

**Wednesday 13 June 2012**

# Google's Computational Thinking

[illegible]

**Astronomer Andrew Pontzen (BBC Stargazing) and particle physicist Tom Whyntie (2009 winner of FameLab) have won prizes for their humorous approach to presenting physics. On Tuesday they spoke at ‘Dark Matters’.**

*At your event you mention that dark matter is a ‘hot topic’ in science and that this affects its funding. Do you think that the media has a role to play in that?*

**AP** Yes, the media plays a huge role. What you can sell to the media you can then sell to a grants panel, because a grants panel love the idea that you will have a press release at the end of the research.

**TW** One of the big things about dark matter is that it’s a mystery, a great mystery story. This idea that scientists are baffled. We don’t know, and we don’t know how to find out!

*You both do a lot of science communication through comedy. What are the benefits of this?*

**TW** I think with comedy the defence mechanisms lower a bit. If you can make people laugh you bring everyone to the same level and then you can start a real dialogue.

**AP** This is supposed to be the start of something. Instead of people going away saying ‘I loved this, this and this’ they go away and think, ‘oooh, what was that about?’. Then maybe they’ll think about some of the things that we tried to raise, even if they don’t remember the details. Ultimately what we’re trying to achieve is a piece of theatre – not a ‘nerd-night’. It’s not a piece of theatre *about* science, it’s just a piece of theatre where the subject is science. We’d like to be able to reach new audiences by doing that.

*You are both full time researchers. Do you think that doing outreach informs your science?*

**AP** I think it does, in a subtle way. It causes you to take a step back and look at the bigger picture, which is what everybody says about it of course, but it is true. It’s hard to then pinpoint and say ‘okay, because I did this, this piece of research came out differently’. But I think it’s more a matter of thinking about your work from a different angle. I don’t know how you would go about measuring it, but I know it happens.

**Litmus Paper 2012**

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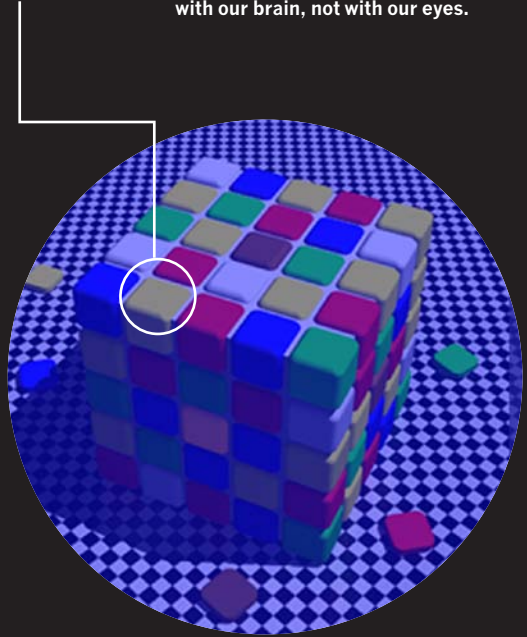
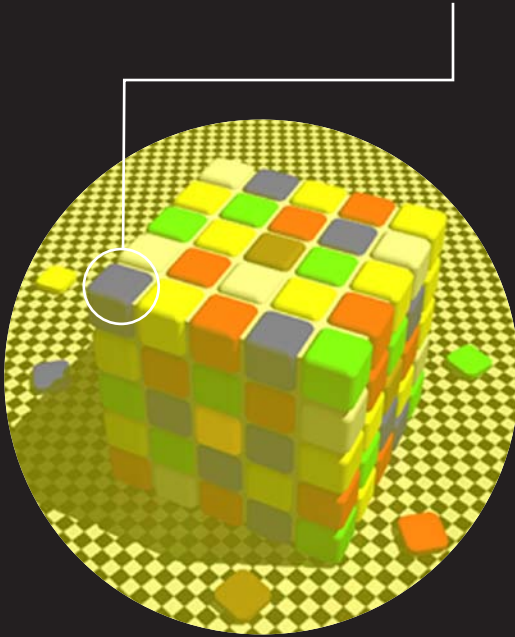
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# Rivalry of the eyes

Neuroscientist **Beau Lotto** researches how and why we see illusions. Illusions are a useful research tool as they provide insight into how the brain works. Illusions are not a result of our brain making mistakes; they reveal how our brain has evolved to make sense of the world – not just to see what is there.

