SCIENTIFIC METHODS IN COMPUTER SCIENCE

Sidharth Kumar[1], Arman Bharti[2], Indu Khatri[3]
[1,2] B.tech Student, [3]Assistant Professor
Department of Computer Science Engineering
Bhagwan Mahaveer College of Engineering and Management, Sonipat

Abstract: - This Paper analyses scientific point of view of Computer Science. First it defines Science and scientific methods in general. It gives a dispute of relations between science, research, development and technology.

The dynamic theory of science has Physics as an ideal. Not many sciences come close to that ideal. Theory of Science as it is today is not of much help when trying to estimate Computer Science. Computer Science is a new field and its object of investigation is a computer, which is an ever-developing artifact, the materialization of the ideas that try to structure knowledge and the information about the world, including computers themselves. However different, Computer Science has its basis in Logic and Mathematics, and both theoretical and experimental research methods follow patterns of classical scientific fields.

Computer model and simulation as a method is specific for the discipline, and it is going to develop even more in the future, not only applied to computers, but also to other scientific as well as commercial and artistic field.

Keywords: - Computer Science, Theory of science, scientific methodology

"EVERYTHING IS THEORETICAL IMPOSSIBLE
UNTIL IT IS DONE".

ROBERT A.HEINLEIN

1. INTRODUCTION

Computer (CS) is a young discipline and necessarily starting from the outset very different from Mathematics, Physic and similar "classic" sciences, that all have their origins in the philosophy of ancient Greece. Emerging in modern period of time (in 1940's the first electronic digital computer was built), CS has necessarily other already existing sciences in the background.

Computer Science draws its foundations from a wide variety of disciplines. Study of Computer Science consequently requires utilizing concepts from many different fields. Computer Science integrates theory and practice, abstraction and design. The historical development has led to disclosure of a large number of sciences that communicate more and more not only because the means of communication are getting very convenient and effective, but also because a need increases for getting a holistic view of our world that is presently strongly dominated by reductionism.
Computer science is no more about computers than astronomy is about telescopes. -Edsger Dijkstra

2. WHAT IS SCIENCE???

"SCIENCE is a beautiful gift to humanity; we should not distort it."

A.P.J ABDUL KALAM
Talking about "Science" we actually mean plurality of different sciences. Different sciences vary so much from each other. The definition of science is therefore neither simple nor unambiguous. See and for more possible classifications. For example, history and linguistics are often but not always catalogued as sciences.

CLASSICAL SCIENCE
The growth of human thought parallel to the development of human society has led to an emergence of sciences that do not linked to any of the classic types we have described earlier, but rather share common parts with several of these. Many of the modern sciences are of interdisciplinary, "eclectic" type. It is a rage for new sciences to find their technique and even questions in very broad areas. It can be seen as a result of the fact that the communications across the borders of different scientific fields is nowadays much easier and more intense than before. Computer Science for example includes the field of artificial intelligence that has its roots in mathematical Logic and Mathematics but uses Physics, Chemistry and Biology and even has parts where medicine and psychology are very important.

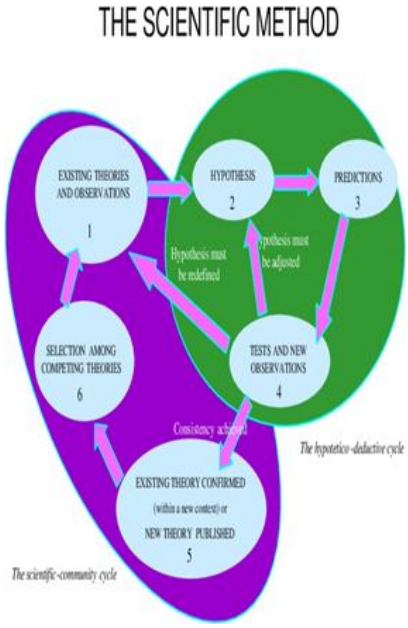
3. THE SCIENTIFIC METHOD

The scientific method is a trusted method of science knowledge that has characterized the evolution of science since at least the 17th century. It involves careful observation, applying rigorous skepticism about what is observed by given that cognitive assumptions can distort how one interprets the observation. It involves formulating hypotheses, via induction, based on such observations; experimental and measurement-based testing of deductions drawn from the hypotheses; and refinement (or elimination) of the hypotheses based on the experimental findings. The scientific method is the medium by which science is carried out.

