Theory Validation

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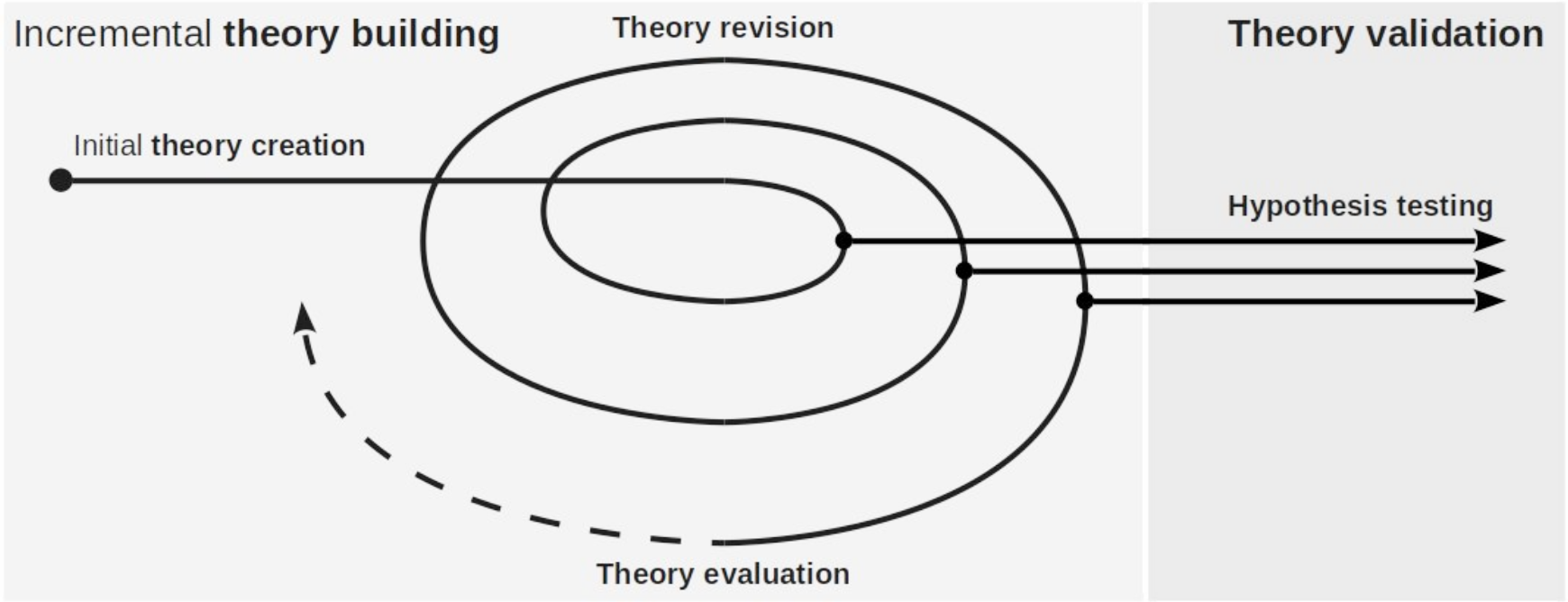
Agenda

1. Theory validation
2. Validation strategy
3. Construct design
4. Research hypotheses
5. Example methods
6. Quality assurance

1. Theory Validation

The Process of Science (Recap)



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Theory Validation

Theory validation is

- The testing of a theory to confirm or punch holes into it

Theory validation should follow a strategy

- The primitives of theory validation are hypothesis tests

Purpose of Theory Validation

The purpose of theory validation is to

- Discriminately and adversarially test a theory
- To identify weaknesses and holes
- In a cost-efficient way

The Theory Validation Process

The **theory validation research process**

- Incremental (one hypothesis at a time)
- Is never finished

The **hypothesis testing process**

- Is often a one-shot process

What Can Be Learned?

