

Theory Validation

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NYT C09

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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

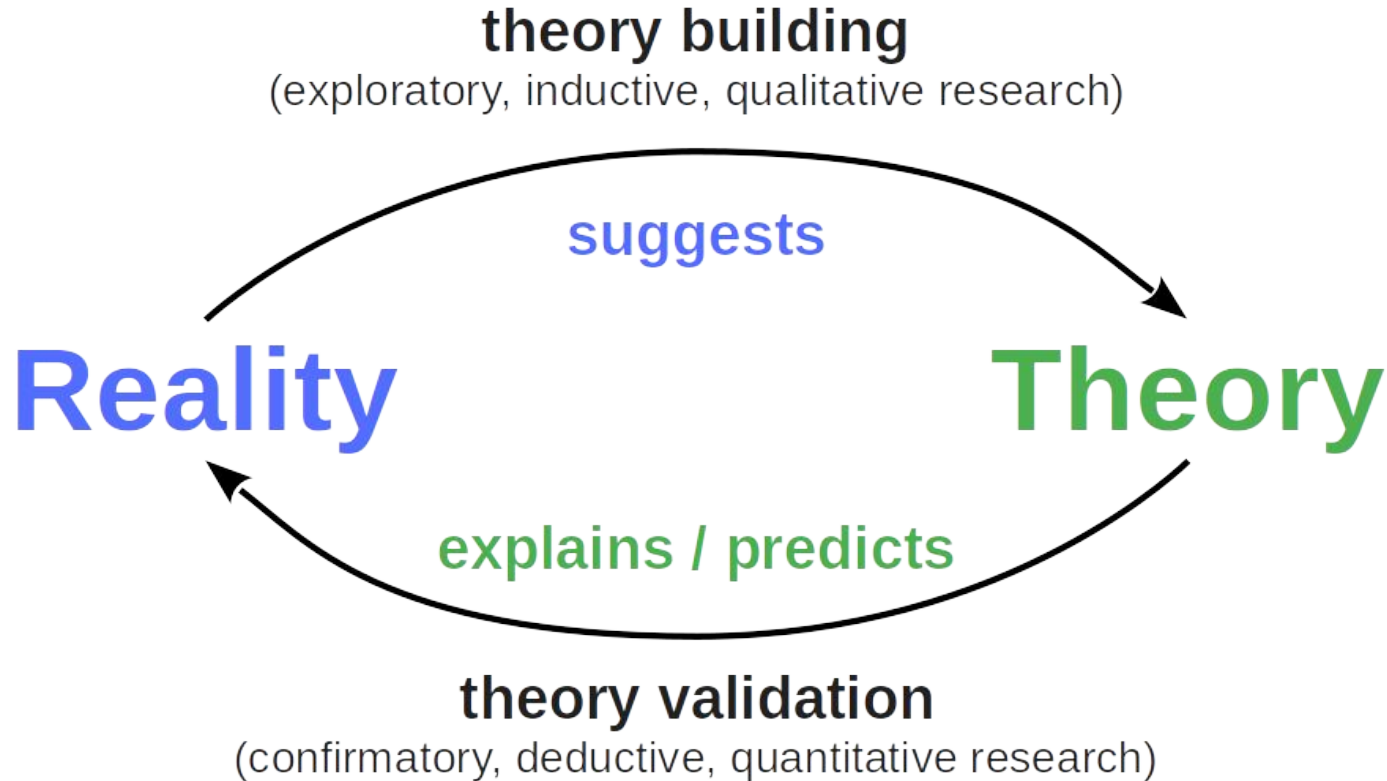
- Act of replacing worn out ducks in science

Agenda

1. Theory validation
2. Research hypotheses
3. Example methods
4. Hypothesis testing
5. Quality assurance

1. Theory Validation

The Process of Science (Recap)



