

Experimentation

What an experiment can prove

No amount of experimentation can ever prove me right; a single experiment can prove me wrong.

Albert Einstein

Letter to Max Born, December 4, 1926

Truth vs. Certainty

Noi non possiamo mai avere la certezza di essere nella verità, ma solo nell'errore.

Karl Popper

Software Engineering Experimentation

Concepts

Credits

Experimentation in Software Engineering: An Introduction.

by Claes Wohlin, Per Runeson, Martin Host, Magnus C. Ohlsson, Bjorn Regnell, and Anders Wesslén

Springer-Verlag, 2005 (Formerly printed by Kluwer Academic Press, 2000).

Main objective of experimentation

The main objective of experimentation is to *evaluate quantitatively* a hypothesis or a relationship.

Introduction to experimentation

There are changes.

There are entities that are subject to change.

Why?

What does cause those changes?

Hypotheses → Test

Testing is usually made by using Statistical methods
(see [Basic Principia](#)).

Introduction to experimentation

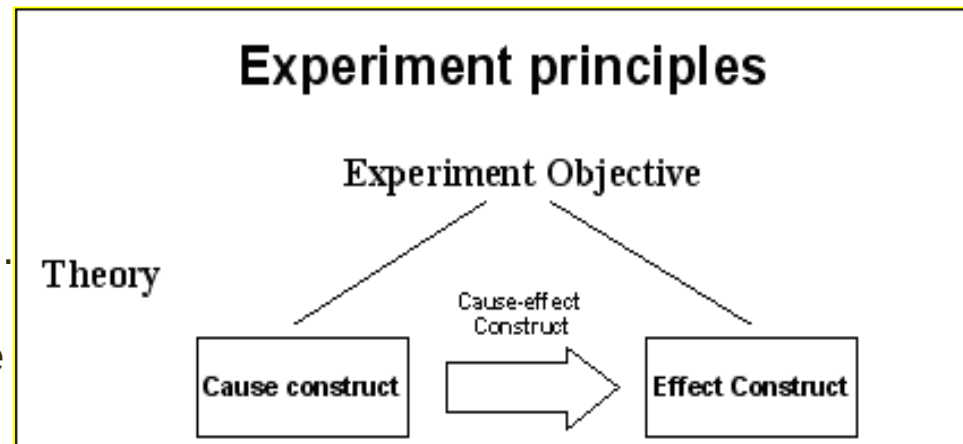
During the experiment process, the researchers usually pass into two main levels, the theoretical level and the observational level.

Theoretical Level

Cause Construct: it is to define the entities that could cause the change that we aim to investigate; we start thinking and expecting causes of the change and reasons behind them.

Effect construct: is to define entities that are affected by changes in the cause.

Cause-effect construct: includes the ability to define a reasonable relationship between the cause construct and the effect construct, including definition of what are the appropriate conditions that we should provide in order to realize such a change.



Introduction to experimentation

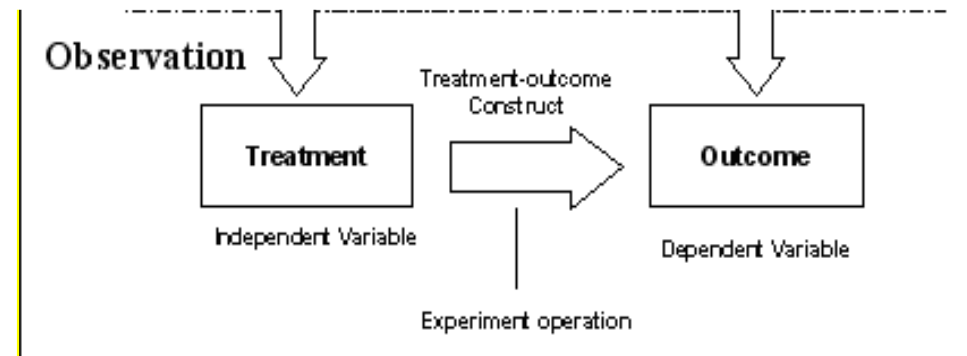
During the experiment process the researchers usually pass into two main levels, the theoretical level and the observational level.

