INTERNATIONAL UNIVERSITY OF JAPAN

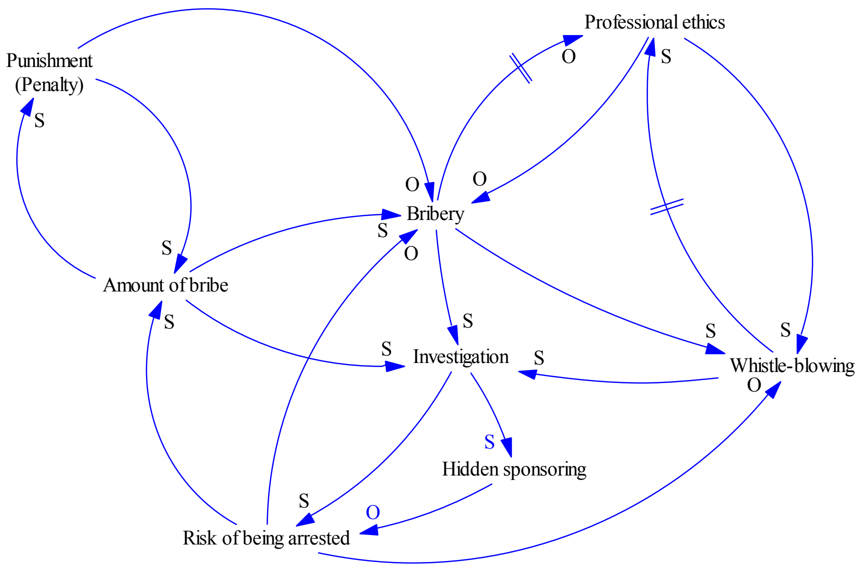
Public Management and Policy Analysis Program
Graduate School of International Relations

PHDC3501 (2 Credits)
Advanced Public Policy Modeling
Spring 2018

Final Exam (100 points)

Instruction: Download the exam template from the course Web page. You MUST ALWAYS show necessary computation and your reasoning as clearly as possible. This is a take-home, open-book, and open-notebook exam. However, you may not communicate (including written, verbal, gestural, any other communication) with others except for the instructor during the exam. Submit your answer by email by 17:00.

Question 1. **(15 points)** The following causal loop diagram depicts a corruption system of the police department with respect to military officers and soldiers in an imaginary country. Note that hidden sponsors are policemen who release investigation information to their clients.



After the success of military coup, military leaders have directly and indirectly influenced all government departments and agencies (including congress and court) so that officers and soldiers receive privileged treatment. (1) Judges are penalized implicitly when their adjudications are not favorable to military units, (2) whistle-blowers who report military scandals are retaliated secretly but completely, and (3) in response to the aggravated public opinion, the penalty for all military crimes was increased significantly. Explain how these three phenomena changed the above causal loop diagram considering the availability of relationship between activities or variables (presence or not), strength of an activity or variable, cause-and-effect relationship (A→B or B→A), and direction of the relationship (same or opposite). For instance, if military unit encourages hidden sponsoring, the activity is available; it becomes stronger; and cause-and-effect and direction of relationships remain unchanged; therefore, the risk of being arrested will decrease and influence bribery positively.

Question 2. **(35 points)** Consider the following decision table under risk. For example, the probability that a candidate is good is .4, P(Good)=.4. You are expected to decide whether or not to hire a candidate. One consulting company argues that its report is very informative to distinguish good performers from poor performers. The report concludes with three results: red, green, and blue. If a candidate's ability is actually good, for instance, there is 30 percent chance that the report will return red: P(Red|Good)=.3. Other conditional probabilities are P(Green|Good)=.3, P(Red|Poor)=.6, and P(Green|Poor)=.3

	Good Performer	Poor Performer
Hire (Yes)	40	-20
Not Hire (No)	-10	10
Prior Probability	.4	.6

- **2.1 (2 points)** Make a decision using the expected monetary value (EMV). Construct a decision tree assuming no (perfect/imperfect) information.
- **2.2 (3 points)** Make a decision the using the expected opportunity loss (EOL).
- **2.3 (2 points)** Calculate the expected value under perfect information and expected value of perfect information (EVPI).
- **2.4 (5 points)** Calculate necessary joint probabilities, marginal probabilities, and posterior probabilities.
- **2.5 (5 points)** Calculate the expected value under imperfect information and the expected value of imperfect information (EVII). Draw a corresponding decision tree with probabilities, payoffs, and expected monetary values.

In order to know your utility function, a series of lotteries were given to get the following results.

U($40) = 1, U(-$20)=0
U($0) = .6*U($40) + .4*U(-$20)
U($30) = .5*U($40) + .5*U($0)
U($35) = .4*U($40) + .6*U($30)
U($10) = .4*U($30) +.6*U($0)
U($20) = .5*U($30) +.5*U($10)
U(-$15) = .5*U($0) + .5*U(-$20)
U(-$10) = .5*U($0) + .5*U(-$15)

- **2.6 (9 points)** Based on the results above, construct a table of utility (0-1), certainty equivalent, expected monetary value, and risk premium. Then draw your utility function with y-axis of utility and x-axis of monetary value as shown in Figure 9.20 (p. 355). You may use Excel or draw in a paper and then scan it. Describe and characterize your utility function (what type of a person are you?).
- **2.7 (9 points)** Make a decision using the expected utility assuming no additional information (replace payoffs in the above decision table with utilities). Report the expected utility of perfect information. Does your utility function make difference in your decision compared to 2.1 and 2.3?

