Bayesian nets
Meeting notes 2/3/2023

Everybody was there.

I. Zhongming has put together an impressive piece of work on 'The Growth of Non-Looping Networks," sent independently and attached.

One of the cool things is his (log) graph of the growth of all the number of total networks (including loops) and the number of looped networks on the last page, for networks up to n nodes.

One of the lessons is both the growth and the unmanageable size of the network space, both looping and non-looping, with increasing nodes n. Buy his calculations, with 6 nodes we already have 14,348,513 non-looping networks. With 7 nodes we have 10,160,350,859. We agreed this makes a look-up table of qualifying networks unmanageable. A look-up table of non-qualifying networks might be possible, though at 8 nodes that is already 16,036.

For practical purposes we agreed that we will just stick with the pyAgrum loop-detector for now.

II. Dennis designed and programmed a new way of scoring how well a representational network does in terms of evidence from the worlds, in terms of two parameters: (a) adequacy and (b) parsimony [sometimes grouped in our discussion as 'accuracy'].

Here is my memory of how this works. I will ask Dennis to correct it and give us omitted details. I also can't quite make my understanding fit Dennis's example in scoring.ipynb, in part because I can't make the representation of evidence in each case match the example networks.

But here's the basic idea:

In 'the world,' activation at a node results in activation of other nodes 'downstream.' In a representation, local adequacy is a measure of whether the downstream nodes activated in the world are also activated in the representation.

A full adequacy measure of a representation is then calculated on the basis of local adequacies from each activated node.

In 'the world,' activation at a node results in activation of others by specific routes. In a representation, there may be routes between two nodes that don't appear in the world. That is an unparsimonious network. Here again we can have a measure of local parsimony for each node, and a full parsimony value for a network calculated on the basis of local parsimonies.

III. With a scoring of representational nets in terms of (a) adequacy and (b) parsimony, we can use that scoring in order to instantiate some of the network-alteration heuristics we've developed:

Single-point mutation
[double-point mutation left off because of oscillations]
Random single- and double-point mutation
Hybrid genetic algorithm

We also have two possible areas of exploration which would have to be designed in terms of the new scoring:

Keep the best
Hill-climbing

IV. We discussed how our heuristics should be implemented in terms of our values of adequacy and parsimony. The consensus was that all should be applied first to try to maximize adequacy, with fine-tuning in terms of parsimony second.

Sophia thought this was most plausible in terms of scientific procedure. Dennis offered the hypothesis that this would result in addition of links first, followed by pruning. Patrick pointed out that this was analogous to how neuron connections grow in brain development: first with an ebullient proliferation of connections, later with a pruning of connections. As a long shot, it may be that this is not merely a biological but an information-processing fact: that the most efficient way of developing an accurate representation of the world is to first maximize adequacy and then parsimony.

For next week:

- I hope Dennis will check his evidence and scoring system, telling Patrick what he is missing in the example in scoring.ipynb.
- At that point Amber can start trying to incorporate that scoring in with our short list of heuristics: single point mutation, random single- and double, and hybrid genetic algorithm.
- Dennis is going to think about how we might implement a 'keep the best' strategy.
- Patrick is going to think about whether a hill climbing method can be outlined in terms of the new scoring.
- Patrick is also going to try to take a closer look at Zhongming's piece for questions and comments.

Meeting same time and place next Friday.