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Edited by
Jon Robinson

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Cognitive Science

Research Papers

Preface

Each year, towards the end of June, postgraduate researchers from Informatics at the University of Sussex get together to discuss their research and (probably more importantly) socialise.

The two-day Isle Of

Program Committee

Sallyann Bryant
David Ellis
Jon Robinson
Sampsa Sojakka
Thom Heslop

Contents

Biographical Information

E y Ad   s

Elly Adams is a former Open University student. In 2000 she began the MRes course and changed to a part-time DPhil in 2001. In 2003 she became a Research Fello

M rtin Co e n

After many years employment in a variety of 'character building' jobs, Martin Coleman finally enrolled at City University (London) in the summer of 1998. Successfully completing a first degree in psychology Martin was then lucky enough to secure a post at the University of Sussex to read for his DPhil. His twin ambitions are to both push back the boundaries of human knowledge whilst simultaneously avoiding the horrors of a 'proper' days work.

D vid E is

David Ellis holds a BSc(Hons) in Computer Science and Artificia

P u Lo der

Paul Loader did his

Ashish Ure

Ashish Umre graduated with a First Class Bachelor of Engineering (B.E.) in Computer Science and Engineering from the University of Madras, India, in 1999. He then came to Sussex in 1999, to pursue Masters of Research (M.Res) in CSAI, and immediately after started his DPhil in CSAI, based at the Networks Research Lab, COGS.

Ay Yukse

I obtained a BSc degree in Mathematical Engineering at the Yildiz Technical University in Istanbul. I taught at an Academy for a year, before coming to Sussex to study for an MSc in Internet Technology and Electronic Commerce. My research interest is in the Remote Usability issues and challenges that are inherent when combining low fidelity prototyping within a collaborative online communication environment.
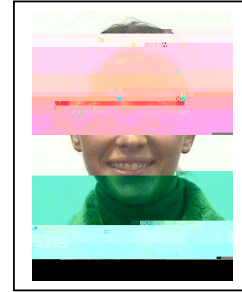
Zin Yusoff

Obtained my BSc (Comp Science) and MSc (IT) from Nasional University of Malaysia in 1996 and 1998 respectively. From 1998 to October 2003, I worked as a lecturer at Universiti Tenaga Nasional. In Oct 2003 I registered as a full time DPhil student at Sussex Uni. My main research interest is about emotion (Meta affective) and Intelligent Tutoring System (ITS).
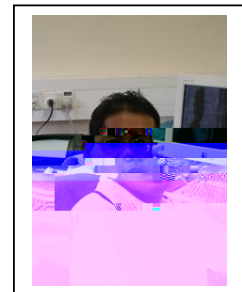
Improving the

Does the direction of time tell us anything about the difference between causation and correlation?

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Department of Informatics

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being mere correlation. One of the most important element of causality is that causes have a definite direction in time, i.e if A causes B and A occurs before B, then B does not cause A. Apart from a few speculations in Theoretical physics, [1], it is universally conceded that causes do not operate backwards in time. This understanding that a cause should precede its effect is a temporal expectation in Human discourse. If we consider time as one of the four dimensions of space-time, objects can only travel on one direction in time; from the past, through the present into the future.

Bayesian and decision networks model relationships between variables at a particular point in time, but it

The value of death: A lesson from Daisyworld

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Death is the endpoint of all living things, and while it is tempting to think of it as an inherently random process, this is far from the truth. Environmental factors, such as lack of food and temperature variations, increase the chance of death in many organisms. This idea is one of the central tenants of Darwin's theory of natural selection. Organisms which are less fit for their environment are replaced by those which are more fit.

In 1978 the Daisyworld model [1] was introduced as a way to lend credence to the Gaia hypothesis, which suggests that organisms have altered conditions on earth to their own liking through localised interactions. Daisyworld is a toy-world and the idea behind it is simple -- localized interactions can affect global dynamics and generate homeostatic behaviour. The model consists of a ``planet'', heated by the sun and populated by black and white daisies. The black daisies have a lower albedo (reflectiveness) than the white daisies, thus they absorb a greater amount of solar radiation and raise the local temperature. The growth rate of the daisies is linked to the local temperature. The difference in growth rate causes the area covered by black and white daisies area to vary, thus warming and cooling parts of the planet. This creates a homeostatic response to external forces, such as increasing incoming solar radiation (insulation), and keeps the temperature of the planet relatively constant.

