CS4FN

Computer Science for Fun

Issue 4

Kerstin Dautenhahn and her polite robots

Win an iPod nano

Evolution solution revolution

Special Issue on

Computer Science and BioLife

Queen Mary University of London

The magazine about the fun side of computer science

When computer science touches other subjects, they emerge morphed into new and exciting things. Computer scientists and performance artists meet and out comes Digital Performance (think Gorillaz – a virtual band that doesn't exist in the real world but gives amazing performances). Get biologists or medics and computer scientists talking together and the results are new subjects like bioinformatics, biometrics and artificial-life. Amazing new things are discovered about the way our brains work or clues are found in the search for cures to cancer. The most exciting discoveries happen on the boundary of subjects – and computer science lives on the boundary of lots.
In this issue we look at some of the things that have resulted from these interactions between computer scientists and the squidgy, BioLife subjects. Some really exciting stuff emerges out of the gunge.

cs4fn continues to be supported by the CS industry and the British Computer Society: Intel, Microsoft and ARM have kindly supported this issue.

The FUNdamentals of Computer Science

The trouble with choosing University subjects is it's hard to know what the subjects might be about. You don't need to have done computer science at school or college to start a CS degree, but how then are you supposed to know what you are getting yourself into? What are those first year topics about?
To help, we've put together an off-beat cs4fn style look at the core topics of Computer Science. It includes articles, games, interactive puzzles and video clips grouped by subject theme…It will give you an idea of the topics you will study…then when you do go to University you will have a head start having learnt some deep Computer Science. Of course, if you end up doing Law or Biology instead you will still have learnt some useful stuff while having fun.

See **www.dcs.qmul.ac.uk/fundamentals/**

In this issue:

Not Just a Pretty (!?) Face

Passionate about Computer Science
CS4FN
www.dcs.qmul.ac.uk/cs4fn

Here's our new cs4fn logo that will be popping up all over the place in future. If you are wondering what it's all about, it's a cartoonized version of a diagram that first appeared on a research poster about something called Separation Logic, which is a way of describing computer systems. Seperation logic is being developed at Queen Mary and is causing a lot of excitement amongst Computer Scientists world-wide including those at Microsoft, where they are building tools around it to help remove bugs in programs used with Windows. Arrow and dot diagrams like this are used a lot in computer science to describe how computer systems change over time. Why the happy face? Because, ultimately, computer science is about people too.

Representing Life ... all of it

Back at the dawn of history, out of the primordial soup, something very special happened … a code began to develop, a code of life. Things started to replicate, making copies of themselves: passing on information about how they were constructed and what made them able to survive. The code that developed was a way of representing that information of how to put together a life, a creature. A code that allowed all the information about a body plan to be passed on came into being: the molecule DNA.

DNA is a long series of protein molecules. If stretched out, each individual DNA molecule in my body would be as long as I am tall. To represent information you need an alphabet. The molecules of life have to be long because they store a vast amount of information. In English we use an alphabet of 26 letters to represent information. Russian has 33 letters. The alphabet of life has just 4: A, G, C and T (see page 14). Of course the letters used are rather arbitrary, it is what they mean that matters. Particular sequences like ACT in particular places in the molecule might be part of the instructions that ultimately leads to "blue eyes" or "brown hair". These protein sequences are used in the cell to do the tasks of life, replicating, building and maintaining bodies. The language of DNA makes it easy both for cells to replicate the information stored but also to process it in other ways: making functioning creatures. It turns out proteins are a good way to store information. DNA also comes with a whole series of mechanisms for detecting errors when the information is replicated, and for repairing it.

Computer scientists are also interested in ways of representing information; processing information efficiently is a lot of what the subject is about, and the way information is represented can make a big difference. Computers use an alphabet of 2 letters, 1 and 0 (known as bits) to represent information. One of the things that the alphabet of 1s and 0s is used to represent are numbers. However there are different ways to do it. For example, the sequence 1101 represents the number thirteen in the normal way of doing things. Each digit represents a power of 2. The 1s mean add it in, the 0s mean don't. So 1101 is 8+4+0+1. Similarly 0110 means 0+4+2+0 or six. This way of coding numbers makes it very easy to do things like multiply and divide. Some other things are not so easy though.

Counting 0, 1, 2, 3, 4 in this representation goes 0000, 0001, 0010, 0011, 0100. To move from one number to the next you need to change several of the characters at once. If all you want to do is count and not (say) do addition, then other ways of representing the numbers might be better. For example, we could make the code zero: 0000, one: 0001, two: 0011, three: 0010, four: 0110, etc. This sequence has a special property that counting now only involves flipping one bit at a time. This kind of code is called a Gray code, after its inventor, and is used very widely in cable and digital TV systems as it also makes it very easy to notice when information has been corrupted and to fix it. That correction of mistakes is just as important in replicating a TV picture across millions of homes as when replicating a DNA molecule in your body.

The world revolves around information and both evolution and computer scientists have come up with ways of representing it. The ways may be different but the aims of being able to process the information and catch errors easily are the same.

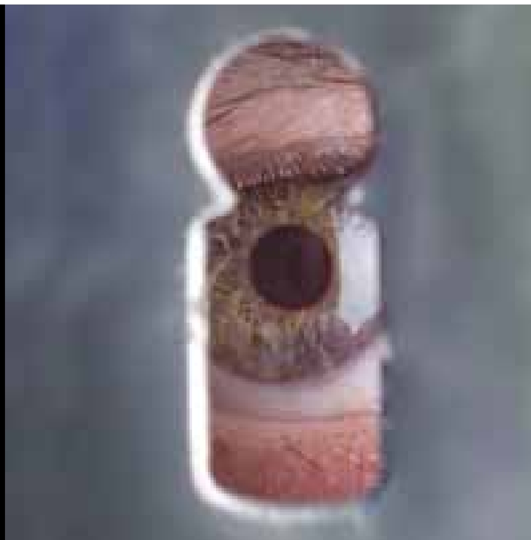
Try our Medieval Challenge

Go to the cs4fn webzine to see if you are up to a medieval Gray code challenge: can you crack the lock and open the treasure chest?

COMPETITION: How do you get from DNA to Alice in Wonderland?

Above we followed a link from DNA to Gray Code. Alice In Wonderland was written by Lewis Caroll and he invented a puzzle that appeared for the first time in Vanity Fair Magazine in 1879. Think of two words, like ALICE and GENES. You have to construct a sequence of actual words starting from the first word and ending with the second. The tricky bit is that no two consecutive words in your sequence can differ by more than one letter. ALICE, SLICE, SPICE, … Spotted how that puzzle makes the link to Gray code patented 74 years later?

We have book voucher prizes donated by Intel for the best answer of how to get from ALICE to GENES in this way. The winner's school will also get voucher prizes. For full details and to submit your answer go to the Magazine+ part of the webzine.



Creating a brain inside a computer

For years a dream of computer scientists has been to build computers that can think: one way being to try and write programs that work like the brain called Neural Networks.

Now it turns out that we can help medics understand the brain using the computer science that people originally thought might create artificial intelligence. Many of the areas of the brain aren't completely understood. Understanding how these individual parts work can help in diagnosing diseases and creating cures.

One area of the brain which until recently was hardly understood is called the basal ganglia. It was thought to be connected to decision making. Different parts of the brain control body movements and purely mental operations like identifying a smell. In response to the things that happen around us ('stimuli'), these brain regions want to take control of our body or our attention. The basal ganglia decides which brain area gets control of the body or the attention, and so what actually happens.

When the brain makes a decision to do something because of, say, a noise, you don't react instantly when you hear the noise. You only react after a certain amount of stimulus has been received by the brain. It only happens after some threshold has been reached. The basal ganglia was believed to perform this but it wasn't understood how... and the basal ganglia contained some very strange neurons not found in other parts of the brain.

The same type of decision problem is also studied in statistics where there's a particular procedure that's the best known method for making decisions on incoming data. It's described by a complicated mathematical formula. Bristol University researcher, Rafal Bogacz with other researchers at Sheffield, discovered that this formula can be written in a way that is similar to a neural network: the computer scientist's programmed version of the brain. The formulae can be written as a series of simpler parts that pass information between each other. What was surprising was that the resulting Neural Network looked remarkably similar to the wiring that was found in the basal ganglia. Could it be that the brain had, via the process of evolution, programmed itself to implement a complex statistical procedure?

