Experiment Process

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Advantages of Experiments

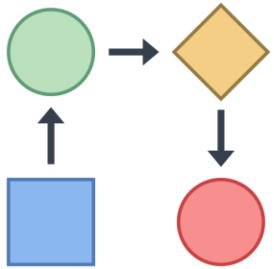
- The high level of control
  - We can draw more general conclusions
- Ability to perform statistical analysis using hypothesis testing methods
- Opportunities for replication
  - Replication is important for reliability

The Need of a Process

- Experimentation is not simple
- The experiment process is formulated to make sure that proper actions are taken to ensure a successful experiment
  - It provides support in setting up and conducting an experiment

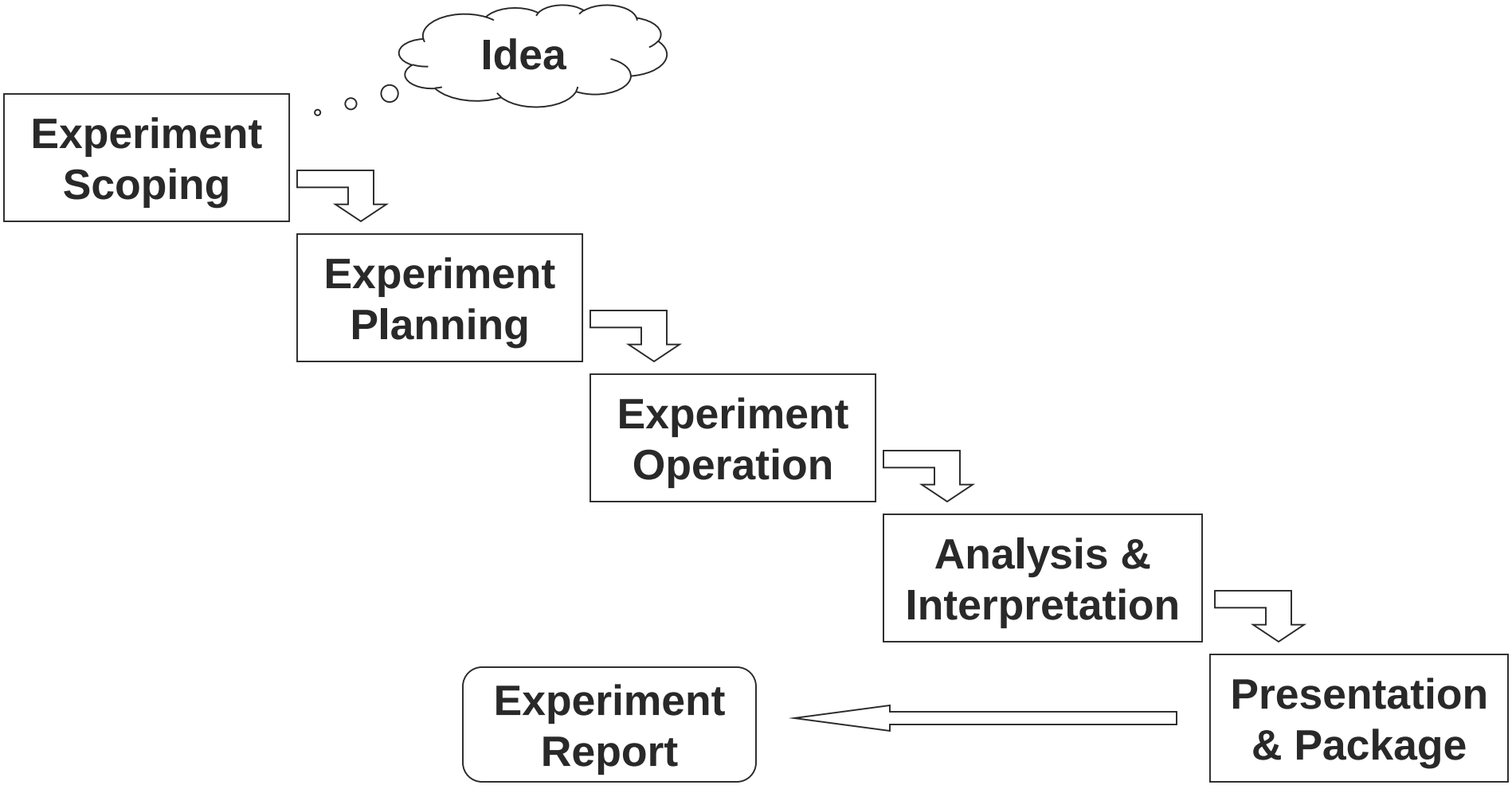
Experiment Process

- An experiment process provides activities that support the experiment
- The activities have to be in a certain order



- The processes is important as it can be used as checklists and guidelines

Overview of the Process



Process Main Activities

- The starting point is the insight (an idea)
  - Is the experiment appropriate for the question we want to investigate?
- The five main activities
  - Scoping
  - Planning
  - Operation
  - Analysis and Interpretation
  - Presentation and Package

Beyond Experiments

- The same basic activities are performed in any empirical studies
  - Adaptations may be required
- Case studies have flexible designs
  - Several iterations are possible
- Experiments and surveys have fixed designs
  - Usually, each activity is only executed once

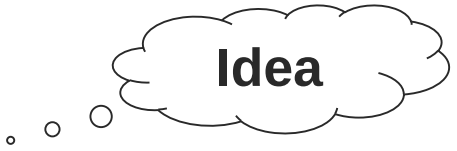
Is the Process Waterfall?

- The experiment process is not supposed to be a “true” waterfall model
  - It is partly iterative

- However, after starting operation, it is not possible to change scope and planning
  - If they changes, subjects have to be discarded

1 - Scope

- Scope is the first activity
  - It is based on an idea



- We scope the experiment in terms of a problem, goals, and hypotheses
  - The goals are formulated from the problem
  - The hypotheses have to be stated clearly based on the goals

Framework for Scoping

- The basic framework consists of five elements
  - Object of study (what is studied?)
  - Purpose (what is the intention?)
  - Quality focus (which effect is studied?)
  - Perspective (whose view)
  - Context (where is the study conducted?)

Framework Instantiation

