INTERNATIONAL UNIVERSITY OF JAPAN

Public Management and Policy Analysis Program
Graduate School of International Relations

DCC5350 (2 Credits)
Public Policy Modeling
Spring 2016

Homework 4: Markov Chain Comment

▉ Read the instruction carefully. One of key instruction was "Use at least four digits below the decimal point, if applied, in your calculation in order to avoid large rounding errors." Because the calculation involves a probability and a big number, there must be rounding errors when only one or two digits below the decimal point are used. This issue is critical.

▉ Use period (.) for the decimal point. Do not use comma (,) for the decimal point because it is really confusing.

▉ Read the handout carefully when interpreting probabilities in Markov chain. Many students interpret their meaning in a sloppy manner. You need to pay special attention to this interpretation since it is closely related to a theoretical aspect. For instance, n-step transition probability (Q1.4) .2275 reads "If a couple visited Ha Long Bay in a particular year, the husband and wife have 22.75 percent chance of visiting Lombok 10 years later." You may not omit "in a particular year." The probability .30 in Q2.4 reads "If a employee in neglect state this year, there is 30 percent of chance that he/she will be in voice state next year." You may not omit "this year" and "next year." The fundamental matrix in Q2.6 read "An employee in the voice state will spend on average 6.767 years in the loyalty state, 7.368 years in the voice state, and 3.308 years in the neglect state before he/she exit the organization eventually." You may not omit "eventually." You don't need to specify specific time period such as "this year" and "in a particular year."

▉ Many students appear to get confused with the calculation of cost of four states. In fact, the challenging part is not calculation but understanding of fundamental matrix. Students cannot explain the result of calculation if they don't know meanings of fundamental matrix. Let us look at the fundamental matrix you are asked to calculate in Q2.5.

	1	2	3
1	8.521303258	6.315789474	3.425229741
2	6.766917293	7.368421053	3.308270677
3	5.513784461	5.263157895	4.17710944

An employee in the loyalty state will be in the loyalty state for 8.5213 years, in the voice state for 6.3158 years, and in the neglect state for 4.3252 years before he/she exit eventually. We don't know exactly when he/she will be in loyality, voice, and neglect states. The fundamental matrix provides parameters (averaged information) of the population.

When we choose a particular time, for instance January 1, 2016, there are 80 employees in the loyalty state, 100 in the voice state, and 500 in the neglect state in the organization. Each of 80 loyalty employees as of January 1, 2016 will spend on average 19 years (8.5+6.3+4.3)

in the organization. 100 voice employees will spend 17 years (6.8+7.4+3.3) and 500 neglect employees will spend 15 years (5.5+5.3+4.2) before they leave the organization eventually. This is the way to read row information.

Column reflects the organization's perspective. Cost of handling loyalty state is 1K per year and person. This cost is applied to the first column. 5K and 50K are applied to the second and third columns. Therefore, the following matrix provides unit cost (per person) of each state. For instance, third row is calculated as 5.5138 K = 5.5138 (year) * 1K, 26.3158K = 5.2632 (year)*5K, and 208.8555K = 4.1771 (year)*50K.

	1	2	3
1	8.521303258	31.57894737	171.2614871
2	6.766917293	36.84210526	165.4135338
3	5.513784461	26.31578947	208.855472

Now, let us calculate the overall cost of each cell. Look at the second column. 2,526.3158K is calculated as 31.5789K * 80 (employees in the loyalty state). 3,684.2105K = 36.8421K * 100 (employees in the voice state). And 13,157.8947K= 26.3158K * 500 (employees in the neglect state). We get 19,368K = 2,526+3,684+13,158 that is interpreted as the total cost that the organization have to pay for handling voice state (some of them from loyalty employees and others from either voice or neglect employees).

	1	2	3
1	681.7042607	2526.315789	13700.91896
2	676.6917293	3684.210526	16541.35338
3	2756.892231	13157.89474	104427.736

The following is the matrix that contains column sum (vertical sum). The sum of these three figures is 158,153K (=4,115+19,368+134,670) in which the organization is interested (total cost of handling loyalty, voice, and neglect states). The question 2.8 and 3.3 expect you to report these numbers. Look at the answer in the next page.