Validation(ism) (verificationism)

- The belief that you can proof (“validate”) a theory
- Closely aligned with classic positivist stance

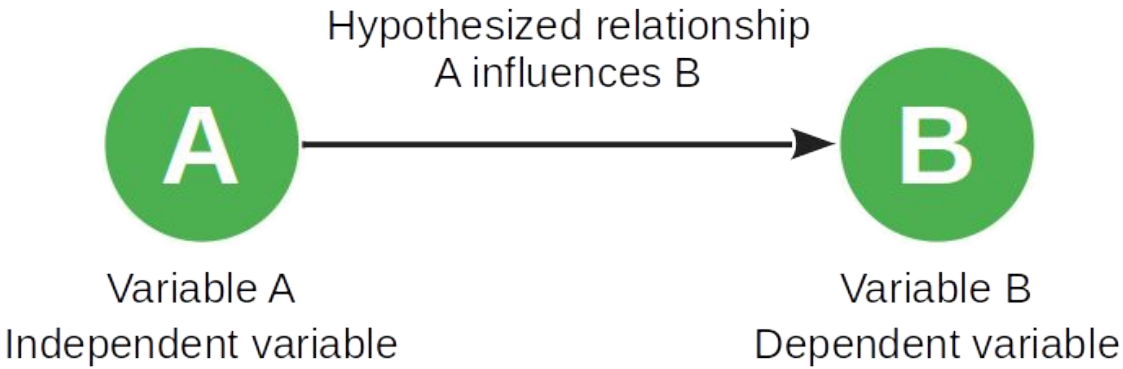
Falsification(ism)

- The belief that you can't proof a theory correct
- But that you should keep it around until it got falsified

Falsification dominates, yet a falsification may be incorrect

2. Validation Strategy

The Minimal Theory (Recap)



The Minimal Validation Strategy

Theory

Hypotheses and measurements

#	A	B
1	…	…
2	…	…
3	…	…
4	…	…
5	…	…

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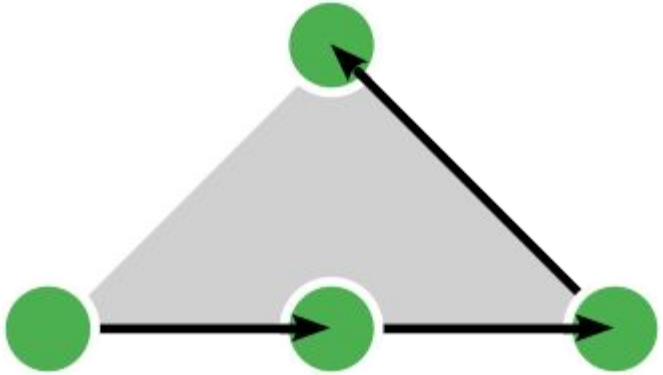
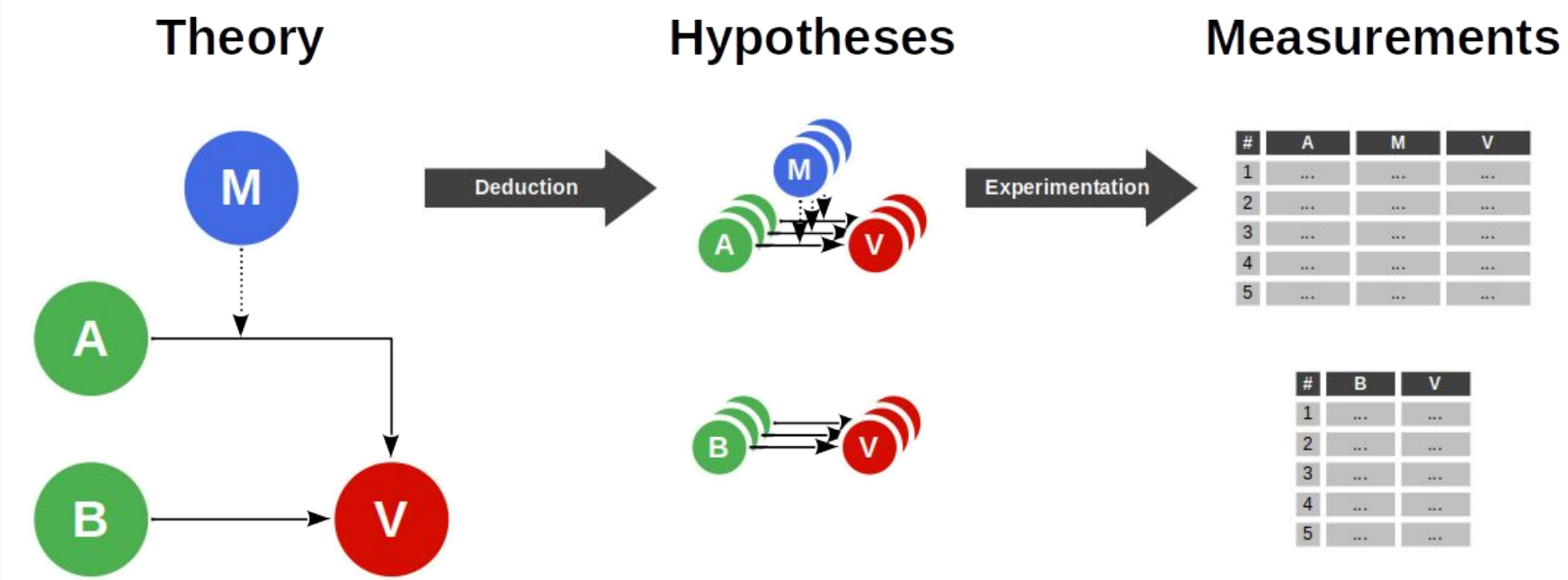
Hypothesis Generation