My research extends a 2D version of the original Daisyworld model [2] by adding a variable mortality rate alongside the standard growth rate. In all previous Daisyworld models, the mortality rate of the daisies was assumed to be a constant random value, regardless of temperature. In my model, the mortality rate is assumed to be dependent on the local temperature. Using this I compared the effect of having the constant random mortality rate with that of having the variable mortality rate. The results of my experiments were rather surprising. Even though the variable mortality rate was much higher overall than that of the constant random mortality rate, the daisy systems persisted for longer in many cases and the temperature of the system was less variable.

The reason for these surprising results lies is that with the constant random mortality model, daisies well suited to their local environments could be killed while le lll ly nts s hlis njh3.005

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previously: the study and exploration of the robot control system and the exploration of the capabilities of the agent interacting with the environment and performing basic visual guided tasks.

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A terminal made for two? Understanding the skill of programming in tandem.

S y nn Bry nt

and that those new to pair programming do not yet consider it very different to working on their own whereas those with more experience are aware of the additional skills required e.g. communicating complex ideas and resolving conflicts of opinion.

3.2 External representations
Although the eXtreme Programming (XP) methodology in use asserts that external representations are not required, in an observational study of 14 one-hour sessions of pair programming a total of eighteen informal external representations were produced. Typically these were highly idiosyncratic and ephemeral, produced only for the task at hand. In informal interviews, comments regarding external representation use were varied. Some developers felt that they were mainly useful for 'helping them think', others used them to communicate with their programming partner while still others used them to communicate outside of their programming pair. A number of experienced pair programmers explained that within a pair the code was adequate to communicate given the intuitive nature of the development environment and the ability to quickly produce a coded demonstration.

Conc usion

In line with the conflicting results shown in current studies of XP, initial findings of an observational study of commercial pair programmers indicate that the knowledge, skill and tools required for programming in pairs may be poorly understood and somewhat under-estimated by those who are not experienced in its practice. This suggests that further analysis of the characterising behaviours of expert pair programmers would be instructive with regards to the selection and training needs of novices. It may also assist in considering the validity of providing a remote pair programming environment.

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Human Reasoning

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and charge other organisations wishing to host their services within the network, much like akamai [1]. This solution assumes that the hosting organisation possesses the capital to set up and maintain such a network, and that there are enough services wishing to be hosted. There may also be issues with "saturation" levels: i.e. what number of services can be successfully maintained in a network of n nodes?

An alternative way to provide the necessary infrastructure is to allow organisations wishing to provide a service to contribute to the network. Organisations could be asked to contribute a small number of nodes to the network, and in return their clients would be able

The role of learning goals in children's collaborative interactions

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The use of peer collaboration as a method of learning has become very popular in the UK primary classroom. The National Curriculum has identified 'working with others' as a 'key skill' which incorporates abilities such as being able to engage in group and paired work (National Curriculum Online, 2004). Improvements in children's problem solving skills after collaboration with either an adult or peer have been widely documented (Roschell & Teasley, 1995, Howe et al 1995, Underwood & Underwood, 1999, Azmitia, 1988). However, while some children engage very effectively in group work others consistently fail to work together productively. The individual differences children bring to the collaborative group therefore play an important role in the effectiveness of the learning experience. Among those identified as being influential are gender, ability and peer relationships. However, individual differences in motivation have not been addressed. This is an important area of investigation as children's beliefs about learning and their attitudes to the tasks they are expected to undertake will impact on the goals they adopt and therefore on the behaviour they display (Dweck and Elliot, 1988).

Cognitive theories of motivation identify a goal as providing an insight into the purpose behind behaviour, and as such is a complex cognitive structure constructed within the person-environment interaction (Lemos, 1996). Learning goals are those that provide a cognitive focus, or purpose to behaviour, in situations where competence is of specific relevance. Traditionally, goal theory has emphasised two types of learning goals eaji 3.0057 0h7d (mzthe1a.698t0 ITdAudsTjiEj 4.56866 0 Td (m)Tj 7.93505 0 Td (i)T

appro

needed for a non-technical user to make sense of it.

