Modelling, Simulation & Gaming

Coordinator contact information
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Description
This specialisation provides students with state of the art knowledge in modelling, simulation and gaming. Modelling, simulation and gaming can be used by organisations to enhance their understanding of complex systems in order to improve decision making. This specialisation deals with the design, development and use of (interactive) simulations and serious games.

As a follow on from basic courses on system dynamics modeling and discrete event simulation, this specialisation:
1. deepens students’ knowledge in the area of modelling and simulation
   Advanced courses in both discrete event simulation and system dynamics modelling are part of the specialisation.
2. broadens the spectrum of modelling and simulation methods
   Agent-based modelling is introduced as a new method. An agent-based model is an individual-based model which represents the actions and interactions of autonomous agents to generate the behavior of the system as a whole.
3. introduces the field of serious gaming
   Serious games are games that have another objective than pure entertainment. In TPM, such a game will often represent a multi-stakeholder situation, which allows the system to be studied and participants to learn from it. A simulation game is a type of game that combines serious gaming with simulation modelling. This is one of the types of games which will be addressed.

Job perspectives
Simulation and gaming are used in many of the organisations that are current employers of our graduates (e.g. management consultancies, such as Accenture; companies in the energy sector, such as Enexis; companies in the transport sector, such as KLM or Prorail; Ministries, such as the Ministry of Infrastructure and the Environment; institutes for applied research, such as Deltares and TNO). A number of former students who specialised in modelling, simulation and gaming have set up their own (simulation) consultancy (Initi8, TBA, D3K (merged with Vreeland Groep)).

Courses
1st period
SPM9325 (X/0/0/0) Simulation Masterclass (4 EC)
System Theory, Object oriented simulation and Discrete Event System Specification will be the core topics of the course. After an intensive training in system theory and object oriented modeling and Java programming, the inner working of simulation environments will be illustrated based on the D-SOL simulation environment. Several special topics will be taught, such as distributed and real-time simulation, and component-based simulation. This material will be illustrated in intensive and interactive courses in which the material will partly be prepared and presented by the students. Several other simulation environments will be studied by groups of students. An extensive modeling project in D-SOL will be carried out in groups. This course requires an active participation of the students. After taking this course the student will have knowledge about:
- internal working of different kinds of discrete event simulation languages and environments;
- underlying theories and formalisms of discrete event simulation, such as DEVS and DESS;
- important differences and similarities between simulation environments;
- examples of successful and less successful simulation studies and the learning experiences of those studies;
- object-oriented simulation environments;
- the ability to reuse model parts by developing domain specific building blocks;
- structure and abilities of distributed simulation; the concept of HLA;
- latest research activities in the field of simulation, with research topics like web-based simulation, real-time control using simulation, agent based modelling and simulation in special domains like business process modelling;

After following this course, the student will be able to:
- develop object oriented conceptual models;
- develop object-oriented simulation models;
- develop building block oriented simulation models;
- use different discrete event simulation environments for different kinds of problems.

**SPM9235 Game Design Project (3 EC)**
The Serious Game Design project offers conceptual insights as well as ‘hands on’ experience with serious gaming and simulation-gaming (SG). SG is an established field of practice with proven value for instance in the field of spatial and urban planning, ecology, engineering and design, public administration, business management, learning, research and consultancy. The staggering growth and success of the video gaming industry, has triggered the interest in serious games – video games for learning and policy making - even more. Experienced speakers will give lectures on history, future, design, typology and facilitation of SG. (We will discuss the role of computers and video games, but emphasis is NOT on technology!) We will have ample opportunity to try out a number of (role-playing, board etc.) games that hold powerful messages about decision-making and management. We will challenge you to develop your own simulation-game to support decision-making, learning, training, business, management and change. Besides creativity and enthusiasm, there are no entry requirements. Lectures and workshops will be arranged in a condensed fashion on 10 full days from 9.30 – 16.00. External companies and organizations provide brief problem statements and game requirements, and act as 'clients'. Or students can define their own topic/client. There is a (restricted and conditional) possibility for external participants (from companies, non-profit organizations, other universities) to participate in the course.

