Q1. What is Estimation Statistics? Explain point estimate and interval estimate.

Estimation statistics deals with estimating unknown **population parameters** using sample data.

Point Estimate

- A **single value** used to estimate a population parameter
- Example: Sample mean x‾\bar{x}x‾ estimating population mean μ\muμ

Interval Estimate

- A **range of values** within which the parameter is likely to lie
- Given by a **confidence interval**

Example:
95% CI for mean = (45, 55)

Q2. Python function to estimate population mean

```
import math
from scipy.stats import t

def estimate_mean(sample_mean, sample_std, n, confidence=0.95):
    alpha = 1 - confidence
    t_crit = t.ppf(1 - alpha/2, df=n-1)
    margin = t_crit * (sample_std / math.sqrt(n))
    return (sample_mean - margin, sample_mean + margin)

estimate_mean(50, 10, 30)
```

Q3. What is Hypothesis Testing? Why is it used?

Hypothesis testing is a statistical method to make decisions about a population parameter based on sample data.

Why used

- To validate assumptions
- To compare groups
- To make data-driven decisions

Q4. Hypothesis for male vs female average weight

- **Null hypothesis (H_0):**

μm=μf\mu_m = \mu_fμm=μf

- **Alternative hypothesis (H_1):**

μm>μf\mu_m > \mu_fμm>μf

Q5. Python script for hypothesis test (two means)

```
from scipy.stats import ttest_ind

sample1 = [70, 72, 68, 75, 71]
sample2 = [65, 66, 64, 63, 67]

t_stat, p_value = ttest_ind(sample1, sample2)
print("t-statistic:", t_stat)
print("p-value:", p_value)
```

Q6. Null and Alternative Hypothesis

- **Null Hypothesis (H_0):** No effect or no difference
- **Alternative Hypothesis (H_1):** There is an effect or difference

Example:

- H_0: μ=50\mu = 50μ=50
- H_1: μ≠50\mu \neq 50μ=50

Q7. Steps in Hypothesis Testing

1. State H_0 and H_1
2. Choose significance level (α)
3. Select test statistic
4. Compute p-value
5. Make decision
6. Draw conclusion

Q8. What is p-value?

The **p-value** is the probability of observing results **as extreme as the sample**, assuming H_0 is true.

- If **$p \le \alpha$** → Reject H_0
- If **$p > \alpha$** → Fail to reject H_0

Q9. Student’s t-distribution plot (df = 10)

```
import numpy as np
import matplotlib.pyplot as plt
from scipy.stats import t

x = np.linspace(-4, 4, 100)
y = t.pdf(x, df=10)

plt.plot(x, y)
plt.title("Student's t-Distribution (df = 10)")
plt.xlabel("x")
plt.ylabel("Density")
plt.show()
```

Q10. Two-sample t-test Python program

```
from scipy.stats import ttest_ind

sample1 = [10, 12, 11, 13, 14]
sample2 = [9, 8, 10, 9, 11]

t_stat, p_val = ttest_ind(sample1, sample2, equal_var=True)
print("t-statistic:", t_stat)
print("p-value:", p_val)
```

Q11. What is Student’s t-distribution? When to use it?

- A probability distribution used when:
  - Sample size is small
  - Population standard deviation is unknown
  - Data is approximately normal

Q12. What is t-statistic? Formula

The **t-statistic** measures how far a sample mean is from the hypothesized mean.

t=x¯−μs/nt = \frac{\bar{x} - \mu}{s / \sqrt{n}}t=s/nx¯−μ

Q13. 95% Confidence Interval (Coffee Shop Revenue)

Given:
x¯=500\bar{x} = 500x¯=500, s=50s = 50s=50, n=50n = 50n=50

CI=x¯±1.96×snCI = \bar{x} \pm 1.96 \times \frac{s}{\sqrt{n}}CI=x¯±1.96×ns CI=500±13.86CI = 500 \pm 13.86CI=500±13.86

✅ Answer:

(486.14, 513.86)(486.14,\ 513.86)(486.14, 513.86)

Q14. Drug Effect Hypothesis Test

Given:
x¯=8\bar{x} = 8x¯=8, μ0=10\mu_0 = 10μ0=10, s=3s = 3s=3, n=100n = 100n=100

t=8−103/100=−6.67t = \frac{8 - 10}{3/\sqrt{100}} = -6.67t=3/1008−10=−6.67

Critical value (α = 0.05) ≈ ±1.96
👉 **Reject H_0**

✅ Conclusion:

Drug does **not** decrease BP by 10 mmHg.

Q15. Product Weight Hypothesis Test

Given:
x¯=4.8\bar{x} = 4.8x¯=4.8, μ0=5\mu_0 = 5μ0=5, s=0.5s = 0.5s=0.5, n=25n = 25n=25

t=4.8−50.5/25=−2t = \frac{4.8 - 5}{0.5/\sqrt{25}} = -2t=0.5/254.8−5=−2

Critical value (α = 0.01, one-tailed) ≈ -2.49
👉 **Fail to reject H_0**

Q16. Two-sample test (Student Scores)

t=80−7510230+8240≈2.38t = \frac{80 - 75}{\sqrt{\frac{10^2}{30} + \frac{8^2}{40}}} \approx 2.38t=30102+408280−75≈2.38

Critical value (α = 0.01) ≈ 2.58
👉 **Fail to reject H_0**

Q17. 99% Confidence Interval (Ads Watched)

Given:
x‾=4\bar{x} = 4x‾=4, s=1.5s = 1.5s=1.5, n=50n = 50n=50

CI=4±2.576×1.550CI = 4 \pm 2.576 \times \frac{1.5}{\sqrt{50}}CI=4±2.576×501.5 CI=4±0.55CI = 4 \pm 0.55CI=4±0.55

✅ Answer:

(3.45, 4.55)(3.45,\ 4.55)(3.45, 4.55)
