Natural defences

The Pentagon is turning biologists' knowledge of evolution into a computer program to predict terrorist threats. Andrew Parker is helping them see the Cambrian explosion as an arms race

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Thursday November 18, 2004

The Guardian

Wind the clock back 540m years and take a plunge into Earth's prehistoric ocean. Animal life is simple. The primitive forms - mostly worms and bags of jelly - are blind, wriggling on the sea floor and drifting gently in the currents.

Fast forward 5m years and the picture suddenly looks very different. The emergence of a remarkable new organ, the eye, has triggered an evolutionary explosion. For those that can see, the oceans have become an all-you-can-eat buffet. In response, other animals have developed new defences or ways to evade capture. The evolutionary race has hotted up, and animal life has begun to flourish into the huge variety of species we see today.

This time of rapid change is called the Big Bang of evolution, or the Cambrian explosion. To biologists, it is one of the most significant periods in Earth's history. But it is not just a subject for natural historians. Now, it has entered the world of defence.

It all started last year when the US assistant secretary for defence and other senior officials within the Pentagon read In the Blink of an Eye, a book I wrote on the Cambrian explosion. It triggered a series of meetings in Washington and Britain, involving all manner of political and military figureheads, as well as defence analysts, computer programmers, tacticians and statisticians. Their hope was to see what a knowledge of evolution could do for national security. They emerged with a plan to create an extraordinary piece of software. Dubbed the "Cambrian program", it will take perhaps the broadest overview of the world's social and defence systems, and use evolutionary theory to predict possible threats and outcomes. I and a team of experts at the MoD's defence science and technology laboratory have already begun work on the program in Britain, and a similar consortium is planned at the Pentagon under Tony Tether of the Defence advanced research projects agency (Darpa).

To understand the thinking behind the idea, picture the Cambrian explosion as an arms race. An eye evolved in one animal, representing a revolutionary new weapon - perhaps the greatest ever. Other life then reacted to deal with the weapon. What followed was a cycle of evolutionary one-upmanship - predators evolved to outwit prey, and prey in turn bolstered their defences. What use is any of this to the defence community? In short, knowledge of the way creatures evolved to counter emerging threats may give defence officials tips on how to deal with new threats to themselves.

The program will work along the same lines as computer programs already used to recreate the evolutionary paths of different species. The programs take data from thousands of different fossils and use artificial neural networks and so-called genetic algorithms to piece together how different species evolved. The Cambrian program will follow suit, only instead of processing fossil data, it will eventually be fed information on the state of our society. Data on the way we travel, the way we use energy and water, our postal services and internet traffic, will be processed alongside information on the availability of weapons, chemicals, radioactive material, and so on. It will then attempt to use the data to piece together possible threats that could emerge in the future. It's ambitious, but worth a try.

At the heart will be a neural network, itself a piece of software, that must first be trained to handle the disparate information it will be fed. This is where the Cambrian explosion comes in particularly handy. The fossil record of the event documents how major advances, like eyes, and myriad minor changes in creatures, put pressure on other animals to evolve responses, be they new defences or different attack strategies. To train the Cambrian program's neural network, it will be fed data from the fossil and genetic record of life just before the explosion. It will then be given data from the very end of the explosion. As the program runs, the neural network will look at both sets of data and work out what connections lead from life before the great arms race to life afterwards. Once it has achieved this, the program can be fed hypothetical new data, for example the early emergence of an electrical sting as a weapon, to see what impact it might have on other creatures.

Though the program will be designed to assess evolutionary events, there are aspects of evolution that apply equally well to defence. Suppose security experts knew that equipment had been stolen to produce a particularly nasty chemical agent. It might be able to shed light on the impact that might have on security at public and government offices, on health services, and on people's behaviour. It would very likely be able to suggest obvious responses to the threat, but might also spot links between factors that humans might not have noticed and alert defence experts to weaknesses in their planned countermeasures.

The inquiry into the 9/11 terrorist attacks in the US showed that a breakdown in communication was largely to blame, there was no single chief who could make decisions using all of the data collected by various disparate security organisations. The Cambrian program, on the other hand, could manage all the data it is fed and provide constant updates on the size of the threat from different areas. That would allow officials to continuously modify their defence strategy.

Of course the program will not give us detailed predictions. It won't be able to predict when and where someone will let off the next terrorist bomb. But it should provide more broad information. In the early stages, we hope to use the program to run through various hypothetical defence countermeasures and predict their outcomes. The answers might best be used to work out how to allocate defence funding, by identifying those areas where potential threats are not being studied.

Unfortunately, we are likely to have a string of unsuccessful prototypes before we hit on an effective, usable program. Why? The problem is that the system is dependent on receiving all the relevant data needed to reach a decision, and at the moment, we simply do not know what the data are. But we will get there.

We may find that the program is most safely employed to test defensive countermeasure options. Recently, on a Nile cruise holiday, I was shocked to see a large gun positioned on the upper deck during a certain, notorious, stretch of the river. The gun was assumed to serve as a warning, but who says that it could not rather provoke a reaction and stir the otherwise calm waters? Maybe consideration of all the facts - enough to confuse even the greatest mind - via an evolutionary program could result in the best decision.

· Andrew Parker is a Royal Society research fellow at Oxford University. To buy In the Blink of an Eye (Simon and Schuster) for £7.99 with free p&p call Guardian Book Service on 0870 836 0875 or go to guardian.co.uk/bookshop