	1	2	3
1	4115.288221	19368.42105	134670.0084

You may calculate the row sum (horizontal sum). See the following matrix. For instance, 20,902K is calculated as 677K + 3,684+16,541K. This figure means the total cost of handling 100 voice employees as of January 1, 2016; some of them will change into the loyalty or neglect state before they leave the organization. The sum of these three figures is, of course, 158,153K (=16,908+20,902+120,342) that is identical to the figure above.

	1
1	16908.93901
2	20902.25564
3	120342.523

End of comment of homework assignment 4.

28. The unit cost of loyalty = $4 115 288.22

$\Leftrightarrow 8.52 \times 80 + 6.77 \times 100 + 5.51 \times 500 \times \$1000 = 4115.29 \times \$1000$ ✓

The unit cost of voice = $19 368 421.05

$\Leftrightarrow 6.32 \times 80 + 7.37 \times 100 + 5.26 \times 500 \times \$5000 = 3873.68 \times \$5000$

The unit cost of neglect = $134 670 008.35

$\Leftrightarrow 3.43 \times 80 + 3.31 \times 100 + 4.18 \times 500 \times \$50\,000 = 2693.40 \times \$50\,000$

The overall cost is $158 ~~153 718~~ = 4115288.22 + 19 368 421.05 + 134 670 008.35

The exit unit costs are not included because is zero by definition. Therefore, the organization have to pay $19 368 421.05 for voice.

+1

Next

Public Policy Modeling
Homework 4: Markov Chain
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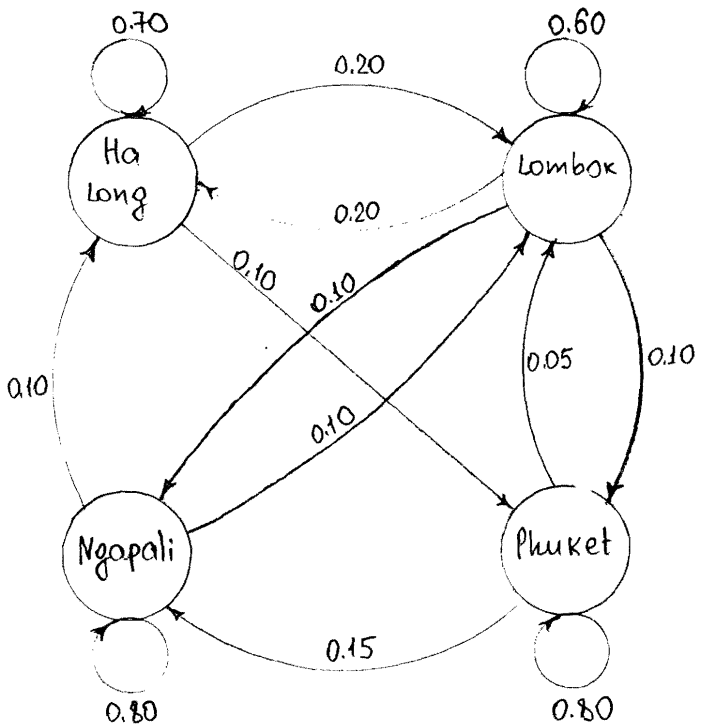
100 − 9 = 91

Q.1. Tourist Attractions for Husband and Wife

$$P = \begin{bmatrix} 0.70 & 0.20 & 0.00 & 0.10 \\ 0.20 & 0.60 & 0.10 & 0.10 \\ 0.10 & 0.10 & 0.80 & 0.00 \\ 0.00 & 0.05 & 0.15 & 0.80 \end{bmatrix} \qquad P^{(40)} = \begin{bmatrix} 0.2495 & 0.2275 & 0.2661 & 0.2549 \\ 0.2504 & 0.2281 & 0.2778 & 0.2437 \\ 0.2651 & 0.2356 & 0.2938 & 0.2056 \\ 0.2204 & 0.2099 & 0.3233 & 0.2464 \end{bmatrix}$$

Question 1.1 Draw the Markov transition diagram of this tourism market

states: 1) Ha long Bay (Vietnam)
2) Lombok (Indonesia)
3) Ngapali (Myanmar or Burna)
4) Phuket (Thailand)