- Analyze <*object of study*> from the purpose of <*purpose*> with respect to their <*quality focus*> from the point of view of the <*perspective*> in the context of <*context*>
- Example:
  - Analyze software metrics from the purpose of bad smell detection with respect to their accuracy from the point of view of the developers in the context of maintenance

2 - Planning

- Planning is where the design of the experiment is determined
- The context is defined in details
  - Personnel and environment
  - Randomization of subjects
  - Instrumentation (e.g., objects, tasks)
- Null hypothesis and alternative hypothesis are formally stated

Variables and Treatments

- Planning also determines the dependent and independent variables
  - The values (treatments) are also planned
  - The measurement scale for each variable
- We have to judge if there is a relationship between the treatments and the outcome
- Threats to validity are evaluated
  - Internal, external, construct, and conclusion

3 - Operation

- Operation follows the design defined in the planning activity
- It consists in three main steps
  - Preparation: we prepare the subjects and material needed
  - Execution: the experiment is executed according to the plan
  - Validation: verify is the data collected provide a valid view of the experiment

4 - Analysis and Interpretation

- This activity analyzes and evaluates the collected measurements
  - The collected data is the input
- The first step is to try to understand the data using descriptive statistics
  - It helps to interpret the data informally
- The next step is to decide whether the data should be reduced
  - e.g., remove an independent variable?

Hypothesis Testing

- After understand and reduce the dataset, we are able to perform a hypothesis test
  - Statistical tests are applied in this step
- The result is to determine if the hypothesis can be rejected

5 - Presentation and Package

- Presentation and package is the last activity
  - It summarizes and presents the results
- Experiments do not aim to present a final answer for a question
  - It is important to facilitate further replications
- We must take some time after the experiment to document and present it

Bibliography

- C. Wohlin et al. **Experimentation in Software Engineering**, Springer. 2012.
  - Chapter 6 – Experiment Process