
	Freshman	Sophomore	Junior	Senior	Leave	
+-----+-----+-----+-----+-----+-----+						
	Freshman	0.1	0.8	0.0	0.0	0.1
	Sophomore	0.0	0.1	0.8	0.0	0.1
	Junior	0.0	0.0	0.15	0.75	0.1
	Senior	0.0	0.0	0.0	0.1	0.9
	Leave	0.0	0.0	0.0	0.0	1.0
+-----+-----+-----+-----+-----+-----+						
+-----+-----+-----+-----+-----+-----+						
	Freshman	Sophomore	Junior	Senior	Leave	
+-----+-----+-----+-----+-----+-----+						
	Freshman	0.1	0.79	0.0	0.0	0.11
	Sophomore	0.0	0.1	0.8	0.0	0.1
	Junior	0.0	0.0	0.15	0.75	0.1
	Senior	0.0	0.0	0.0	0.1	0.9
	Leave	0.0	0.0	0.0	0.0	1.0
+-----+-----+-----+-----+-----+-----+						
+-----+-----+-----+-----+-----+-----+						
	Freshman	Sophomore	Junior	Senior	Leave	
+-----+-----+-----+-----+-----+-----+						
	Freshman	0.1	0.78	0.0	0.0	0.12
	Sophomore	0.0	0.1	0.8	0.0	0.1
	Junior	0.0	0.0	0.15	0.75	0.1
	Senior	0.0	0.0	0.0	0.1	0.9
	Leave	0.0	0.0	0.0	0.0	1.0

	Freshman	Sophomore	Junior	Senior	Leave
Freshman	0.165	0.815	0.0	0.0	0.02
Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9
Leave	0.0	0.0	0.0	0.0	1.0

	Freshman	Sophomore	Junior	Senior	Leave
Freshman	0.16	0.81	0.0	0.0	0.03
Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9
Leave	0.0	0.0	0.0	0.0	1.0

	Freshman	Sophomore	Junior	Senior	Leave
Freshman	0.155	0.8049999999999999	0.0	0.0	0.04
Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9
Leave	0.0	0.0	0.0	0.0	1.0

	Freshman	Sophomore	Junior	Senior	Leave
Freshman	0.15	0.8	0.0	0.0	0.05
Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9
Leave	0.0	0.0	0.0	0.0	1.0

	Freshman	Sophomore	Junior	Senior	Leave
Freshman	0.14500000000000002	0.795	0.0	0.0	0.06
Sophomore	0.0	0.1	0.8	0.0	0.1

	Junior	0.0	0.0	0.15	0.75	0.1
	Senior	0.0	0.0	0.0	0.1	0.9
	Leave	0.0	0.0	0.0	0.0	1.0
	Freshman	Sophomore	Junior	Senior	Leave	
	Freshman	0.14	0.79	0.0	0.0	0.07
	Sophomore	0.0	0.1	0.8	0.0	0.1
	Junior	0.0	0.0	0.15	0.75	0.1
	Senior	0.0	0.0	0.0	0.1	0.9
	Leave	0.0	0.0	0.0	0.0	1.0
	Freshman	Sophomore	Junior	Senior	Leave	
	Freshman	0.135	0.785	0.0	0.0	0.08
	Sophomore	0.0	0.1	0.8	0.0	0.1
	Junior	0.0	0.0	0.15	0.75	0.1
	Senior	0.0	0.0	0.0	0.1	0.9
	Leave	0.0	0.0	0.0	0.0	1.0
	Freshman	Sophomore	Junior	Senior	Leave	
	Freshman	0.13	0.78	0.0	0.0	0.09
	Sophomore	0.0	0.1	0.8	0.0	0.1
	Junior	0.0	0.0	0.15	0.75	0.1
	Senior	0.0	0.0	0.0	0.1	0.9
	Leave	0.0	0.0	0.0	0.0	1.0
	Freshman	Sophomore	Junior	Senior	Leave	
	Freshman	0.125	0.775	0.0	0.0	0.1
	Sophomore	0.0	0.1	0.8	0.0	0.1
	Junior	0.0	0.0	0.15	0.75	0.1
	Senior	0.0	0.0	0.0	0.1	0.9
	Leave	0.0	0.0	0.0	0.0	1.0

	Freshman	Sophomore	Junior	Senior	Leave
Freshman	0.12	0.77	0.0	0.0	0.11
Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9
Leave	0.0	0.0	0.0	0.0	1.0

	Freshman	Sophomore	Junior	Senior	Leave
Freshman	0.115	0.765	0.0	0.0	0.12
Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9
Leave	0.0	0.0	0.0	0.0	1.0

