ISSN 1754-3657 (Print)
ISSN 1754-3665 (Online)

CS4FN

Computer Science for Fun

Issue 8

Computer Science in Space

Richard Garriott: computer scientist, games designer and astronaut

Explore the stars yourself

Chased in cyberspace

Computer science in space

Mad for Mars? Obsessed with the Oort Cloud? Really quite crazy about quasars? No one could blame you.

The lure of unexplored territory is amazingly powerful. People have gone to enormous trouble to launch themselves into the unknown throughout human history. Sure, in the last century we've invented incredible technology dedicated to chucking ourselves out of the Earth's atmosphere, but we've always been dreaming up gadgets to get us to new places. The wheel was only a start. When Charles Babbage invented one of the world's first calculating machines almost 200 years ago, the use he had in mind for it was to make navigation easier for ships. So even the rise of computers came stuck in a motherboard of mad exploration.

> "Computer science is no more about computers than astronomy is about telescopes."

Computers have stayed attached to that exploration, and now we couldn't get our glimpses into space without them. Both astronomy and computing are about more than just their cool gadgets, though. The renowned computer scientist Edsger Dijkstra knew it when he said "computer science is no more about computers than astronomy is about telescopes". That's why in this issue you'll read about both the fantastic tech and the deep thinking that's up there in space. Enjoy.

Space is all around you

Just as humans extend our reach into the stars with telescopes, probes and shuttles, space is coming down to meet us on Earth. Our mobiles, televisions and satnavs all rely on satellites to make them work. In this issue you'll read about more than just the far-flung points of the galaxy – there's plenty of spacey stuff around you every day. It's only 50 years after we first began to feel our way around the heavens, and now the heavens have a firm grip on our lives.

Computers set to make cracking Christmas telly

No matter what electronic delights you're hoping to find under the tree this Christmas, we can guarantee you at least one fascinating bit of computery goodness. Well five in fact. This year the Royal Institution Christmas Lectures are all about computer science, and you can catch them for five nights in a row over the Christmas holidays on Channel Five.

How can we build a machine the size of a postage stamp with a billion tiny components? Will computers continue to improve at a breathtaking pace? Why do we need even faster machines anyway? You'll find out what's inside the box and discover the secrets of the web. Plus you'll see how, although machines can learn for themselves, they're still not as intelligent as a three-year-old toddler.

This Christmas, skip the naff repeats. Join Microsoft Research's Chris Bishop on a hi-tech trek as he explores the science behind the digital revolution in search of the ultimate computer. Check the holiday TV listings for times.

Cover image credit: NASA

‘The thundering engines vibrate throughout your body’

Computer scientist Jason Cordes tells us what it’s like to work for NASA

Working for a space agency is brilliant. When I was younger, I often looked up at the stars and wondered what was out there. I visited Johnson Space Center in Houston, Texas and told myself that I wanted to work there someday. After completing my college degree in computer science, I had the great fortune to work at NASA's Johnson Space Center as well as Kennedy Space Center.

Johnson Space Center is the home of the Mission Control Center. This is where NASA engineers direct in-orbit flights and track the position of the International Space Station and the Space Shuttle when it is in orbit. Kennedy Space Center, situated at Cape Canaveral, Florida, is where the Space Shuttle and most other space-bound vehicles are launched. Once they achieve orbit, control is handed over to Johnson Space Center in Houston, which is why when you hear astronauts calling Earth, they talk to “Houston”.

Space City

Houston is a very busy city and you get that feeling when you are at Johnson. There are people everywhere and the Space Center looks like a small city unto itself. While I was there I worked on the computer control system for the International Space Station. The part I worked on was a series of laptop-based displays designed to give astronauts on the station a real-time view of the state of everything, from oxygen levels to the location of the robotic arm.

The interesting thing about developing this type of software is realising that the program is basically sending and receiving telemetry (essentially a long list of numbers) to the hardware, where the hardware is the space station itself. Once you think of it like that, the sheer simplicity of what is being done is really suprising. I certainly expected something more complex. All of the telemetry comes in over a wire and the software has to keep track of what telemetry belongs to what component since different components all broadcast over the same wire. Essentially the program routes the data based on what component it comes from, then acts as an interpreter that takes the numbers from the space station and converts them into a graphical format that the astronauts can understand. The best part of working in Houston was interacting with astronauts and getting their feedback on how the software should work. It's like working with celebrities.

Launch time

While at Kennedy Space Center, I was tasked with working on the Shuttle Launch Control System for the next generation of shuttles. The software is very similar to that used to control the space station.

The coolest thing about working at NASA, and specifically Kennedy Space Center, is being able to watch shuttle launches from less than 10 miles away. It’s an incredible experience. The thundering engines vibrate throughout your body. It is very amazing to watch this machine and realise that you are the one who wrote the computer program that set it in motion.

Image credit: NASA

Oh no, it’s raining again!

The Vehicle Assembly Building (VAB) (see left) at Kennedy Space Center is the fourth largest building, by volume, in the world. The VAB was originally designed to house the enormous Saturn V rocket that took humans to the moon. It is now used to stage and mount fuel tanks onto the space shuttles. The building is so large that it literally has its own weather patterns. It even rains inside the building!

Love your data

How are you two doing together? You and your data, we mean. It'd be nice to have an update. Do you understand one another in that special OMG-we've-talked-all-night-and-now-the-sun's-up kind of way? Is it more like you just kind of hang out together without really bothering to think about each other? Or maybe you're just a bit baffled by the whole data scene. If your heart doesn't beat with fervent love for the wild binary information all around you, that's OK. In fact that's pretty normal. It just so happens, though, that there's a guy who wants to improve your data relationships. He's called Andy Broomfield and he's just graduated as a designer from the Royal College of Art.

Andy's worried that as we rely more and more on gadgets like mobiles and satnavs, a lot of us stop thinking about where the data comes from. "Increasingly we're becoming dependent on the data," says Andy. "We are just blindly fed it." He tells the story of some councils that had to put up 'Ignore Your Satnav' signs after lorry drivers followed electronic directions down narrow lanes rather than believe their own eyes. He reckons that hapless users wouldn't get quite so "data-lost" if we had a way to really connect with the pure information out there, being broadcast from satellites every second of the day. So he designed some gadgets of his own to help get our data relationships back on the rails.

