Chapter 1. Overview of Research in Computer Science

Contents

In this chapter, we will introduce the overview of the research in Computer Science. Throughout the studies of this chapter, students need to gain the basic understanding about the context of computing research. The main objective of learning this chapter is to provide students with a brief introduction about the computing research for future academic activities. After completing this chapter, students are supposed to be able to:

- Discern the meaning of the research in Computer Science.
- Perceive different research methodologies and identify the differences between research methods.
- Have a clear cognition about the research process focusing on Computer Science.
- Know the main approaches of doing a research.

1 MAIN CONCEPTS OF THE RESEARCH

This section focuses on the main concepts related to the research and provides a holistic view about the research activities in Computer Science. Understanding the main concepts of the research can assist students to gain a better understanding of the research construct and future research design.

1.1 Definition of the Research

A generalized concept of the research is a chain of activities based on original investigations for the purpose of the knowledge gains [1], [2]. In the discipline of the Computer Science, the concept of the research mostly concentrates on the novel or emerging technologies that can be implemented in the future or current industries. Therefore, we define the *Research of Computer Science* as an *academic or practical actions pursuing the contributions to the body of the knowledge in applying digital-related techniques to improve or revolute people's quality of life.*

There are a variety of types of the research, which are associated with different research goals. In Computer Science, some research is a theoretical-based exploration that is usually designed and implemented for developing or analyzing novel algorithms and techniques. Some other research has a different concentration, which may involve more evaluations in applications. For both research types, we can consider a research an intellectual exploration that aims to advance specific knowledge field of the computer science implemented by one or a group of scholars who have solid and proper knowledge structures.

There are a few critical terms emphasizing the characteristics of the research, which include *Originality*, *Contributions*, and *Knowledge*. These three critical characteristics are considered three main aspects formulating a good research in computer science. Detailed statements of these three aspects are discussed in the following section.

1.2 Main Characteristics of the Research in Computer Science

This section mainly discusses three crucial dimensions for a solid qualified research. Three aspects include *Originality*, *Contributions*, and *Knowledge*.

1.2.1 Originality

This characteristic means that an effective research must be a work that had not been done by the prior research. The term *Originality* stands for a "new" attempt in an unknown domain. In computer science, there are mainly three types of the originalities.

1) **Implement new tools**, **techniques**, **procedures**, or **methods** that had not been applied before. Essentially, this type of exploration needs to configure a certain application circumstance. A proof is required to explain why and how the proposed approach is suitable.
2) **Investigate unknown fields** is another originality type. Researchers may propose a novel approach solving the problems that were not effectively solved or addressed by the prior research.
3) **Study the unanticipated problems** is also an originality type, which allows researchers to investigate a field addressed by the prior research. Distinguishing from the explorations in unknown fields, this originality type enables researchers to examine the existing research topic by trying a different approach.

1.2.2 Contributions

The *Contribution* of the research refers to that the research activities need to contribute to the whole body of knowledge. The *body of knowledge* represents the cognitions of the technical approaches, such as theories, models, framework, mechanisms, schemes, paradigms, and solutions. In common, the body of knowledge describes a pool of existing knowledge. A research contribution can be either an expansion deriving from the existing approaches or a new idea.

1.2.3 Knowledge

Term *Knowledge* refers to the representation of the research achievements that is usually based on the model descriptions and data evaluations. The model descriptions mainly consist of the main concepts, constructs, and entities used in the proposed model. The target solution is explained by representing the interrelations between entities. The proposed knowledge constructs need to be examined and proved by a research-oriented evaluation, such as an experimental evaluation.

2 MAIN RESEARCH METHODOLOGIES

2.1 Qualitative Research

As an important research methodology, *Qualitative Research* is being applied in various research domains, which provides the research with a theoretical view as well as a broad pool of research methods. The purpose of executing a qualitative research is not only knowing the research background, but also figuring out the relations, rationale, and implementations of all entities or parities involved in the target objects or systems. The investigation of a qualitative research can assist researchers or investigators to gain a deep understanding or cognition in a specific field. The method mainly provisions the demonstrations of observable phenomenon and the information produced by the qualitative research derives from cognizing the context or specific case studies.

The applications of qualitative research are wide in multiple research domains. There are a variety of approaches for implementing the method. *Case Study* is one of the most popular methods of the qualitative research in many disciplines. Executing a case study can enable researchers to produce information and build up the knowledge scaffold from a selected dimension that is implemented under a certain context. Sometimes, a case study is considered an empirical research method that can also used to examine the target implementations or evaluate the existing phenomenon. This requires the investigators to have a good understanding in the field by reviewing all relevant domains. Sometimes, a qualitative case study is associated with other research methods, such as on-ground research method. The selections of the research methods depend on the research goal and the requirements.

Moreover, there are a few ways for qualitative research data collections. The main approaches of gathering data in a qualitative research are listed as the follows: grounded theory, narratology, case study, qualitative statistics, and shadowing. The main methods of data collections include interviews, group discussions, observations, reflection field notes, and pictures. For each method, there might be a variety of approaches for gathering data. Researchers can determine which method(s) used in the research based on the research aim and methodology. In many situations, data collection methods are related to the discipline in which the researchers are working on. In computer science, a case study or a survey is a common way for doing a qualitative research.

