

# Computer Science: At the Cross-Roads of Humanity<sup>1</sup>

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## Introduction

In this essay, I wish to do three things.

I wish to consider the contributions of, and the relevance of, computer science to humanity and I intend to demonstrate that computer science is centrally involved in many facets of humanity and society; that it is, in fact, 'at the cross-roads of humanity'.

I wish to suggest that humanity itself is at a cross-roads, especially from the perspective of the evolution of society, that we need to make some fundamental decisions in choosing the road ahead. In this I will pick out two areas which, for me, form the basis of our continuing development of humanity (or lack of development, as the case may be). These areas are ethics and philosophy.

In the process, I will argue then that computer science and computer scientists have a major role to play, in concert with all colleagues from every reach of the Arts and Sciences, in understanding these choices and in leading the way forward down the right road. Our principal task as educators in a university is to highlight these issues, and to discuss them actively with our students, so that we create leaders for tomorrow's society, leaders capable of guiding society forward in the direction of increasing humanity.

In all this, I have a number of key messages.

At one level, there is the simple message that software-based computing systems are so ubiquitous that they are becoming the root of all our work and recreation in modern society; and that the computer is in a sense a universal machine which is fast becoming indispensable to mankind.

At a different, deeper, level I also wish to convey that computers, though universal machines, are still no more than 'fast pencils', modern-day extensions of our intellectual capacity, in exactly the same way as the use of iron in the creation of the spade and the plough extended our physical capacities thousands of years ago. However, what we choose to design with these pencils is up to us as human beings. Significantly, it is not clear now that we will use them well, just as it was not clear centuries ago that mankind understood that plough-shares were better than gun muzzles.

Crucially, the ubiquity and the power of the pencil itself heavily influences the way we conceive the world — when your only tool is a hammer, everything around you begins to look like a nail — and we need to be very careful not to believe our own self-invented view of the world, that is, not to fall into a form of technological fundamentalism.

I hope also to entertain a little in this essay! I will endeavour to do so by resorting to some poetry whose verse may catch a little of the messages I am trying to convey.

## The Contributions of Computer Science to Humanity

Let us begin by considering the contributions of computer science to humanity. The examples are legion. For instance, in the arts we have software-controlled recording laboratories; remote access to the art galleries world-wide through the World-Wide Web; and computer-assisted music synthesis such as timbre morphing.

In the Sciences, the presence of computer science is very strong, especially in that new branch of science — computational science — which bridges the gap between the theoretical and the empirical, facilitating experiments which are too complex to address analytically and too expensive to address empirically. Examples include the simulation of chemical reactions, molecular modelling, simulation of high energy physics. But we must also remember that much of modern scientific equipment could not function were it not for automatic computer control systems. And in science we cannot neglect computer science itself and its evolution. In the past, almost all computation was carried

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out digitally by electronic semi-conductor devices. In the future, we may well see the widespread realization of alternative technologies such as acousto-optical computing.

Engineering too has benefitted from the development of computer-based systems for modelling of fluid dynamics, computer-aided design (in all areas, civil, electronic, mechanical, aeronautical), and for the simulation of the behaviour of materials under failure conditions.

Economics and economies have exploited and continue to exploit computer and communication -based technologies. The banking industry could not survive without transaction processing systems, automatic teller machines, and point-of-sale verification terminals. Neither could the stock exchange function without computer-mediated transactions and communications. Whilst major economies and corporations have long traded electronically, we are today witnessing the advent of domestic electronic commerce *via*, for example, the WWW. The economies of countries depend on the successful use of software-based analysis of geological data for oil and mineral exploration. The same is true in the use of remotely-sensed satellite and airborne imagery for crop control and environmental monitoring.

Modern medicine depends on computer systems, almost to an alarming degree: advanced diagnostic imaging techniques, such as computer aided tomography (CAT) and magnetic resonance imaging (MRI) are totally dependent on computers systems. In reconstructive surgery we are now using computer-based 3-D imaging to assist in the assessment of pre- and post-operative procedures. In the future, it is likely that remote and rural areas will benefit from the deployment of telemedicine whereby specialists and consultants in major hospitals will be able to carry out routine checks on patients in local clinics.

Some of the most advanced systems theory is carried out by computation biologists, such as the autopoietic model of cell self-regulation (although it is arguable that this is a contribution of biology to computer science rather than vice versa!)

