Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Evolucijska teorija iger
Course title:	Evolutionary game theory

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Fizika 2. st.		**1**	**2**
Physics 2nd degree		**1**	**2**

Vrsta predmeta / Course type	izbirni / optional
Univerzitetna koda predmeta / University course code:	

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
15		**30**			**105**	**5**

Nosilec predmeta / Lecturer:	Matjaž Perc

Jeziki / Languages:	**Predavanja / Lectures:**	**slovenski/Slovene**
	Vaje / Tutorial:	**slovenski/Slovene**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Osnove teorije verjetnosti, teorije dinamičnih sistemov in programiranja v poljubnem jeziku.	Basic knowledge of probability theory, dynamical system's theory, and programming skills in an arbitrary language.

Vsebina:

1. Igre z in brez strategije kooperacije. 2. »Payoff« matrike pri dveh igralcih. 3. Primeri iger: npr. boj med spoloma, dilema zapornika, igra sokola in goloba. 4. Posplošitev na igre z več igralci, igre v prostoru.5. Tragedija in propad družbe.6. Aplikacije teorije iger v biologiji, npr. igra sokola in goloba v populacijskih sistemih, dilema zapornika v metaboličnih sistemih. 7. Aplikacije teorije iger v ekonomiji. 8. Evolucija kooperacije.

Content (Syllabus outline):

1. Cooperative and non-cooperative games. 2. Payoff matrix for two players. 3. Examples of games, e.g., prisoner's dilemma, hawk-dove game. 4.Generalization to n players and to spatial problems.5. Tragedy of the commons.6. Applications of the game theory in biology, e.g., hawk-dove game in population systems, prisoner's dilemma in metabolic systems. 7. Applications of the game theory in the economy. 8. Evolution of the cooperativity.

Temeljni literatura in viri / Readings:

·Hofbauer, J. and Sigmund, K. (1998). Evolutionary Games and Population Dynamics. Cambridge University Press, Cambridge.
·Axelrod, R. (1984) The Evolution of Cooperation. Basic Books, New York.
·Pfeiffer, T. and Schuster, S. (2005) Game-theoretical approaches to studying the evolution of biochemical systems. Trends Biochem. Sci. 30, 20-25.
·Hauert, C. and Szabo, G. (2005) Game theory and physics. Am. J. Phys. 73, 405-414.
·Drugi strokovni in znanstveni članki v revijah / Articles published in professional and scientific journals.

Cilji in kompetence:

·Razvijati sposobnosti za kvalitativno in kvantitativno analizo kompleksnih sistemov. ·Predstaviti zvezo med strukturo, dinamiko in evolucijo kompleksnih sistemov. ·Poudariti pomen evolucijskih mehanizmov za razvoj dinamike in strukture sistemov. ·Uporaba računalniških programov za simulacijo iger.

Objectives and competences:

·Developing skills for qualitative and quantitative analysis of complex systems.·Presenting interconnections between the structure, dynamics and the evolution of complex systems.·Pointing out the importance of evolutionary mechanisms for developing the system’s dynamics and its structure. ·Using computer programs for game simulations.

Predvideni študijski rezultati:

Znanje in razumevanje: Poznati metode za kvalitativno in kvantitativno analizo kompleksnih sistemov. ·Predstaviti zvezo med strukturo, dinamiko in evolucijo kompleksnih sistemov. ·Poudariti pomen evolucijskih mehanizmov za razvoj dinamike in strukture sistemov. ·Uporaba računalniških programov za implementacijo iger.

Prenesljive/ključne spretnosti in drugi atributi:·Metode kvantitativne analize kompleksnih sistemov so univerzalne in jih je mogoče uporabiti na najrazličnejših področjih. ·Poudarek je na prenosu znanja s primerov iz

Intended learning outcomes:

Knowledge and understanding: Knowledge and Understanding:·Be able to use methods for qualitative and quantitative analysis of complex systems.·Be able to realize interconnections between the structure, dynamics and the evolution of complex systems.·Know the importance of evolutionary mechanisms for developing the system’s dynamics and its structure. ·Using computer programs for the implementation of games.

