Research methods

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Categories of research

There are different ways to classify research:

- by type
- by objective
- by form
- by reasoning

- **Primary research**: collection of data that does not yet exist
- **Secondary research**: summary, collation and/or synthesis of existing research

Primary research is known as **field research**

- it involves the collection of data that does not already exist (research to collect original data)
- it is often undertaken after the researcher has gained some insight into the issue by collecting secondary data
- the most adopted types of collection of data are questionnaires, direct observations, interviews (research subjects or experiments)

Secondary research is known as **desk research**

- it involves the summary, collation and/or synthesis of existing research
- the most adopted methodology is the systematic review (often using meta-analytic statistical techniques)
- it can come from internal or external sources

The proliferation of web search engines has increased opportunities to conduct desk research

Categories of research - by objective

- **Qualitative research**: understanding of human behaviour and the reasons that govern it
- **Quantitative research**: systematic empirical investigation of quantitative properties and phenomena along with their relationships
- **Mixed methods research**: uses a combination of quantitative and qualitative methods for data collection/analysis

The qualitative methods:

- investigate the **why and how of decision making**, not merely what, where, when
- usually require **smaller but focused samples**
- produce information only on the **particular cases studied**

The qualitative methods:

- help form informative guesses (**are only hypotheses**) and not draw **general conclusions**
- they can be used to **verify** which of such **hypotheses** are true
- help flesh out the story and **develop a deeper understanding of a topic**

Examples of qualitative research include:

- **participant observation**
- **in-depth interviews**
- **focus groups**

The quantitative methods:

- refer to the **systematic empirical investigation of quantitative properties**, phenomena and their relationships
- are aimed at **developing/employing mathematical models, theories and/or hypotheses** pertaining to phenomena

The quantitative methods:

- adopt the process of measurement because it provides the **fundamental connection between empirical observation and mathematical expression of quantitative relationships**
- involve information or data in the form of **numbers**

The quantitative methods:

- allows the **measurement or quantification** of things
- **respondents do not necessarily give numbers as answers** but answers are analysed as numbers

Examples of quantitative research include:

- **surveys**
- **lab experiments**
- **formal methods & mathematical modelling**

Categories of research - by objective - qualitative vs quantitative

	qualitative	**quantitative**
general framework	explore phenomena	confirm hypotheses about phenomena
analytical objectives	to describe (subjective)	to quantify (objective)
question format	open-ended (unstructured)	close-ended (structured)
data format	textual/verbal	numerical
study design	flexible	stable

Mixed research methods:

- use a **combination of quantitative & qualitative methods** for data collection/analysis
- **capitalise on the strengths** of each approach and **offsets their different weaknesses**
- provide a **more comprehensive answer to research questions**, going beyond the limitations of a single approach

- **sequential explanatory design**: data collection/analysis is firstly *quantitative* and then*qualitative* (2 phases)
- **sequential exploratory design**: data collection/analysis is firstly *qualitative* and then *quantitative* (2 phases)
  Findings: integrated during the interpretation.
- **concurrent triangulation design**: *quantitative* and *qualitative* data collection and analysis are conducted separately yet *concurrently* (1 phase).
  Findings: integrated during the interpretation phase.
- **concurrent nested design**: a predominant data collection method is used (1 phase) and embeds the method with less priority.
  Findings: the data collected from the two methods is mixed during the analysis phase of the project.

Examples of mixed research include:

- survey followed by interview

- survey and parallel observation

- open-ended and close-ended surveys

Categories of research - by form

- **exploratory research**: structuring and identifying new problems
- **constructive research**: developing solutions to an existing problem
- **empirical research**: testing the feasibility of a solution using empirical evidence

Exploratory research:

- it is carried out for a **problem** that has **not been clearly defined**
- it helps determine the **best research design**, **data collection method** and **selection of subjects**
- it should draw definitive **conclusions** only with **extreme caution**

It often concludes that a perceived problem does not actually exist

Constructive research:

- refers to the **new construct** (contribution) being developed (model, SW, framework, theory)
- it demands a form of validation that **does not require a high degree of empirical validation**
- involves, however, the **objective definition and arguing of the conclusions**
- include the **validation of the construct** (eg. via analytical comparison with predefined criteria, benchmark tests)

Often used in computer science research.

Empirical research:

- is a way of **gaining knowledge by direct observation or experience**
- is used to answer **empirical questions**, which must be precisely defined and answered with data
- it involves the definition of **hypothesis and predictions** that can then be tested with a suitable **experiment** (The scientific method)

Core research category in computer science

Categories of research - by reasoning

- **deductive reasoning**: from the general to the specific
- **inductive reasoning**: from the specific to the general

1. **premise** P_1: it's rainy in Dublin
2. **premise** P_2: if it's rainy in Dublin I will be carrying an umbrella
3. **conclusion** C: I will be carrying an umbrella

$$\text{Deductive argument (A): } P_1, P_2 \rightarrow C$$

C strictly follows from P_1, P_2 & the inference ($\rightarrow$).
A is a definitive proof of the truth of the conclusion.
A is deductively valid.

A deductive approach to research is a top-down approach (*waterfall*). From the more general to the more specific:

1. theory
2. hypothesis
3. observation
4. confirmation

A conclusions logically follows from premise (available facts)

1. **premise** P_1: Einstein was german
2. **premise** P_2: Most germans were smart
3. **conclusion** C: Einstein was smart

$$\text{Inductive argument (A): } P_1, P_2 \rightarrow C$$

P_1, P_2 support ($\rightarrow$) C
If the premises are true, there is a reason to believe the conclusion would be true.

However, special cases can arise – the black swan.

An inductive approach to research is a bottom-up approach (*Hill climbing*). From specific observation to broader generalisations of theories:

1. observation
2. pattern
3. tentative hypothesis
4. theory

A conclusion is likely based on the premises and it involves a degree of uncertainty

Categories of research - by reasoning
deductive vs inductive

Top-down (deductive)
       ↓

  1 theory
  2 hypothesis
  3 observation
  4 confirmation

Bottom-up (inductive)

  4 theory
  3 tentative hypothesis
  2 pattern
  1 observation
           ↑

What kind of research are you planning?

type	objective	form	reasoning
- primary	- qualitative	- exploratory	- deductive
- secondary	- quantitative	- constructive	- inductive
	- mixed	- empirical	

*delete as appropriate

Objective: specify which technique.

qualitative: participant observation, in-depth interview, focus group
quantitative: surveys, lab experiments, formal method/math modelling
mixed: sequential or exploratory, concurrent triangulation, concurrent nested

Suggested readings

- John W. Creswel, **Research Design: Qualitative, Quantitative, and Mixed Methods Approaches** (SAGE Publications)
- Johnny Saldana, **The Coding Manual for Qualitative Researchers** (SAGE Publications)
- M. Ling Pan, **Preparing Literature Reviews: Qualitative and Quantitative Approaches** (Pyrczak Publishing)
- Jonathan Lazar, Jinjuan Heidi Feng, Harry Hochheiser, **Research Methods In Human-Computer Interaction** (Wiley)
- Anthony M. Graziano, Michael L. Raulin, **Research Methods: A Process of Inquiry** - 8th Edition- (Pearson)