Time to yourself

His first device lets you keep a personal time zone, and was inspired by a group of data-lovers who are sweet on measuring time. Time zones divide the globe into long tall ribbons based on longitude. Since GPS satellites can give each of us extremely accurate longitude readings all the time (the cs4fn office is apparently at .042 degrees west), why not go further and cut the ribbons up even more? That's what Andy's Longitude Time Piece does, to the point where you can uncover what Andy calls "your own local time zone", right down to the second. Then you'd know that wherever you go, your timing would always be perfect.

Flooded with facts

Andy's second invention is another GPS-flavoured one. Even though a lot of us can get lost really easily (even with maps and satellites to help), others love getting down and dirty with geographic data. This gadget's good for both groups. People with a great sense of data direction can use the Geo Flood Browser to get info on the nearest river, wherever they are.

They can also share the love with others who get a bit data-lost, by leaving electronic tags around to let them know if the area gets flooded a lot. Then people nearby can look at the tags with their own gadget to find out whether they ought to be stocking up on boats and snorkels before the next flood hits.

Spot a satellite

Finally Andy's designed a gadget for your data relationships in space. Satellite spotters are kind of like backyard astronomers, except they love catching glimpses of the satellites that orbit the Earth. With Andy's device anyone can tune into a satellite that's above them and listen to it. You can either hear a voice tell you about the satellite, or you can actually listen into the bleeps of information coming from the satellite itself. That way, Andy says, you get "a connection to the pure data, the data that we're dependent upon in the world." It's strange to think that this data is around us all the time – it's just our phones and TVs that normally listen in, rather than us. If information is the lifeblood of our high-tech lives, the Satellite Scanner lets you listen to its heart.

Get your own time zone!

Andy's given us the secret to calculating your own time zone. To find out how, visit the Magazine+ section of our website at www.cs4fn.org.

Anyone can tune into a satellite that's above them and listen to it

Each of Andy's devices uses information from the satellites whizzing, Cupid-like, around the Earth. The unusual thing is what they do with it – they're not about being really useful so much as they are about actually experiencing the data that's out there in the real world. That's how he's aiming to improve our data relationships. It's like the way you can know someone for ages, but never see what they're really about until you look from a different angle. Except this time it's with satellites. Weird, eh? But good. A little like love.

Affection connection

Next time you send a message to someone you love using a wifi connection, sit so you are directly between the computer and the wifi box that's connecting you to the Internet. Hit send and all those 1s and 0s in your message just passed into your body and out the other side on the way.

It adds that personal touch to your message!

Find a hidden hoard with satellite help

It's really easy to get started with geocaching, the tech-head treasure hunt beloved of geomappers like the ones Andy Broomfield met. Loads of people have already hidden secret deposits around the world, and all you have to do is find them – they're all listed online at www.geocaching.com. There are so many lurking outdoors that there might be one near you right now. We discovered that there's a geocache only a few minutes' walk from the cs4fn office! Most people use GPS devices to find them, and some people even swipe the satnavs out of their cars to go hunting with. If your mobile is swish enough to have GPS on it you can download a free geocaching application from www.geocachenavigator.com. But you don't necessarily need a GPS unit – the geocaching website even has its treasures listed on Google Maps.

Image credits: 'Ignore your satnav' and timepiece: Andy Broomfield. Geocaching: Evelyn Symons

Finding plan cosmic blips

You only have to look up at night to discover planets close to us like Mars, Venus and Jupiter, but how do scientists find planets all the way out in the centre of our galaxy? Out there planets get hidden by the brightness of the stars, so astronomers cunningly hunt for the distant planets' traces in the night sky. To do that they rely not just on their own observatories, but also on lots of linked computers and telescopes around the world.

OK, start by bending space...

The trick to finding faraway planets all began with Einstein. About a hundred years ago he predicted that mass would actually bend space. That means really huge objects like stars and planets bend the space around themselves a lot – and light passing next to them gets bent around too.

A star acts like a big celestial magnifying glass (see box). If one star drifts in front of another as our galaxy moves around, the more distant star will look extra bright for about a month or so. That's because the mass of the closer star is magnifying the light from the one further away. Now imagine that the closer star also has a planet revolving round it. That planet will spend a bit of time lined up with the light from the distant star too, and that's when it'll show itself to scientists.

Keith Horne and Martin Dominik, astronomers from the University of St Andrews, explain how. "The result is when the planet lines up, we'll have a very brief flash or dip in light – a blip – that reveals the location of the planet and the size of it," Martin says. "So typically that would last a few days if it's a big planet like Jupiter and if it's a planet like the Earth, [the blip] lasts only a few hours."

Bend it like Beckham!

To get the idea of mass bending space think of space as a big snooker table but made from a rubber sheet instead of a hard surface. Now place a snooker ball (a star) on the sheet and the surface sags and bends under the weight. Roll a marble past the snooker ball and the curve in the sheet will now make the marble bend as it passes by.

In a similar way, light bends as it passes a star (only space is bent in all directions – it's not just on a surface of course).

The effect is the same as that of a glass lens – bending the light causes it to make things look bigger and brighter, focusing light in one place.

PS Actually we've a feeling David Beckham doesn't manage to bend space-time to score goals - he uses some different physics, and that's another story.

Knowing where to look

Since the blips are so short and the sky is, well – rather large, Keith explains that "the trick is to figure out which star to look at, at the right time." The way the astronomers accomplish this is with some serious computing power. After figuring out which stars are lined up so they will undergo the lensing effect (about a thousand every year), they start each day by calculating which of them have the best chance of revealing a new planet. Then they train their telescopes on the field of stars around their target.

Keith tells what happens next. "Each time we take a picture of the star field, we use our computers to find the right star in that picture, measure the brightness of it, and determine if that target is being lensed by a planet or not. When we find one that is, the computer will tell the telescope to go back and look at that one again, just to make sure. And when that is confirmed, then it tells all of our telescopes to look there. So we have an alert system under way here that's all coordinated through the Internet."

