



Wrocław
University
of Science
and Technology

Methods of science research

14th ACIIDS 2022 Workshop

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Agenda

Workshop schedule

Biographical note

Workshop objectives

Introduction

Fundamental concepts

Research procedure

Ontology of scientific research

Workshop schedule

14th Asian Conference on Intelligent Information and Database System - Workshop					
	Start	Finish	Duration	Topic	Speaker
December 2nd, 2022 (Friday)	08:30	08:40	00:10	Introduction to the Workshop	<i>Marek Krótkiewicz</i>
	08:40	09:20	00:40	Methods of science research	
	09:20	09:30	00:10	Q&A, discussion	
	09:30	09:40	00:10	break	
	09:40	10:20	00:40	How to write a scientific paper	<i>Marek Krótkiewicz, Krystian Wojtkiewicz</i>
	10:20	10:30	00:10	Q&A, discussion	
	10:30	10:40	00:10	break	
	10:40	11:10	00:30	Research proposal	<i>Krystian Wojtkiewicz</i>
	11:10	11:20	00:10	Q&A, discussion	
	11:20	11:30	00:10	Workshop summarization	<i>Marek Krótkiewicz</i>



Biographical note

Marek Krótkiewicz holds the position of Associate Professor in the **Faculty of Information and Communication Technology (FICT)** of **Wrocław University of Science and Technology (WUST)**. He earned his computer science doctorate in 2001 and a DSc degree (habilitation) in information and communication technology at Wrocław University of Technology in 2020. His main interest is in data meta-modeling, database models, software engineering, knowledge representation, signal processing, and classification. He is an author of over 50 international scientific publications published in journals and at conferences. One of his achievements is integrated, script-based graphic processing software that integrates commonly known algorithms as well as a wide range of his own solutions, previously published in national and international journals. He is also an author of the **Association-Oriented Database** model that **Knowledge Engineering Group** has used in the process of **Semantic Knowledge Base** development. He participated in many scientific and R&D projects. The developed advanced scientific and technical solutions are commercialized within the **Science in Software Ltd.** company established for this purpose, of which he is the president.



Workshop objectives

- Explanation of fundamental concepts used in science.
- An attempt to show the issue of science from a bird's eye view.
- Description how to write a scientific paper.
- Presentation of some important research areas in the context of their impact on science and in the environment of excessively explored issues.



Introduction

Due to limited time, the presentation focuses on the basic concepts and the relationships between them.

A few definitions will be presented at the outset, which will then be discussed.

The ontology of science, which by definition is an *open world*, will also be presented.



Fundamental concepts

Research problem

Research problem

A research problem is a statement that addresses a **gap in knowledge, challenge or contradiction** in field of interest.

- theoretical or applied
- general or generalizable
- determine the direction of **research**
- should consist of:
 - assumption(s)
 - research question(s)
 - hypothesis(s) – *optionally*
 - objective(s)
- **scientific result**:
 - is a solution of **research problem**
 - may generate new **research problems**



Fundamental concepts

Research

Research

Research is **creative** and **systematic** work undertaken to increase the **stock of knowledge**.

- research techniques
- scope
- research procedure
- result
- research methodology
- research problem



Fundamental concepts

Research

Original research

Original research (primary research)

Original research is research that is not exclusively based on a summary, review, or synthesis of earlier publications on the subject of research.



Fundamental concepts

Scientific result

Scientific result

A results outcomes from **research** that fulfills the **research problem objective** and fills the **gap in knowledge** addressed by this **research problem**.

The type of results depends on the research problem and how the research is conducted. Some types of results:

- algorithm, method;
- metamodel, language, (model – *if it is a simplified description of a part of reality from which important, general conclusions regarding the structure or behavior of the research object*);
- theorem, proof;
- discovery.

Important issues:

- **implementation,**
- **evaluation.**



Fundamental concepts

Gap in knowledge

Gap in knowledge

The gap in knowledge may be the **lack of a complete picture** of the study area, both in **structural** and **behavioral** terms. It can also mean the existence of a **contradiction** in the existing description of reality.

Gap in knowledge vs engineering problem

Fundamental concepts

Evaluation of the results

Evaluation of the results

Evaluation is an assessment or judgement made by **comparing** what actually **happened** with what **was intended**. Assessments or judgements made are based on the analysis of information.

