Complexity Science mini-project:
Evolving Control Rules for Complex Systems

Background: Finding good control rules to optimise the performance of complex systems in a dynamic environment is a challenging task. One way to do this is by simulation optimisation: Given a simulation model of the complex system, and a space of possible control rules, a search algorithm can try to find the control rule that yields the best result on the simulation model.

A powerful class of search algorithms would be Evolutionary Algorithms (EAs), i.e., heuristics inspired by the principles of natural evolution. We have already successfully applied EAs to automatically design dispatching rules that control the production process in a complex semiconductor factory [1].

Mini-project:

In this project, the idea of automatically generating control rules by means of an evolutionary algorithm shall be applied to another problem. Any of the following applications could be considered:

- assigning jobs to a set of parallel machines with setup times
- assigning calls to staff members in a call centre, where staff members have different skills
- deciding whom to vaccinate in case of an outbreak of an infection
- any other complex control system you would like to optimise.

For the first application (parallel machine scheduling), we have a running simulation, for the other applications, a simulation model would have to be developed as part of the project (which would require some programming skills).

PhD prospect: The topic of simulation optimisation is a hot research topic, and for a PhD project, it could be addressed on a more general level. A particular question is how to best deal with stochastic simulations, e.g., how much computational effort should be spent to accurately estimate a solution quality, given that with a higher accuracy, the number of solutions that can be examined in a given time frame is smaller.

Deliverables:

Control rule for the problem considered.

Student's requirements:

Some programming is necessary.

References

[1] Pickardt, C.; Hildebrandt, T.; Branke, J.; Heger, J.; Scholz-Reiter, B.: "Evolutionary generation of dispatching rule sets for complex dynamic scheduling problems". International Journal of Production Economics, Elsevier, 2013