



ICS 500: Research Methods and Experiment Design in Computing

Lecture

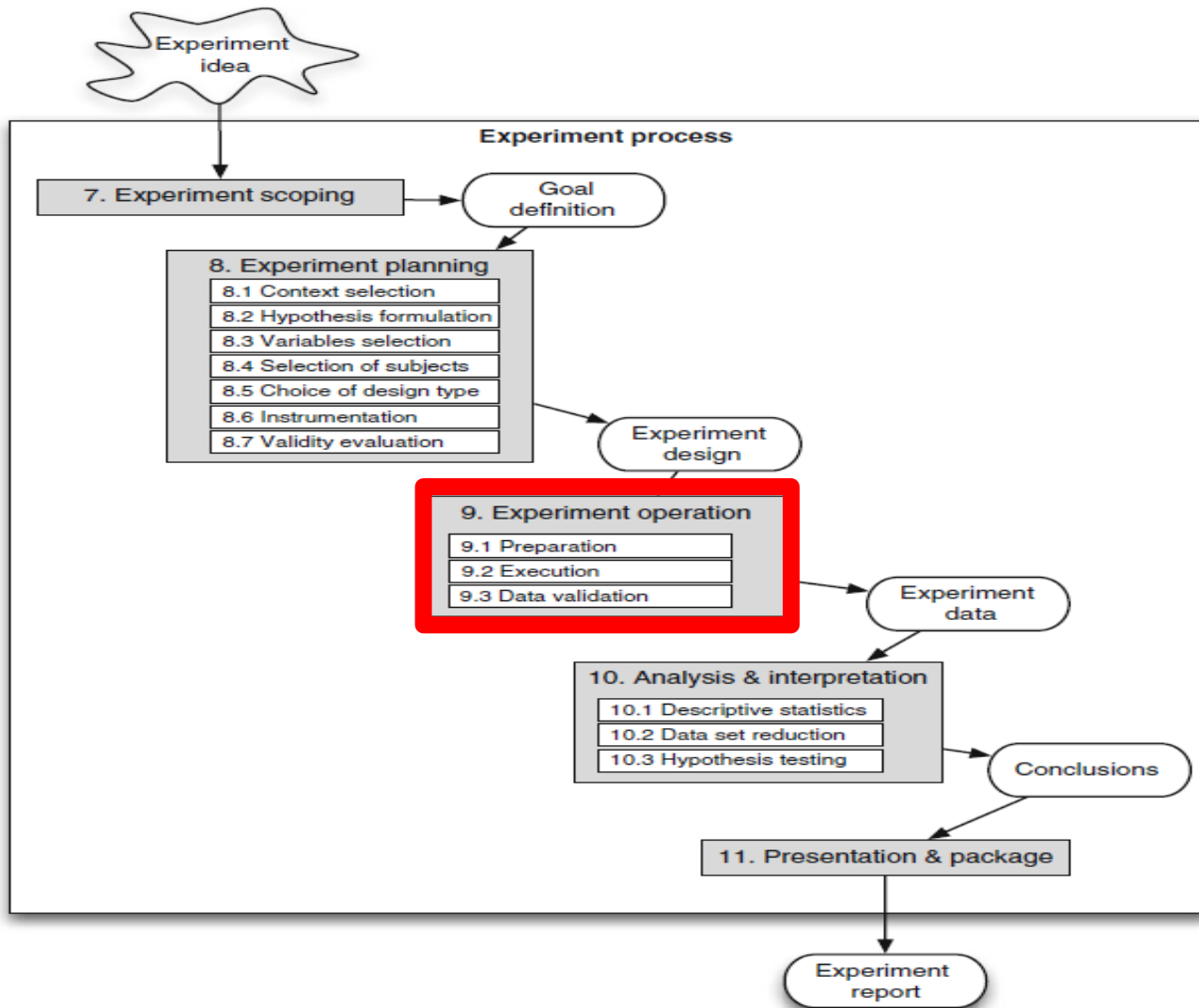
Experiment Process: Step 3. Operation

Lecture Objectives

- ✓ Preparation
- ✓ Execution
- ✓ Data validation



Experiment Process



Operation

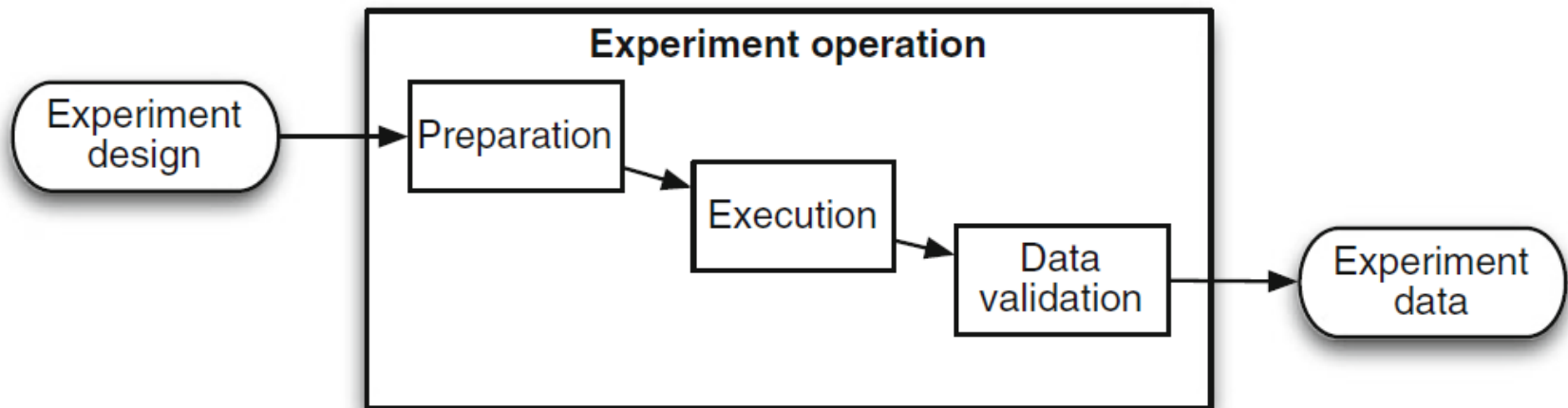


- Operation of an experiment: when an experiment has been designed and planned it must be carried out in order to collect the data that should be analyzed.
 - In the operational phase of an experiment, the treatments are applied to the subjects. This means that this part of the experiment is the part where the experimenter actually meets the subjects.

- Even if an experiment has been perfectly designed, the result will be invalid if the subjects have not participated seriously in the experiment.

Three steps in experiment operation

- **Preparation** where subjects are chosen and forms etc. are prepared
- **Execution** where the subjects perform their tasks according to different treatments and data is collected
- **Data validation** where the collected data is validated.



Preparation



- Before the experiment is executed there are some preparations that have to be made. The better these preparations are performed the easier it will be to execute the experiment.

- There are two important aspects in the preparation.
 - Select and inform participants.
 - Prepare material such as forms and tools.


Commit participants



- It is essential that the people are motivated and willing to participate throughout the whole experiment.
- In many cases it is important to find people who work with tasks in the experiment that are similar to their ordinary work tasks.


Commit participants (*Cont'd*)



- Several ethical aspects have to be considered when people are participating as subjects.
 - Obtain consent
 - The participants have to agree to the research objectives. It is important to describe how the result of the experiment will be used and published. Participants are free to withdraw from the experiment.
 - Sensitive results
 - The results of their participants' personal performance in the experiment will be kept confidential.
 - Inducements
 - One way to attract people to an experiment is to offer some kind of inducement (incentive).