Q 1.2. Interpret P_{13} and P_{41} substantively.

$$P = \begin{array}{c} \\ \text{Ha Long} \\ \text{Lombok} \\ \text{Ngapaly} \\ \text{Phuket} \end{array} \begin{array}{c} \begin{array}{cccc} \text{Ha Long} & \text{Lombok} & \text{Ngapaly} & \text{Phuket} \end{array} \\ \begin{bmatrix} 0.10 & 0.20 & 0.00 & 0.10 \\ 0.20 & 0.60 & 0.10 & 0.10 \\ 0.10 & 0.10 & 0.80 & 0.00 \\ 0.00 & 0.05 & 0.15 & 0.80 \end{bmatrix} \end{array}$$

$$P = \begin{array}{c} \\ \text{Ha long} \\ \text{Lombok} \\ \text{Ngapaly} \\ \text{Phuket} \end{array} \begin{array}{c} \begin{array}{cccc} \text{Ha long} & \text{Lombok} & \text{Ngapali} & \text{Phuket} \end{array} \\ \begin{bmatrix} P_{11} & P_{12} & P_{13} & P_{14} \\ P_{21} & P_{22} & P_{23} & P_{24} \\ P_{31} & P_{32} & P_{33} & P_{34} \\ P_{41} & P_{42} & P_{43} & P_{44} \end{bmatrix} \end{array}$$

$P_{13} = 0.00$: means the probability that a couple who visited Ha Long Bay last winter will visit Ngapli Beach this winter. By another words a couple who visited Ha long Bay last winter have not chance visit Ngapali Beach this winter.

$P_{41} = 0.00$: means the probability that a couple who visited Phuket last winter will visit Ha long Bay this winter. By another words a couple who visited Phuket last winter have not chance visit Ha long Bay this winter.

Q.1.3 Excel worksheet is attached.

You must report the answer. b. (-2)

Q. 1.4 Interpretation of the second column $p^{(10)}$ substantively

$$p^{(10)} = \begin{array}{c} \\ \text{Ha long Bay} \\ \text{Lombok} \\ \text{Ngapali} \\ \text{Phuket} \end{array} \begin{array}{c} \begin{array}{cccc} \text{Ha Long} & \text{Lombok} & \text{Ngapali} & \text{Phuket} \end{array} \\ \begin{bmatrix} 0.2495 & 0.2275 & 0.2661 & 0.2569 \\ 0.2504 & 0.2281 & 0.2778 & 0.2437 \\ 0.2651 & 0.2356 & 0.2938 & 0.2056 \\ 0.2204 & 0.2099 & 0.3233 & 0.2464 \end{bmatrix} \end{array}$$

$p_{12}^{(10)} = 0.2275$ It means 22.75% of chance for couple who visited Ha Long Bay last winter will visit Lombok 10 years Later. (in a particular year)

$p_{22}^{(10)} = 0.2281$ It means 22.81% of chance for couple, who visited Lombok last winter will visit again lombok 10 years later. (in a particular year)

$p_{32}^{(10)} = 0.2356$ It means 23.56% of chance for couple, who visited Ngapali last winter will visit Lombok 10 years Later.

$p_{42}^{(10)} = 0.2099$ It means 20.99% of chance for couple, who visited Phuket last winter will visit Lombok 10 years later.

Q. 1.5 Four equations for long-run behavior

$$\pi = \pi \cdot P \rightarrow [\pi_1 \ \pi_2 \ \pi_3 \ \pi_4] = [\pi_1 \ \pi_2 \ \pi_3 \ \pi_4] \cdot P =$$

$$= [\pi_1 \ \pi_2 \ \pi_3 \ \pi_4] \cdot \begin{bmatrix} 0.70 & 0.20 & 0.00 & 0.10 \\ 0.20 & 0.60 & 0.10 & 0.10 \\ 0.10 & 0.10 & 0.80 & 0.00 \\ 0.00 & 0.05 & 0.15 & 0.80 \end{bmatrix}$$

Cont. Q. 1.5.

