

**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 (100 points)**

**Instruction:** Please write down your student ID and name at the top of your answer. PLEASE handwrite. Submit your answer to TA at the start of the class on May 30<sup>th</sup>.

- Organize your answer in the ascending order (1, 2, ...) and use single column.
- You MUST always show your computation clearly. Otherwise, you may not get the full credits.
- Use at least four digits below the decimal point, if possible, in your probability calculation in order to avoid large rounding errors.
- Attach hardcopies of your Excel Worksheets (Excel Solver) as shown in homework 3.
- You may not communicate (including written, verbal, gestural, any other communication) with others except for the instructor or TA to do this homework. Collaboration (cheating) is NOT tolerable.
- Do not wait until the last minute to do this homework.

Again, *DO NOT ASK your classmates to show their work. DO NOT SHOW your work to other classmates. You may not share any electronic file with your classmate.* Defend yourself by keeping your work in a safe place to avoid unintended cheating. Failure to comply with this rule will be considered academic dishonesty and misconduct. The penalties include sanctions up to and including expulsion from the university. I trust each of you implicitly but you should be aware IUJ's policy. If you need clarification regarding this issue, you may contact the instructor or OAA (ofcgsir@iuj.ac.jp).

**1. Tourist Attractions for Husband and Wife (35 points).**

Suppose that Ha Long Bay (Vietnam), Lombok (Indonesia), Ngapali (Myanmar or Burma), and Phuket (Thailand) are competing to attract couples (husband and wife) in the globe during the winter vacation. Ignore Hawaii and other similar places in this tourism market. The following transition probability matrix is arranged in the alphabetical order. For instance,  $P_{23} = .10$  means the probability that a couple who visited Lombok last winter will visit Ngapali Beach this winter (1 year time period). These data are, of course, 100% bogus.

$$P = \begin{bmatrix} .70 & .20 & .00 & .10 \\ .20 & .60 & .10 & .10 \\ .10 & .10 & .80 & .00 \\ .00 & .05 & .15 & .80 \end{bmatrix} \quad P^{(10)} = \begin{bmatrix} .2495 & .2275 & .2661 & .2569 \\ .2504 & .2281 & .2778 & .2437 \\ .2651 & .2356 & .2938 & .2056 \\ .2204 & .2099 & .3233 & .2464 \end{bmatrix}$$

1.1 (5 points) Draw the Markov transition diagram of this tourism market.

1.2 (3 points) Interpret  $P_{13}$  and  $P_{41}$  substantively. What do they mean?

- 1.3 (5 points) If a couple visited Phuket last year ( $t=0$ ) or the initial probability is  $p_0 = [0 \ 0 \ 0 \ 1]$ , what are the probability that the couple will visit Ha Long Bay three years later ( $t=3$ )? Use Excel (do not calculate manually) and attach your Excel worksheet.
- 1.4 (5 points) The second matrix above is 10-step transition probability,  $P^{(10)}$ . Interpret the second column of  $P^{(10)}$  substantively.
- 1.5 (5 points) Obtain four equations for long-run behavior. Rearrange the equations so that you can use  $X=B^{-1}Y$ .
- 1.6 (7 points) Calculate steady-state probabilities using Excel Solver. Attach Excel worksheet. Compare your answer with the result in 1.4. What do you learn from this comparison?
- 1.7 (5 points) Interpret this steady-state probability substantively (See 1.6). Which one will be the winner in this competition eventually? Why?

**2. Exit, Voice, Loyalty, and Neglect (40 points).**

Farrell (1983) extended Hirschman (1970) and discussed four types of responses to job dissatisfaction in an organization. Exit option is to quit or leave the job and the organization (turnover). Voice is “any attempt at all to change rather than to escape from an objectionable state of affairs” (Hirschman 1970: 30). Examples of voice are talking to supervisor, making some suggestions, and writing a letter (email). Loyalty is to “stick with the firm for a period of time before reacting to the problem” (Farrell 1983: 598) with “confiden[ce] that things will soon get better” (Hirschman 1970: 38). The final option of neglect is to lax, disregardful, and inattentive behavior such as absenteeism, lateness, low commitment, and error-prone output (Farrell 1983: 598). See the following paper and book for the details.

