

Review of Methods Used in Computer Science Research

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Abstract: *Research is simply the principle method for acquiring knowledge and uncovering the causes of behavior (or a phenomenon), Once can also define research as an academic activity and as such the term should be used in a technical sense. In computer science there is several research methods. We need to select the right method to describe how the objective can be achieved; otherwise the result will not be valid. In this paper we will discuss which research methodologies that can be used in computer science.*

Keywords: Computer science research, Research methodologies

1. Introduction

Research is simply the process of thoroughly studying and analyzing a phenomenon. Research also an organized, systematic, data-based, critical, objective, scientific enquiry or investigation, into a specific problem or issue with the purpose of finding solutions to it or clarifying it. Once can also define research as a scientific and systematic search for pertinent information on a specific topic. In fact, research is an art of scientific investigation (Kothari 2004). The Research is an effort to obtain new knowledge in order to answer a question or to solve a problem. New knowledge can either be new idea or a new problem, a new technique to solve the current problem, or to adjust a current technique to solve a current problem in a new environment. The purpose of research is to discover answers to questions through the application of scientific procedures. On other word the main aim of research is to find out the truth which is hidden and which has not been discovered as yet. (Kothari2004). In an academic context, research is used to refer to the activity of a diligent and systematic inquiry or investigation in an area, with the objective of discovering or revising facts, theories, applications etc (Ayash2015).

The methodology is the general strategy that outlines the way in which the project is to be undertaken and, among other things, identifies the methods to be used in it (Setzer 2005). In computer science there are several research method. We need to select the right method to describe how the objective can be achieved; otherwise the result will not be valid. In this paper we will discuss which research methodologies that can be used in computer science.

Research must be done within a certain philosophical framework, by using procedure, method and techniques that are reliable and properly designed so that it is objective and not bias. So research must controlled, rigorous, systematic, valid, empirical and critical.

1.1 Literature Review

Literature survey is summary of past research related to the research to be conducted. A literature review is an account of what has been published on a topic (to be researched) by scholars, academics and researchers. A central activity in CS research is the literature review. The literature review

involves a systematic study and analyze of documented ideas in the areas of study. (Odejobi 2012)

A literature review must be organized around and related directly to the research question also, finding the relationships between concepts and hypothesis. Ideas in the literature to Identify similarities and differences to understand the nature of the problems to be addressed and the structure of a desirable solution (Osuala2005)

1.2 Developing Research Problem and Hypothesis/Research Objectives

A research problem, in general, refers to some difficulty which a researcher experiences in the context of either a theoretical or practical situation and wants to obtain a solution for the same. There must be an individual or a group which has some difficulty or the problem. Also there must be some objective to be attained at. (Kothari2004). Like in all science the first step will consist on modeling the problem or phenomenon to be studied - abstraction. This simplifies the subject of research taking in consideration only the relevant aspects (Crnkovic2002).

First identify the area of research (field of research) and choose the sub-area, then identify research questions, build objectives. Lastly, examine and confirm the objectives. Objectives are based on the research hypothesis. Objectives can be divided into: main Objectives and Specific Objectives, for examples, for improve students' achievement in programming courses the hypothesis is use of a new teaching method can improve students' achievement in programming courses the objectives will be to propose a new teaching method to improve students' achievement in programming courses

2. Research Process

Research process involves preliminary information gathering (initial analysis), specification gathering ; needs assessment The research process follow 7steps: selection of topic, reviewing the literature, developing your theoretical and conceptual frameworks, clarifying your research question, developing a research design, collecting and analyzing data (Engle2010). The pre research stage to

determine what type of research to be done, and then plan how to do the research, and then do the research.

However the process of scientific research has its bases in empirical (based in theoretical background) knowledge - observational-inductive science (Freitas2009).By way of illustration, Figure 1 explains stages of research process activities

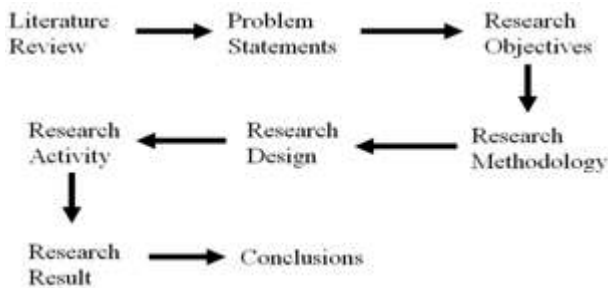


Figure 1: Stages of research process activities

3. Conceptual Framework

All of the computer science research must be based on the computer science theoretical framework. It used to represent relationship between various theories in the area of research, it focus only on the aspects to be studies. Framework can be represented by using a diagram.

