

... is the systematic collection, analysis, and interpretation of data to answer a certain question.

- **Research**

... is the systematic investigation of scientific theories and hypotheses.

- **Scientific research**

... Discover and disseminate new knowledge

- **Goal of the research**

Objectives of Scientific Research:

- Observe and Describe
- Predict
- Determination of the Causes
- Explain

... Is The first stage of any research

- **Observation**

... develop a strong hypothesis

- **Predict**

... Providing numerical data to prove or disprove the hypothesis

- **Determination of the Causes**

... try to find possible explanations of 'Why?' and 'How?'

- **Explain**

Types of Research:

- Exploratory
- Constructive
- Empirical

... research structures and identifies new problems.

- **Exploratory**

... research develops solutions to an existing well-defined problem Common in Computer science.

- **Constructive**

... research tests the feasibility of a solution using empirical evidence.

- **Empirical**

- Observe → Induce → Deduce → Test → Evaluate

... It is the way in which we conduct research.

- **Research method**

... The study of the research method

- **Research methodology**

... The tools we are using to collect and infer data

- **Research technique**

Research techniques:

- Field study
- Surveys
- Case study
- Secondary research
- Computing and Engineering
- Building a concept and prototyping

Scientific Research process:

- Observe → Pose Questions → Develop Hypothesis → Plan → Assemble Data → Analyze → Document conclusion → Present findings → Pose new question

... clear and testable proposition or predictive statement to answer a research question

- **Hypothesis**

... needed when we have statistical hypothesis testing

- **Null hypothesis**

... Algorithmic study, investigation, and development of computer-related phenomena

- **Computer Science**

Types of data:

- Observational: e.g., surveys
- Derived: From existing data points
- Experimental
- Simulation: Computer algorithm-generated

Research methods:

- Formal: prove facts about algorithms and systems
- Experimental: exploration + evaluation
- Build: a new system, features
- Process: understand computing tasks
- Model and simulate

Qualitative vs. Quantitative research

Qualitative

- ▶ The aim of qualitative analysis is a complete detailed description.
- ▶ The design emerges as the study unfolds
- ▶ Researcher is the data gathering instrument.
- ▶ Data is in the form of words (interviews), pictures (videos), or objects (artifacts).
- ▶ Qualitative data is more rich, time consuming, and less able to be generalized.

Quantitative

- ▶ In quantitative research we classify features, count them, and construct statistical models in an attempt to explain what is observed.
- ▶ All aspects of the study are carefully designed before data is collected.
- ▶ Researcher uses tools (questionnaires or equipment) to collect data.
- ▶ Data is in the form of numbers and statistics.
- ▶ Quantitative data is more efficient, able to test hypotheses, but may miss contextual data.

- A scientific experiment is not complete until the results have been published and understood.

The purpose of scientific writing is to communicate new ...

- **Scientific findings**

Scientific writing must use ... which gives the sense in the fewest short words

- **proper English**

Scientific paper parts:

- Title
- Abstract
- Introduction
- Methods
- Results
- Discussion & Conclusion
- Acknowledgments
- References

... help you to determine if an article is interesting or relevant for your project

- **Title**

... provide you with a complete, but very succinct summary of the paper.

- **Abstract**

... contains brief statements of the purpose, methods, results, and conclusions of a study

- **Abstract**

... often included in article databases, and are usually *free to a large audience*

- **Abstract**

... may be the most widely read portions of scientific papers.

- **Abstract**

... background information and a statement of the author's hypothesis.

- **Introduction**

... describes the theoretical background, indicates why the work is important, states a specific research question, and poses a specific hypothesis to be tested.

- **Introduction**

... help you determine exactly how the authors performed the experiment

- **Method**

... describes both specific techniques and the overall experimental strategy used by the scientists

- **Method**

... contains the data collected during experimentation.

- **Results**

... is the heart of a scientific paper.

- **Results**

... explain the authors interpret their data and how they connect it to other work.

- **Discussion & Conclusion**

... tell you what people or institutions (in addition to the authors) contributed to the work

- **Acknowledgments**

... provides the sources cited throughout the paper.

- **Literature cited (References)**

Short definitions:

- **Title:** Describe concisely the core contents of the paper
- **Abstract:** Summarize the major elements of the paper
- **Introduction:** provide context and rationale for the study
- **Literature review:** surveys scientific articles, books, journals, dissertations & other sources relevant to the research question.
- **Materials:** Describe the experimental design so it is reproducible
- **Methods:** Describe the experimental procedures
- **Results:** Summarize the findings without interpretation
- **Discussion:** Interpret the findings of the study
- **Summary (Conclusion):** Summarize the findings
- **Acknowledgement:** Give credit to those who helped you
- **References:** List all scientific papers, books, and websites that you cite

Sources of Literature:

- **Journal articles:** good for up-to-date information.
- **Books:** tend to be less up to date.
- **Conference proceedings:** useful in providing research that has not been published.
- **Government/corporate reports**
- **Thesis and dissertations:** difficult to obtain, student may not be an experienced researcher
- **Internet:** the fastest-growing source of information, may not be reliable.