

**Theory (12 points)**

**Answer the following questions:**

**Q1)** Explain how locally weighted regression differs from linear regression, including their formulas.

What is an advantage of locally weighted regression over linear regression? **[2 points]**

**Q2)** Given you want to apply a model to predict whether a patient has malignant or benign tumor, where model output  $y = 1$  means malignant and  $y = 0$  means benign. Explain how the binary logistic regression model is used to train on patient data and then predict tumor of a new patient. Include formulas and learning algorithm used in your answer. **[2 points]**

**Q3.a)** Given the output,  $y^{(n)}$ , of 3 training items of softmax regression are represented by the following one-hot vectors where  $y \in \{1,2,3\}$ :  $y^1 = [1 \ 0 \ 0]$ ,  $y^2 = [0 \ 1 \ 0]$  and  $y^3 = [0 \ 0 \ 1]$ . Write the expanded form of the softmax cost function  $J(w)$  for these 3 items, and the softmax output function  $f(x;w)$ . **[2 points]**

**b)** What is the relationship between softmax and binary logistic regression? **[1 point]**

**Q4)** What is the penalty term of ridge/L2 regularization and how does it reduce overfitting? **[1 point]**

**Q5.a)** Write the pseudocode/steps of applying Policy iteration to solve an MDP, including the equations. **[1 point]**

**b)** What is the advantage of using an exploration-based policy like  $\epsilon$ -greedy, to solve an MDP? **[1 point]**

**Q6.a)** What makes Q-learning an off-policy algorithm? **[1 point]**

**b)** What is the difference between on-policy and off-policy algorithms? **[1 point]**

**Implementation (18 points)**

**Implement the following code using Jupyter Notebook:**

**1. Value iteration [8 points].** Implement code as needed to solve the value iteration problem in the notebook file *value\_iteration*. Instructions to implement your code are given in the notebook file. The notebook file should produce expected results when run with your code.

**2. Q-Learning [10 points].** Implement code as needed to solve the Q-learning problem in the notebook file *q-learning*. Instructions to implement your code are given in the notebook file. The notebook file should produce expected results when run with your code.

**Submission**

Submit your modified python notebook files and a document containing the answers to the Theory questions in word or pdf format in the assignment folder. Make sure to write your name and student ID in the document containing the Theory answers.