$\pi_1 + \pi_2 + \pi_3 + \pi_4 = 1$

$\pi_1 = \pi_1 \times 0.70 + \pi_2 \times 0.20 + \pi_3 \times 0.10 + \pi_4 \times 0.00$

$\pi_1 + (-\pi_1) = 0.70\pi_1 - \pi_1 + 0.20\pi_2 + 0.10\pi_3$ (Cancellation Law by adding $(-\pi_1)$)

$0 = -0.3\pi_1 + 0.2\pi_2 + 0.1\pi_3$ (1) ✓

$\pi_2 = \pi_1 \times 0.20 + \pi_2 \times 0.60 + \pi_3 \times 0.10 + \pi_4 \times 0.05$

$\pi_2 + (-\pi_2) = 0.2\pi_1 + 0.6\pi_2 + (-\pi_2) + 0.1\pi_3 + 0.05\pi_4$ (Cancellation Law by adding $(-\pi_2)$)

$0 = 0.2\pi_1 - 0.4\pi_2 + 0.1\pi_3 + 0.05\pi_4$ ✓

$\pi_3 = \pi_1 \times 0.00 + \pi_2 \times 0.10 + \pi_3 \times 0.80 + \pi_4 \times 0.15$

$\pi_3 + (-\pi_3) = 0.1\pi_2 + 0.8\pi_3 + (-\pi_3) + 0.15\pi_4$ (Cancellation Law by adding $(-\pi_3)$)

$0 = 0.1\pi_2 - 0.2\pi_3 + 0.15\pi_4$ ✓

$\pi_4 = \pi_1 \times 0.10 + \pi_2 \times 0.10 + \pi_3 \times 0.00 + \pi_4 \times 0.80$

$\pi_4 + (-\pi_4) = 0.1\pi_1 + 0.1\pi_2 + 0.8\pi_4 + (-\pi_4)$ (Cancellation Law by adding $(-\pi_4)$)

$0 = 0.1\pi_1 + 0.1\pi_2 - 0.2\pi_4$ ✓

⇒ Choose 3 among 4 equation and $\sum_{i=1}^{4} \pi_i =$ ⇒ 4 equation for long-term behavior are:

Equation 1 : $0 = -0.3\pi_1 + 0.2\pi_2 + 0.1\pi_3$

" 2 : $0 = 0.2\pi_1 - 0.4\pi_2 + 0.1\pi_3 + 0.05\pi_4$

" 3 : $0 = 0.1\pi_2 - 0.2\pi_3 + 0.15\pi_4$

" 4 : $1 = \pi_1 + \pi_2 + \pi_3 + \pi_4$

✓

Public Policy Modeling
Homework 4. Question 1 (1.6)
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Tourist Attractions for Husband and Wife

		pi1	pi2	pi3	pi4				
B	=	-0.3	0.2	0.1	0	X=	π_1	Y=	0
		0.2	-0.4	0.1	0.05		π_2		0
		0	0.1	-0.2	0.15		π_3		0
		1	1	1	1		π_4		1

Inverse B	=	-3.4409	-1.3978	-1.1828	0.2473
		-0.9677	-2.5806	-0.6452	0.2258
		1.6129	0.9677	-2.2581	0.2903
		2.7957	3.0108	4.0860	0.2366

π_1	=	-3.4409	-1.3978	-1.1828	0.2473	*	0	=	0.2473
π_2		-0.9677	-2.5806	-0.6452	0.2258		0		0.2258
π_3		1.6129	0.9677	-2.2581	0.2903		0		0.2903
π_4		2.7957	3.0108	4.0860	0.2366		1		0.2366

pi1	pi2	pi3	pi4		
0.2473121	0.225807	0.290323	0.236559	=	1

✓ good

-0.30	0.20	0.10	0.00	for pi1
0.2	-0.4	0.1	0.05	for pi2
0	0.1	-0.2	0.15	for pi3

1.843E-09	=	0
1.041E-17	=	0
-8.81E-10	=	0

Q. 1.6 Steady-state probability

$\pi = [0.2473 \quad 0.2258 \quad 0.2903 \quad 0.2366]$ ✓

(Excel worksheet attached below)

Compare result in 1.4 the probabilities of states in P^{10} is almost similar to stedy state probability.