Purpose of Theory Validation

The purpose of scientific theory validation is to

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

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

Theory Validation Research

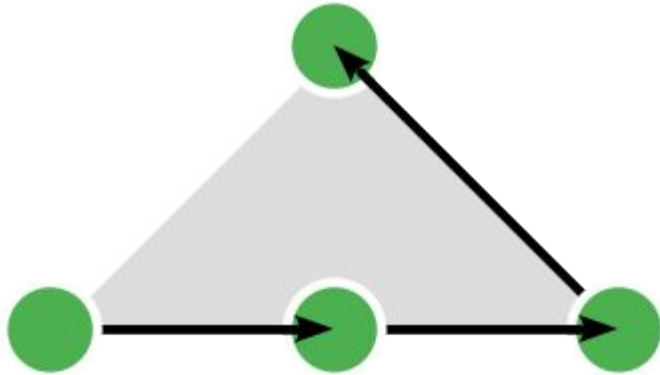
Theory validation research is

- Confirmatory
- Deductive
- Quantitative

Deductive Reasoning

Deductive research is based on **deductive reasoning** (in research) which is

- Generating hypotheses from theory for purposes of testing these



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

Quantitative Research Methods

A quantitative research method

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

What Makes a Research Design a Quantitative Design?

The **theory validation** purpose

The use of **random sampling** in data collection

The acquisition and use of **quantitative data**

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

2. Research Hypotheses

Hypotheses (Expanded)

A **research hypothesis** (recap) is a

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

This binary nature is often turned into a quantified relationship

- Variable A (the independent variable) influences the variable B (the dependent variable)

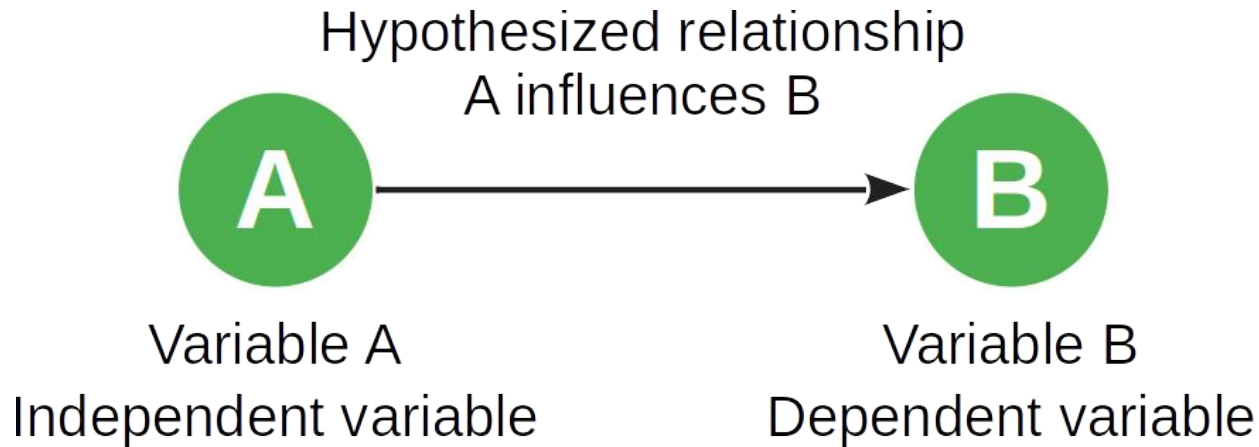
An **independent variable** is a

- Variable taken as input, possibly purposeful varied as part of the test

A **dependent variable** is a

- Variable that is measured in response to changes in the independent variable

Hypothesis Testing



Theoretical Constructs

A **construct** is a

- Human-made phenomenon

A **theoretical construct** is a

- Non-tangible construct

A measurable construct is a variable

Example Theoretical Constructs

- Usability of a website
- Ability to write error-free code
- Willingness to share information