The scientific method is an interchanged, cyclical process through which information is continually revised. It is generally recognized to develop advances in knowledge through the following elements, in varying combinations or contributions:

-: Characterizations (observations, definitions, and Measurements of the subject of inquiry)
-: Hypotheses (theoretical, hypothetical explanations of Observations and measurements of the subject)

-: Predictions (inductive and deductive reasoning from the Hypothesis or theory)
-: Experiments



4. SCIENCE, RESEARCH, TECHNOLOGY

4.1 Aristotle's Science contra Technology

In his well-known reflections of science and technology, Aristotle has recognize some key distinctions that are still frequently quoted and even used to explore contemporary science and technology.

4.2 Modern Science contra Technology

Traditional sharp binary contrast between science and technology seem however to fail when applied to contemporary science, because the underlying concepts of science are out-dated. Today's science is much more complex and heterogeneous than science of the Aristotle's time (the contemporary relations are illustrated by Figure 3); the reality that modern philosophers have difficulty to admit. That is why philosophy of science is in major need of a deeper, more realistic to acknowledger of contemporary sciences.

5. WHAT IS COMPUTER SCIENCE??

Computer science is the study of computation, automation, And information. Computer science spans theoretical disciplines, such as algorithms, theory of computation, and information theory, to practical disciplines including the design and implementation of hardware and software. Computer science is generally regard an area of academic research and marked from computer programming. Algorithm and data-structure have been called the heart of computer science. The theory of computation concerns abstract models of computation and general classes of issue that can be resolve using them. Cryptography and computer security study the means for secure communication and prevent security vulnerabilities. Computer graphics and computational geometry study the generation of images. Programming language theory considers approaches to the description of computational processes and database theory concerns the management of repositories of data. Human–computer interaction searches the interfaces through which humans and computers interact and software engineering focuses on the design and principles behind developing software.

Areas such as operating systems, networks and embedded Systems investigate the principles and design behind complex systems. Computer architecture describes construction of computer components and computer-operated equipment. Artificial intelligence and machine learning aim to synthesize goal-orientated processes such as problem-solving, decision-making, environmental adaptation, planning and learning found in humans and animals.

Within artificial intelligence, computer vision aims to understand and process image and video data, while natural language processing aims to understand and process textual and linguistic data.

The fundamental concern of computer science is regulate what can and cannot be automated. The Turing Award is generally recognized as the highest distinction in computer science.

It is impossible to give a unique and simple definition of Computer Science. Let me mention some of existing ones:

1. Computer Science is the inspect of phenomena related to computers, Newell, Perlis and Simon, 1967
2. The discipline of determine is the systematic study of algorithmic processes that describe and transform information: their theory, analysis, design, efficiency, implementation, and application 2001.
3. Computer Science is the knowlege of information structures, Wegner, 1968, Curriculum 68
4. Computer Science is the study and management of complexity, Dijkstra, 1969.
5. Computer Science is the mechanization of abstraction, AHO and Ullman1992.

The first definition reflects an empirical tradition since it asserts that Computer Science is concerned with the study of a class of phenomena.

The second and third definitions shows a mathematical heritage since algorithms and information structures are two abstractions from the circumstance of Computer Science.
The third definition was used by Wegner as the merge detachment in his book on Programming Languages, Information Structures and Machine Organization. This outlook of Computer Science has its historical roots in information theory. It strongly influenced the development of Curriculum 68; a record which has been very important in the growth of undergraduate Computer Science curricula. It

is implicit in the German and French use of the respective terms "Informatik" and "Informatique" to denote the discipline of Computer Science.

It is compelling to notice that the British term "Computer Science" has an empirical orientation. This is major difference in terminology appears to support the view that the nineteenth-century traits of British empiricism and continental abstraction have persisted.

Sub-areas of computing according to:
1. Distinct Structures
2. Programming Fundamentals
3. Algorithms and Complexity
4. Programming Languages
5. Architecture and Organization
6. Operating Systems
7. Net-Centric Computing
8. Human-Computer Interaction
9. Graphics and Visual Computing
10. Intelligent Systems
11. data Management
12. Software Engineering
13. Social and Professional Issues
14. machine Science and Numerical Method

Dijkstra forenamed that to clepe the field "Computer Science" is like calling surgery "Knife Science". He noted that departments of Computer Science are exposed to a permanent pressure to overemphasize the "Computer" and to under emphasize the "Science."

