

## Experiment Process

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## 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 a experiment

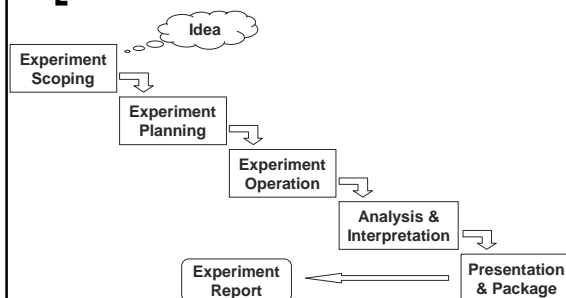
## Advantages of Experiments

- 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

## Experiment Process

- Processes are important as they can be used as checklists and guidelines
- An experiment process provides steps that support an activity
- The process we presented is focused in experiments
  - The same basic steps are performed in any empirical studies (survey, case study, etc.)

## Overview of the Process



## Process Main Steps

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

## Beyond Experiments

- The same basic steps are performed in any empirical studies
  - Adaptations may be required
- Case studies have flexible designs
  - It is possible several iterations over steps
- Experiments and surveys have fixed designs
  - Usually, each step 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

## Scope

- Scope is the first step
  - 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

## 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

## [ Experiment ]

- 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

## [ Operation ]

- Operation follows the design defined in the planning step
- 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 if the data collected provide a valid view of the experiment

## [ Analysis and Interpretation ]

- Analysis and interpretation 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
  - Remove an independent variable?

## [ Hypothesis Testing ]

- After understand and reduced the dataset, we are able to perform a hypothesis test
  - Statistical tests are applied in this step
- The result is to determine if the hypotheses are accepted or rejected

## [ 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