In addition, we need to identify various concepts and relationship between these concepts. The relationship may Cause-effect relationship, Co-relational relationship, or Network relationship. Fig2, fig3, fig4 shows the type of relationship between concepts.

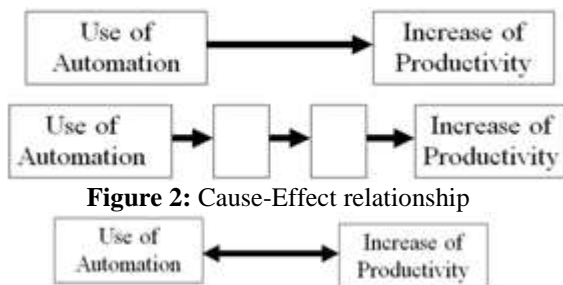


Figure 2: Cause-Effect relationship

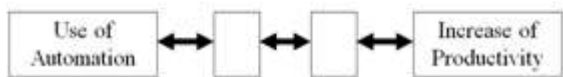


Figure 3: Co-relational relationship

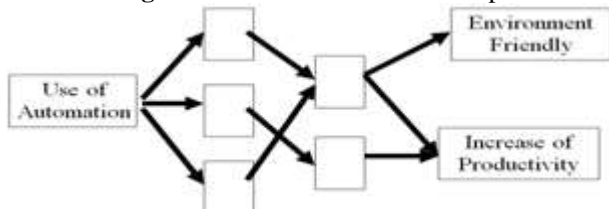


Figure 4: Network relationship

4. Principles of Scientific Method In Computer Science

Computer Science is a field of study that is concerned with theoretical and applied disciplines in the development and

use of computers for information storage and processing, mathematics, logic, science, and many other areas. However Computer Science is transversal to very different domains in science (Ayash2015).Scientific research can be seen as the usage of a rigorous method or methodology for achieving new knowledge (Freitas 2009). A method is a way of solving a problem and technique is normally used in a relation to a scientific problem. In particular, the field of CS is concerned with a number of different issues seen from a technological Perspective, e.g. theoretical aspects, such as numerical analysis, data Structures and algorithms; how to store and manipulate, the relationship between different pieces of software and techniques and tools for developing software (Ayash2015).The scientific method consists on a series of stages with the purpose of providing answers to questions that emerge from science theories or observations. Fig4 show the logical structure of scientific method

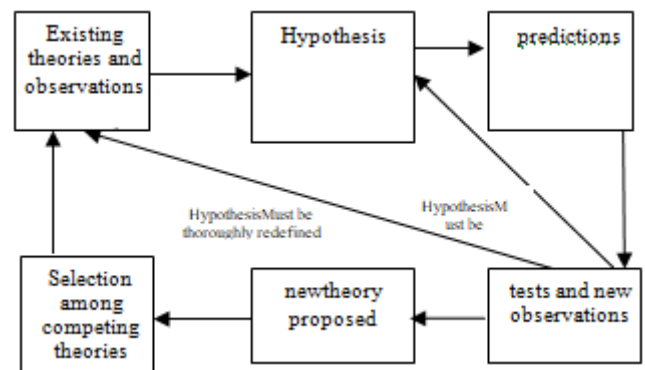


Figure 5: Logical structure of scientific method

5. Research Methodology

The Hypothesis must be proven; method for proving the hypothesis is called the research methodology Research methodology to be used depends on the research types and objectives. Research methodology is a way to systematically solve the research problem. It may be understood as a science of studying how research is done scientifically (Kothari 2004). Research contributions can result from systems development, experimentation, observation, and performance testing of the systems under development and that all of these research approaches are needed to investigate different aspects of the research question. (Nunamaker2015).

Computing Science researchers use several methodologies to tackle questions within the discipline (Nelson 2015). However a little of research method can be reasonable for Computer science (Ayash 2015). In the next subsections we will discuss methods of research methodology and its reasonability for the Computer science field.