After completion of this course the student will have acquired knowledge and insights about:
1. The history, backgrounds, key-concepts, formats and applications of gaming-simulation

After completion of this course the student will be able to:
1. Design a (prototype) of a simulation-game to be used for learning, research or intervention
2. Apply a game design cycle (or design steps)
3. Define, conceptualize and construct the various game components
4. Facilitate simple simulation-games

For more information contact i.s.mayer@tudelft.nl

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**2nd period**

Choose two of the three following:

**SPM9155 Advanced System Dynamics (4 ECTS)**
This advanced course focuses on the theoretical and practical basis for selecting, building, validating, analysing and communicating a systems model and so acquiring knowledge and skills in the practice of System Dynamics. The course comprises the following topics: conceptualisation, use of data, explaining structure-behaviour relationships, validation, communicating, justifying the choice of modelling method, and use of serious gaming and System Dynamics. The theory underpinning these topics will be applied in a number of assignments related to a case which runs in parallel to the lecture series. Guest lectures by experts in the practice of System Dynamics from different organisations form an integral part of the course.

Upon completion of this course the student will have knowledge of:
- the possibilities and limitations of the System Dynamics modelling method
- the relevant scientific literature on selected topics in the field of System Dynamics such as the use of data, model structure and behaviour, model validation, communicating modelling results, System Dynamics and serious gaming, and group model building

The student will have the skills:
- to make an informed choice as to when to use System Dynamics
- to apply the theoretical knowledge on building, validating and communicating models in a problem situation
- to understand current literature and recent advances in the field of System Dynamics

**SPM9555 Agent Based Modeling of Complex Adaptive systems (4 ECTS)**

Our human society consists of many intertwined Large Scale Socio-Technical Systems (LSSTS), such as infrastructures, industrial networks, the financial systems etc. Environmental pressures created by these systems on the earth’s carrying capacity are leading to exhaustion of natural resources, loss of habitats and biodiversity, and are causing a resource and climate crisis. To avoid this sustainability crisis, we urgently need to transform our production and consumption patterns. Given that we, as inhabitants of this planet, are part of a complex and integrated global system where and how should we begin this transformation? And how can we also ensure that our transformation efforts will lead to a sustainable world?

LSSTS and the ecosystems that they are embedded in are known to be Complex Adaptive Systems (CAS). According to John Holland CAS are "...a dynamic network of many agents (which may represent cells, species, individuals, firms, nations) acting in parallel, constantly acting and reacting to what the other agents are doing. The control of a CAS tends to be highly dispersed and decentralized. If there is to be any coherent behavior in the system, it will have to to arise from competition and cooperation among the agents themselves. The overall behavior of the system is the result of a huge number of decisions made every moment" by many individual agents.

Understanding Complex Adaptive Systems requires tools that themselves are complex to create and understand. Shalizi defines Agent Based Modeling as "An agent is a persistent thing which has some state we find worth representing, and which interacts with other agents, mutually modifying each other’s states. The components of an agent-based model are a collection of agents and their states, the rules governing the interactions of the agents and the environment within which they live."

This course will explore the theory of CAS and their main properties. It will also teach you how to, work with Agent Based Models in order to model and understand CAS.

**IN4302 Building Serious Games (5 ECTS)**

This is a project-based interdisciplinary course. The main goal of the project is to take students with varying talents, backgrounds, and perspectives and put them together to do what none of them could do alone: to design and implement a serious game aimed at being applied in a real-world setting (educational, social, training, etc.). The emphasis is both on constructively fulfilling the game requirements, and on deploying the adequate technology for that purpose. Assignments for this course will be provided by real-world end-users (e.g. the Science Centre Delft), to whom the group will be reporting throughout the term of the project.

**Additional Information**

Basic courses in System Dynamics (e.g. spm2313 Systeemdynamica or epa1322 Continuous Systems Modelling) and Discrete Event Simulation (e.g. spm2321 Discrete Modellen or epa1332 Discrete Systems Modelling) are prerequisites for students who wish to participate in this specialisation.