Teaching activities, supervised theses and diploma exams

I supervise(d) 6 bachelor theses, 3 master theses and 3 PhD theses in Biology/Zoology and co-supervise(d) 9 bachelor theses, 4 master theses and 2 PhD theses in Biology/Zoology. I supervise(d) 1 bachelor thesis and 1 master thesis in the study USW (Environmental System Sciences) at the university of Graz. I co-supervise(d) 2 PhD theses in Computer science at the Technical University Graz (TU Graz) and I supervise(d) 3 bachelor theses and 1 master thesis in the study Computational Sciences at the University of Graz. In addition, I supervise(d) 4 bachelor theses and 2 master theses at the University of Applied Sciences St. Pölten. **In total I am/was involved as supervisor in 41 theses.**

Please note that: I was legally allowed to supervise master/PhD theses only at FH St. Pölten before 2012 (when I di my habilitation) and thereafter only at the University of Graz and not at TU Graz. Thus I always needed another professor to co-supervise those theses at those other times/locations. Those facts are indicated in the table as follows: (SU): supervised alone; (CS) Co-supervised with another researcher (bachelor theses) / professor (master & PhD theses)).

Name	Work	Thesis title
Daniel Hofstadler	PhD Thesis in Biology (SU)	Development of a bio-inspired computational model for application in physically embodied bio-hybrid robotic systems and simulation studies (started 04/2015)
Martin Stefanec	Master Thesis in Zoology (SU)	Simple motion laws of self-propelled particles, that lead to emergence of complex life-like structures (started 04/2015)
Michael Bodi	PhD Thesis in Biology/Zoology (SU)	Evolution of robotic behaviour in mixed robot-animal societies (02/2015-now)
Daniela Kengyel	PhD Thesis in Computer Science (TU Graz, CS)	Re-Embodiment of honeybee behaviours in a robot swarm for collective and autonomous search and decision-making tasks. Started 03/2010)
Laura Elsler	Master thesis in USW (Environmental System Science),(SU)	Social-ecological resilience in responding to environmental change (Venice and Venice lagoon) in cooperation with James R. Watson (Stockholm resilience Center) and Sonia Silvestri (Duke University)
Sarah Schönwetter	Master Thesis in Zoology (SU)	Beeinflussung des Vernetzungsgrades in Bienengesellschaften durch reaktive physikalische Reizmuster (07/2014-now)
Stefan Schönwetter-Schistek	Master Thesis in Zoology (SU)	Collective decision making among honey bees triggered by vibration patterns (started 07/2015)
Magdalena Witzmann	Bachelor thesis in USW (Environmental System Sciences, SU)	Modelling „Breaking Bad“ An economic model of drugs and population dynamics to predict how the series itself feeds back into the drug market (01/2015-06/2015)
Joshua Varughese	PhD Thesis in Computer Science (TU Graz, CS)	Investigations of the interplay of behaviour, neurons, emotions and evolution in computer-simulation (to be started in fall 2015)
Martin Stefanec	Bachelor Thesis in Biology (CS)	Untersuchung der Auswirkung des sozialen Gradienten auf den BeeClust Algorithmus (06/2013-02/2014)
Martina Szopek	PhD Thesis in Biology/Zoology (SU)	Untersuchung verschiedener physikalischer Reize im Hinblick auf die Manipulation von Verhaltensmustern bei der Honigbiene (Apis mellifera) (2013-now)
Sibylle Hahshold	PhD thesis in Biology/Zoology (CS)	Aggregation behaviour of honeybees in a temperature gradient (started 2009)