The 'blue' tiles on the top of the left cube, and the 'yellow' tiles on the top of right cube appear very different in colour. But in reality they are the same – 'grey' in both cases. (Fold one next to the other to reveal this.) This is called the 'colour contrast' illusion. Context is everything when it comes to what we see.

Our visual system automatically makes assumptions about the type and the source of light and adjusts what we see accordingly. Colour contrast is 'seeing' identical colours as different, whereas colour constancy is when the perceived colour of an object remains constant under varying light conditions. We see with our brain, not with our eyes.



Beau Lotto has used this colour contrast illusion to study how we process the signals we receive from our eyes. We view the world with two eyes, yet are typically only aware of a single image. The simplest explanation for this is that the visual system unites the information from both eyes into a common stream that eventually leads to a single sensation.

But this notion is inconsistent with the well known phenomenon of rivalry; when different images hit same point on the retina of each eye, what we actually 'see' alternates between the views received by each eye. The mechanisms underlying binocular rivalry remain controversial and uncertain.

Using this image and another illusion, Beau Lotto and his team have shown that this colour contrast illusion causes binocular rivalry (alternating images from each eye) even though the tiles are physically the same colour. This suggests that the physical similarity between the images in our two eyes is less important than the perceived similarity.

# Parkinson's increase prediction in ageing world

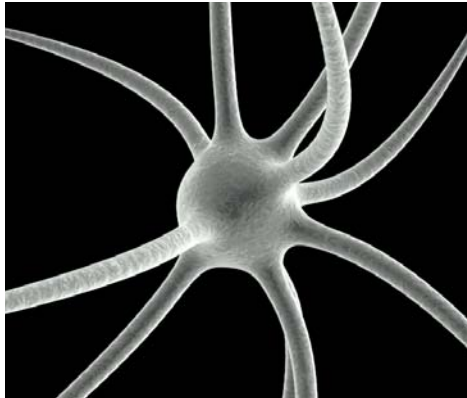
The global rate of Parkinson's disease could double, and possibly triple by 2030, according to a leading specialist.

It is known that the risk of developing Parkinson's disease increases with age. Today Professor Peter Jenner of Kings College London will announce his prediction that the number of Parkinson's sufferers will rise as our population ages. He warned that this could particularly affect developing

countries, where the average lifespan is increasing rapidly. 'I don't think people are prepared for this', he said.

It is currently unclear why older people are more susceptible to the disease, and research is searching for clues in order to find treatments. Dr Kieran Breen, Director of Research and Innovation at the charity Parkinson's UK said of the projected rise, 'this is why it is so important we continue to fund vital research to develop better treatment and care for people living with this condition.'

Professor Jenner argues that current Parkinson's studies, mostly done in cell cultures and animals, are flawed because they focus on younger samples. 'The ageing factor seems to have been completely forgotten', he said, 'even by those in the know.' He explained that we need to rethink our approach to the disease, as it does not have a single cause, and will be unlikely to have a single cure.



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## Did optimism bias cause the financial crisis?

Optimism bias causes us to feel that events and their outcomes will always be positive, even if they do not

always occur that way. Ultimately, this results in more decisions being made based on thinking 'I have a good feeling about this one'. This can make us underestimate the risk associated with our behaviour. Some have even suggested a link between this phenomenon and the financial crisis in 2008.

Tali Sharot, a neuroscientist, has been investigating the intrinsic perspective humans have on events in their lives. She has shown that when we envision an event, we will always be optimistic that the outcome of the event will be positive, even if it has been negative in the past.



