Lab 6
Quiz: Sampling data and analyzing distributions: Bernoulli, Binomial

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Level: 3rd Semester
Total Questions: 7
Duration: 25 minutes

Section A: Multiple Choice Questions

1. **If a coin is tossed 10 times, and the probability of heads is 0.5, what is the expected number of heads:** a) 2.5
   b) 5
   c) 7.5
   d) 10

   Answer: n×p=10×0.5=5. b) 5

2. **Which of the following is true about the relationship between Bernoulli and Binomial distributions?**
   a) Bernoulli is a special case of Binomial when $n>1$.
   b) Binomial is a special case of Bernoulli when p=0.5.
   c) Bernoulli is a special case of Binomial when n=1.
   d) they are completely unrelated.

   Answer: c) Bernoulli is a special case of Binomial when n=1.

3. **In a binomial distribution with n=8 and p=0.3, what is the variance?**
   a) 1.68
   b) 2.4
   c) 0.7
   d) 1.2

   Answer: n=8, p=0.3 => np(1−p)=8×0.3×0.7=1.68np(1−p)=8×0.3×0.7=1.68
   a) 1.68

Section B: Short Answer Questions

4. **Write the probability mass function (PMF) of a Bernoulli distribution and Binomial distribution.**

   Answer:
   Bernoulli: P(X=k) =p^k(1−p)^1−k. for k∈{0,1}
   Binomial: P(X=k)=(n, k) p^k. (1−p)^n− for k=0,1,2,...,n

5. **Explain the significance of the parameter p in Bernoulli and Binomial distributions.**
   Answer: p represents the probability of "success" in a single trial.
   In Bernoulli, p is the probability that the random variable is 1 (success).
   In Binomial, p is the probability of success in each of the n independent trials.

Section C: Python Coding

6. **Generate 10 random samples from a Bernoulli distribution with p=0.6 and print them.**

Answer:

```
import numpy as np

bernoulli_samples = np.random.binomial(1, 0.6, 10)
print("Bernoulli samples:", bernoulli_samples)
```

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7. **Generate a large sample (10000 points) from a Binomial distribution with n=20, p=0.3. Calculate and print the sample mean and variance.**

Answer:

```
import numpy as np binomial_samples =

np.random.binomial(20, 0.3, 10000) mean =

np.mean(binomial_samples) variance =

np.var(binomial_samples) print("Binomial sample

mean:", mean) print("Binomial sample variance:",

variance)
```

Task-2

Lab (Week -6)

Sampling data and analyzing distributions: Bernoulli, Binomial (Lab Exercise)

Question 1:

A factory produces light bulbs, and the probability that a bulb is defective is 0.1. If a quality inspector checks 20 bulbs, find using Python:

a. **The probability that exactly 3 bulbs are defective.**
b. **The probability that at most 2 bulbs are defective.**

Answer:

```
#Question 1 from scipy.stats import binom,

nbinom # Question 1: Light bulb defective

probabilities p_defective = 0.1 n_bulbs = 20


# a) Probability exactly 3 bulbs defective prob_3_defective =

binom.pmf(3, n_bulbs, p_defective) print(f"a) Probability

exactly 3 defective: {prob_3_defective:.4f}")


# b) Probability at most 2 bulbs defective prob_at_most_2_defective =

binom.cdf(2, n_bulbs, p_defective) print(f"b) Probability at most 2

defective: {prob_at_most_2_defective:.4f}")
```

Question 2:

A family with 5 children can be modeled as a Binomial distribution where each child is equally likely to be a boy or a girl (assume probability of boy = probability of girl = 0.5). Out of 800 families with 5 children each, answer the following using Python:

a. **How many families would be expected to have exactly 3 boys?**
b. **How many families would be expected to have exactly 5 girls?**
c. **How many families would be expected to have either 2 or 3 boys?**
d. **How many families would be expected to have at least 2 girls?**

Write Python code to compute the answers using the Binomial probability formula. Also, verify the results using Answer:

```
#Question 2
from scipy.stats import binom

n_children = 5 p_boy
= 0.5
n_families = 800

# a) Expected number of families with exactly 3 boys prob_3_boys
= binom.pmf(3, n_children, p_boy) expected_3_boys = prob_3_boys
* n_families print(f"a) Expected families with exactly 3 boys:
{expected_3_boys:.0f}") # b) Expected families with exactly 5 girls (0
boys) prob_5_girls = binom.pmf(0, n_children, p_boy) expected_5_girls
```

```
= prob_5_girls * n_families print(f"b) Expected families with exactly 5
girls: {expected_5_girls:.0f}")

# c) Expected families with either 2 or 3 boys prob_2_boys = binom.pmf(2,
n_children, p_boy) expected_2_or_3_boys = (prob_2_boys + prob_3_boys)
* n_families print(f"c) Expected families with 2 or 3 boys:
{expected_2_or_3_boys:.0f}")

# d) Expected families with at least 2 girls (girls >= 2 means boys <= 3)
prob_at_least_2_girls = binom.cdf(3, n_children, p_boy)
expected_at_least_2_girls = prob_at_least_2_girls * n_families print(f"d)
Expected families with at least 2 girls: {expected_at_least_2_girls:.0f}")
```

Question 3:

You are playing a game where the probability of winning (success) in each trial is p = 0.3.

a. **Write a Python program to calculate the probability that there will be exactly 5 failures before achieving 4 successes. (Hint: Use Negative Binomial distribution formula)**
b. **Write a Python program to calculate the probability of getting exactly 4 wins in 9 trials. (Hint: Use Binomial distribution formula)**
c. **Write a Python program to calculate the probability that the 4th win occurs exactly on the 9th trial. (Hint: Use Negative Binomial pmf for r=4 and k=9-r=5 failures)**

Answer: #Question
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```
from scipy.stats import nbinom, binom

p = 0.3
r = 4 # number of
successes k = 5 # number
of failures
n = 9 # total trials

# a) Probability exactly 5 failures before 4 successes (Negative Binomial PMF)
prob_neg_binomial_a = nbinom.pmf(k, r, p)
print(f"a) Probability 5 failures before 4 successes: {prob_neg_binomial_a:.4f}")

# b) Probability exactly 4 wins in 9 trials (Binomial PMF)
prob_binomial_b = binom.pmf(4, n, p)
print(f"b) Probability exactly 4 wins in 9 trials: {prob_binomial_b:.4f}")

# c) Probability 4th win occurs exactly on 9th trial (Negative Binomial PMF)
prob_neg_binomial_c = nbinom.pmf(k, r, p)
print(f"c) Probability 4th win on 9th trial: {prob_neg_binomial_c:.4f}")
```