Name	Work	Thesis title
Martina Szopek	Master thesis in Zoology (CS)	Group Size affects Speed and Accuracy in Collective Decision Making in Honeybees (finished 2012)
Michael Bodi	Master thesis in Zoology (CS)	Bio-inspired aggregation and decision-making systems. (finished 2012)
Stefan Schönwetter-Schistek	Bachelor Thesis in Biology (SU)	Reaction of the honey bee to sound and vibration stimuli (started 07/2014)
Wolfgang Friedhuber	Bachelor thesis in Computational Sciences (SU)	Modell eines Evolutionsprozesses in fragmentierten Habitaten mit besonderer Berücksichtigung von Migration (03/2014-09/2014)
Silvia Plaschke	Bachelor Thesis in Biology (CS)	Untersuchung des Temperaturpräferendums von Gruppen junger Honigbienen in der Temperaturorgel (07/2013-05/2014)
Eva Bauer	Bachelor Thesis in Biology (CS)	Evolution of predator-prey systems consisting of interacting Braitenberg-Vehicles (2013-2014)
Tobias Meister	Bachelor Thesis in Biology (CS)	Cooperation of two different swarms controlled by BEECLUST algorithm (01/2013-09/2013)
Renate Ploder	Bachelor Thesis in Biology (CS)	Temperature preferendum of young, single honeybees (Apis mellifera) in a temperature gradient (06/2012-02/2013)
Carmen Fikar	Bachelor Thesis in Biology (SU)	Modellierung eines Bienenstocks (finished 2011)
Jürgen Stradner	Bacheor thesis in Computational Sciences (SU)	Mathematical Modelling in Computational Neuroethology: Comparisons of Information Processing Between Neuronal and Hormonal Control Devices (finished 2010)
Markus Dauschan	Master thesis in Computational Science (SU)	Using virtual embryogenesis to build multi-robot organisms (2011-now)
Markus Dauschan	Bachelor thesis in Computational Sciences (SU)	Development of input/output Routines for a simulation Environment in virtual Embryology (finished 2011)
Marlene Karrrer	Bachelor thesis in Biology (CS)	Exploring the behaviour of young honeybees on natural and on artificial underground materials (finished 2009)
Clio Cirny	2nd Bachelor thesis in Computer Simulation (SU)	Homeostatic regulation of behavior in a robot swarm (finished 2010)
Claudia Radler	Bachelor thesis in Biology (CS)	Spatial distribution of young honeybees in a honeybee colony (finished 2009)
Helmut Haller	Bachelor thesis in Biology (SU)	Antbots: A Feasible Visual Emulation of Pheromone Trails for Swarm Robots (finished 2010)
Martin Luger	2nd Bachelor thesis in Computer Simulation (SU)	Coordination of worker groups into robotic foraging behavior (finished 2010)
Daniela Kengyel	Master thesis in Computer Simulation (SU)	Embodiment of honeybee aggregation behaviour in swarm robots. (finished 2009)
Alexander Luger	1st Bachelor thesis in computer simulation (SU)	Interactions among hormone-controlled robots (finished 2009)
Reihard Wunderer	1st Bachelor thesis in computer simulation (SU)	Artificial Intelligence – Developments and Applications (finished 2009)

Name	Work	Thesis title
Gerald Radspieler	Master thesis in Zoology (CS)	Investigations of the aggregation behavior of young honeybees in a temperature-gradient (started 2007).
Gerald Radspieler	Bachelor thesis in Biology (SU)	Multi-agent honeybee simulation (03/2006-09/2006)
Ronald Thenius	Ph.D. thesis on Biology/Zoology (CS)	Investigations of foraging strategies of honeybees using multi-agent models (2004-2006)
Martina Hergouth	Master thesis in Zoology (CS)	Assessment of parameters governing the self-organization of brood-care in honeybees (2003-2005)
Christoph Möslinger	Master thesis in Computer Simulation (SU)	Strategies for a self-organized robot swarm (2005-2011)
Andreas Zapf	Bachelor thesis in Biology (SU)	Porting a honeybee population model from Mathematica to Vensim (2005)
Thomas Paulitsch	Bachelor thesis in Biology (SU)	Modeling a population model of the small hive beetle. (2006)
Bernd Steinwender	Bachelor thesis in Biology (CS)	Comparison of the activity budgets and of the dominance behaviors in Japanese macaques between the in the mating season and the birth season (females, 2006).
Manuel Martinelli	Bachelor thesis in Biology (CS)	Comparison of the activity budgets and of the dominance behaviors in Japanese macaques between the in the mating season and the birth season (males, 2006).

In addition to that, four bachelor works were performed based on techniques the students adopted from my courses (modeling and computer-based observation techniques), I supervised these students in these aspects.

