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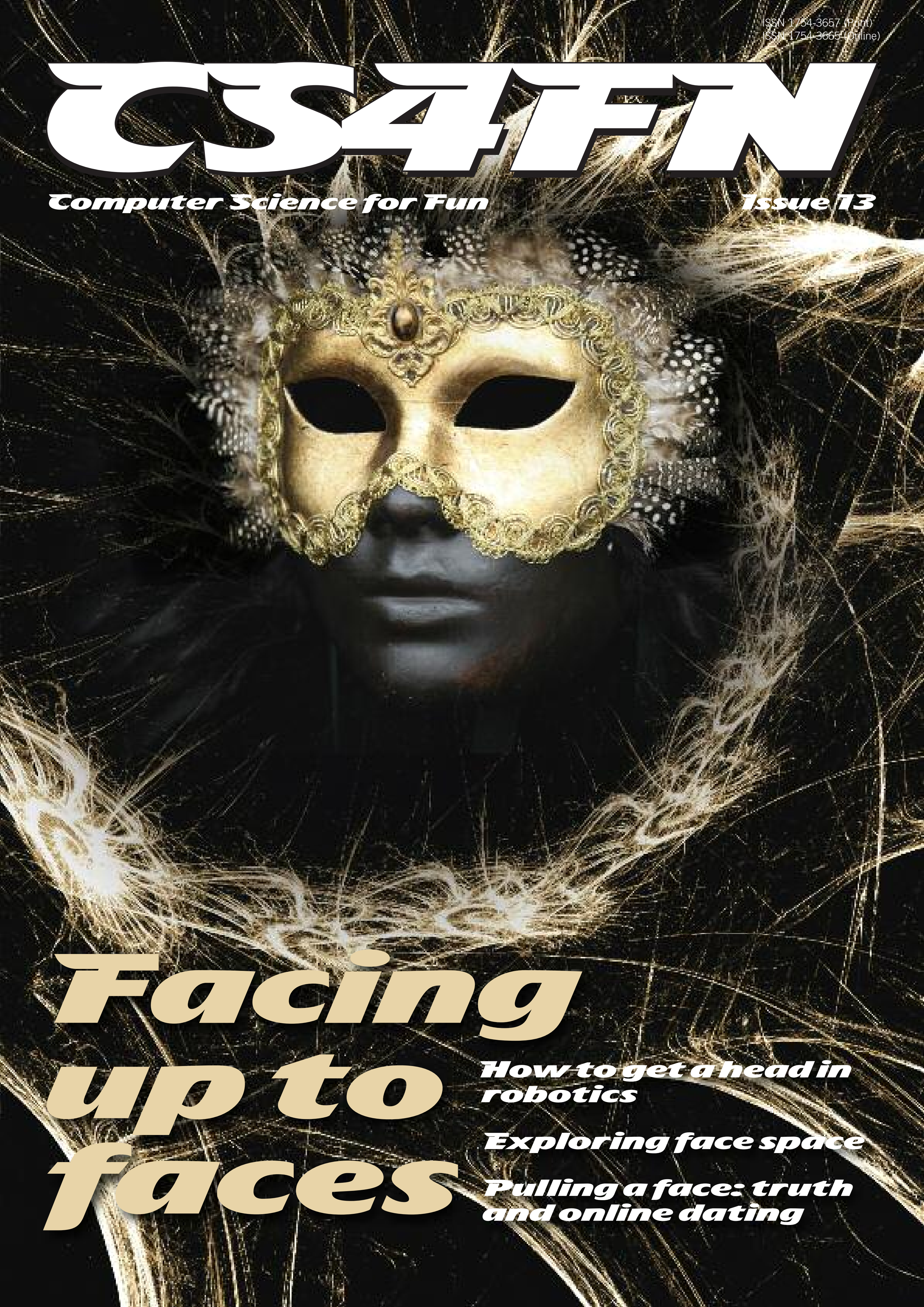
CS4FN

Computer Science for Fun

Issue 13



Facing up to faces

How to get a head in robotics

Exploring face space

Pulling a face: truth and online dating

The faces issue

Know someone's face, and you know who they are. Sure, you know what they look like, but their face is also the closest thing you have to a window into their mind. A facial expression can tell you what they think and feel, even when sometimes they would rather keep it hidden. Faces help us socialise, bond with people and even find love.

In this issue you'll find out how much faces help computer science. You'll read about the face space in our brains, robotic faces that mimic human emotion and the tricks that faces play on us. There are stories about faces on the Internet, on clocks and in the Earth. All humans are natural face experts – even babies an hour old can recognise a face – but here's your chance to find out even more.

Fingers feeling focus

People with visual impairments use interfaces to get online that don't rely on sight. For example, instead of reading text printed on a screen, screen readers can turn text on a webpage into speech. That works OK, but sometimes the methods for images can be a bit indirect, like relying on wordy descriptions of what's in a picture. But now researchers in the USA have come up with a way for people with visual impairment to get more out of images – they have a method for automatically turning photos of faces into raised pictures that people can feel with their fingers.

The computer program concerned, TactileFace, first needs a portrait photo. Once it detects where in the photo the face is, it sets about redrawing the various features. The tough bit is that people can't feel as much detail with their fingers as they can see with eyes, so the raised portraits need to be simpler than the original photos. To do this the computer needs to know which important lines to keep, and which details it can discard. Luckily, it's been trained to know the big landmarks of a face, like the eyes, nose and mouth. It can then detect line edges in the rest of the face, ending up with a face that's got a reasonable amount of detail without being too much to handle.

Finally, the portrait goes to a printer, where it's printed on to special paper that swells when it's exposed to the heat of the print head. A person with a visual impairment can then feel the face to find out what a person looks like. The researchers tested their system with a range of people, and it works well – folk were good at locating facial features, could figure out the pose the picture was taken in, and could even pick out two different pictures of the same person from a group. Feels like they've found a good solution!

Changing the face of the Earth

We tend to think of a jigsaw these days as being a gentle pastime – or a psychotic serial killer in the Saw movies. But being able to put the pieces together in one particular jigsaw has helped us understand the planet we live on and how it will look in the future.