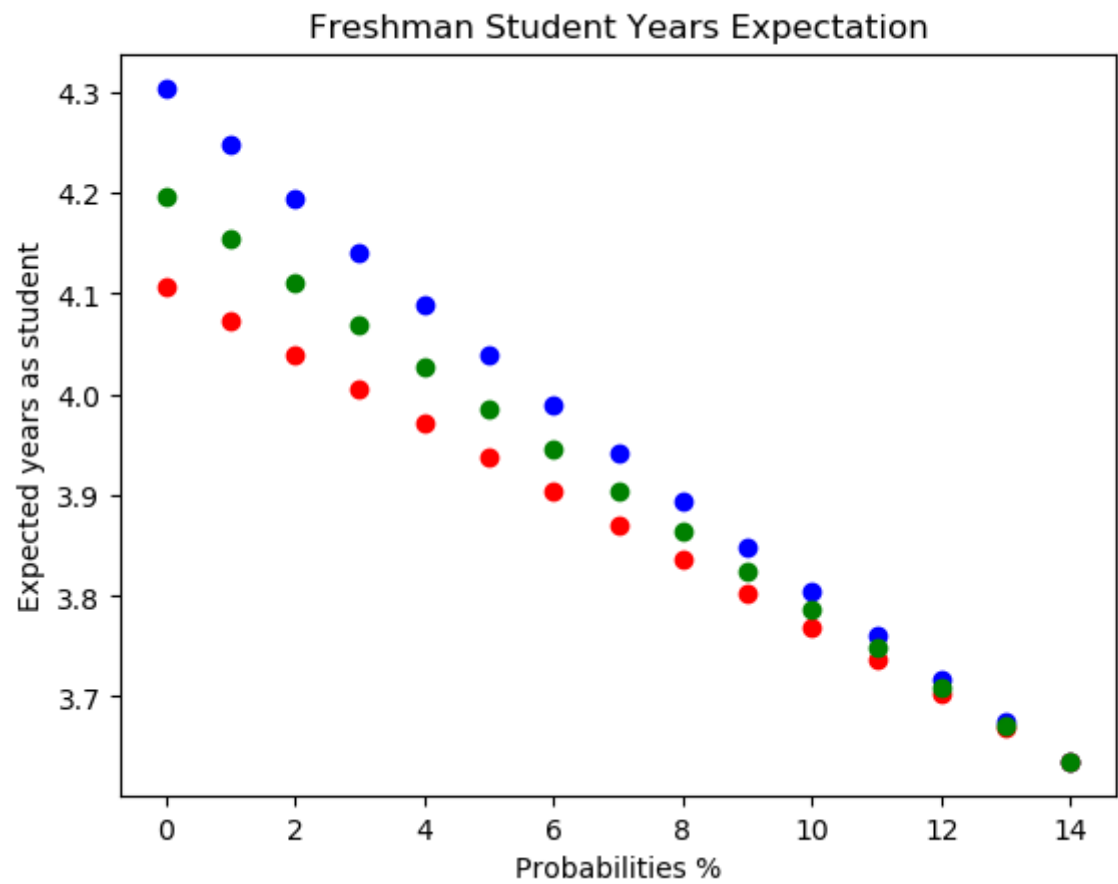
	Freshman	Sophomore	Junior	Senior	Leave
Freshman	0.11	0.76	0.0	0.0	0.13
Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9
Leave	0.0	0.0	0.0	0.0	1.0

	Freshman	Sophomore	Junior	Senior	Leave
Freshman	0.105	0.755	0.0	0.0	0.14
Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9
Leave	0.0	0.0	0.0	0.0	1.0

	Freshman	Sophomore	Junior	Senior	Leave
Freshman	0.1	0.75	0.0	0.0	0.15

Sophomore	0.0	0.1	0.8	0.0	0.1
Junior	0.0	0.0	0.15	0.75	0.1
Senior	0.0	0.0	0.0	0.1	0.9
Leave	0.0	0.0	0.0	0.0	1.0

b



Scenario A

Probabilities %	Expectation
0	4.304265565875474
1	4.248366013071895
2	4.193899782135076
3	4.1408124431207085
4	4.0890522875816995
5	4.038570160574517
6	3.989319304957755
7	3.941255216946216

8	3.8943355119825713
9	3.848519800076894
10	3.8037695698434417
11	3.7600480805348964
12	3.7173202614379086
13	3.6755526180509657
14	3.6347131445170664
+-----+	

