
MATH 80667A *Experimental Design and Statistical Methods*

Practice final examination

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Instructions: The time allotted for the examination is 180 minutes. You may answer in either English or French. No written material may be brought into the examination, but a simple (non-programmable) calculator may be used.

There are a total of 21 marks available in the exam paper, the distribution of which can be found in the right margin.

Last name:

First name:

STUDENT ID:

Question:	1	2	3	4	5	Total
Points:	6	5	6	2	2	21
Score:						

Question 1.**6**

The following concepts are considered to be the pillars of experimental design:

- **Randomization:** observational units randomly allocated to treatment group
- **Replication:** having multiple observations for each treatment allocation
- **Blocking:** dividing experimental units into blocks

Briefly explain the relevance of each concept.

Question 2.**5**

The following quote is taken from the *Strategic Management Journal* guidelines and addresses reporting of results of statistical analyses:

Authors of submitted papers should not search databases for statistically significant coefficients with the intention of subsequently formulating hypotheses that fit the significant coefficients. Authors also should not adapt experimental designs with the primary intention of producing statistically significant results. In addition, authors of submitted papers should address the material significance (magnitude) of the results, in addition to statistical significance.

Explain the quote in the context of the reproducibility crisis, addressing

- *post hoc* formulation of hypothesis
- use of 'statistical significance' (e.g., $p < 0.05$) for assessing results
- material relevance of results

Question 3.**6**

3.1 What is the impact on power of

[2]

- using Bonferroni's correction with a family of $m = 10$ tests?
- assuming a larger effect size?

3.2 Selective reporting: explain why using reported effect size from studies with small sample size to compute the power is not good practice.

[2]

3.3 Would the same problem apply to meta-analysis, which pool the results from multiple published studies of the same phenomenon? Why or why not?

[2]

Question 4.**2**

What is a collider? Draw a directed acyclic graph showing the relationship between an experimental factor X , a response Y and a collider Z . Provide an example of collider and explain why it would be counter-productive to control for it in a mediation analysis.

Question 5.**2**

Assume we want to perform m independent tests controlling the family-wise error rate (FWER) at level α using Bonferroni's correction. Circle the correct statement.

1. When applying Bonferroni's correction, we will reject more null hypotheses relative to the situation with no correction.
2. The Bonferroni correction consists in testing the individual hypotheses at level αm .
3. We can only apply the Bonferroni correction if the tests are independent.

4. The Bonferroni correction can be performed by multiplying the p -values obtained from the individual tests by m and using the same level α .

Two additional data analysis questions. See the practice exam from Dr. Lukas Meier (ETHZ) Q1 and Q2 (except b) from `problems-demo.pdf` for an example of the expected level.