Put it together

Way back in the 1500s a Flemish map-maker called Abraham Ortelius noticed something strange about the shape of the world. If you took the shapes of the continents and moved them around, they all seem to fit together. For example, South America kinda fits into the bend in the west side of Africa, just like jigsaw pieces. It wasn't till the 1900s, when meteorologist Alfred Wagner added some significant extra layers to the puzzle, that scientists began to realise that all the land on the Earth had once been joined in a giant super-continent called Pangaea. Areas of ancient rock and mineral belts matched across the continents, the scars and debris caused by ancient icy glaciation were shared, and the fossil sequences were the same. These tell-tale fingerprints all helped to support the idea that today's separate continents had once been joined together.

As if!

At first, as is always the way when new ideas come along, scientists didn't believe it. However as time passed, and more information became available, the idea of continental drift became accepted. Studies in paleomagnetism, the study of the magnetic properties of rock, showed either the continents had moved or there were two North Poles. Since, well, there's only one North Pole, it looked like maybe the continents really had moved. It wasn't an easy ride, though. Most scientists at the time worked in the northern hemisphere, where the evidence was less obvious. More importantly no one agreed on how the continents had drifted apart in the first place. Continents didn't move – you just had to look at them. See, nothing moves! It was only when the clever idea of plate tectonics came around that the final piece was put into the jigsaw. Plate tectonics was the discovery that we live on a load of floating plates – rocky rafts that drift around on the molten liquid at the core of the earth. These rafts could move when the squiggly lava contents below squeezed up through cracks, pushing them apart.

Coming soon to a planet near you

That's the past, but what about the future? Continental drift happens, but at such a slow pace that humans never see it – even over generations. However it is possible to see the shape of the world to come. Computer scientists have created programs that mimic the way the plates will move over millions of years. Our future will definitely have a different shape as our continents drift, but predicted changes in sea level will also delete sections of familiar countries. The scientists may be showing us the possible faces of our future, but some of what it will look like is up to us.

Go exp

Space is the stuff all around us – up, down, back, front, left, right. Wherever we go, we all move through space. Now imagine instead that the space you inhabit isn't filled with space but is filled with faces. Welcome to the strange world of face space.

Enter face space

We'll try and give you an idea of what face space is like. Start by imagining a room. On one side of your room is an open door and on the other is a window. Starting in the middle, as you move towards the window things get lighter, and as you move toward the door you get more cooling air wafting in from outside. At any point in between the two you have a specific combination of light and breeze. Now let's teleport the room to face space, so that on one side of this new 'room' is a really narrow nose, on the other side is a really broad nose. Now take any nose – how about yours if you're not using it at the moment? You can place your nose at a specific position between the two extreme noses so that it's just the right distance from both. Right in the middle would be the average nose, created by combining all the noses you know. Your nose might be wider than average or narrower than average, and you could let people know exactly what your nose looks like by giving them the average nose measurements and an indication of how much broader or narrower your nose was from this. Knowing the average and how far you are from it in each direction are the signposts in face space.

Your face looks like...

There are all sorts of ways to describe a face, like nose width, eye separation and so on. You can build up a complicated face space by deciding what the important features are, measuring lots of them, finding the average and then putting the bits making up individual faces at different positions relative to the average for those features. Eventually, researchers began to see evidence that there might actually be an average face stored in our brains too. We tend to recognise distinctive faces more easily. They are further from the average so we get a stronger signal. An average face shape doesn't seem to carry any particular information about a person's identity – it's what's different from the average that lets us identify people. By using a series of cartoons of varying levels of extremeness researchers showed that certain cells in the brain became more active the more different the face presented is from the average face. Somewhere deep inside our brain, it seems, we have learned an average face to compare other faces against.

Computers – our GPS in face space

To create this face space in a computer we first take lots of pictures of faces. We can align the features like the eyes and nose by changing the size and the orientation of the images. A picture of a face is just a massive number of pixels, where each pixel is the colour value needed at that particular point in the image – for example the shiny white of the teeth. With hundreds of face pictures all aligned, it's easy to calculate the average face. Just add the values for all the images together, pixel by pixel, and divide the final value for each pixel by the number of images used.

But there is more information we can extract. We know about the average so let's take that away from our information and look at what's left. We can use a method called 'principal components analysis' to find a set of images that we can add to the average face to let us recreate any of the original faces. In effect we convert our huge combined face into a series of independent images, which then become the staging posts in face space, starting from the average face at the centre. So any face has a place in the space, a certain distance and direction away from the central average face. As we move out into the space, we combine the different component images to recreate the face from our original set that lies at our current position. In essence, we can determine positions in face space much like GPS can on the Earth.

Girl face vs boy face

That's not all we can do. We can turn boys into girls! We can take a load of female faces, find the average and the staging post faces, and we can do the same with male faces. For any particular male face we can calculate its distance and direction from the average male face at the centre. Now, imagine a line on a map joining the starting place to the finish position. We can take the line we've drawn in the male face space and draw the same one in the female face space. Anchor its starting point at the average female face and see what female face it ends at. This will be the closest female equivalent of the male face. By moving in face space we can change the gender of faces.