Scenario B

+-----+	
Probabilities %	Expectation
+-----+	
0	4.105785524086177
1	4.072137496974098
2	4.038489469862019
3	4.00484144274994
4	3.9711934156378597
5	3.9375453885257805
6	3.9038973614137014
7	3.870249334301622
8	3.836601307189543
9	3.802953280077463
10	3.769305252965384
11	3.7356572258533047
12	3.702009198741225
13	3.668361171629146
14	3.6347131445170664
+-----+	

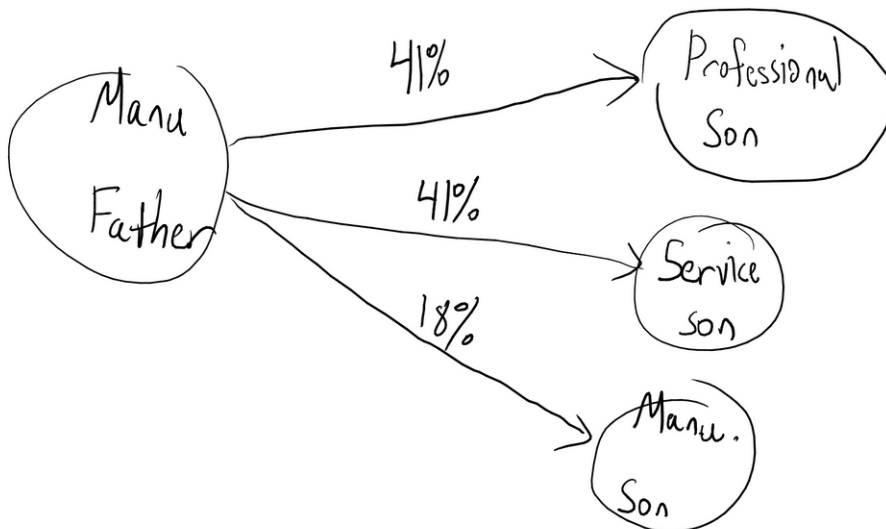
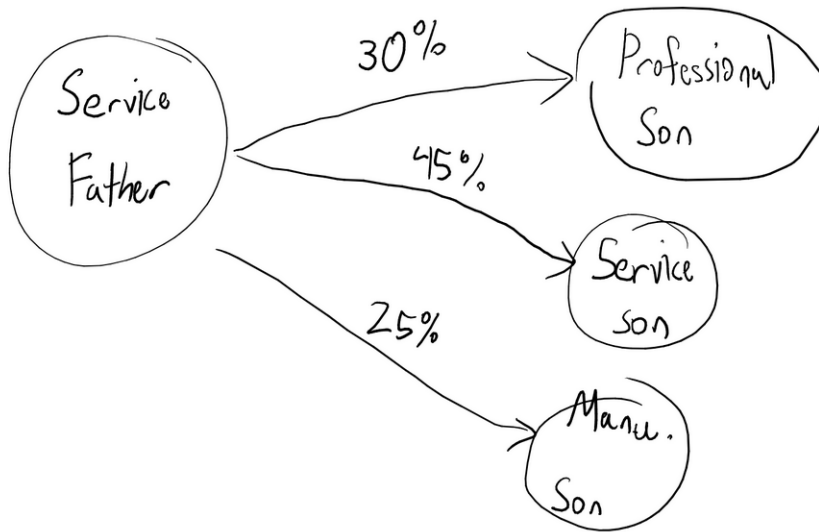
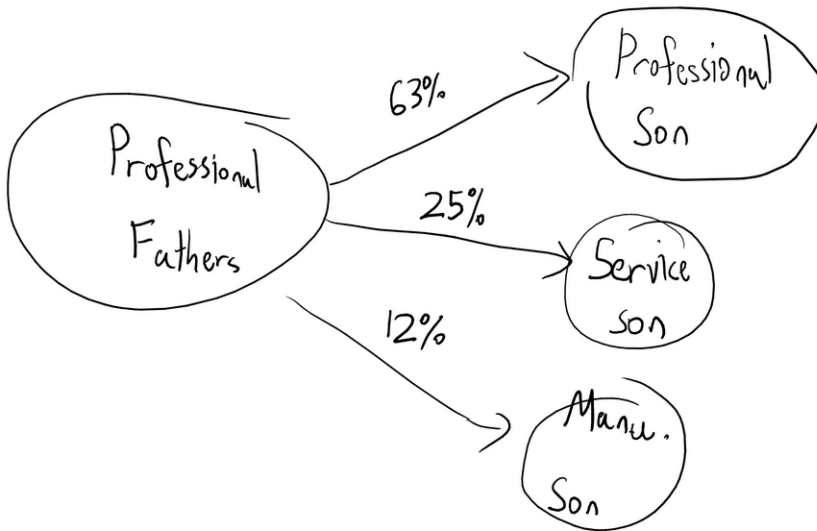
Scenario C