- 1 Identification of the **results** being the object of the evaluation.
- 2 Defining evaluation **criteria**.
- 3 Identification of the **values** of the result features significant from the point of view of the adopted criteria.
- 4 Defining the **measure** for evaluating results.
- 5 **Comparison** of evaluation results with other solutions.
- 6 Drawing **conclusions** regarding the scope of usefulness of the developed solution.

Evaluation of the results may proceed by e.g. formal proof, case study, survey, experiment.



Fundamental concepts

Hypothesis

Hypothesis

Hypothesis is a supposition or proposed explanation based on limited evidence as a starting point for further investigation.

Myths functioning in science:

- *"You have to formulate a hypothesis if you start your research."*
 - **No**
- *"The only way to verify the hypothesis is statistical research."*
 - **No**
- *"Hypothesis is a thesis you need to proof."*
 - **No**

Fundamental concepts

Research method

Research method

The research method is a way to achieve the research **objective** that conforms to the **research methodology**.

The research methods:

- development of the theory,
- simulation,
- modeling,
- experiment,
- survey,
- exploration,
- reasoning:
 - synthesis,
 - analysis,
 - inference:
 - induction,
 - deduction,
 - generalization.



Research procedure

- 1 Determine the **research area**
- 2 Identify of **gap in knowledge**
- 3 Formulate of **research problem**
- 4 Choose **research methods** and prepare **research plan**
- 5 Proceed **research methods**
- 6 **Evaluate** scientific results



Research procedure

Determine the research area

Determine the **research area**

Input: own knowledge, personal interests

Outcome: research scope



Research procedure

Identify of gap in knowledge

Identify of **gap in knowledge**

Input: research scope, state-of-the-art

Outcome: description of lack of a complete picture of the study area, or contradiction in the existing description of reality



Research procedure

Formulate of research problem

Formulate of **research problem**

Input: identified gap in knowledge

Outcome: objectives, hypothesis, assumptions, research questions



Research procedure

Choose research methods and prepare research plan

Choose **research methods** and prepare **research plan**

Input: formulated research problem

Outcome: research plan



Research procedure

Proceed research methods

Proceed research methods

Input: adopted research plan

Outcome: scientific results: algorithms, methods, models,
discoveries, theorems, proofs

Research procedure

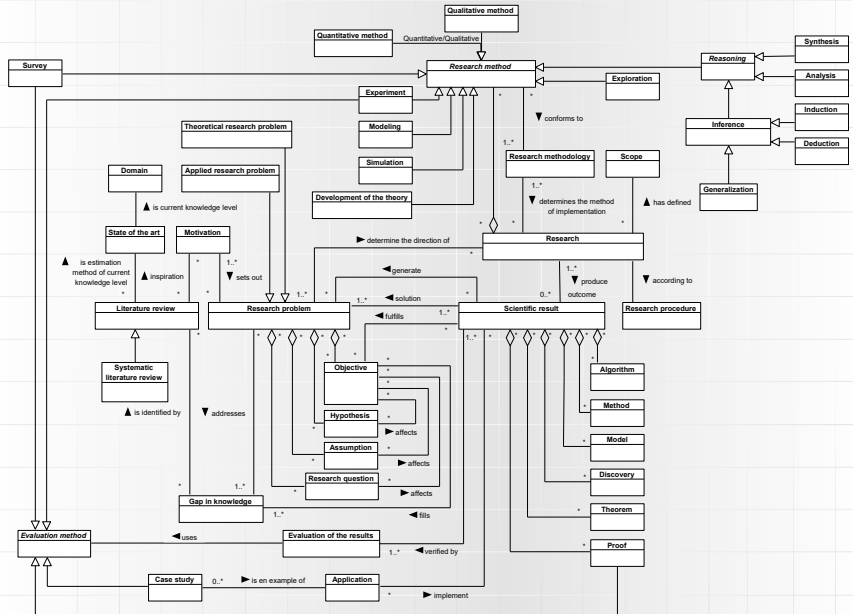
Evaluate scientific results

Evaluate scientific results

Input: scientific results, evaluation method

Outcome: case study, proof, experiment, survey

Ontology of scientific research





Thank you for your attention

Questions and answers,
discussion