IAI - Exercise Sheet 3

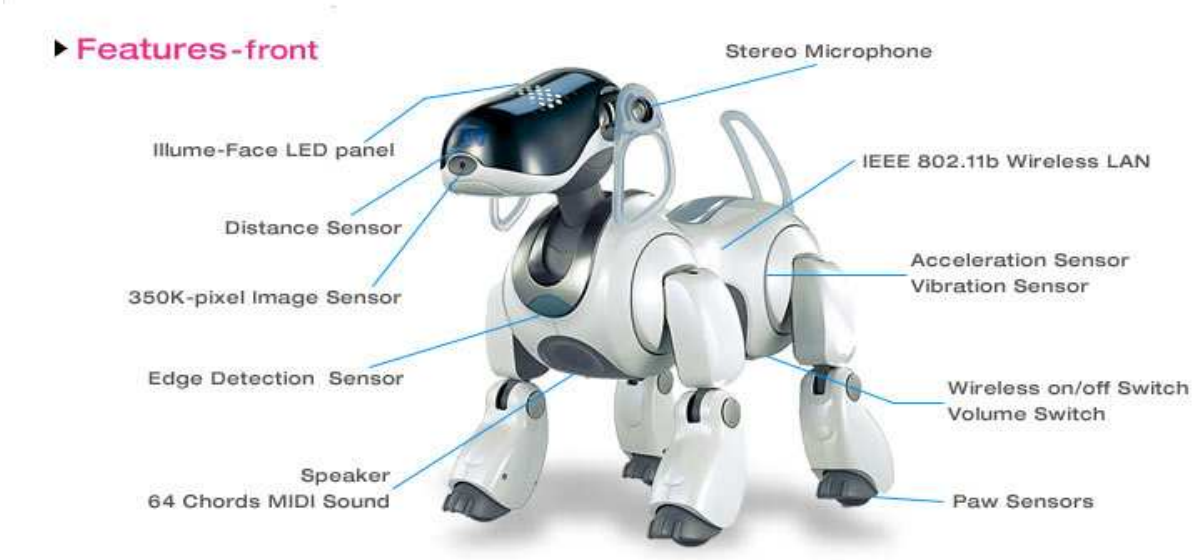
This week we have a set of questions about copying the intelligence and other capabilities of biological systems, and about neural network systems. All but the last question are rather open-ended, designed to encourage you to find out more about current AI systems.

Question 1

To what extent are modern robots being modelled on human and other animal systems? Does it make sense to build humanoid robots, or are other configurations more appropriate?

Question 2

The SONY Entertainment Robot *AIBO* has a good web-site at http://www.aibo-europe.com/ .



From an AI point of view, what are the main feature of the current *AIBO*? What important AI features do you think the *AIBO* still lacks?

Question 3

What is the state-of-the-art in humanoid robot building?

As you can see from: http://world.honda.com/ASIMO/ , the Honda *ASIMO* is a pretty impressive humanoid robot. What underlying principles have been used in developing *ASIMO*?

How many other humanoid robot systems like that are currently in existence? Is *ASIMO* the best?

Do you think the current trend is moving towards *Terminator* style robots as seen in the movies? If so, should we be worried about them taking over the world? Or are there fundamental technical limitations that will prevent us from ever building such systems?

Question 4

The *ALVINN* (Autonomous Land Vehicle in a Neural Network) project developed a neural network system that learned to drive a land vehicle by watching a human drive it. Starting from the official web-site at http://www.ri.cmu.edu/projects/project_160.html , or books in the library, find out as much as you can about this system.

Would you go for a drive in a car with such a neural network system at the wheel? If not, what improvements would you like to see made first?

Question 5

Aeroplanes don't have feathers. Many AI systems don't involve neural networks. Are there any general principles that can inform us when to follow biology, and when not to?

Question 6

How are long term and short term knowledge commonly represented/encoded within a neural network?

Find out more about the distinction between *symbolic* and *sub-symbolic* systems.

If neural networks are sub-symbolic systems, how is it that brains appear to perform symbolic computations? Can symbolic systems perform sub-symbolic computations?

Question 7 (Hard!)

What are *invariant representations*? Why are they important? How can they arise in neural network systems?

Question 8 (Exam style question)

A McCulloch-Pitts neuron is a simplified model of a biological neuron that receives inputs in_i, multiplies each by a connection strength/weight w_i, sums them, and produces a binary output depending on whether the sum exceeds a threshold θ.

Draw a labelled diagram of such a neuron with two inputs, and express the output mathematically as a function of its inputs and parameters.

Show that it is possible to find specific weights and threshold for such neurons so that they can implement logical AND and OR functions.

Similarly, show how a McCulloch-Pitts neuron can implement a NOT function.

In what way is implementing the XOR (eXclusive OR) function more difficult?

What do such considerations of simple logic gates tell us about the power and limitations of networks of McCulloch-Pitts neurons?