GC7 Journeys in Non-Classical Computing

Post Conventu version

Socially Sensitive Computing:

A Necessary Paradigm Shift for Computer Science

"Rules are for the obedience of fools and the guidance of wise men"
Douglas Bader (1910 – 1982)

Tom Addis,
Department of Computer Science and Software Engineering,
University of Portsmouth,
Buckingham Building, Burnaby Road, Portsmouth PO1 3AE
Visiting Research Fellow
Science Studies Centre,
Department of Psychology,
University of Bath
Email: tom.addis@port.ac.uk

Dave Billinge
Department of Creative Technology,
University of Portsmouth,
Buckingham Building, Burnaby Road, Portsmouth PO1 3AE
Email: dave.billinge@port.ac.uk

Bart-Floris Visscher
Department of Computer Science and Software Engineering,
University of Portsmouth,
Buckingham Building, Burnaby Road, Portsmouth PO1 3AE
Email: bart-floris.visscher@port.ac.uk

The Essence of the Challenge

We argue from the Church-Turing thesis (Kleene 1967) that a program can be considered as equivalent to a formal language similar to predicate calculus where predicates can be considered as functions. We can relate such a calculus to Wittgenstein's first major work, the Tractatus, and use the Tractatus and its relationship to the world as a model of the formal classical definition of a computer program. However, Wittgenstein found flaws in his initial great work and he explored these flaws in a new Thesis described in his second great work; the Philosophical Investigations. The challenge we make is *"can computer science make the same leap?"* Appendix I gives the justification of it being a grand challenge. After the references there is an epilogue (post conventu) that relates this challenge to the interests of GC7.

We are proposing that because of the essential flaw identified by Wittgenstein, computers will never have the possibility of natural communication with people unless they become part of human society. We will come to this conclusion by examining the way people communicate and by considering the two major works on the philosophy of language by Wittgenstein. We suggest that such a lack of natural communication is evident by the common complaint of 'computer rage' and that the same paradigm shift that Wittgenstein took is thus long overdue for Computer Science.

Inferring Internal Experience

Classical linguistic philosophy suggests that language understanding arrives from denotational (referential) semantics. If we examine what people talk about we find that many of the conversations are descriptions of our own internal life. Since nobody can have direct access to another's internal experiences, then the only way in which such experiences can be understood is indirectly through inference. We can infer each other's experience because we share the state of being a person, in a culture, using a language and sharing external experiences (such as a musical performance; see Billinge & Addis 2003). It is hence possible through conversation to build an internal model of another person's view of the world. The only requirements for this model is to be able to make predictions from conversations about:

- one's own possible future experiences
- the way one should respond to another person
- an interpretation of what is said
- new ideas and ways of looking at the world

For example, if the non-technical music literature is examined[1], it becomes evident that the common experience does not have to be even the music itself in order for one person to describe an experience to another. The rich and extensive use of metaphor suggests that emotional resonance and association to a commonly understood situation can be employed to trigger what, to the author of the description, is his "accurate" emotional response to a piece of music. Communication, in this case, will depend mostly upon our shared humanity, sometimes upon our personal experiences but, unlike computers, little upon any referential semantics.

A Philosophical Paradigm and Computing

The implications of such observations on the communication of internal experience are radical. They have led us to take Wittgenstein's *Tractatus* [Wittgenstein 1921] as a paradigmatic description of the current state of computer science. We can take this step because the Church-Turing Thesis shows that the Turing Machine (the classical computer) is equivalent to Lambda calculus and recursive functions. Lambda calculus and recursive functions together form the description of a functional programming language (e.g. ML). Such a functional language embodies Wittgenstein's *Tractatus*[2]. This early work encapsulated a formal and logical representational schema into a descriptive form that was based upon denotational (or referential) semantics. In this case, the referents (the objects) have some logically strange properties. Objects must be:

- *independent* in that they can freely combine to form "states of affairs" that can be described (T2.01, T2.0272, T2.0122, T2.0124)
- *atomic* in that there are no smaller constituents (T2.02, T2.021)
- *in all possible worlds* (T2.022, T2.023)
- *immaterial* (T2.0231, T2.0233)
- *indescribable* except by their behaviour (form) (T2.021, T2.0121, T3.0271)

[1] Examples are, record reviews, concert reports, descriptive, as opposed to analytical, music histories and biographies.