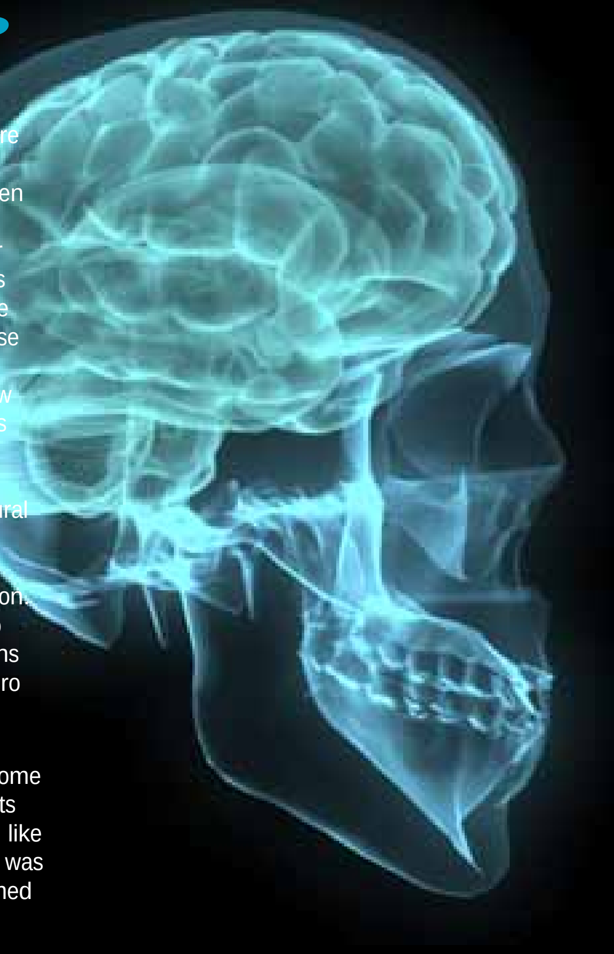
Scientific models are a way to see into the future!

So this version of the statistical procedure acts as a model of the brain. Once scientists have a model of something then often they try to predict something that follows from the model and see whether this appears in the real world. This gives confidence that the model is correct. We believe Newton's Laws of Motion because we can use them to predict where the planets are in the sky and to predict how objects travel on earth. Scientific models are a way to see into the future!

A particularly interesting part of the Neural Network model developed was that one part of the model needed to perform a calculation called the exponential function. This is the calculation that converts 0 to 1, 2 to 4, …8 to 256 and so on. In maths terms if the input, x was greater than zero then the output would behave like 2^x.
In other words it would grow very fast. Remember that the basal ganglia had some strange neurons? Well the model predicts that the strange neurons should behave like the exponential function, and when this was checked they did! The biologists confirmed that they 'fire' in a way that follows the behaviour of the exponential function.

So by understanding how to implement statistics using Neural Networks we now understand parts of the brain better that were a mystery. The goal now is to use this model to predict what happens when this part of the brain is damaged. That way we might produce cures for the resulting diseases. There are still many other aspects of this area of the brain that we do not understand. Maybe we can understand those in a similar way too.

So we may not have created a computer that thinks yet, but the computers are helping us understand how we think!



Biometric Mice

In the old days people proved their identity by signing their name.

Then the world went online and suddenly we had to remember passwords galore: phrases, numbers, but never a word in a dictionary in any language not even Lord of the Rings Elven. Nothing personal that someone could find out about you as that's easily crackable. Ideally at least 8 letters long … passwords that are memorable but hard to guess. Impossible! People write them down, tell them to friends and colleagues, even to random people who phone them up claiming to be from a bank or the IT department. Password gone, secrets gone…and your money…even your whole identity.

check your identity online using a kind of biometrics without grisly or yucky consequences

Enter biometrics: using some unique physical characteristic of the person such as fingerprints, iris scans or the like. It's been suggested that the biometric industry could be soon worth $2.5 billion. However, most biometric systems need special hardware of some kind to measure the characteristic. They can also carry a stigma as well as raising privacy problems. Worse if you can only start your car with a fingerprint a grisly consequence might be a robber chopping your finger off to use as the key. Maybe DNA is the ultimate biometric ID…but that is easy, if yucky, to steal – after all scientists even extract fragments of DNA from Egyptian mummies and millennia old insects trapped in Amber. You leave copies of it everywhere you go, flaking skin, saliva on glasses or when you go to the toilet.

Enter Computer Scientists Peter McOwan and Ross Everitt of Queen Mary. They have invented a new way to check your identity online using a kind of biometrics without grisly or yucky consequences. It could make shopping over the Internet much more secure and give people more confidence buying online. It could even replace signatures and chip and PIN in supermarkets.

The new biometric mouse signature system uses a written signature, just as with paper but the person writes it with their mouse. No special gadgets are needed it just uses a standard web browser. The clever part is that it is not just the pattern on the screen that matters but the pattern of mouse movements to create it. Sophisticated artificial intelligence software learns the way that the person writes the signature and matches any subsequent writing of the signature against it. It can also adjust to the gradual change of a signature over time - a problem with a pencil and paper signature. A fraudulent attempt to sign a document needs more than just the pattern itself but to be able to copy the way it was done. In future you might not be trying to remember yet another PIN or password to login, but just signing your name.

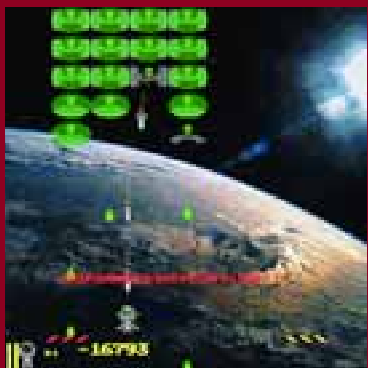
cs4fn Space Invaders wins research award!

A scientific paper based on results from the cs4fn online SpaceInvaders experiment together with a similar car game experiment just won the best short paper award at HCI2006: a top International research conference on Human-Computer Interaction.

Congratulations to Rob Dann and Wai Lok Cheng, students at Queen Mary on whose MSci project work the paper was based and to Jonathan Back at UCL who wrote the paper. Thanks to all the cs4fn readers for taking part.

The Space Invaders experiment is investigating how hard it is for people to remember to do things in the future. Can you avoid losing points by always remembering to switch on your gun. One of the ways we overcome our imperfect memories is to manipulate our environment – for example to make sure I remember to post a letter when I go out in the morning, I leave it on the floor in front of the door where I can't miss it: a message to myself for the future. Now you can even send an email to your future self, thanks to a new web site www.futureme.org. Type the message as normal but add the date you want it sent.

What do you need to tell your future self? Send the email now before you forget. Then go play spaceinvaders in the webzine.



Looking inside medicine–
computer scientists in the body

Computer scientists are helping doctors, surgeons, biologists and psychologists get inside the body and mind, and improving the way that medical care will be provided now and in the future. It's a fascinating story of biology, maths and computing and it all starts with an X.

What a picture!

X-rays were the first practical method of examining the inside of a living body. The process involves firing high energy X-rays through the body with a photographic plate at the other side. Dense bits of the body like bones absorb radiation. That leads to a lighter area on the developed photographic negative. In effect a shadow is cast through you onto the photograph, giving a view inside. A problem with this is that, as with any camera, it's hard to get the photograph exposure right. Worse you have to find the space to store hundreds and thousands of sheets of film. Worse still, suppose your doctor in Manchester needs the X-ray taken of you when you are wanting to play football so you are in Frankfurt. The film has to be sent by post. Enter computer scientists to make things easier.