Proposed Syste

I am currently working with the NatHab project, which is engaged in exploring systems for service composition using natural language descriptions of *o* [5]. I propose to develop a parallel system using an interactive graphical representation of the domain environment, dynamically generated from the same ontological source as the aforementioned NL system. This virtual environment will feature graphical representations of all services available to the user at any given time allowing for graphical expressions of semantic expressions – that is the user will be able to see an animated visualization of their policy originally expressed in natural language and how it will affect the system (such as already existing policies). It is intended that this external representation will use the same underlying policy representation language. This system will be used to evaluate how an external representation of the pervasive environment helps the user to create mental models for its use.

It may also be possible to extend the graphical expression so that the user would be able to directly interact with it in order to amend or create policies – in effect a simple Visual Programming Language [6] for the composition of services. Although this is not currently the main focus of the research discussed here, it could provide an interesting additional avenue, time permitting.

Rese rch P n

In order to develop the system outlined above the following I am currently investigating the following issues as part of a literature review:

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I currently envisage that my research will follow the following stages:

A – L at v : as well as the issues outlined above I am investigating external representation and the construction of mental models. Other dynamic visualization systems are also being evaluated, such as the ProtoViz system [7] as well as already existing graphical simulations for service composition, such as the "Haystack" information management program [8].
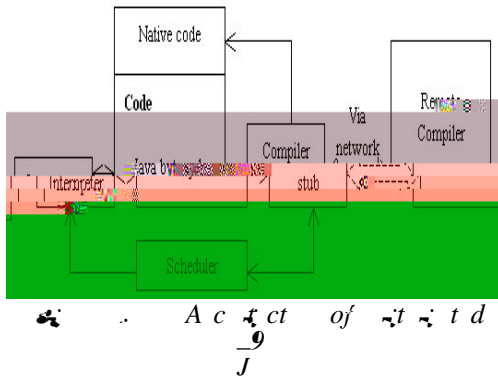
B Development and implementation of system, based on the findings of the previous stage.

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Fig 9. Architect of distributed JIT

In a distributed JIT, two improvements aimed at resource-constrained environment are made. One is on the JIT compiler itself and secondly through compiler procedure improvements. The JIT compiler is separated into two parts, the compilation service worked on the servers and the compiler stub co-operate with the JVM as a client of the former. Thus it will try to request the server to translate a methods matched translation condition into an efficient native version. This should be done automatically and the target machine can execute the Java program as normal even if the connection of target machines is broken. Secondly the compiler procedure can be improved. Usually, traditional JIT compilers work in "user time" whereby it is usually the case that the program is paused and waits for the JIT compilation. The native version of the procedure is immediately executed until the compilation finishes. he execution engine, the interpreter, does not know the native version and continues to execute the interpreted version of code until the native version is successfully registered to the schedule by the compiler stub. Therefore, the benefit of the asynchronous compilation approach avoids the execution pause even when the compilation and transmission take a long t it56866 0 Td (q)Tj 5.1698 0 Td (u)Tj 5.1698 0 Td (e)Tj 4 2.88547 0 Td (a)Tj 4.56866 0 Td (t)Tj 2(w)Tj 7.4541

to (2)

IEEE 802.11e QoS Enhancement for Wireless LAN

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Introduction

During the past few years, there has been an explosion in Wireless LANs (WLANs) development conforming to the IEEE 802.11 standard. They are expected to support the network applications with the same QoS level and the wired Ethernet. IEEE 802.11 group is developing Medium Access Control (MAC) protocols to enable a better mobile user experience and to make more effici

The tow new MAC modes, EDCH and HCF, being defined under 802.11e, supports up to ✌ *t* priority (Traffic Class) that map directly to the protocol priority levels.

Enh nced Distri uted Coordin tion Function EDCF

EDCF is DCF with some of the elements of the MAC parameterized per-TC. Each TC starts a backoff after detecting the channel being idle for an AIFS (Arbitration Interframe Space). The AIFS is at least as large as the DIFS and can be chosen individually for each TC. It provides a deterministic priority mechanism between the TCs.

Within a station, the eight TCs have independent transmission queues. These behave as virtual stations with the above mentions parameters determining their ability to transmit. The *X* (Transmit Opportunity) is given to the TC with the highest priority of the colliding TCs. These QoS parameters can be adapted by the AP via the beacon frames.

Enh nced Coordin tion Function HCF

HCF is an extension of the polling idea in PCF. Under HCF, as in PCF, the superframe is divided into the CFP that starts with every beacon, and the CP. During the CP, access is governed by EDCF, however, the HC (Hybrid Coordinator, generally collocated at the AP) can initiate HCP access at any time. During the CFP, the HC issues a QoS CF-Poll to a particular station to give it a TXOP, specifying the start time and maximum duration.

If a station is given a CF-Poll, it is expected to start responding with data within a SIFS (Short Interframe Space). If it does not, the HC can take over the medium after a PIFS and allocate another CF-Poll to another station. This allows very efficient use of the medium during the CFP.

Schedu ing

The HC has available over time a snapshot view o

Bootstrapping a better parser

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Enactive Distributed Associationism: Psychological ALife

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bumping into things. By associating its actions with their probable outcomes in various different contexts, the robot implicitly avoids future collisions. And by learning sensory motor contingencies the model is able to deal with any form of sensor or coding without requiring specialisation beyond experience. All of this however requires the potential separation of the appropriate representational forms. This is achieved by viewing the representational entities as transient and separable states constantly in flux. For the times in which they exist, predictable relations will result between them as a result of associationist learning.

Liquid Co put tion

Recent theories in Liquid Computation and Liquid State Machines (LSM) (Maass et al. 2002) suggest that a key role of cortical columns in the brain is to amplify the differences in, and the dimensionality of, sensory data. The idea is that like the ripples on a pond, 'information' about the disturbances that caused them is preserved. The increase in dimensionality following liquid dynamics results in complex non-linear data becoming linearly separable. This high dimensional liquid state turns out to have exactly the properties required to support the complex representations necessary for psychological investigation.

Cognitive Mode ing

The recently developed AutoIAC model (Morse 2003) achieves performance equal to hand designed IAC structures in an ongoing unsupervised learning architecture. This hybrid algorithm combines associative learning with pattern recognition (a specific form of associative learning) such that associations are learnt in, and thus mediated by, specific

pack

the network or not; i.e, nodes that are expected participate and be dedicated to supporting a certain network operation and those that are not. In other words, the absence of an infrastructure impedes the usual practice of establishing a line of defence, separating nodes into trusted and untrusted. As result, attacks cannot be classified as internal or external either, especially at the network layer. Of course, such a distinction could be made at the application layer, where access to a service or participation to its collaborative support may be allowed only to authorized nodes. In the latter example, an attack from a compromised node within the group, that is, a group node under the control of an adversary, would be consider an internal one.

Most of the currently consider MANET protocols were not originally designed to deal with malicious behaviour or other threats. Thus, they are easy to abuse. Incorrect routing information can be injected by malicious nodes that respond with or advertise nonexistent or stale routes and links. In addition, compromised routes, i.e., routes that are not free of malicious nodes may be repeatedly chosen with the "encouragement" provided by the malicious nodes themselves. The result is that the pair of communicating end-nodes will experience a DoS, and they may have to rely on cycles of time out and new route discovery to find operational routes, with successive query broadcasts imposing additional over-head. or even worse, the end nodes may be easily deceived for some period of time that the data flow is undisputed, while no actual communication takes place. For example, the adversary may drop a route error message, "hiding" a route breakage, or forge network and transport layer acknowledgements.

Finally, mobile or nomadic host have limited computational capabilities, due to constraints stemming from the nature of the envisioned MANET application. Expensive cryptographic operations, especially if they have to be performed for each packet and over each link of the traversed path, make such schemes implausible for the vast majority of mobile devices. Cryptography algorithm may require significant computation delays, which in some cases would range from one to several seconds for low-end devices. These delays, impose for example by the generation or verification of a single digital signature, affect the data rate of secure communication. But, more importantly, mobile devices could become ideal target of DoS attacks due to their limited computational resources. An adversary could generate bogus packets, forcing the device to consume a substantial portion of its resources. Even worse, a malicious node with valid credentials could frequently generate control traffic, such as route queries, at a high rate not only to consume bandwidth, but also to impose cumbersome

cryptographic operations on a sizable portion of the network nodes.

