Homework 7: Eligibility Trace and TD(λ)

Due: Sunday, November 22nd 11:59 pm

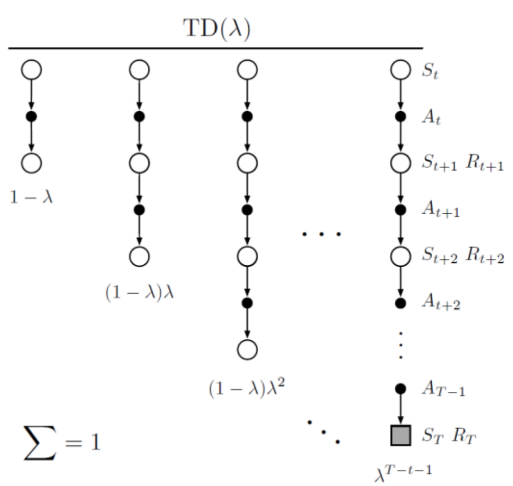
Q1. For a task with three states s_1, s_2, s_3 where $s_i \in \mathbb{R}$ generate the feature vectors using

(a) order-3 polynomial-bases $x_i(s) = \prod_{j=1}^{k} s_j^{c_{i,j}}$

(b) order-3 Fourier-bases $x_i(s) = \cos(\pi \boldsymbol{s}^\intercal \boldsymbol{C}^i)$

Note: you can either write the bases manually, or generate them using a python function. In both cases, you should enter all the bases to get full credit.

Q2. Prove that the sum of weights in the following graph adds up to 1. Your proof should cover all the cases ($\lambda = 0,\ 0 < \lambda < 1$, and $\lambda = 1$).



Q3. Using

(a) the definition of n-step return

$$G_{t:t+n} \doteq R_{t+1} + \gamma R_{t+2} + \cdots + \gamma^{n-1} R_{t+n} + \gamma^n \hat{v}(S_{t+n}, \mathbf{w}_{t+n-1}), \quad 0 \le t \le T-n,$$

(b) the definition of λ – return

$$G_t^\lambda \doteq (1-\lambda) \sum_{n=1}^{\infty} \lambda^{n-1} G_{t:t+n}.$$

derive the following equation:

$$G_t^\lambda = \gamma(1-\lambda)\hat{v}(S_{t+1}) + R_{t+1} + \gamma\lambda G_{t+1}^\lambda$$

Note: you need to use the fact you have proven in Q2.

Evaluation: we will grade your submission according to the following table:

Item	**COMP4600**	**COMP5300**
Question 1	20	20
Question 2	30	30
Question 3	50	50

Note 1: The parts marked with **(*)** are optional for COMP4600 (undergraduates) but mandatory for COMP5300 (graduates). This homework does not include any optional section.

Note 2: All explanations, formulae, and answers should be included in a single Jupyter Notebook (`.ipynb`) file. Include your name as part of the filename and submit through Blackboard.

Submission: By 11:59pm on Sunday, November 22nd 2020, submit both your `student_name.ipynb` files on Blackboard. Make sure everything is entirely contained within this file and it runs without any error.

Late Policy: Up to two late days are allowed, but a grade penalty of 50% and 75% will be applied at the first and second day, respectively.