6. Computer Science Careers in the Global Economy

by

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Computer Science (CS), also popularly known as Information Technology (IT), has enabled numerous individuals all over the world to have highly successful and lucrative careers. The field started in the 1960s and became popular in the 1970s and 1980s and skyrocketed in the 1990s with the dot com boom. In spite of the dot com bust, it continues to produce a significant number of jobs in numerous fields. However, with globalization, outsourcing and the emergence of China and India as powerhouses in information technology, the opportunities for IT specialists are changing rapidly. Today, I would like to share some of my thoughts with you on the opportunities and challenges that computer scientists have in the global marketplace. I strongly believe that we cannot have CS/IT education as usual. We need innovative ways to educate our students in CS/IT, especially in interdisciplinary programs, so that they can be effective and thrive in an extremely competitive global marketplace.

First let us look at the history of computing. While many credit Charles Babbage and Ada Lovelace as the Father and Mother of Computing for the development of the early mechanical computers in early 19th century, electronic computing was born around the 1930s and 1940s. The work of the greatest minds in logic including Kurt Gödel (incompleteness Theorem), Alonzo Church (Church’s Thesis) and Alan Turing (Turing Machines) resulted in exploring the theory of computability which in turn resulted in the von Neumann machines of the 1940s. Soon after that, corporations such as IBM were formed followed by Control Data Corporation and Digital Equipment Corporation. Powerful mainframes were used for complex numerical computations to support scientists and engineers in the 1950s and 1960s. Then in the 1970s and 1980s, there was a revolution in computing with computers being used to store records, textual data and eventually multimedia data. Numerous computer science departments were set up in universities throughout the world and those who had their undergraduate degrees in other fields including even arts and humanities took conversion courses and subsequently got their masters degree in CS and had successful careers in IT. With the numerous opportunities not only in computer corporations but also in applications programming, there just was not enough supply of CS/IT graduates in those days. While there were some ups and downs in the computer industry in the late 1980s and early 1990s, the advent of the web and the Internet increased the demand for IT professionals a great deal in the late 1990s. Even those with English majors with some programming knowledge got into high paying IT work without knowing the fundamentals of computing. However, the dot com bust, together with jobs being outsourced to countries like India, made the computing community more realistic and focused. With the advent now of web 2.0, social networking and the application of computing in numerous fields, as well as non-computer scientists taking up in programming, we need to develop novel programs for computer
scientists. In the next few paragraphs, I will discuss my opinions of how we could devise novel and interdisciplinary programs in computing.

First of all, a computer scientist should have a solid understanding of the essentials. Therefore, every computer scientist must learn the following subjects: Algorithms and Data Structures, Computer Architectures, Automata Theory and Formal Languages, Theory of Computation, Operating Systems, Database Systems, Programming Languages, Assemblers and Compilers, Computer Networks and Distributed Systems, Artificial Intelligence, Software Engineering, Systems Modeling and Analysis and Information Security. These are what I call hard-core computing subjects and should be part of every CS curriculum. Furthermore, more advanced courses of these subjects can be offered for graduate degrees in CS in addition to some specialized courses. For example, those wanting to specialize in information security should also take some additional courses in Network Security, System Security, Data and Applications Security, Digital Forensics, Vulnerability Analysis, Web and E-commerce Security, Cryptography, Governance and Risk Analysis, Business Continuity Planning, and Legal and Policy Issues among others.

The question then is: are the courses described in the previous paragraph sufficient for a CS education? I believe that while these courses may have been sufficient for a CS education back in the 1980s and 1990s, in today’s competitive world with increasing number of non-computer scientists excelling in programming, CS grads should also have a minor in a second field (e.g., science, engineering, finance, arts, medicine, sociology, psychology, or law among others). Note that interdisciplinary research and education is becoming key to having successful careers. For example, a person in healthcare IT should not only have a strong IT background, but he/she must also have a solid understanding of healthcare issues. Therefore, a certificate, minor or even an MS in healthcare would be highly desirable.