Enter the antiface

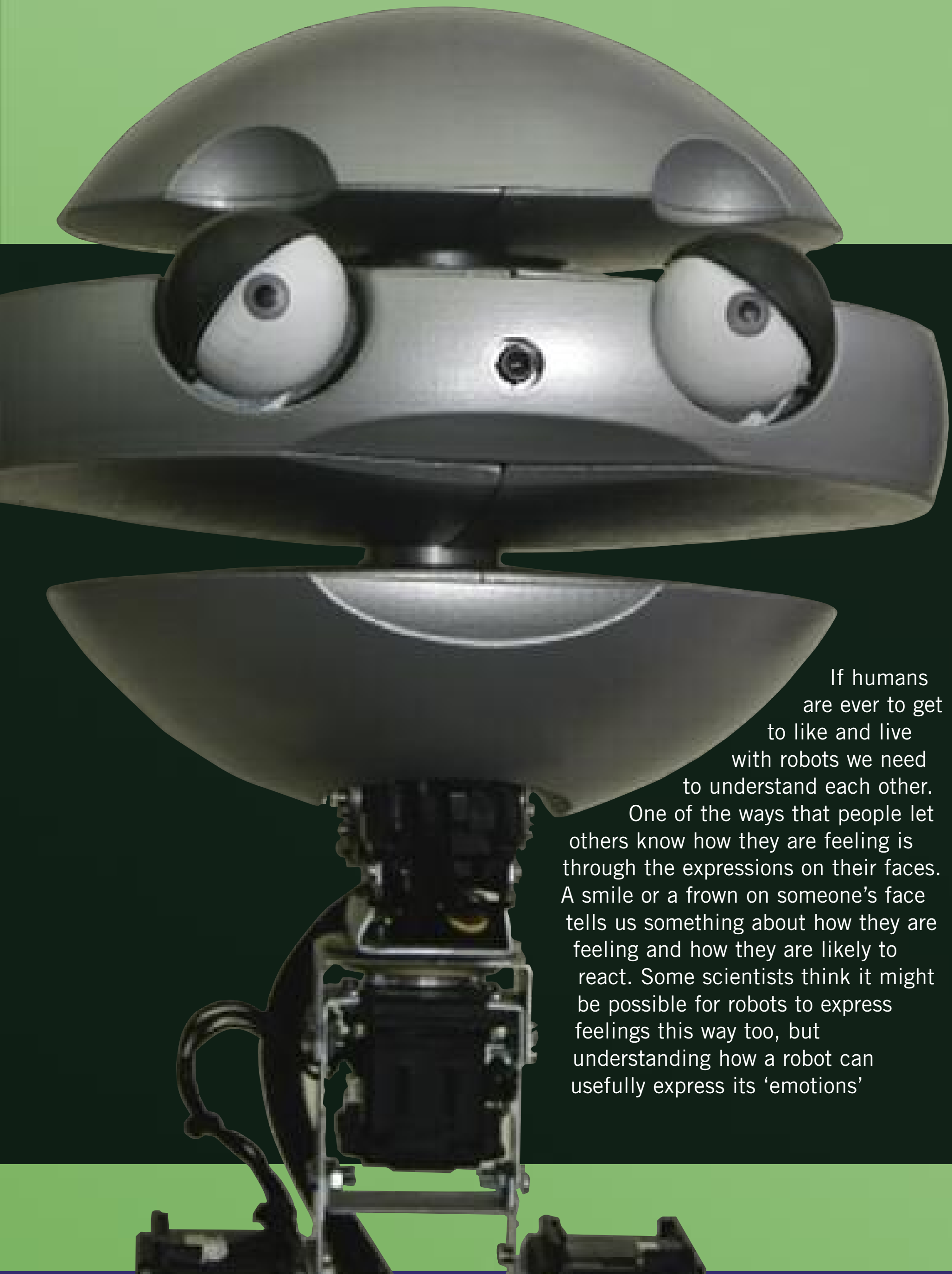
We can also change the direction of our line in face space so it points backwards. If you follow this line all the way through the centre, then continue for the same distance out the other side, you'll end up at the antiface: the face that is essentially the opposite of the original face. People rate these antifaces as being more dissimilar from the original than randomly created faces. It seems our brain knows its way around the face space we create in a computer, which might mean we keep a face space in our heads too.

ploring

Facing forward

You can probably see that recognising faces is a very complex job for our brains to do. Fortunately, it looks as though we have particular parts of our brains that specialise in helping us perceive faces. By building computer software that, as with face spaces, mimics the way our brains understand faces, we can start to explore and test our understanding of them. Then these discoveries can help us build new technologies, like robots that can recognise and express emotions (see pages 6 and 18). That should give us something to smile about in the future.

How to get a head in robotics



If humans are ever to get to like and live with robots we need to understand each other. One of the ways that people let others know how they are feeling is through the expressions on their faces. A smile or a frown on someone's face tells us something about how they are feeling and how they are likely to react. Some scientists think it might be possible for robots to express feelings this way too, but understanding how a robot can usefully express its 'emotions' (what its internal computer program is processing and planning to do next), is still in its infancy. A group of researchers in Poland, at Wroclaw University of Technology, have come up with a clever new design for a robot head that could help a computer show its feelings. It's inspired by the Teenage Mutant Ninja Turtles cartoon and movie series.

The real Teenage Mutant Ninja Turtle

Their turtle-inspired robotic head called EMYS, which stands for EMotive headY System is cleverly also the name of a European pond turtle, Emys orbicularis. Taking his inspiration from cartoons, the project's principal 'head' designer Jan Kedzierski created a mechanical marvel that can convey a whole range of different emotions by tilting a pair of movable discs, one of which contains highly flexible eyes and eyebrows.

Eye see

The lower disc imitates the movements of the human lower jaw, while the upper disk can mimic raising the eyebrows and wrinkling the forehead. There are eyelids and eyebrows linked to each eye. Have a

look at your face in the mirror, then try pulling some expressions like sadness and anger. In particular look at what these do to your eyes. In the robot, as in humans, the eyelids can move to cover the eye. This helps in the expression of emotions like sadness or anger, as your mirror experiment probably showed.

Pop eye

But then things get freaky and fun. Following the best traditions of cartoons, when EMYS is ‘surprised’ the robot’s eyes can shoot out to a distance of more than 10 centimetres! This well-known ‘eyes out on stalks’ cartoon technique, which deliberately over-exaggerates how people’s eyes widen and stare when they are startled, is something we instinctively understand even though our eyes don’t really do this. It makes use of the fact that cartoons take the real world to extremes, and audiences understand and are entertained by this sort of comical exaggeration. In fact it’s been shown that people are faster at recognising cartoons of people than recognising the un-exaggerated original.

High tech head builder

The mechanical internals of EMYS consist of lightweight aluminium, while the covering external elements, such as the eyes and discs, are made of lightweight plastic using 3D rapid prototyping technology. This technology allows a design on the computer to be ‘printed’ in plastic in three dimensions. The design in the computer is first converted into a stack of thin slices. Each slice of the design, from the bottom up, individually oozes out of a printer and on to the slice underneath, so layer-by-layer the design in the computer becomes a plastic reality, ready for use.

Facing the future

A ‘gesture generator’ computer program controls the way the head behaves. Expressions like ‘sad’ and ‘surprised’ are broken down into a series of simple commands to the high-speed motors, moving the various lightweight parts of the face. In this way EMYS can behave in an amazingly fluid way – its eyes can ‘blink’, its neck can turn to follow a person’s face or look around. EMYS can even shake or nod its head. EMYS is being used on the Polish group’s social robot FLASH (FLexible Autonomous Social Helper) and also with other robot bodies as part of the LIREC project (www.lirec.eu). This big project explores the question of how robot companions could interact with humans, and helps find ways for robots to usefully show their ‘emotions’.