Portable pixel pictures

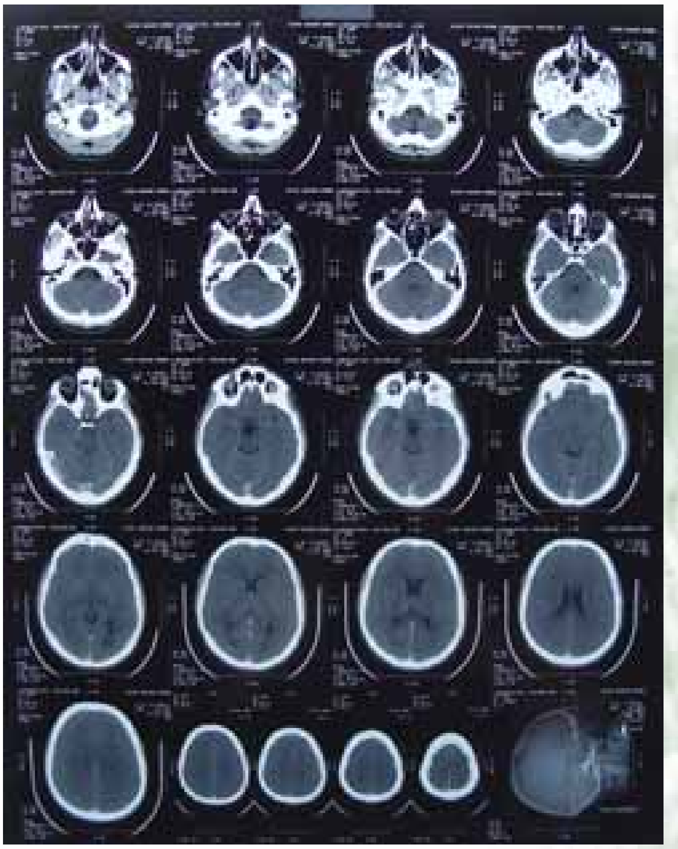
New digital X-ray systems are being developed. These use X-ray detectors not film and produce digital images rather than the standard photographic images. The advantage here is that those images can be processed using clever algorithms to correct for problems in exposure, or even to pick up particular shapes in the image. The diagnosis can be helped by the artificial intelligence in the computer, which can spot unusual patterns in the image and alert the doctor. Better still since these digital X-rays are computer based. They can be easily stored and transmitted throughout the world to places where they are needed.

A slice of life

X-rays, even digital X-rays, can only give you flat images of the body innards. Like a shadow they squash all the depth details. Your insides are three-dimensional (3D) though so it would be useful to be able to slice through your body and get a view inside. This is possible using a computer based method called tomography, from the Greek tomos (slice) and graphia (describing). It still uses X-rays but in tomography the X-ray source and the detector rotate round the body taking lots of images at different angles. It's like casting different shadows as the sun moves round

you. So imagine you're using tomography on a cylinder, and your X-ray source is a torch. Move the torch round the cylinder and look at the shadow cast on a piece of paper moving at the opposite side to the torch. Each 'shadow' picture would look the same because a cylinder is circularly symmetric. Now imagine a more interesting shape. Each of the shadow pictures would depend on where you were at the time in relation to the shape. With some clever maths, a reconstruction algorithm and a computer you can go from the shadow pictures back to the shape. These shapes are the organs and innards of your body, and they can be recorded in their full 3D glory. There are now systems that spiral the X-ray source round the body making it quicker. You can even do tomography at very high speed allowing slices through the beating heart to be calculated. Interestingly the maths behind this technology, called the "Radon transform" after Czech mathematician Johann Radon (1887–1956), was developed purely as an abstract mathematical theory. No one at the time could see any use for it!

Go to the Magazine+ section of the cs4fn webzine for more on how magnets and wobbly protons mean we can now even see inside your squishy bits.



Check in at the Digital Hospital

Life saving healthcare and medical imaging is going digital. Using video conferencing, mobile scanners and even remote operated robotic surgery the field of tele-medicine allows expert medical care to be provided any time, any place. Today's progress towards the digital hospital combines different ways of taking information about the state of your body, such as digital X-rays, or tomographic images, readings from digital thermometers or digital blood pressure readers. We can combine all this information with your personal information into one big file, so there is no need for multiple paper copies to get out of date or lost. The hospital information system keeps track of all your data, and also importantly who has access to it.

Tomorrow's world and you

According to Alan McBride, a computer scientist who is working on these state of the art medical systems:

'This technology is a major step forward in health care where the UK is leading the way. The government's grand scheme will allow images taken in Newcastle to be shown on your GP's desk in London, together with the hospital report, which will automatically be emailed to their inbox. Computer science is playing the major role in all this, creating new ways to aid clinical practice, with plenty of scope in the future for talented computer scientists to get involved.'

The computer scientists who make this happen will not only be technical specialists but also experts in understanding human behaviour. We will only get the benefits such a grand scheme promises if the conflicting needs and concerns of all those involved are taken into account: patients, nurses, doctors, managers and politicians…that will take major people skills.

Predicting Cancer Cures

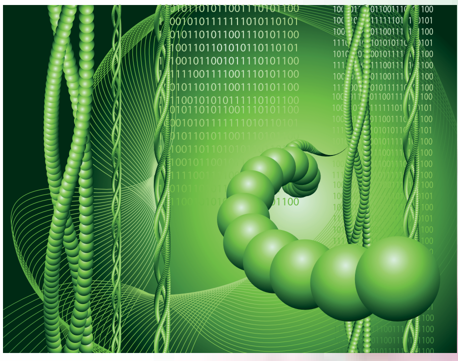
The most exciting research often comes about when people from different subjects work together and it can come from unexpected directions. How might Computer Scientists help in the discovery of drugs to fight Cancer?

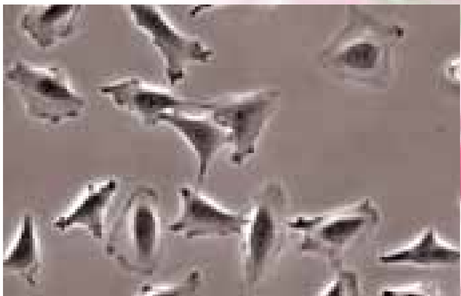
The obvious way is in building faster super-computers to number-crunch the problems. However, there are more subtle ways. Ideas from one area can have a big impact on others, if the researchers are creative enough to see the links. Professor Muffy Calder, a Computer Scientist at Glasgow University, discovered one intriguing link while working with cancer specialists. It turns out that the problems of understanding how drugs act on our cell chemistry are very similar to those in understanding communication networks. Tools for one can be used for the other.

Muffy and team are aiming to understand the biochemical “pathways” in which signals pass through from the membrane of cells into their nucleus. These “pathways” are just a series of chemical reactions where different protein molecules are created and destroyed. To develop cancer drugs, scientists need to have a better understanding of how this happens. It will help them predict the way the reactions are affected by drugs.

The pathways are normally modelled using complex maths built into tools that simulate the processes involved – allowing virtual experiments to be done on the computer instead of on real cells. These simulations are used to suggest actual experiments and to help understand the results. Muffy’s team realised that the diagrams used by biochemists to illustrate the reactions are well known to computer scientists – they look just like the “producer-consumer” networks already used to analyse telecom networks. That means tools already developed for analysing telecom networks can be used to analyse the biological networks. What advantage does this give? Proof can be used rather than just simulation. Simulation allows you to check what happens in particular individual situations: the ones you simulate. Unfortunately other situations may or may not give the same results: you don’t know unless you simulate them too. With the mathematical proof-based tools, general properties of the biological system as modelled can be shown to always be true. You can, for example, work out the probability that too much of a particular protein will be produced.

Previous work like this had a focus on proving properties at a molecular level: what will happen if single molecules react? Muffy realised that when developing drugs it’s not what single molecules do that





ultimately matters, but being able to predict how test tubes of reagents (substances that react) behave. That means you have to model something slightly different: what’s known as the molar level, the test-tube level. It turns out that to prove properties interesting to the biochemists only two levels of concentration of reagents matter - high and low - corresponding to enough and not enough reagent to trigger a reaction. This is a similar idea to one computer scientists use to reason about hardware circuits, thinking in terms of high and low voltage levels rather than about individual electrons.

The work opens up a whole new approach for developing drugs. The ultimate aim is to provide predictive tools for biochemists. They will suggest what effects different drugs might have on the processes taking place in cells and so suggest experiments to perform. If the team of computer scientists and cancer specialists do manage this, they will have handed the biochemists a powerful new tool to help in the fight against cancer.

The Tale of the Stormy Petrel

Biology and Computer Science can meet in some unexpected, not to mention inhospitable, places. Who would have thought that the chemical soup in the nests of Stormy Petrels studied by field biologists might help in the development of futuristic computer technologies at Intel, for example.

Just Keep Doubling

One of the most successful predictions in Computer Science was made by Gordon Moore, co-founder of Intel. Back in 1965 he suggested that the number of transistors that can be squeezed onto an integrated circuit – the hardware computer processors are made of - doubled every few years: computers get ever more powerful and ever smaller. In the 40 or so years since Moore's research paper it has remained an amazingly accurate prediction. Will it continue to hold though or are we reaching some fundamental limit? Researchers at Intel are confident that Moore's Law can be relied on for the foreseeable future. The challenge will be met by the Material Scientists, the Physicists and the Chemists. Computer Scientists must then be ready for the Law's challenge too: delivering the software advances so that its trends are translated into changes in our everyday lives. It will lead to ever more complex systems on a single chip and so ever smaller computers that will truly disappear into the environment.

