COURSE DESCRIPTION CARD - SYLLABUS

Course name
Game Theory with Elements of Sociobiology [S1Bioinf1>TGIER]

Course

Field of study
Bioinformatics

Year/Semester
4/7

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
15

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

2,00

Coordinators

mgr Mateusz Twardawa
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Lecturers

Prerequisites

Student has basic skills in modeling biological processes and know crucial concepts related to genetics and evolutionary processes.

Course objective

The main course objective is to introduce students to social interaction modeling in biology with game theory. Students will gain practical skills that will allow them to create basic game models and ability to apply those models to study biological processes.

Course-related learning outcomes

Knowledge:
1. Student has basic knowledge on sociobiology, sexual selection and behavior ecology, simultaneously being familiar with game theory models related to those processes, which he (or she) is able to use in order to gain better insight and understanding of biological processes.
2. Student knows evolutionary mechanisms and models related to different aspects of animal social behavior.
3. Student possess basic knowledge on game theory approach in biological process modeling.

Skills:
1. Student is capable of selecting proper game theory model that is the best to represent biological process (in the scope covered by this course).
2. Student is able to implement game theory model under supervision of teacher in order to solve biological problem, perform simulations and interpret obtained results.
3. Student interconnects relations between mathematical modeling and sociobiology and behavior ecology. Student can postulate biological hypotheses and draw conclusions based on simulation results.

Social competences:
1. Student will be obligated to prepare in pairs and present to the group developed game model and discuss topics related to game theory and sociobiology.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

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Knowledge accumulated during lectures will be verified based on test.
Students work will be scored on laboratories based on their preparation and activity. In order to pass the course students shall develop and implement game model of biological process in pairs.

Programme content

Lectures on Game theory with elements of sociobiology will be divided into 7 parts.
First part of lectures will introduce students to game theory modeling and sociobiology.
Second part of lectures will cover static games. During this part key concepts in game theory will be presented such as dominant strategy, Nash equilibrium, evolutionary stable strategy, Pareto optimality, payoff matrix and mixed strategies. In this part chosen simple games will be discussed including prisoner's dilemma, games with multiple strategies and cyclic dynamics.
Third part will focus on iterative and spatial games. This part will cover methods for game simulation and analysis in 2D space, including some aspects of cellular automata. Moreover, Axelrod's tournaments along with tit for tat and other more advanced strategies will be presented.
Forth part of lectures will be concentrated on games with elements of uncertainty, opponent assessment and learning. This part will cover assessor strategies, cheaters, multistage games and Bayesian games. This part will also cover war of attrition.
Fifth part of lectures will be focused on evolutionary games. This part will cover game models that are based on differential equations, frequency based strategy selection, replicator equation and dynamics, Morgan process, evolutionary graph theory and graph based games.
Sixth part of lectures will cover sociobiological aspects that can be modeled with game theory. During this part following concepts will be presented: types of social interactions (altruism, egoism, collaboration, malice), aggression and reciprocal altruism. Crucial aspects of group and kin selection will be presented along with kinship analysis and Hamilton's inequality. Moreover, this part will also focus on evolutionary mechanism involved in evolution of cooperation, eusociality and parental care.
Last part of lectures will focus on sexual selection. During this part mechanisms and processes related to sexual dimorphism evolution, alternative mating tactics, male-male competition, monogamy and polygamy will be presented. In scope of this part most important hypotheses in sexual selection will be discussed such as good genes hypothesis, sexy sons hypothesis, "handicap" principle and sensory bias. Elements of animal communication will be also presented in this part.
Laboratory classes will focus on developing practical skills in game theory modeling. Students will practice material covered on lectures by implementing, simulating and analyzing chosen games. Students shall discuss topics related to this course and solve given biological problems. In order to pass this course students will team up in pairs and implement game theory model for sociobiological problem chosen by themselves.

Course topics

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Teaching methods

1. Lecture – multimedia presentation with examples presented on blackboard.
2. Laboratory classes – implementation of game models, discussion on topics related to material covered on lectures, case study of chosen examples, preparing and presenting developed game model in pairs (project).

Bibliography

Basic
John Maynard Smith, Evolution and the Theory of Games, Cambridge University Press, 1982
Krebs, J.R., Davies, N.B. Wprowadzenie do ekologii behawioralnej, PWN, 2014
Stephen Schecter, Herbert Gintis, Game Theory in Action - An Introduction to Classical and Evolutionary Models, Princeton University Press ,2016
Additional
Wilson, E.O. Socjobiologia, Wydawnictwo Zysk i S-ka, 2001
Trivers R., Social Evolution, Benjamin/Cummings, Menlo, CA, 1985
Thomas L. Vincent, Joel S. Brown, Evolutionary Game Theory, Natural Selection, and Darwinian Dynamics, Cambridge University Press, 2005
Łomnicki A., Ekologia Ewolucyjna, PWN, Warszawa, 2012
Dawkins, R. Samolubny gen, Prószyński i S-ka, 1996
Wilson, E.O. O naturze ludzkiej, Wydawnictwo Zysk i S-ka, 1998
Lorenz K., Tak zwane zło, PIW, 1996
Ridley, Matt O pochodzeniu cnoty, Rebis, 2000

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	20	1,00