Since I am most interested in integrating computer sciences with social sciences, I will give my views on what a PhD in CS/IT should do with respect to social sciences if he/she wants to work in say social informatics. First of all, the CS/IT education should include all the courses I have mentioned earlier. In addition, for analyzing social data, the person should have a solid background in the following IT areas: Data Mining/Machine Learning, Semantic Web, and Information Retrieval. An MS in social sciences would be ideal. The student should have a good knowledge of the following topics: Probability and Statistics, Economics, Social Theories and Methods, Sociology Principles, Risk Analysis and Supply Chain, Organizational Learning Theory, Game Theory, and Policy Management.

Gone are the days when a CS degree with the core subjects is sufficient. Corporations and even Universities are now looking for people who can not only excel in IT, but those who have excellent domain knowledge. Before the banking and financial crisis in 2008, typically investment banks hired IT folks, traders, and business specialists. The business specialists would go back and forth between the traders and the IT folks. Now traders are expected to know some IT. More importantly, IT folks are expected to carry out the functions of the middleman. This means the IT folks must have an excellent understanding of the business processes and finance issues.
My mentor, Prof. C. V. Ramamoorthy, mentioned to me last week “Mathematics is the Queen of Science. CS is the Queen of Engineering”. However, I believe that CS/IT is rapidly becoming the Queen of Queens or perhaps the King of Kings. IT has invaded every aspect of our lives – whether it is healthcare, finance, banking, accounting, security, energy or environment. We cannot have expertise in a stovepipe fashion. That is, expertise has to be well-integrated. To accomplish this we need a strong CS/IT education with a solid understanding of the application domains. Therefore, whether the person is a BS, MS or a PhD in CS/IT that person must have a minor, certificate, an MS or even a PhD in the application domain. Examples include PhD in CS with a JD, PhD in CS with an MD, PhD in CS with a Finance MS/PhD, PhD in CS with a MS/PhD in Social Sciences, or a PhD in CS with a MS/PhD in physics (e.g., for work in the high powered fields in nano technology or quantum computing). With such an education, we in the US will be in an excellent position to innovate and make breakthroughs and this will possibly alleviate the worries and concerns we have about programming jobs being outsourced. Therefore, our education should not be rushed. We need to plan about 10 years of education at least starting at 18 and some of this education should be in the form of industry experience. We need very strong public-private-academic partnerships to make our next generation of CS/IT grads extremely successful and competitive in the global marketplace.

I believe that globalization is here to stay. We cannot now go back to the post-war era (1950s) or even the pre-web area (1980s) Therefore, companies will continue to outsource to show profits to the investors and please their boards of directors. Therefore we have to be several steps ahead and ensure that our children and grand children are properly and truly educated so that they need not fear globalization, outsourcing and immigration. As President Franklin D. Roosevelt has so eloquently put it: “the only thing we have to fear is fear itself.” We have to bravely face the challenges of the global economy by getting the best education we can possibly have. Furthermore, the focus should not be on just getting degrees. We should have a very strong appreciation of the areas we get into and take our education very seriously and acquire true knowledge. Every move we make should have a strong purpose that will take us closer toward our vision and goals and ultimately serve our nation and help humanity.

I would like to leave you with the famous quotation of Sir Francis Bacon “Knowledge Is Power”. As stated in its wiki entry, “The famous phrase scientia potentia est is a Latin maxim - For also knowledge itself is power - stated originally by Francis Bacon in Meditationes Sacrae (1597), which in modern times is often paraphrased as "knowledge is power." The phrase implies that with knowledge or education one's potential or abilities in life will certainly increase. Having and sharing knowledge is widely recognized as the basis for improving one's reputation and influence, thus power. Sir Francis Bacon was truly an interdisciplinary researcher and visionary. As stated in his wiki entry, “Francis Bacon, 1st and Only Viscount of St. Alban, KC (22 January 1561 – 9 April 1626) was an English philosopher, statesman, scientist, lawyer, jurist and author. He served both as Attorney General and Lord Chancellor of England.”