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trivial. Besides the server maybe multi-hops away and may also move. This not only causes complicated dynamic repartitioning of the network, but also stretches the problem of locating and tracking a local server.

2) Multi-hop communication over the error-prone wireless channel exposes the data transmission to high loss rate. This reduces the success ratio and increases the average service latency.

3) Every local server is exposed to a single point of attack. Threshold secret sharing among local servers solves this problem, but aggravates the previous two concerns.

A more recent proposal [10], [11], [12] addressed availability by making all n nodes in the network share the functionality of a centralise entity. Any t + 1 nodes in the local neighbourhood of the requesting node can issue or renew a certificate. Another novelty is that any node not possessing a share can obtain a share from any group of at least t + 1 nodes already possessing a share. However, just like in [9] the first t + 1 nodes must be initialised by a trusted authority. Also while this system address availability and fault tolerance, it compromises the security of the network. In general, the gap between t and n in a secret sharing scheme defines the security of the system. t can be chosen between 1 and n in any secret sharing . As t approaches, thus closing the gap between t and n, the system becomes more secure because an dversary needs to compromises at least t nodes to collapse the system. But if t is too large, the system becomes less available to clients and also less tolerant to fault. When t approaches 1, making the gap larger, the effect is reversed and the system becomes more available and less secure. Kong chose to keep t relatively small to address the availability problem and ended up with a vulnerable system where any adversary need only compromise a small number of nodes in the network to collapse the service.

Another notable scheme that employs threshold cryptography is one proposed by Seung Yi and Robin Kravets [13], [14]. In their scheme, they took in to consideration the heterogeneity of ad-hoc networks. They argued that mobile nodes in many ad-hoc networks will be heterogenous in many respect, especially in term of their security and that any service or framework should take this into account. Seung Yi et al threw more light on their argument by describing a battlefield scenario which comprises of a military unit consisting of infantry soldiers, platoon commander's jeep, company commander's vehicles artillery vehicles, transport vehicles, and even tanks. They stressed the fact that all of these nodes have different strength in terms of their transmission range, ranks, power, capabilities and level of security. They suggested that it will be wise to pick nodes with higher ranks, more power, more capabilities to provide security services for the entire network. They

called these nodes mobile certification authorities (MOCA). However, the scheme still relies on the need of a trusted third party for the initialisation stage of the MOCA.

One other scheme worth mentioning is the one proposed by Hubaux et al [15], [16], [17]. In this scheme, every node plays the role of its own centralise entity, similar to the PGP web of trust model but unlike the latter, there is no certificate repository where certificates are stored. Each node is required to store its own certificates. For two parties wanting to authenticate themselves, they must search there certificate repository for a chain of certificates that link both of them. Hubaux equated this to finding an intersection point between the certificate chain carried by each user and proposed a shortcut-hunter algorithm for this purpose. While this fits the description of self-organisation in ad-hoc networks, however,it does not scale beyond a relatively small community of trusted nodes because it would be difficult for each node to maintain a long list of trusted friends, potentially as large as the list containing all the nodes in the whole network.

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Biological and Astronomical Time

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There are two platforms that permit the establishment of the scientific notion of time in the human mind. These are (1) the internal human cognitive capacity to experience duration and have an episodic memory, and (2) factors, that may be regarded as external to the cognitive domain such as the cyclic phenomena in the external world.

Virtually all living organisms have "biological clocks" that regulate their behaviour in the temporal domain. Their mechanisms are based on either (1) oscillations, or (2) unidirectional processes, that trigger development and aging (hourglass clocks). The function of the first is based on a genetic transcription-inhibition feedback loop, which is common, in its principle of function, to virtually all living organisms from primates through rodents, fish, frogs, insects to even cyanobacteria (the prokaryote, blue-green algae).

The function of the second, the hourglass clock, is governed by the limited number of cell division cycles that can be performed by individual cells in the body, and this type of clock plays a predominant role in development and ageing. However, they are subject to alterations in their function by environmental factors such as temperature (in cold blooded creatures), nutrients and cytotoxic agents, while the body clock which functions on an oscillatory basis is temperature compensated and is accurate to a few parts in a thousand.

It is interesting to note that the body's circadian rhythm, which when averaged, has the periodicity of the moon around the earth, becomes entrained by the 24 hour cycle of the sun. Entrainment occurs through a dedicated pathway from the eyes to the bodily clock located, in mammals, in the suprachiasmatic nucleus of the hypothalamus.