## Innovative new materials will build future cities

‘One of the amazing things about bioluminescence is that it gets activated by vibrations,’ says Dr Rachel Armstrong, a sustainability innovator who creates new materials possessing some of the properties of living systems. She envisages the cities of our future being encircled by lighting tubes flowing with bioluminescent bacteria. It would be environmentally friendly but furthermore, says Armstrong, fusing our cities with synthetic biology could restore the emotional connection with our buildings that we may

be losing. ‘A house is not just a machine for living in,’ she says. And with growing numbers residing in them we need to think carefully about how to make the experience a pleasant one.

Professor David Worsley, from Swansea University, was more concerned with the short term. The flexible and transparent dye-sensitised solar cells he works on will prove to be a more agreeable sight on buildings, he explains, and could mean solar energy is soon a mainstream reality in the UK.

## Sunspot 11 year mystery

Dark spots on the sun disappear and reappear from view like clockwork exactly every 11 years. This solar cycle is studied intensively. However, one question which still baffles leading scientists is: why is the cycle 11 years long?

This question was asked by an audience member in Tuesday’s event: ‘*Does the Sun cause Climate Change?*’ Even solar physicist Dr Lucie Green is stumped.

Lucie Green is a space scientist at UCL’s Department of Space and Climate Physics. She is an expert in her field, and a popular speaker here at The Times Cheltenham Science Festival. Jupiter and Saturn, the ‘gas giants’, and the solar jet stream, seismic waves in the sun, have both been suggested to cause the cycle. However, nobody is sure exactly what causes this phenomenon.





# Festival vision

Circadian neuroscientist Russell Foster explains how Cheltenham has taught him how to communicate science to the broader, non-scientific community.

**I**t took me a few years to fully understand the novel vision of The Times Cheltenham Science Festival and why this philosophy is important within the complex and often confused framework of science communication. Before Cheltenham I, like many scientists, took a rather traditional approach to public engagement. The old format was simple: you gave a lecture for 50 minutes or more, followed by a few short questions and then back to the laboratory with a sense that one's duty had been done. Colleagues would be broadly appreciative of the effort but a little sceptical that it was worth the time or effort mumbling... 'how could a member of the public understand complex issues in science without a scientific training?'

I am pleased to report that those days are long gone; there is a new generation of scientists genuinely committed to public engagement, driven in-part by the philosophy developed by Kathy Sykes and Mark Lythgoe and delivered at Cheltenham. Over the past 11 years their vision of communicating science has moved beyond

Cheltenham to dominate science festivals both nationally and internationally.

So what revolutionary seed has Cheltenham nurtured? When I was first asked to speak at Cheltenham, like all speakers I was instructed gently but very firmly not to speak for longer than 20 minutes or so. This was shocking. Asking an academic *not* to speak at length about their favourite topic is a bit like asking a dog not to pee against a lamppost. The next body-blow was the realisation that the question and answer session must dominate. Like a cold hand on the vitals, you appreciate that you have not only lost control but must also be able to think on your feet. This was public engagement, but not as I knew it.

What dawned on me, rather slowly I am afraid to admit, is that the replacement of a lecture by real and sustained dialogue permits huge benefits: 1) Scientists can engage directly with non-scientists, without the distorting veil of the media. Allowing scientists to inspire, inform, and influence the activities of non-scientist; 2) Scientists can learn from non-scientists and gain a

direct understanding of public concerns and/or areas of confusion; 3) Scientists and non-scientists are encouraged to work together for the development of new initiatives.