Do try this at home

In this issue, there is a chance for you to program an EMYS-like robot. Follow the instructions on the *Emotion Machine* in the centre of the magazine and build your own EMYS. By selecting a series of different commands in the Emotion Engine boxes, the expression on EMYS’s face will change. How many different expressions can you create? What are the instructions you need to send to the face for a particular expression? What emotion do you think that expression looks like – how would you name it? What would you expect the robot to be ‘feeling’ if it pulled that face?

Go further

Why not draw your own sliders, with different eye shapes, mouth shapes and so on. Explore and experiment! That’s what computer scientists do.

Pulling a face

How close is your online self to your real self? When you tell people about yourself online, on social networking sites like Facebook, you've got the luxury of being able to edit your life a bit. You can choose the profile picture you look best in, and you can write status updates that make you seem as interesting, funny and exciting as possible. Wanting to present yourself in the best light is pretty natural, and all of us do it at least a little bit. Even we here at cs4fn aren't immune. For example, right now we're tempted to look clever by pointing out that there's a line from Shakespeare about this – "God has given you one face, and you make yourself another". But when does this impulse go too far? Is there a line where a little self-editing becomes more like lying?

Do you match up?

One place where this question becomes important is on online dating sites. On the one hand, everyone is there to get dates, so it's important to make yourself look as good as possible. On the other hand, if you do find a date you're going to meet each other in person. That means any big differences between your profile and the real-life you will be rumbled. There are good reasons to lie, and other good reasons to tell the truth. When researchers find a situation like this – where there are big incentives to do two completely opposite things – they know they've found a gold mine. Jeffery Hancock and Catalina Toma, two sociologists from Cornell University in the USA, wanted to see what people eventually choose to do, so they decided to find out whether people's online dating profile pictures matched their real-life appearance. To do it they needed to get some people round to their place. Well, their lab anyway.

Here's what the researchers did: they found some people with dating profiles online, who all agreed to visit a psychology lab in New York City. When the test subjects got there they were shown their own profile from a dating website, and asked to say how accurate they thought their own profile picture was. Then they had a second picture taken in the lab, in the same pose as their online photo. Later on, independent judges, who had never met the volunteers, compared the two photos and rated the accuracy of the online version. What they found was: people are tricky.

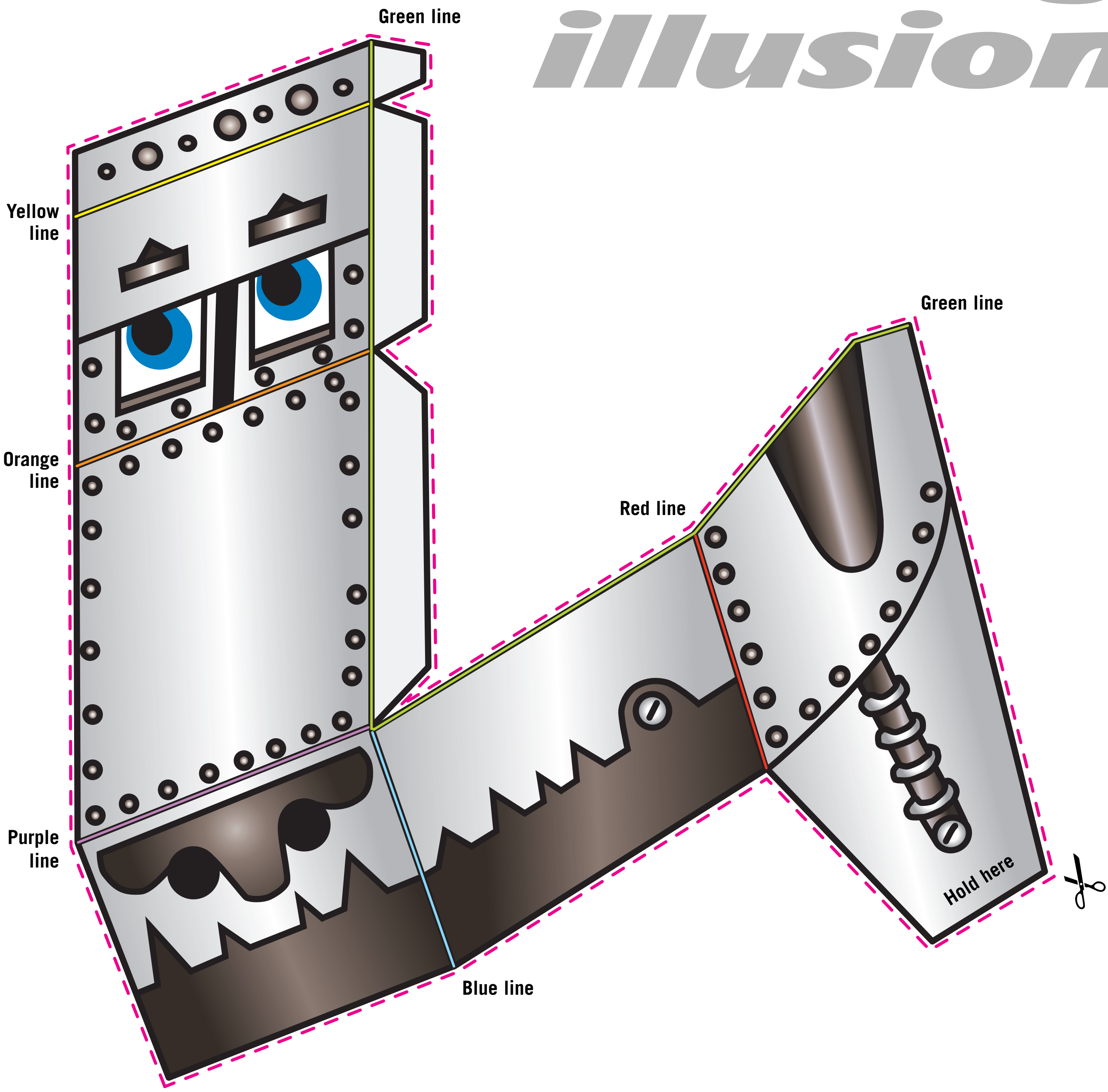
Rate my date

When the volunteers were asked to rate the accuracy of their own profile photos, they tended to say the photos were very accurate. The independent judges didn't agree. The average score was closer to 'barely accurate'. Almost a third of the pictures were found to be downright inaccurate. There were differences between the genders, too: women tended to have more inaccurate pictures than men (possibly because they face more social pressure about their appearance), and the judges tended to see different inaccuracies in men's and women's photos. The differences that made judges think women's photos were inaccurate were related to their hair, their weight and (oddly) their teeth, but judges took notice when men's online photos made them look younger or less bald.

So when faced with a dilemma between looking more attractive and being more true-to-life, it seems people are more likely to choose attractiveness. But when does good presentation become fakeness? For that matter, when does being true-to-life become, well, just sloppy? The more you think about this, the more you realise just how fine a line it can be, and it seems harder to judge the people who try and make themselves look hotter online than they are in real life. On the other hand, this experiment seems to say that even if the line is fine, it does exist, and you can be caught out if you try and push the fib too far.

Turn the page for some special cut-out experiments!

The robot dog illusion



Build this robot dog's head and watch it pop into 3D life! This activity is based on an optical illusion where the brain is fooled into thinking that a hollow face is actually popping out towards you. It's also inspired by the LIREC project (**www.lirec.eu**), which is trying to discover how to make robots as friendly as a real-life pooch.

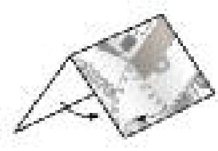
Putting it together

1 Punch out the cartoon. By the end of these steps, you'll have made a face that bends inwards, rather than pointing out like a normal face. Even though the dog's face is hollow, you can make your brain see it coming out towards you!

2 Make a valley fold on the blue, purple and yellow lines, and a mountain fold on the orange and red lines.

A valley fold looks like this:

A mountain fold looks like this:



3 Do a valley fold on all the tabs.

4 Bring the green lines together so they meet. Tape or glue the tabs so they wrap round the back of the cartoon, joining the pieces together.

5 Grab the neck where it says 'hold here'. Hold the face upright in front of you, shut one eye, and slowly tilt the face from side to side. Eventually the dog's nose should pop out at you. It may take some time – try different angles or switching which eye you've closed.

How it works

This illusion works because we don't normally see faces that bend inwards. When our brains try to make sense of the information, we end up seeing a normal 3D face. In fact, our brains treat lots of concave objects the same way.

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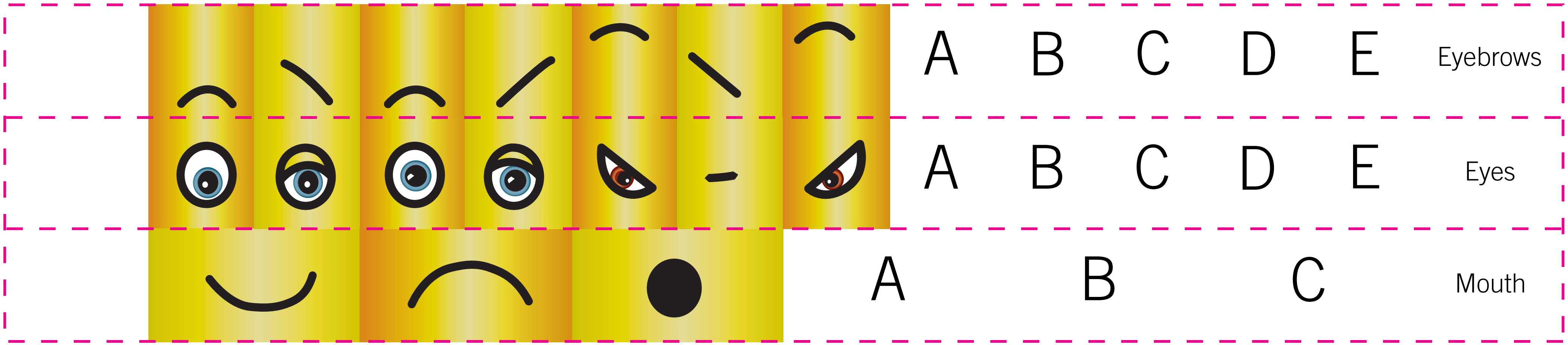