Question 3. (25 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, p. 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, p. 598) with "confiden[ce] that things will soon get better" (Hirschman, 1970, p.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, p.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 states are arranged from loyalty, voice, neglect, (natural/voluntary) exit, and (unwilling and forced) lay-off and time interval is year. Of course, exit and lay-off are absorbing states. The annual cost of loyalty is 0, \$10K (10,000) for voice, and \$50K for neglect per employee.

$$Q=\begin{bmatrix} .75 & .15 & .05 \\ .10 & .75 & .12 \\ .02 & .03 & .93 \end{bmatrix} R=\begin{bmatrix} .05 & .00 \\ .01 & .02 \\ .01 & .01 \end{bmatrix} (I-Q)^{-1}=\begin{bmatrix} 8 & 7 & 18 \\ 6 & 10 & 21 \\ 5 & 6 & 29 \end{bmatrix} (I-Q)^{-1}R=\begin{bmatrix} .67 & .33 \\ .59 & .41 \\ .59 & .41 \end{bmatrix}$$

- **3.1 (3 points)** Draw the transition diagram of this Markov chain.
- **3.2 (3 points)** Interpret the <u>second row</u> of Q and R substantively.
- **3.3 (3 points)** Report infinity-step transition probability, $P^{(\infty)}$.
- **3.4 (5 points)** Explain all elements in the <u>second row</u> of the fundamental matrix and all elements in the <u>second column</u> of absorption probability matrix substantively.
- **3.5 (8 points)** Calculate the average cost that the organization will spend for an employee in the loyalty state before he or she exits or is laid-off eventually. Do the same calculation for an employee in the voice and neglect states. Therefore, you are expected to get three numbers (costs) of three states.
- **3.6 (3 points)** Based on 3.4-3.5, how would you evaluate this organization? Is it a good organization? Why and why not?

Question 4. (25 points) Answer the following questions about queueing models.

- **4.1 (10 points)** Assume M/M/s/FCFS/∞/∞. The mean arrival rate is 4 per minute and mean service rate 1 per minute. Take a look the handout attached and check the list of performance indicators of this queueing system. Your boss wants you to find the optimal number of servers that satisfies (1) the utilization factor (please calculate manually) should be greater than .4 in order for efficiency, (2) the average waiting time in the line to begin the service should not be longer than one second, (3) the probability that the number of customers in the system exceed seven should not be larger than six percent, and (4) For at least 99 percent of the customers, the time spent in the queue should not exceed 30 seconds. Check each requirement and then report your answer. Explain why you chose the model (only one).
- **4.2 (5 points)** Look at the performance indicators in Q4.1 and see the section 11.9 of the textbook (pp. 473-476). The unit service cost per server and per minute is \$10 and unit waiting cost of a customer is \$150. Calculate the expected service cost, waiting cost, and total cost per unit time. It will be useful to a construct a calculation table as

shown in the textbook. Then determine the optimal number of servers and tell me your reasoning.

4.3 (10 points) Why does a waiting line of a government especially in developing countries tend to be longer than that of commercial firms in developed countries? What does the "internalization of waiting cost" mean? Authoritative regimes are often proud of its efficient way of doing business (e.g., "just do it" without any discussion, debate, and conflict). Do you think they can maximize social efficiency? Why and why not?

End of the final exam.

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Question 4.1 and 4.2

	M/M/6	M/M/7	M/M/8	M/M/9	M/M/10
λ =	4	4	4	4	4
μ =	1	1	1	1	1
ρ =	?	?	?	?	?
s =	6	7	8	9	10
σ =					
L_q =	0.56952169	0.1801469	0.05904399	0.0190063	0.00587648
L =	4.56952169	4.1801469	4.05904399	4.0190063	4.00587648
Wq =	0.14238042	0.04503672	0.014761	0.00475157	0.00146912
W =	1.14238042	1.04503672	1.014761	1.00475157	1.00146912
Pr(W > t) =	0.67448918	0.63243131	0.61580441	0.60964559	0.60751217
When t =	0.5	0.5	0.5	0.5	0.5
Prob(W_q > t) =	0.10475766	0.03014715	0.00799074	0.00195017	0.00043886
When t =	0.5	0.5	0.5	0.5	0.5
P(n > N) =	0.28476085	0.2364428	0.22141498	0.2167906	0.21540984
When N =	5	5	5	5	5
n	Pn	Pn	Pn	Pn	Pn
0	0.01668521	0.01781238	0.01816295	0.01827083	0.01830304
1	0.06674082	0.07124951	0.07265179	0.0730833	0.07321215
2	0.13348165	0.14249901	0.14530358	0.14616661	0.14642429
3	0.17797553	0.18999868	0.19373811	0.19488881	0.19523239
4	0.17797553	0.18999868	0.19373811	0.19488881	0.19523239
5	0.14238042	0.15199894	0.15499049	0.15591105	0.15618591
6	0.09492028	0.10133263	0.10332699	0.1039407	0.10412394
7	0.06328019	0.05790436	0.05904399	0.05939468	0.05949939