Dusting computers

Motes are one technology under development on the back of this trend. They are dust-sized computers. Scatter them around the environment and they form unobservable webs of intelligent sensors. Scatter them on a battlefield to detect troop movements or on roads to monitor traffic flow. Mix them in concrete and monitor the state of a bridge. Embed them in the home to support the elderly or in toys to interact with the kids.

What barriers must be overcome to make Motes a ubiquitous reality? Much of the area of a computer is taken up by its connections to the outside world - all those pins allowing things to be plugged in. They will be replaced by wireless communications. At the moment computers contain multiple chips each housing separate processors. It is not the circuits that are the problem but the packaging - the chip casings are both bulky and expensive. The future is for what is known as “multicore” chips: large numbers of processors on a single small chip courtesy of Moore's Law. This will lead to significant challenges to Computer Scientists over how to develop the software to run on such complicated hardware. Battery technology is the only big problem that remains. Motes will soon be with us.

Enter the Petrels

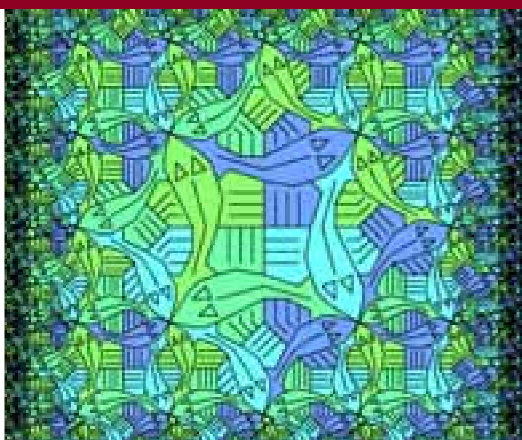
But how do you test a device like that? Enter the Stormy Petrel birds. Intel's approach is not to test futuristic technology on average users but to look for extreme ones who believe a technology will deliver them massive benefits. In the case of Motes, the extreme users are field biologists who want to keep tabs on birds in extremely harsh field conditions. Not only is it physically difficult for humans to observe sea birds' nests on inhospitable cliffs but human presence disturbs the birds. The solution: scatter motes in the nests to detect heat, humidity and the like from which the state and behaviour of the birds can be deduced. A nest is an extremely harsh environment for a computer though, both physically and chemically. A whole bunch of significant problems, overlooked by normal lab testing, must be overcome. The challenge of deploying Motes in such a harsh environment has led to major improvements in the technology.

Moore's Law is with us for a while yet, and with the efforts of Material Scientists, Physicists, Chemists, Computer Scientists and even Field Biologists and their sea birds it will continue to revolutionise our lives.

Win an ipod nano

Win great prizes for you and your school ... and learn a fun way to program pictures

iPod nano and book vouchers up for grabs. Prizes provided by ARM and Intel



Using GeomLab, developed by Mike Spivey of the University of Oxford with support from NAGTY, you must program a picture. Simple pictures come easy but even ones as complicated as Escher's beautiful, thought-provoking pictures with ever-repeating lizards, fish and other animals that you may have come across, are possible.

GeomLab is a great way to learn about this different style of programming called functional programming. You will also get an idea of the issues in laying out the elements of web pages.

See the Magazine+ section of the webzine for full details and how to enter.

Future Friendl
Focus on Kerst

Kerstin Dautenhahn is a biologist with a mission: to help us make friends with robots.

Kerstin was always fascinated by the natural world around her, so it was no surprise when she chose to study Biology at the University of Bielefeld in Germany. Afterwards she went on to study a Diploma in Biology where she researched into the leg reflexes in stick insects, a strange start it may seem for someone who would later become one of the world's foremost robotics researchers. But it was through this fascinating bit of biology that Kerstin became interested in the ways that living things process information and control their body movements, an area scientists call biological cybernetics. This interest in trying to understand biology made her want to build "things" to test her understanding. These "things" would be based on ideas copied from biological animals but be run by computers. These "things" would be robots.

Follow that robot

From humble beginnings building small robots that followed one another over a hilly landscape, she started to realise that biology was a great source of ideas for robotics, and in particular that the social intelligence that animals use to live and work with each other could be modelled and used to create sociable robots. She started to ask fascinating questions like "What's the best way for a robot to interrupt you if you are reading a newspaper - by gesturing with its arms, blinking its lights or making a sound?" and perhaps most importantly "When would a robot become your friend?" Now at the School of Computer Science at the University of Hertfordshire where she is a Professor of Artificial Intelligence, she leads a world famous research group looking to try and build friendly robots with social intelligence.

Good robot/Bad robot – East vs West

Kerstin, like many other robotics researchers, is worried that most people tend to look on robots as being potentially evil. If we look at the way robots are portrayed in the movies that's often how it seems: it makes a good story to have a mechanical baddie. But in reality robots can provide a real service to humans, from helping the disabled, assisting around the home and even becoming friends and companions.

This fall in acceptability is called the 'uncanny valley'

The baddie robot ideas tend to dominate in the west, but in Japan robots are very popular and robotics research is advancing at a phenomenal rate. There has been a long history in Japan of people finding mechanical things that mimic natural things interesting and attractive. It is partly this cultural difference that has made Japan a world leader in robot research. But Kerstin and others like her are trying to get those of us in the west to change our opinions by building friendly robots and looking at how we relate to them.

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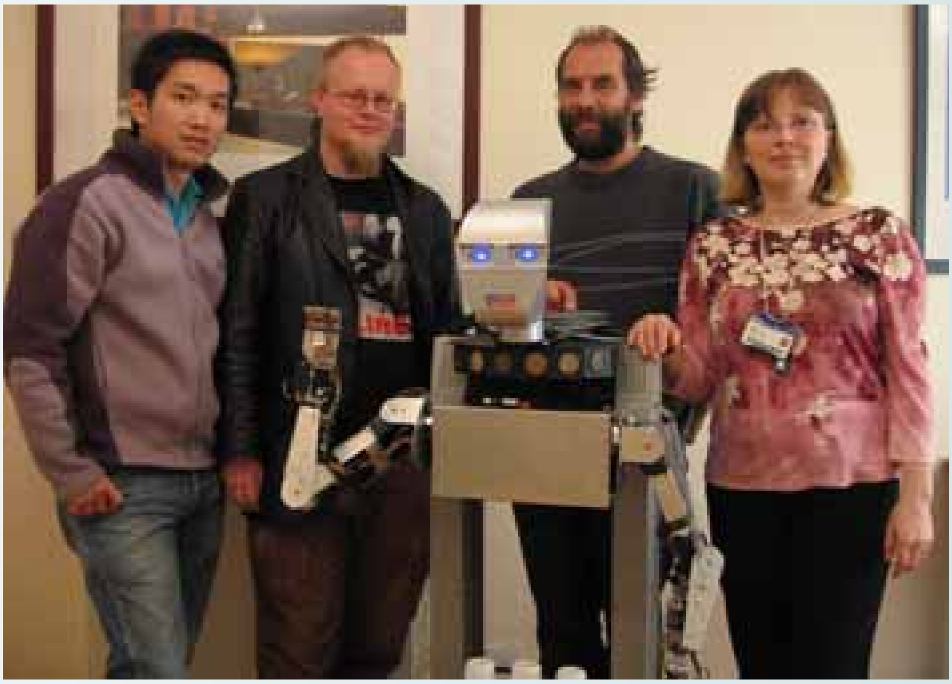
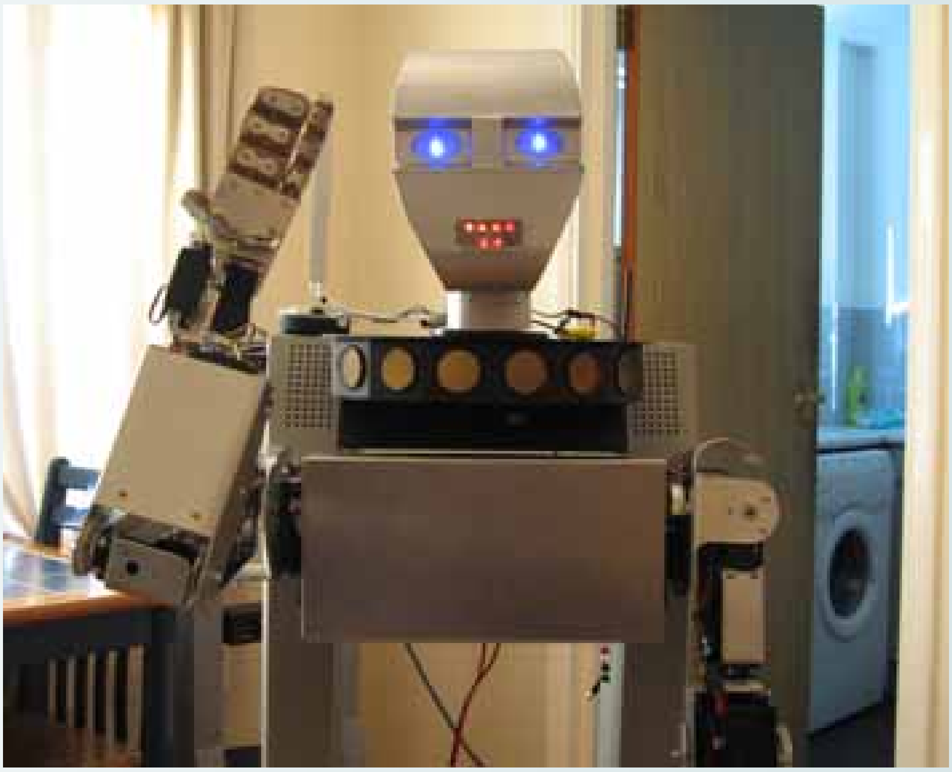