Q. 1.7 Interpret steady state probability.

The steady state probability says that on average 25% chance that couples will visit Ha long Bay (Vietnam), 22.73% chance that a couples will visit Lombok (Indonesia), 29.55% chance that couples will visit Ngapali (Myanmar), ✓ 22.73% chance that couples will visit Phuket (Thailand). In this competition on attracting couples winner will be Ngapali, because ~~the~~ of its lagest probability

Question 2. Exit, Voice, Loyalty, and Neglect

State: 1) Loyalty
2) Voice
3) Neglect
4) Exit

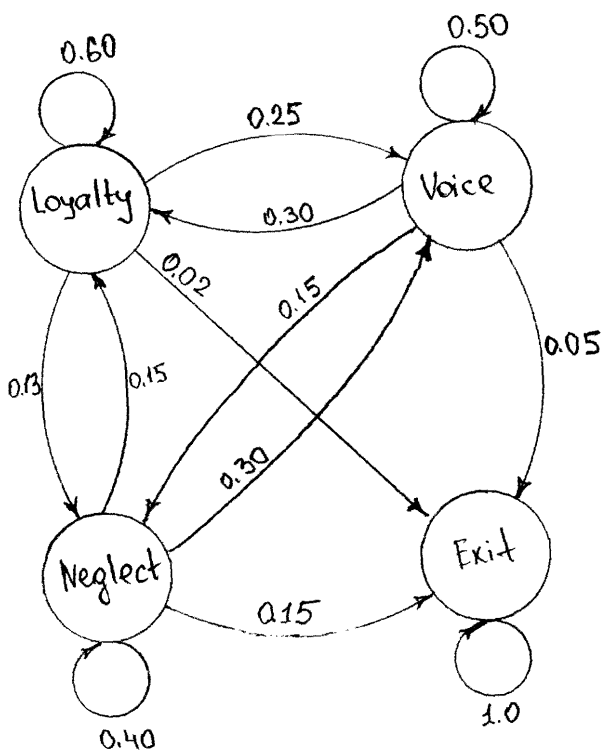
Employees' Response before

$$P = \begin{bmatrix} 0.60 & 0.25 & 0.13 & 0.02 \\ 0.30 & 0.50 & 0.15 & 0.05 \\ 0.15 & 0.30 & 0.40 & 0.15 \\ 0.0 & 0.0 & 0.0 & 1.0 \end{bmatrix}$$

Employees' Response After

$$P = \begin{bmatrix} 0.30 & 0.40 & 0.25 & 0.05 \\ 0.10 & 0.30 & 0.50 & 0.10 \\ 0.00 & 0.10 & 0.75 & 0.15 \\ 0.00 & 0.00 & 0.00 & 1.00 \end{bmatrix}$$

Q.2.1 Draw the transition probability diagram before the regime



Q. 2.2. Absorbing state

$$P = \begin{array}{c} \\ \text{Loyal.} \\ \text{Voice} \\ \text{Negl.} \\ \text{Exit} \end{array} \begin{array}{c} \begin{array}{cccc} \text{loyalty} & \text{Voice} & \text{Neglect} & \text{Exit} \end{array} \\ \begin{bmatrix} 0.60 & 0.25 & 0.13 & 0.02 \\ 0.30 & 0.50 & 0.15 & 0.05 \\ 0.15 & 0.30 & 0.40 & 0.15 \\ 0.0 & 0.0 & 0.0 & 1.0 \end{bmatrix} \end{array} \Rightarrow P = \begin{bmatrix} P_{11} & P_{12} & P_{13} & P_{14} \\ P_{21} & P_{22} & P_{23} & P_{24} \\ P_{31} & P_{32} & P_{33} & P_{34} \\ P_{41} & P_{42} & P_{43} & P_{44} \end{bmatrix}$$

Here $P_{44} = 1.0$ is absorbing state. State Exit, whose self-loop have transition probability 1.0. Here we have only one absorbing state. In this matrix I is [1] (1x1) absorbing state P_{44}.

