Education in Modelling and Simulation: Mathematical Formulation and Case Studies

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Abstract
This paper deals with the conceptual structure for courses in modelling and simulation. An important part in planning modelling and simulation courses is a good combination of theory and application. In order to impart all aspects student should also be motivated to implement a model their selves. It is not enough to only attend lectures about it but also develop a model.

Keywords: Modelling and Simulation, Mathematics, Education, E-Learning

Introduction

The basic concept of a modelling and simulation course is the right combination of theoretical knowledge and the formulation and implementation of a model. Starting with the theoretical basics the lectures in the course continue with their applications. There are different mathematical methods which should be included in the course. The complexity of these methods depends on the attending students. If the course is part of a curriculum for mathematicians there will be more theoretical parts compared to a course for electrical engineers. Also the application examples will be different.

2. Course Structure

There are different important topics which should be part of a simulation course more or less independent of the students' study. The following list shows the most important subject areas regarding Modelling and Simulation:

- Modelling and Simulation Circle
- Behaviour model
- Differential Equations and State Models
- Physical Modelling
- Discrete State Models
- Cellular Automaton
- Agent based Modelling
- Discrete Event Simulation
- Modelling with Event Graphs
- State Event Modelling

Additionally to the important theoretical lessons regarding the different kind of models the course should also introduce various applications of the different areas. In order to give various examples during the lectures a support system using an E-Learning platform can be helpful. In case of the Vienna University of Technology two different systems are used. For organizing and administration students and lecture materials a Moodle based platform is used. This platform is supported by the university itself. The second environment focuses more of

presentation and testing of different examples. These questions are not only dealing with simulation examples but also with mathematical exercises. Using this tool the mathematical basics can be tested before starting with the application examples. The last important part of a modelling and simulation course is an implementation of a model by the students themselves.

Regarding application one important example can be mentioned. The Lotka Volterra Model, also known as Prey and Predator Model, which describes the dynamics between different populations. It is originally used to formalize the correlation between the population growths of animals where one strain is part of the food chain of the other. This is e very useful model for education. On the one hand the mathematical formulation of this model is a differential equation.

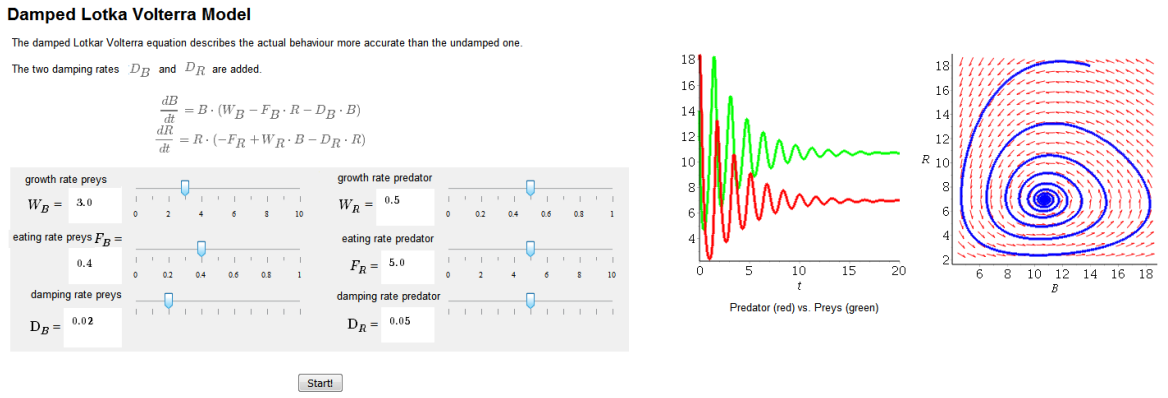

Figure. 2. Lotka Volterra Example in the E-Learning Platform

It is a classic example for mathematical modelling and simulation. Using differential equation leads to the application of different mathematical methods to solve the equations using numerical theory.
The second advantage of this example is that also the applications of this basic model are various. There is as well an economic application. The predators can be seen as workers and the capitalists are the prey. Therefore if the profits are high also the investment is high. The high investment leads to rapid employment growth. But if the employment is low, wages are decreasing and leads to increasing profits.
Different mathematical models can be used for various application which is very useful to impart modelling and simulation.

References

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