Kerstin and her team



Polite robots roam the room

Kerstin decided that the best way to see how people would react to a robot around the house was to rent a flat near the university, and fill it with robots. Rather than examine how people interacted with robots in a laboratory, moving the experiments to a home, with bookcases, biscuits, sofas and coffee tables, make it real. She and her team looked at how to give their robots social skills, what was the best way for a robot to approach a person? At first they thought that the best approach would be straight from the front, but they found that humans felt this too aggressive, so the robots were trained to come up gently from the side. The people in the house were also given special 'comfort buttons', devices that let them indicate how they were feeling in the company of robots. Again interesting things happened, it turned out that not all, but quite a lot of people were on the whole happy for these robots to be close to them, closer in fact than they would normally let a human approach. Kerstin explains 'This is because these people see the robot as a machine, not a person, and so are happy to be in close proximity. You are happy to move close to your microwave, and it's the same for robots'. These are exciting first steps as we start to understand how to build robots with socially acceptable manners. But it turns out that robots need to have good looks as well as good manners if they are going to make it in human society.

Looks are everything for a robot?

How we interact with robots also depends on how the robots look. Researchers had found previously that if you make a robot look too much like a human being, people expect it to be a human being, with all the social and other skills that humans have. If it doesn't have these, we find interaction

very hard. It's like working with a zombie, and it can be very frightening. This fall in acceptability of robots that look like, but aren't quite, human is what researchers call the 'uncanny valley'. People prefer to encounter a robot that looks like a robot and acts like a robot. Kerstin's group found this effect too, so they designed their robots to look and act the way we would expect robots to look and act, and things got much more sociable. But they are still looking at how we act with more human like robots and have built KASPAR, a robot toddler, which has a very realistic rubber face capable of showing expressions and smiling, and video camera eyes that allow the robot to react to your behaviours. He possesses arms so can wave goodbye or greet you with a friendly gesture. He's very lifelike and hopefully as KASPAR's programming grows, and his abilities improve he will emerge from the uncanny valley to become someone's friend.

Autism – mind blindness and robots

The fact that most robots at present look like and act like robots can help in supporting children with autism. Autism is a condition that prevents you from developing an understanding of how to interact socially with the world. A current theory to explain the condition is that those who are autistic cannot form a correct understanding of others' intentions. It's called mind blindness. For example if I came into the room wearing a hideous hat and asked you 'Do you like my lovely new hat?' you would probably think, 'I don't like the hat, but he does, so I should say I like it so as not to hurt his feelings'. You have a mental model of my state of mind (that I like my hat). An autistic person is likely to respond 'I don't like your hat', if this is what he feels. Autistic people cannot create this mental model so find it hard to make friends and generally interact with people, as they can't predict what people are likely to say, do or expect.

Playing with Robot toys

It's different with robots: many autistic children have an affinity with robots. Robots don't do unexpected things. Their behaviour is much simpler, because they act like robots. Using robots Kerstin's group have been examining how we can use this interaction with robot toys to help some autistic children to develop skills to allow them to interact better with other people. By controlling the robot's behaviours some of the children can develop ways to mimic social skills, which may ultimately improve their quality of life. There is no final conclusion yet, but some promising results, and this work continues to be one way to try and help those suffering with this socially isolating condition.

Future friendly

It's only polite that the last word goes to Kerstin

'I firmly believe that robots as assistants can potentially be very useful in many application areas. For me as a researcher, working in the field of human-robot interaction is exciting and great fun. In our team we have people from various disciplines working together on a daily basis, including computer scientists, engineers and psychologists. This collaboration, where people need to have an open mind towards other fields, as well as imagination and creativity, is necessary in order to make robots more social.'

In the future, when robots become our workmates, colleagues and companions it will be in part down to Kerstin and her teams pioneering effort as they work towards making them future friendly.

Blade
the emotional computer

Communicating with computers is clunky to say the least – we even have to go to IT classes to learn how to talk to them. It would be so much easier if they went to school to learn how to talk to us.

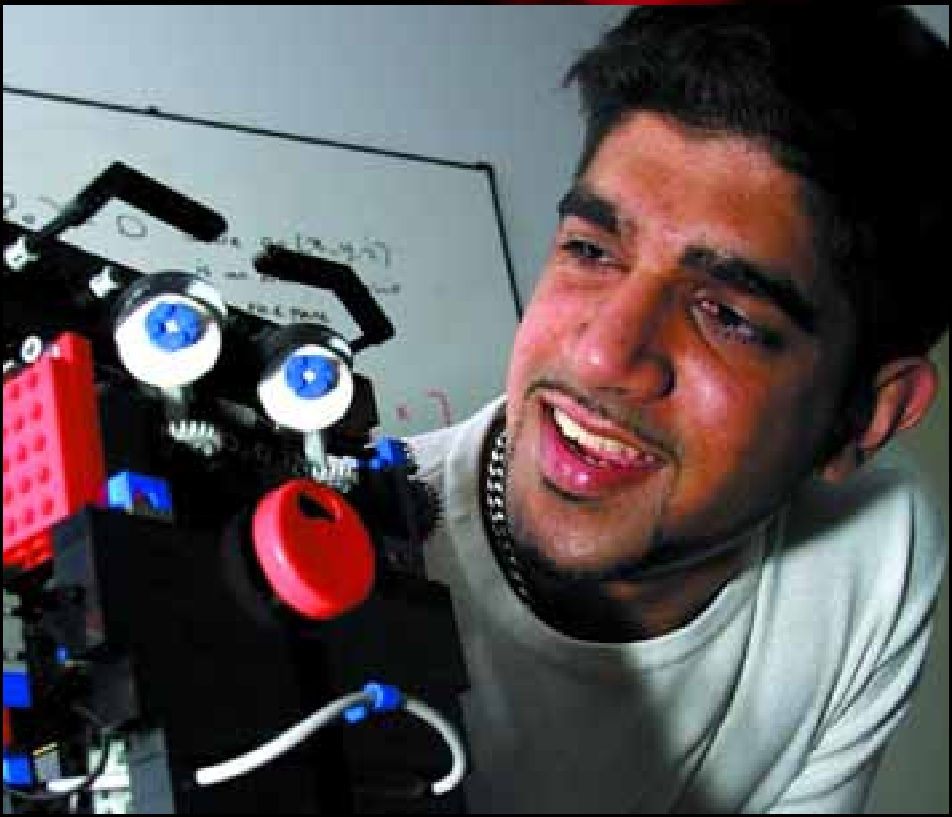
If computers are to communicate more naturally with us we need to understand more about how humans interact with each other. The most obvious way that we communicate is through speech – we talk, we listen – but actually our communication is far more subtle than that. People pick up lots of information about our emotions and what we really mean from the expressions and the tone of our voice – not from what we actually say. Zabir, a student at Queen Mary who went on to work for a Merchant Bank was interested in this so decided to experiment with these ideas for his final year project. He used a kit called Lego Mindstorm that makes it really easy to build simple robots. The clever stuff comes in because, once built, Mindstorm creations can be programmed with behaviour. The result was Blade.