Dialogue between scientists and the public is especially important in today's political and economic climate. History tells us that science and engineering will be vital in recovering from the current financial crisis: creating jobs in industries based upon biotechnology, developing new sources of energy and finding new ways to address the multiple health challenges facing an ageing, 24/7 society. There has never been a more important time to invest in science and engineering, and if we are to inspire the next generation and deliver progress, then scientists and non-

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scientists must work together effectively. Not simply to take the ideas and results from the laboratory bench into clinical practice or industrial application, but also to explain to the broader community what is being done in their name and why it is so important. A failure to communicate leads to mistrust and ultimately rejection, as we have seen with the MMR vaccination and the current controversy surrounding genetically modified (GM) foods. Understanding the vision of the Cheltenham Science Festival has taught me, and many colleagues, how to communicate science to the broader, non-scientific community, and importantly, given us an appreciation of the broader personal and societal benefits of this philosophy. *Russell Foster FRS was appointed Chair of The Times Cheltenham Science Festival in 2011.*

## Litmus Paper by DesignScience

Good design is able to engage public interest in contemporary science. But despite the increase in science communication and public engagement, the potential of design in this field is overlooked. Science poorly communicated leads to suspicion, disbelief and marginalisation. Synthetic biology, neuroscience, artificial intelligence, nanotechnology and data programming are just some of the ways in which science is profoundly changing our lives, both for good and in ways not yet known. How are we to position ourselves to make sense of these scientific discoveries?

In 2011 DesignScience was established to tackle this issue. It researches and develops new forms of science communication and applies existing effective methods. Design, like science, is an advanced tool, providing systems that make the complex and esoteric intelligible.

This year, with generous support from the British Library, DesignScience has created *Litmus Paper*. Alongside a daily feature from the science team at the British Library, we invited four writers: Phil Wagner, Rudy Rucker, Douglas Rushkoff and Phillip Kent, to contribute a series of pieces which reflect our ideas about how science can be communicated well.

[design-science.org.uk](http://design-science.org.uk)  
[dslitmuspaper.wordpress.com](http://dslitmuspaper.wordpress.com)  
[twitter.com/DSLitmus](http://twitter.com/DSLitmus)

### EXPLORE THE INTERACTIVE COVERS

DesignScience commissioned mathematics educator and DesignScience Associate Phillip Kent to create the series of covers. Each was made using the Processing programming language ([processing.org](http://processing.org)). Download any code you like in the Open Processing Collection, modify it, then upload your contributions to the Collection. You can also submit new programs – anything relevant to the Festival is welcome (at the editors' discretion). *Thanks to OpenProcessing.org for providing the social coding site*

To explore: [design-science.org.uk/litmuspaper](http://design-science.org.uk/litmuspaper)

# Where the Shhh! happens

BRITISH  
LIBRARY

The British Library's Science Team explores how libraries are moving into the digital age. New online resources and a growing calendar of live events indicate that books are only the beginning.

**T**he British Library is a hushed building reserved for scholarly academics; it's where they go to consult highly intellectual texts... right? Well, it is true that we are the UK's national library and provide access to one of the world's largest research collections here at our St Pancras building, but there is more to us than huge dusty old tomes and manuscripts.

We in the Science Team here at the British Library are a pretty varied bunch – coming from scientific research, policy and funding to library and information backgrounds, we work to support

contemporary scientific research and researchers in the UK. But what does that really mean in practice? It means we get to do some really interesting stuff!

Unsurprisingly, being a library, we provide access to information and we do this for everybody who is interested in science – including academia, industry, government, charities, NGOs and the general public. But as a team, we also get to experiment a little – thinking about tools and services that people will require in the future, by understanding how people's information needs and behaviours are changing.



The British Library's collection fills over 625km of shelving and is growing at about 12km per year



The collection contains over 150 million separate items including books, journals, maps, manuscripts, newspapers, patents, prints, drawings, stamps, music scores and sound recordings



If you see 5 items a day, it would take you over 80,000 years to see the whole of the collection



From astronomy to zoology, basic to applied, we cover all scientific disciplines. To find out more: [www.bl.uk/science](http://www.bl.uk/science) and @ScienceBL



Clearly, the internet has transformed our lives; search engines offer access to more information than ever before and people can view that information at the touch of a screen on mobile devices wherever they are. So you might be forgiven for thinking that traditional libraries and even books will soon be a thing of the past. But libraries, such as us, see this rise of all things digital as a tremendous opportunity to rethink our approach, to look beyond our walls and figure out how best we can connect people with the information they want. None of us yet knows what the libraries of the future will look like, but one thing's for sure: we're going digital!