Q. 2.3 Interpret P_{32} and P_{24} substantively

-3

$P_{32} = 0.30$: It means that if the states of employees is Neglect in ~~particular~~ this year, 30% of chance the state of this employee will become Voice next year

$P_{24} = 0.05$: It means that if the state of employee is Voice in ~~particular~~ this year, 5% of chance the state of this employee will become Exit next year

Q. 2.4. Report Q and R

$$P = \left[\begin{array}{cccc|c} 0.60 & 0.25 & 0.13 & 0.2 \\ 0.30 & 0.50 & 0.15 & 0.05 \\ 0.15 & 0.30 & 0.40 & 0.15 \\ \hline 0.0 & 0.0 & 0.0 & 1.00 \end{array}\right] = \begin{bmatrix} Q & R \\ 0 & I \end{bmatrix}$$

$$Q = \begin{bmatrix} 0.60 & 0.25 & 0.13 \\ 0.30 & 0.50 & 0.15 \\ 0.15 & 0.30 & 0.40 \end{bmatrix} \checkmark \quad \text{and} \quad R = \begin{bmatrix} 0.2 \\ 0.05 \\ 0.15 \end{bmatrix} \checkmark$$

Q. 2.5 Obtain $(I-Q)^{-1}$

$$(I-Q)^{-1} = \begin{bmatrix} 8.521 & 6.316 & 3.425 \\ 6.767 & 7.368 & 3.308 \\ 5.514 & 5.263 & 4.177 \end{bmatrix} \checkmark$$

Public Policy Modeling
Homework 4. Question 2 (2.5)
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Exit, Voice, Loyalty, and Neglect before the regime

		Loyalty	Voice	Neglect	Exit
	Loyalty	0.60	0.25	0.13	0.02
P=	Voice	0.30	0.50	0.15	0.05
	Neglect	0.15	0.30	0.40	0.15
	Exit	0.00	0.00	0.00	1.00

Q=

0.60	0.25	0.13
0.30	0.50	0.15
0.15	0.30	0.40

R=

0.02
0.05
0.15

0=

0.00	0.00	0.00

I=

1.00	0.00	0.00
0.00	1.00	0.00
0.00	0.00	1.00

I-Q

0.40	-0.25	-0.13
-0.30	0.50	-0.15
-0.15	-0.30	0.60

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

8.521	6.316	3.425	Fundamental matrix
6.767	7.368	3.308	
5.514	5.263	4.177	

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

1.0000
1.0000
1.0000

	loyalty	Voice	Neglect	Average annual cost (USD 1000)	Number of employees	Average cost (USD 1000)	Total average cost (USD 1000)
loyalty	8.521	6.316	3.425	1	80	211.362	16908.939
Voice	6.767	7.368	3.308	5	100	209.023	20902.256
Neglect	5.514	5.263	4.177	50	500	240.685	120342.523

The overall cost ($1,000) 158153.718

Q.2.6 Explain elements in the second row of this fundamental Matrix

The second row of $(I-Q)^{-1}$ says that in organization Voice employees, spend time on average 6.767 in loyalty state, 7.368 years on average in Voice state, and 3.308 years in average spent time as Neglect employee before he/she Exit organization. eventually

Q.2.7 Report $(I-Q)^{-1}$ in a regular mathematical expression.

$$(I-Q)^{-1}R = \begin{bmatrix} 8.521 & 6.316 & 3.425 \\ 6.767 & 7.368 & 3.308 \\ 5.514 & 5.263 & 4.177 \end{bmatrix} \times \begin{bmatrix} 0.02 \\ 0.05 \\ 0.15 \end{bmatrix} = \begin{bmatrix} 1.0 \\ 1.0 \\ 1.0 \end{bmatrix} \checkmark$$

$$(I-Q)^{-1}R = \begin{bmatrix} 1.0 \\ 1.0 \\ 1.0 \end{bmatrix}$$ - It says that anyone Exit organization eventually no matter in what state (loyalty, Voice, Neglect) employees is. ✓