Having all those connected telescopes and computers means that even though we may not actually see those distant planets, when they do peek round at the Earth there's a better chance an astronomer will catch it.

ets with

World record counting

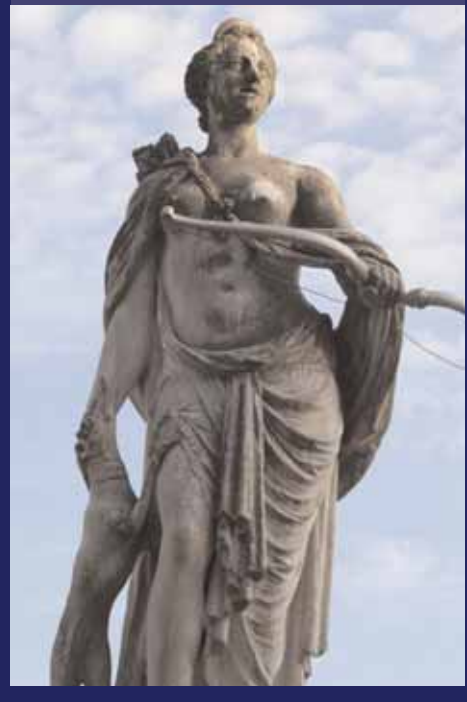
How many planets (well, minor planets anyway) do you think you'd have to discover before you were the best? The current leader is LINEAR, an observatory at MIT in the US. Over the last eleven years they've discovered 96,163 minor planets!

Hot Jupiter!

A 'hot Jupiter' is a planet as big as our solar system's largest member, but even closer to its sun than Mercury is to ours. Keith Horne filled us in on what they're like."They're crazy planets," he says. "They're big planets with deep gas envelopes, like Jupiter, except that they're so hot – they're about 2000 degrees – that the clouds in the atmosphere are not made of water vapour like the clouds in our atmosphere, but of things like molten droplets of iron and liquid drops of rock – things that would be rock here on Earth."

Join the hunters

It's not just astronomers who hear about new planets online. You can follow the search too! Just go to www.artemis-uk.org/targetview.html and see what the planet hunters are looking at these days.



Moons, maths and mystical maidens

Heavens above, you've discovered a new celestial object! What would you call it? Would you name it Clom, Skaro, Poosh, or even Raxacoricofallapatorius? Or maybe those names are already taken. This sort of thing is complicated – even when it comes to naming new planets, moons or asteroids there are rules, and the need for a bit of computer science too.

It's not Spock

Asteroids start off being designated using the year and the month they were first detected. Only once their orbit has been correctly predicted can they then be named. Predicting the orbit needs a cosmic fusion of astronomy, physics and lots of computer processing to predict and then check they are where they should be. Choosing a name is not too easy either. Since 1971 when one astronomer named an asteroid '2309 Mr. Spock' after his pet cat, the International Astronomical Union decided to ban pets' names, but that didn't stop some creative discoverers getting the names '6042 Cheshirecat' and '9007 James Bond' agreed.

Over the moon

Moons are more difficult to name – more rules apply and more physics and computer science are needed to show they are what they are. A moon not only has to orbit a planet, it must do it in a well-defined way. For example the Cassini probe that's exploring Saturn and its wonderful ring system discovered a range of small moons that keep the rings of Saturn crisp. Some of these tiny 'shepherd moons' orbit near the edges of the gaps in the rings. Materials that drift close to them are pulled back by gravity into the rings, spun off into space or made to crash on the shepherd moon itself. To be able to name one of these moons you need to be able to show that its orbit is stable. When the scientists think they have found a moon, the data from the sensors on the Cassini probe is fed into sophisticated computer simulations to show if that moon has a stable orbit. The outcome of the calculation decides if the moon is, well, a moon.

Good Moon Hunting

The software can even hunt down and find unknown moons. Using the laws of geometry and Kepler's laws of planetary motion (three rules that German astronomer Johannes Kepler discovered in the 16th century) and applying them to the data from the probe it's possible to guess where a moon might be. Scientists then perform a full analysis of the data, including whether the possible moon's orbit is affected by other known moons, and are able to determine where the previously unknown moons actually are. Using this method, scientists have even discovered so-called retrograde moons, which orbit in the opposite direction to Saturn's rotation.

Once the orbit is predicted and checked the computer-discovered moon can be named. The scientists have now found so many of these mini-moons that the rules about names have had to change.

More giants and monsters please

To start with the moons of Saturn were named after mythological Greek and Roman giants, but as more were discovered astronomers went over to naming them after the mythical Titans, who fought alongside the giants (and were pretty huge themselves). Finally as more moon hunting showed an ever larger and more fascinating picture the names had to expand to include giants and monsters in Norse, Inuit and Gallic mythologies. Astronomer Carl Murray of Queen Mary, University of London, part of the team who discovered the Saturnian moons Polydeuces and Anthe said "I never thought that a knowledge of ancient mythologies would help me do astronomy". Quite where this moon-related voyage of discovery will end no one quite knows.

Galileo was the first to observe Saturn's rings though he had no idea what they were. He wrote in his notebook that the planet had 'ears'.

Knowing the neighbourhood

Finding moons and keeping an eye on asteroids is an activity that involves astronomers, physicists and computer scientists. Without these scientists all working together, each bringing their skills to work on the problem, our solar system could be a less well-known and more dangerous place to live. We know where things are, after all. We don't want to end up like Poosh and loose a moon.

Out of the way

Computer science also allows the paths of asteroids to be predicted, which is what's needed to name them. More importantly these computer models can predict if the asteroids will cut across Earth's orbit. We don't want to be unexpectedly hitting one of these lumps, even if the idea makes for a good movie.

Star signs

It's always a good idea to know where you're going, whether heading down the shops or heading into space. If asked to point the way to a particular planet, most of us would simply point up, but a clever project called the 'Space Signpost' shows that this isn't always right.

Which way to Mars?

The rotating Space Signpost is a clever combination of computer programming and electronics. It can be set up anywhere on Earth and points towards any object in the solar system you fancy, and like any good signpost it also tells you how far away it is. Though we tend to think of our solar system moving in a very slow, majestic way, in fact it's constantly in quite rapid motion as the planets orbit the sun. The word 'planet' means 'wanderer' in Greek, and the Space Signpost shows us that the planets can wander quite quickly to cover the distances they have to.

Real time, real space

The Space Signpost is able to show both the direction and distance to your chosen planet. You can watch as the distance changes in real time – in reality the planets are moving relative to each other at some very high speeds. Also surprising for some is that the current direction to their chosen planet may actually be down towards the ground. It's very easy to forget that the solar system is three-dimensional.

The current direction to a planet might be down towards the ground!