[2] David Gooding (University of Bath, private communication 2004) notes that "the Tractatus was modelled on Hertz' Principles of Mechanics. Hertz believed that his book would be a full and final statement of the principles of mechanics; Wittgenstein thought that Frege, Russel and Whithead had done the same for mathematics and that he would do the same for language."

- *self governed* in that they have their own internal rules of behaviour (T2.0141, T2.033, T2.012, T2.0121, T2.0123, T2.01231, T2,03)

These referents (objects) are intended to be more than just elements of description; they form the real world (T2.04, T2.06). From these referents, the full force of logic, predicate and propositional calculus retains stability of meaning and sense. Such a stance results in the position that everything is potentially unambiguously describable (T2.225, T2.224, T7).

We (the authors) introduce here the idea of a 'rational' set[3]. *A* ***'rational' set*** *is a set where there is a finite set of rules that can include unambiguously any member of that set and unambiguously excludes any non-member of that set* (see also the definition of irrational sets – section Paradigm Leap). It should be noted that all the sets referenced by the Tractatus are rational where set membership is always specifiable and context independent or has an explicit context that is also rational.

The *Tractatus* provides an extensive model of computer languages. The argument is that names (in practice signs; the visible part of an expression or name) in propositions do not always refer to primitive objects but are themselves referencing propositions (T3.14, T3.31, T4.03, T4.22, T4221, T5.135 and further discussed in P43-60 [Wittgenstein 1953]). These, in turn, are complexes that finally end up as compound statements whose ultimate referent is the bit[4]. Here the bit is the mechanical equivalent of Wittgenstein's referent objects. The bit, if taken as a detectable distinction, has all the strange properties of Wittgenstein's object[5]. Further, it is at the bit that the program links to the world and has meaning. It is this meaning that allows the program to have "sense" with respect to the computer. This formal semantics and the ability for programmers to create procedures and sub-routines (sub-propositions or expressions) is the primary characteristic of all high level and assembler programming languages[6].

The consequence of such a formal model is that any set of names can be used in a program to represent a proposition. All that is necessary is that there is a formal definition that gives the name meaning within the program in terms of the proposition it represents. Since a proposition can take on an infinite number of forms through the use of tautologies and other formal equivalences then there is an infinite but bounded set of possible organisations that can be adopted for a program. Such a set is bounded by the meaning of the essential program (the base or minimum program). However, the additional adopted structure is also represented, in the end, by bits on a computer. This

---

[3] The idea of rational and irrational sets was proposed by Jan Townsend Addis (private communication February 2004) who related the irrational sets to Cantor's (1845-1918) irrational numbers. In the case of rational numbers the rule was a member number could be expressed as a ratio of integers. Examples of irrational numbers are $\sqrt{2}$ and π. There are infinitely more irrational numbers than rational numbers. However, as for irrational numbers an irrational set can always be approximately represented by a rational set.

[4] For example, in computer languages we have seven bits of the ASCII code identifying 1000001 as the character A and 1000010 as the character B etc. There are also special characters such as 'delete' 1111111 and 'start' 0000001.

[5] For example, a world cannot exist (or at least be detectable) unless it contains at least one distinction. A 'bit' is a concept that can only be embodied in a distinction. A particular 'bit' is an argument place (T2.0131).

[6] The original high level programming language COBOL in its initial form did not provide for procedures and sub-routines except those that were pre-constructed in assembler as library routines.

will appear as a program overhead that is used to support a chosen program organisation or structure and in this sense only the program interpretation has changed.

There are also social consequences of the view adopted by the Tractatus in that it is assumed that rules can be created for all situations and as such these rule can bypass human judgement. It also assumes that there is only one correct way of seeing the world and so human existence can be governed by some finite set of laws. It is because there is a tendency to support such a 'rational' view that we now have all the measures of performance and rules of assessment in the modern work environment[7].

Dual Semantics

One of the problems we address here is that computer languages have a *dual semantics* in that the program signs (e.g. the names/labels given to data items, procedures and sub-routines) at the highest level also have referents in the world (figure 1 – the Problem Domain). This is the analysis of the problem domain in terms of records (as in database and program structures), relations (as in normalised data structures) and objects (as in object-orientation). It is this analysis that identifies constructs in the world that are meant to be stable and unchanging (as per *Tractatus* referents) to which names can be given and meaning assigned.

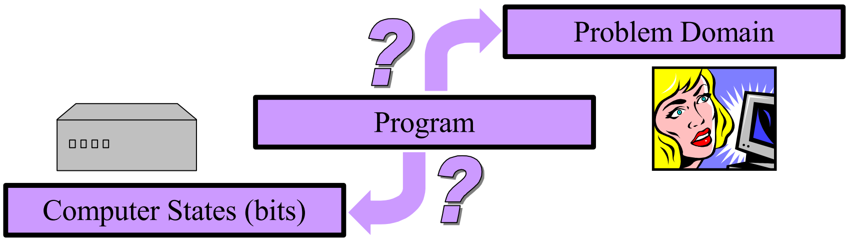

Figure 1. The problem of dual semantics

Now it is acceptable that propositions can represent material properties (T2.0231), relationships (T2.031), and any complex model of the world (T3.1, T3.11, T3.32, T4.01, T4.021) *but a proposition can have one and only one complete analysis* (T3.25). Such an analysis is dependent upon only the essential features of the proposition (program) that link it to the referent objects (which is the bit in our case).

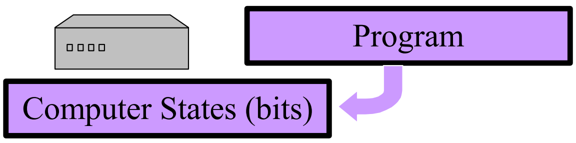

Figure 2 The only rational interpretation of a computer program

A computer program, as we have already seen, has such an analysis with respect to the computational engine (figure 2), so the 'alternative' interpretation of a program depends upon its accidental features (T3.34). This develops a peculiar tension in program design that is hard to keep stable, particularly with respect to the informal, and often undefined, mechanism which links the program names with the user's domain. Further, the 'objects'

[7] It was this rational view that was the driving force behind Artificial Intelligence during the 1960's and was the major reason for the demise of Cybernetics as a serious science.

that are usually chosen to be referenced in the informal analysis of the problem domain do not normally have all the features required of Wittgenstein's objects.

The Paradigm Leap

The *Tractatus* is a magnificent piece of work and is an effective description of how programming languages should be linked to a computer through 'sense' (as with meaning) assignment. There is no problem with the engineering necessity of this approach to sense and meaning. On a broader scale it sidesteps many of the paradoxes of the linguistic philosophy of the day. However, it has *one fatal flaw* when applied to the human use of language and its author eventually exposed this flaw. He noted that *it is not possible to unambiguously describe everything within the propositional paradigm*. He found that the normal use of language is riddled with example concepts that cannot be bounded by logical statements that depend upon a pure notion of referential objects. One of his illustrations is an attempt to define a game (P69 – P71). Such a definition cannot be achieved that will either exclude all examples that are not games or include all examples that are. It is through such considerations that Wittgenstein proposed a new linguistic philosophy that was based upon what we (the authors) are calling inferential semantics[8].

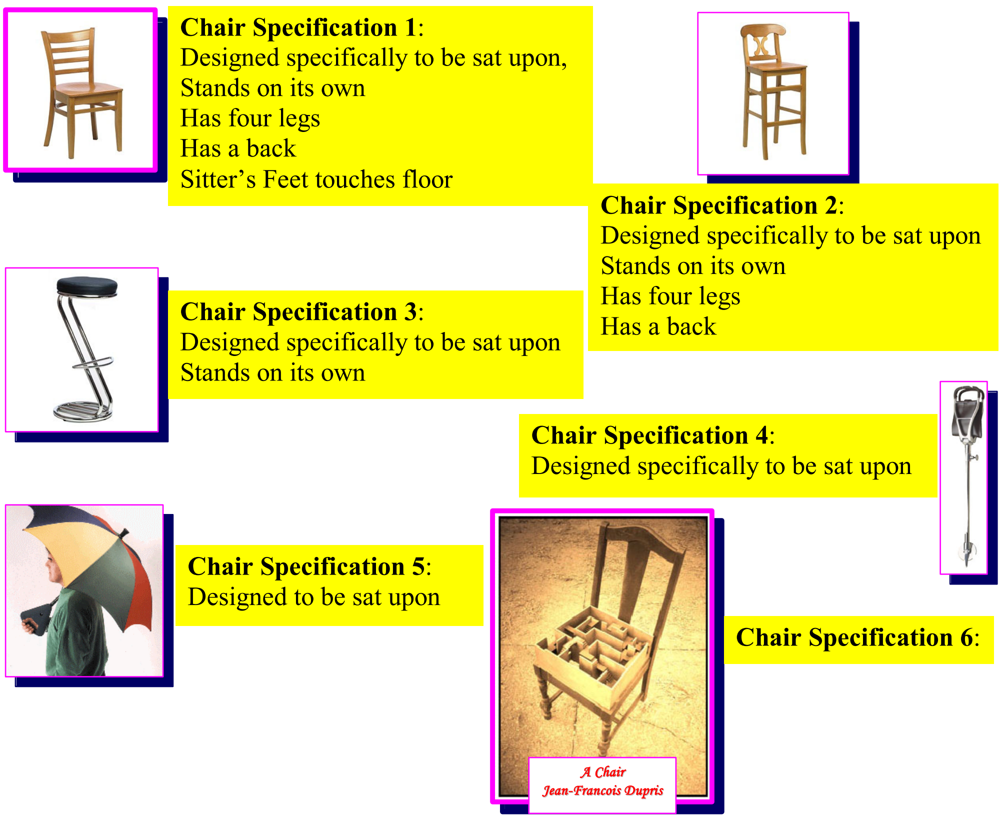

Figure 3 An attempt at identifying a chair

[8] David Gooding (University of Bath, private communication 2004) notes that "The view epitomised by Wittgenstein's Philosophical Investigations is that meaning, grammar and even syntactic rules emerge from the collective practices (the situated, changing, meaningful use of language) of communities of users."

It is because of this observation by Wittgenstein that we make the distinction between rational and irrational sets. *An **irrational set** is where no finite set of rules can be constructed that can include unambiguously any member of that set and, at the same time, unambiguously exclude any non-member of that set.*

By way of illustration consider the set of chairs and a possible specification (figure 3.1). It is always possible to find some exception to a finite set of rules that attempts to identify a member of the set 'chair'. Even if every exception were added to a membership list this would break down by simply discovering a context in which at least one member would cease to be identified as a member through the use of the rules. The more additions made of extreme cases to the set, the more opportunities there will be for finding situations that exclude accepted members of the set. We are thus in a position where most things are not potentially unambiguously describable. (See Appendix II for examples drawn from the press.)

Attempts at providing a rational description of irrational sets has stimulated extensions to the 'crisp' set by assigning a 'value' to a membership. Examples are fuzzy and probabilistic membership assignments. However, fuzzy sets are rational in that members are assigned a membership number that is explicit and essentially ordinal. Such assignments can be expressed by a finite set of rules. Similarly, a probabilistic assignment of a member is also rational where a rule is in the form of a ratio of integers that specifies its membership.

