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Engineering Evidence

A course-text essay on evidence, uncertainty, and decisions

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Abstract

Small experiments can improve a design decision without attempting to model an entire system. This essay presents a repeatable way to choose a measurable outcome, compare competing explanations, and record the limits of the result.

Chapter 1

From uncertainty to a decision

An experiment is useful when it changes what a team will do next. A broad question such as “is the prototype reliable?” is therefore less helpful than the decision question “which enclosure should be tested at scale?” The second question identifies an action and makes it possible to choose a result that discriminates between alternatives.

1.1 State competing explanations

Before collecting data, write down at least two explanations. For a sensor whose readings arrive late, one explanation might be queueing in the device; another might be contention in the network. The test should vary the suspected mechanism while holding the payload, sample rate, and measurement instrument constant. This is more informative than increasing the size of a benchmark that changes several variables simultaneously.

1.2 Choose an observable

Latency, failure rate, energy use, and calibration error are all observables, but they answer different questions. If t_i is the measured response time for request i, a simple estimate of the mean is

$$\bar{t} = \frac{1}{n} \sum_{i=1}^{n} t_i. \tag{1.1}$$

The mean should be accompanied by a spread measure and by the conditions under which the observations were collected.

Chapter 2

A compact experimental protocol

1. Name the decision and the alternatives it could change.
2. Define one primary observable and a stopping rule.
3. Run a baseline before changing the proposed mechanism.
4. Record environmental conditions and possible confounders.
5. Repeat the test and publish inconclusive results as well as successes.

Table 2.1: Example evidence record for a small prototype test.

Run	Changed factor	Primary observation
Baseline	None	Response latency
A	Local queue limit	Response latency
B	Network payload size	Response latency

Chapter 3

Limits and conclusion

Small experiments do not remove uncertainty; they make its remaining shape visible. A quiet laboratory test may not predict production behaviour, while a highly realistic test may change too many factors to explain its result. The best protocol is consequently the smallest repeatable test that distinguishes the decisions under consideration. Its conclusion should state what changed, what did not, and which measurement would resolve the next uncertainty.

Appendix A

Checklist

- Decision and competing explanations written before the test.
- Primary observable, units, and stopping rule recorded.
- Baseline and changed-condition runs both available.
- Limitations and follow-up measurement identified.