ELL788: Major Test

November 19, 2016

Maximum Marks: 50

1. Consider the process of adding two numbers using a simple calculator app on a smartphone. Describe this event at each of Marr's three levels of information processing. **[4.5]**

2. How is taste different from flavour? What is flavour perception? Describe the mechanism in detail with a figure demonstrating the flow of sensory information. **[1+1+6]**

3. What's the fundamental mechanism of object recognition by insects and primates? How does the view-based recognition scheme appear to be supported by experimental results? What would be a probable approach to come up with a novel scheme for object recognition? (If you think that model X will work better, justify with proper explanations.) **[2+8+2]**

4. A group of 100 human subjects in an experiment were shown the following data from a medical study:

	Had liver disease	Healthy
Alcoholics	300	200
Non-alcoholics	50	450

The subjects in the experiment were asked to look at this data and assess the degree to which alcoholism causes liver disease. We would like to model the cognitive causal induction process of the subjects using Bayesian model comparison of two models, one which contains the causal link and one which does not.

(a) Draw the two relevant graphical models (Bayesian networks) to be compared in this case. Introduce appropriate random variables for this purpose, clearly defining what they mean. Also write down clearly the respective hypotheses that your two graphs correspond to. **[2]**

(b) Write down the conditional probability table (CPT) for the 'effect' variable (i.e., having liver disease) for both graphical models. Introduce appropriate parameters for this purpose, and define what they mean. One of the graphical models will involve a possible interaction of two causes for the effect. Write down the corresponding CPT entry under *both* the linear and noisy-OR parameterisation assumptions for this case. (Note that you are *not* being asked to estimate the values of the parameters in any way.) **[4]**

(c) Why is the noisy-OR parameterisation generally preferred to the linear one, in these kinds of models? **[1.5]**

(d) Suppose we define the random variable d to refer to the data from the medical study tabulated above. In order to assess the strength of the causal effect from alcoholism to liver disease, we would like to calculate the conditional probability of d, given each of the two graphical models considered (recall that the log-ratio of these two probabilities is what we called 'causal support'). Write down the expression for each of these two conditional probabilities, as an integral over the parameters in your respective graphical model. **[4]**

(e) The two expressions just written should include terms corresponding to the *priors* over your different parameters. What would be reasonable priors to assume, in this case? Write

down the corresponding prior distributions over all of your parameters for both graphical models. Would your assumed priors work for both the noisy-OR and linear parameterisations? Why or why not? **[4]**

5. As children acquire the ability to use language, they often produce two or three word sequences, e.g., 'See cow' (Eve; 2 yrs) or 'Her gone school' (Domenico; 2 yrs). Nim Chimpsky, a chimpanzee trained to use language was able to produce sequences such as 'play me Nim', 'eat me Nim', 'tickle me Nim'.

   (a) Can we make a claim that chimpanzees such as Nim have language abilities that are the same as a 2 year old human child? Provide your reasoning. **[2]**

   (b) If a chimpanzee like Nim were given more training, would he achieve the language ability of a normal human? **[3]**

6. Word meanings are unlike alphabetical dictionary entries in our memory, hence if we hear 'dinner', we are likely to to think of 'food'.

   (a) What is the mental process that takes place when we think of these associations? **[2]**

   (b) You are given a task to examine the association between two words 'pollution' and 'climate change'. Design a simple experiment based on your understanding of the mental lexicon to investigate their relationship. **[3]**