Transferable/Key Skills and other attributes:·Methods for quantitative analysis of complex system are universal and can be

fizike na področja biologije, ekonomije.	implemented in different fields of research. ·In particular, a knowledge transfer from examples in physics to examples in biology, economics, etc. is emphasised.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in individualno raziskovalno delo.	Lectures and individual research work.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt) ustni izpit 80% seminar 20%		Type (examination, oral, coursework, project): oral exam 80% seminar 20%

Reference nosilca / Lecturer's references:

- Defense mechanisms of empathetic players in the spatial ultimatum game, Attila Szolnoki, Matjaž Perc and György Szabó, Phys. Rev. Lett. 109, 078701 (2012)
- Impact of generalized benefit functions on the evolution of cooperation in spatial public goods games with continuous strategies, Xiaojie Chen, Attila Szolnoki, Matjaž Perc and Long Wang, Phys. Rev. E 85, 066133 (2012)
- Adaptive and bounded investment returns promote cooperation in spatial public goods games, Xiaojie Chen, Yongkui Liu, Yonghui Zhou, Long Wang and Matjaž Perc, PLoS ONE 7, e36895 (2012)
- Self-organization of punishment in structured populations, Matjaž Perc and Attila Szolnoki, New J. Phys. 14, 043013 (2012)
- If players are sparse social dilemmas are too: Importance of percolation for evolution of cooperation, Zhen Wang, Attila Szolnoki and Matjaž Perc, Scientific Reports 2, 369 (2012)
- Different reactions to adverse neighborhoods in games of cooperation, Chunyan Zhang, Jianlei Zhang, Franz J. Weissing, Matjaž Perc, Guangming Xie and Long Wang, PLoS ONE 7, e35183 (2012)
- Percolation threshold determines the optimal population density for public cooperation, Zhen Wang, Attila Szolnoki and Matjaž Perc, Phys. Rev. E 85, 037101 (2012)

- Sustainable institutionalized punishment requires elimination of second-order free-riders, Matjaž Perc, Scientific Reports 2, 344 (2012)
- Conditional strategies and the evolution of cooperation in spatial public goods games, Attila Szolnoki and Matjaž Perc, Phys. Rev. E 85, 026104 (2012)
- Evolution of public cooperation on interdependent networks: The impact of biased utility functions, Zhen Wang, Attila Szolnoki and Matjaž Perc, EPL 97, 48001 (2012)
- Win-stay-lose-learn promotes cooperation in the spatial prisoner's dilemma game, Yongkui Liu, Xiaojie Chen, Lin Zhang, Long Wang and Matjaž Perc, PLoS ONE 7, e30689 (2012)
- Does strong heterogeneity promote cooperation by group interactions?, Matjaž Perc, New J. Phys. 13, 123027 (2011)
- Evolution of interactions and cooperation in the spatial prisoner's dilemma game, Chunyan Zhang, Jianlei Zhang, Guangming Xie, Long Wang and Matjaž Perc, PLoS ONE 6, e26724 (2011)
- Group-size effects on the evolution of cooperation in the spatial public goods game, Attila Szolnoki and Matjaž Perc, Phys. Rev. E 84, 047102 (2011)
- Success-driven distribution of public goods promotes cooperation but preserves defection, Matjaž Perc, Phys. Rev. E 84, 037102 (2011)
- Imitating emotions instead of strategies in spatial games elevates social welfare, Attila Szolnoki, Neng-Gang Xie, Chao Wang and Matjaž Perc, EPL 96, 38002 (2011)
- Effects of competition on pattern formation in the rock-paper-scissors game, Luo-Luo Jiang, Tao Zhou, Matjaž Perc and Bing-Hong Wang, Phys. Rev. E 84, 021912 (2011)
- Resolution of the stochastic strategy spatial prisoner's dilemma by means of particle swarm optimization, Jianlei Zhang, Chunyan Zhang, Tianguang Chu and Matjaž Perc, PLoS ONE 6, e21787 (2011)
- Evolutionary games on visibility graphs, Aleksandra Murks and Matjaž Perc, Adv. Complex Syst. 14, 307-315 (2011)
- Coveting thy neighbors fitness as a means to resolve social dilemmas, Zhen Wang, Aleksandra Murks, Wen-Bo Du, Zhi-Hai Rong and Matjaž Perc, J. Theor. Biol. 277, 19-26 (2011)
- Phase diagrams for the spatial public goods game with pool punishment, Attila Szolnoki, György Szabó and Matjaž Perc, Phys. Rev. E 83, 036101 (2011)
- Impact of link deletions on public cooperation in scale-free networks, Luo-Luo Jiang, Matjaž Perc, Wen-Xu Wang, Ying-Cheng Lai and Bing-Hong Wang, EPL 93, 40001 (2011)
- Heterogeneous aspirations promote cooperation in the prisoner's dilemma game, Matjaž Perc and Zhen Wang, PLoS ONE 5, e15117 (2010)
- Reward and cooperation in the spatial public goods game, Attila Szolnoki and Matjaž Perc, EPL 92, 38003 (2010)
- Aspiring to the fittest and promotion of cooperation in the prisoner's dilemma game, Zhen Wang and Matjaž Perc, Phys. Rev. E 82, 021115 (2010)
- Punish, but not too hard: How costly punishment spreads in the spatial public goods game, Dirk Helbing, Attila Szolnoki, Matjaž Perc and György Szabó, New J. Phys. 12, 083005 (2010)
- Defector-accelerated cooperativeness and punishment in public goods games with mutations, Dirk Helbing, Attila Szolnoki, Matjaž Perc and György Szabó, Phys. Rev. E 81, 057104 (2010)

