**Gen 575 Winter 2022**

**Problem Set 1**

*Due by 11:59 pm Apr-29-2022 to beliveau [at] uw.edu*

**Name:**

**Problem 1 (10 points)**

* 1. **(5 points)** You were reviewing the lecture 4 slides (as one does), and understandably couldn’t stop yourself from reading up on how the Kibble Balance mentioned on *slide 6* works. In your own words, describe below in a few sentences what the Kibble Balance is designed to do and how it achieves this. A high-level description is sufficient. Be sure to point out and force transduction or energy transfer occurring:
  2. **(5 points)** You couldn’t help but noticing the “Acoustic Resonator” on *slide 10* of the lecture 4 slides as well, and of course had to investigate further. You google dot com search led you to <https://www.nist.gov/programs-projects/acoustic-thermometry>. In your own words, describe below in a few sentences what the Acoustic Resonator is designed to do and how it achieves this. A high-level description is sufficient. Be sure to point out and force transduction or energy transfer occurring:

**Problem 2 (15 points)**

You had so much fun playing the guessing games in class that you decided to make your own version of it to unveil at your next social gathering. You decide to come up with a game that combines aspects of the number and card guessing games. In your game, the goal is to guess a number between 1 and 75. Your game has the following structure:

|  |  |  |
| --- | --- | --- |
| **Guess** | **Example** | **Reveal** |
| Value | “Is it 33?” | “Yes” OR “No” |
| Multiple of 7 | “Is it a multiple of 7?” | “Yes” OR “No” |
| Prime | “Is it prime?” | “Yes” OR “No” |
| Cube | “Is it a cube?” | “Yes” OR “No” |

**2.1 (5 points)** Calculate the Information Entropy *H* of your game. Show your work:

**2.2 (10 points)** Calculate the Information gain *I* for each outcome of each guess listed in the table above. Show your work:

**Problem 3 (25 points)**

The accompanying *tabulated.cake.scores.xlsx* contains the predicted and true labels for your “Is it cake?” guessing game (0 = “not cake”, 1 = “cake”).

**3.1 (10 points)** Populate the 10 confusion matrices below based on the predicted and true labels:

|  |  |  |
| --- | --- | --- |
| *Cake Score =* 1, Team A | **Actual 0** | **Actual 1** |
| **Predicted 0** |  |  |
| **Predicted 1** |  |  |

|  |  |  |
| --- | --- | --- |
| *Cake Score =* 2, Team A | **Actual 0** | **Actual 1** |
| **Predicted 0** |  |  |
| **Predicted 1** |  |  |

|  |  |  |
| --- | --- | --- |
| *Cake Score =* 3, Team A | **Actual 0** | **Actual 1** |
| **Predicted 0** |  |  |
| **Predicted 1** |  |  |

|  |  |  |
| --- | --- | --- |
| *Cake Score =* 4, Team A | **Actual 0** | **Actual 1** |
| **Predicted 0** |  |  |
| **Predicted 1** |  |  |

|  |  |  |
| --- | --- | --- |
| *Cake Score =* 5, Team A | **Actual 0** | **Actual 1** |
| **Predicted 0** |  |  |
| **Predicted 1** |  |  |

|  |  |  |
| --- | --- | --- |
| *Cake Score =* 1, Team B | **Actual 0** | **Actual 1** |
| **Predicted 0** |  |  |
| **Predicted 1** |  |  |

|  |  |  |
| --- | --- | --- |
| *Cake Score =* 2, Team B | **Actual 0** | **Actual 1** |
| **Predicted 0** |  |  |
| **Predicted 1** |  |  |

|  |  |  |
| --- | --- | --- |
| *Cake Score =* 3, Team B | **Actual 0** | **Actual 1** |
| **Predicted 0** |  |  |
| **Predicted 1** |  |  |

|  |  |  |
| --- | --- | --- |
| *Cake Score =* 4, Team B | **Actual 0** | **Actual 1** |
| **Predicted 0** |  |  |
| **Predicted 1** |  |  |

|  |  |  |
| --- | --- | --- |
| *Cake Score =* 5, Team B | **Actual 0** | **Actual 1** |
| **Predicted 0** |  |  |
| **Predicted 1** |  |  |

**3.2 (15 Points)** Generate a ROC curve using the data from 3.1. Using any reasonable method of your choosing, compute/estimate the area under the curve (AUC) for the *Cake Score* classifiers of Teams A and B. Which was more performant (ie, had a higher AUC?). How does the AUCs of the two teams compare to random guesses? Show your work: