On Agent-Based Models of Sex, Plants and Sustainability

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Addendum: Valorization

In the manual of Maastricht University on how to write a valorization chapter, it is said that "Knowledge valorization involves the process of creating societal and/or economic value from scientific knowledge". I strongly believe that the scientific knowledge of my content chapters (Chapters 3-6) can be the basis for societal and/or economic value.

Chapter 3 shows that for sexually reproducing populations, there is a trade-off between optimizing the population fitness and being robust against environmental changes. In particular, we show that if a population is too much specialized, it cannot respond well to changes of the environment. This problem occurs in day-to-day life all the time. Many people in their career have to decide at some point whether to specialize more in one direction or to achieve a wider range of knowledge. While a specialized worker may be indispensable, he might lose his complete expertise if the production system in the company is changed. However, the trade-off can also be noticed from the company's point of view: If they hire people that are very good at producing a certain good, then the company will be very successful in the production of that good. If, however, some development in terms of modifications of the good is needed, these workers might not perform that well anymore, and the company loses its supremacy. Thus, the original problem can be translated to very many situations of day-to-day life where a trade-off between specialization and generalization can be noticed. Our findings can be used to better evaluate the advantages and risks of being too specialized in all situations. For example, biodiversity of plants helps to adapt to climate change [Mijatović et al., 2013]. However, agriculture destroys the biodiversity and thus promotes climate change [McLaughlin and Mineau, 1995]. Thus, we need more understanding about the advantages of biodiversity and how to protect it.

Chapters 4 and 5 examine plant reproduction strategies. Some newspapers say that until 2050, in order to feed the human population, the world has to produce twice as much food as compared to today without using more resources like space or water. Even if these numbers are not correct, it is obvious that more and more food is required to feed the growing number of humans in the world. Plants are needed both as food for humans and as food for other animals. Thus, increasing, e.g., the biomass of plants without using more resources, may solve a big part of the problem. In order to be able to modify genetic structures or plant growing processes, it is essential to understand how these mechanisms work in plants. Furthermore, it may be that nature shows us ways to improve artificially produced goods. One example of such a good is the lotus wand paint, where the plant *Nelumbus* was the inspiration for a water-repellent surface. When understanding mechanisms of plants, this understanding may be useful in order to invent new tools as well.

Chapter 6 directly addresses a big societal and economic problem, namely air pollution. There, we investigate how national policies of the European Union (EU) countries influence the air pollution over Europe. With our model and the simulation results, we give insights into how countries can be forced to produce their goods environmentally more friendly while also keeping their national needs in mind. This model can easily be extended to any set of countries and can, as such, serve as a basis for understanding the mechanisms behind pollution problems.

Additionally to these concrete problem contexts, the models used in this thesis can be applied to many other scenarios. After implementing the framework, only small changes, e.g., in defining other interactions among the agents, may be enough to apply the model to scenarios in all kinds of different domains. These domains include, e.g., tumor growth, asset pricing, migration, and disease spreading.