The Space Signpost is a great example of taking a familiar idea, applying state-of-the-art technology and producing an experience that can change the way we think about the world(s) around us. So the next time you're planning a trek round the stars, don't forget your signpost to help give you a real feeling for our solar system neighborhood.

You can read more on the Space Signpost and see some movies of it working – go to the Magazine+ section of www.cs4fn.org for details.

Image credit: Space Signpost

The space game

Imagine!

Richard Garriott is a really nice guy, good sense of humour, smart dresser, full of energy – oh, and a multimillionaire award-winning computer games designer, a daring adventurer and also an astronaut. It's all thanks to computer science, creativity and lots of hard work.

Games!

Richard was born on July 4th, 1961 in Cambridge. His dad was US astronaut Owen Garriott. When he was a kid he worked in a computer shop, and in his spare time he wrote computer games, often giving them away free to his friends. One of his games, called Akalabeth, was different. He managed to get the folk who owned the shop he was working in to buy some ziploc bags and to try and sell it. They sold a few, but one of the bags also made its way into the hands of a computer games company. They were impressed and signed Richard up. Over the next few years Richard, a self-taught computer programmer, developed the legendary Ultima game series. These were classic role-playing games (RPGs) where the players could take on the personas of wizards and warriors. During this time Richard, who now lived in the USA, was called 'Lord British', because people thought he had a strong British accent.

"After my first publisher started selling my first game in a bigger ziploc bag, they started mailing me $5 per copy they sold," Richard says. "That first game, which took me a few weeks to create, sold 30,000 units. If you do that math, that is $150,000 for a high school senior's after-school time. Clearly a good idea to continue!" His place in the computer games hall of fame was secured when he moved to the next level and created Ultima Online, the first large-scale commercial 'massively multi-player online game' (MMOG). This outsold all previous versions of the Ultima series, won numerous awards, and has a cult following today. He sold his computer games company, but later created another which became NCsoft, an online games publisher. His passion for fantasy computer gaming, computer programming and creativity combined with a good idea and a commercial brain made him very, very rich. What to do next?

Being an astronaut isn't the only unearthly fun Richard's into. But will his magic obsession invade the International Space Station? We'll reveal all on our website! Just check **www.cs4fn.org** later on in October for all the details.

Adventures!

What would you do if you had all that money? Richard used it to make his dreams reality. He has explored the world, from the icy desert of Antarctica to the watery depths of the Titanic. But the world was not enough. His dad had been a spaceman, and Richards's dreams were to follow him – and to let others follow too. He helped set up Space Adventures, the first commercial spaceflight company, who plan to launch their own space voyages by 2011. The first small step will be a trip to the International Space Station (ISS) in October. Richard will be the sixth so-called 'space tourist', paying for his flight and accommodation to spend 10 days aboard the ISS. He will show that companies can make money in space by running some of his own experiments in the microgravity of the space station, the results of which will help develop new drugs to fight disease.

Science!

But the flight will also involve Richard's other passion, a passion for science. In the last edition of cs4fn we carried an advert for a UK-wide schools competition to suggest experiments Richard can do in space. There were some brilliant new ideas and Richard will perform the winning suggestion on the ISS. He will also be doing live links to schools to discuss his space station experience, and may have a magical trick or two up his space suit sleeve.

Magic!

Richard is also an avid magician and magic collector. He even appeared on the cover of the January 2008 issue of MUM, the magazine of the Society of American Magicians. His interests in magic led him to build a 'haunted house' and a magic museum at his home in Austin, Texas. His house is called Britannia Manor, an appropriate home for Lord British.

Space!

Space can inspire; we all look up at the sky and wonder. It's scientists, mathematicians and engineers that make journeys up there possible, along with people like Richard Garriott, who have the passion to make it and take it to the next level. We'll leave the last word with Richard: "Humanity's destiny is to explore and live beyond the confines of our mother planet. Exploring and settling in space should not remain exclusively in the hands of governments. If it is valuable, as I believe it is, for humans to live and work in space, then private individuals and companies should be able to build businesses in space that go beyond planting flags and provide real value to humanity. I hope that my participation in this industry will provide at least a small step to achieving that goal!"

