Comments on pre-reading quiz 4

1. Which of the following is an accurate summary of the simulation parameters used by Oliphant?

- [x] Population size = 100; mutation rate = 27% chance of mutation per bit; 10% chance of crossover per genotype
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These parameters are given on page 32 and 33. Mutation rates tend to be per allele - as in the code we are using (e.g. evolution1.py), you scan along the whole genotype, and for each position on that genotype you make a random decision as to whether to change the value at that position). In contrast, crossover rates tend to be for whole genotypes - you make a random decision whether to crossover or not. Oliphant doesn't actually explain very well how crossover works in his model: crossover (recombining the genes of two individuals) tends to be used in models where you have sexual reproduction (so every organism has two parents, their offspring are produced by crossing over the parental genotypes), but as far as I can make out Oliphant has asexual reproduction (i.e. every organism has a single parent). My best guess is that he generates a new population by asexual reproduction then occasionally crosses over two randomly-selected individuals. That's obviously not very close to how crossover works in the real world, but if he is just using it as a device to inject variation into the population, then that doesn't really matter.

2. Oliphant uses Monte Carlo simulations to evaluate communicative accuracy of his population. Based on your own experiences with this technique, did you find the number of trials he used too small, too large, or about right? Explain why.

He says (page 33) that each agent is involved in, on average, 32 communicative episodes. That seems on the low side to me - in Lab 2 we were using on the order of 1000 to 10000 evaluations per pair to get an accurate measurement of communicative accuracy. On the other hand, the number Oliphant uses seems to be enough, since even with this very approximate measure of communicative accuracy, selection is able to identify the best signalling strategies. His results are quite noisy (look at the gene frequencies bouncing around in all his plots), and this could in part be due to the extra noise introduced by his rough measurement of fitness or (more likely) his high mutation rate.

3. Which of the following conditions result in the evolution of Saussurean communication in Oliphant's model?

- [x] Sender and receiver both benefit from successful communication
- [ ] Only the receiver benefits from successful communication
- [x] Only the receiver benefits from successful communication, and senders remember their previous interaction with this receiver.
- [x] Only the receiver benefits from successful communication, and the population is spatially organised.

These are, in order, Simulation 1, 2, 3 and 4 - the only condition where communication fails to evolve is in Simulation 2, which is receiver-only payoff and no additions (reciprocity, kin selection) to compensate.

4. In your own words, explain why communication fails to evolve in the condition(s) you didn't select in the previous question.

The problem with the receiver-only condition is that there is no selection acting on the population's send behaviour, so it fluctuates randomly.

Oliphant encodes an individual's send and receive behaviours as entirely separate (which is what we are also doing at the moment, with our separate send and receive matrices), so you could have an individual who sends signal a for meaning 1 but interprets signal a as conveying meaning 2, for instance. In Oliphant's Simulation 2, the only thing which influences an individual's fitness (reproductive chances) is their reception behaviour - production behaviour is irrelevant for determining who reproduces and who doesn't. Consequently, production behaviour doesn't evolve by natural selection - there is heritable variation in production behaviour, but it doesn't impact on fitness at all. The population's production behaviour therefore just changes randomly - one production system will increase in numbers for a while, since it happens to live in individuals who are good receivers, but then mutation will introduce different variants and the numbers of the various possible production systems will fluctuate unpredictably. As a result, communication is never stable - the population is always evolving to be able to understand the current most common production system, but that production system is always changing (and probably changing fast, given how high Oliphant sets his mutation rate).

We will spend some time discussing this result in the lecture, so if this explanation doesn't make sense, come equipped with questions!