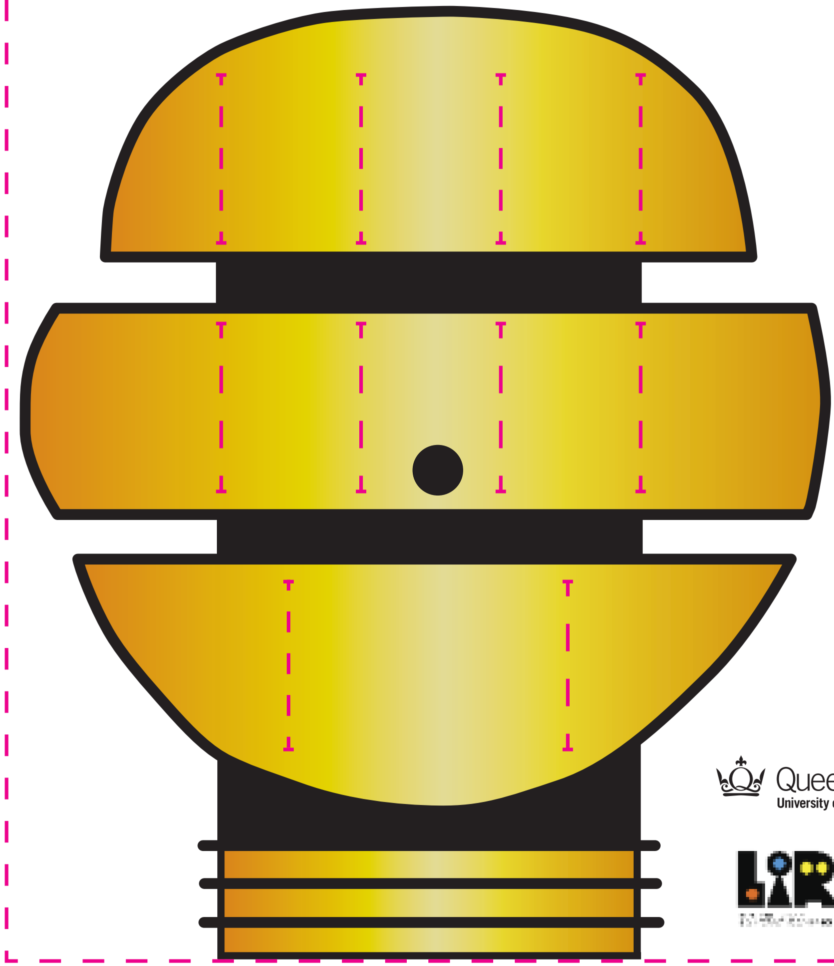

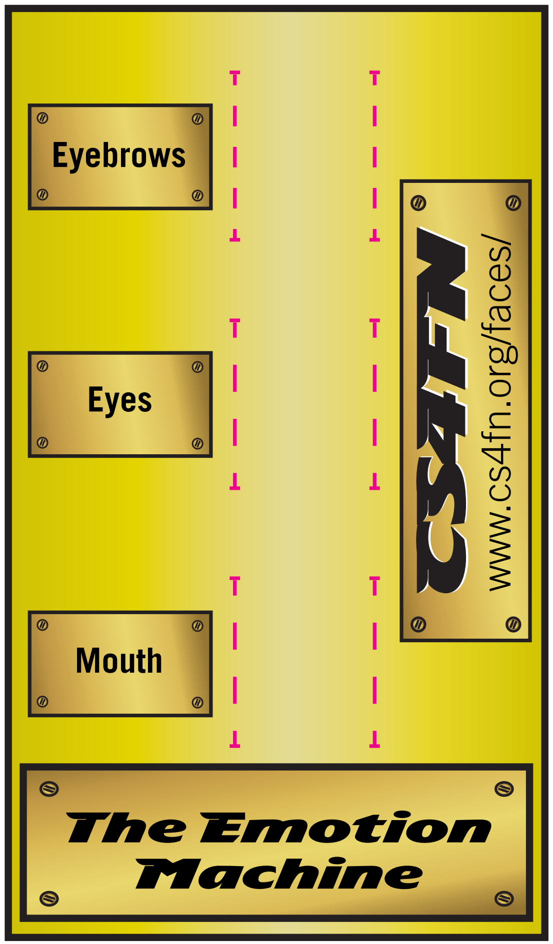

The emotion machine

Try programming this robot face!

1 Punch out along the dotted lines, so you've got the emotion machine and face with some empty slots in them, plus three strips to slide through the slots.

2 Weave the strips through the slots for the eyebrows, eyes and mouth.

3 Get programming! Moving the strips to different letters will give you different expressions.

Things to try

What combination of letters makes the robot look happy? Can you come up with different expressions for mild happiness and utter joy? How about a series of combinations to make the robot look happy, surprised, then sad?

Create your own new emotions by drawing different eyebrows, eyes and mouths. What expressions would the robot need to do if it were going to be someone's friend?

Our robot face is based on a real design used in the LIREC research project. To see the real one in action go to **www.lirec.eu**.

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LIREC

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Can you trust a Smile?

How can you tell if someone looks trustworthy? Could it have anything to do with their facial expression? Some new research suggests that people are less likely to trust someone if their smile looks fake. Of course, that seems like common sense – you'd never think to yourself 'wow, what a phoney' and then decide to trust someone anyway. But we're talking about very subtle clues here. The kind of thing that might only produce a bit of a gut feeling, or you might never be conscious of at all.

To do this experiment, researchers at Cardiff University told volunteers to pick someone to play a trust game with. The scientists told the volunteers to make their choice based on a short video of each person smiling – but they didn't know the scientists could control certain aspects of each smile, and could make some smiles look more genuine than others.

Here's where things get very subtle: it turns out that genuine smiles take longer to build up to, and come back from, than fake smiles. For a real smile, your facial muscles begin to move, eventually forming the grin we're all familiar with, after which your face gradually returns to normal. When people try to fake a smile, their face tends to snap into the grin almost immediately and hold it there for an unnaturally long time. Suddenly the smile disappears and their face goes back to normal. In short, fakers concentrate just on making the 'smiley face', but the fake emotion snaps on and off like a switch. A real smile washes over the face like a wave.

The researchers used computer graphics to control the timing of each stage of a smile. In some videos, the smile built up and diminished the way real smiles tend to; in others it snapped into and out of existence in a more fake way. Amazingly, the differences amounted to less than a second for many of the stages. Could the volunteers tell the difference with such a difficult clue? It seems they could. The volunteers were less likely to pick the people with less authentic smiles. They didn't always spot the phoney, and some fake smilers still ended up being trusted enough to play the game. Still, it suggests that we as humans have evolved some pretty sophisticated ways of catching cheaters if all it can take to give you away is a smile that's too sudden. It's a lesson to trust your gut feelings: those feelings are often a sign that your brain is adding together a lot of tiny but important clues.

Robot street smarts?

In the future, artificial intelligence might have to learn this trick too. Imagine a robot interacting with a human – the robot would need to be able to pick up the clues if the human was trying to trick them! We wouldn't want robots falling for confidence tricksters, now would we?

Something special in the brain

On the face of it faces are easy. We all recognise friends and family, and we can tell how they are feeling by the look on their face. But if we look inside our brains we find that the whole process of understanding faces, which scientists call face perception, is far from easy. It's also proving hard to work out whether our brains treat faces as a special case or not.

Are there places for faces?

Our brains seem to work particularly hard at recognising and processing faces. That's perhaps not surprising as we are social animals. We live in groups and faces are the way we often signal our intentions – if I look angry avoid annoying me – or identify who we are interacting with. Inside our skulls, at certain spots in our brains, are millions of neurons that seem to respond to faces and do the work for us. These areas, landmarks on the wiggles on the surface of our brain, occur mostly on the right hand side. But how do we know these places take care of face perception? Well, we can use scanners that measure the amount of blood going to particular brain areas when doing particular things. When we look at faces certain areas light up on the scans, flooding with more blood as they crack on with the face processing business. Some experiments also suggest that the face processing activity differs between men and women: in men the greatest activity happens on the right side of the brain and for women it's the left. Why? That's yet to be discovered.