Observational Level

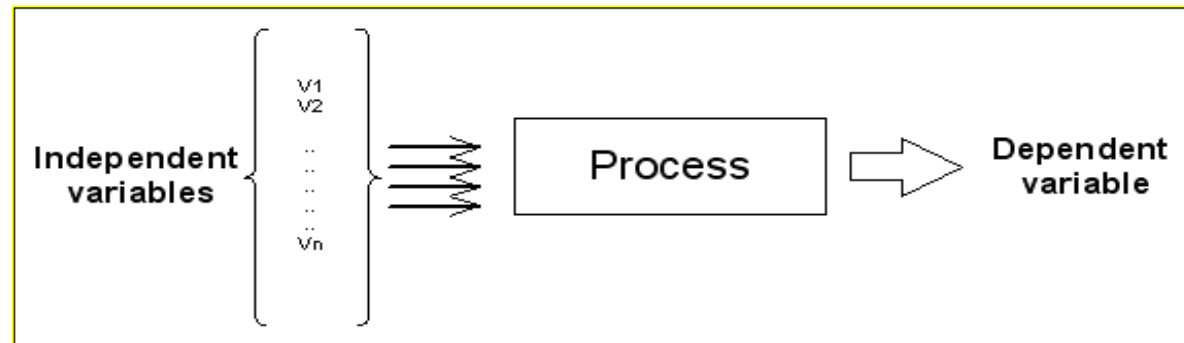
Treatment: is any of the (fix | random) values that the experimenter uses as an instance of the Cause construct. Here we use fix values that the experimenter selects.

Outcome: any of the entities that are affected by changes in the cause. In the experimenter view, an outcome is the instance with parameter Treatment of the effect construct.

Treatment-Outcome Construct: is to verify that changes in the outcomes result just and significantly from changes in the treatments.



Experiment Variables



Some kinds of variables are involved with an experiment process.

Response and Dependent Variables

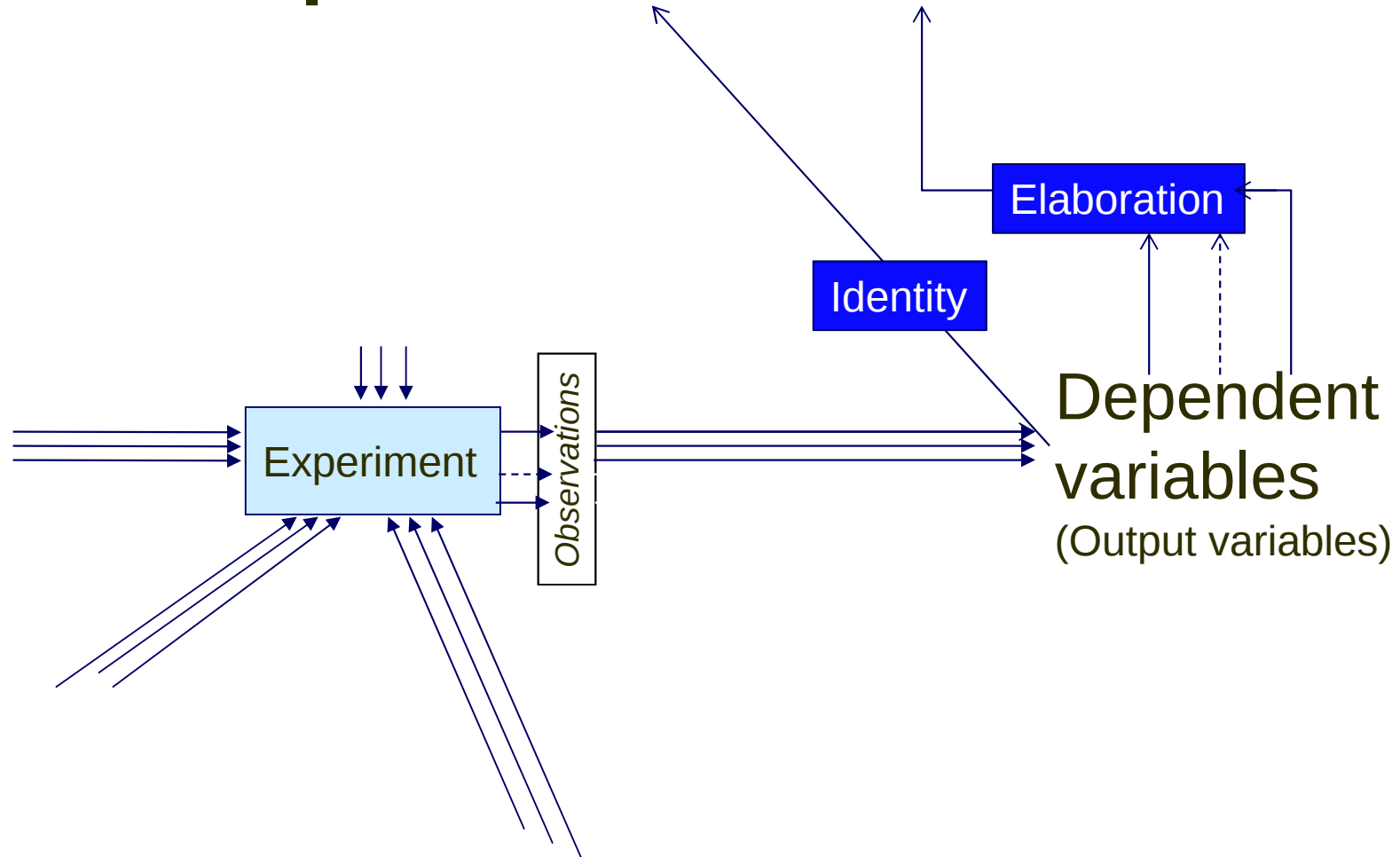
The **Response variables** of an experiment are the characteristics we want to investigate. They derive from the *experiment goals*.

