Left-biased Ants: 
It’s a Maze Thing!

by Edmund Hunt

We are all familiar with the idea of handedness in humans, with around 90% of people preferring to use their right hand to perform a variety of tasks. This is thought to be due to brain hemisphere specialisation, which enhances cognitive efficiency. As the left side of the brain is typically employed for speech, which requires fine motor movements, this also favours the manipulation of objects with the right hand.

Lateralisation of the brain and behaviour seems to have emerged early in the tree of life: studies of 600-million-year-old trilobite fossils show significantly more predation injuries on the right side of the body, suggesting lateralised behaviour in the predators or the trilobites themselves. Studying more primeval organisms may provide insights into the origins of ubiquitous lateralisation in the modern animal kingdom.

In a recent paper (Biology Letters, http://dx.doi.org/10.1098/2014.0945) the Bristol Ant Lab provided evidence for a leftward turning bias in ants exploring unfamiliar nest sites and branching mazes. This research was prompted by previous findings suggesting that our focal ant species Temnothorax albipennis (which nests in rock crevices) prefers to track landmarks with its right eye during navigation, indicating a lateralised nervous system.

One ecological reason for the leftward bias could be that nest-seeking colonies of T. albipennis need to investigate rock cavities that are typically dark, narrow and partly maze-like, and thus scouts exploring such spaces require a reliable method to ensure that they find their way back to the entrance. One well-known maze-solving algorithm is the ‘wall follower’ technique. By consistently turning left or right in a simply connected maze, following the wall will return an explorer to either the same entrance or a different exit. Such a simple heuristic mitigates the cognitive demand on ants confronted with repeated decision-making.

We suggest that when the ant enters a dark cavity it switches between behavioural modes and different brain regions: from exploring or foraging outside and considered decision-making (right eye) to predator vigilance and readiness for rapid response (left eye). This favours approaching unfamiliar and potentially dangerous passages on the left, and is our proximate explanation for the left-turning bias in individuals.

The presence of population-level laterality (the fact that the majority
What’s that coming over the hill?

The automatic identification of individual Gila monsters

by Benjamin Hughes

It was hot outside and even hotter in. I was looking at her and she was looking at me, her expression inscrutable. While I did wonder, I had no idea what she made of the slightly sweaty student, camera in hand, that was perched outside her enclosure. If she wondered what I was thinking, it would have been something along the lines of “Yes, you are a charming lizard, but if you’d be so good as to move, I’d be especially grateful.” And this was how, over a few days in the summer, I found out what it must be like to be a wildlife photographer.

My task that day formed a central part of my work developing a visual biometric system to identify individual Gila monsters - a charismatic if laid-back, venomous species of lizard native to the deserts of the southern United States - within a captive population housed at Bristol Zoo. The system was to form an integral part of the innovative multimedia, multicast Wild!:I system that was being developed by the Archive in Your Pocket (AiYP) project - a broad consortium involving the University and various industrial partners. Aside from overcoming technological challenges, a key objective was to provide an enhanced experience for visitors to the zoo, and in particular, to help forge a sense of connection between them and the animals they saw. The concept for the identification system was simple – a user would submit a query image containing a single individual and the system would return an ID, along with information about the life history of that animal.

Biometric identification systems seek to reduce the uncertainty about the identity of an individual, within a population, by making a set of feature measurements. As with all pattern recognition tasks, the expected uncertainty reduction depends on the ratio of inter- and intra-individual variance present within those measurements. The more similar, different instances of the same individual are, and the more unique those instances are with respect to the rest of the population, the greater the expected information gain.

In most human visual biometric applications, intra-class variability is minimised by selection of typically rigid and planar biometric entities, as in iris or fingerprint recognition, while variability due to lighting and pose are limited by tightly controlled image acquisition conditions. More importantly, thanks to subject cooperation and a well-defined domain on which to extract individual-specific data, singularly mapped, partial descriptions can be avoided while descriptive components can be cleanly separated from redundant background data.
This means the same information can be repeatedly extracted, even if some normalising transform is needed later.

By contrast, in the zoo, the system would have to make fast, high recall and fully automatic identifications of free moving, highly non-linearly deforming, constitutively self-occluding, sand-covered three dimensional lizards who, as my experience at the enclosure showed, were not likely to cooperate. Leaving singularities aside, fast multi-pose identification of non-linearly deformable objects is a complex and challenging task. Given dense correspondence sets, methods for non-linear normalisation exist, but, in the absence of a common reference frame, it is necessary to map the query to each reference image separately, a process that takes time. In addition, this leaves the problem of finding correspondences unsolved and does not provide a solution in the case of partial occlusion, where a mapping from query to reference does not exist.