Watch Richard in space at www.richardinspace.com

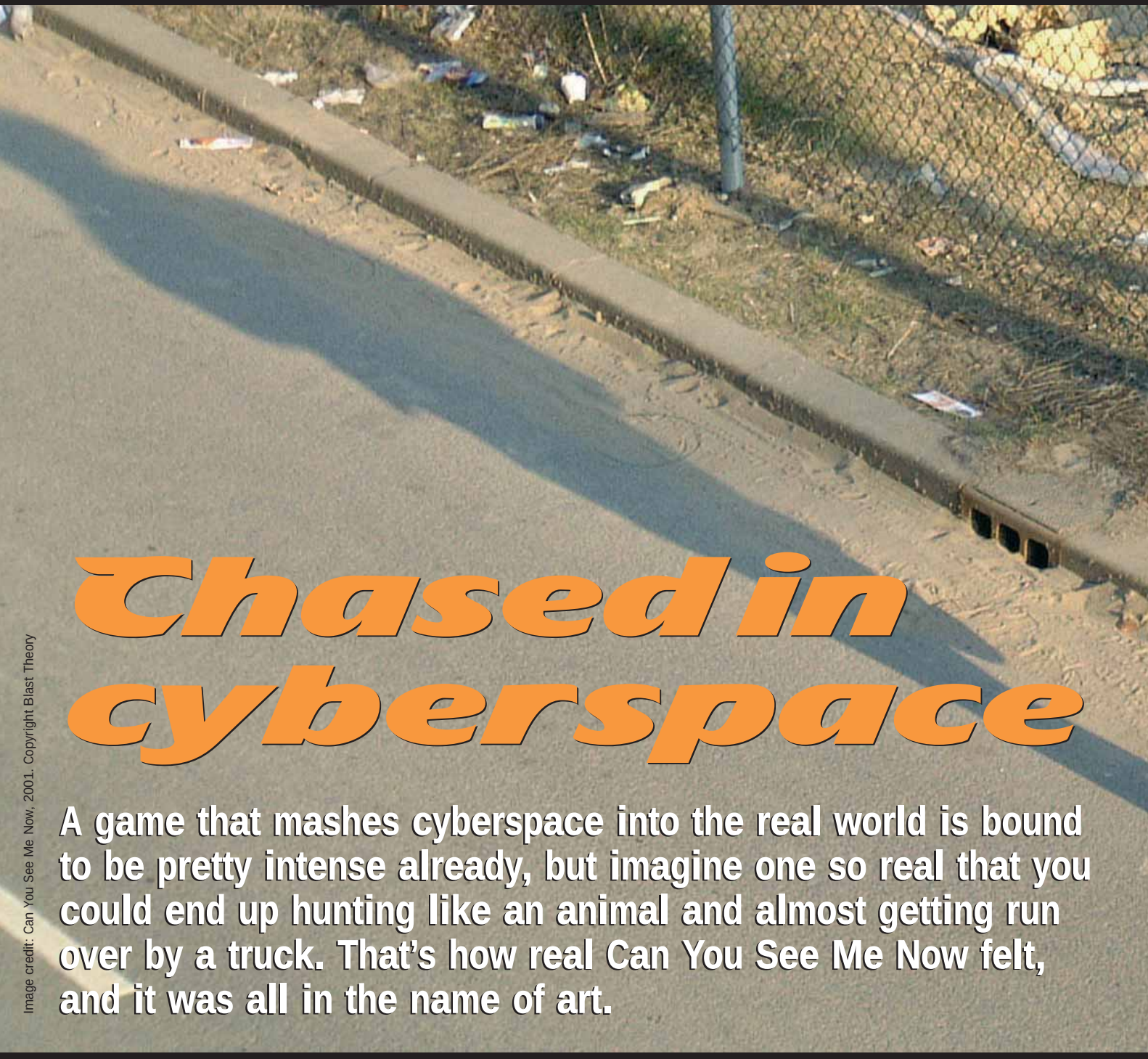


Image credit: Can You See Me Now, 2001. Copyright Blast Theory

Chased in cyberspace

A game that mashes cyberspace into the real world is bound to be pretty intense already, but imagine one so real that you could end up hunting like an animal and almost getting run over by a truck. That's how real Can You See Me Now felt, and it was all in the name of art.

The basic idea is simple: hide from a group of runners tracking you down. Except the 20 hunters, from a group of artists called Blast Theory, are on a real street in the real world, with their locations tracked by Global Positioning System satellites. The players are all around the world, navigating the same streets online and listening to the hunters as they conspire with each other over walkie-talkies.

It was first tried out on the streets of Sheffield. Even though the players and hunters weren't in the same space as each other, the technology kept them so close they evolved some pretty freaky connections.

Predador versus prey

The players and the hunters started to form relationships with one another that weren't so much from the world of humans as they were from the wild. More like predators and prey, but with a technological twist. Early in the competition, the runners found the game pretty easy – after all, they're just navigating in cyberspace whereas the hunters had to run around a real city with all the crowds, traffic and sweaty panting that goes with it.

Then the hunters found a trick. They realised that if they waited at the top of a hill (there are lots in Sheffield!) they could swoop down on their 'prey' fast enough to catch them unawares.
They also realised they could do even better than that. In a city there are 'GPS shadows' formed when the satellites drop behind skyscrapers. That's one reason why satnavs sometimes seem flaky in a city. The hunters realised that at those times and places the GPS system lost track of them. They could hide there and be completely invisible to the runners. Then as one came unsuspectingly past, a quick jump out of the electronic shadows and snap! They were done for.
The hunters had found a way of using the supposed weaknesses in the satellite system to give them an advantage.

"A heart-stopping moment"

With the strange blending of the real world and a fake one, being hunted and hearing your pursuers, the players said things could get pretty emotional. When one player heard a hunter spot her and say "let's run up and get her", the hairs stood up on the back of her neck. The players and the hunters sometimes felt concern for one another though, too. A player from Seattle wrote that she had "a heart-stopping moment" when she was trying to run away and heard what sounded like the person hunting her being run over by a reversing truck.

Technology may sometimes seem cold, but it can sure get under our skin – whether it's making us think like hunting animals or gasp with concern about someone else. The hunter didn't get run over, by the way. At least, we're pretty sure about that.

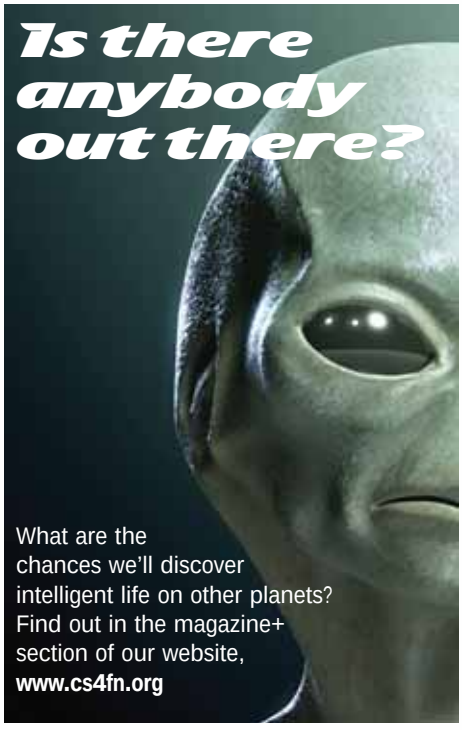
As easy as a bee sees?

If it weren't for the bees we would be in trouble. In the worst case, life on Earth could go the way of Mars. No plants, no animals, no life. Bees are the main way that flowers get pollinated. As the bees sup the nectar they carry pollen from flower to flower, allowing new generations of flowers to grow. But the way a flower looks to our eyes isn't the same way a bee sees it. For example, bee vision works into the ultraviolet part of the spectrum and under the correct lighting in a laboratory the wonderful, normally invisible, patterns that bees can see are revealed. Biologists all over the world have been collecting information about the sorts of patterns that particular flowers display. This display is called a spectral profile, and Samia Faruq, a computer science undergraduate at Queen Mary, University of London has done her bit to help these scientists peer into the world of the bees.

Samia Faruq

Her project involved creating a massive online database containing worldwide spectral profile information, so scientists can search this information easily. They can also combine information to help discover new facts using a method called clustering, where the computer pulls together all the data with similar properties.

Samia enjoyed the project: "I met and worked with amazing biologists during the project. It was great to find out what they needed and to be able to create it for them. I got the chance to collaborate and publish material together with them too. To know it will be used in their research is also very rewarding."



