Pravega
2014

TurnCoat

Finals Topics

- The following are the six topics for the Finals round
- Each chosen finalist will be randomly allotted one of these after the Prelims round, and will be given a preparation time of 30 min before the Finals round commences
- Use of all available resources is permitted for preparation. However, it is recommended to have a general understanding of each of these topics before-hand and utilise the 30 minute preparation time for framing arguments properly
- The time duration for each participant during the Finals round is 4 minutes followed by a 2-minute interjection of specific arguments. Please try to conform to the time limit.

The topics begin on the following page.

These six topics will require you to challenge your intuition and general perception of some of the most fundamental notions in biology, and that will lead to interesting arguments for both sides. Please remember that these questions do not have a clear yes-or-no answer and it is hence recommended to have an unbiased consideration of each of the topics. And the ultimate aim of this event to broaden your horizons and recognize the existence of ambiguities in scientific research. Look at some of the most famous debates in the history of Science – the Curtis-Shapley debate of 1920, or the one between Schrodinger and Heisenberg, quite often both parties turn out to be right. In that spirit, join us on 1st Feb for a stimulating and refreshing debate event, and be prepared for the fiercest of battles!

All the best!

Topic I

Neurolaw is an emerging field of interdisciplinary study that explores the effects of discoveries in neuroscience on legal rules and standards. Drawing from neuroscience, philosophy, social psychology, cognitive neuroscience, and criminology, neurolaw practitioners seek to address not only the descriptive and predictive issues of how neuroscience is and will be used in the legal system, but also the normative issues of how neuroscience should and should not be used. New insights into the psychology and cognition of the brain have been made available by procedures like functional magnetic resonance imaging (fMRI).

In the case of American rapist and murderer Brian Dugan, fMRI scans of brain activity were used for the first time, as evidence in the sentencing phase of a murder trial. Behavioural neuroscientist Dr Kent Kiehl discovered that the part of the brain responsible for processing emotions, the para-limbic system, was considerably less dense in Dugan than in other test subjects. His conclusion was that Dugan was not evil or bad, but was suffering from a disorder.

In this context, there is a possibility that traditional notions of criminal and legal responsibility can be radically undermined. To hold somebody responsible for a criminal action is to assume that individual was capable of choosing to do otherwise. And it is this claim that neuroscience seemingly casts into doubt. As a professor of psychology at the University of California argues, 'Defence lawyers are looking for that one pixel in their clients' brain scans that shows an abnormality - some sort of malfunction that would allow them to argue: "Harry didn't do it. His brain did."'

Others are more cautious about what neuroscience has to offer when it comes to understanding criminal actions, for example, pointing out the claim that mass murderers rarely suffer from serious mental illnesses. We should be cautious about the limits of our current understanding and the danger of leaping from correlations to assumptions of causation. As Stephen Morse, Professor of Psychology and Law in Psychiatry, argues, that decisions of guilt are for the courtroom not the laboratory: 'neuroscience . . . can never identify the mysterious point at which people should be excused responsibility for their actions'.

In light of the above discussion, argue for or against the question:

Should sentencing or rehabilitation regulations be altered by neuroscience?

Topic II

Two centuries earlier, Jean-Baptiste de Lamarck, a French naturalist had proposed a theory of evolution that proposed that characteristics acquired during a lifetime of an organism could be passed on to the next generation. However, fifty years later, when Charles Darwin published his 'On the Origin of Species', the scene was set for scientific the community to get devoted to the one-way hereditary determinism theory. After another fifty years, the discovery of genes cemented the dogmatic era of Neo-Darwinism, and as a result, Lamarck's "Theory of Use and Disuse of Organs" was discarded. This led to the common belief among most scientists that the characteristics of an individual are determined by their genes and it is at the genetic level that natural selection works.

Then in 1978, Steele produced evidence that acquired immunity can indeed alter genes for transmission to future generations. He developed the theory of reverse transcription, observed in the form of information transfer from the somatic (body) cells to the germline (reproductive) cells. With the dawn of the twenty-first century, Lamarck's widely discredited work began serious ascendancy. Scientific focus is now shifting from DNA as the supposedly immutable architect of life's blueprints, to RNA acting as a courier delivering myriad messages from everyday experiences back to an ever-changing genome in the DNA. RNA not only constantly evaluates environmental conditions and carries that information back to the DNA, but also making its own decisions about which cells were produced and the form that the organisms would take. Epigenetics studies are also stressing the need to re-evaluate our ideas of evolutionary processes, and rework on traditional examples. The question then arises whether a more thorough application of Darwinian theories can explain the results of modern experiments, or is Lamarckism staging a comeback?

Do we need to revamp our understanding of Lamarck's theory in light of new evidence and is it needed to fill in the gaps created by Neo-Darwinism?