It was clear therefore that a conventional, supervised, single instance biometric model was not suitable in this setting. Instead the problem was solved by sampling the patterns locally. A model comprising colour, texture and local structure was used to perform fast, probabilistic, soft, species detection, before the most probable local descriptions were matched in sub-linear time against a precomputed database representing the population. Finally, instead of classifying images in accordance with the best matching database image, we used an approach that reconstructs the query image using local parts from different images of each individual. In this way, a much higher degree of variability in appearance could be captured than with any individual image alone. The query images were then classified according to the individual, and not the image, that provides the best explanation for the observed data.

To conclude, I am pleased to say the system worked exactly as intended and it was rewarding to receive universally positive feedback from users who reported feeling a greater sense of connection to the animals. This was similar to the sense of connection I felt having spent many hours with the lizards, collecting the data on which the system was built.
What is AI?
by Patrick McGovern

Well, we all have a vague idea, don’t we? It’s robots. It’s computers. It’s problem-solving, pattern-detection, feedback control. It beats grandmasters at chess, lands planes in adverse weather conditions, reads your facial expressions. It’s HAL, Terminator, Agent Smith. It threatens our jobs, our species, the scientific method. It’s possibly a little sensationalised. It’s a lot of things really.

In all seriousness, it is actually quite hard to pin down what AI is exactly. Part of the reason for this is that it has changed substantially since its inception.

In the beginning, AI was reasoning. The defining image of the early AI days is the Turing machine. Alan Turing’s 1936 invention was not a physical computer, but a thought experiment which beautifully encapsulated the field of mathematical logic, as well providing inspiration for the physical computers created in the decades to come. It showed all that could be done through mechanical computation, and what couldn’t (for an enthralling explanation of Gödel’s incompleteness theorem and its implications, read Douglas Hofstadter’s Gödel, Escher, Bach). The initial optimism amongst Al researchers (in 1970 Marvin Minsky claimed that “in from three to eight years we will have a machine with the general intelligence of an average human being”) gradually wore off. Several major problems became apparent, one of which is called the combinatorial explosion. The Turing machine can, in principle, solve most problems. It’s just that some of them take a long time to solve.

For example, take AI as applied to gaming. You could easily write a program to solve noughts and crosses. The game lasts 9 moves at most, with the total number of possible games equal to 9! = 36280. Take into account the four-way symmetry and that many games last less than 9 moves, and you have a very solvable game. Now, try applying that approach to chess. Technically you can solve it, since it is deterministic. But there are so many possible moves on each go that even to compute 15 moves in advance would take about 10,000 years (assuming your computer examines a billion sequences per second).

Now, early AI was certainly aware of the combinatorial explosion problem, and there were plenty of people trying approaches which were not brute force (an early idea called connectionism was based on the structure of the brain, and eventually inspired neural networks, a successful modern field). But for one reason or another, each approach hit a brick wall, funding evaporated, and AI winter set in through the 80s.

After a while, the ice began to thaw, the computers started getting faster, and AI came out of hibernation. It had not undergone a drastic transformation, but the goals that had been shifted a bit. The objective of replicating and surpassing human intelligence was acknowledged as fanciful. Solving specific “intelligent” problems was recognised as more productive. It turns out the things that seem easy to us are actually very complicated. Minsky reportedly assigned a first-year undergraduate computer vision as a summer project; the project is still ongoing, with businesses pouring millions into it each year.

Furthermore, sophisticated ways of circumnavigating the combinatorial explosion emerged. A particularly successful field has been machine learning. Originating from Bayesian statistics, this field has been successfully applied to a varied set of problems, including computer vision, game playing, and medical diagnosis. The procedure for supervised machine learning is quite elegant: you have some set of training data (emails classified as spam or non-spam, for example); you apply some classifier to it and, if it’s a good classifier, it will successfully apply the rule it has learnt to new data.

One interesting aspect of supervised learning is that at the end of the process, you don’t necessarily know how the classifier works (particularly if you use a neural network, for example). It uses some rule, but the process does not reveal what that rule is. Many scientists are troubled by this. The foundation of science for centuries has been to observe some phenomenon, form a hypothesis to explain it, and test that hypothesis experimentally. The theories emerging from this process can be used to make future predictions. Machine learning skips all of this, and predictions are made statistically, without any need to understand the system at a deeper level.

For me and for many others, AI is interesting because in attempting to emulate human cognitive processes we can potentially gain an understanding of how they work. If we use machine learning, do we gain any insight into the processes that are mimicked? As I said, AI is a lot of things. Here I have touched on a very small subset of these things but I hope I have at least shown what an exciting subject it is.