Three Major Research Areas in Computer Science

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Abstract

This paper analyses and discuss the three following areas in computer science: Operating and distributed systems with networking, security, and theatrical computer science. As computers evolve and technology develops at a rapid pace, specific areas of research within the computer science field stay the same by name but the components within this area change along with technology. Understanding this, there are several different areas to consider, but this presentation will briefly discuss how involved out computing environment is and the diverse nature in which it used. A theoretical computer science is also an interesting component, and this research focuses on theoretical foundations and related applications such as algorithm design and computational complexity. Finally, we will look at how security and how to incorporate it during the development and continuously monitored through the system lifecycle. Things such as access control, cryptography, and privacy are paramount to a secure system

Keywords—Computer Science, Distributed Computing, Theoretical Computer Science, Security.

I. INTRODUCTION

Computer Science is often difficult to define. It is probably because using the words computer and science together in the name. As we are aware, computer science is not just simply the study of computers but computers are just a tool and indeed plays an important supporting role in the discipline. The study of problems, problem-solving and the solutions that come from the problem-solving processes is the focus. Computer Science can be characterized as the study of algorithms (which are the solutions). However, we must be cautious to the fact that some problems do not have a solution and proving this statement is beyond the scope of this text.It is often common to include the word computable when describing the problems and its solution. If the problem is computable, then an algorithm must exist to solve it. Therefore, an alternative description of computer science is the study that is both computable and not computable. In any case, many factors play a role on whether a solution can be solved.

The are some common research areas that dig into the complexities of each area, but this presentation looks at three regions. The first being the distributed and operating systems and the networks they are in. This research area focuses on building the massive prototype infrastructure, the principals involved in the design and the implementation techniques. The next area considers the theoretical foundations of computer science and related applications. This digs into the rigorous methods of mathematical proofs. Topics often include algorithm design, computational complexity and the randomness in computation. Finally, security is another focus research area which looks at systems built to certain properties. Besides such technology, defending against attacks and demonstrating security flaws in systems that are thought to be secure. Topics in security include access control, cryptography, and privacy.

II. OPERATING SYSTEMS, DISTRIBUTED SYSTEMS, AND NETWORKING

A. Operating Systems

An Operating System is an interface between users and computer hardware. It is the software that performs all tasks for a computer such as memory management, file management, process management, handling the input and output, and controlling peripheral devices such as printers and disk drives. Some popular Operating Systems are Windows and Linux.

In general, the operating system is just a program that acts to interface between computer hardware and then controls the overall execution of all kinds of programs. The following are essential functions of an operating system.

- Memory/Processor/Device/File Management
- Security
- Job accounting
- Control over system performance
- Coordinating between other software and users
- Error detecting

Up to this point, we have been discussing what an operating system do in a single environment. However, as we look at this from a distributed system standpoint which deals with multiple central processors to serve multiple real-time applications and users. These processors communicate through various communication lines which are referred to as loosely coupled systems or distributed systems. The following section discusses distributed systems.

B. *Distributed Systems*

In today's world, networks of computers are everywhere. Of course, the internet is one of many networks of which it is composed. Corporate networks, mobile phones, campus networks, factory networks, home networks, in-car networks, either separately or in combination, share essential characteristics that make relevant to understand distributed systems. Distributed systems are usually defined as one in which hardware/software components communicate and coordinate actions only be passing messages. This simple definition can cover the entire range of systems or components in which a network of computers can usefully be deployed. Computers that are connected by networks may be separated by distance. They could be in the same room, in the same building or separate continents. With this understanding and definition of distributed systems, there are consequences to consider:

Concurrency: In a network of computers, programs running concurrently is the norm. Work can be done on one computer while work is being done on the other, sharing of resources such as web files or pages when needed. The capacity of the systems to be able to handle the sharing of resources can increase by adding more resource (for example, computers) to the network. The coordination of concurrently executing programs that are sharing resources is an important and recurring topic.

No global clock: Programs will coordinate their actions by exchanging messages. When resources or shared, close coordination often depends on common ideas of time by which the program's actions occur. As this coordination is happening, it turns out that there can be limits to the accuracy with which computers in a network can synchronize its clocks. There is no single global notation of correct time. This is a direct consequence of the fact that the only communication happening between distributed systems are be sending messages through the network.

Independent Failures: All computer systems can and will fail, and system designers are responsible for the planning of the consequences related to these failures. Distributed systems will fail in new ways. Faults within the network can result in isolation of computers that it is connected to, but it does not mean that the computer stops running. In most cases, programs may not detect whether the network has failed or has become slow Furthermore, the failure of a computer, or the unexpected termination of an application or program somewhere in the system (crash), may not be immediately made known to the other systems within its communications. Each system may fail independently, leaving the other still running.

