CS 784: Computational Linguistics - Waitlist Quiz

Full Name: _____   Student Number: _____

Problem 1 (25 pts) There is a bag with 3 red balls and 2 blue balls. All balls have the same probability of being drawn. Please beiefly explain your answer for each case.

1. (5 pts) We randomly draw a ball from the bag. What is the probability that the ball is red?

2. (10 pts) We randomly draw a ball from the bag. Without putting it back, we randomly draw another ball from the bag. What is the probability that the second ball is red, if the first ball is red?

3. (10 pts) We randomly draw a ball from the bag. Without putting it back, we randomly draw another ball from the bag. What is the probability that the second ball is red, no matter what the color of the first ball is?

Problem 2 (30 pts) We have a function $f(x)$. For the following cases, what value of x minimizes $f(x)$ in the given domain? What is the minimum value of $f(x)$? Please briefly explain your answer.

1. (15 pts) $f(x) = x^2 - 2x + 1$, $x \in \mathbb{R}$

2. (15 pts) $f(x) = x \log x - 5x + 4$, $x \in \mathbb{R}^+$

Problem 3 (25 pts) Given the matrix: $A = \begin{bmatrix} 3 & 2 & -2 \\ 1 & 3 & -1 \\ 1 & 2 & 0 \end{bmatrix}$

1. (10 pts) Write down a vector $\mathbf{x}$ such that $A\mathbf{x} = \mathbf{x}$.

2. (15 pts) Find all eigenvalues of A. Note: for an eigenvector $\mathbf{x}$ with eigenvalue λ, $A\mathbf{x} = \lambda\mathbf{x}$.

Problem 4 (20 pts) What is the time complexity of this algorithm, in terms of n? Explain your answer.

```
def foo(a: list[int]):
   n = len(a)
   b = list()
   for i in range(n): # enumerate all elements in a
      while len(b) > 0 and b[-1] >= a[i]: # compare the last element in b with a[i]
         b.pop() # remove the last element with O(1) complexity
      b.append(a[i]) # append a[i] to the end of b with O(1) complexity
   return b
```