Even though there are irrational sets we still have rational sets and so denotation remains one mechanism for relating meaning to a name. For irrational sets there is an additional and more important mechanism for meaning assignement based upon human usage and context. It is this latter mechanism that provides the link between the program and the world it is designed to represent and is the other half of the dual semantics.

Some Predictions from this Thesis

So we have computer programs with a semantics based upon computer bits but we create programs that cannot rationally be assigned meaning to the very problem domain for which they have been written. Programs must remain in the domain of rational sets if they are to be implemented on a machine. However, we do have the freedom to use the program's accidental properties without affecting the program's meaning with respect to the computer. We can chose the names we use and select the computer organisation from the possibilities bounded by the essential program.

A proposition, and hence a program, can adopt many equivalent forms. It is the job of a compiler to make a transformation of a program in order that it is acceptable for a particular computer to run it. For any particular computer there are an infinite but bounded number of possible structural forms for a given program. The possibilities are bounded by the limitations of the compiler and the intended final form of the program (the essential program). Apart from these limitations the choice of form chosen is in the hands of the programmer. This means that:

- reverse engineering is impossible unless domain information is used.

- design methods will generally only limit what is possible to implement unless they are ‘complete’. A ‘complete’ method is one that constrains the possible designs to that of the limits of the machine being programmed.
- machine mismatches can be detected through tautology
- programs on ‘quantum’ computers are bounded by operations that do not depend upon knowing an interpretation.
- formal ‘objects’ (e.g. Windows in OO) will be stable but informal ‘objects’ (e.g. persons, chairs or games) will never be fully captured or be stable because they are irrational sets.
- it will not be possible to completely represent certain human functionality such as natural language understanding on any machine that is not adaptable.
- increasing a training set for machine-learning algorithms will eventually cause a degradation in its recognition performance if the set includes irrational distinctions.

Inferential Semantics

From an engineering point of view the only information that can be experienced by an individual is the result of the interaction of the individual’s sense organs with the world. This is not a passive view since these organs are also controlled by an inference engine; namely the human mind. It is only through inference and the senses that we experience the world and relate to other people. So like the computer we might be able to trace the sense of our understanding of the world through the tracing of internal constructs to our senses. However, this would not be of any great help to other people since it is unlikely that we are identical in the same way as two computers, constructed according to a defined engineering diagram, are identical. If we were to be different by as little as one bit we could not ever be sure that a ‘program’ would mean the same if ‘run’ in different heads or that it would even ‘run’ at all. So tracing and knowing the ‘program’ (or our internal constructions) is not very useful.

What could work, from a purely pragmatic point of view, is if individuals could construct models of the world, and other people, that were sufficient to meet the needs of surviving in the world and with others. This model does not have to be exact, just sufficient. However, to do this we have to extend our semantic model to have another definition of meaning; a definition that does not depend upon the direct referencing of objects. For Wittgenstein, the *meaning* of a word was also defined as its *use in language* (P43).

We can interpret this extended definition of meaning to imply a *process* of inference. During conversation, both observed and participating actively, a process is going on where a model of the meaning of words is being constructed through inference. This is a *group* activity and one designed to construct something common in the way language and the world may be perceived; a way that allows communication to occur. However, these models are only understood by their effectiveness, their ability to make predictions and their coherence within a group-dynamic situation. They can never have been ‘seen’ directly since they only exist within an individual. It is the hidden dimensions of the model that express concepts and since these dimensions are likely to be different for different people we have the effect of distinctions having no proper boundaries that can be logically defined.

This lack of boundaries for concepts is the *family resemblance* effect detected by Wittgenstein and illustrated by his example (P67). It is an effect that fuzzy sets, in some cases probability and belief networks were intended to overcome (see also P71) without losing the power of referential assignment. Very recently a research team in Mexico, in conjunction with Salford University, have started to explore the use of family resemblance with a learning system in order to approach human performance in categorization [Valdera, Rodriquez & Succar 2003]. However, despite this insight, they remain firmly fixed in assessing their results within the classical paradigm.

