Foundations of Computing and Communication

Lecture 1: Introduction
A University Education
Overview

• Announcements
• What is a ‘University Education’
• The Foundations of Computing
  – Historical Background
  – What is Computation?
  – IT in Society
  – Computation and Intelligence
Announcements

• WEEK 1 Tutorials
  – Yes they are happening, please attend
Universities, Degrees and Education

• The Bachelor of Information Technology
  – Qualification for a job
  – Valued certificate of knowledge and proficiency
  – Provides skills needed to work in the IT industry
    • Programming
    • Database design
    • Software engineering
    • Networking, etc
Traditional View of the University

• University strongly differentiated from a technical college
• Technical college designed to teach ‘techniques’ necessary for a trade or profession, i.e. provide a training
• University not just in the business of training people for a job, the aim is to provide an ‘education’
• Obtain an ‘educated’ perspective over a particular field of knowledge
• Something of value that will endure longer than the latest technique
Ideals of Education and Reason

- University is the ‘church of reason’
- Dispassionate perspective – not swayed by feelings or self-interest
- Questions decided on basis of evidence, critical balanced analysis of facts, not on feelings, revelation or superstition
- Knowledge of argumentation guards against deception
- Knowledge of history uncovers prejudice of the present
- Educated people can ‘think for themselves’, do not uncritically accept what they are told, or what they have been brought up to believe
The Information Technology Industry

• Most of the facts and techniques that you have and will learn during your education will become obsolete during your working career.
• What will be of practical use will be your ability to adapt, to see what is important, and to learn new skills.
• But how do you learn to see ‘what is important’?
• This depends on your having developed an informed perspective on the world you will work in - in this case the IT industry.
• From such a perspective (if it is a good one) you can see the context - what is important, what needs to be done in a given situation, where to go in your career, and so on.
• But you can only finally develop such a perspective by working and living in the everyday world of the industry.
• So (you may ask) what is the good of a university education?
Learning How to Learn

• At one level university is a place (or should be) where you learn how to learn - and where you learn how to see and think clearly.
• Once you have mastered that then you will have the ability to handle the work world and all its changes and challenges.
• But how do you learn how to learn?
• Firstly, you do a lot of learning.
• From that you can see how to go about discovering facts (information) on your own - and how to dismiss opinion and heresay.
• But learning isn’t just asking Google or going to the library.
• Learning finally involves understanding - putting all the facts together into a coherent whole in which everything you have learnt falls into place - then the thing you need to know in a given situation emerges immediately without you having to laboriously remember it.
Understanding

• Understanding is mysterious.
• You can’t pass it on like facts. You can only put yourself in the situation of learning: reading, trying exercises, asking questions, etc.
• The most important thing is to see when you don’t understand something.
• When you don’t understand then that’s the signal that it’s time to expend some effort.
• Knowledge of an area grows in levels, like a hierarchy - as you go up a level then everything that was previously separate and required effort to understand and remember, comes together and ‘makes sense’. After that you can use the knowledge at that level with ease.
• Then there’s the next level - and university courses go up in levels like this - at the next level you have to put together several things that you understood at a lower level to form a new higher level understanding or synthesis.
Not Understanding

• If you miss out on a level of understanding then the rest of the course (at university) will start to become incomprehensible, you will stop enjoying what you are doing and (probably) start avoiding facing up to the situation, e.g. by not attending class and/or blaming the lecturer.

• As an example, this can happen when trying to understand how pointers work in a programming language like C or C++.

• The signs are that you start guessing how the code should be, and keep compiling until it ‘appears’ to work. Or you copy some code that someone else wrote from the web. In either case, you don’t understand the code and that will make you uncomfortable at a certain level (even if you don’t consciously admit it).

• Such being uncomfortable is a sign that you need to face up to what you don’t understand. It’s a good thing - it’s the energy you need to learn something new!
Questioning

• It’s all very well to say that if you don’t understand something then you need to make some effort - but if you don’t understand something then the problem is you just don’t know what kind of effort to make.

• If understanding were like collecting facts then we could invent rules - if you don’t understand X then do Y.

• But understanding is mysterious.

• If you don’t understand something and you have collected together all the facts you can, asked all the books and people you can, and still don’t see it, then what do you do next?

• Answer: you have to live with it - you have to keep with it as a question, you have to look at examples of what you don’t understand, and you have to go to bed at night having looked at what you don’t understand and wait to see if there is an answer in the morning.

• In other words, you have to live with your not knowing, your not understanding, you have to go through it.
Understanding Computing

• If you study an area like computing and information technology then your understanding will naturally move to higher levels.

• Finally, if you really enjoy asking questions and understanding things, you will start to inquire into what computing itself is, what information technology is, and how it all connects with the rest of the world.

• Now, most people, if you ask them what computing is, or what information technology is, will give you an answer, because, of course, we all use the words, and so we can explain the meaning we attach to those words.