 - Disclosure
 - Disclosure means to reveal all details of the experiment as openly as possible to the experiment subjects.
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Instrumentation concerns



- Before the experiment can be executed, all experiment instruments must be ready.
 - This may include the experiment objects, guidelines for the experiment and measurement forms and tools.
 - If the subjects themselves should collect data, this means in most cases that some kind of forms must be handed out to the participants.
 - One thing to determine when forms are constructed is whether they should be personal, or the participants should fill them out anonymously.
 - This will mean that there is no possibility to contact the participant if something is filled out in an unclear way.
 - If data should be collected in interviews, questions should be prepared before the execution of the experiment.
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Execution



- The experiment can be executed in a number of different ways.
 - Some experiments, such as simple inspection experiments can be carried out at one occasion when all participants are gathered at, for example, a meeting.
 - Result of the data collection can be obtained directly at the meeting and there is no need to contact the participants and later on ask for their respective results.
 - The experimenter is present during the meeting and if questions arise, they can be resolved directly
 - Some experiments are, however, executed during a much longer time span.
 - Impossible for the experimenter to participate in every detail of the experiment and the data collection.

Execution (*Cont'd*)



■ Data collection


- Data can be collected:
 - Manually by the participants that fill out forms
 - Manually supported by tools, in interviews,
 - Automatically by tools.

■ Experimental environment

- If an experiment is performed within a regular development project, the experiment should not affect the project more than necessary.
 - The reason for performing the experiment within the project is to see the effects of different treatments in an environment such as the one in the project.
 - If the project environment is changed too much because of the experiment that effect will be lost.