Q2.8 Calculate average cost and overall cost

Calculation average cost for loyalty

$(8.521 \times \$1K + 6.316 \times \$5K + 3.425 \times \$50K) \times 80 = \$211.362K \times 80 = \$16,908.94K$

calculation the average cost for Voice

$(6.767 \times \$1K + 7.368 \times \$5K + 3.308 \times \$50K) \times 100 = \$209.02K \times 100 = \$20,902.26K$

Calculation for Neglect

$(5.514 \times \$1K + 5.263 \times \$5K + 4.177 \times \$50K) \times 500 = \$240.685K \times 500 = \$120,342.5K$

The cost for voluntary exit is = 0

The cost that organization has to pay for handling voice is \$20.9 million ($20902260 = \$20902.26 \times 1000$)

No wrong interpretation

Cont 2.b

Calculation of overall cost

Sum of costs = loyalty + Voice + Neglect + Exit.

$16908.94K + $20902.26K + $120342.5K + 0 = $158153.7K

$158153.7K = $158153700

The overall cost is $158.153 million OK

Question 3. Second transition probability Matrix after the regime change.

Q.3.1 Results of fundamental Matrix in new regime

$$(I-Q)^{-1} = \begin{bmatrix} 1.667 & 1.667 & 5.000 \\ 0.333 & 2.333 & 5.000 \\ 0.133 & 0.933 & 6.000 \end{bmatrix} \quad \checkmark$$

Q.3.2 Interpret all elements in the third column of this fundamental Matrix substantively.

The third column of $(I-Q)^{-1}$ says that after changing regime

- Loyalty employee will spend time as Neglect 5 years in organization before he/she Exit organization eventually. It means that he/she spend 1.575 years (1.575 = 5.0 - 3.425) longer than before regime.
- Voice employee will spend time as Neglect 5 years in organization before he/she Exit organization. Also it means that he/she spend 1.692 years (1.692 = 5.0 - 3308) longer than before regime.
- Neglect employee will spend time as Neglect 6 years in organization before he/she Exit organization. Also it means that he/she spend 1.823 years (1.823 = 6.0 - 4.177) longer than before regime change.

Q.3.3 Calculate average cost of loyalty, voice, neglect, Exit what is the overall cost? (K = $1000), (number = 80)

Calculation of average cost of loyalty:

$(1.667 \times \$1k + 1.667 \times \$5K + 5.00 \times \$50K) \times 80 = \$260.0K \times 80 = \$20800K$ ✓

$\$20800K = \$20800 \times 1000 = \$20800000 \Rightarrow \$20.8$ million

Cont 3.3

Calculation average cost of Voice employees:

Number of Voice employees is 100

$(0.333 \times \$1K + 2.333 \times \$5K + 5.00 \times \$50K) \times 100 = \$262.0K \times 100 = \$26200K$

$\$26200K = \$26200 \times 1000 = \$26200000 \Rightarrow \$26.2$ million

Calculation average cost of Neglect employees:

Number of Neglect employees is 500

$(0.133 \times \$1K + 0.933 \times \$5K + 6.00 \times \$50K) \times 500 = \$304.8K \times 500 = \$152400K$

$\$152400K = \$152400000 \Rightarrow \$152.4$ million

Calculation average cost of Exit employees:

Number of Exit = 20 and cost 500K

$20 \times \$500K = \$10000K \Rightarrow \$10$ million

The overall cost is sum of four states:

$\$20.8$ million + $\$26.2$ million + $\$152.4$ million + $\$10$ million =

$= \$209.4$ million

Q. 3.4. Do you think the new regime ran the organization better than old regime? Why and why not?

Based on result of Q 3.3 ($209.4 million) and Q.2.8 ($158.153 million) we can conclude that before regime is better than new regime, because organization spend money for handling employees (loyalty, Voice, Neglect) $199.4 million and also lose $10 million for Exit of higly talanted human. So after changing regime organization organization loose in total $51.246 million ($51.246 = 209.4 - 158.153)

Also based on fundamental matrix duration of loyalty and voice employees has dereased after regime change.

Question 3.5 What is the most serious weakness or problem of this modeling?

One of the weaknesses of this model is Markov chain assumes homogeneity of employees in a given state. This assumption means that once an employee in a particular state, he/she is not different from any other employees in that state. This assumption is not realistic in real world situations. yes, but not sufficient