The astronomical factors that provide the human system with the concept of time are principally those arising from the rotation of the earth on its axis and its revolution around the sun. Knowledge of the regularity of the motion of astronomical objects can be dated back to over 5,000 years ago.

The Scooby Event-Based Middleware for Service Composition in Pervasive Computing Networks.

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Introduction

Pervasive computing, or Ubiquitous Computing as it is alternatively known as, was first introduced in concept by Mark Weiser of Xerox Park Laboratories in 1991 through the publication of his seminal paper entitled "The computer for the 21st Century"[1]. In this paper, he envisioned a world where computers would no longer be considered to be obtrusive devices as characterised by desktop and server computers of today, but instead, computers would become invisible and transparent to the average user, and be embedded in a variety of devices. These *a t* devices would permeate throughout this pervasive infrastructure whereby human-computer interactions would become transparent, and oblivious to end-users. At the time, computer technology was not sufficiently advanced to provide a realistic real-world interpretation of his vision. However, due to advances in:- miniaturisation; increased processing and storage; and development of wireless communication protocols (for example Bluetooth [2]), we can start to effectively produce smart devices that are small and powerful enough to provide the infrastructure that Weiser first envisioned.

Now that these smart devices are starting to become main stream (for instance WAP/Java enabled phones, PDA's, Tablet PC's) and cost effective for the general public to own, attention can now be focused on the dynamic composition of services and resulting middleware layer required to power such scenarios as outlined by Weiser.

The focus of my work is the exploration and development of a middleware layer that aids in the composition of dynamic services, based on polices outlined by an individual user. The first stage was to investigate and determine which type of messaging system would suit such an ad-hoc, dynamically changing distributed environment. There are three types variants of Publish/Subscribe systems available at present [4], to which all messaging systems can be attributed to. Topic-based systems come in a variety of forms, of which an example is the Corba Event [10] system that utilise a flat model for representing events. Type-based systems allow for events to be filtered and classified by objects on which operations can be performed. Examples of such systems would include, Java RMI [8], Jini [7] & Trader [9]. The third form of Publish/Subscribe is that of Content-based systems. These allow for an event to be composed out of tuples of information, and transmitted indiscriminately to any listening services. Such examples are Elvin [5], Gryphon [11].

Ideally, in a pervasive environment, information needs to be propagated throughout with the least amount of specific information for identifying the target services. To this end, we can introduce a set of criteria that is required to be satisfied for providing a general form of communication. The notions of *ac d co*, *t d co* and *f o d co* [12] can be introduced that allows for the decoupling of location dependant information from the event. Introducing this decoupling, allows the consumer and producer to be independent of each other and not be reliant on any dependencies, by allowing each to be; unaware of the whereabouts of each other; not to be dependant on the linear execution of a service (i.e. can be doing something else once an event has been transmitted); and not be in a blocking state waiting for a reply to occur once an event has been dispatched.

Out of all three variations of the Publish/Subscribe paradigm, only Content-based routing satisfies all three requirements. To this end, the proposed infrastructure we have developed utilises the Elvin [5] event notification system, as the backbone message system.

The Scooby Middleware

The components of our system, can be characterised by the following layers:

Elvin event System   Middleware Layer   Service Composition
Language

The middleware layer provides the mechanisms for discovery, service identification, accessing of remote service functionality and synchronisation between services. The novelty of this implementation, is the introduction of binding variables that allow services to search for any matching proxy services based on a given criteria. A combination of late and lazy dynamic binding between these constructs and services are provided at different points within the lifecycle of a users' service. For instance, when first instantiated, bindings are resolved against any matching services available within the infrastructure based on the pre-requisites laid down by the user in their initial composition. As these binding constructs have a number of states, that continually change between, discovery, suspend and connection, they will continually evolve over time to link to

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require more empirical evidence of their global utility for teaching in a real university class.

The events of learning have been termed lesson instructional strategy by some authors (Smith & Ragan, 1999) who include supplantive or generative approaches to the lesson strategy. These strategies refer to the level of independence or scaffolding that should be provideo

interest between signallers and receivers. Where such a conflict exists, the receiver's need to acquire information may favour sensitivity to the cues provided by the behaviour and appearance of the signaller. In turn, this sensitivity may give rise to opportunities for manipulation and exploitation by the signaller. It is understood that exploit

HOW TO IMPROVE LOW-TECH PROTYPING REMOTELY?