Travel today is heavily dependent on computer-control: from the Airbus fly-by-wire systems, to satellite navigation systems, air traffic control, and, indeed, road traffic control.

Education is beginning to exploit computer-based systems although much remains to be done to validate that there actually is a pedagogic benefit to the adoption of some of the much-hyped computer-assisted learning systems in traditional educational forums. However, the main take-up of computer-based system may be in the new education media such as in remote learning *via* the WWW and in the use of virtual reality simulations, such as in animal and human dissection exercises.

We have already mentioned agriculture and the way it can benefit from remote-sensing data. But the forestry and timber industry too benefit from computer modelling systems such as the structural modelling of Sitka spruce.

The list of example goes on: meteorology, weather forecasting, and climatology are amongst the hungriest users of computing power. The manufacturing industry has long depended on computer systems, either for visual inspection, robot control, or management information systems. White-collar industries are amongst the world's foremost consumers of office information systems based predominantly on the ubiquitous PC. The communications industry too, with software-controlled digital switching, and micro-processor controlled mobile telephones exploits the fruits of computer science, in addition to micro-electronic and communications engineering. Even police forces and forensic services depend, for example, on software image enhancement to extract evidence. Government services could not survive without sophisticated databases and the military's use of computer equipment is renowned: the euphemistically-entitled 'target acquisition' tasks all depend on sophisticated computer processing of sensor data as do the navigation systems of, e.g., cruise missiles.

I hope you are impressed by all of the foregoing. But I hope more so that you are *somewhat nonplussed!* I seem to be suggesting that all of these contributions in some amorphous way represent the sum totality of humanity. Surely I have presented no more than a catalogue of human endeavour? Is there anything in the above which one would herald as a significant contribution to the humanity of mankind, as opposed to the growth in our technological prowess? I believe not. In all of the above, I have left out some of the chief defining factors in the nature of humanity. Culture, Social Behaviour, and Philosophy. But before turning to these, let's also consider the importance of humility! The foregoing catalogue of human achievement in all spheres of life, impressive though it is, is also a pastiche of the arrogance of western man, supremely confident that he has at last mastered nature. We are drifting further and further down the stream of rational and technological vanity, borne, I have to say, on a current of scientific progress. As we shall shortly see, such arrogance is not only ill-founded but it is a very dangerous thing.

This is probably a good time for a poem!

I walked out in my Coat of Pride;  
I looked about on every side;

And said the mountains should not be  
Just where they were, and that the sea

Was out of place, and that the beech  
Should be an oak! And then, from each,

I turned in dignity, as if  
They were not there! I sniffed a sniff;

And climbed upon my sunny shelf;  
And sneezed awhile; and scratched myself.

James Stephens — *The Fur Coat*

Let us now take a look at these three defining factors of culture, social behaviour, and philosophy.

Culture, it seems to me, reflects the priorities of a society: what it feels worthwhile. In a sense it is a derivative of society; a manifestation of society's long-term biases, a behavioural and psychological memory of society's intellectual and emotional values. So, to understand culture, we must look further afield: to society in general.

Society, and societies, have as their hallmark the fact that they are populated by individual members and the characteristics of the society as a whole are essentially a function of the interaction of these individual members and the dynamics of these interactions. In turn, the global societal values reflect the set of values which are in some sense permissible for the long-term stability, and evolution, of the society, sometimes with complete disregard for the predilections of minority elements in the community. In a society, all are equal but some are more equal than others. These some are those who have power. Power itself may derive any different sources: physical might, financial strengths, or, knowledge of some form. Historically, this power has been used to control the resources, or raw material, which form the foundation of the economic activity that ensures the material well-being of the society. At the end of the 20th century, we are witnessing the dawning of a new age — the information age — which is quite different from what has gone before. The difference is predicated on two factors: the primary economic raw material and the provenance of this raw material.

Specifically, information is the natural resource of the new industries; it is the raw material of wealth creation in the developed world and it is beginning to supplant, if it has not already supplanted, the traditional resources which once made empires great (or, at least, wealthy). This fundamental shift in raw material presents great opportunities for nations and economies which did not have access either to know-how or the resources that fuelled the industrial revolution. However, it also brings with it some dangers, for the coming of the information age is not borne of an evolution of technical capability but, instead, of a revolution in technological prowess. And it carries with it, as have all technological and scientific revolutions, the potential for a fundamental shift in social patterns and social organization. Later on we will look at the possible impact of these shifts, but for the moment the chief point which I wish to make is that it is computer science, communications engineering, and their convergence, which are the primary components of the engine that is powering this new age. Computer science is having a pivotal impact on the evolution — or revolution — in society.

