SURPRISING OR NOT SURPRISING: 'I AM THEREFORE I THINK' INTERVIEW WITH PROFESSOR KARL FRISTON

Omne autem quod intelligo scio; non omne quod credo, scio.
– Augustin, De Magistro, XI, 37–

Cătălin MOSOIA

Introduction:
Prof Karl Friston, University College London, UK, member of the Royal Society, is a neuroscientist and authority on brain imaging. He invented the statistical technique named statistical parametric mapping (SPM) that is used to look for correspondences in brain activity as measured by magnetic resonance imaging. Also, he invented voxel-based morphometry (VBM), a sensitive method of measuring the volume of brain structures. Dynamic causal modelling (DCM), another invention of Prof Friston, is used to estimate how different cortical regions of the brain influence one another. Referring to theoretical neurobiology, one of Karl Friston contributions is a free energy principle for action and perception. Karl Friston suggestion that the minimisation of surprise can explain many aspects of action and perception.
Prof Karl Friston was keynote speaker at the first international conference on neuroscience, neuroinformatics, neurotechnology and neuro-psycho-pharmacology in Bucharest, Romania. To find more about his presentation and scientific interests we did the following interview.

REVISTA BIBLIOTECII ACADEMIEI ROMÂNE, Anul 4, Nr. 1, ianuarie-iunie 2019, p. 73-78.

Cătălin Mosoia: 'I am therefore I think'. How would you explain the theme of your presentation to a high school student?[1]

Prof Karl Friston: With great difficulty – as we have had discussed before this interview. But I did like your notion of Eureka moments. The free energy principle is a mathematical description of not only how but why we experience Eureka moments – at many different levels. Eureka moments are necessary to understand our world; from the laws that govern the way the world works, through the understanding how our bodies work. The idea is that 'to exist' is to make the right sorts of predictions based upon the right sort of understanding. And this provides a straightforward explanation for both perception and action. If one looks carefully at the physics and the mathematics that describe that perception and action, one can derive – or prove to a certain extent – that understanding, and prediction is necessary to survive in a changing world.

For example, if you take perception, the idea is that to perceive something is to understand it. To understand it we have to have an idea, a plan, a hypothesis, a fantasy about what could have caused those sensory inputs; namely, that visual pattern, what I am hearing, what I am sensing from my body and so on. To perceive it is to understand and to understand is to select or infer the right explanation for what caused that. Finding the right explanation is precisely the Eureka moment – it is precisely choosing and identifying the right sort of explanation that provides the best account of our sensations. If we now turn to action – action is just a way of sampling the world to elicit the right sorts of answers; in other words, touching the world with our eyes, or moving our bodies around in a way that confirms the predictions based on our explanations. So, both action and perception can be written down mathematically as a process of minimising prediction error – in the service of rediscovering these Eureka moments, at many, many different levels. That's an intuitive explanation.

If you wanted to build a little machine that did this – and you had to write down the mathematical equations or dynamics that would describe creatures, systems

[1] O variantă în limba română a interviului este disponibilă la adresa electronică: https://acad.ro/mediaAR/interv2019/int2019-0218-KarlFriston/pag_media_interviuri_invitati_2019_0218KF_text.htm

or agents that engage in this constant search for Eureka moments – then the sorts of systems you get are exactly those that have to self-organise. Put the other way around: if systems self-organise and maintain themselves in face of a changing environment – if they have a generalised homeostasis – if they engage in some form of self-maintenance or self-assembly – much like you and I do and survive for long periods of time, then they must experience leaves surprise-minimising Eureka moments. To exist or to survive in a changing world, we are compelled to understand the way that the world works. That is how I would try to explain it.

Cătălin Mosoia: When we say action, we may think of behaviour. What about perception?

Prof Karl Friston: I think many people look at action and perceptions, as two sides in the same coin. We cannot separate vision, touch, and hearing from movement. What we see depends upon where we are looking – and where we are looking depends upon how we move our eyes – and how we move our eyes depends upon what we think we will see if we look over there. Therefore, it is misguided to separate them.
There are only two ways that we can change the physical world by acting upon it. These are either by contracting some muscles or secreting things. There are no other ways of 'doing' anything. Therefore, all the talk about action and behaviour, on ways of being and interacting with our world, is how do we move and what we secrete.

Cătălin Mosoia: Are there any common points of contact between mathematics and neurosciences?

