Computer Science Research Methodologies

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ABSTRACT

This paper discusses the several research methodologies that can be used in Computer Science (CS) and Information Systems (IS). The research methods vary according to the science domain and project field. However a little of research methodologies can be reasonable for Computer Science and Information System.

Keywords- Computer Science (CS), Information Systems (IS), Research Methodologies.

1. INTRODUCTION

Science is an organized or systematic body of knowledge (Jain, 1997). Science embraces many different domains however those domains are related. Logic and mathematics sciences are the core of all sciences. From there and descending it emerge the natural sciences such as physic, chemistry and biology. In the next come the social sciences.

As (Denning, 2005) reported Computer Science (CS) should not be called as a science. Although CS is definitely a recent discipline, few will still argued that it is not provided with attributes to be qualified as a science. Computer Science has its specificity and has its bases in logic and mathematics.

However CS is transversal to very different domains in science. To understand which research methodologies that can be used in CS and IS we have to understand the differences between CS and IS.

Computer science (CS) characterized as an empirical discipline, in which each new program can be seen as an experiment, the structure and behavior of which can be studied (Allen ,2003). 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 .The field of Information Systems (IS) is concerned with the interaction between social and technological issues (Allen ,2003).

In other words, it is a field which focuses on the actual "link" between the human and social aspects (within an organization or other broader social setting), *and* the hardware, Software and data aspects of information technology (IT). In the next sections we will discuss the different methods of research methodology and its reasonability for the CS and IS domains.

Abstraction in Computer Science

Computer scientists are often thought to labor exclusively in a world of bits, logic circuits and microprocessors. Indeed, the foundational concepts of computer science are described in the language of binary arithmetic and logic gates, but it is a fascinating aspect of the discipline that the levels of abstraction that one can lay upon this foundational layer are limitless, and make possible to model familiar objects and processes of every day life entirely within a digital world. When digital models are su ciently realistic, the environments they inhabit are called virtual worlds. So today, of course, there are virtual libraries, virtual shopping malls, virtual communities, and even virtual persons, like the digital version of actor Alan Alda created in an episode of PBS's Scienti c American Frontiers.

Complex virtual worlds such as these are made possible by computer scientists' ability to distance themselves from the mundane and tedious level of bits and processors through tools of abstraction. To abstract is to describe something at a more general level than the level of detail seen from another point of view. For example, an architect may describe a house by specifying the height of the basement foundation, the location of load-bearing walls and partitions, the R-factor of the insulation, the size of the window and door rough openings, and so on. A realtor, however, may describe the same house as having a certain number of square feet, a certain number of bedrooms, whether the bathrooms are full or half, and so on. The realtor's description leaves out architectural detail but describes the same entity at a more general level, and so it is an abstraction of the architect's description. But abstraction is relative. For example, the architect's

description is itself an abstraction when compared to a metallurgist's description of the nails, screws, and other fasteners making up the house, and the botanist's description of the various cellular properties of the wood it contains.

The computer scientist's world is a world of nothing but abstractions. It would not be possible to create the complex virtual worlds described above if the only things computer scientists could talk about were bits, bytes, and microcircuits. One can give an accurate idea of what computer scientists do by describing the abstraction tools they use. Now to characterize computer science as involved with abstractions seems to claim for it a place alongside mathematics as a purely formal endeavor. But the general trends in all programming are toward higher-quality software by abstracting away from the lower-level concepts in computer science and toward the objects and information that make up the real world. This is a kind of abstraction that is fundamentally different from that which takes place in mathematics. Understanding the difference is crucial in avoiding the persistent misconception by some that computer science is just a branch of pure mathematics. Both mathematics and computer science are marked by the introduction of abstract objects into the realm of discourse, but they differ fundamentally in the nature of these objects. The difference has to do with the abstraction of form versus the abstraction of content.

Not all philosophers of mathematics agree with Carnap that mathematics has only linguistic utility for scientists, but there is agreement on the nature of mathematical abstraction being to remove the meanings of specific terms. M. Cohen and E. Nagel, for example, present a set of axioms for plane geometry; remove all references to points, lines, and planes; and replace them with symbols used merely as variables. They then proceed to demonstrate a number of theorems as consequences of these new axioms, showing that pure deduction in mathematics proceeds with terms that have no observational or sensory meaning. An axiom system may just happen to describe physical reality, but that is for experimentation in science to decide

Research Methods

Before we start in discuss the different types of research methodologies we have to define the research. 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. The goal is to discover and disseminate new knowledge. There are several methods that can be used in CS and IS in next subsection we will show these methodologies.

Experimental Method

Experimental shows the experiments that will occur in order extract results from real world implementations. Experiments can test the veracity of theories. This method within CS is used in several different fields like artificial neural networks, automating theorem proving, natural languages, analyzing performances and behaviors, etc. It is important to restate that all the experiments and results should be reproducible. Concerning, for example, network environments with several connection resources and users, the experiments are an important methodology Also in CS fields and especially IS

fields that take in consideration the Human- Computer Interaction. It is mandatory the usage of experimental approaches. If we use the experimental method in IS field we may need to use some methods or tools in conjunction with the experimental method. These methods or tools used to support and prove the legibility of the developed project. For example if a student wants to implement new social network with new concepts or develop an existing social network, who he can measure the legibility of his implementation? The answer of this question consists of two parts according to the nature of the project. The technical issue is the first part of the project that can be tested by benchmarks like (availability, reliability, scalability, stability, etc.). The usability of the project is the second part of testing that needs a feedback from the users of the system; the results for the second part can be obtained by the statistical analysis of a questionnaire which is a tool the used in conjunction with the experimental method.

Simulation Method

Simulation method used especially in CS because it offers the possibility to investigate systems or regimes that are outside of the experimental domain or the systems that is under invention or construction. Normally complex phenomena that cannot be implemented in laboratories evolution of the universe. Some domains that adopt computer simulation methodologies are sciences such as astronomy, physics or economics; other areas more specialized such as the study of non-linear systems, virtual reality or artificial life also exploit these methodologies. A lot of projects can use the simulation methods, like the study of a new developed network protocol. To test this protocol you have to build a huge network with a lot of expensive network tools, but this network can't be easily achieved. For this reason we can use the simulation method.

Theoretical Method

The theoretical approaches to CS are based on the classical methodology since they are related to logic and mathematics. Some ideas are the existence of conceptual and formal models (data models and algorithms). Since theoretical CS inherits its bases from logic and mathematics, some of the main techniques when dealing with problems are *iteration, recursion and induction*.

Theory is important to build methodologies, to develop logic and semantic models and to reason about the programs in order to prove their correctness. Theoretical CS is dedicated to the design and algorithm analysis in order to find solutions or better solutions (performance issues, for example). Encompassing all fields in CS, the theoretical methodologies also tries to define the limits of computation and the computational paradigm. In other words we can say that we can use the theoretical method to model a new system. However the theoretical method can help in finding new mathematical models or theories, but this method still needs other methods to prove the efficiency of the new models or theories. For example when a student need to develop a new classifier in AI by using the mathematical representation and theoretical method, he need to prove the efficiency of this model by using one of the previous methods.

Conclusion

In this paper we try to differentiate between the domains of science and CS and IS to understand the best methods that can be used in CS and IS. Each project in CS or IS have its free nature so the paper give examples of different kinds of projects in CS and IS and the prober research methodologies that can used in these projects.

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