Assignment 2

Question 1: Simple Probability Calculation

Write a function to calculate the probability of rolling a six on a die
based on experimental data. The function should:
- Accept a list of die roll results (1-6)
- Return the probability of rolling a six

Example Input: [1, 6, 3, 6, 2, 6, 4, 5, 6, 1]
Expected Output: 0.4 (4 sixes out of 10 rolls)

```
def calculate_six_probability(roll_results):
    # Your code here
    pass
```

Question 2: Joint Probability

A weather station records daily data about:
- Whether it rained (True/False)
- Whether it was cloudy (True/False)

Write a function to calculate the joint probability of it being both rainy AND cloudy.

Example Input:
rain_data = [True, False, True, True, False, False, True, False]
cloud_data = [True, False, True, False, False, True, True, False]

Expected Output: 0.375 (3 days out of 8 were both rainy and cloudy)

```
def calculate_weather_joint_probability(rain_data, cloud_data):
    # Your code here
    pass
```

Question 3: Conditional Probability

Using student data, calculate the probability of passing an exam given that
The student studied. The function should:
- Accept two lists: study_data and exam_results (both boolean)
- Return P(Pass|Studied)

Example Input:
studied = [True, True, True, False, False, True, False, True]
passed = [True, True, False, False, False, True, False, True]

Expected Output: 0.83 (5 passed out of 6 who studied)

```
def calculate_passing_probability(studied, passed):
    # Your code here
    pass
```

Question 4: Bayes' Theorem Application

A medical test for a rare disease has the following properties:
- 1% of the population has the disease (prior probability)
- The test is 95% accurate for people who have the disease (sensitivity)
- The test is 90% accurate for people who don't have the disease (specificity)

Write a function to calculate the probability that a person has the disease
given a positive test result using Bayes' Theorem.

Expected Output: ~0.087 (8.7%)

```
def calculate_disease_probability(prior_prob, sensitivity, specificity):
    # Your code here
    pass
```

Question 5: Probability Distribution

Write a function that:
1. Generates 1000 random numbers following a normal distribution
2. Calculates the probability that a number falls within one standard
   deviation of the mean
3. Plots the distribution with matplotlib
Expected Output:
- A probability value close to 0.68 (theoretical value)
- A histogram showing the normal distribution
```
def analyze_normal_distribution(sample_size=1000):
    # Your code here
    pass
```