**ASSIGNMENT 7**

**1. How do you assess the statistical significance of an insight?**

Statistical significance is determined by first specifying a null hypothesis (H₀: no effect) and an alternative hypothesis (H₁: expected effect). An appropriate statistical test—such as a t‑test for means or a χ² test for proportions—is selected, and its test statistic is calculated from the sample data. A p‑value is then obtained, representing the probability of observing results at least as extreme as those measured under the assumption that H₀ is true. Comparison of the p‑value to a predetermined significance level (α, often 0.05) dictates the decision: if p ≤ α, H₀ is rejected, indicating a statistically significant effect. An effect‑size measure (e.g., Cohen’s d or an odds ratio) and a confidence interval are reported to convey practical magnitude and precision.

**2. What is the Central Limit Theorem? Explain it. Why is it important?**

The Central Limit Theorem holds that, for sufficiently large sample sizes (commonly n ≥ 30), the distribution of the sample mean (or sum) approaches a normal distribution—regardless of the underlying population’s shape—centered on the true mean μ with standard deviation σ/√n. This “averaging” phenomenon ensures that many inferential methods, including z‑tests, t‑tests, and normal‑based confidence intervals, remain valid even when the population distribution is unknown or non‑normal.

**3. ⁠What is the statistical power?**  
Statistical power denotes the probability of correctly rejecting a false null hypothesis (i.e., detecting a true effect), equal to 1 minus the Type II error rate (β). Power increases with larger true effect sizes, greater sample sizes, higher significance levels (α), and reduced data variability. Designing studies with power of at least 80% is standard practice to minimize the risk of overlooking meaningful effects.

**4. How do you control for biases?**Biases are controlled through both experimental design and statistical adjustment. Randomization of subjects or units across conditions mitigates systematic differences; blinding of participants and/or analysts prevents expectation effects; and standardized measurement protocols reduce instrumentation bias. Remaining confounders can be addressed via multivariable regression, stratification, matching techniques, or sensitivity analyses to evaluate robustness under alternative assumptions.

**5. What are confounding variables?**Confounding variables are factors associated with both the independent variable and the outcome, potentially producing a spurious relationship. For instance, if smoking correlates with coffee consumption and also influences heart‑disease risk, smoking confounds any observed link between coffee and cardiovascular outcomes. Strategies to address confounders include randomization, restriction (e.g., excluding smokers), matching on confounder values during design, and statistical adjustment via regression or propensity‑score methods during analysis.

**6. What is A/B testing?**A/B testing is a randomized controlled experiment comparing two variants—A (control) versus B (treatment)—to evaluate which yields better performance on a predefined metric (e.g., click‑through rate). The process involves defining the key outcome metric, randomly assigning samples to each variant, collecting data until a predetermined sample size or duration is reached, and then applying hypothesis testing and confidence‑interval estimation to determine whether the observed difference is both statistically significant and practically meaningful.

**7. ⁠What are confidence intervals?**

A confidence interval provides a range of values, derived from sample data, that is expected to contain the true population parameter with a specified confidence level (commonly 95%) under repeated sampling. For example, a 95% confidence interval of [1.2, 3.8] for a mean difference indicates 95% confidence that the true difference lies within those bounds, assuming model assumptions hold. Confidence intervals offer both an estimate of effect size and its precision, with narrower intervals indicating greater certainty and intervals excluding a null value corresponding to statistical significance at the associated α level.