An Agent-Based Model For Economics

This is the fourth year for the agent-based economic model research, and I am very glad to work on it. There are three major parts of this year’s research: finishing the line-by-line conversion from Python to C++ because C++ is much faster and Python was too slow to do the extensive simulation, adding some functionalities of heterogeneity and testing the code.

The first part -- the complete conversion from Python to C++ -- took about a month. Most of the code has already been converted by Professor Victor Norman. What I did was looking through all the converted code to see if there were any obvious bugs, rewriting the part that was used to set the running options such as which config file to use, etc., and adding the functions to save the running results into csv files. At the end of the conversion, we finished all we needed.

After the conversion, we started the unit tests to see if the results produced by C++ were consistent with Python’s. There are four scenarios of this program: no trade no tools, trade only, trade and tools only, trade and with devices; each one is of a higher level than the one before. Professor Becky Haney set up the first set of unit tests for these four scenarios. For the first two scenarios the program passed easily. Then we stuck at the tool_test (trade and tools only) for a long time. To debug, I checked the code again and again and tested the random mechanism but did not find anything that might cause the differences. After a week of debugging without any major progress, I took Professor Norman’s advice and commented out all parts that were related to random so the program would produce the exactly same results for every run. In this way we could run both versions in parallel and knew at which step C++ went wrong.

After passing all the unit tests, we finally moved to the phase of implementing heterogeneity. The agents have a config file which is used to store the properties of each agent so we only needed to change some of them and see what would happen. Nevertheless, these properties were not complicated enough. To simulate the real world economics, I added the functionalities to control the power of trading, the speed of
inventing devices and the diffusion delay of making devices. First, for the trade power, everyone was trading equally before, but now if agent A has high power than agent B, then A will push B to trade for the lowest value B would accept. Second, the chance that a device being invented was equally random for all agents. Now, with the added invention speed, agents have different opportunities to invent. Third, the diffusion delay controls the experience an agent needs to have before making a device. The higher the delay is, the longer it takes for the agents that are not inventors to make devices.

I learned a lot from this research. The first major part is of course the general improvement of programming skills. I gained a better understanding of both Python and C++ and the differences between them. For example, Python does not need declare the type of a variable but C++ does and that caused a lot bugs in our program, and Python has all kinds all built-in libraries which make it easy to program but C++ does not. I also got to use some libraries in C++ that I did not know before, especially the boost library which is really powerful. The second major part I learned is some economic knowledge, including how marginal utilities play an important role in making trading decisions and how gathering and inventing speed would affect the results differently. The other things I also learned include working with a large project that was not written by me, using gdb and pdb, writing documentation, using hg (a software versioning system), and doing unit tests.

By the end of this summer, the research will have the ability to run with homogeneous agents correctly and quickly and also with some functionalities of heterogeneous agents, including different speed of gathering resources and of making devices, different trade power for both resources and devices, and different inventing speed and making devices speed.