We also have fun hosting a broad range of events; some are designed to engage the public with science, for example 'Do you hear what I hear?' with UCL (University College London) Neuroscience and Deafness Research UK, featured a 6 foot model of an ear and hair cells as part of the event. Our most recent 'Performing Brain' event brought together UCL neuroscientists with musicians, dancers and beatboxers! Our popular TalkScience event series meanwhile is targeted at scientists and those that influence the scientific research landscape. It aims to promote informed

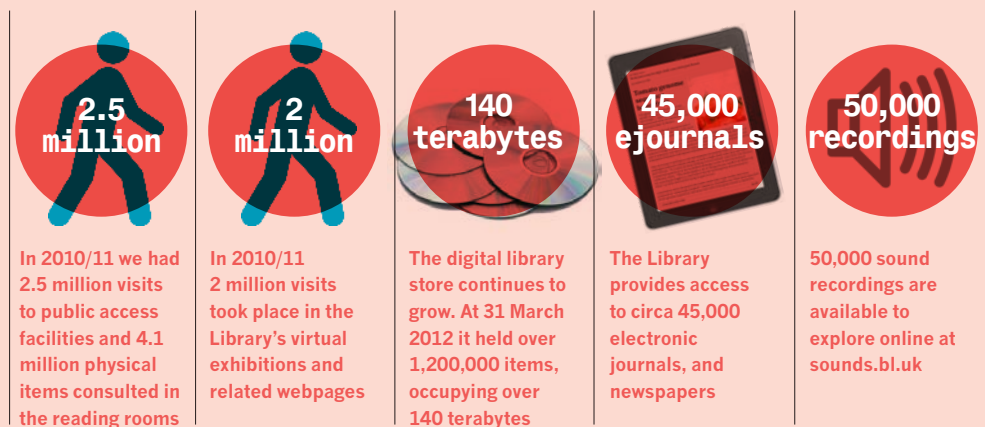
discussion on topical scientific issues from stem cell therapies to scientific advice in Government.

We are a small team so to be able to do all of this we tend to work in partnership with organisations including the Association of Medical Research Charities, Sense About Science, Living With Environmental Change, a range of Universities, major UK and EU funders and Microsoft, to name but a few.

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**None of us yet knows what the libraries of the future will look like, but one thing's for sure: we're going digital!**  
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Over the coming days you will get to know us better as we tell you about some of the things we are doing and find interesting.

But why are we at the Cheltenham Science Festival? Well, regeneration, the theme of the festival, strikes a particular chord with us given the metamorphosis that libraries are currently undergoing. But mostly, we're hugely excited to indulge our inner (not so well hidden) science geek and get to be a member of the audience at what looks set to be an amazing programme of events – engaging and thought provoking in equal measure.

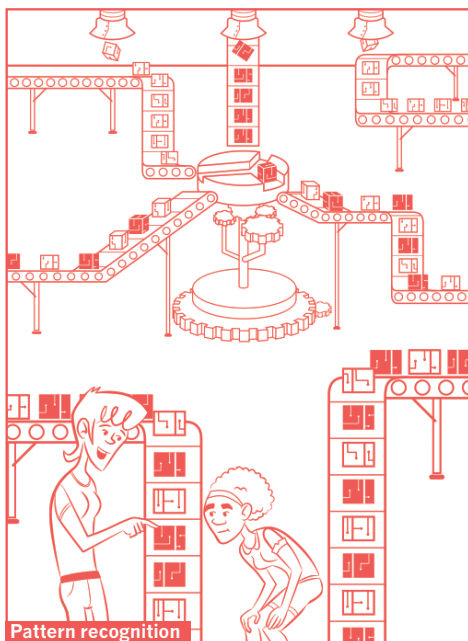


# Tools for computational thought

Phil Wagner describes Google's 'Exploring Computational Thinking' project – an initiative aimed at helping science and maths educators to place the power of computational thinking into the hands of students

