Lab 4: Stochastic Dynamic Programming

Due: Friday 4/9 at 11:59pm

In this laboratory assignment, you are asked to formulate and implement a Stochastic Dynamic Programming algorithm that can be used to solve for an optimal maintenance and replacement policy for Reinforced Concrete bridge decks. The data used for the analysis consist of bridge deck maintenance and replacement costs and transition matrices. Note that replacement has the effect of bringing the deck back to a new condition by the end of the year that the replacement is performed.

Data

The condition state of a bridge deck is described by the Concrete Bridge Deck Condition Ratings[1] which classifies deck condition into ten possible states (9 for the best state, 0 for the worst). User costs are not used; instead, it is assumed that the three worst states of the bridge are not acceptable and that users are indfferent among the other states. The agency costs depend on the action performed and the state of the deck, as shown in the following tables. The cost function is in cxu.m and is summarized in Table 1.

	Condition State									
	0	1	2	3	4	5	6	7	8	9
Do nothing	0	0	0	0	0	0	0	0	0	0
Maintenance	38.5	38.0	37.0	34.5	32.0	26.5	18.0	8.0	3.0	0.5
Replacement	60	60	60	60	60	60	60	60	60	60

Table 1: Costs of action ($ per square yard)

For example, the cost of maintenance for a deck in condition 7 is 8.0 dollars per square yard. Given an action and a condition, the bridge transitions to a new condition with some probability. These probabilities are in transitionMatrices.mat. The transition matrix for the "do nothing" action is shown in Tbale 2..

[1] Federal Highway Administration (FHwA), 1979. *Recording and coding guide for structure inventory and appraisal of the nations bridges*, U.S. Department of Transportation, Washington, D.C.

		Next year's state									
		0	1	2	3	4	5	6	7	8	9
This year's state	0	1.00	0	0	0	0	0	0	0	0	0
	1	0.65	0.35	0	0	0	0	0	0	0	0
	2	0.08	0.52	0.40	0	0	0	0	0	0	0
	3	0	0.06	0.47	0.47	0	0	0	0	0	0
	4	0	0	0.05	0.19	0.76	0	0	0	0	0
	5	0	0	0	0.02	0.12	0.86	0	0	0	0
	6	0	0	0	0	0.02	0.09	0.89	0	0	0
	7	0	0	0	0	0	0.02	0.08	0.90	0	0
	8	0	0	0	0	0	0	0.04	0.21	0.76	0
	9	0	0	0	0	0	0	0	0.04	0.29	0.67

Table 2: Transition matrix for the "do nothing" action

For example, the probability to go from condition 3 to condition 1 when performing doing nothing is 0.06.

Problems

1. Assuming the planning horizon of the bridge is 5 years, complete the function viteration.m (on class webpage) to get the optimal policies at each year. For each condition of the bridge at the beginning of the first year, find the expected cost to manage the bridge over 5 years.
2. Assuming an infinite planning horizon with discount factor 0.95, complete the function viterationInf.m (on class webpage) to get the optimal policy and costs.

Submission

1. a copy of your Matlab files (.m - files) with instructions.
2. a PDF report including:
   - the optimal decision rules for problems 1&2 in the following format.
     Problem 1

	Condition									
Years	0	1	2	3	4	5	6	7	8	9
1										
2										
3										
4										
5										

Problem 2

Condition									
0	1	2	3	4	5	6	7	8	9

- the optimal costs for problems 1&2 in the following format.
  Problem 1

	Condition									
Years	0	1	2	3	4	5	6	7	8	9
1										
2										
3										
4										
5										

Problem 2

Condition									
0	1	2	3	4	5	6	7	8	9