sparcc-day-2-test

Part 1: Multiple Choice Questions

Instructions: Circle the correct answer(s). Note that more than one answer may be correct

1. If A and B are unconditionally d-separated

a) Information flows between A and B
b) No information flows between A and B
c) Social desirability bias may influence the relationship between A and B
d) No further causal assumptions are required to consistently estimate the causal effect of A on B

2. When selection into a randomised controlled traial leads to differences in the response we say?

a) There is confounding bias
b) There is selection bias
c) The positivity assumption is violated
d) There is reciprocal confounding

3. Imagine that happiness increases income and that marriage increases income. Further imagine that researchers "control for" income in studying whether marriage causes happiness—even though there is no real causal effect of marriage on happiness. Which of the following would we expect?

a) The true positive relationship between marriage and happiness becomes stronger
b) The relationship appears negative, despite no actual relationship
c) The relationship remains unchanged
d) The relationship disappears completely

4. Which of the following assumptions is not required to identify causal effects from a randomised controlled trial (RTC)?

a) Individual Causal Effects are Unknowable: $Y_i(1) - Y_i(0)$ cannot be observed (the fundamental problem of causal inference)
b) Causal Consistency: $Y_i(a) = Y_i$ when $A_i = a$
c) Exchangability: Treatment assignment is independent of potential outcomes (possibly conditional on confounders)
d) Positivity: Non-zero probability of receiving each treatment within every confounder stratum

5. Which type of confounding bias occurs when a variable mediates the effect of an exposure on an outcome, and we condition on this mediator?

a) Mediator bias
b) Collider bias
c) Fork bias
d) Proxy bias

6. In the notation used for conditional independence, what does $A \coprod Y(a) \mid L$ mean?

a) A and $Y(a)$ are statistically dependent given L
b) A and $Y(a)$ are statistically independent given L
c) L mediates the effect of A on $Y(a)$
d) L is a collider between A and $Y(a)$

7. In the context of the five elementary structures of causality, which structure describes a scenario where conditioning on a variable creates an association between two previously independent variables?

a) Fork
b) Chain
c) Collider
d) Causality Absent

8. To consistently estimate a causal effect for a continuous treatment we must

a) Validate the treatment in independent samples
b) Draw our assumptions on a causal Directed Acyclic Graph (DAG)
c) Distinguish the concepts “no unmeasured confounding” from “conditional ignorability”
d) Conceptualise a causal contrast as the difference between two binary states of the continuous treatment.

9. In the context of regression, which of the following statements about model fit is TRUE from a causal inference perspective?

a) A better model fit (lower AIC/BIC) always indicates less confounding bias
b) Adding more variables to a model always improves causal inference
c) Model fit is a reliable indicator of the model's causal validity
d) A model with better fit may still be confounded and lead to incorrect causal conclusions

10. Which of the following is NOT a prerequisite for valid causal inference from regression models?

a) Correctly specified causal structure
b) No unmeasured confounding
c) The highest possible (R^2) value
d) Proper functional form

11. Which of the following best describes effect modification?

a) When the effect of an exposure on an outcome varies across levels of a third variable
b) When two exposures interact to produce an outcome
c) When a confounder affects both the exposure and outcome
d) When measurement error affects the exposure variable

12. Which type of measurement error bias occurs when the error in measuring the exposure is related to the true value of the exposure and there is no other measurement error bias?

a) Undirected/uncorrelated measurement error
b) Undirected/correlated measurement error
c) Directed/uncorrelated measurement error
d) Directed/correlated measurement error

13. We say there is selection bias in setting where:

a) Investigators condition on a common effect of the exposure (A) and outcome (Y)
b) Investigators condition on the mediator (M) of an exposure (A) and outcome (Y) in a randomised experiment.
c) There is a common cause (L) of exposure (A) and outcome (Y)
d) Investigators condition on a common effect (Z) of the exposure (A) and an another modelled variable (X), where:

- $A \rightarrow \boxed{Z}$
- $\boxed{X} \rightarrow \boxed{Z}$
- $\boxed{X} \rightarrow Y$
- There are no other causal relationships

14. In the context of transportability, which of the following statements is TRUE?

a) Results from randomised trials are always transportable to the target population
b) Selection bias is irrelevant to considerations of transportability
c) Transportability requires similar distributions of effect modifiers in both the study and target populations
d) External validity and transportability are unrelated concepts

15. What is the fundamental problem of causal inference?

a) We cannot be certain we have identified all confounders in an observational studies
b) We cannot observe both potential outcomes for the same individual
c) We cannot randomise treatments in most real-world settings
d) We cannot know we have measured outcomes with sufficient precision, even if we have randomised and controlled the treatment