Faces vs things

While some think that those special parts of the brain only process faces, others argue that a face is just another sort of 'thing' to process. The reason, they say, for the increase of brain activity for faces in particular is that faces are hard. Most faces on the whole are similar to one another, and it's far more difficult to tell the difference between your mates' faces than, say, the difference between their houses. So it would be no surprise that it takes more effort, so more blood to the brain, and thus those areas would light up in a brain scan. Some experiments have, in fact, shown that the same brain areas are active when we try to tell the difference between types of cars or types of birds, so perhaps faces aren't that special after all?

Baby look at that

Using an experimental method called 'preferential looking' researchers have shown that babies spend more time looking at faces than at other things. The experiment is simple: on the right side of a screen is a face, and on the left side all the parts of a face in a jumbled order. Video recordings show that babies (even some less than an hour old!) tend to spend longer looking at the face than the jumbled parts. Both pictures contain the same information, just presented in a different way. That suggests faces do have a special place in our brains after all!

So has the notion of special brain processing for faces had its chips? The jury is still out.

That illusionary smile

Do illusions tell us anything about how our brain processes faces?

In everyday life we encounter faces that are mostly in the right order: eyes above nose, nose above mouth. Researchers call this a configuration, and our brains seem to understand that a face is there even if it's fairly low in details. A good example is the smilies (aka emoticons) used in text messages. There is very little information in :-) or :-(but we still see a happy or sad face. That's because the configuration (eyes, nose, mouth) still looks like a face even if it's on its side. But what happens when you turn a face upside down? Our brains still recognise it as a face, but we can do strange things to it and our brains won't notice. The Thatcher Illusion, named after the famous UK prime minister, is a classic example. Two upside-down faces are put next to one another. They both look like normal faces, but when you turn them both the right way up, you see that one picture has had the eyes and mouth turned upside down. It now looks grotesque and obvious, but you didn't notice this when the pictures were inverted. Why? Because your brain has problems with inverted faces. You don't see many of them in daily life, so all it can manage to do is recognise all the parts of a face in roughly the right upside down order. The fine detail – the fact that the eyes and mouth are the wrong way – is lost.

Facing up to the potato

Another illusion with faces comes about when you take a look inside a plastic Halloween mask. They are made by stretching plastic over a mould of a person's face. Looking at the mask from the front it's clearly a face protruding out at you. Now take a look behind. It starts out looking hollow, but if you look at it for a bit, perhaps closing one eye, it starts to look like a face peaking out at you too. Researchers have argued that this is because we don't normally experience faces that curve inwards, only faces that point outwards, so given the same information our brains will see a hollow face as a normal face. Perhaps this is a special face thing? Well, perhaps not. You can take any shape – for example, a potato – and make a plaster cast of it. Looking into this cast it's hollow, but your brain sees the potato shape bulging out, just like the real thing.

Build your own hollow face! See the robot dog illusion in the centre of the magazine.

The digital age

Whether you're young or old (or somewhere in between), computer science can tell you something about faces. Take a look at these stories on faces and age.

A glimpse of the future

Predicting what a person will look like when they're older is tricky. At the moment it often depends on the imagination of a single person, whether it's a sketch artist helping to solve a missing person case, or a makeup artist trying to make someone look older. A PhD computer science student in Canada has designed a program to automatically age people's appearances, by applying rules for how faces change as we get older.

The student, Khoa Luu, actually needed to come up with two sets of rules. In the beginning of our life, when we're still growing and developing, our faces change their actual structure: they get longer and wider. But once we've finished growing, for the rest of our life the changes are all in the soft tissues around the face. Wrinkles appear, and the facial muscles aren't quite so toned.

Having a set of general rules for how everybody ages is a good start. But a prediction will be more accurate if you can use images from your subject's family too. It's a more sophisticated take on the old rule of thumb that says you can tell what someone will look like when they're older by looking at their parents. So Khoa put together a database of photographs of family members, all from different stages of their lives. It doesn't even have to take information from your parents. For example, by comparing how your siblings looked years ago with how they look now, the computer program can get clues about how you will look as you get older.

In the future Khoa's system could help police when searching for a missing person or a fugitive, or it could even help cosmetics companies design anti-ageing products. Computer science is all about the future, but who knew it could predict your future face too?

You'll never forget a face

When you're young you might wonder what there could possibly be to look forward to at age 30. Boredom and decrepitude? We'll be honest: maybe. But you can at least count on being at the peak of your ability to recognise faces. Researchers at Harvard and Dartmouth colleges in the USA have found that while most of our mental abilities peak in our early twenties, the ability to recognise and remember faces takes another decade to mature.

The researchers used an internet-based face memory test, completed by 44,000 volunteers. For most of the mental tasks, like remembering names, people around the age of 23 or 24 scored the highest. That is pretty consistent with other findings that show people are generally at their brainy best in their early twenties. Things were different when volunteers got to the face recognition test, in which volunteers tried to recognise and remember a lot of computer-generated faces. There, people's abilities got much better between 10 and 20 years old, then continued to get better bit-by-bit throughout the next decade. The group who scored highest on this bit of the test were between 30 and 34 years old. After that, scores gradually declined. People who were 65 years old were about as good at recognising faces as 16 year-olds.

Researchers aren't really sure why face recognition is at its best almost ten years after our other mental abilities. It could be that faces are so complex that our brain needs some extra time to practise. So if you've yet to hit the big three-oh, settle in and wait – your best face time is yet to come.

Turn back the clock

Now that you know how computer scientists can make someone look older (see 'A glimpse of the future'), how about making someone look younger? Turns out psychologists can help us there. Some researchers at Jena University in Germany have found an easy way to make yourself look younger than your years – just hang out with a bunch of older people.

Their experiment hinges on the idea that we average out the faces we see, and judge other faces based on that average. The researchers got a group of people to concentrate on a series of pictures of elderly people on a computer screen. Then, when asked to guess the age of a middle-aged person, the volunteers guessed substantially younger than the person's real age. The effect was even more pronounced when the volunteers were asked to guess the age of someone of the opposite sex.

For anyone who's ever wished they looked older rather than younger, there's good news: this effect goes the other way too. After looking at pictures of younger people, the volunteers thought the middle-aged person looked older than they really were. There's no way to tell how long the effect lasts, but the researchers helpfully point out that the age of the people next to you has an important effect on the age you're perceived as. So if you're a celebrity looking for an entourage the scientific advice is clear: make sure they're the right age to make you look your best.