+-----+	
Probabilities %	Expectation
+-----+	
0	4.105785524086177
1	4.072137496974098
2	4.038489469862019
3	4.00484144274994
4	3.9711934156378597

	5		3.9375453885257805	
	6		3.9038973614137014	
	7		3.870249334301622	
	8		3.836601307189543	
	9		3.802953280077463	
	10		3.769305252965384	
	11		3.7356572258533047	
	12		3.702009198741225	
	13		3.668361171629146	
	14		3.6347131445170664	
+-----+-----+				

Problem 2

a.



b.

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Service 0.3674 Professional 0.454 Manufacturing 0.1786
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c.

Service: \$29,392

Professional: \$45,400

Manufacturing: \$10,716

Problem 3

a

```
{1: 1, 2: 2, 3: 4, 4: 2, 5: 4, 6: 1}
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are the visits per node

b

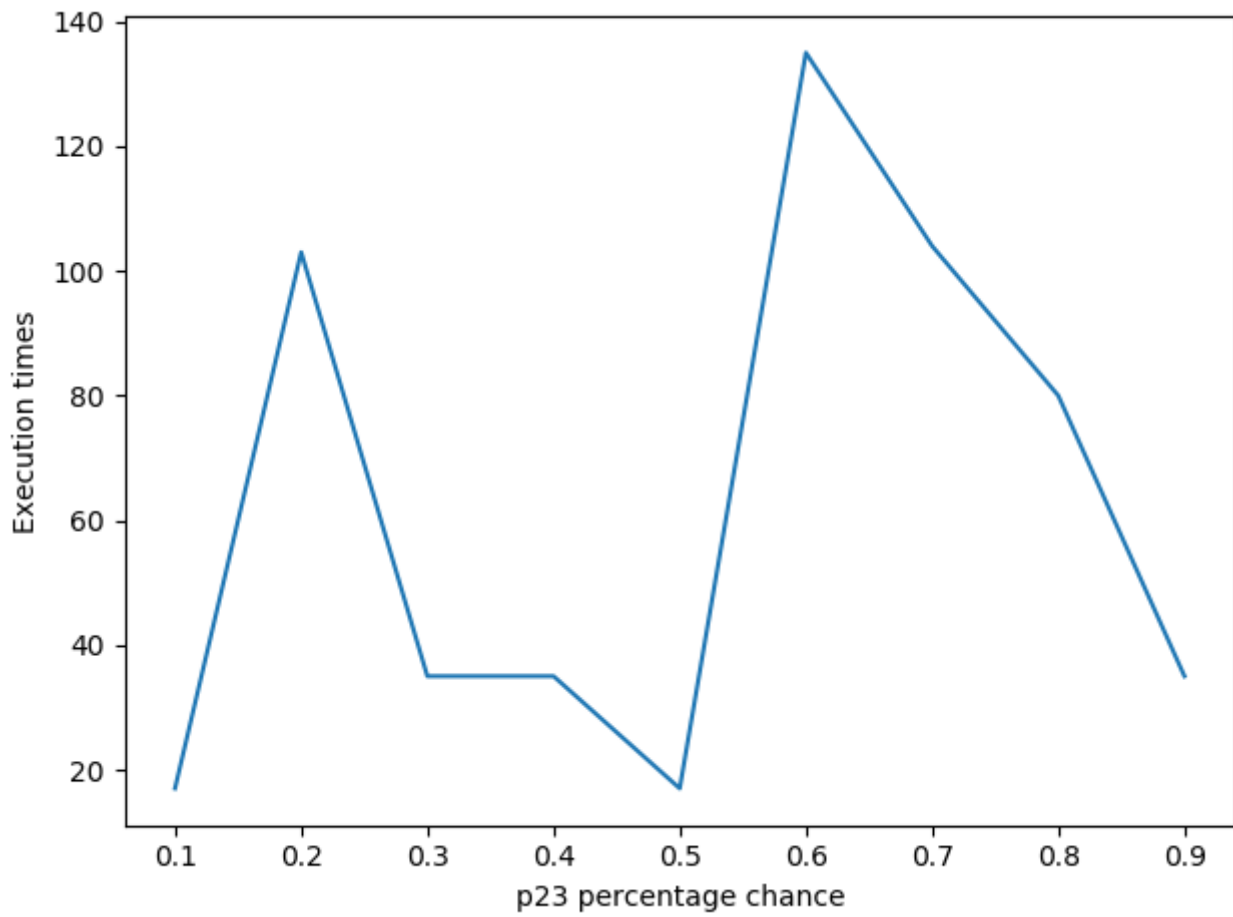
Average time visited is 103 for one of the simulations ran

c