Student	Work	Thesis title
Christian Mösenbacher	Bachelor thesis in Biology	Observing the behavior of pollen foragers on their returns to the beehive (2004)
Gerald Radspieler	Bachelor thesis in Biology	Modeling the aggregation behavior of honeybees (2006)
Marlene Neuhold	Bachelor thesis in Biology	Observing the aggregation of young honeybees in small groups (2006)
Nicole Krajnc	Bachelor thesis in Biology	Observing the aggregation of young honeybees in large groups (2006)

I was examiner at several diploma exams (“Diplomprüfungen”) at the University of Applied Sciences St. Pölten:

Student	Year	Course of study
Kunz Stephan	2005	Simulation and telecommunication (SIMCOM)
Klinger Nicolaus	2005	Simulation and telecommunication (SIMCOM)
Moser Peter	2009	Computer simulation

Student	Year	Course of study
Winkler Thomas	2009	Computer simulation
Kengyel Daniela	2009	Computer simulation
Christoph Möslinger	2011	Computer simulation

Three master students worked part-time at research projects using techniques, which they learned in my courses and I supervised them also in these works. Nine bachelor students that learned observational techniques in my course had part-time employments in research projects and were partially supervised by myself. These students conducted experimental work (observation of honeybee behavior) and behavioral analysis under my supervision, the work they performed varied between 40 hours and 300 hours.

Student	Status	Project title
Gessl Wolfgang	Bachelor student	Observing trophallactic behavior in a honeybee colony (2005)
Peter Mehlmauer	Bachelor student	Observing trophallactic behavior in a honeybee colony (2005)
Barbara Vospernik	Bachelor student	Observing trophallactic behavior in a honeybee colony (2005)
Anita Diviak	Bachelor student	Observing trophallactic behavior in a honeybee colony (2005)
Manuela Ablasser	Bachelor student	Observing trophallactic behavior in a honeybee colony (2005)
Michaela Maderbacher	Bachelor student	Reactions of a honeybee colony to changing nursing workloads (2004) Adaptations of a honeybee colony to different amounts of brood (2003)
Jutta Vollmann	Master student	Reactions of a honeybee colony to changing nursing workloads (2004) Adaptations of a honeybee colony to different amounts of brood (2003)
Karin Petritsch	Master student	Reactions of a honeybee colony to changing nursing workloads (2004)
Sibylle Hashold	Master student	Reactions of a honeybee colony to changing nursing workloads (2004)
Sarah Weiss	Bachelor student	Reactions of a honeybee colony to changing nursing workloads (2004) Adaptations of a honeybee colony to different amounts of brood (2003)
Nina Mocnik	Bachelor student	Reactions of a honeybee colony to changing nursing workloads (2004) Adaptations of a honeybee colony to different amounts of brood (2003)
Claudia Pribitzer	Bachelor student	Reactions of a honeybee colony to changing nursing workloads (2004) Adaptations of a honeybee colony to different amounts of brood (2003)
Robert Brodschneider	Master student	Adaptations of a honeybee colony to different amounts of brood (2003)

Supervision of Post-Docs in the Artificial Life Lab Graz:

Name	Status	Project title
Payam Zahadat	PostDoc	Project SYMBRION, Project REPLICATOR, project CoCoRo (20011-2014), ASSISIbf (2015), FloraRobotic (2015-now)
Ronald Thenius	PostDoc	Project I-Swarm (2007-2008); Projects SYMBRION and REPLICATOR (2008-2011); Project CoCoRo (since 2011), ASSISIbf (2014-2015), subCULTron(2015-now)
Heiko Hamann	PostDoc	Project SYMBRION, project REPLICATOR (2009-2012)
Jürgen Stradner	PostDoc	Project SYMBRION, project REPLICATOR, project CoCoRo (2008-2014)

Teaching Concepts & Tools

1. Teaching Philosophy and Goals

In all my courses I am very concerned in encouraging the students to actively participate in the pedagogic process. In lectures I try to avoid "frontal teaching" and actively motivate/provoke discussions amongst my students and myself. Especially in lab classes, my concept is that I mentor my students to engage actively in a full cycle of the scientific process: First, they develop their own experiments with tools (laboratory tools, simulation software) that I provide, without a pre-written recipe for the experimental procedure. Then, they first digest a scientific question, derive a testable hypothesis and design their own experimental setups. After conduction of their experiments they analyze and interpret their own results. Finally, they have to present their results and interpretations orally in class or have to produce posters. This way, the students are highly motivated in improving their personal skills and knowledge because they can directly use the learned knowledge in their projects. Normally the level of identification of students with their work is very high in my courses, they often ask me at the end of the courses for possible applications or public presentations of their work. In several cases these works are quite inventive and some of these works have led to bachelor theses, diploma works (master theses, PhD works) and/or presentations at conferences in the past. I use an especially tailored eLearning platform that I installed in my lab to extensively to support my students in their projects with the needed infrastructure for discussions and the sharing of results.

The way I teach can be described as decentralized coaching during the project phase of my courses, combined with many exercises where I follow the paradigm of "blended learning". In order to deliver the basic skills and knowledge to perform these exercises, I use classical "ex-cathedra teaching" at the beginning of my course units, combined with discussions in class and in bulletin boards on the internet afterwards.