Correlation and Causation

Variable A **correlates** with variable B if

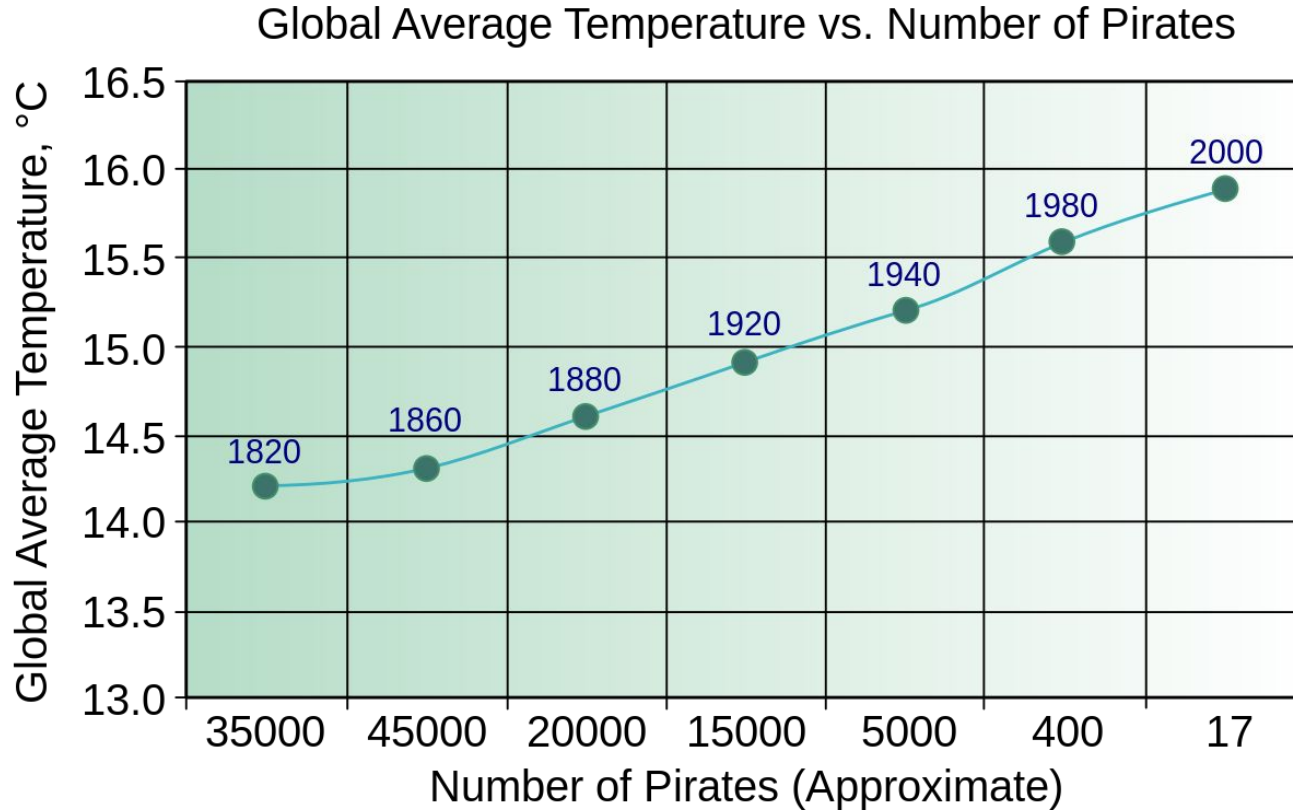
- Changes to variable A correspond to defined changes in variable B

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]



3. Example Methods

Common Quantitative Research Methods

Common quantitative research methods

- Hypothesis-testing surveys
- Controlled experiments

Noteworthy, but ...

- Confirmatory case studies
- Post-facto analyses

Hypothesis-Testing Surveys

A **hypothesis-testing survey** is a

- Quantitative investigation of one or more phenomena to test one or more hypotheses
- Usually performed using a questionnaire on a large representative population
- Having them answer in their natural (uncontrolled) environment

There are other types of surveys, e.g. **descriptive surveys**, which

- May suggest interesting insights, are useful in theory building

Hypothesis-Testing Survey Research Process

1. Define goals
 - a. Identify constructs
 - b. Define hypotheses
2. Design survey
 - a. Identify or develop instruments
 - b. Design questionnaire
3. Determine sample
 - a. Define or identify population
 - b. Choose sampling strategy
 - c. Sample from population
4. Beta-test survey
5. Execute survey
6. Evaluate results

Controlled Experiments

A **controlled experiment** is a

- Quantitative investigation one or more phenomena to test one or more hypotheses
- Usually performed by providing treatments to small samples
- In a tightly controlled environment

