

## EN.601.448/648 Computational genomics: Problem set 0

YOUR\_NAME (YOUR\_JHED)

**Instructions**

We have provided this L<sup>A</sup>T<sub>E</sub>X document for turning in Problem set 0. We give you one or more boxes to answer each question. The question to answer for each box will be noted in the title of the box.

**Other than your name, do not type anything outside the boxes. Leave the rest of the document unchanged.**

For written answers, replace the `\TextRequired (Place Answer Here)` command with your answer. For the following example *Question 0.1*, you would place your answer where `\TextRequired (Place Answer Here)` is located,

Question 0.1

Place Answer Here

**Do not change** the height or title of the box. If your text goes beyond the box boundary, it will be cut off. We have given sufficient space for each answer, so please condense your answer if it overflows. The height of the box is an upper bound on the amount of text required to answer the question - many answers can be answered in a fraction of the space. Do not add text outside of the boxes. We will not read it.

For True/False or Multiple Choice questions, place your answers within the defined table. To mark the box(es) corresponding to your answers, replace `\Unchecked (☐)` commands with the `\Checked (☒)` command. Do not make any other changes to the table. For example, in *Question 0.2*,

Question 0.2

- |                                     |                     |
|-------------------------------------|---------------------|
| <input checked="" type="checkbox"/> | Logistic Regression |
| <input type="checkbox"/>            | Perceptron          |

For answers that require a single equation, we will provide a specific type of box, such as in the following example *Question 0.3*. Please type the equation where `\EquationRequired (Type Equation Here)` without adding any \$ signs or `\equation` commands. Do not put any additional text in this field.

## Question 0.3

 $w =$ 

Type Equation Here

For answers that require multiple equations, such as a derivation, place all equations within the specified box. You may include text short explanations if you wish (as shown in *Question 0.4*). You can put the equations in any format you like (e.g. within  $\$$  or  $\$\$$ , the `\equation` environment, the `\align` environment) as long as they stay within the box.

## Question 0.4

$$x + 2$$

x is a real number

the following equation uses the variable  $y$ 

$$y + 3$$

Do not change any formatting in this document, or we may be unable to grade your work. This includes but is not limited to the height of textboxes, font sizes, and the spacing of text and tables. Additionally, do not add text outside of the answer boxes. Entering your answers are the only changes allowed.

We strongly recommend you review your answers in the generated PDF to ensure they appear correct. We will grade what appears in the answer boxes in the submitted PDF, NOT the original latex file.

## 1. Expected value and likelihood (1 point)

### Question 1.1

$P(30 \text{ tosses all yield heads}) = \text{Place Answer Here}$

### Question 1.2

$\mathbb{E}(\text{One toss}) = \text{Place Answer Here}$

### Question 1.3

$\mathbb{E}(\text{sum of 4 coin tosses}) = \text{Place Answer Here}$

### Question 1.4 (a)

Given  $\theta = 0.5$ , Likelihood = **Place Answer Here**

### Question 1.4 (b)

Given  $\theta = 0.8$ , Likelihood = **Place Answer Here**

### Question 1.4 (c) Which model do you prefer

☐  $\theta = 0.5$

☐  $\theta = 0.8$

### Question 1.4 (c) Justification

**Place Answer Here**

Question 1.5 (d) Is there better setting?

**Place Answer Here**

## 2. Probability and independence (0.5 points)

### Question 2.1 Prove

Place Answer Here

### Question 2.2 (a.1) are these two events independent

☐ Yes

☐ No

### Question 2.2 (a.2) Justification

Place Answer Here

### Question 2.2 (b)

$P =$ Place Answer Here

### Question 2.2 (c). which is more likely

☐ Steel

☐ Wooden

### 3. Bayes' Theorem (0.5 points)

Question 3.1 Probability of actually have the disease (write out the derivation)

Place Answer Here

## 4. Gaussian data and likelihood

### Question 4.1

$$\mathbb{E}[\sum_{i=1}^{10} x_i] = \text{Place Answer Here}$$

### Question 4.2

$$E[\sum_{i=1}^{10} x_i^2] = \text{Place Answer Here}$$

### Question 4.3

Actual ten values (3 signif digits): **Place Answer Here**

Sum = **Place Answer Here**

Sum of squares = **Place Answer Here**

### Question 4.4

$p(x_1)$  = **Place Answer Here**

$p(x_2)$  = **Place Answer Here**

$p(x_3)$  = **Place Answer Here**

### Question 4.5

Likelihood( $x_1, x_2, \dots, x_{10}$ ) = **Place Answer Here**

### Question 4.6

$\log \text{Likelihood}(x_1, x_2, \dots, x_{10})$  = **Place Answer Here**

Question 4.6 Why might people prefer to work in log space?

**Place Answer Here**



## 5. Linear algebra (0.5 points)

Question 5.1 A is orthonormal

$A^T A$  is **Place Answer Here**

Question 5.2 (a) If A is invertible write the inverse of A

$A^{-1} =$

[	Place Answer Here	Place Answer Here	Place Answer Here
	Place Answer Here	Place Answer Here	Place Answer Here
	Place Answer Here	Place Answer Here	Place Answer Here

Question 5.2 (a) If A is not invertible write the justification

**Place Answer Here**

Question 5.2 (b) If A is invertible write the inverse of A

$A^{-1} =$

[	Place Answer Here	Place Answer Here	Place Answer Here
	Place Answer Here	Place Answer Here	Place Answer Here
	Place Answer Here	Place Answer Here	Place Answer Here

Question 5.2 (b) If  $A$  is not invertible write the justification

**Place Answer Here**

Question 5.3 Implement the function in Python

**6. Matrix derivatives. (1 point)**

Question 6.1 Matrix derivative (write out the derivation)

**Place Answer Here**

Question 6.2 Optimal  $\beta$

$\beta =$  **Place Answer Here**

Question 6.3 Unique solutions in linear regression

**Place Answer Here**