Despite delivering biological and mathematical knowledge and skills, I have additional goals in my teaching: I encourage my students to present (and to explain) their current results frequently in class to all other participants and to take part in the discussion rounds. In some cases, I also use short role playing and group games to demonstrate dynamical chemical/physical/biological/social processes. Through these exercises, the students gain self-confidence, conflict management skills, critical faculty and ability to cooperate. As described later in detail in this document, I often teach several modeling approaches to the same problem (top-down vs. bottom-up, discrete vs. continuous, ...). The students are often split in groups and each group uses one of several modeling approaches or parameter sets. After these works are completed, the students compare their results and predictions with published mathematical models of the same topic and with empiric studies with real animals or plants. Based on these comparisons, they discuss the "pros and cons" of their selected approaches. This way I try to encourage the students to stay discerning or even "skeptical" to published mathematical models of biological processes.

At the end of my courses, they improved their skills in cooperating in groups, they learned how to "defend" their own works and they have seen that modeling is an excellent tool for understanding and for investigating biological processes. In addition, they finally have a good overview over the different techniques used in computational biology. What is also important, is that they know how to explain differences between real empiric results and simulation results and that they have learned to interpret the results of several modeling approaches.

2. Qualification and Techniques

I have been teaching biology, modeling and simulation since the year 2000 on university level in a very intensive way. In the last 15 years, I have taught several thousand contact hours. Thus I consider myself to be an experienced teacher of biology, modeling and simulation.

I consider myself to be well qualified and experienced in teaching the following topics: introductory biology, ethology, biology of social animals, conservation biology, sociobiology, entomology, physiology, evolutionary dynamics and speciation, self-organization of biological systems, swarm-intelligence, modeling, simulation, and computer based observation of behavior. I also feel myself well qualified to teach those topics, which directly relate to my focal research topics. These topics include: ecology, evolution, theoretical biology, population biology, origin of life, natural philosophy, artificial life, biostatistics, modeling, artificial intelligence, ethological methods, simulation methods and all flavors of "computerized biology", that are programming languages, CASE tools, model driven software development, databases, data mining, statistical tools, visualization tools, multi-agent simulations, artificial life tools, developing algorithms and optimization.

In my 15 years of academic teaching I developed an extensive set of techniques and tools to support teaching and to allow my students to engage in active learning:

Selfmade multimedia content: Multimedia is an important cornerstone in my teaching. My first profession was photographer, because I financed my studies by working as a professional photographer. Beside that, I educated myself in video filming: In 1994, I was employed at a professional movie production (Austrian Broadcasting Corporation, ORF). In my research, video based observation and video-tracking techniques always played an important role. Also in my courses, I frequently use films for teaching. These films are often compiled by myself from different sources (documentary films, television snippets, ...) to treat several aspects of the focal topic. In addition, I also use self-made video films in my courses, which I have produced in my research activities. My experiences as professional photographer and as advanced scientific video filmmaker allow me to produce high quality and informative films and pictures. Several hours of movies are online for my students, the press and the public at https://www.youtube.com/user/IZGartlife.

eLearning: My students are supplied with a collection of short movies, which illustrate processes described in scientific articles. These movies and the corresponding articles are available for them via my eLearning platform. After studying these materials, the students have to discuss about specific questions in class or via bulletin boards (also part of the eLearning platform). These discussions in the bulletin boards stay consistent on-line throughout the whole duration of the courses and are often revised, commented or extended during the process of a course, whenever new relevant facts are introduced by my teaching. This way the students see an overview of their learning history and are generating an "organic" growing structure of the courses' content by themselves. **I was trained in a set of special courses (WiFi & FH Joanneum (Train-the-Trainer)) to teach students with eLearning tools.**

Specialized websites: In addition, I am trained to produce high quality web sites for remote teaching. During my study time, I frequently created websites for companies. In 2002, I introduced a comprehensive web site that contains a variety of online simulations at http://zool33.uni-graz.at/schmickl/. This website is frequently used in teaching activities, not only by myself, but also by various teachers worldwide. The web site contains interactive simulations that demonstrate self-

organization in biology as well as artificial life topics. The topics are: ant trail formation, honeybee foraging, sorting by ants, building by termites, fish schools, daisyworld (GAIA theory), L-Systems (plant growth), slime mold dynamics and court dynamics of the honeybee queen.