**C**omputational thinking (CT) consists of a powerful set of problem-solving skills and techniques that enables anyone to tackle big problems and explore uncharted territory. The process roughly consists of decomposing or breaking down a problem, looking for patterns in the data, creating abstractions, and finally developing an algorithm that can be used by others to solve the problem and others like it.

In the past CT was mainly used by computer scientists, engineers and mathematicians who typically used it to write programs that underlie computer applications such as search, email and maps. But around three years ago Google set up 'Exploring Computational Thinking' in response to the growing number of people using CT. Maths and science teachers were invited to develop the curriculum, promote the project and inspire others to implement it in their own classrooms in order to help students of all ages and technical backgrounds to start using these cognitive tools. Google believed CT was relevant in enabling students to see how computer science applied to what they



**DECOMPOSITION** – Breaking a task or problem into steps or parts

**PATTERN RECOGNITION** – Make predictions and models to test

**PATTERN GENERALIZATION AND ABSTRACTION** – Discovering the underlying laws and principles

**ALGORITHM DESIGN** – Develop the instructions to solve similar problems and repeat the process

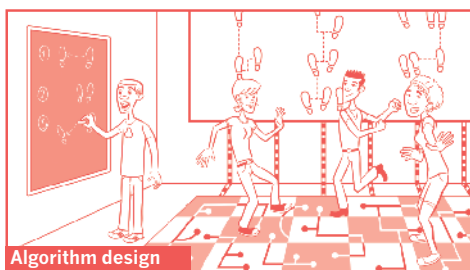
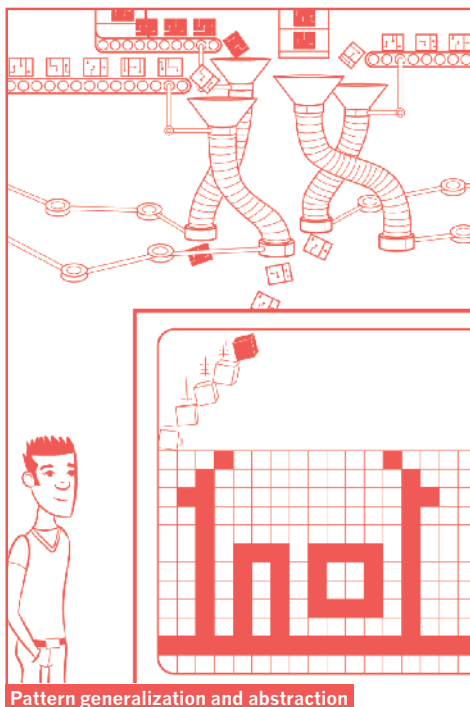
were interested in, and was necessary if they were to innovate and create in this age of big data and enormous challenges.

CT is often referred to as CS + X for all x. This means that wherever computer science (CS) meets another discipline (X), students discover how it is relevant to their lives and how useful it can be. We all use technology, but there is a growing shift away from simply consuming information towards collecting our own data and analysing it for new insights and ideas, and this is where CT can help. Although the principles and methods of CT are abstracted from computer science and engineering, one can start applying it to ones own questions without any technology at all.

Today CT is pivotal in enabling new scientific discoveries. The patterns of genes and inheritance that Gregor Mendel spent almost a decade studying in his pea pods garden can now be replicated in seconds, and for an entire genome! This capacity enables scientists to search for genetic homology and better understand how genes express themselves.