Second star to the right, and emailed by morning

Robots can come in all sorts of different shapes and sizes, but there is one robot that's really a 'star player'. The team in the Department of Cybernetics at the University of Bradford have come up with a unique sort of robot, a robot that controls a giant telescope observatory in the Canary Islands. The Bradford Robotic Telescope installation is part of the Observatorio del Teide site perched on top of the northern part of the volcano caldera in Tenerife, and you can take control of it. It's free to use, you just need to register. You can ask the robot telescope to take pictures of any part of the sky you want and have it email the picture to you. So whether it's pictures for a school project or just because you are wondering what the surface of the moon is looking like today, the telescope is there for you to use.

Smart scope

Like many robots the telescope has intelligence. It has the sense to decide if it's safe to open the dome and expose the telescope to the elements. The robot has sensors that can detect the weather outside, the wind speed, the temperature and so on, and if the weather is too bad, which it can be on top of an exposed volcano, it doesn't open the door. Assuming the weather is fine, the sky views are spectacular. The isolated location cuts out 'light pollution' from street lamps, and the clear atmosphere makes the images much sharper. The robot is also clever in the way it works through the long list of images that people have requested. Rather than simply swinging the telescope around randomly, it looks through the requests and works out the most efficient sequence to take them in, using a clever method (or algorithm as a computer scientist would call it). It then sends the images in emails to eager astronomers the world over.

So if you fancy trying your hand at astronomy from the comfort of your PC, link up with the Bradford telescope at www.telescope.org.

Image credit: Bradford Robotic Telescope

3, 2, 1, blastoff

The rocket-countdown, capture-the-evil-supervillain, card-prediction trick.

In keeping with the theme of space, here's a James Bond-type card trick based around rocket launches, supervillains and secret codes. The scenario is the following: you write a prediction and put it to one side. Your spectator is now going to play the part of a rocket launch controller. It will be a tense time: how many of the four rockets will they be able to successfully launch? Some will launch, others will fail on the launch pad, but what is the identity of the supervillain behind the sabotage?

Countdown

You shuffle the pack, then deal the top card face up onto the table. This is your first launch pad. As the card hits the table you and your spectator start the countdown at '10'. Deal the next card face up on top of the first as you both count 'nine', then for the next card you count 'eight', and so on – you get the picture. As you count down you're looking for a 'hit' to launch the rocket. Like a tense game of snap a 'hit' happens when you deal a card with the same value as the number you reached in the countdown. Suppose at the count of 'five' the card dealt is also a five. You have a hit, you have blastoff and the countdown is finished. Success! Court cards – jacks, queens and kings – all count as 10 in this trick. If the countdown manages to get all the way to one without a hit (matching card and number) the rocket fizzles out on the launch pad, the villain has managed to sabotage that launch, and you deal an extra face-down card on top of it (card 'zero') to cover the launch pad.

Failure to launch?

After demonstrating the first launch or fizzle you can hand the deck to the spectator. Tell them to try and launch three more rockets using the same rules. After these attempts (you can add a dramatic commentary to increase the fun – will the rocket launch or fizzle?) you will have four piles of cards on the table. These piles will either have a face-up card (where the launch happened) or a face-down card (where the countdown fizzled out and the launch pad was capped).

The secret code

The evil mastermind behind the sabotage has hidden their identity in this secret code (as meglomaniac masterminds do). Look at the values of the cards on the face-up piles. These are the secret code numbers that will reveal the evil villain behind the sabotage. Add these numbers together to find the total. Then ask the spectator to count that number of cards from the undealt portion of the deck. They turn the last card over, and zap! It's the villian's calling card you predicted at the start. Out-of-this-world magic, or is there a more down-to-earth explanation for your psychic ability?

To find out how to do the trick look in the Magazine+ section of our website, www.cs4fn.org. Look out for an online exclusive, too – a Mathemagic card trick by celebrity mathematician Johnny Ball!

Life imitates art
The idea of a countdown to a rocket launch first came about from German film director Fritz Lang, or so the story goes. He wanted a way to convey the tension of the launch. Later on the idea was picked up by real rocket scientists, for exactly the same reason.

Punk robots find space in the mosh pit

It's the second of three punk gigs in a row for Neurotic and the PVCs, and tonight they're sounding good. The audience are enjoying it too. All around the room the people are clapping and cheering, and in the middle of the mosh pit the three robots are dancing. They're jumping up and down in the style of the classic punk pogo, and they've been doing it all night whenever they like the music most. Since Neurotic came on the robots can hardly keep still. In fact Neurotic and the PVCs might be the best, most perfect band for these three robots to listen to, since their frontman, Fiddian, taught them to like the same music as he does.

Programming punks

What the robots' programmers did was to wire up a network of computerised connections like the ones in a real brain. Then they let the robots sample lots of different kinds of music and told them what it was, like reggae, pop, and of course, Fiddian's collection of classic punk. That way the connections in the neural network got stronger and stronger – the more music the robots listened to, the easier it got for them to recognise what kind of stuff it was. When they recognised a style they'd been told to look out for, they would dance, firing a cylinder of compressed air to make them jump up and down.

What happened when the punk robots went to their first gig?
Find out on www.cs4fn.org

Teachers' pets?

Learn to play the Soda way. Talk to your teacher about using the BAFTA-winning robot building software and tell them there are whole new rafts of free-to-use sodaconstructor-based activities now online. The activities are designed to inject some serious fun into teaching and learning. For 11-14 science you can try preventing a topple in the leaning tower or get on the pitch with our sports clinic. Or if you're into 11-14 Design and Technology there are two robot explorer activities for you to, well, explore. All the activities and supporting teaching materials (that's what teachers like to have) are free and easy to download on one of the UK's top educational websites at **www.upd8.org.uk/sodaconstructor/**

The Internet goes to the Moon

We're used to the Internet linking computers all over the globe in a network of networks, but now there are plans afoot to build an internet on the Moon. Being able to join up networks of computing devices makes new applications possible, and that's the idea behind the lunar internet. You can't expect to get YouTube from up there yet, though – it's more about finding out why the Moon's there at all.