Toolbox of stand-alone teaching tools/programs/simulations: In addition to the Internet, self-programmed stand-alone programs are my favorite tools in the teaching process. I acquired high skills in computer programming during the time I worked as professional software developer at software companies. Additionally, I produced several commercial programs for clients during my study time and produced commercial (shareware) and open-source tools. The abilities I obtained from this professional work are now intensively used in producing simulation programs, which are specially designed for teaching purposes. I use a wide variety of such self-made tools in my courses; these tools are also provided via my eLearning platform.

3. My own education in teaching

I started to educate myself for teaching in 1997, when I attended to several IT-focused and pedagogic courses at the WIFI in Graz, Austria. This institution is specialized to perform "on-the-job" trainings of employees. A special pedagogic training is obligatory to teach at this institution, because teaching adults is different from teaching at schools. I successfully applied to the courses listed below and started to co-teach at the WiFi:

1997	"PC User" and "PC Administrator" (WIFI) [Those certificates were obligatory for being allowed to computer-base teaching at WiFi]
1997	Teacher training "Teaching and learning in on-the-job-trainings" (WIFI, 80 hours course)
1998	"Certificate of Excellence" from Microsoft as "microsoft certified professional" (WIFI).

I applied to several pedagogic courses at the beginning of my teaching career. Most of them were part of the "Train-the-Trainer" program of the University of Applied Sciences Joanneum in Graz, Austria. They focused mainly on the topics: "group collaboration", "eLearning and web based teaching", and "usage of modern media in courses":

Year	Title	Duration
2002	"Global change: cooperative development of a web based course"	3 months
2002	"Potentials of eLearning" (part of the Train-the-Trainer Program).	4 weeks
2003	"Building interactive media with dreamweaver" (part of the Train-the-Trainer Program).	4 weeks
2003	"e-Moderator" (part of the Train-the-Trainer Program).	4 weeks

In 2007 I was part of a multi-disciplinary team of biologists and mathematicians at the ETSU university (USA) to develop a special set of class material (book, online tools, …) to co-educate students of biology and mathematics during the first 2 semesters of their studies.

4. My teaching history

4.1. Tutor experience

I started to get involved into university-level teaching of Biology as a "tutor" in several courses at the Karl-Franzens-University Graz. (SS = summer term (semester), WS = winter term (semester), extent is given in "total contact hours").

Semester	Title	Extent	Students
SS 1998	"Breeding, physiology and social behavior of the honeybee"	30h	20-30
SS 1998	"Animal physiology"	15h	20-30
SS 1999	"Breeding, physiology and social behavior of the honeybee"	30h	20-30
SS 1999	"Animal physiology"	15h	20-30
SS 2000	"Breeding, physiology and social behavior of the honeybee"	30h	20-30
SS 2000	"Animal physiology"	15h	20-30

4.2. Teaching experience

In total I have taught more than 3100 contact hours in the last 15 years in various classes in several subjects: Biology, Ecology, Environmental Systems Science, Simulation Engineering.

4.2.1. Courses in biological modeling for biologists

I started teaching biological topics in 2000 by giving a course about biological modeling. For teaching this course, I was granted a "guest-professorship" for 3 months (see CV) at the Karl-Franzens-University Graz. This course was extended in 2001 from 30 hours to 60 contact hours. I received again a grant as "guest-professor", this time for 6 months. I continued to teach this course until 2006. Since 2004, I have been giving this course twice a year, see table below. I established these courses mentioned above on my own. Since 2003, I have been cooperating in teaching with my colleague M. Hartbauer. (M. Hartbauer teaches 15h per term, I teach 45h per term in this course). The first courses (2000 – 2002) were visited mainly by experienced students at the end of their studies on a voluntary basis. Since 2003, the courses are obligatory for reaching the Bachelor; the students are in their 4th semester. Since 2008, I co-teach this course with Dr. Hartbauer and Dr. Thenius.