Blade, named after the Wesley Snipes film, was a robotic face capable of expressing emotion and responding to the tone of the user's voice. Shout at Blade and he would look sad. Talk softly and, even though he could not understand a word of what you said he would start to appear happy again. Why, because your tone says what you really mean whatever the words – that's why parents talk gobbledegook softly to babies to calm them.

Blade was programmed using a neural network, a computer science model of the way the brain works, so he had a brain similar to ours in some simple ways. Blade learnt how to express emotions very much like children learn – by tuning the connections (his neurons) based on his experience. Zabir spent a lot of time shouting and talking softly to Blade, teaching him what the tone of his voice meant and so how to react. Blade's behaviour wasn't directly programmed, it was the ability to learn that was programmed.

Eventually we had to take Blade apart which was surprisingly sad. He really did seem to be more than a bunch of lego bricks. Something about his very human like expressions pulled on our emotions: the same trick that cartoonists pull with the big eyes of characters they want us to love.

Watch the video of Blade in action in the cs4fn webzine.



Hans Moravec, of Carnegie Mellon University, has suggested it may be possible to download the information in your brain and store it in a digital format as a way to achieve immortality... others aren't so sure...

Music in the key of life

Combining musical notes makes all the music in the world; from Mozart to the Artic Monkeys it's simply a case of creatively putting the right notes together to make a tune.

A musical score, is a sequence of marks telling you what to play next. It's a way to record the instructions. All life on earth has its own set of instructions, but rather than being marks on a paper to tell you how to play the tune, life uses chemicals in a long thin molecule called DNA to code the instructions for building living things.

Give me an A - C - G - T

DNA, or Deoxyribonucleic acid, is a very clever molecule. It needs to be. After all its storing all those important life building instructions. Its actually two long strings of chemicals that wrap round each other in a special way, called a double helix. It's a bit like two spiral staircases twisted together, and it lets the molecule store the instructions twice, for safety. The instructions on the individual strands are made up of chemicals called bases. There are four of them, called adenine (abbreviated A), cytosine (C), guanine (G) and thymine (T), and its these four letters that make you what you are. When the DNA is active each pattern of these bases (normally thought of in groups of 3 bases e,g, AAC and called a codon) allows a cell to put together a chunk of a protein in the correct order. Following the codon instructions on the DNA, the cell can build long complex protein chains. These chains then float off into the cell and chemical forces within the chains cause them to twist into particular shapes. It's the shape of proteins that let them do their work. They act like a lock and key, fitting their three dimensional shape onto the surface of other proteins and chemicals and so allowing chemical reactions to happen.

Genetics and garden genomes

All life on earth has DNA as its basis. It's the way that information on what it means to be a particular plant, flower, virus or animal passes from one generation to the next, along with instructions on how to build them. The DNA is the data store of life; each species has its own set of DNA, often bundled into larger structures called chromosomes. This full set of data to build a species is called the species genome, and understanding how it works is one of the greatest challenges in current science.

Can you see a pattern here?

Biology and computer science have often been seen as separate. Biology looks at plants and animals, computer science at programs. But when you start to look at the genetic basis of life, its all about patterns of data. With DNA it's the codons with their four letter alphabet, while in computer science it's tended to be the two letter alphabet of binary. Computer scientists can cope with some extra letters, and today the fascinating and expanding field of bioinformatics takes the techniques of computer science and applies them to help untangle the world of biological genetics.

A pattern of guilt

How do we know that, for example, a particular blood sample found at a scene of a crime belongs to the suspect? We can take the sample, and using some clever chemistry amplify the amount of DNA in it to amounts that we can measure more easily. We then look at the pattern of the DNA from the crime scene and compare it to the pattern of DNA taken from the suspect. If the patterns match then you have evidence of guilt. DNA is like a fingerprint: each person has a unique pattern. A computer vision system scans the patterns and tell us if there is a match. This ability of computers to rapidly find whether two patterns are the same is at the core of work in genetics to try and decode the genome. Let's suppose that a particular sequence codes up a particular protein in one species. Imagine we then find that pattern in another new species' DNA. We have strong evidence that the new species also produces that particular protein, and that helps us understand how the new species lives.

It's a string thing

Long lists of text or numerical elements, such as AGGTAC or 122552424, are called strings in computer science. There is a long history of computer scientists inventing clever ways to efficiently find string matches. It's important to them. For example when you type in your computer password the password string is compared with the stored password string. If these strings match exactly you are granted access. So we can take these techniques over to use in biology where it's exactly the same problem we need to solve, just different types of strings.

A Slice of Life

The Visible Human Project aims to create a complete, anatomically detailed, 3D model of male and female human bodies. Using computer assisted imaging methods like tomography this gigantic set of images are available online for researchers to examine and add information to. A grizzly aspect is that the bodies used for the project were actually cadavers (dead bodies), which were cut up into thousands of thin slices. The male body was sliced at one-millimetre intervals, the female at one-third-of-a-millimetre intervals, and the data digitised for the project. Both had left their bodies to science – the man was actually a criminal who had been executed.

Bioinformatics: It's a BLAST

BLAST which stands for Basic Local Alignment Search Tool, is a computer algorithm that quickly searches for matching patterns in genetic data. BLAST search compares the genetic data you want to examine (often called the query sequence) with a library or database of previously identified sequences. However, often with biological data no two sequences are exactly the same, term by term, so BLAST gives an estimate of how well the sequences match to those in the library. To start with BLAST tries to get a perfect match. The algorithm defines a range, or window, over which it will search for a good match. For example, if the algorithm was given the sequences AGGTAC and ACGTAG and a window size of 3, it would pick out the matching three-element pattern GTA that is in both sequences. For real data the window size is normally larger, typically looking for matches of a dozen or so elements.

Let's try that again

BLAST has identified a part of the sequence that's an exact match between the query string and the library string, but there's more to do. In the second stage, BLAST tries to extend the match in both directions, starting at the point where it found the exact match. It looks for a match at each letter as it moves out, adding 1 to its score value if the letters match, and giving no score if they don't. In this way you can extend the search. A low score tells you the matching isn't good, but it may be good enough to give you some useful information. There are of course lots of improvements that can and have been made to this algorithm. They let you take into account any gaps in the patterns, but the basic idea is the same, and this method is employed all over the world to search and help understand the massive amount of genomic data that has been amassed over the last few years.

DNA and the Prosecutor's Fallacy

DNA fingerprint evidence can close a case. If you have found a DNA match the result is certain…or is it? Why did the Society for Expert Witnesses call in a Queen Mary Computer Scientist to make a video for them explaining clearly what you can deduce from such "fingerprint" evidence? …Because lawyers often get it wrong even in high profile cases, claiming cast iron cases when they have none at all. Turns out tools developed for Software Engineers help.

Go to the webzine to find out more…

The music of life

DNA is the musical score for life, and computer scientists are helping us to understand its beauty and complexity. Music tends to repeat phrases, as does DNA. The same pattern of notes are played in a tune. The same patterns of codons occur again and again in a genome. In fact both music and DNA share another thing in common. They both have a similar distribution of repetitions and it crops up all over the natural world. Intrigued by this fact many people have actually used DNA sequences to produce music! Some say that the music of DNA sounds a bit like Mozart, but whatever tune DNA plays, understanding how it works will be top of the science charts for many, many years to come.

The evolution solution revolution

In theory it should explain something

Good scientific theories are predictive. They don't just describe the way the world is as we know it but suggest experiments or other investigation that we don't know the answer to. If the theory is correct then the predictions should turn out to be true. The theory should also be able to explain future observations. That's why Darwin's theory of evolution by natural selection is accepted by scientists. It's sometimes argued that evolutionary theory can't be good science because you can't do experiments about the past. There's more to scientific investigation than test tube science though. There have been vastly many correct predictions based on the theory of natural selection (see Box). The most profound is that it predicted the need for a biological way for passing information between generations. That ultimately led to the discovery of the DNA molecule and within half a century the mapping of the human genome as well as that of other animals. Where does computer science come in? Well it works both ways.