The tension caused by the dual semantics that pivots on the essential and accidental meaning of the signs used in programs has been recognised as can be seen by the continued search for new languages, program structuring and systems design methods (e.g. Java, conceptual modelling and object orientation). The central problem of the human context has also been addressed through the pursuit of natural language understanding, naïve physics, case-based reasoning and adaptive interfaces. There is a belief that given sufficient power or moving beyond the Turing machine would somehow solve the problem. This has not been demonstrated with such efforts as many-fold increases in computer power or parallel mechanisms such as neural nets. Perhaps those new aims discussed in GC7 and elsewhere (e.g. Wegner and Eberbach 2004) may prove successful. However, none of the approaches tried so far have really succeeded. Many of the pursuits have been constrained by the formal bounds represented by the Tractatus and for those approaches that have broken away they have not bridged the gap identified here.

The Challenge

An alternative to Wittgenstein's family resemblance is Lakoff's (Lakoff 1986, Lakoff & Johnson 1980) use of prototypes (paradigms) and metaphor instead of reference. With either route we have a more acceptable approach to human relationships in that there will always be a need for human judgement because what is acceptable behaviour or performance is a time sensitive and socially dependent notion. The requirement to encapsulate a wide range and ever changing perceptions of a problem domain will be the need for a continuous link with human activity. Such perceptions cannot be predicted and hence planed for in advance. So many of the current principles of design will have to be shelved and two distinct design paths will need to be forged that involve the two independent elements of a program; the formal rational and the informal irrational (figure 4).

The challenge is can we construct computing based upon family resemblance rather than sets, paradigms rather than concepts, and metaphor rather than deduction? Can we devise systems that have judgement rather than decisions? One possibility is that we might be able to write dynamic, socially sensitive interfacing-compilers that can match any program to any user (see figure 4).

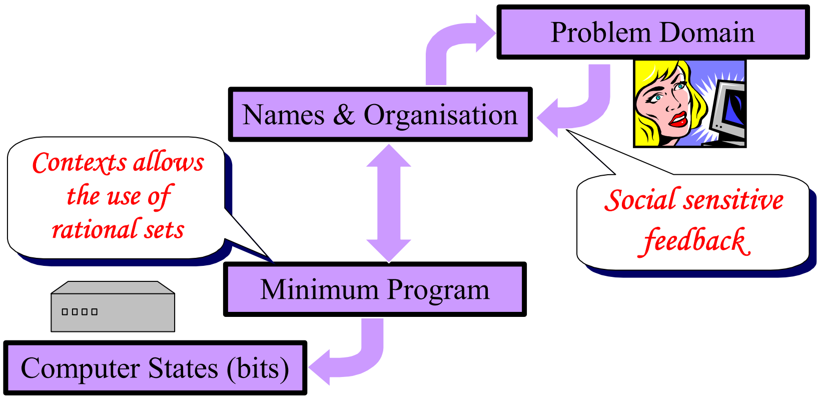

Figure 4. Showing where change can occur to solve the dual semantic problem

Such a compiler would be in 'conversation' with its user, other users and machines via (say) the Internet absorbing the human cultures and language so that its generated semantic and semiotic mappings make a program usable by a person. This might stop 'computer rage' through a more natural communication between people and machines; it may identify what is really meant by common sense.

References

Billinge D. & Addis T. (2003) *The Functioning of Tropic Communication: A Mechanism for Consistent Figurative Descriptions of Artistic Effect*. AISB'03 Symposium on AI and Creativity in Arts and Science, University of Wales at Aberystwyth

Kleene, S.C. (1967). *Journal of Mathematical Logic*, New York: Wily.

Lakoff G. and Johnson M. (1980). *Metaphors We Live By*. University of Chicago Press.

Lakoff G. (1986). *Women, Fire, and Dangerous Things*. University of Chicago Press.

Vadera S, Rodriquez A, Succar E (2003) *Family resemblance, Bayesian networks and exemplars*. AISB Quarterly No.114 p.1 & 11

Wegner P. & Eberbach E. (2004) *New Models of Computation*, The Computer Journal, Vol 47, No1, pp. 4-9.