And so let me now turn to philosophy. What possible impact could computer science have on the area of philosophy? I wish to argue that computer science today plays a central role in the on-going development of philosophical argument, especially in the domain of ontology and epistemology. Specifically, the branch of computer science known as artificial intelligence — which represents the epitome of the ignorance of man in his unending quest to understand himself, in this instance by re-inventing himself — is in its attempts to simulate or construct co-operative autonomous agents intrinsically involved in the resolution of the epistemological conundrum caused by the apparently commonly-held world-views and languages of quasi-independent sentient entities or life-forms.

In addition, if we consider the research of computer vision systems, systems which can visually sense and understand their surroundings, it is clear that the problems of perception and the relationship of the system to its environment are at the core of the endeavour. This, in turn, leads one to consider the nature of reality, of what part of one's perceptions is

in the perceiver and what part is in the environment. These issues cannot be addressed in any substantive way without reference to the classical models of reality, whether it be the realism of Ockham, Gallileo, Hobbes, Locke, Hume, Moore, or Russell, who all, in one form or another that reality is external and is perceived by the senses. Perception is conceived as a causal process whereby physical stimuli act on the sensory apparatus to produce ideas (or representations, in the modern parlance). In all realistic viewpoints, there is the underpinning assumption that reality exists — it is there — and, whether rationally by reason or empirically by sense, we apprehend it and thence come to understand its form and structure.

Idealism, at the other end of the spectrum, is a doctrine which posits that reality is ultimately dependent on the mind and has no existence outside of it. In one sense, this doctrine denies absolutes since, without a single mind, there will be many subjective realities. If Locke was the quintessential realist, then Berkeley was the quintessential idealist. Berkeley developed, and subscribed to, the philosophy that nothing exists save that which is perceived by a mind. This is neatly summarized by his famous aphorism ‘esse est percipi’ — to be is to be perceived — and, thus, the reality and existence of an entity is premised upon that entity being perceived (or perceiving). This is not to say that the entity ‘vanishes’ if it is no longer perceived nor that it is in some sense ethereal: the entity ‘really’ exists but Berkeley’s position is that our idea about it are based on our perceptions of it. In this sense, Berkeley is also proposing an empirical point of view: that our knowledge of the world is gained exclusively from our senses. On the other hand, Berkeley denied the existence of matter: what exists is that which is perceived, and it exists because it is perceived. Reality pervades all perception but corporeal matter has no place in this scheme. This denial of the reality of matter is significant for it clearly distinguishes Berkeley’s empirical idealist notions of perception from the realist, empirical, notion that perception is an abstraction or apprehension of the (material) world *via* a causal process of sensing.

Immanuel Kant was also an idealist, but his views differed significantly from those of Berkeley. Kant differentiated between *noumena*, the domain of ‘things in themselves’ and *phenomena*, or the ‘appearances’ of things as they are presented to us by our senses. Kant argued that noumena are not accessible to us, and cannot be known directly, whereas the phenomena — the contact we have with these things via our senses and perceptions — are the basis for knowledge. Kant refers to noumena as ‘transcendental objects’ and his philosophy is sometimes referred to as ‘transcendental idealism’. Thus, Kant admits the ‘reality’ of a domain of objects, the unknowable noumenological domain. On the other hand, he maintains that the objects of our experience are the only knowable objects and it is the mind that shapes and forms these sense data and, hence, for us, these objects are the only objects that really exist and they exist *because* of us and our minds. Reality, then, exists as an unknowable, non-sensible, noumenal domain which gives rise to the phenomenal domain of our senses. Viewed in this light, Kant can also be seen as supporting a form of realism. This is significant as it is a position which has begun to be echoed in the work of current philosophers. In any event, the idealist tradition did not stop with Kant and has been added to by, *e.g.*, Schopenhauer, Nietzsche, and Hegel.

Time for another poem!

Everything that I can spy  
Though the circle of my eye;

Everything that I can see  
Has been woven out of me!

I packed the sun with fire, I threw  
Gold of morn, of noon and eve

In the deeps and steeps of blue!  
And all else that I perceive,

Sun and sea and mountain high,  
Are made, are moulded by my eye!

Closing it, I yet shall find,  
All that is in the mind.