Topic III

The term quorum sensing (QS) is used to describe the communication between bacterial cells, whereby a coordinated population response is controlled by diffusible molecules produced by the individuals. Bacteria exhibit remarkable social behaviours, which some workers have suggested are similar to those performed by insects, vertebrates and humans. For example, Myxococcus xanthus cells exhibit socially-dependent swarming across surfaces, which allows the population to seek out bacterial prey in a manner that has been likened to hunting wolf packs.

Biofilms, for example those found on the human teeth, can contain up to 500 species of bacteria, providing an environment that is ripe for social interactions both within and between species.

The integration of cooperative and communicative interactions appear to be extremely important to microbes; for example, 6–10% of all genes in the bacterium Pseudomonas aeruginosa are controlled by cell-cell signalling systems. In order for this gene transcription to be activated, the cell must encounter signalling molecules secreted by other cells in its environment. This opportunistic bacteria uses quorum sensing to coordinate the formation of biofilms, swarming motility, and cell aggregation. These bacteria can grow within a host without harming it, until they reach a certain concentration. Beyond that, they become aggressive, with their numbers becoming sufficient to overcome the host's immune system, and form a biofilm, which ultimately lead to disease within the host.

Thus, it is clear from the above discussion that co-ordinated population-based behaviour allows single cell organisms like bacteria to behave as multi-cellular entities. It is also hypothesised that such forms of cooperation led to the evolution of "true" multicellularity.

Given the significance of quorum sensing in pathogenicity, virulence and several other phenomenon, as well as significant analogies between social behaviour of bacteria and higher organisms, is it reasonable to consider these group of bacteria as a multicellular organism?

Topic IV

We're seeing a new revolution in artificial intelligence known as deep learning, which is a set of algorithms in machine learning that attempt to model high-level abstractions in data. Some of the most successful deep learning methods involve artificial neural networks. Artificial neural networks were inspired by the 1959 biological model proposed by Nobel laureates David H. Hubel and Torsten Wiesel, who found two types of cells in the visual primary cortex: simple cells and complex cells. Various deep learning architectures such as deep neural nets and convolutional deep neural networks have been applied to fields like computer vision, automatic speech recognition, natural language processing, and music/audio signal recognition where they have shown to produce state-of-the-art results on various tasks. Creation of such AI systems depends on progress in neuroscience and improvement in our understanding of neural processes and information processing in the brain.

But AI network studies also help to model cognitive processes and aid in understanding the brain better. Large-scale simulations can provide a virtual research tool by which characteristics of the human brain, and their relation to cognitive function, can be investigated on a scale and level of detail that is not hampered by the practical and ethical limitations of (invasive) brain research. No experimental method gives detailed information about the interaction of thousands of neurons, and no experimental method can vary parameters in such neural interaction at will, to study their effect. The Blue Brain Project at IBM is an attempt to study how the brain functions in this way, and to serve as a tool for neuroscientists and medical researchers.

Thus the relation between artificial intelligence is mutually beneficial. But which one is the more fundamental area of research that is crucial for the survival of the other?

In your opinion, between artificial intelligence and neuroscience, which follows the other?

Topic V

Assume a hypothetical scenario – a self-assembling, self-replicating entity (molecule / structure / device) has been designed by humans that can support its existence by using certain resources made available to it. It possesses levels of organization, can grow in size (not in an unbounded manner however), replicate and increase its population, use and metabolize specific substrates to derive energy for maintaining "homeostasis", respond to environmental cues, and also adapt itself to changing conditions in a slow evolutionary process! Basically, it possesses all the characteristics of a living being, but is this entity actually living?

This question requires a deeper thought about the currently-accepted criteria for classifying an entity as living - are these criteria sufficient and all encompassing? Do they leave out a lot of other potential candidates that can also be labelled as living? Or are we missing some other important criterion that can distinguish "living" from "non-living"?

Given that the above structure can mimic life in the limited number of fundamental aspects stated above, should we consider it to be living?

Topic VI

The biological basis of homosexuality is an interesting area of research. Although homosexual behaviour can be observed throughout the animal kingdom, specific individuals of a species having only homosexual orientations is rare. In humans though, it is a clearly defined individual behaviour. Whether sexuality is innate, is however, in question. Preliminary behavioural genetics studies do show evidence for genetic predisposition for homosexuality. But there is certainly no single gene for homosexuality, and the genes that do seem to play a role are not completely deterministic. This has led others to argue in favour of prenatal hormones and brain structure. They claim that biological basis for homosexuality is rooted not in genetics but in brain functionality, as programmed by maternal hormones during early development.

Following from the above discussion, argue whether there exists a predominantly genetic basis for sexual orientation in humans, or if it is mostly determined by developmental and environmental factors.