• But, if you were to ask a person to explain exactly what an algorithm is, for instance, or what makes a computer a computer in terms of the way it functions ‘inside’ then the average understanding would turn out only to be an ability to indicate that “that thing there is a computer” and to describe a few of the things you can do with it.
Going Beyond Technical Education

• In starting to ask questions about what computing and information technology are (in themselves) we move beyond a merely technical perspective.

• It is often thought that a university education exceeds a purely technical education because you develop higher levels of understanding - you grasp the theory that lies behind the practice - such as the theory of formal languages that underlies programming languages.

• Yet any mastering of technique involves understanding and an element of theory. And many think that a discipline like information technology is entirely a matter of learning techniques along with the necessary underlying theory to use those techniques effectively.

• So what else is there to know? What does (should) distinguish a university education from a purely technical education?
From Technician to Graduate

- A technical education is about learning techniques. A technique is a method - a set of rules that you follow. As your understanding grows you can follow new techniques and become an expert in your field. As an expert you will be able to command a high salary and engage interesting work.

- But being a professional (should) involve more than just being good at what you do - it involves seeing how your work is enmeshed within the rest of society, how what you are doing affects others.

- Think about the people who sold the loans in the USA that precipitated the global financial crisis. They were following techniques - very effective techniques (in the short-term) - but they were not seeing the social and moral consequences of their actions.

- You can only assess social and moral consequences of your work on the basis of an understanding of the world in which it is applied, of what it is being used for, what it is, where it is going …

- These are finally philosophical questions that cannot be answered according to any technique because they involve your understanding of yourself, of human society, its history and your place within it.
Foundations of Computing

• So, the aim in this course is to seriously ask: What is computing? What is IT? And how do they fit into the world as a whole?
• These are not ‘technical’ questions - they are not directly concerned with the theory and practice of designing, building and maintaining IT systems and as such you may not see them as relevant to your career as an IT professional.
• But finally you will need an overarching perspective within which to place everything that you have and will learn about computing and IT.
• And, to build this perspective you will need to learn how to ask fundamental questions about the area in which you work.
• It is not enough just to ask how to do something - a complete understanding also asks what something is - its meaning and purpose.
• And the first place to inquire into what something is, is to look into its origins. This requires a study of the relevant history, not a history of facts, but a history of ideas.
So What is Information Technology?

- This is not a question that can be casually answered and learnt - it requires genuine effort to see behind the artefacts into the nature or essence of technology as such.
- As an introduction we shall consider that the essence of information technology is a way of thinking, a way of approaching problems, breaking them down into something that can be ‘formally’ specified, expressed in computer programs, modified as a system and controlled.
- Technology/technique is a method of control – to get desired outcomes – and IT is one of the latest and most powerful forms of technique.
- IT is basic characteristic of modern life, defining
  - How we work
  - How the economy operates
  - What we know/how we know it
  - How we are educated and how we spend our leisure time
Motivating Questions

• Although technology continually progresses and changes, does it possess an underlying character that does not change?
• Can we consider technology to be ‘neutral’, i.e. just a tool to make our lives easier, something we control and use for our own ends?
• Or does technology embody a hidden agenda? Who is directing the progress of technology? Who does it benefit? Is technology primarily being used to improve our quality of life?
Topic Overview: Historical Background

• Computer technology did not just happen overnight
• It is the culmination of over 2,000 years of development in mathematics, logic and science
• The idea of such a thing as a computer as we know it could only have been conceived of in recent times
• Not so long ago the human race found it difficult to conceive of a number as something distinct from something being counted
• The computer represents the culmination of an enormous effort to abstract human intelligence from everyday experience
Topic Overview: Historical Background

- Our technology and our attitudes towards it have arisen due to a particular historical development, the roots are embedded deeply in a culture that we have virtually forgotten.
- To understand where we are, we have to examine how we arrived here.
- Hence the first part of the course looks at the historical foundations of information technology, particularly the development of mathematics and science.
Topic Overview: Computation, Computing Machines

- What exactly is computation? How can it be realised in a computing machine? These are questions that were clearly answered very early in the computer ‘revolution’
- The notion of a computer language and a computer program have far reaching ramifications for our understanding of human intelligence and human society
- Hence we will look at the theory of computation and basic computer architectures, to try and grasp the essence of computation
Topic Overview: Technology and Society

• More and more the different societies on earth are adopting the same path of development – the technological path – and hence all human civilisation is becoming more homogenised, more connected, more ‘global’
• Human problems are seen as technical problems, amenable to technical solutions – religious, moral and ethical considerations are becoming secondary
• Obtaining the consent of the populace is now a technical problem of controlling public perception
• The central issue is what is the most efficient (technical) way a problem can be solved while still adhering to the ideal of technical progress
Topic Overview: Information Technology and Society

- Information technology has enormously expanded the reach of technical organisations and their ability to control the earth’s human and natural resources.
- Human communications are now more and more mediated by technology and controlled by technological considerations.
- Is our culture anything more than the aggregation of these techniques?
Topic Overview: Computation and Intelligence

- Understanding of human intelligence strongly influenced by computational model
- Materialists see the human race as biological machines evolved by natural selection
- What relevance do ideas of subjectivity, consciousness and spirit have in the modern world of technology and technological education?