Computer Science naturally

Computer simulations can be used to explore whether things might be possible. For example, some people find it hard to believe that complex biological features like an eyeball could possibly come about step by step as predicted by natural selection. Computer simulations have shown that such things are feasible: for example an early computer experiment showed it is possible to construct sequences of partial eyeballs from single light detecting cells to complete eyeballs that each work in a way that would help a creature survive. This compares well in fact with the range of similar "eyes" found in real creatures.

Evolving answers

In the other direction the ideas of evolution have given computer scientists ideas for new ways to program – the notion of genetic algorithms. Computer science is about coming up with solutions to problems and that is exactly what nature does over time – adapt animal species via natural selection to allow them to survive better in their changing environments. The idea is that to solve a problem you turn it into "digital DNA" and evolve a solution.

Instructive DNA

DNA is the biological molecule that codes the instructions for creating all living things on earth. It's a sequence of instructions, data, that cells use to build new cells, and it's also the key to evolution. When species mate, part of the mother's and part of the father's DNA combine to give the new instructions for the child. That's why you look a bit like your mum and dad. Parts of their data were used to build you. That DNA has been crossed over. When a species is under environmental threat often only particular types of offspring survive: those that can run fastest, or climb highest or blend into the background best. Inspired by Darwin, this is what English Philosopher Herbert Spencer pithily called "survival of the fittest"; the new set of instructions in an offspring, combined from parents, can give that offspring a survival advantage. Survival means this creature can go on to breed itself and will pass those useful instructions to its offspring and so on. Very occasionally due to the effects of cosmic rays or other factors the DNA can be changed, the chemical sequences are mutated. Normally this causes death. The instructions are corrupted and the offspring dies, but from time to time a non-lethal mutation occurs, and this can lead to offspring with a new survival trick. If it's advantageous it will let the offspring and its descendants thrive. In effect the process of evolution keeps the species and the environment matched to one another. You could say the species solves the problem of survival in the environment.

Visiting with a Genetic Algorithm

Computer scientists can now take a problem, code it up as a sort of digital DNA and use the evolutionary model, crossover between parents to create offspring and mutation, to find a good solution. A classic example is the Travelling Salesperson Problem. In this problem you have to visit say twenty towns, and do the least travelling (you need to keep the travelling expenses down). We start by randomly creating a population of 'creatures' whose digital DNA is simply a list of the twenty towns (say numbered 1-20) initially in random order. We then test how fit each of these 'creatures' is by calculating the amount of travel expenses each of them requires (how expensive that route would be to follow). From our initial population of possible solutions we choose the best solutions, those with the lowest travel expenses, and let these breed together: making a new route with parts from each parent. Those solutions with high costs don't survive in this low cost financial environment, and are simply killed off, removed from the program. The next generation, made by swapping (crossover) the digital DNA of the original best solutions, are then tested, again the best solutions survive and we breed them to create a new generation and so on. Many thousands of generations later we have really good solutions, which have survived because they are a good solution to the problem.

Mutate and explore

We always have a small random mutation rate in the background, as this parent offspring breeding can often result in you only exploring a good solution, they are breeding in only one isolated part of all the possible good solutions, and possibly missing the best solution. That may require something very different.

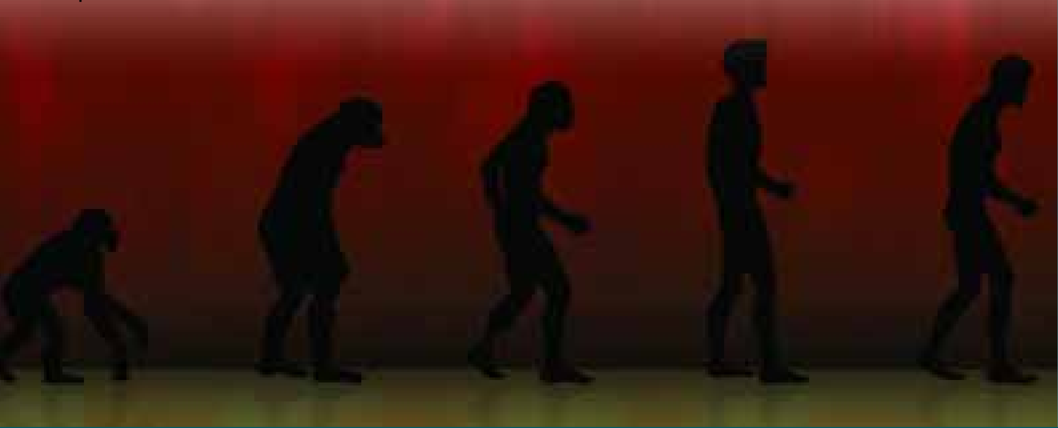
After running a genetic algorithm on your problem you simply turn the digital DNA back into, in this case the list of towns in order, and you're done. Problem solved.

Evolution works

There are many different variants on the basic genetic algorithm which try to ensure that they find the best solution possible rather than just a good solution. This ability to find the very best, or global solution, cannot yet be guaranteed mathematically – nature doesn't guarantee perfection either. However genetic algorithms are useful and powerful and have been used to solve problems in water distribution and computer networks, robotic learning, school timetabling and even back into biology and chemistry to calculate the shapes of folded proteins or atomic forces.

So computer science gives a way of exploring predictions about the details of how evolution works and can even help suggest things to look for in nature. On the other hand, by understanding how nature, through DNA and evolution leads to good solutions to ensure survival in often incredibly harsh environments, scientists have created a powerful new form of computing in the genetic algorithm.

Try it out – join a sodarace (www.sodarace.net) and see how powerful genetic algorithms can tune a virtual beast to its current environment!



Evolutionary Predictions

Fossils for the record

Recently palaeontologists went looking for fossils on Ellesmere Island in the Arctic. They were specifically interested in finding fossils that made the link between fish and land living animals. Why did they look there? Not because fossils had been found there before but because they knew from existing fossils from elsewhere the time, 400 million years ago, when such animals should have existed. Next they used their knowledge of geography to work out where rocks of that age existed. Ellesmere Island fitted so that is where they looked. After 5 years of digging on the island, earlier this year, they found near perfect skeletons of fish with wrist like arrangements that one would expect from the missing link.

Beak to the future

A Herculean study showing the amazing dedication of some scientists is that of Rosemary and Peter Grant. They did field work on small remote islands in the Galapagos documenting evolution as it took place in the islands' finches. They did this over a staggering 30 years. They carefully measured the beaks of the finches generation after generation, also recording things like the weather and kinds and quantities of seeds available each year. Based on the data they collected they were able to predict what would happen to beak sizes when droughts happened.

Protecting Big Brother's Da Vinci Code

What do the book The Da Vinci Code, TV show Big Brother, computer software and computer chip designs have in common? They are all based on ideas and all form something called intellectual property.

It can be a big issue for the computer industry. Computer firms like ARM sell ideas not tangible chips. They design microprocessors, in effect licensing their ideas to other companies who actually create the microprocessors and put them in their mobile phones or game consoles. Are programs just ideas? After all you can't touch the code. It's just bits. So what does the law protect? Will someone else make their fortune from your great ideas?

It's mine, I thought of it first

If you were to craft a lovely, smooth wooden table, and someone came along and nicked it the law would be on your side. Your table is physical property. You can polish it, you can lend it to a friend for a party or you can sell it. This kind of protection for physical objects has been enshrined in law for centuries. However in today's information economy it's often ideas, rather than carpentry, that are the key to making loads of money. So how do you go about protecting the mental, or intellectual, effort you put into thinking up say a new TV show, a plot for a book, a movie or a mathematical algorithm in a computer program, when there is nothing physical about it? You can't touch it, but it's still something worthwhile you have created.

Wanna buy my scribble?

The law protects intellectual property, things built with your brain rather than your hands, in several ways. One of the main forms of protection is copyright. Copyright is a law that goes back centuries. It gives the creator of a work the right to decide how the work can be used. Copyright is automatic, scribble on a bit of paper, and so long as it's permanently recorded in some way it's copyrighted. You have the power to decide who can use your doodle, or make copies of it, and you can sell this right on if you can find someone willing to buy. What's more this right currently falls to your descendants for 70 years after your death. Of course copyright tends to be used to protect things that have more worth than a scribble; books, plays, paintings and so on are protected by copyright. For copyright the law says that what is important is 'expression of thought' and not the 'originality of ideas'. In fact copyright legally does not require that an expression must be original – just that it is not copied from another work.