We are now able to predict fundamental particles years before they are found or produced using models and algorithms. Just as Mendelev found patterns in the periodic table, modern scientists are using CT to find gaps or solutions to equations that enable more targeted searches for the underlying structure of the universe. What scientists may do with such computational tools, so can students – our future scientists, engineers and technologists. The tools are accessible to secondary school students, enabling them to manipulate realistic models of physical situations, for example when creating a simulation of a projectile and truly seeing the effect of gravity and air resistance on a moving object.

CT is a creative and artistic endeavour in its capacity for revealing patterns in data



that was previously too large to analyse. A deeper understanding of a concept is gained when one can create an algorithm to process images, find prime numbers, or analyse a Shakespearian text. Today the amount of tools and resources is large and the community is growing. There has never been a better time to start exploring. [www.google.com/edu/computational-thinking/](http://www.google.com/edu/computational-thinking/) Phil Wagner is curriculum fellow for Google's Exploring Computational Thinking project. [www.brokenairplane.com](http://www.brokenairplane.com)

## Today's cover by Phillip Kent

The five covers for *Litmus Paper* form a planned sequence, with each cover responding to the theme of the day. For the opening of the Festival I thought about 'information inflow', as festival-goers load up their minds with stimulating ideas of scientific culture. There is a lot to take in, and many of us are on the verge of overflow!

The cover was created using the programming language called Processing. The 'flow' of words is a wordle, where words are sized according to their frequency in a source text and placed in random, non-overlapping positions. I have

used the excellent code library WordCram by Dan Bernier [[www.wordcram.org](http://www.wordcram.org)], which takes wordles to a whole better place in terms of sophistication and artistic interest, because the size, position and appearance of words is controllable to a high degree, whilst keeping the potential for random results.

For the source text I started with the Festival Programme, which was passed through a textual analysis program to count the frequency of one and two word phrases. To get a better final image I edited the word table to remove frequent but trivial, or non-sensical, phrases; as well as phrases with frequencies less than 7. I also tweaked the frequency numbers a little to

(de-)emphasise certain phrases.

The abstract design for neuronal interconnections in the brain makes use of a mathematical pattern, about which I will write more tomorrow...

The source code for today's cover can be accessed at [design-science.org.uk/litmus-paper](http://design-science.org.uk/litmus-paper). You can run the code interactively and explore some different options, and download the code to your own computer to work on. You are also invited to upload any code that you modify/create to a 'social coding' website. All of the software required is free and open source. I hope you will join in with the coding. [phillip.kent@gmail.com](mailto:phillip.kent@gmail.com)

# Today's free activities

## DISCOVER ZONE

**Town Hall, 10am – 5pm**

For all ages, the Discover Zone is open every day of the Festival, and gives kids the perfect opportunity to get hands-on with interactive technology and experiments.

[cheltenhamfestivals.com/discoverzone](http://cheltenhamfestivals.com/discoverzone)



## GE PAVILION

**Imperial Gardens, 11am – 6pm**

The GE team are offering lots of things to do and see for all ages including a Caterham Formula 1 racing car, the hugely popular flight demonstrator, a model of the first jet engine and much more!



## NEW EVENT:

**FESTIVAL EXCLUSIVE**



**EDF Energy Arena, 6.30pm**

*Have climate models reached their limit?*

Right at the frontline of scientific research, this week's issue of *Nature* will publish a provocative Comment article about the complexity of climate modelling. Its author, Mark Maslin, is in Cheltenham and will be interviewed live on the festival stage.

**nature**

## EDF ENERGY ZONE

**Imperial Gardens, 11am – 6pm**

Come to the EDF Energy Zone to visit the fascinating interactive exhibits exploring the world of energy generation including models of the latest nuclear reactors.



## SCIENCE QUESTION TIME

The Times Eureka Tent, 4.45pm  
With Andrew Pontzen, Alice Roberts and Giles Whittell. Explore today's biggest debates, newest discoveries and favourite Festival moments with a selection of the day's speakers, *The Times* journalists and the Festival team.

**THE TIMES**