This propensity matches the inclination to appreciate the rarity of computers solely in their capacity of tools. Computer Science does not deal merely with computer use, technology or software. It is a science that encompasses abstract mathematical thinking and includes an element of engineering. The mathematical element is expressed in finding solutions to problems, or in proving that the solutions don't exist, whereas the engineering element demands skills for coming up with complicated computer code systems.
"People expect that computer science is the art of geniuses but the actual reality is the opposite, just many people doing that build on each other, like walls of mini stones".
-DONALD KNUTCH

6. PROGRAMMING PARADIGMS

Programming languages can be used to accomplish different tasks in different ways. Common programming paradigms include:
-: Functional Programming
-: Imperative programming
-: Object-oriented programming
-: Service oriented programming

6.1 Theoretical Computer Science
Concerning Theoretical Computer Science, which sticks to the heritage of Logic and Mathematics, we can conclude that it follows the very classical methodology of building theories as logical systems with stringent definitions of objects (axioms) and operations (rules) for deriving/proving theorems. The key recurring concepts fundamental for computing are:
- Abstract and formal models
- Levels of abstraction
- Efficiency

Data models are used to formulate different mathematical concepts. In CS a data prototype has two features : the values that data objects can conjecture and the operations on the data. Here are some typical data models:
- The tree data model
- The list data models
- The set data
- The relational data model
- The graph data
- Patterns, automata and regular expressions

6.2 Experimental Computer Science
Experimental computer science is most effective on problems that require complex software solutions such as the creation of software development environments, the organization of data that is not tabular, or the construction of tools to solve constrained optimization problems. The approach is largely to identify concepts that facilitate solutions to a problem and then evaluate the solutions through construction of prototype systems.

Experiment in different fields (search, automatic theorem proving, planning, NP- complete problems, natural language, vision, games, neural nets/connectionism, machine learning) is also used in CS, a

6.3 Computer Simulation
In recent years, computation, which comprises computer-based modeling and simulation, has become the third research methodology, complementing theory and experiment. Today, computing environments and methods for using them have become powerful enough to tackle problems of great complexity. Mastery of Computational Science tools, such as 3D visualization and computer simulation, structured grasping of big data sets, ability to access a variety of distributed resources and alliance with other experts over the Internet, etc. are now expected of university graduates, not necessarily Computer Science majors. Those skills are becoming a part of scientific culture.
Computer simulation makes it possible to investigate regimes that are beyond current experimental capabilities and to study phenomena that cannot be replicated in laboratories, such as the evolution of the universe. In the realm of science, computer simulations are guided by theory as well as experimental results, while the computational results often suggest new experiments and theoretical models. In engineering, many more design options can be explored through computer models than by making physical ones, generally at a small fraction of the cost and elapsed time.

7. CONCLUSIONS

In spite of all feature that vary the young field of Computer Science from many thousand years old sciences such as Mathematics and Logic, we can draw a result that Computer Science contains a analytical mass of scientific features to qualify as science. From the principal point of perspective it is important to conclude that all modern sciences are very much determined by technology. That is a natural consequence of the fact that the research leading to the development of modern sciences is very firmly vault to technology. This is very much the case for Biology, Chemistry and Physics, and even more the case for Computer Science that is clearly influenced by industry via engineering. Engineering parts in the Computer Science often have connection to the hardware ingredient of computer, but they even appear in form of software engineering.

Theoretical Computer Science, on the other hand, is scientific in the same sense as theoretical parts of any other science. It is based on hard ground of Logic and Mathematics. The important difference is that the computer (the physical object that is directly connected to the theory) is not a focus of investigation (not even it he sense of being the cause of certain algorithm proceeding in certain way) but it is rather theory materialized, a tool always capable of changing in order to accommodate even more powerful theoretical concepts.

"Whether you want to uncover the secrets of the universe, or you want to pursue a career in the 21st century, basic computer programming is an essential. - STEPHEN HAWKINS

REFERENCES

- http://www.chem.ualberta.ca/~plambeck/u dc/ Universal Decimal Classification (UDC)
- http://www.tnrdlib.bc.ca/dewey.html Dewey Decimal Classification
- http://www.computer.org/education/cc200 1/index.htm Computing Curricula 2001 Denning, P.J. et al. Computing: as a Discipline. Communication. ACM 32, 1 (January 1989), 9-23.
- https://en.wikipedia.org/wiki/Computer_sci enc

