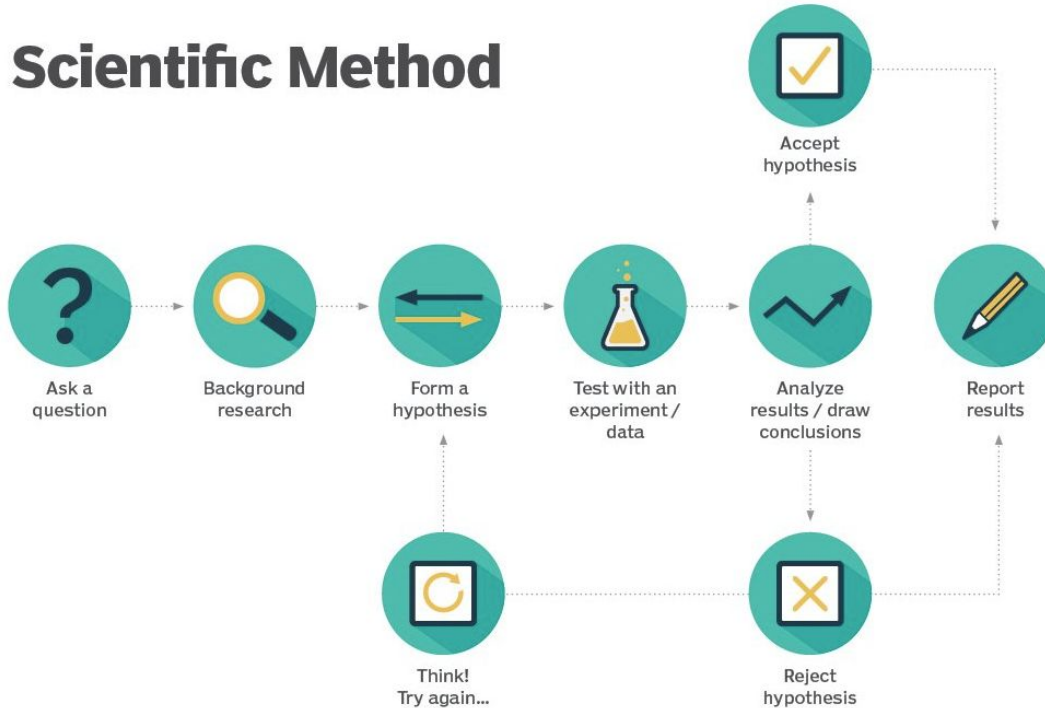


# **IN5140**

**Smart processes and agile methods in  
Software Engineering**

# Scientific Method

## Scientific Method



# Empirical Method

Empiricism vs. rationalism

Rationalism is a school of thought that truth can be determined by starting from simple truths, or axioms, and using logic and reasoning alone to build up to larger truths without needing to verify the truths with reality. A strictly empirical approach is limited to only what can be observed and can only produce results that support, disprove or are neutral to a theory.

Both an empirical and rational approach are needed to produce practical results. A purely rational approach can produce ideas that do not agree with observable reality, while relying on empirical data alone cannot produce new ideas and insights. Making good use of both is the cornerstone of the scientific method.

# Quantitative and Qualitative

Empirical analysis relies on gathering data through quantitative research, qualitative research or a mix of the two.

Quantitative research is related to things that can be quantified or assigned numbers. It deals with things that can be counted or measured. It may also use multiple-choice or closed-ended questions. In quantitative research, if two different people made the same measurements, they would get the same results.

Qualitative research is related to human perception. It deals with likes, dislikes, opinions, thoughts and behavior. It is often gathered in interviews, focus groups or open-ended surveys. Qualitative research can give excellent insight into data, but due to human nature and the difficulty of gathering large amounts of unstructured information, it may not always be reliable.

# Methods for collecting empirical evidence

## Quantitative methods

Experiments

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Surveys

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Polls

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Causal-comparative research

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Correlational research

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Cross-sectional research

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Longitudinal study

## Qualitative methods

Interviews

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Observation

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Textual analysis

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Case studies

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Focus groups (e.g., in market research)

# Empirical methods

- Observation. Initial observations of a phenomena are made. This sparks an idea or a line of inquiry. Initial empirical data and research into existing information can be done.
- Induction. A probable explanation of the observed phenomenon is proposed. Inductive reasoning is used to take the specific example from step one and infer a generalized explanation for it.
- Deduction. A testable hypothesis is proposed that can support the explanation. Deductive reasoning is used to take the generalized explanation and make a specific prediction that can be tested and observed.

# Empirical methods

- Testing. Quantitative and qualitative empirical data are gathered. The data is examined, often with statistical analysis. The results can support, refute or be neutral to the hypothesis. Because of the limits of empirical data and human perception, it is not said that the results prove or disapprove the hypothesis, only that they support or don't support it.
- Evaluation. The reasoning, methodology and findings of the experiment are written down, and the conclusions of the researcher are presented. Information relating to any difficulties, challenges and limits of the test are also included. It may also include further possible avenues of research.

# Example

- **Observation.** I do not sneeze at home, I do sneeze at my sister's home and my sister owns a cat, while I do not have a cat.
- **Induction.** I may be allergic to cats.
- **Deduction.** I hypothesize that, if I go to the pet store and pick up a cat, I will start sneezing.
- **Testing.** I went to the pet store, and when I picked up the cat, I started sneezing.
- **Evaluation.** My trip to the pet store supports the idea that I am allergic to cats. But it was a different type of cat, and it was the same season, So, it may have been hay fever. If I wanted to gather more evidence, I should visit another person with a cat.

# Objective or subjective

- Objective:
  - Based on facts rather than feelings, opinions, prejudices or interpretations [Merriam-Webster].
- Subjective:
  - Related to the way people experience things in their own mind
  - Based on feelings or opinions rather than facts, modified or affected by personal views, experience or background [Merriam-Webster]

# Quantitative or qualitative

- Quantitative:
  - Data expresses quantity
  - Data expressed as numbers
  - Used in statistics
- Qualitative:
  - Data expresses quality in some sense
  - Data expressed as text, images, audio or video but not numbers
  - Not used in statistics

# Nominal, ordinal, interval or ratio scale measurement

- Nominal: Divides the set of objects into categories, with no particular ordering among them. E.g. labeling, classification, defect type.
- Ordinal: Divides the set of entities into categories that are ordered. E.g. ranking, difficulty, failure severity, complexity.
- Interval: Comparing the differences between values is meaningful. E.g. temperature, start and end date of activities.
- Ratio scale: There is a meaningful “zero” value, and ratios between values are meaningful. E.g. Length, weight, lines of code, number of errors.

**Break**

## A causal test of the strength of weak ties



# Mentimeter task

Try to summarise the key takeaways from this paper

<https://www.science.org/doi/10.1126/science.abl4476>

in about 20 minutes and after that they discuss in group

# Group Discussion

What is the hypothesis and what is Conclusion

How did they test the hypothesis

Reflect and discuss the randomized experiment used in this study.

**Thank you for today!**