Farrell, Dan. 1983. Exit, Voice, Loyalty, and Neglect as Responses to Job Dissatisfaction: A Multidimensional Scaling Study. *Academy of Management Journal* 26(4): 596-607.  
 Hirschman, Albert O. 1970. *Exit, Voice, and Loyalty: Responses to Decline in Firms, Organizations, and States*. Cambridge, MA: Harvard University Press.

The following transition probability matrices are employees’ responses before and after the “regime change” in a public organization. The new regime was infamous for its authoritarianism, favoritism, ill-natured personality, violence, and lack of expertise. For instance, it showed an extreme form of “spoils system” by appointing a security man as a board member and 1-month career employee (novice) as a division chief only because they are blind followers of the regime. By contrast, the old regime is characterized by MGE’s leadership as shown in [http://www.sonsoo.org/management/pm/case\\_MGE.pdf](http://www.sonsoo.org/management/pm/case_MGE.pdf)

Employees’ Response Before	Employees’ Response After	State
$P = \begin{bmatrix} .60 & .25 & .13 & .02 \\ .30 & .50 & .15 & .05 \\ .15 & .30 & .40 & .15 \\ .0 & .0 & .0 & 1.0 \end{bmatrix}$	$P = \begin{bmatrix} .30 & .40 & .25 & .05 \\ .10 & .30 & .50 & .10 \\ .00 & .10 & .75 & .15 \\ .0 & .0 & .0 & 1.0 \end{bmatrix}$	(1) Loyalty, (2) Voice, (3) Neglect, (4) Exit Interval: year

The states are arranged from loyalty, voice, neglect, and (voluntary or unwanted) exit, and time interval is year. The average number of employees in loyalty is estimated to be 80, 100 in voice, 500 in neglect and 20 for exit. The average annual cost of loyalty is USD 1K (1,000) per year, 5K for voice, and 50K for neglect per employee. The cost of voluntary exit (before

the new regime) is 0. However, all 20 after the new regime are unwanted exits and incur 500K because they are highly talented human assets of the organization (brain draining).

For question 2.1-2.8, use the first transition probability matrix before the regime above.

- 2.1 (5 points) Draw the transition probability diagram.
- 2.2 (3 points) Is there any absorbing state? If any, what is it? How do you know that?
- 2.3 (5 points) Interpret  $p_{32}$  and  $p_{24}$  substantively.
- 2.4 (4 points) Report Q and R.
- 2.5 (3 points) Obtain  $(I - Q)^{-1}$  using Excel. Attach your Excel Worksheet. Handwrite the results.
- 2.6 (5 points) Explain all elements in the second row of this fundamental matrix substantively.
- 2.7 (5 points) Report (do not calculate)  $(I - Q)^{-1}R$  in a regular mathematical expression. Explain the meaning of this absorption probability matrix substantively.
- 2.8 (10 points) Calculate average cost of loyalty, voice, neglect, and exit. For instance, what is the cost that the organization has to pay for handling “voice?” Use the fundamental matrix, the number of employees in each state, and unit cost of handling each state. What is the overall cost (sum of costs of handling four states)? Take a look at 4.11 and 4.12 of *Applications of Markov Chains*. Again handwrite.

**Question 3 (25 points)** Use the second transition probability matrix after the regime change.

- 3.1 (3 points) Obtain the new fundamental matrix using Excel. Attach your Excel Worksheet. Handwrite the results.
- 3.2 (5 points) Interpret all elements in the third column of this fundamental matrix substantively.
- 3.3 (7 points) Calculate average cost of loyalty, voice, neglect, and exit. What is overall cost?
- 3.4 (3 points) Do you think the new regime ran the organization better than old regime? Why and why not?
- 3.5 (7 points) Think about the nature of Markov chain. What is the most serious weakness or problem of this modeling?

### ■ Checklist.

1. Your answer sheet
2. Two Excel Worksheets for question 1 (Q1.3 and Q1.6)
3. Two Excel Worksheets for question 2 and 3 (Q2.5 and Q3.1)

*End of homework assignment 4.*