Our desire to share resources and information is the primary motivation for constructing and using distributed systems. The term ‘resources’ is abstract, but it does characterize the range of components that can be shared throughout a network. It includes things such as hardware components such as printers and disks to software defines items such as data objects, databases, and files of all kinds. Video and audio files whether from the computer, tablet or mobile phone are also included. We have to consider that everything in today's world is connected. Today everything is connected. Whether is out phones, cars, TV’s and many other dives make us a distributed environment.

Trends in distributed systems are undergoing significant changes and can be traced to some influences:

- Pervasive networking technology emergence
- Ubiquitous computing coupled with desiring to support user mobility
- Multimedia demand services increase
- Distributed systems being viewed as a utility

Distributed systems are everywhere. As a user, the internet allows users throughout the world to access any services wherever they are located. Resource sharing is the primary factor for constructing these systems. Some of the consequences were discussed earlier int his text, however also understanding why constructing systems produce challenges:

Heterogeneity: This means construction from many different networks, computer hardware, programming languages and operating systems. The internet communication protocols allow for the differences in the network, and the middleware deals with the other differences.

Openness: These systems should be extensible. This is the first step in publishing the interface requirements of the components, but since the integration of these elements is written by different, this presents a real challenge.

Security: Using encryption can provide protection and keep sensitive information private while in transmission over the network, but denial of service attack are major problems.

Some other considerations are scalability, failure handling, concurrency, transparency and quality of service.

III. SECURITY

Protection of computers and information has become a major challenge since the age of equipment. Given the business operations widespread adoption of computer technology, the problem of securing our systems and information has become more urgent than ever. Whether its computer files, networking, databases or Internet applications all have become a critical part of organizations. As theses assets are strengthened, attacked or damaged, integrity becomes a problem which can lead to business operations disruption. The problem has only increased with the adoption of the Internet and the Web. As described above in distributed systems, the Internet has become a major highway for virus and malware.

A. *History and Security*

To truly understand computer security, we must look at the sequence of actions that have taken place to address the issue. The US government began with the Computer Security Act of 1987, which was created to help develop standards and guidelines to assess the cost-effective security and privacy of sensitive information for Federal systems. This started at all in regards to security and below are some other policies that have been adopted:

- The Joint Security Commission's 1994 report
- Executive Order 13010
- Presidential Decision Directive 63

Again these are just some of the policies created, and much more have been established. The key here is to understand how security has jumped to the forefront and needs to become one of the driving factors when developing systems.

The next step involved is an assessment of requirements. Every organization is trying to strike the right balance between security and daily operations. Usually, companies are afraid to apply security due to how it affects its day-to-day operations. Some key questions should be answered when trying to understand the organization needs of security

- How do we prepare employees to become security literate?
- Do we have the proper employees that can teach and implement the security program throughout the company?
- Technical solutions needed. (firewalls, encryption, access control, auditing)
- What are the priorities and the value of the information to the company

B. *Certifications*

Certifications have become very popular within the security industry. Along with the proper education, certifications can enhance an individual's knowledge base with continuing education. This certification is becoming a requirement within the workforce, and there are not enough certified individuals for employment opportunities available.

IV. Theoretical computer science

The last major area this paper will address is theoretical computer science. This is a scientific field that borders between computer science and mathematics. The area investigates general questions concerning algorithms and computations. It applies abstract models and mathematical reasoning to problems and computation. It addresses and provides a set of tools and different ways of thinking that applies to the different variety of challenges and it contributes to national security through cryptography protocols and computational science through algorithms. Through its core, it deals with fundamental and interrelated questions about computation. A variety of different topics fall into this study and include the following:

- Complexity and algorithms computation
- Limits of proof methods
- Logic and problem verification
- Power of randomization
- Cryptography
- Quantum computation

This list is not all-inclusive, and studying algorithms and the different systems and complexity are beyond the general scope of this presentation. Data models are used to formulate mathematical concepts. These models perform two aspects the value of the objects the data assumes and the operation conducted on the data. Tree models (an abstraction that models hierarchical structure) and list data models are some examples.

Next thing to consider are the methodologies in theoretical computer science. A brief description of the theories is below:

- *Induction*: proofs and definitions used in the basis and inductive steps to encompass all possible cases
- *Iteration*: The easiest way to perform a sequence of operations
- *Recursion*: Either directly or indirectly. This is self-definition which a concept can be developed and is defined regarding itself.

Theoretical computer science looks to try and investigate and understand the limits on computations and to discover the power of conceptualization paradigms. This helps developed approaches to problem-solving.

V. Conclusion

Looking at the future of computer science research is to how to employ, analyze, and interpret large data sets. In this paper, we briefly discussed only 3 of the major areas they represent the current research directions in computer science which were operating systems, distributed systems and networking, security and theoretical computer science. As computing involves every facet of our everyday lives and the data collection become ubiquitous, algorithms are needed to solve these problems are necessary to analyze and understand the quantities of information available. To develop these algorithms, mathematical foundations must be created all the large data sets and need to include the theory high-dimensional data and large graphs.

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