A **Dependent variable** is an output variable of the experiment process.

If a Response variable is *directly measurable*, it is a Dependent variable. Otherwise we use simple Dependent variables to obtain *compound* [“indirect”] Response variables.

Usually we utilize the mean and/or standard deviation of each characteristic we want to investigate.

Response Variables

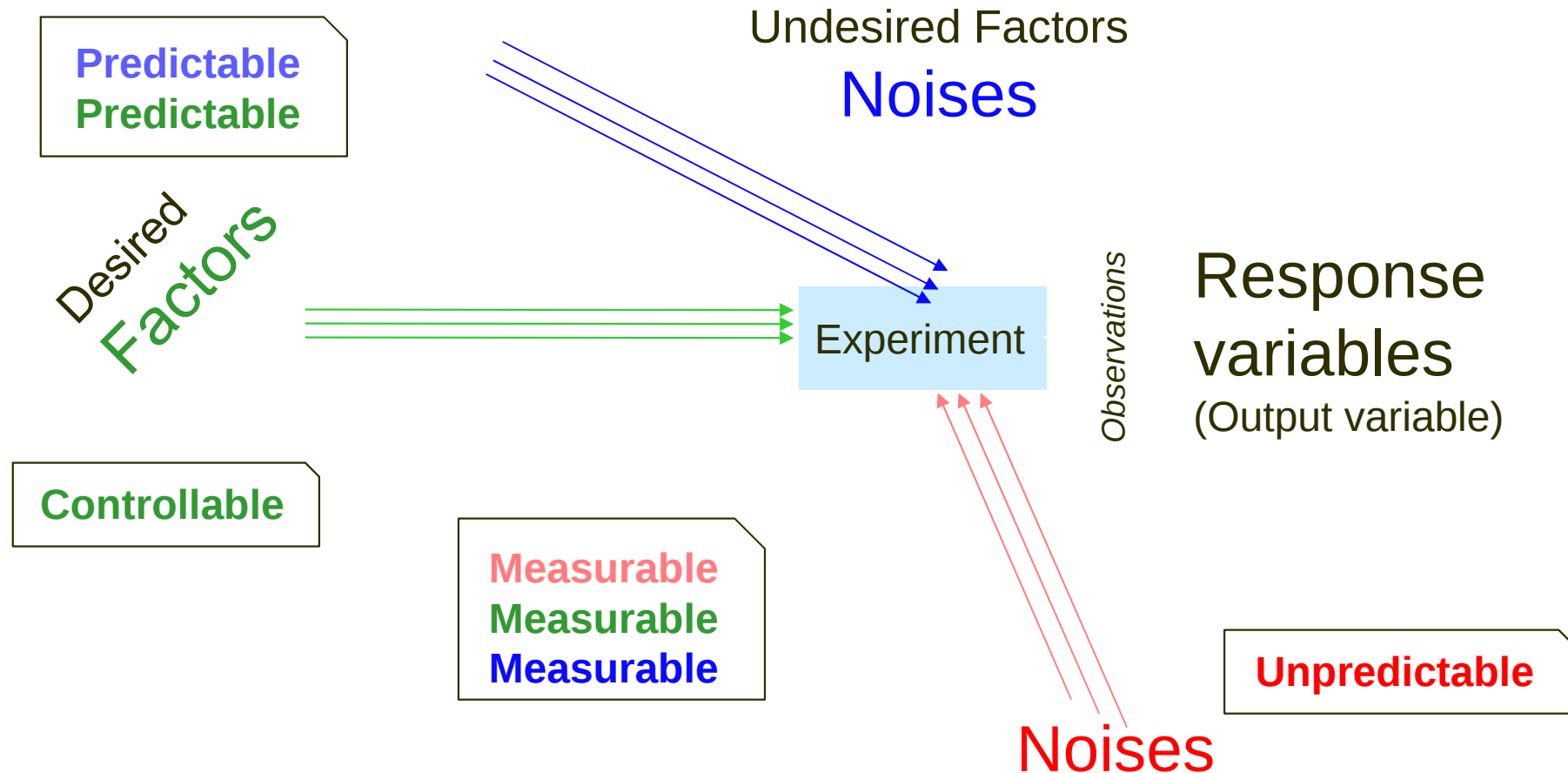


Input Variables

Input variables are Independent variables, which affect output.

They can be classified as **Factors** (or Alternatives), and Noises (including Undesired variables factors).

Independent Variables



/* Noises are measurable uninteresting input variables that cannot be controlled and may or may not change during the experiment */

Factors and Noises

There are:

❑ Variations that we are *able to predict*:

- **Factors** that we can allow change, so having desired variations; anyway, we are able to control them.
- **Noise** (Undesired Variable Factors), i.e., undesired variations that we predict but could not keep in complete control, and handle as Blocking Variables.
 - Instances of the latter are the Level of expertise (LOW, HIGH) and the Gender of student subjects participating to an experiment where those variables are not of interest.

❑ **Noise** that we are *unable to predict* (and cannot control).

Factors

Beside the **Undesired Variable Factors**, as already mentioned, further **Factors** are variables which effects on output and we are able to control.

They include:

- **Parameters** (or **Constant Factors**); we are not intended to investigate the effect of these input variables on output; we set each of them to some value and control them at that *constant level*.
- **Design Factors** (or **Factors** simply), i.e. those Input variables, which effects on output we want to investigate. We call **Treatment** each of the values we select for these variables.

Independent Variables

Measurable
Measurable
Measurable
Measurable
Measurable

Factors
Factors

Constant Factors
(or Parameters)

// They are input variables that can be controlled
// They are controlled at constant level

Design Factors

/* They are input variables and the experimenter wants to assign each of them some different values*/

Controllable
Controllable

Noises: to Block

/* They are undesired input variables that we can predict and measure

Predictable
Predictable
Predictable

Experiment

Observations

Dependent
variables
(Output variable)

Unpredictable

Noises

Searching for Relationships among Variables

- Descriptive relationship
- Correlations
- Causal relationship
 - Deterministic relationship
 - Statistic relationship