- Impact of critical mass on the evolution of cooperation in spatial public goods games, Attila Szolnoki and Matjaž Perc, Phys. Rev. E 81, 057101 (2010)
- Evolutionary establishment of moral and double moral standards through spatial interactions, Dirk Helbing, Attila Szolnoki, Matjaž Perc and György Szabó, PLoS Comput. Biol. 6, e1000758 (2010)
- Sustainability of culture-driven population dynamics, Stefano Ghirlanda, Magnus Enquist and Matjaž Perc, Theor. Popul. Biol. 77, 181-188 (2010)
- Coevolutionary games - A mini review, Matjaž Perc and Attila Szolnoki, BioSystems 99, 109-125 (2010)
- Topology-independent impact of noise on cooperation in spatial public goods games, Attila Szolnoki, Matjaž Perc and György Szabó, Phys. Rev. E 80, 056109 (2009)
- Phase diagrams for three-strategy evolutionary prisoner's dilemma games on regular graphs, Attila Szolnoki, Matjaž Perc and György Szabó, Phys. Rev. E 80, 056104 (2009)
- Emergence of target waves in paced populations of cyclically competing species, Luo-Luo Jiang, Tao Zhou, Matjaž Perc, Xin Huang and Bing-Hong Wang, New J. Phys. 11, 103001 (2009)
- Emergence of multilevel selection in the prisoner's dilemma game on coevolving random networks, Attila Szolnoki and Matjaž Perc, New J. Phys. 11, 093033 (2009)
- Impact of aging on the evolution of cooperation in the spatial prisoner's dilemma game, Attila Szolnoki, Matjaž Perc, György Szabó and Hans-Ulrich Stark, Phys. Rev. E 80, 021901 (2009)
- Resolving social dilemmas on evolving random networks, Attila Szolnoki and Matjaž Perc, EPL 86, 30007 (2009)
- Evolution of cooperation on scale-free networks subject to error and attack, Matjaž Perc, New J. Phys. 11, 033027 (2009)
- Promoting cooperation in social dilemmas via simple coevolutionary rules, Attila Szolnoki and Matjaž Perc, Eur. Phys. J. B 67, 337-344 (2009)
- Making new connections towards cooperation in the prisoner's dilemma game, Attila Szolnoki, Matjaž Perc and Zsuzsa Danku, EPL 84, 50007 (2008)
- Restricted connections among distinguished players support cooperation, Matjaž Perc, Attila Szolnoki and György Szabó, Phys. Rev. E 78, 066101 (2008)
- Chaos between stochasticity and periodicity in the prisoner's dilemma game, Marko Gosak, Marko Marhl and Matjaž Perc, Int. J. Bifurcat. Chaos 18, 869-875 (2008)
- Coevolution of teaching activity promotes cooperation, Attila Szolnoki and Matjaž Perc, New J. Phys. 10, 043036 (2008)
- Diversity of reproduction rate supports cooperation in the prisoner's dilemma game on complex networks, Attila Szolnoki, Matjaž Perc and György Szabó, Eur. Phys. J. B 61, 505-509 (2008)
- Towards effective payoffs in the prisoner's dilemma game on scale-free networks, Attila Szolnoki, Matjaž Perc and Zsuzsa Danku, Physica A 387, 2075-2082 (2008)
- Social diversity and promotion of cooperation in the spatial prisoner's dilemma game, Matjaž Perc and Attila Szolnoki, Phys. Rev. E 77, 011904 (2008)