Data validation




- This deals with aspects such as if the participants have understood the forms and therefore filled them out correctly.
 - Another source of error is that some participants may not have participated in the experiment seriously and some data therefore should be removed before the analysis.
 - It is important to review that the experiment has actually been conducted in the way that was intended.
 - For example, check if the subjects have applied the correct treatments in the correct order.
 - Give a seminar, or in some other way present the results of the data collection.
 - This will give the participants the possibility to reflect on results that they do not agree with.
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Example operation- Preparation



■ Preparation

- In this example, Ph.D. and M.Sc. students are invited as subjects.
 - After having an initial commitment, consent must be ensured from the participants.
 - Assign subjects to treatment using a randomization procedure.
 - If the design includes a blocking factor (type of student), subjects should be split according to that factor, and then randomly assigned to treatments within each blocking group.
 - If a balanced design is chosen, the selection must end up in the same number of subjects for each group.
 - Have a suitable room booked, for example, providing sufficient distance between the subjects.
 - Copies of all documents and forms must be available for all subjects.
 - Given that time is going to be collected, a clock is needed in the room.
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Example operation- Execution



■ Execution

- As it is an inspection experiment, it should be possible to run the experiment once with all subjects doing the inspection at the same time.
 - Support for any questions that may arise during the experiment.
- Depending on whether the data should be collected by filling in forms by hand or by use of a computer, preparation has to be done accordingly.

Example operation- Data validation



■ Data validation

- It may be the case that one or several subjects leave the experiment very early, and their data forms have to be checked carefully to ensure that they have filled in the forms in a reasonable way.
- It must be checked that everybody has understood how to fill in the data in a correct way.
- If this is not the case, it may be the case that data from one or several subjects must be removed.

Recommendations on Experimenting*

- Defining the goals of the experiment
 - Describe the general goals of the experiment: what the experiment aims to investigate and its motivation.
 - Determine whether the experiment in question is an external replication of an existing experiment or a new experiment.
 - Deduce the hypotheses to be investigated from the general goals of the experiment, which should be represented as H_0 and H_1 .
 - Remember that the hypotheses to be tested as a result of the experiments must be quantifiable, that is, there must be a formal procedure for outputting the result of the experiment so as to test the hypothesis in question as objectively as possible.

Recommendations on Experimenting*

- Designing experiments
 - Try to use metrics that are as objective as possible to measure the response variables.
 - Consider the possibility of using blocks to assure that subject variation does not affect the results.
 - Carefully consider the number of internal replications.
 - If too few replications are run, the results of the experiment are meaningless, as the type II error is likely to be high.
 - Consider a possible learning effect.
 - If so, try to assign different subjects to both the alternatives and the experimental units.
 - Be careful with subject get bored by the experiment.
 - Try to keep the conditions, that is, the characteristics of the days, time, etc., under which the experiment is run constant throughout in order to prevent a possible setting effect.
 - Do not forget to assign experimental units to subjects and techniques as randomly as possible.
 - Determine the type of experimental design that is best suited to your particular case (one-factor, factorial, fractional design, etc.).

Recommendations on Experimenting*

■ Running experiments

- Try not to disturb or interrupt the subjects when they are running the experiment.
- Be sure to remind the subjects who are taking part in an experiment that the goal of the experiment is to measure not their performance but the alternatives of the factors under consideration.
- Try not to let the subjects know what the hypothesis to be tested is.
- The fact that subjects drop out of the experiment after it has got under way must be taken into account, as, depending on the factors addressed, this can invalidate the results.
- Make sure that none of the subjects participating in any combination of alternatives of an experiment communicate with each other in the course of the experiment.
- Use protocol analysis to be sure about the process enacted by the subjects while running the experiment

Recommendations on Experimenting*



- Analyzing data
 - Try to use a statistically powerful test.
 - Carefully validate the assumptions of the different tests.
 - Take care when extrapolating the results of your experiment to industrial practice.
 - One point must be considered is regarding the relationships of causality investigated by the experiment.

Summary

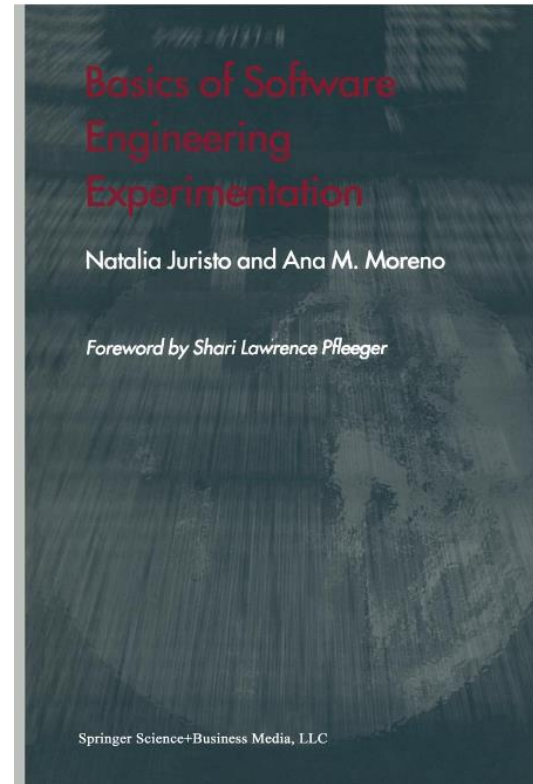


- Experiment execution goes through 3 phases:
 - Preparation
 - Execution
 - Data validation

Reference



Chapter 9



Chapter 16