James Stephens - *Everything That I Can Spy*

There are many variations on these two themes of idealism and realism, perhaps the most famous of which is *dualism* which holds that reality comprises two distinct ‘substances’: one physical and one mental. To clear up any confusion we might remark here that realism and idealism are both monistic philosophies, *i.e.* reality is comprised of one ‘stuff’. Dualism, then, stands between and accepts something of both of these two extreme types of monism. Dualism was first propounded as a philosophical system by Rene Descartes who argued for the existence of *two* domains of reality: one corporeal and one non-corporeal. Both mutually-exclusive domains exist concurrently. It is this mutual exclusivity which has caused dualism most of its problems for, if they are truly mutually exclusive, how can they interact? This difficulty has been transposed into modern philosophical debate as the so-called ‘mind-body’ problem. Here, one is faced with the problems posed by the premise that there are two domains: one, the body, and the other, the mind. The body is the corporeal reality while the mind is the metaphor, or mechanism, depending on your standpoint, for non-corporeal reality. Again, we are presented with the obvious paradox that if these are mutually exclusive entities, then how do they ‘communicate’ as they most manifestly do?

Realistic positions suffer from the problem that all empirical knowledge is exactly that: sensed, perceived, and is thus acquired *indirectly*. It begs the question as to *what* really is being perceived. When we note that most of our modern scientific knowledge has been acquired indirectly using instruments, such as radio telescopes and electron microscopes, which augment our natural sensory apparatus, it is quite clear that our empirical knowledge is gained indirectly. Indeed, Wittgenstein, who had a profound influence on the development of logical positivism, in his later work argued that it is language which gives us our conceptions of reality, but 'language is only the film on deep water'. In a remark in his earlier work, he notes that there are things about which nothing can be said: 'We feel that when *all possible* scientific questions have been answered, the problems of life remain completely untouched'.

There has, however, been a development in philosophical thinking, which begins with Kant's distinction between noumena and phenomena, and has evolved into a type of reconciliation of the idealist and the realist positions. It was developed by Edmund Husserl who held that reality is personally and fundamentally phenomenological but is set against an objective spatio-temporal world. But it was best espoused by Martin Heidegger. Heidegger denied the dichotomy between the world and 'us' and saw existence or 'being in the world' as our activity in a constitutive domain. Reality does not exist 'outside us'; we are beings in a world, not disjoint from it. To recall Thomas Hardy: 'In making even horizontal and clear inspection, we colour and mould according to the wants within us whatever our eyes bring in'[Far from the Madding Crowd]. I believe that it is this commonly-accepted disjointedness, this subject-object duality or polarity, which underpins conventional rationalist and empiricist understanding of science and which is the cause of so many of our philosophical problems. It is significant too that our language, with its subject-object structure, promulgates this mode of thought and understanding. What is real is experience and, in particular, our experience of being. What we perceive depends on what it is we are. This thesis is central to our development of a sound philosophical basis for a scientific investigation of the possibility of replicating (or synthesizing) artificially perceptive systems, artificial intelligent systems, or indeed artificial life, three of the principal concerns of computer science.

I pause beside the stream, and hear  
The waters talking on the way;  
If I had a proper ear  
I could tell you what they say!

Yon lovely tree against the sky,  
Which the sun first rests upon,  
Has a message for my eye;  
If I had a proper one!

On the golden heath a wind  
Whispered to me as I stood;  
If I had a proper mind  
I could answer, so I could!

I am deaf and dumb and blind!  
No reply can I invent  
When a stream, a tree, a wind,  
Asks am I intelligent.

James Stephens — *Barbarians*

## Humanity at a Cross-Roads

In the previous section we spoke of the dawning of the Information Age and the part which computer science is playing in powering its development. We intimated that this dawning may not be without its dangers and it is to this point that we now return.

In the past, the power of individuals and societies has often been predicated upon their having exclusive access to knowledge. Indeed, this knowledge was tightly guarded by the few people who were the keepers of this knowledge. Specifically, the empowering was achieved exactly because the knowledge was held by a relatively *small* number of people. What made countries great during the industrial revolution was not that they had great natural resources but that a small number of people knew how to process them and exploit them (and, often, exploit the sources of the natural resources).

The information age is quite different from this. There is occurring a fundamental reversal in the order of things. Now, information — and access to information — is the province of everyone, at least in the so-called western world.