Hypothesis generation = theory instantiation = deductive reasoning



Triangulation in Theory Validation



Theory Validation vs. Application

Use (application) of a theory is a form of hypothesis generation

In **theory validation,** we

- Adversarially seek out boundary cases to test the theory

In **theory application,** we

- Make sure we stay within the sweet spot to build something of use

Pushing application to the edge of theory is usually not a good idea [1]

[1] Cf. the Gallopping Gertie

Quantitative Research Methods

A **quantitative research method**

- Gathers quantitative data
- Using sampling methods that allow for statistical generalization
- To run a hypothesis test

3. Construct Design

Variables and Constructs

A **variable** is a

- Directly observable one-dimensional phenomenon

A **physical variable** is a variable that

- Reflects a physical reality

A **construct** is a

- Not-directly-observable “latent” phenomenon

Constructs can be multi-dimensional

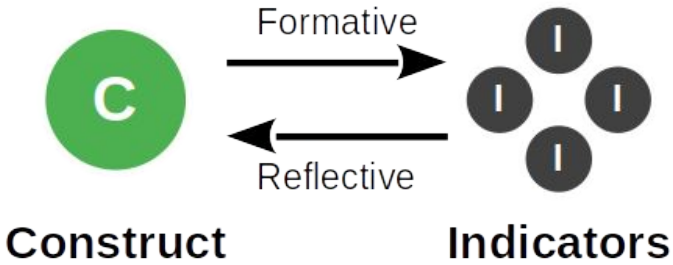
Reflective vs. Formative Constructs [1]

A **reflective construct** is a construct that

- Can be assessed (measured) through appropriate indicators
- Reflects some underlying reality

A **formative construct** is a construct that

- Is defined by its measurements
- Is entirely created by humans



[1] See Petter et al. (2007): Specifying formative constructs.

Constructs and Indicators

Construct	Indicator 1	Indicator 2	Indicator 3
Temperature	Brownian motion		
Exam stress level	Heart rate	Amount of sweat	
Usability of a website	Clarity	Relevance	Accessibility
Ability to write bug-free code	Number of bugs by difficulty per unit of time		
Intention to share access	Open mindedness	Collaborativeness	Goal orientation

Construct Operationalization

Intrinsic definition (reflective constructs)

- The definition is based the construct's assumed intrinsic properties
- Then, there can be different ways of measuring the construct

Extrinsic definition (formative constructs)

- The construct's operationalization is its definition
- Then, there is is exactly one way of measuring the construct

Construct Validity

Construct validity is

- The extent to which an operationalization matches the construct's definition

Questions to ask

- Are any individual indicators measured correctly?
- Are the indicators correctly aggregated?
- Is the construct domain fully covered?