Joining up with the ILN

The surface of the Moon is already home to a range of unmanned probes from many countries, with more on the way. The idea behind the ILN, the International Lunar Network, is that there will be a common protocol – a shared way to communicate – between probes from any country. The Internet has a protocol at its heart too. It's just an agreed set of ways to pass messages between computers. This communications protocol is what allows your PC to be able to talk with all the other computers in the world. All you need to know is the address of the computer you want to contact, and how to send the data. This computer science opens up a whole range of exciting new ways to explore our rocky near space neighbour.

Core secrets

How did the Moon form? It's still a mystery. We know quite a bit about the Earth's core, but what about the Moon's? Is it solid and metallic, or molten, or perhaps both? One way to discover the answer is through seismology. You hit the surface of the Moon, then watch how the waves travel through the lunar ground and reflect back. There have been experiments looking at this already, but the problem is that good results depend on taking your measurements at fairly large distances apart. In the past that was difficult. The astronauts in the Apollo Moon landings, for example, weren't able to separate the seismic stations by a great distance, so their results, while useful, were limited.

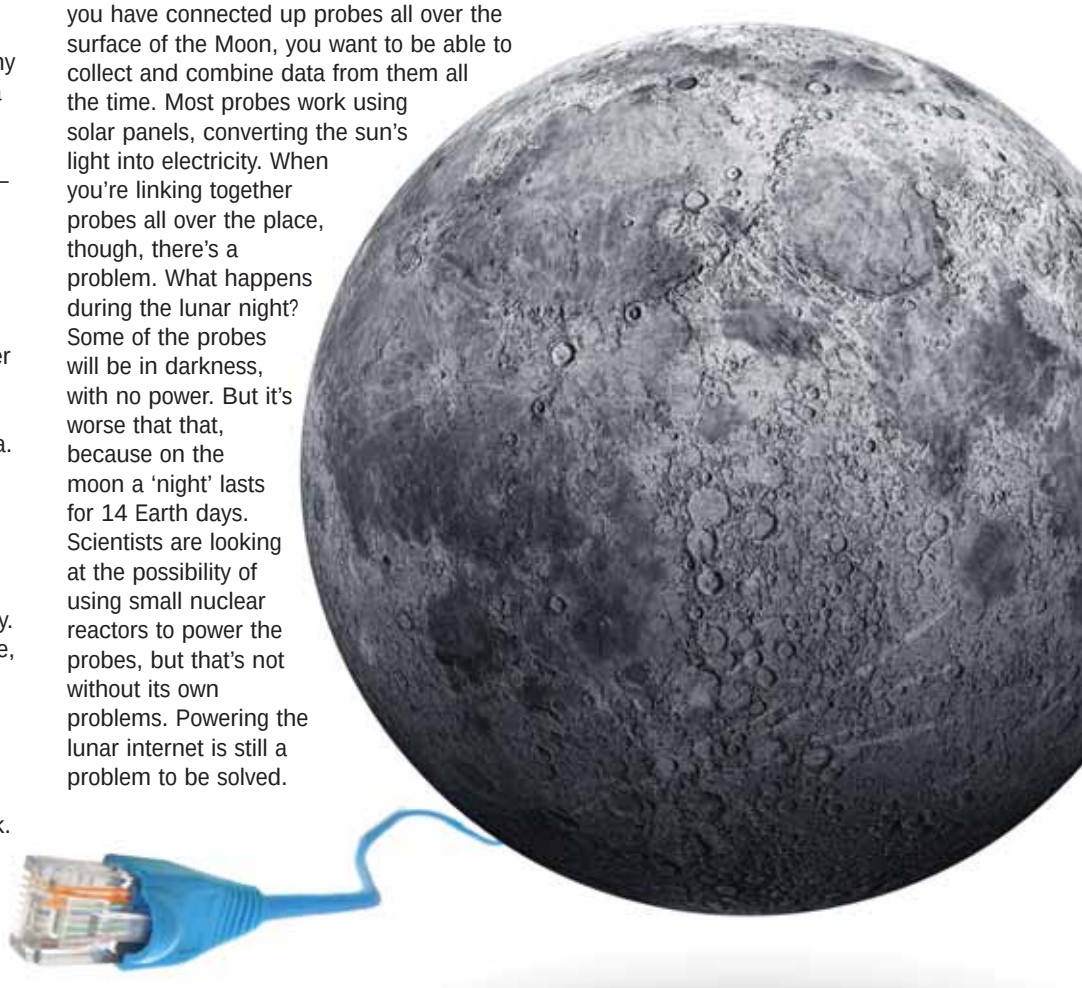
Now imagine having an internet linking a whole range of seismic stations, all on different probes, and each on different parts of the Moon. The result is bigger, better ways to probe the lunar core. The same trick works with other devices, like the ones that measure heat flow, or others that detect changes in the Moon's magnetic field. Different probes in different places can combine their data to produce bigger, better scientific instruments.

Long day's night

One of the technical problems still to be overcome is how to power the probes. Now you have connected up probes all over the surface of the Moon, you want to be able to collect and combine data from them all the time. Most probes work using solar panels, converting the sun's light into electricity. When you're linking together probes all over the place, though, there's a problem. What happens during the lunar night? Some of the probes will be in darkness, with no power. But it's worse that that, because on the moon a 'night' lasts for 14 Earth days. Scientists are looking at the possibility of using small nuclear reactors to power the probes, but that's not without its own problems. Powering the lunar internet is still a problem to be solved.

The Internet steps towards the stars

As humanity moves out into the solar system in search of new adventure, discoveries and even to develop new types of businesses, how will the Internet extend in the future? There are enterprising companies on Earth who are currently selling internet addresses, called domain names, for the future when the planets of the solar system are wired together in a giant internet. You can buy up domain names such as .lunar, .moon, .venus, .mars, .jupiter, .saturn, .uranus, .neptune and .pluto all for your future spacefaring needs. Hurry while stocks last.



My space

Explore the stars for yourself in Google Sky

Throughout this issue, you've been reading about how other people are exploring what's up there in space. Now it's your turn. The geographic superstar known as Google Earth has been given an amazing little tool called Sky. It lets you fly around to millions of stars and galaxies just by moving your mouse. The universe is a pretty big place to explore, though, so Ed Parsons, Google's Geospatial Technologist, helped cs4fn find the best bits for you to go out and try. After a curry in Google's decked-out London office, he gave us a tour of Sky and told us how it all works.