Prof Karl Friston: Yes, from my point of view. Mathematics is probably the crispiest, most formal way of writing down how you think the brain works. If you read a book on neurophysiology, then you'll come across the notion of neural dynamics and neural networks, and as soon as you say words like networks and dynamics, you are effectively talking about differential equations. A differential equation is an equation that expresses the rate of changes of something as a function of that thing. The interesting questions that arise are what is unique about the equations that govern you and me – as opposed to the heavenly bodies or tiny particles.

Cătălin Mosoia: Do you think that the brain may indeed be associated with a computer, or is a computer?

Prof Karl Friston: I think in the most general sense it is a computer. I am smiling, because the original 'computers' were women employed during the industrial revolution to do all the accounting. Therefore, a computer was originally a person, who did all the numerics and bookkeeping. I don't see computation as any different from a dynamical process with its differential equations. In my work computational processes are just probability density dynamics. If we associate a probability density with a probabilistic belief, then a probability density that changes is belief updating, and belief updating is an inference, is just as in Eureka moments. It is the same process but just expressed in terms of probabilistic dynamics.

Cătălin Mosoia: What is the free energy principle?

Prof Karl Friston: Very simply, it just says that any system that exists – and by existing I mean maintains a separation between the itself and the Universe or the environment in which it is immersed – will look as if it is trying to minimise variational free energy. Variational free energy is just a technical way of describing the improbability of various states of being. Some people call it surprise; other people call it model evidence. It's a very simple quantity; it is the log negative probability of being in a particular state. If you can minimise that quantity through everything you do – by changing your states or by acting upon your world – then effectively what you are doing is searching for those surprise-resolving free-energy minimising, Eureka moments; maximising the probability of the states you expect to be, which is just minimising surprise. Free energy is effectively a quantitative, information-theoretic measure of surprise.

Cătălin Mosoia: Statistically speaking, how can you minimise surprise or free energy?

Prof Karl Friston: That is an excellent question because statistically or mathematically speaking you just use the right sort of differential equation, which is a gradient flow, or a gradient descent on surprise. If it is the case that to exist you have to continually minimise surprise or minimise variational free energy, then you can write down a differential equation – of the sort of just we have been talking about – that minimises surprise.
The free energy principle is effectively saying that the dynamics of any self-organising system that preserves its integrity, or differentiates itself from the rest of the Universe, can be written down as a gradient flow on variational free energy. And variational free energy is just a fancy way of talking about surprise, and the inverse of surprise is just the states I like to be in.

Cătălin Mosoia: Let us have a short free talk about pursuing the minimum of surprise.

Prof Karl Friston: I don't think you ever get there. We'll try to find the minimum but as soon as we think we have reached it, it has moved. Think in terms of potential wells: if you picture free energy (any objective function really), as a curve, the idea is that you want to be at the bottom of that curve, at the bottom of a dish or a bowl or a potential well. When you are at the bottom, then you minimise your surprise – enjoy your Eureka moment, because you've got the best explanation for the world at hand. So, what's the simplest way of finding the bottom of a valley or a bowl? If I keep on going downhill, then ultimately, I should find the bottom. The reason I am hesitating to say that this is a complete picture is that, in reality, because our world is always changing, and we are open systems – in an exchange with that world – the bottom of the free energy valley is moving around. We are always chasing it but we never actually get there, which is why we keep on moving all the time, constantly learning and inferring.

Cătălin Mosoia: Theoretically speaking, when we reach the minimum, then it doesn't matter in what direction we are moving, it is always up.

Prof Karl Friston: Absolutely! Ontological security, comfort and closure lives at the minimum. When you simulate these things – or you think about why we keep on going; why do we keep on changing – you see that once you get to the bottom the minimum has moved. And that is because we are not a closed system. If we were a closed system, if we were completely isolated from our world, then we would find that one unique minimum – this is effectively thermodynamic equilibrium in physics. But for us, this fixed point keeps moving around, much like a moving target. You are always chasing that minimum, but you never quite get there.

Cătălin Mosoia: It is like the clay target shooting.

Prof Karl Friston: Yes, a perfect example. It is even worse than a moving pigeon, the 'pigeon' keeps slowing down and speeding up, so that you can never quite keep up, but you always try to go as close as you can to that ideal point – the minimum of surprise, the minimum of the free energy landscape.
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