There are other types of experiments, e.g. **quasi experiments**, which

- May suggest interesting insights, are useful in theory building

Controlled Experiments Research Process

1. Define goals
 - a. Identify constructs
 - b. Define hypotheses
2. Design experiment
 - a. Identify variables
 - b. Design treatments
3. Determine treatment groups
 - a. Define or identify population
 - b. Perform random sampling
 - c. Assign to treatment groups
4. Perform experiment
 - a. Perform treatments
 - b. Measure variables
5. Evaluate results

Hypothesis-Testing Survey vs. Controlled Experiment

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

4. Hypothesis Testing

Construct Operationalization

Two approaches to defining a construct

1. Intrinsic definition

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

2. Extrinsic definition

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

Two discussion examples

1. Economic value of a public company
2. Societal value of a non-profit organization

Measurement Instruments

A measurement instrument

- Measures a (theoretical) construct / variable

Examples for tangible constructs

- **Clock** for measuring **speed**
- **Thermometer** for measuring **heat**
- **Particle** counter for measuring **pollution**

Examples for non-tangible (theoretical) constructs

- **Checker / linter** for measuring **source code quality**
- **Question set** for measuring **intention to share knowledge**
- **Market capitalization** for measuring a **company's economic value**

Construct Validity

Construct validity is the extent to which a

- A construct's operationalization matches the construct's intrinsic definition

Easy if the operationalization defines the construct

Sampling Model (Recap)

A sampling model

- Is a model of the population designed to sample from
- Focuses on the **variables** of relevance to the research question

Sampling

The primary sampling strategy in testing hypotheses is random sampling

Random sampling is a

- Sampling strategy in which elements of the population are chosen randomly

Stratified random sampling is a

- Sampling strategy, in which the population is split into strata before random sampling

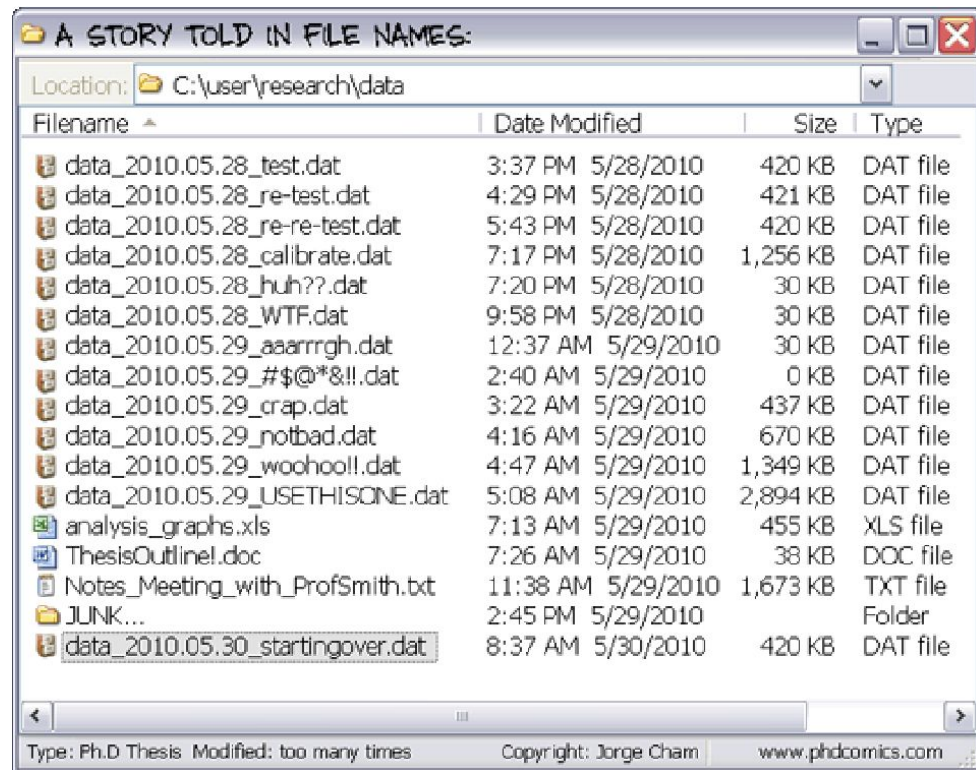
Random sampling is the strategy of choice

- To avoid researcher and other biases

Convenience Sampling [1]