5.1 Library Research

In this method we determine research questions, and then search for materials in order to answer the questions and finally analyze findings.

For example: A constraint satisfaction problem (CSP) is a problem defined by a set of variables each of which can take

a number of values from some domain and a set of constraints involving one or more variables.

CSP ($\{X, Y\}$, $\{D(X) = \{4, 6, 7\}, D(Y) = \{4, 3\}\}$, $\{X + Y = 10, X \neq Y\}$)

One approach for solving this type of problem is by using local search algorithm. As shown in fig 6, fig 7 this approach involves searching through the search space of the CSP. A search space consists of all possible states of the CSP.

Example of possible states: $X + Y = 10, X \neq Y, D(X) = \{4, 6, 7\}$ and $D(Y) = \{4, 3\}$

The possible states are: $\{X/4, Y/4\}, \{X/4, Y/3\}, \{X/6, Y/4\}, \{X/6, Y/3\}, \{X/7, Y/4\}, \{X/7, Y/3\}$,

A solution for a (set of) constraint (s) is a state that satisfies this (these) constraint (s). One possible solution for these constraints is: $\{X/6, Y/4\}$.

Research Problem: There are number of LSA that have been developed, also, most of the current LSA involves searching through a huge search space.

Possible Solution: We can speed up the local search by reducing the search space.

Research Objective: To develop a technique for improving local search algorithms by reducing the search space.

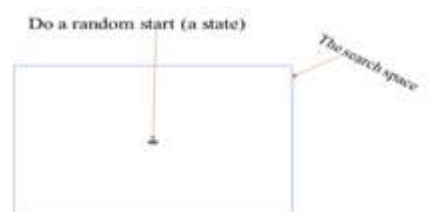


Figure 7: Random start in the search space



Figure 7: Move to a better neighbor

Methodology: To develop a new technique, you need to read through the current literature in this particular area. Then, create research questions, such as: Can we confine LSA to search within part of the search space, s , instead of searching the whole search space? How can we find s ?

5.2 Formal Methods

Computer scientists study the behaviors of human neurons as described in the biological sciences. Using this knowledge, the CS researchers produced computational models with varying configuration as structures. (Odejobi 2012). Computer Science as a research discipline has always struggled with its identity. On the one hand, it is a

field deeply rooted in mathematics which resulted in strong theories. (Demeyer 2011). In Computing Science, formal methods and mathematical proof is most used to prove facts about algorithms and system or to design a system which has those properties. (Setzer2015) (Johnson2000) (Nelson2015).

However the idea to use mathematical modeling approach to solve a research problem in other words we can say that we can use the formal method to model a new system.

In Formal Methods determine the suitable formal model to be used, then Develop the model Analyze the model by using suitable technique. There are three formal models to be used;

- Analytical model: Involves the use of formal mathematics to represent a system. For examples, Use of differential equations to describe a model.
- Stochastic model: To model systems that involves probabilistic elements. For examples, To model a queuing system, To predict
- Computational Model: Many systems are highly complex, so the valid mathematical (analytical or stochastic) models of them are complex. In some cases, these mathematical models are not available. Alternative approach for modeling these systems is by using a computational model (i.e. to develop an algorithm or a heuristic that describe the behavior of the system).

5.3 Experiment

The hypothesis is tested to ascertain its truth. In empirical methods we Use experiments designed to test hypothesis (Nunamaker 2015). Once we have developed a new technique, how do we know that this technique is better than the current techniques, we have to carry out an experiment. On other word the experiment determine how systems perform in real use, by studying their use. However some experiments involve human participation. Experimental evaluation is often divided into two phases. In an exploratory phase the researcher is taking measurements that will help identify what are the questions that should be asked about the system under evaluation. Then an evaluation phase will attempt to answer these questions. A well-designed experiment will start with a list of the questions that the experiment is expected to answer (Nelson 2015).

5.4 Survey research

Survey research is the method of gathering data from respondents thought to be representative of some population, using an instrument composed of closed structure or open-ended items (questions). Survey is aimed primarily at tapping the subjective feeling of the public. Survey are designed to produce statistics about a target population, some set of people (Floyd j.2014).