Semester	Title	Extent	Students
WS 2000	"Modeling biological systems and analysis of biological data using standard methods" (lab course)	30h	16
WS 2001	"Modeling biological systems and analysis of biological data using standard methods" (lab course)	30h	16
WS 2001	"Modeling and programming for biologists (advanced course)" (lab course)	30h	15
SS 2002	"Modeling for biologists" (lab course)	45h	16
WS2002/03	"Biological modeling" (lab course)	45h	16

Semester	Title	Extent	Students
SS 2004	“Modeling biological systems 1” (lecture)	45h	16
SS 2004	“Modeling biological systems 2” (lab course)	90h	16
SS 2005	“Modeling biological systems 1” (lecture)	45h	16
SS 2005	“Modeling biological systems 2” (lab course)	45h	16
SS 2006	“Modeling biological systems 1” (lecture)	45h	16
SS 2006	“Modeling biological systems 2” (lab course)	45h	16
SS 2008	“Modeling biological systems 1” (lecture)	30h	24
SS 2008	“Modeling biological systems 2” (lab course)	60h	10
SS 2009	“Modeling biological systems 1” (lab course)	30h	12
SS 2009	“Modeling biological systems 2” (lab course)	60h	28
WS 2009/10	“Modeling of ecological systems and evolutionary processes” (lecture)	8h	31
WS 2009/10	“Modeling of ecological systems and evolutionary processes” (lab course)	22h	19
SS 2010	“Modeling biological systems” (lecture)	22h	23
SS 2010	“Modeling biological systems” (lab course)	30h	17
WS 2010/11	“Artificial life and robotics” (lecture)	15h	13
WS 2010/11	“Artificial life and robotics” (lab course)	15h	9
WS 2010/11	Modeling of ecological systems and evolutionary processes” (lecture)	8h	38
WS 2010/11	“Modeling of ecological systems and evolutionary processes” (lab course)	22h	27
SS 2011	“Modeling biological systems” (lecture)	22h	46
SS 2011	“Modeling biological systems” (lab course)	30h	28
WS 2011/12	Modeling of ecological systems and evolutionary processes” (lecture)	15h	41
WS 2011/12	“Modeling of ecological systems and evolutionary processes” (lab course)	45h	33
SS 2012	“Modeling biological systems” (lecture)	22h	40
SS 2012	“Modeling biological systems” (lab course)	30h	32
SS 2013	“Modeling biological systems” (lecture)	22h	33
SS 2013	“Modeling biological systems” (lab course)	30h	24
WS 2013/14	Modeling of ecological systems and evolutionary processes” (lecture)	12h	24
WS 2013/14	“Modeling of ecological systems and evolutionary processes” (lab course)	15h	12
SS 2014	“Modeling biological systems” (lecture)	15h	33
SS 2014	“Modeling biological systems” (lab course)	36h	26
WS 2014/15	“Artificial life and robotics” (lecture)	6h	31
WS 2015/15	“Artificial life and robotics” (lab course)	20h	28
WS 2014/15	“Modeling of ecological systems and evolutionary processes” (lecture)	12h	31
WS 2015/15	“Modeling of ecological systems and evolutionary processes” (lab course)	36h	28
SS 2015	“Modeling biological systems” (lecture)	15h	3ß
SS 2015	“Modeling biological systems” (lab course)	30h	18

4.2.2. Courses in ethological observations and data analysis

In 2003, I started to teach another course that focuses on the methodology of behavioral observation and on the computer-based analysis of such data in a extensive practical course with 2 student groups in parallel. Also this course has been repeated in the following years and I have been giving this course twice a year (22.5 contact hours) until 2006. I gave this course together with my colleague C. Franz; we cooperatively developed this course. This course is voluntary and visited by students at the end of their bachelor (5^{th} to 6^{th} semester). Since 2010, the course is aimed at master students and I teach only 7.5 contact hours per year.

Semester	Title	Extent	Students
WS 2003/04	"Methods in the analysis of social systems in the animal kingdom" (lecture)	15h	18
SS 04	"Methods in the analysis of social systems in the animal kingdom" (lab course)	120h	18
SS 2005	"Methods in the analysis of social systems in the animal kingdom" (lab course)	30h	16
WS 2005/06	"Methods in the analysis of social systems in the animal kingdom" (lab course)	22.5h	12
WS 2006/07	"Methods in the analysis of social systems in the animal kingdom" (lab course)	22.5h	14
WS 2007/08	"Methods in the analysis of social systems in the animal kingdom" (lab course)	22.5h	11
WS 2008/09	"Methods in the analysis of social systems in the animal kingdom" (lab course)	22.5h	11
SS 2010	"Social systems in the animal kingdom" (lecture)	8h	17
SS 2011	"Social systems in the animal kingdom" (lecture)	8h	16
SS 2012	"Social systems in the animal kingdom" (lecture)	8h	8
SS 2013	"Social systems in the animal kingdom" (lecture)	8h	4
SS 2014	"Social systems in the animal kingdom" (lecture)	8h	4
SS 2015	"Social systems in the animal kingdom" (lecture)	8h	7