Information is the natural resource of the new industries; it is the raw material of wealth creation in the developed world and it is beginning to supplant, if it has not already supplanted, the traditional resources which once made empires great (or, at least, wealthy). This is good, given that information is a resource which is potentially the product of any human mind, and thus knowledge, that which information begets, is potentially capable of empowering vast numbers of people world-wide. And that brings with it the possibility, although not necessarily the certainty, of a much more egalitarian society. This emancipation through accessible information also brings with it some dangers, for the coming of the information age is not borne of an *evolution* of technical capability but, instead, of a *revolution* in technological prowess. And it carries with it, as we have said, the potential for a fundamental shift in social patterns and social organization.

In the following, I wish to look at the possible implications of this shift in culture and society and, in particular, I wish to assess the very real dangers that confront humanity as its people are emancipated: given free access to information and free rein to use and to interpret it just as they wish. In particular, I wish to focus on the individual and his or her personal behaviour and the values which guide that behaviour as I believe that if we fail to do so then the great positive potential of emancipation can very quickly become a creeping erosion of what makes society meaningful: its humanity.

The hallmark of the advent of the information age is, as we noted above, the proliferation of communications. The Internet and the WWW are not so extra-ordinary for their information content but for the fact that all of the information which they embrace is transparently available to anyone who cares to look at it anywhere in the world. Thus, the advent of the information age and the information society is helping to accelerate the transformation of the world's individual societies into a global village. This is a transformation which is being echoed in several other domains. The growing awareness of the ecological sensitivity of the earth is making us conscious that any action we take in one part of the globe has an effect on all other parts of the globe. So too in industry and commerce, where multi-national corporations and small businesses alike are being forced into forging strategic alliances with other companies elsewhere in to world in order to compete in an every more 'globalized' market. Nowadays, it is common for a company to manufacture parts on one continent, assemble the product on another, and sell it on yet another.

And yet, the free global access to information may have the most profound effect of all, not on the ecology or the economy, but on human society. Why? If every person is able to read and to view and to hear all of the information on the increasingly domesticated WWW, so too are they able to express their own views and to make available to everyone else their own brand of written, visual, or aural information. The WWW and the Internet enable not just complete freedom of speech but they provide a global platform or soapbox. There is no censorship on the 'net' and, despite emerging attempts to enforce some form of regulation, given the complex interconnectivity of the 'net', it is highly unlikely if there will ever be any effective censorship. Significantly, with the increasing pervasiveness of satellite transmissions, this trend is being mirrored in other global communication media.

All of this is very positive, of course, especially in an ideal and altruistic world. But we don't live in an ideal and altruistic world and, with all of the interesting and educational information on the 'net', there comes as well huge amounts of material which some might consider seditious, or pornographic, or racial. Just about every topic conceivable is catered for: from sado-masochism to paedophilia to fascism. It's all there sitting alongside the information which we might consider 'normal'. The key point in this is not the availability of the information but that it all resides in one global infrastructure without any differentiation whatsoever. To the browser on the WWW, to our children, there are no absolute values anymore: it's all just information to be looked at and assimilated and any value it has or doesn't appear to have is entirely relative to the disposition of the individual, an individual who is now more free to choose than at any previous point in the history of mankind.

The endless cycle of idea and action,  
Endless invention, endless experiment,  
Brings knowledge of motion, but not of stillness'  
Knowledge of speech, but not of silence;  
Knowledge of words, and ignorance of the Word.  
All our knowledge brings us nearer to our ignorance,  
All our ignorance brings us nearer to death,  
But nearness to death no nearer to God.  
Where is the Life we have lost in living?  
Where is the wisdom we have lost in knowledge?  
Where is the knowledge we have lost in information?  
The cycles of Heaven in twenty centuries  
Bring us farther from God and nearer to Dust.

