Artificial Intelligence
Homework 5
Reinforcement learning
Part 2- Model free approach

A DC motor dynamics is defined as:

$$\begin{cases} \boldsymbol{L\frac{di}{dt} + iR + K_e\omega = u} \\ \boldsymbol{J\dot{\omega} + B\omega = K_t I} \end{cases}$$

$$\boldsymbol{\omega(0) = 0, I(0) = 0}$$

where

ω : motor speed (rad/sec)

i : the current of the motor (Amp);

u : the input voltage to the motor (V)

R = 0.2Ω : the resistance of the motor coils

L= 0.000002 : the inductance of the motor coil

K_e = 0.0017 : the electric constant of the motor (V/rad/sec)

K_t = 0.0017 :the torque constant of the motor (Nm/Amp)

J =2 : the equivalent moment of inertia of the motor rotor and load

B = 0.2 : the equivalent damping coefficient of the motor system

ω_{targ} : the target speed (rad/sec)

Objective :

Define the speed error as

$$e = \omega_{targ} - \omega,$$

you are required to design a RL-based speed controller to stabilize the motor speed from initial conditions to the target speed of

$$\omega_{targ} = 2 \text{ rad/sec.}$$

Remarks :

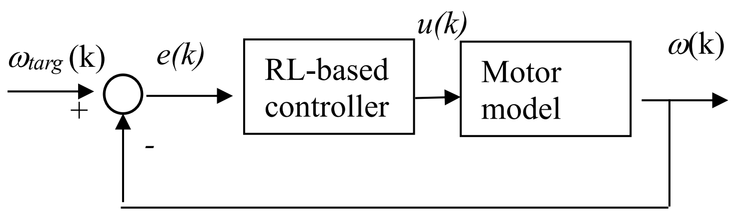
1. You are required to derive the discrete-time state space model of the original model with its parameters in the form as

$$x_{k+1} = f(x_k, u_k) = Ax_k + Bu_k$$

   where

$$\boldsymbol{x}(\boldsymbol{k}) = \begin{bmatrix} \boldsymbol{i}(\boldsymbol{k}) \\ \boldsymbol{\omega}(\boldsymbol{k}) \end{bmatrix}$$

2. The block diagram of feedback speed control system:



3. The RL model is recommended as (but not limited to) :
   - State: (e(k), Δe(k)), where Δe(k)= e(k) - e(k-1)
   - Action: u(k)
   - Reward: $r = e^2$
4. The followings are necessary in your report
   - a cover page
   - the 3D mesh plot of the finished Q-table
   - the control and simulation code,
   - simulation of controlling results
   - discussions
   - conclusions