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Introduction

Low-tech prototyping is an emerging area in
human-computer interface design. It   3ffd ck)Tj 5@§077igpTj 5.1698i9nTnbt(c)Sju4.56866 0 Tdke

remote usability challenges that would be highlighted from such a fusion.

On ine Co   unic tion

Online communication is the way in which to exchange information or to convey an idea if the user is located remotely. There are presently, several forms of online communication that can be characterised by *a ;   c at,   vo c   conv   at on* or *conf   nc*   amongst others. Each form of communication may introduce different issues in the flow of information between design and user. For instance, issues regarding bandwidth consumption [11] that dictates the amount of information that can flow at any single time, and that of latency that can introduce sequencing problems with online communications.

Other issues may arise when using communication tools such as NetMeeting for text or audio based chatting, or web conferencing that requires the user to be knowledgeable of the communication tool or have the ability to learn how to use it. Due to such a faceless form of medium, communication with an unknown (or known) user may sometimes result in potential ambiguities or misunderstandings as nonverbal elements are left out [9840]Tj319675248547 0Td (u)Tj4003 0 Td (l)Tj 2.88547 0 T61 0 Td ( )Tj 9.73847 0 Td

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A Sound Emotionally Affective Framework for Intelligent Tutoring System (ITS)

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A str ct

This paper is a step towards incorporating emotion in an ITS environment. A sound emotionally affective framework, which integrates emotion appraisal theory and ITS is presented. There are two benefits from this system to students:

1. by maintaining student's positive emotional state or by regulating students' negative emotional state and
2. by suggesting potential learning strategies to students. This proposed model has the potential to n2n88547 0 Td (e)Tj 457 0e

generic example in his/her next programming task.

This proposed model is implemented in two phases: 1) the appraisal phase, which propose to infer the students' emotional state and 2) the reaction or regulation phase, which propose to use adaptive strategies and activities, in order to maintain or to regulate the elicited emotion. To strengthen this appraisal phase, Roseman's emotion appraisal model (Roseman, 1984, revised 1996) is referred to. A student's emotional state is inferred based on their reaction to self, others or notes, the control that the students have over the learning material, and the difficulty level of the lesson. For instance, a student is inferred to experience *oy* emotion when he/she has completed a *difficu t* programming task very well mainly by using his/her *o n kno edge* with a *high contro* over the lesson.

The second phase of this model is the reaction or regulation phase. The underpinning strategies used in this phase are to maintain students' positive emotional state or to reduce or regulate students' negative emotional state. Statement such as "*I c n ke things h ppen*" is an example of a coping statement used to maintain student happiness. By contrast, "*I s this pro e in nother perspective to ke it see ore e r e*" statement is used to reduce the anger of students. Apart from coping statements, relaxation activities such as muscle and head exercises will be employed to help students reduce their negative emotional state.

Possible strategies and suggestions are also made to these students in this second phase. To a sad inferred student, the system might suggest to the student to request for an easy programming task or to study more programming examples before proceeding with his/her lesson. On the other hand, the system might suggest to a happy student to do a more difficult programming level and to ask for less help in his/her next lesson. The complete framework for this proposal is as figure 1.
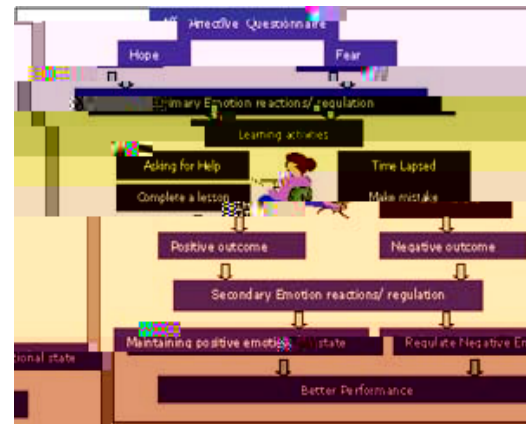
Figure 1. A o nd ot ona y Aff ct f a o

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