T.S. Eliot — *Choruses from 'The Rock'*

Clearly, the information society affords very significant intellectual freedom — emancipation of thinking — but along with that freedom comes the hazard that this freedom will not be used in a manner which contributes to the greater benefit of *human* society, as opposed to the *information* society. Or, if one wishes to cast this in less idealistic language, there is a significant hazard that the humanity in society may regress rather than progress. This is the dilemma of emancipation in the information society. With freedom comes responsibility: the responsibility to choose well rather than poorly, to opt for 'good' rather than 'bad'. The questions then which necessarily arise are: what is 'good' and what is 'bad' and, perhaps more importantly, what guides our development of an understanding of good and bad and right and wrong. These are old questions which are ultimately concerned with the development of a value system — a system of ethics — in a society. Paradoxically, the emergence of the fact-based value-neutral information society makes them more pertinent questions than ever before. I would like to suggest that now more than ever our young people and our children, who are the ultimate owners of the information society, need a framework for the development and adoption of these values. I place heavy emphasis on the word *development* in the previous sentence for I suspect that any attempt to foist values or ethics on young people in any dogmatic manner in the information age is doomed to failure. These are people who are intellectually liberated — who see the process of questioning and challenging received wisdom as an inalienable right — and they will not accept values unless they themselves perceive them to be meaningful for their lives. The only way that this can come about is for them to be empowered to develop these ethical values for themselves, by providing them with choices and providing them with a framework in which they can understand the implications of these choices.

I believe that all groups in society who are concerned with education — schools, universities, and, indeed, religious organizations of all denominations — must play its part in this process. Traditionally, these agencies, together with the conventional family and peer groupings, have been the primary mechanisms by which the values of a society have been passed on from generation to generation. However, if this educational forum is to be in any way successful in rising to the current challenges, I believe it must adopt a more dialectic stance, with less emphasis on dogma, and more emphasis on the development of understanding through the exploration of the experience of the individual, for this is the way in which values are developed and, especially, adopted. This is perhaps best summed up in the words of J.G. Bennett:

'Unless knowledge can be brought into a coherent system, we shall either have to abandon the hope of finding man's place in the universe or else to accept, with pious resignation, dogmas that disregard the lessons of natural science, and acquiesce in the continuing divorce of fact from value that has been the chief cause of our present bewilderment.'

If the global intellectual emancipation of the individual is a hazardous, albeit a good, development for humanity, there is yet another related development which has accompanied the proliferation of technology. With the opening blow to the grand ego of man dealt by Copernicus, displacing us from the centre of the universe, to mortal wounds inflicted by Einstein's relativity and Schroedinger's quantum mechanics in placing absolutes forever beyond our grasp, surely the *coup de grace* to our collective egos is now being delivered by the apparent reduction of life to the information content of DNA and the purported mechanization of mind by modern computer science? Perhaps. But is this supposed inexorable demise in the importance of the individual as frightening as it seems? Young people appear less concerned about the need for certainty as were their forebearers and they seem to attach less importance to their own individual fears and more importance to the global ecology. From the apparently despondent chasm of modern materialism is springing an understanding of the limitations of our own knowledge and, indeed, the limitations of knowledge itself. Humanity has a choice to make here: to retreat from the advances of science into a religious fundamentalism which is unwilling to enter into any dialogue on the matter, to adopt a thorough-going scientific fundamentalism which is unwilling to accept that there are any epistemological limitations to knowledge, or to realize that, above all else, we are intelligent but ignorant beings whose totality of experience is far greater than a shallow collection of facts, facts, worse still, grounded in an inherently limited epistemology.

In the information age, we have unprecedented intellectual freedom — we are emancipated — but, in this new-found sea of fact, we have lost our anchor and there exist no absolutes any more. If we are not to drift, we must have a compass: a value system, a system of ethics, a set of beliefs. All of which are meaningless if they are not grounded upon one's own personal experience. The answer, I believe, lies in the creation of a deep ethical developmental framework which itself embraces the information society's paradigm of personal emancipation. The challenge in education today is not to train the young for the technological opportunities presented by the information age but to equip them with the ability to make sense of this 'brave new world' and, in the process, to enhance the humanity of society. The challenge is there; will we rise to it?

I sit and look out upon all the sorrows of the world,  
 and upon all oppression and shame,  
 I hear secret convulsive sobs from young men at  
 anguish with themselves, remorseful after deeds done,  
 I see in low life the mother misused by her children,  
 dying, neglected, gaunt, desperate,  
 I see the wife misused by her husband, I see the  
 treacherous seducer of young women,  
 I mark the ranklings of jealousy and unrequited love  
 attempt to be hid, I see these sights on the earth,  
 I see the workings of battle, pestilence, tyranny,  
 I see martyrs and prisoners,  
 I observe a famine at sea, I observe the sailors  
 casting lots who shall be kill'd to preserve  
 the lives of the rest,  
 I observe the slights and degradations cast by  
 arrogant persons upon laborers, the poor, and  
 upon negroes, and the like;  
 All these - all the meanness and agony without end  
 I sitting look out upon,  
 See, hear, and am silent.