The tests the researchers used are all available to try at **www.testmybrain.org**. You can try tests on your memory, your ability to read emotions, and even whether your taste in beauty is the same as other people! Fun to try, and you'll be helping science too.

Your future check mate

Robots that play games with you need to be able to tell how you feel. When you're playing with a friend they know what's on your mind, no matter if you're winning or losing. The expressions we make on our faces are a part of the social glue we call friendship. So if we want to build robots that can be our friends, they need to be able to read our faces.

The main features

People's faces are interesting. Over the inflexible bone of our skull is stretched a layer of skin and muscles that make us look like the people we are. We can wrinkle our noses, we can flex an eyebrow or two, we can smile or frown. Our faces are wonderfully flexible. But this amazing flexibility is a real problem for computers. When is a smile a smile? What did that narrowing of the eyes really mean? To work with us, computers need to be able to give meaning to the subtle shapes we create with our faces. Researchers in the UK, Portugal and Poland working on a joint research project called LIREC have had to think of new ways to understand the expressions on faces. That's because they are developing a robot companion to help school kids learn to play chess.

Your checkmate and its secrets

The body of the robot is called the iCat. Shaped like a cartoon cat, it can make sounds, and move its mouth and eyes to create expressions that the other human player can understand. But how does the robot know what face to pull? It needs to understand how you are feeling about the game. To do this the robot uses lots of different clues: it can detect how often you crouch over the board, which tells the robot how interested you are in what's happening. Perhaps most importantly, though, the iCat has learned to recognise the expressions on children's faces, which is particularly tough for a computer.

Kids vs adults

Adults in social situation tend to make fairly strong expressions with their faces. It's often clear when an adult means to smile, but kids' expressions tend to be more subtle. So the researchers recorded hours of video at a local kids' chess club and went through it by hand, deciding when a smile or a frown was present. Then they noted the situations where these expressions occurred. Armed with the videos, they were able to train up a computer program to recognise how the various parts of the face moved when the kids were feeling in a particular mood.

Check your learning by example

Here's how to train a computer to recognise a smile. The researchers gave the computer around 500 of the videos, and programmed it to automatically recognise where a face was and notice how the important parts of the face moved between a neutral expression and a smile. Each time someone in the videos smiled, it was up to the computer to notice. If the computer got it right, great! If it missed the smile, the program used this error to correct itself so it got it right in future. Just as though it were in school, it learned by example and by having a teacher telling it when it was right and wrong. After its schooling, the computer was able to recognise new smiles it hadn't seen before at about 90% accuracy – it had learned what the smile on a young child's face looks like.

This face reading ability was then combined with information on the state of the game, giving the robot the ability to 'understand' what the human player was feeling. It could constantly check the face of its human companion and make sure that it was playing at an appropriate level to help them improve their game.

Using this technology, based on our understanding of human faces, the companion robot became a checking mate rather than just getting checkmate!

Playing for real

How can the iCat computer play on a real chess set when most play on a screen? Partly it's because the chess set contains a secret: there is a small microchip in each piece that lets the robot know how it's being moved on the board. The robot also has a state-of-the-art chess program installed, so it can play an easy or a more challenging game as it sees fit. It then just tells you what move it wants to make.

Tick-tock, a magic clock

In this quick magical effect you can predict the future and also read your friend's mind at the same time. All you need is a pack of playing cards and you too can do magic with a clock face. Find out how in the magazine+ section of our website at **www.cs4fn.org**, if you have the time. As a bonus, find out how this trick can save time for nurses!

Back (page) to front

In this edition we have explored the science behind backwards and upside down faces, but it's not just faces that go funny when we look at them in different ways.

You can da Vinci code

For years, the Renaissance scientist and artist Leonardo da Vinci kept his journals secret using a simple code: he wrote all his letters and numbers backward. You can train your brain to learn his secret code too. All it needs is paper, a mirror and practice. Start by writing out all the letters of the alphabet and the numbers in your best handwriting. Then take a mirror and use it to reflect what you have written. Copy all the letters as seen in the reflection on to another sheet of paper, and when that's done put the mirror away. Now take the sheet with your mirror copies and start to duplicate these on another sheet of paper. You will probably find that the capital Q, lower-case b, d, j, k and q, and the numbers 2, 3, 6 and 9 seem to be the most difficult, but keep at it. After a bit of practice in duplicating the shapes, get the mirror out again. This time you're going to try and draw those letters and numbers so that they look right in the mirror. Get a bit of paper and stick it to the wall so you can see it in the mirror. Now swing your arms and body and write the letters and numbers on the paper so that they look the right way round in the mirror. Keep practising. After a while your brain will learn the body and hand movements (called motor memory) for mirror writing in the same way you learned to write the first time round. You can then code like da Vinci.

Motto: backward or front, writing is important

Sounds backwards?

It's been shown that when people listen to recordings of piano music played backwards they believe the sounds are played on an organ. This is because when played backwards, piano tones start quietly and grow in volume. This type of sound, we have learned, is the way an organ sounds. Our brains' preconceptions are fooled and so we make a mistake. Playing music backwards was something of a fashion in days gone by. In the fifteenth century it was fashionable to create palindromic canons – pieces of music containing two melodies. One melody was the notes of a tune played forward and the other, called the counterpoint, was the same notes but in the reverse order. Beethoven, Bach and Haydn all got into this mixing of musical symmetry. Mozart once helpfully composed a canon in which the second melody was the same as the first, but backward and upside down. That meant it could be read by the player from the opposite sides of the music sheet. What a thoughtful guy, that Mozart.

Motto: music is just a pattern however you look at it

Upside down weather

The sun heats the land and the land heats the air above it, so as you go up things get cooler. However from time to time things get a little upside down. This is called a temperature inversion: a layer of dense cold air traps the lighter, warmer air underneath it. When it does, smog from car fumes can be trapped near the ground, leading to an increase in health problems. If the trapped warm air contains a lot of moisture, an inversion can lead to violent thunderstorms as the cold layer prevents the humid warm air from rising. Understanding how our weather works in order to make the daily weather forecast needs complex computer programs to calculate future events. Being able to look at the weather from lots of different angles in a computer helps us plan for a rainy day.

Motto: Whether the weather be cold, or whether the weather be hot, we'll weather the weather, whatever the weather, whether we like it or not?

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