4.2.3. Courses in biological modeling for non-biologists

In 2003, I started to teach in a second department at the Karl-Franzens-University Graz, in a course of studies called "Sciences of Environmental Systems". The first course I gave there was an interdisciplinary course in cooperation with several other departments and universities (mathematics, economics, technical departments). This course was named "Global change" and I taught topics of ecological modeling. In that year, I started two other courses at this department, called "Modeling Self-Organization of Biological Systems" and "Modeling the Environment and the Effects of Civilization". Both courses were continued until 2012 and held once a year. I developed both courses by myself and receive an enormous resonance to these courses: Students are usually advanced (between the 6^{th} and the 10^{th} semester in this course of studies). In 2012 the courses were renamed to "system modeling".

Semester	Title	Extent	Students
WS 2003/04	"Global change"	15h	12
WS 2003/04	"Modeling the environment and the effects of civilization" (lab course)	30h	16
WS 2003/04	"Self-organization in biological systems" (lab course)	30h	16
WS 2004/05	"Modeling the environment and the effects of civilization" (lab course)	30h	16
WS 2004/05	"Self-organization in biological systems" (lab course)	30h	16

Semester	Title	Extent	Students
WS 2005/06	"Modeling the environment and the effects of civilization" (lab course)	30h	16
WS 2005/06	"Self-organization in biological systems" (lab course)	30h	16
WS 2006/07	"Modeling the environment and the effects of civilization" (lab course)	30h	16
WS 2006/07	"Self-organization in biological systems" (lab course)	30h	16
WS 2007/08	"Modeling the environment and the effects of civilization" (lab course)	30h	25
WS 2007/08	"Self-organization in biological systems" (lab course)	30h	12
WS 2008/09	"Modeling the environment and the effects of civilization" (lab course)	30h	25
WS 2008/09	"Self-organization in biological systems" (lab course)	30h	12
WS 2009/10	"Modeling the environment and the effects of civilization" (lab course)	30h	25
WS 2009/10	"Self-organization in biological systems" (lab course)	30h	12
WS 2010/11	"Modeling the environment and the effects of civilization" (lab course)	30h	21
WS 2010/11	"Self-organization in biological systems" (lab course)	30h	14
WS 2011/12	"Seminar for Modelling of systems: Modeling the environment and the effects of civilization" (lab course)	30h	15
SS 2012	"Seminar for Modelling of systems: Self-organization in biological systems" (lab course)	30h	16
SS 2013	"Seminar for Modelling of systems: Self-organization in biological systems" (lab course)	30h	14
WS 2013/14	"Seminar for Modelling of systems: Modeling the environment and the effects of civilization" (lab course)	30h	12
SS 2014	"Seminar for Modelling of systems: Self-organization in biological systems" (lab course)	30h	8
WS 2014/15	"Seminar for Modelling of systems: Modeling the environment and the effects of civilization" (lab course)	30h	11
SS 2015	"Seminar for Modelling of systems: Self-organization in biological systems" (lab course)	30h	12

4.2.4. Courses in modeling and simulation for simulation engineers

In 2003, I started to teach at the University of Applied Sciences St. Pölten, Austria. I teach there in a course of study called "SimCom", an abbreviation for "Computational Simulation". The main focus of these courses is on the technical aspects of simulation. I have been teaching these courses up to 2013, the courses vary between 2 and 8 hours per week per semester. I developed these courses on my own; the courses are obligatory for students on the master level. The students are between the 3rd and the 7th semester.

Semester	Title	Extent	Students
WS 2002	Simulation Ia (lab course)	15h	16
WS 2002/03	Simulation Ib (lab course)	15h	16
SS 2003	Simulation IIa (lab course)	30h	16
SS 2003	Simulation IIb (lab course)	30h	16
WS 2003/04	Simulation I (lab course)	45h	15
WS 2003/04	Simulation IIIa (lab course)	22.5h	16