Measurement Instruments

Physical variables

- Corresponding **physical devices** e.g. a thermometer

Atomic constructs

- Human-made instruments e.g. **item (question) blocks**

Composite constructs

- Composites of measurement instruments

Development of Measurement Instruments

Measurement instruments need to be

- Invented
- Standardized, and
- Consistently calibrated

The correspondence of indicators and constructs is its own hypothesis

So is that a measurement instrument correctly reflects this correspondence

4. Research Hypotheses

Research Hypothesis (Recap)

A **research question** is

- The question of interest to be answered by research

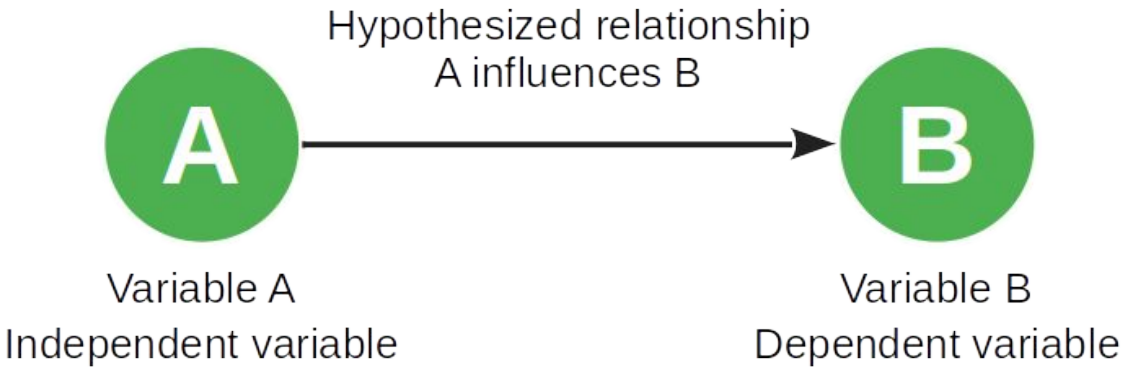
A **research hypothesis** is

- A research question that can only be answered with yes or no, true or false

Research questions should answerable and non-trivial

- The answer can be big (a whole theory) or small (yes/no)

Hypothesis Testing (Recap)



Correlation and Causation

Variable A **correlates** with variable B if

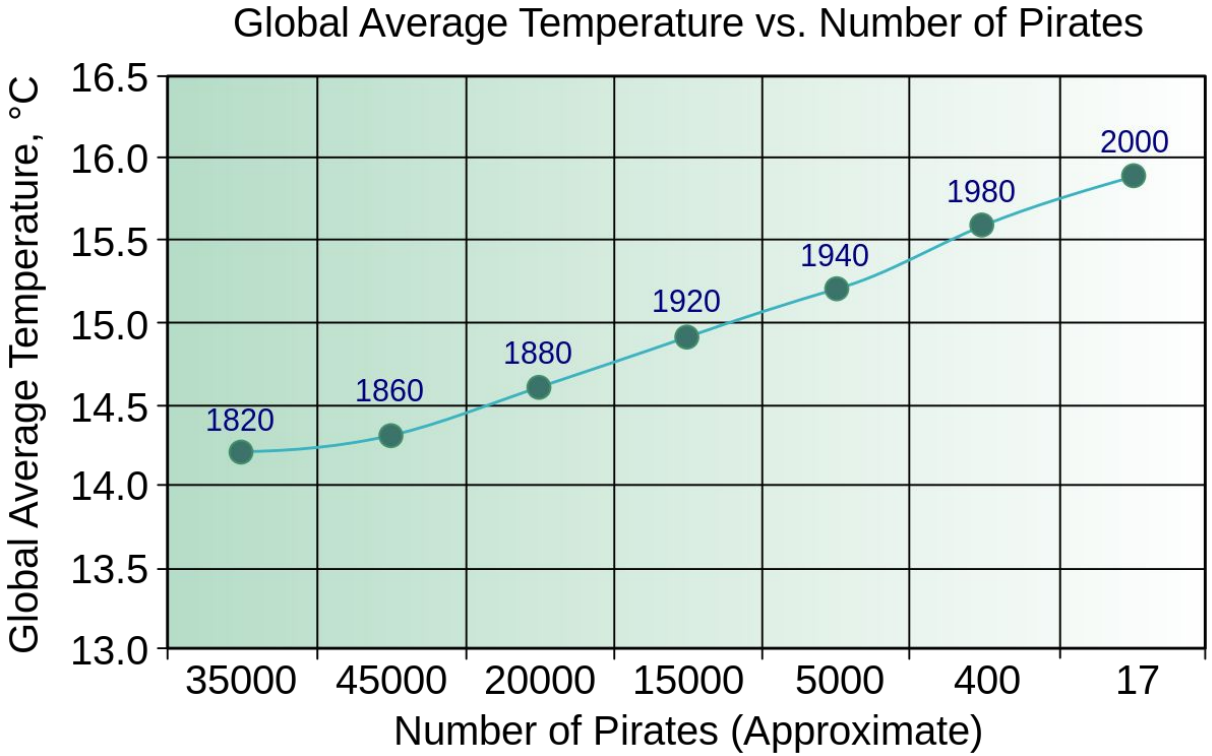
- Changes to variable A correspond to defined changes in variable B

