# School of Computer Science and Engineering

## Task 1

Course- B.Tech.

Type- Core

Arin Chauhan
S24CSEU1777

Course Code- CSET204
Year- 2025-26

Course Name- Probability and Statistics
Semester- ODD

### Lab (Week -5): Expected Value, Variance and Joint Probability

1. Two dice are rolled simultaneously. Let the random variable X represent the maximum of the two numbers obtained. Compute the probability distribution of X. (Within Lab)

   Answer: P(X=k)=(2k−1)/36, k=1,2,3,4,5,6

   Code:

```
prob_max = {k: (2*k - 1)/36 for k in range(1, 7)}

for k, p in prob_max.items():

    print(f"P(X={k}) = {p:.4f}")
```

2. A school is analyzing students' performance in a science quiz (6 questions total). Let the discrete random variable X = 'Number of Correct Answers.'

   Out of 60 students, the teacher recorded the following distribution:

| Number of Correct Answers (x) | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Frequency f(x) | 4 | 7 | 11 | 14 | 13 | 8 | 3 |

a) Find the Mean and variance of the variable X.

Answer: x=0,1,2,3,4,5,6 f(x)=4,7,11,14,13,8,3f(x) = 4,7,11,14,13,8,3f(x)=4,7,11,14,13,8,3

Total students = 606060.
So, p(x)=f(x)/60

= 0.0666667, 0.1166667, 0.1833333, 0.2333333, 0.2166667, 0.1333333, 0.05.
$E[X] = (0·4 + 1·7 + 2·11 + 3·14 + 4·13 + 5·8 + 6·3) / 60 = 181/60 \approx 3.0166667$
$E[X^2] = (0^2·4 + 1^2·7 + 2^2·11 + 3^2·14 + 4^2·13 + 5^2·8 + 6^2·3) / 60 = 693/60 = 11.55$
$Var(X) = E[X^2] - (E[X])^2 = 11.55 - (181/60)^2 = 8819/3600 = 2.45$

b) If a student is randomly selected from the class, what is the probability that they scored at least 4 correct answers on the exam?
Answer: $P(X \geq 4) = (13 + 8 + 3) / 60 = 24/60 = 0.4$

Code:
```
x = [0, 1, 2, 3, 4, 5, 6]
freq = [4, 7, 11, 14, 13, 8, 3]
n = sum(freq)
p = [f/n for f in freq]

mean = sum(x[i]*p[i] for i in range(len(x)))
mean_sq = sum((x[i]**2)*p[i] for i in range(len(x)))
variance = mean_sq - mean**2
p_at_least_4 = sum(p[i] for i in range(4, len(x)))

print(f"Mean = {mean:.4f}")
print(f"Variance = {variance:.4f}")
print(f"P(X>=4) = {p_at_least_4:.4f}")
```

3. Draw 1500 random number from the following distribution.

| X | P(X=x) |
|---|---|
| 0 | 0.25 |
| 1 | 0.5 |
| 2 | 0.125 |
| 3 | 0.125 |

You are not allowed to use any built-in function. You have to use the ideas of PMF and CDF.
Answer:
```
import random



values = [0, 1, 2, 3]

probs = [0.25, 0.5, 0.125, 0.125]
```

```
cdf = []
cum_sum = 0
for p_val in probs:
    cum_sum += p_val
    cdf.append(cum_sum)


def generate_sample():
    r = random.random()
    for i, threshold in enumerate(cdf):
        if r <= threshold:
            return values[i]


samples = [generate_sample() for _ in range(1500)]
sample_freq = {val: samples.count(val) for val in values}
print("Generated Frequencies:", sample_freq)
```

# Lab 5 Task 2

## Quiz: Expected Value, Variance and Joint Probability

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

### Section A: Multiple Choice Questions

1. **A die is rolled once. Let the random variable X be the outcome. Then the expected value E[X] is:**
   a) 3.5
   b) 35/12
   c) 2.5
   d) 25/6
   Answer: a)
   3.5
2. **For two random variables X and Y, Cov(X,Y) = 0 always implies independence.**
   a) True
   b) False
   c) True and converse is also true
   d) None of the
   above Answer: b)
   False
3. **A discrete random variable X has PMFs: P(X=1)=0.2, P(X=2)=0.5, P(X=3)=0.3. Find Var(X).**
   a) 0.41
   b) 0.49
   c) 0.51
   d) 0.61
   Answer: b) 0.49

---

### Section B: Short Answer Questions

4. **Write the relationship between variance and standard deviation.**
   Answer:
   Variance = standard deviation^2 ( σ^2)

5. **What is marginal probability? How is it related to the joint distribution?**
   P(X=x) = ∑y P(X=x,Y=y)
   P(Y=y) = ∑x P(X=x,Y=y)

---

### Section C: Python Coding

## 6. Joint s Marginal Probability Simulation

**Problem Statement:**

**Simulate rolling two dice 10,000 times. Let X = outcome of die 1, Y = outcome of die 2.**

- **Estimate the joint probability table** P(X, Y)**.**
- **Compute marginal probabilities** P(X) **and P(Y).**

**Answer**: import random

```
trials = 10000

joint_counts = [[0]*6 for _ in range(6)]

for _ in range(trials):

    x =

    random.randint(1,6) y

    = random.randint(1,6)

    joint_counts[x-1][y-1] += 1

joint_prob = [[joint_counts[i][j]/trials for j in range(6)] for i in range(6)]

marginal_x = [sum(joint_counts[i][j] for j in range(6))/trials for i in range(6)]

marginal_y = [sum(joint_counts[i][j] for i in range(6))/trials for j in range(6)]

print("Joint probability table P(X,Y):")

for i in range(6):

    print(["{:.4f}".format(p) for p in joint_prob[i]])

print("Marginal P(X):", ["{:.4f}".format(p) for p in marginal_x])

print("Marginal P(Y):", ["{:.4f}".format(p) for p in marginal_y])
```

---

---

## 7. Conditional Probability from Simulation

**Problem Statement:**
**Simulate tossing a coin twice and repeat the experiment 10,000 times.**

- **Let** X=1 **if the first toss is a Head, else 0.**
- **Let** Y=1 **if the second toss is Head, else 0.**

**Estimate** P(X=1|Y=1) **using simulation.**

```
import random

trials = 10000

count_Y1 = 0

count_X1_and_Y1 = 0

for _ in range(trials):

    first = random.choice([0,1])

    second = random.choice([0,1])

    if second == 1:

        count_Y1 += 1

        if first == 1:

            count_X1_and_Y1 +=

1 if count_Y1 == 0:

    est = None

else:

    est = count_X1_and_Y1 / count_Y1

print("Estimated P(X=1 | Y=1) =", est)
```

---

---