WS 2003/04	Simulation IIIb (lab course)	22.5h	16
SS 2004	Simulation II (lab course)	15h	15
SS 2004	Simulation IVa (lab course)	30h	16
SS 2004	Simulation IVb (lab course)	30h	16
WS 2004/05	Simulation I (lab course)	30h	12
WS 2004/05	Simulation III (lab course)	30h	15
SS 2005	Simulation II (lab course)	30h	10
SS 2005	Simulation IV (lab course)	30h	15
WS 2005/06	Selected chapters in simulation I (lab course)	30h	10
WS 2005/06	Selected chapters in simulation II (lab course)	15h	10
SS 2006	Simulation II + IV (lab course)	30h	12
SS 2006	Selected chapters in simulation III (lab course)	30h	8
WS 2007/08	Selected chapters in simulation I (lab course)	30h	8
WS 2007/08	Selected chapters in simulation II (lab course)	15h	8
SS 2008	Selected chapters in simulation III (lab course)	30h	8
SS 2008	Selected chapters in simulation IV (lab course)	15h	8
WS 2008/09	Multiagent simulations I (lecture)	15h	10
WS 2008/09	Multiagent simulations II (lab course)	30h	10
SS 2009	Selected chapters in simulation I	30h	10
WS 2009/10	Multiagent simulations I (lecture)	15h	9
WS 2009/10	Multiagent simulations II (lab course)	30h	9
WS 2011/12	Multiagent simulations (lab course)	30h	8
WS 2012/13	Multiagenten simulations (lab course)	30h	9

4.3. Other classes (for PhD and master students in Zoology/Biology)

Semester	Title	Extent	Students
WS 2013/14	Tutorial for the Master's Thesis	30h	1
WS 2013/14	Seminar for the Postgraduates/Evolution III	4h	11
SS 2014	Tutorial for the Master's Thesis	30h	1
SS 2014	Seminar for the Postgraduates/Evolution IV	4h	2
WS 2014/15	Tutorial for the Master's Thesis	30h	1
WS 2014/15	Seminar for the Postgraduates/Evolution III	4h	5
SS 2015	Tutorial for the Master's Thesis	30h	1
SS 2015	Seminar for the Postgraduates/Evolution IV	4h	3

4.4. Other activities in university education

December 2006 to December 2013, I was part of the curriculum commission of the course of study "Computational Sciences" at the Karl-Franzens-University Graz.

4.5. Other teaching involvements

Teaching material that was developed by myself was used in the following courses:

- "Topics in Ecology and Evolution Dynamic Systems in Biology" (BIOL 4910-004/5300-002 and CSCI 4957/5957-003), 3 credits, fall semester 2012.
- "Artificial Life and Swarm Intelligence" (BIOL 4910-002/BIOL5910-002 or CSCI 4957/5947-004), 4 credits, fall semester 2012, co-teaching with Dr. I. Karsai.
- BIOL 1810 "Integrative Biology and Calculus" (IBMS 1200) Spring 2008. Teacher: Dr. Istvan Karsai. East Tennessee State University, Johnson City, Tennessee, USA.

4.6. Other teaching experiences

- Guest teaching at the Seminar for the Institute for Quantitative Biology (IQB). 24th of October 2012. ETSU, USA. Invitation by Dr. Debra Knisley.
- Teacher & students discussion: Round table on collective cognition and swarm intelligence", 16th of November 2012, ETSU, USA. Invitation by Dr. Debra Knisley
- Guest teaching at the class "Great Ideas in Science". 29th of November 2012. ETSU, USA. Invitation by Dr. D.W. Harker and Dr. F.B. Hagelberg
- Guest teaching in the class "Modern drama" on swarm robots in theatre plays. 19h of November 2012. ETSU, USA. Invitation by Dr. K. Weiss.
- Guest lecturing "Ecology of Predator-Prey systems" and "Evolution of Predator-Prey systems" in the course "Complex Biological Systems" (BIOL-4017/5017 for biology and math undergraduate and graduate student; January 2007)
- Guest lecturing "Ecology of Predator-Prey systems" in the course "Introduction to Quantitative Biology" (MATH/BIOL 2190; August 2007).
- EURON conference (February 16th-18th 2005) in Warsaw, Poland: February 17th, 2005: I gave an "Introduction into biological swarms and self-organization" at the "I-SWARM"-workshop.
- Karl-Franzens-University Graz, Austria: May 7th, 2004: Conducting a workshop "Modeling of biological swarms" (5 hours). Participants: Scientists from the following universities: Stuttgart (D), Karlsruhe (D), St. Ingbert (D), Lausanne (CH), Sheffield (UK), Kanpur (India) and Pisa (I).

5. Public media

It was always very important for me that my students see the relevance of our science in the "real world", not only within the scientific context. This is one reason why I always presented my work in several popular science media. In addition I always encouraged students to take part in conferences and to show their work at several occasions to the public at the university. In return, several news overages (articles in newspapers, radio features, TV features) have been produced about my work in recent years, what in turn motivated my students.