Complexity Science mini-project:
Prediction in self-organising production systems

Background: The scheduling of production has been a major concern in manufacturing operations for many decades due to its importance for the reduction of production costs and its complexity. Real world manufacturing environments are usually dynamically changing, i.e., they experience various unexpected events on the shop floor, such as the arrival of new orders, or machine breakdowns.

A common approach for dynamic stochastic scheduling problems is to use dispatching rules, i.e., priority rules applied locally at each machine. Because this delays scheduling decisions to the latest possible moment, it takes into account the latest available information and thus naturally responds to the dynamics and stochastic events of the shop floor. Basically, the shop floor can be considered as a self-organising complex system. In a research project funded by the German Research Council, we try to understand and improve such self-organising scheduling systems.

Mini-project: One problem of such a system is that the schedule is not known a priori, but emerges from the interdependent local decisions of each agent/machine and the stochastic events. Still, the manufacturers would like to promise completion dates to their customers. The task for the mini-project is thus to design a prediction tool, which, based on the current status of the shop floor and past performance, predicts the completion time of a new job. The tool should be tested in combination with a simulation module of a factory already available.

PhD prospect: The mini-project is only a first step in better understanding and controlling self-organising production systems. The larger vision is to use more advanced prediction modules in combination with revenue management to allow pricing decisions depending on the requested delivery date. That is, earning more money and/or satisfying more customers by charging more for a fast delivery, and less if the customer allows for more time. How practices of revenue management, which are traditionally found in the service sector, e.g. airlines, could be applied to self-organising manufacturing operations shall be investigated in a follow-up PhD project.

Deliverables:

- Literature survey on predicting job completion times
- Observer module that monitors activities within the production system in real time
- Module that predicts the most probable completion date of a newly arrived job (based on the system's state, e.g., sensible aggregation of the real time information from the observer module)

Student's requirements:

- Programming skills (preferably Java or some similar object-oriented language)
- Some experience with regression/machine learning techniques