Wittgenstein L (1921) *Tractatus Logico-Philosophicus* edition 1961Routledge and Kegan Paul London

Wittgenstein L (1953) *Philosophical Investigations* Blackwells Oxford

Epilogue: A Science of Mechanisms

The original idea behind GC7 was to provide a series of challenges that would be represented by non-classical computing. It was a hope that such explorations would produce computational engines that somehow would avoid some of the limitations found in the current crop of computers. It was noted during the meeting that many of these difficulties can be identified by either:

- the existence of irrational sets

or

- created by the mismatch between the computer and its system with the problem domains.

It was suggested that a bigger challenge would be to develop a *Science of Mechanisms*. The science would evolve a way of arranging mechanisms into family organisations and in particular identify such mechanisms by their organisational features; features that are relevant to a counter family organisation of problem domains. A result would be a way of reducing complexity of implementation by construction mechanisms that match the problem. Flexibility to change (as required for irrational sets) would be provided by a change in mechanism definition. Mechanism definition would also include the soft variants in terms of program organisation and the possibility of combining distinct physical implementations.

Appendix I

Criteria for SSC being a Grand Challenge

Forword

The SSC proposal is clearly 'Non-Classical Computing' and therefore should be assigned to GC7. However, if you look at the current set of proposals the proposers are concerned mainly with new engines of computing which is not the main issue concerning this proposal (SSC). I would suggest that it might be considered in a general class (GC0) but that would be a shame because it has consequences for most of the headings.

I note that some of the new proposals on the web all start with a justification of why the proposal is being presented as a challenge. Although this seems unnecessary, since it is clearly addresses the notions of 'advancement in science', we have done so anyway. However we might ask the question as to what criteria are used to determine whether any of the answers are of any consequence anyway?

Meeting the Criteria:

- *It arises from scientific curiosity about the foundation, the nature or the limits of a scientific discipline.*

The proposal arises from the puzzle as to why, after sixty years of effort, millions of man hours and technology that boasts of silicon machines that do 1000+ Gigaflops with a 1000+ Terabytes of storage, have still not even addressed many of the important functions of a human brain; a device that looks like a bowl of porridge and consists of only 15 Gigacells working at about 50 cycles per second.

- *It gives scope for engineering ambition to build something that has never been seen before.*

The proposal suggests new ways of looking at current problems. New types of computation would arise and new engines created along different principles; notions such as 'a structure malleable program' to any single solution.

- *It will be obvious how far and when the challenge has been met (or not).*

The challenge will have been addressed when it is no longer a problem that the world cannot be classified or partitioned.

- *It has enthusiastic support from (almost) the entire research community, even those who do not participate and do not benefit from it.*

That remains to be seen. However, there already is a growing group of people at Sussex University (Informatics) who have responded very positively to what has been written.

- *It has international scope: participation would increase the research profile of a nation.*

It clearly has worldwide implications.

- *It is generally comprehensible, and captures the imagination of the general public, as well as the esteem of scientists in other disciplines.*

This could be since most of the public suffer from 'computer rage' now as do esteemed scientists. But, of course, what is meant by this criterion is excitement about the 'idea' proposed. The notion would strike at the very heart of how we organise ourselves and accept hypotheses. The accelerated growth of laws and regulations are derived from the misapprehensions that concepts can be captured exactly through definition. The rejection of this idea would releases us all from the inappropriate constraints imposed by those in authority; it would give us a rationale on which to reject nonsense.

- *It was formulated long ago, and still stands.*

If by 'long ago' it is meant in the early part of the 20th century then it does still stand.

- *It promises to go beyond what is initially possible, and requires development of understanding, techniques and tools unknown at the start of the project.*

This promise is certainly the case. A whole new technology and science would stem from this proposal.