The Da Vinci Copyright

In a recent court case author Dan Brown, writer of the international best-selling book 'The Da Vinci Code`, was taken to court by the authors of an earlier book `The Holy Blood and the Holy Grail', because they believed that Dan Brown had infringed their copyright by using similar plot ideas in his new book. They lost their case. The Judge decided that there is no copyright for an idea and the legal protection is for the way that the idea was expressed. There had been no significant copying between the books.

Opportunity knocks for TV Gameshows?

A TV gameshow is in effect an idea, a recipe for how to entertain the viewers. These so-called TV formats are big business worth millions around the world. Can these ideas be protected? With all that money at stake it's not surprising that there have been several legal cases when one TV station has tried to copy an idea from another and they have ended up in court. The first major case like this was in New Zealand in 1989.

At the time Hughie Green was the host of a very popular TV talent show called Opportunity Knocks. A company in New Zealand put on a TV show that the makers of Opportunity Knocks considered to be a copy of theirs, and so infringed their copyright. The format, their recipe for the show, was simple, it involved a talent show with a 'clapometer' that measured the noise of audience applause. The highest score chose the winning act. They also included several host 'catchphrases'. Green lost the case, the courts deciding that there was no copyright in the format of a talent show.

Big Brother's Big Day in court

Fast forward to Brazil a few years ago. The reality TV show Big Brother was an international hit, and it was being discussed for a slot on Brazilian TV. The Brazilians decided not to pay Endemol the creators of Big Brother to air the show or to buy the Format Bible, the book that Endemol were trying to sell them which detailed how to make the Big Brother show. Instead they created a new show called "Casa Dos Artistas" (the Artist's House), which Endemol felt was a "rude copy" of their show. The case went to court, Brazilian TV claiming that a reality show is no more than an idea, and that the idea of locking folk up and watching them wasn't new either. It had been used in the book "1984" by George Orwell. Even more ironically they argued that the lack of scripts, which is what makes reality TV reality TV, meant there was no copyright protection to the show.

The cost of a good idea

After much deliberation the Endemol case was upheld. They had shown that their format was more than just the idea, it had a load of identifiable elements to it that had been copied. The expression of the idea such as microphones on the housemates linked 24/7 to the viewers, the music styles, the way housemates had contact with the outside world, and the tasks, were sufficient that is was clear the Brazilian show copied them directly. The Judges awarded costs and damages of approximately £1.4million.

Software: the plot thickens

So legally ideas, such as those in the Holy Blood and the Holy Grail, cannot be protected but the way they are expressed in detail (the actual words of the book or the elements of the game show) can stand up in court. So what happens in computer software? Computer software is written, not in flowery literary prose or in a Format Bible, but in a computer language. The program, as written, is protected by copyright. However at the core of computer software is the algorithm, the mathematical recipe of how the software does what it is supposed to do. The algorithm is like the 'plot', the 'ideas in the book', the 'Format', and the computer program is merely the expression of the ideas like the actual words in the book. More complex still, algorithms are mathematics, and the law doesn't do maths very well. Mathematical formulas are considered legally as a discovery of the workings of the universe, rather than an invention like the paperclip. You can protect an invention, that's created by a human, but discovering the earth goes round the sun, or that a certain mathematical equation describes the earth's orbit is seen as simply revealing what's already there. That's two reasons that algorithms can't be protected. There is a similar controversy over whether western companies can patent products like medicines based on plants from other countries where the locals have known the effects for generations: Biopiracy.

Software: a twist in the plot?

The software industry is worth billions worldwide, and many argue that if companies spend time and money creating better software to solve real problems they should be able to protect this investment. Copyright is a major weapon in this war. When you buy a piece of software on a CD you don't buy the copyright, you only buy a license for your own personal use. Software piracy is actually where illegal copies of software are made, infringing the owners copyright and is a major threat to the software industry. A company can spend a vast amount of time trying to prevent the copying of software, but it's normally only a matter of time till someone cracks the security. Add to this the fact that much software, to ensure it works effectively, makes use of previously written code in the form of software libraries and you can see we are in a situation where things get tricky. Software is often a blend of many peoples' intellectual property.

While TV companies can fight in the courts, small software companies have problems in protecting their work, the expression of their ideas. Some computer scientists believe that copyright is the wrong way to go with software, that software should be Open. That is, all the code (at least that they write) should be available for others to share. After all what's the likelihood that your software will still be current and usable 70 years after your death?

Stealing Bits

The expression of ideas in the form of digital bits on a CD or download has taken as much intellectual effort, if not more, than writing a novel, painting a picture or coming up with the next big TV game show idea. While few of us would ever steal another person's carefully sanded wooden table or the Mona Lisa, many still think it OK to copy software. The way our society sees the difference between physical and intellectual property, and the tools the law gives us to protect each, will help define the way that the next decades advance. We must hope that we learn to respect and correctly handle computer code in the same way the courts respect the Da Vinci Code if we want opportunity to knock for us all in the future.

Back (page) to Life

There are many advances in science and technology where the innovators involved are way ahead of their time. The technology just wasn't there to support their futuristic ideas or the time just wasn't right. Later they were proved to be correct, here we celebrate how, one way or another, computer science has brought their ideas to life!

Da Vinci coded

One of the most famous examples is Leonardo Da Vinci, the renaissance scientist, engineer and artist. His drawings show that he thought up many completely novel inventions for his time. He is credited for inventing things like the helicopter, tank, solar power, robots and the calculator. Many of his inventions have since been made once modern materials and tools were available. Computer simulations also showed the levers and strings in his robot knight worked perfectly.

Life Lesson: Even Leonardo's ideas didn't always get off the ground straight away!

Muslim programs

Back in the 9th century in Baghdad the Persian Muslim scholar Abu Abdullah Muhammad ibn Musa al-Khwarizmi wrote a book "On the Calculation with Hindu Numerals". It was responsible for the subsequent widespread use of the Hindu-arabic number system we use today. He also developed rules for doing arithmetic using this system. The word algorithm, derived from his name, started to be used to refer to such rules that could be followed to achieve a calculation. Once computers were eventually invented in the 20th century this whole idea of algorithms suddenly became crucial as that is really all a computer program is: a set of instructions that if followed precisely in the given order lead to some task being achieved…but now followed by a computer rather than by a mathematician.

Life Lesson: Always have a plan and stick to it!

Grumpy old men can make a difference

In the 1800s "computers" were teams of people employed to calculate tables of numbers used for example when navigating. Charles Babbage changed that inventing the first programmable computer, called "The Difference Engine" to take over and so eradicate human error from the table. Unfortunately he struggled to get the funding for his ideas not least because of his confrontational personality and he never built it. The world had to wait a century longer for a functioning computer. In 1991 a version was finally built directly from his plans – and worked perfectly.

Life Lesson: Success takes personality too!

The pen, the paper and the poet's daughter

Babbage's computers needed programs and for that he needed a woman: Ada Lovelace, daughter of poet Byron and an accomplished mathematician. Even though the Difference Engine did not exist she wrote programs for it, and even tested them on paper to make sure they did work even though she couldn't run them on the machine. The same technique is still used today by programmers to help get rid of bugs in their code at an early stage.

Life Lesson: You don't need a famous poet dad or a computer to teach yourself to program.

Small but perfectly formed

In 1960, Richard Feynman, Nobel prize winning physicist, arguing that we were a long way off the fundamental limit of how small machines could get (after all biological "machines" like cells manage at molecular scales) challenged scientists and engineers to make nano-machines. This helped trigger a whole new area of computer science and is starting to achieve results: with nano-engines and messages written in atoms that can be read only with atomic force microscopes. Computers the size of specks of dust are not far away. They will be everywhere, but how will we use and program them?

Life Lesson: There is plenty of room for computers at the bottom, top, sides, edges….

Computer say 'No!'

In 1990, entrepreneur Hugh Loebner offered a prize for the first piece of software to pass a variation of a test first suggested by Alan Turing in 1950 as a way to see if artificial "intelligence" had been achieved. To pass the test and so win the prize the winning chatbot program must convince a panel of experts that they are conversing with a human not a chatbot. So far Artificial Intelligence eludes us and the prize is unclaimed: recently Loebner claimed "At this rate, I will be dead before the Turing test is passed".

Life Lesson: Chatting is far harder than you think, just ask any computer.

See the webzine's Magazine+
www.dcs.qmul.ac.uk/cs4fn
for extended versions of this and other articles

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This issue also includes a contribution by members of Bristol University - see page 4

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