Google Earth is, in Ed's words, "this big mosaic of imagery". Just like tiles on a wall, millions of tiny pictures get put together in relation to one another to form the globe. Google's server is always working out which part of the world you're looking at, and how close you want to get. That makes the difference between whether it loads up a big satellite image of Europe or an aerial photo of your own town. As you zoom in, the server starts sending you more detailed shots until you're finally staring at your neighbour's camper van.

Sky works much the same way only flipped upwards. The story goes that two years ago, a couple of astronomers visited Google and got to thinking that the same technology that lets you fly around the Earth could make exploring the sky a lot easier. "In the similar way that we had that mosaic of satellite imagery on the planet, why not make a mosaic that produces the universe?" says Ed. "So that's what we've done." Observatories from all over the world, including telescopes on the ground and in space, like the Hubble, dug out their photos to be added to the mosaic in Sky. Then more people – some astronomers, some hobbyists – got to work adding labels, constellations, planets and even video.

That huge community makes it seem like you could spend one of Neptune's years in Sky without seeing everything that they've added. So to get you started, we've collected some of the most fun, interesting and surprising things to see. Start by looking at the sky above your house. It's easy – we've put directions in the box below.

Look at the sky above your house

Everyone does the same thing when they first load up Google Earth – they look at their own house. In Sky you can see what's above it right now.

1. First, open up Google Earth. Then in the search bar in the top left, enter your postcode or your street address.
2. Once you've had enough of looking at your roof, go to the View menu and select Switch to Sky.
3. The view will switch round so that you're looking out to the same stars you'd see if you went outside your house at night and looked up. Which is probably another good activity to put on your list, come to think of it.
4. Sometimes when you switch over to Sky, it will zoom all the way in on something rather than just show you the sky. If this happens, just go back up to the top left and double-click on your location underneath the search bar. After Sky flies you over, zoom back out and you'll see what the sky above you looks like.
5. While we're zoomed out, now's a good time to watch the motion of the planets across the sky. In the top right is a time slider. Press the play button and you'll see an animated solar system follow its orbit across the sky. You might have to hunt around the sky for them a bit, but they're there.

That's just the start of our discoveries in Sky. For lots more how-tos, including tours, video and downloads, go to the magazine+ section of our website, www.cs4fn.org. You'll also find out how to use Sky to get deeper into stories from this issue, so get online!

More space? Backyard astronomers have reason to feel spoiled, with another digital powerhouse getting in on the free sky browser action. Microsoft's World Wide Telescope (WWT) was released in May, and also features smooth navigation and starry graphics. It was designed specifically to explore the sky, so you can browse easily around a whole universe of exotic objects, and switch between different views of the same thing. There's a wealth of cool stuff for the astronomically-minded – like downloading star photos or actually controlling your own telescope through WWT – but it also has lots of multimedia tours for the average user who's just plain curious. It's only available for Windows as yet, but it's free just like Google Earth, so if you're keen on space why not have both?

Back (page) in space and time

Space and time: the stuff that makes up the universe around us. Let's look at the ways that computer science is helping us manipulate and measure these galactic bits and bobs.

3D space and the Wii

The Nintendo Wii, with its famous wireless controller, has changed the gaming industry. Now millions of people are playing games where they jump, point or punch in the air. The Wii knows where it is in three-dimensional space, but how? It's a clever little microchip called an accelerometer. When you move, the forces you apply cause masses to start to move. The bigger the force the faster the mass moves. Newton tells us that force equals mass multiplied by acceleration, so if we have a mass and we can calculate its acceleration we have an idea of the forces involved. That's what the accelerometer chip does.

On the chip a tiny mass (called a proof mass) is held in place by tiny silicon springs. When you move you're providing a force, so the mass starts to accelerate in the same direction you're moving. The proof mass shifts, and as it does it changes the electrical properties of its surroundings. The capacitance, which is the amount of electrical charge something can store, changes as the mass moves over an electrical plate. If you have three plates, each perpendicular to each other, surrounding the mass as it moves, the capacitances of the plates change. You can measure this change, and then extract information that lets you know the direction the mass is moving. This gives you an electrical signal that shows the direction the accelerometer moved in 3D space, and that's converted to a signal that allows the console to know what you're doing with your Wii. Game on.

Time travel on the radio

Live radio talk shows have a problem. What happens if one of the callers says something inappropriate? A naughty word! You can't let that happen. To get round this, live radio normally includes a time delay to allow any naughtiness to be removed. On radio shows it's called the dump button. The transmission of the caller's voice is delayed by around seven seconds and if bad words happen the dump button is pressed and the caller goes silent. The problem is that you've just used up your delay time and are now live. So how do you create another seven seconds' worth of delay so it's safe to go back to the callers again? You can't just sit quietly – that's dead air and radio listeners don't like it. Enter computer science. As the host chats, a computer system recognises the natural pauses in their voice, and makes them just that little bit longer. It's not noticeable to the listener, but after a while you have accumulated enough delay time that the dump button can work again, and it's back to normal.

If the Beagle had landed?

Beagle 2 was a British-built space probe that was sent to explore Mars in 2003. Named after biologist Charles Darwin's famous ship, Beagle 2 sadly it never made it. It was due to land on Christmas Day that year, but something went wrong and it vanished without a trace.

Beagle 2's disappearance is perhaps the inspiration behind the Guinevere One space probe in the 2005 Doctor Who episode 'The Christmas Invasion', but Beagle 2 is unlikely to have been stolen by the Sycorax. Had Beagle 2 made it through, the first thing we would have heard was its radio call sign, which was digital music specially composed by Britpop group Blur. It wasn't the only part of the ill-fated Beagle 2 mission that had an artistic twist. Famous British artist Damien Hirst (the man who had previously pickled halved calves in formaldehyde tanks), had designed one of his famous spot paintings – rows of differently coloured spots – that was to be used as an instrument calibration chart. It would have been the first art on Mars, but now it's probably the first art all over Mars.

For more on the topics in this issue go to the Magazine+ section of the webzine www.cs4fn.org/magazine/

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cs4fn is funded by EPSRC and Queen Mary, University of London.

cs4fn is written and edited by Jonathan Black, Paul Curzon and Peter McOwan of Queen Mary, University of London.

Queen Mary University of London

The Higher Education Academy Information and Computer Sciences

EPSRC Engineering and Physical Sciences Research Council

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cs4fn is supported by industry including **Google**, **Microsoft**, **ARM** and **Intel**.

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