Walt Whitman — *I Sit and Look Out*

Computer science is a young science, brash in its loud acclamations as modern empirical philosophy, bold in its sincere attempts to understand what is man, his intelligence, his thought processes, his perceptual faculties, his use of knowledge and information. It is eager in its endeavours to serve mankind it its blinding rush into an information society, almost self-conscious in its understanding that an information society founded on information alone is a society bound to founder. And, if it is self-conscious of this understanding, then it is equally conscious - perhaps because of its philosophic ground - that humanity embraces far more than fact and data, that it embraces too the whole nature of man and his relationship to his universe. It understands the relativity of epistemology and the transcendental nature of ontology, not merely as rhetorical artifacts of scholastic speech but as essential boundary condition on a very real empirical effort to augment, support, re-create, and in the process understand, the human condition. James Stephens again manages to capture the sentiment of enthusiastic youth and mature understanding in unparalleled fashion.

When I was young  
 I dared to sing  
 Of everything,  
 And anything!  
 Of Joy, and woe, and fate, and God!  
 Of dreaming cloud, and teeming sod!  
 Of hill that thrust an amber spear  
 Into the sunset! And the sheer  
 Precipice that shakes the soul  
 To its black gape — I sang the whole  
 Of God and Man, nor sought to know  
 Man or God, or Joy, or Woe!  
 And, though an older wight I be,  
 My soul hath still such Ecstasy  
 That, on a pulse, I sing and sing  
 Of Everything, and Anything!

What is Knowing?  
 'Tis to see!  
 What is Feeling?  
 'Tis to be!  
 What is Love? But, more and more,  
 To See and Be! To be a Pour  
 And Avalanche of Being, till  
 Being ceases, and is still  
 For very motion — What is Joy?  
 — Being, past all earthly cloy  
 And intermixture! Being spun  
 Of Itself is Being won!  
 That is Joy — And this is God,  
 To be That, in cloud and clod:  
 And, in cloud and clod, to Sing  
 Of Everything, and Anything!

James Stephens — *The Pit of Bliss*

## Reprise

Computer scientists and computer engineers, with our fellow-travellers of philosophers and natural philosophers, mathematicians, biologists, chemists, poets, psychologists, artists, musicians, sociologists, indeed everyone engaged in an odyssey of discovery, we all stand at the cross-roads of humanity, at a nexus of man's evolutionary development on many planes, striving to understand what it is we are. And, as with all cross-roads, we are presented with a choice of paths to take. It is my deep belief that what must guide our choice of path is not technological utility, much less capitalistic or economic expediency, but instead a value system based on the paradigm of the information age itself, which recognizes the inviolability of the individual and his deep responsibility to the total fabric of humanity of which he finds himself a part.

It may not appear to be the case at first sight, but I hope you will now agree with me that it is the case in fact, that computer science is intrinsically involved in all of these areas if only because it is at the cross-road of the arts and the sciences, binding them in our effort to extend mankind's intellectual power — the fast pencils of the late 20th century — and endeavouring, in the process, to understand, or re-invent, man himself. But I do not claim this position solely for computer science, I claim it for all disciplines. And, as we jointly endeavour to push back the boundaries of our ignorance we influence humanity and its evolution. We are poised at present at the advent of the so-called information society and I believe that humanity is, once again, at a cross-roads. We must all ensure that we take the high-road of cultural and social development, seeking greater meaning, greater values, greater humanity. The alternative is the low road of more information, tracts of data, pathologically extreme relativism, and a devalued humanity. We stand together, poised. Let us join together in launching our society along the high road, ever vigilant for the unexpected appearance of future cross-roads which will inevitably present themselves, in ever more subtle guises.

We shall not cease from exploration  
And the end of all our exploring  
Will be to arrive where we started  
And to know the place for the first time.

T.S. Eliot — *Little Gidding*

## Acknowledgement

I cannot finish without reflecting upon the source of what I have tried to convey. I wish it were that it all had its beginning in my own original thought. But the truth is that I have been very privileged to have been exposed to the wisdom, humanity, and unstinting friendship of Dr. D.J. Furlong, Trinity College, Dublin, over some twenty-one years; it is to him that I owe many of the ideas which form the basis for the tapestry of thought which I have woven today. The loose threads, the clashes of colour, and the uneven stitching are all my own.

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