16. Which of the following best describes the difference between interaction and effect modification?

a) Interaction concerns the effect of combining two interventions, while effect modification concerns how one intervention's effect varies across subgroups
b) Interaction is a statistical concept, while effect modification is a causal concept
c) Interaction affects the average treatment effect, while effect modification does not
d) Interaction requires experimental data, while effect modification can be assessed with observational data

17. If confounding is controlled, what does a positive value for an additive interaction measure indicate?

a) Antagonism: the combination of treatments is less effective than expected
b) Synergy: the combination of treatments is more effective than expected
c) No interaction: the treatments work independently
d) Dose reponsiveness: the treatments are correlated with each other or with unmeasured variables

18. When estimating causal interaction between treatments (A) and (B) on outcome (Y), which confounders must be controlled for?

a) Only confounders of the $A \rightarrow Y$ relationship
b) Only confounders of the $B \rightarrow Y$ relationship
c) The union of confounders for both the $A \rightarrow Y$ and $B \rightarrow Y$ relationships
d) The intersection of confounders for the $A \rightarrow Y$ and $B \rightarrow Y$ relationships

19. The assumption that the potential outcome corresponding to the exposure an individual actually receives is exactly what we observe is called:

a) Counterfactual consistency
b) Positivity
c) Exchangeability
d) Causal consistency

20. When the treatment assignment is unrelated to potential outcomes by design, this achieves:

a) Counterfactual consistency
b) Positivity
c) Exchangeability
d) Causal consistency

Part 2: Short Answer Questions – Choose 4

Instructions: Answer four questions only, each in one or two paragraphs (plus diagrams if needed). If you answer more than four, only the first four will be graded. For exach response, please clearly indicate the question number you are answering.

1. A researcher finds that higher religiosity is associated with lower charitable donations the following year when controlling for income. Describe a scenario where this finding could be misleading. Draw a causal diagram to explain this bias.
2. Compare and contrast internal validity and external validity. Use an example to clarify the differences.
3. Suppose you want to investigate the causal effects of beliefs in God and a prosocial outcome. Do not pick your project but rather conceive of of another. Outline a workflow for defining a study, including a brief example.
4. Explain the "Proxy Rule" for confounding control, and provide an example of how it can reduce bias and how it can introduce bias.
5. Create a causal diagram for a study of whether religious attendance affects personality. Imagine early childhood experiences affect both personality development and religious attendance. Personality also directly influences career choice, and career choice affects later attendance. Use your diagram to discuss what needs to be measured to estimate and interpret a causal effect in this example.

6. Investigators wish to study the effect of ritual worship on longevity. The researcher decides to control for cardiovascular health. Use a causal diagram and explain what must be measured to correctly estimate the causal effect of ritual on longevity, and what investigators should consider when controlling for cardiovascular health.
7. Consider a study examining social media use and religious belief. Investigators have data at three time points on: Age, Socioeconomic Status, Number of Online Friends, Screen Time, Social Media Use, and Religious Belief. What must be done to estimate a causal effect? Propose a brief workflow.
8. Explain the concept of 'd-separation' in causal diagrams and why it is important for identifying causal effects. Provide an example.
9. Explain how a variable can act as a collider. How does conditioning on a collider create spurious associations between variables that would otherwise be independent? Provide an example.
10. Describe the concept of 'M-bias' in causal inference. When might researchers inadvertently introduce M-bias into their analyses?
11. Explain the relationship between selection bias and transportability in cross-cultural research. How might selection bias threaten the external validity of findings?
12. Explain the concept of Average Treatment Effect (ATE) in causal inference. How does it relate to individual causal effects, and why is it often the focus of causal analyses?
13. Describe the positivity assumption in causal inference. What challenges might arise in satisfying this assumption in cross-cultural research on Religion?
14. Describe the distinction between a true individual causal effect and an estimated Conditional Average Treatment Effect ($\hat{\tau}(x)$). Why can we only generally estimate the latter?

Part 3: Conceptual Question (20 points)

A well-known regression text (Aiken, West, and Reno 1991) states that three conditions must hold to infer causation, where (A) is the exposure (treatment) and (Y) is the outcome:

1. A and Y must be correlated.
2. The correlation must not be spurious (i.e., there must be no uncontrolled confounder).
3. A must precede Y in time.

Question: Discuss how these criteria align with, or differ from, the standard potential-outcomes framework for causal inference. Are these three conditions sufficient to establish causality in practice? What needs clarification? Justify your reasoning with examples or counterexamples.

References

Aiken, Leona S., Stephen G. West, and Raymond R. Reno. 1991. *Multiple Regression: Testing and Interpreting Interactions*. Newbury Park, CA: SAGE Publications, Inc.