Survey is used most often to describe a method of gathering information from a sample of individuals; this "sample" is usually just a fraction of the population being studied. There are several different ways in which a probability sample can

be selected. The design chosen depends on a number of factors such as the available survey frame, how different the population units are from each other (i.e., their variability) and how costly it is to survey members of the population. (Fellegi 2010). In Computer sciences Surveys are conducted to study use on Computer sciences products & services. For example Survey on use of Internet facilities in business, schools, institutions of higher learning.

The sample size required for a survey partly depends on the statistical quality needed for survey findings; this, in turn, relates to how the results will be used.

Depending on Population Issues, Sampling Issues, Surveys can be classified by their method of data collection: Mail surveys, Group administered questionnaire, Group administered interview, Household drop-off survey, Interviews, and Telephone interview.

5.5 Prototype Development

A lot of research in computer sciences involves prototype development. In fact, prototype development is considered one of the most important contributions of computer sciences research. It normally used to show that the hypothesis that you have proposed is feasible. A good design often needs several prototypes, thus prototyping activates is a vital process to create a successful product (Basili2007)

Prototype development must be carried out according to an established software development methodology. All Software methodologies involve the Requirement Analysis, Design, Implementation and Testing.

In Prototype Development determine the software specification, Design Software, then Implementation Software, in the last testing software. Software prototype is normally produced as an output of a research work. At the end of the development activity produce the Software product, as shown in fig8.

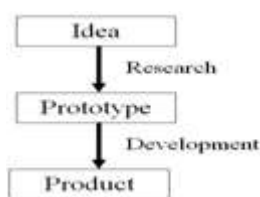


Figure 8: Software product

In software product all of software quality factor must be taken into account such as Correctness, Efficiency, Portability, Usability, Availability, Reliability, Safety, etc. on the other. In developing a prototyping. Only importance factors (i.e. relevant to the research) need to be considered.

6. Design

A research design is the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure (Kothari 2004). After we have identified the research methodology to be used we plan the strategy to be

used in implementing the research. Research design is the master plan specifying processes and actions from a practical perspective. In the design stage must identify the List of tasks; List of tasks depends on the research methodology that is used. If the research involves data collection, identify how this will be done; finally determine time needed and the cost for each task.

The design helps the researcher to organize his ideas in a form whereby it will be possible for him to look for flaws and inadequacies. Such a design can even be given to others for their comments and critical evaluation (Kothari 2004). However any development approach involves:

- 1) Software Requirements Specification (SRS) is a comprehensive description of the intended purpose and environment for the software undergoing development. The SRS fully describes what software will, and how it will be expected to perform. A good SRS defines how the application will interact with the system hardware, other programs and human users in real world situations
- 2) Software Design Specification (SDS) is the task of precisely describing the software to be written, possibly in a rigorous way. In practice, most successful specifications are written to understand and fine-tune applications that were already well-developed, although most safety-critical software systems. Fig 9 show the using of (SRS) and (SDS) in development approach.

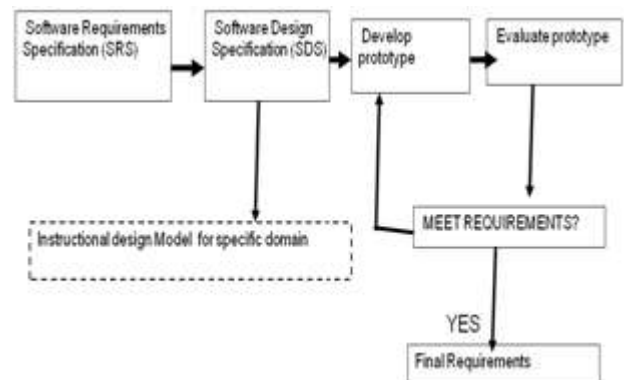


Figure 9: Using of (SRS) and (SDS) in development approach

7. Conclusion

The scientific method is a tool for conducting a rigorous and systematic search of new theories or paradigms. In short we can say that, due to its nature, computer science can be seen or studied using these five main methodologies (library research, survey research, prototype development, Formal Methods, and experiment). Each one more appropriated to specific areas within the domain of computer science. Most of the researches need to use more than one methodology. for example research may involves: library research to develop a new technique, survey research to obtain users requirements, prototype development to develop prototype based on users requirements, formal method to prove facts about algorithms and system and experiment to evaluate the effectiveness of the technique.

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