```
[(0.1, 17), (0.2, 103), (0.3, 35), (0.4, 35), (0.5, 17), (0.6, 135), (0.7, 104), (0.8, 80), (0.9, 35)]
```

(probability, execution time)

p23 simulation

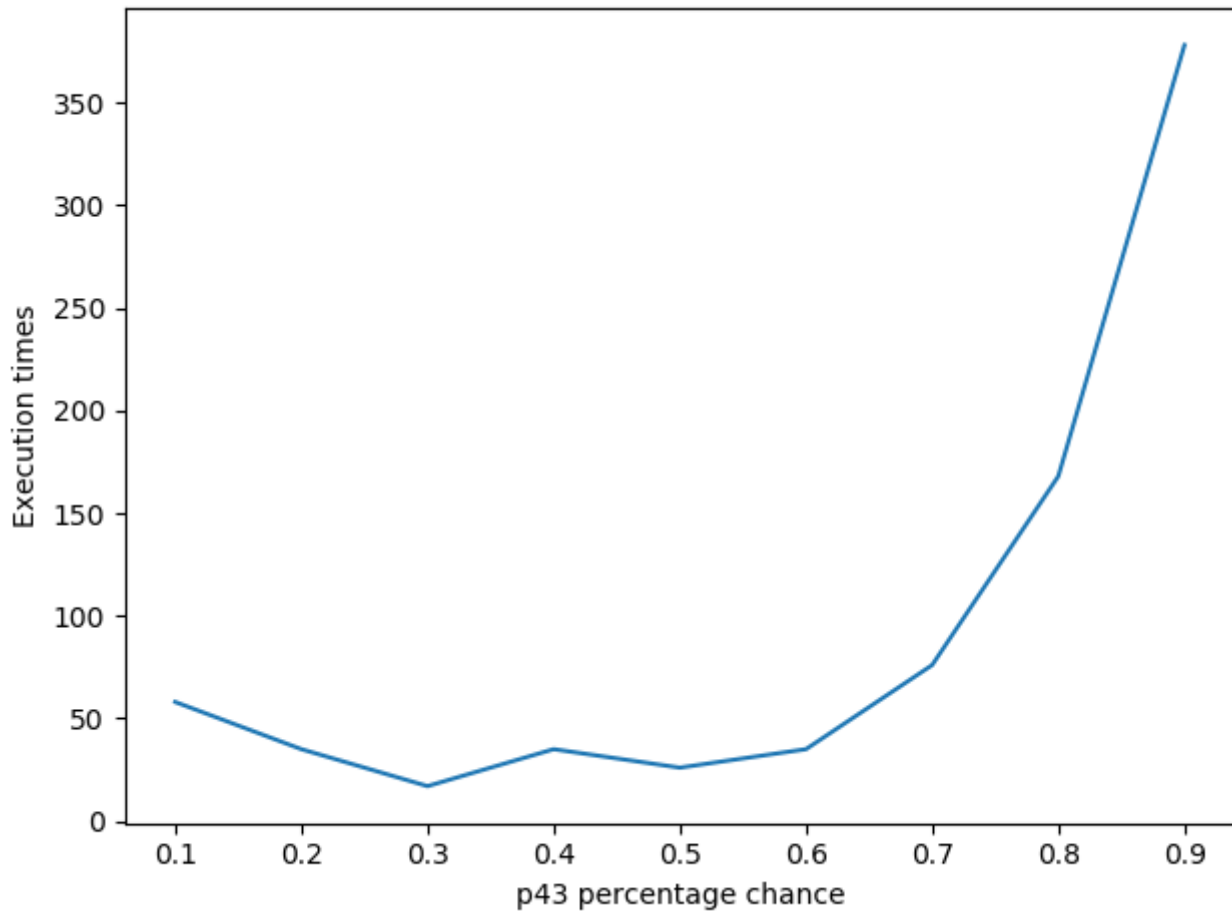


d

```
[ (0.1, 58), (0.2, 35), (0.3, 17), (0.4, 35), (0.5, 26), (0.6, 35), (0.7, 76),  
(0.8, 168), (0.9, 378) ]
```

(probability, execution time)

p43 simulation



e

p43 produces the largest variation in execution time. The reason for this is that if going to 6 is given a higher probability, then the simulation just ends. However, if 3 is given a higher probability, then the simulation has a greater chance of continuing longer