Variable A **causes** variable B to change if

- Changes to variable A cause defined changes in variable B

Correlation can be measured, causation needs to be established

Causation vs. Correlation [1]



[1] See https://commons.wikimedia.org/wiki/File:PiratesVsTemp(en).svg

5. Example Methods

Quantitative Research Methods

Common quantitative research methods

- Hypothesis-testing surveys
- Controlled experiments

But many other forms of experiments

Hypothesis-Testing Surveys

A **hypothesis-testing survey** is

- A collection of hypothesis tests
- Typically with a large sample size
- Using item blocks as instruments
- Usually presented as a questionnaire

There are other types of surveys, most notably, **descriptive surveys**

- These are not useful for theory validation
- They may be useful in theory building

Item Blocks in Hypothesis-Testing Surveys

An item block is

- A measurement instrument of a construct

It typically takes the form of set of questions that

- Triangulate a measure for the underlying construct

Example item block for personal innovativeness [1]

1. If I heard about a new technology, I would look for ways to experiment with it
2. Among my peers, I'm usually the first to try out new technologies
3. In general, I am hesitant to try out new technologies
4. I like to experiment with new technologies

[1] See Agarwal & Prasad (1998): Personal innovativeness.

Controlled Experiments

A **controlled experiment** is

- A collection of hypothesis tests where
  - A treatment is applied to the independent variable to
  - Measure the effect on the assumed dependent variable
- In a tightly controlled environment to isolate the variables of interest

Recipients are typically split into a

- Treatment group (which receives the treatment) and a
- Control group (which does not)

Controlled Random Trials

Controlled experiments = controlled random trials (in medicine)

Other Types of Experiments

- Field experiments
- Natural experiments
- Quasi-experiments
- …

Hypothesis-Testing Survey vs. Controlled Experiment

	Hypothesis-Testing Survey	Controlled Experiment
Sample size	(Usually) large	(Comparatively) small
Dealing with variation	Through large sample size	Through sample size By controlling the environment
Data collection	Questionnaire	Observation

6. Quality Assurance

Quality Criteria for Research Methods (Recap)

Intuition	Qualitative research	Quantitative research
Truth value	Credibility	**Internal validity**
Applicability	Transferability	**External validity**
Consistency	Dependability	**Reliability**
Neutrality	Confirmability	**Objectivity**

Traditional Empirical Criteria

Internal validity is the extent to which the study result

- Shows a cause and effect relationship

External validity is the extent to which the study result

- Can be generalized beyond the study

Reliability is the extent to which the study result

- Can be repeated under the same conditions

Objectivity is the extent to which the study result

- Can be repeated by other researchers

Summary

1. Theory validation
2. Validation strategy
3. Construct design
4. Research hypotheses
5. Example methods
6. Quality assurance

Thank you! Any questions?

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In-, De-, and Reduction

Induction is the

- Act of inserting ducks into science

Deduction is the

- Act of removing ducks from science

Reduction is the

- Act of replacing worn out ducks in science