Fishing for results [1]



5. 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

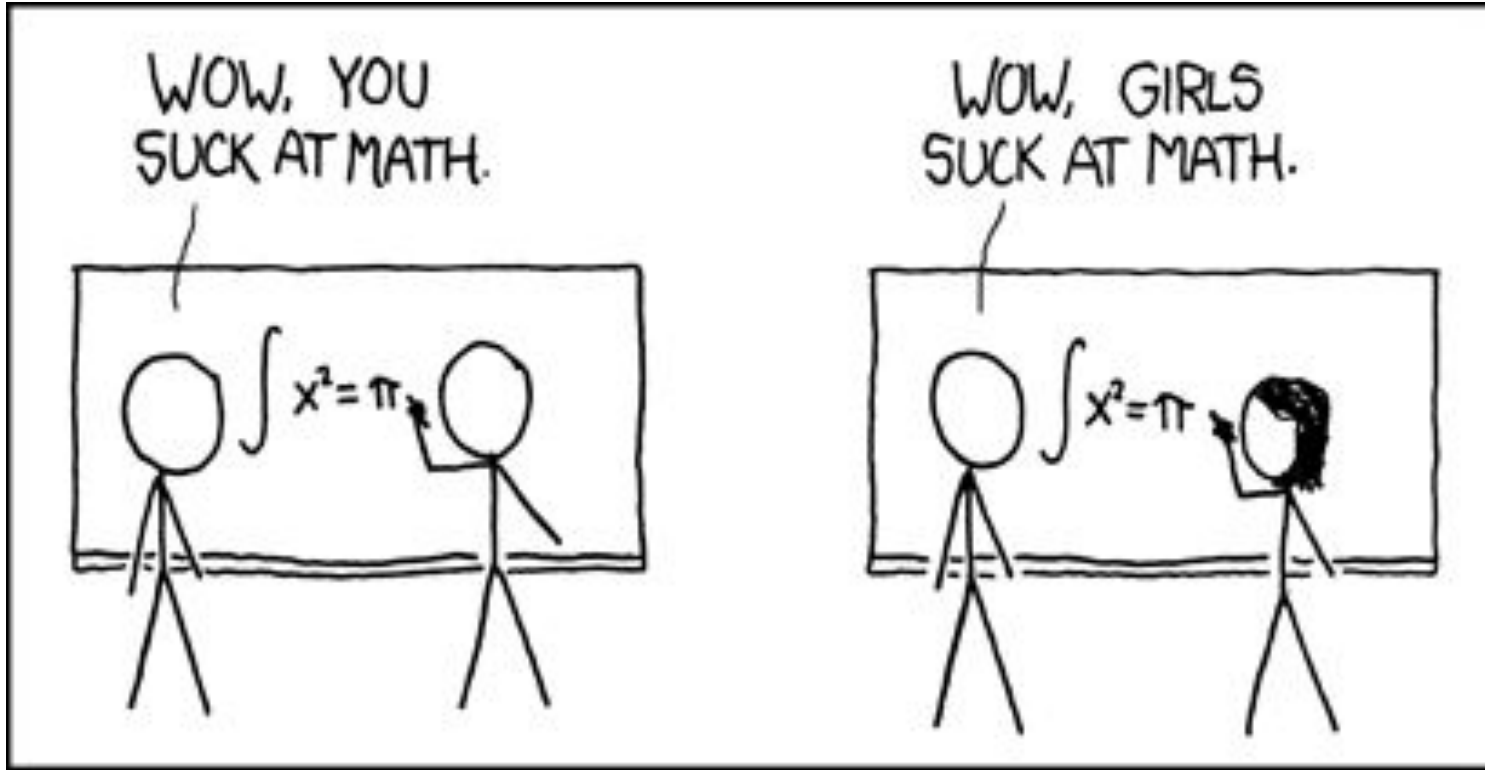
Reliability is the extent to which the study result

- Can be repeated under the same conditions

Objectivity is the extent to which the study result

- Can be repeated by other researchers

Inappropriate Generalization [1]



Summary

1. Theory validation
2. Research hypotheses
3. Example methods
4. Hypothesis testing
5. Quality assurance

Thank you! Any questions?

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