After data are collected, researchers need to consider the approach of data analysis. One popular interpretive way is implementing *Coding* technique that formulates the collected qualitative data into structured data. A label can be either assigned to each item, such as a word or a phrase, or assigned to a group of data. It depends on whether the collected data are structured. The process of data analysis usually requires the support of computing programs. Sometimes, the data analysis of qualitative research uses the same format form as the quantitative research. Next, some data analyses do not have coding process, such as Recursive Abstraction. A

recursive abstraction method analyzes the summarized datasets for the final determinations. In some situations, a mixture of multiple data analysis approaches is needed for gaining the analysis results.

2.2 Quantitative Research

Quantitative research methodology is usually considered the positivist/postpositivist paradigm that requires statistical calculations based on the data collections and conversions for drawing the conclusions. In general, hypotheses are needed in the quantitative research, which aims to find out or evaluate the hypothetical relationships among the target entities or objects. In computer science, quantitative research is one of the most popular research methodologies to examine, analyze, and encapsulate the approaches, phenomena, and solutions. The followings represent examples of implementing quantitative research method in two different dimensions.

2.2.1 Cloud Computing

As an emergent technology, cloud computing [3] has been broadly accepted by a variety of industries. Crucial aspects concerning the concept of cloud computing include *Central Processor Unit* (CPU) Memory, remote storage, and bandwidth. Considering the performance enhancement, one of the significant issues is ensuring the response time is sufficiently short for efficient communications [4], [5]. This introduces a great challenge to implementing cloud computing since a very small difference of the response time may result in a great difference of the performance when the data size becomes large. Addressing this issue, quantitative research is an effective research methodology to analyze the problem and the proposed solution. For instance, the quantitative research can be applied to analyze the jamming problems during the wireless communications.

2.2.2 Cyber-Security

Cyber-security is an important research domain in computer science. One of the research issues is investigating the trade-off between energy consumptions and security levels. In general, security levels have a positive relationship with energy consumptions since the more loops are needed for the purpose of the higher-level security. Loops are considered a great component of energy consumptions in cyber-security. The energy consumptions will become less when the level of the security is lower. Therefore, the rationality and capability of implementing a proper security configuration is a great challenge, which can be analyzed by using quantitative research methodology. The data generated by different configurations can represent the relationships between security performances and security levels.

3 Crucial Processes for A Research in Computer Science

The major goal of this section is exploring the effective technical writing skills. A research paper is a representation of the research as well as the findings, instead of a "lab report" The follows main explain the key processes and steps of formulating an effective research.

3.1 The Research Process

There are many different research processes proposed by the previous researchers. We formulate the main sequential steps of a research in computer science as follows

1) Identify the area of study.
2) Select a research topic.
3) Determine or propose a technical approach
4) Execute the approach
5) Data collection and data analysis
6) Conclude the results and present the findings.

3.2 Form of a Research Paper

Aligning with the main research processes, we give a common form of a research paper in computer science as follows.

1) **Introduction**

   This section mainly represents the main background of the research, the crucial information about the proposed approaches, main contributions of the research, and the structure of the paper.
2) **Research background and descriptions**

   In this section, the authors need to give a clear statement about the research background and the research problem. Audiences can have a clear understanding on why this research needs to be done. For example, common titles of this part include *Related Work*, *Research Problem*, *Research Background*, and other related statements.
3) **Proposed approach**

   This section is a crucial section in which the authors need to represent the crucial information about the proposed model, technique, schema, mechanism, framework, or approach. Common section titles include *Concepts and the Proposed Model*, *Algorithms*, *Proposed Solutions*, and so on.

4) **Experimental evaluations**

In this section, the authors need to give a clear description about the experimental configurations and represent the experimental results. The evaluations or findings are usually based on the data analysis deriving from the experimental data.

5) **Conclusions**

A high level summary about the research needs to be given in this section.

4 CONCLUSIONS

This chapter represented a high level introduction about the research in Computer Science. Main definitions and characteristics were stated and discussed. Students also need to understand the main research methodologies employed in the research of computer science after reading this chapter. Moreover, research paper writing skills were also represented.

REFERENCES

[1] S. Kumar and P. Phrommathed. *Research methodology*. Springer, 2005.

[2] W. Neuman. *Social research methods: Quantitative and qualitative approaches*, volume 13. Allyn and Bacon Boston, 2005.

[3] K. Gai and S. Li. Towards cloud computing: a literature review on cloud computing and its development trends. In *2012 Fourth Int'l Conf. on Multimedia Information Networking and Security*, pages 142–146, Nanjing, China, 2012.

[4] M. Qiu, M. Zhong, J. Li, K. Gai, and Z. Zong. Phase-change memory optimization for green cloud with genetic algorithm. *IEEE Trans. on Computers*, PP(99):1–13, 2015.

[5] K. Gai, M. Qiu, H. Zhao, L. Tao, and Z. Zong. Dynamic energy-aware cloudlet-based mobile cloud computing model for green computing. *Journal of Network and Computer Applications*, 2015.