- *It calls for planned co-operation among identified research teams and communities.*

It will require a wide range of specialisation ranging from psychologists, philosophers, linguists, sociologists and computer scientists of many specialisations (e.g. networking, systems, architecture and interface design).

- *It encourages and benefits from competition among individuals and teams, with clear criteria on who is winning, or who has won.*

I would not like to see this happen. It could do, but I would discourage it.

- *It decomposes into identified intermediate research goals, whose achievement brings scientific or economic benefit, even if the project as a whole fails.*

This is most likely the case. A simple solution to such outcomes as information retrieval that works for people would be of considerable benefit to the community as a whole. Many of the objectives already pursued and abandoned from lack of practical success (such as natural language understanding and adaptive interfaces) could be re-examined from this new paradigm.

- *It will lead to radical paradigm shift, breaking free from the dead hand of legacy.*

It is a radical paradigm shift. The problem is, would we be able to go against our own training and start thinking within this new framework?

- *It is not likely to be met simply from commercially motivated evolutionary advance.*

SSC is not a simple evolution from where we stand and that is a problem (see last point above).

Appendix II

Examples from the Press of Irrational Set at work

The Problem of Rules:

From a report by David Hewson, Sunday Times, April 4th 2004.
"Can't an intelligent filter analyse a page beforehand and make a machine judgement on its suitability? There are stacks of those around, too, and pretty worthless they are. Peacefire (www.peacefire.org), a web group opposed to online censorship, carried out an interesting experiment recently. It created dummy pages supposedly run by small sites; each carrying examples of anti-gay hate speech. Posing as individuals, the organisation complained about these pages to the big content-filtering programs, including SurfWatch, NetNanny and CyberPatrol.

Sure enough, the filtering companies responded by blocking the offenders. Then Peacefire revealed the true sources of the quotations – all were taken verbatim from the websites of conservative organisations, including the Family Research Council, Focus on the Family and Concerned Women for America. Would the content-filtering companies now block these big and influential lobby groups? Not yet, which means you can read the selfsame daft words on their sites, along with plenty of other material, but not on the bait pages that Peacefire erected to test the system."

From a report by Jeremy Clarkson, Sunday Times, April 4th 2004.
"…. the HSE (Health and Safety Executive) says that simple cost-effective steps can be taken to ensure that nobody trips. Spillages, they say, must be managed, suitable footwear should be fitted, effective matting systems must be used, offices must be redesigned and workers must be retrained. Cost effective? How can it be when the staff do nothing all day except work to stay upright.

Health and Safety is now so out of control that I find it nearly impossible to do my job. Certainly the series I made a few years ago called Extreme Machines simply couldn't be produced today."

"On Top Gear, we refer to the Health and Safety people as the PPD. The Programme Prevention Department."

The Problem of Irrational Sets

Report on the film 'Capturing the Friedmans' by Cosmo Landsman, Sunday Times, April 4th 2004.
"What makes Jarecki's film so riveting is that as soon as you make up your mind, up pops another piece of evidence or another testimony that makes you change it. You leave the cinema never quite sure who are innocent and who are guilty.

It is a harrowing story of a family being destroyed before your eyes – one that is brought to vivid life with the extensive use of Friedmans' home moves, video tapes and Jarecki's interviews with the family. But it's also a fascinating film about memory and the fluidity of facts. You won't see a more perplexing and poignant film this year."

Report on the execution of Paul Hill at Starke, Florida, CBSNEWS.com, September 4th 2003

"The execution of Paul Hill for the murder of doctor who performed abortions and his bodyguard left U.S. abortion providers anxious – and wary that the former minister may become a martyr to the anti-abortion cause and spur others to act violently."

"Paul Hill's final statement ….. If you believe abortion is a lethal force, you should oppose the force and do what you can to stop it"

"Paul Hill should be honoured today, the abortionists should be executed. said Drew Holman"

"We think that unborn children should be protected and it should be law. Said Sheila Hopkins, a spokeswoman for the Florida Catholic Conference. We definitely reject his statement that it was justifiable homicide."