

1.	Course	<i>Learning with structured data</i>		
2.	Code	KNI_E31		
3.	Study programme	Computer Science and Engineering PhD study programme		
4.	Study programme organized by	FCSE		
5.	Cycle	Third – PhD		
6.	Academic year / semester winter/summer/elective	7. ECTS credits 7,5		
8.	Teacher	Prof. d-r Ivica Dimitrovski, Prof. d-r Gjorgji Madzarov		
9.	Prerequisites	None		
10.	<p>Course programme goals (competences):</p> <p>The students will have an in depth understanding of the machine learning techniques used on structured data (input and output). They will be able to successfully apply machine learning algorithms when solving real problems concerned with computational biology, multimedia systems and social networks. They will be able to concept, analyze, realize and evaluate the developed machine learning system performances.</p>			
11.	<p>Course syllabus:</p> <p>Evaluating similarity using kernel, discriminating models, structure modeling using graphical models, connected kernel maps, state vector machines for connected and structured output spaces, efficient max-margin structural classification algorithms, discriminative suffix trees learning for predictions using the perceptron algorithm, search optimization learning, energy based models, generalized limit and structural tagging consistency, Hilbert space, Baes approach to structural models, structural output density measurements.</p> <p>Algorithm application for problems concerned with microorganism characteristics (e.g. temperature resistance, need for oxygen), and phenotype prediction multimedia applications, social media aggregators.</p>			
12.	<p>Teaching methods:</p> <p>Classes supported with slide presentations, interactive teaching, lab equipment and other software packages, teamwork, case studies, invited guest lecturers, presentations of project works, e-learning materials, forums and consultations.</p>			
13.	Total fund of work hours	7,5 EKTC x 30 h = 225 h		
14.	Available hours distribution	45+30+150 = 225		
15.	Teaching activities	15.1.	Theoretical classes	45 h
		15.2.	Practical classes (labs, exercises), seminars, team work	30 h
16.	Other activities	16.1.	Project tasks	50 h
		16.2.	Self study	50 h
		16.3.	Homework	50 h
17.	Grading			
	17.1.	Tests		40 points
	17.2.	Seminar work/ project (presentation: written and oral)		50 points
	17.3.	Active participation		10 points

18.	Grading criteria (points/grade)	to 59 points	5 (five) (F)		
		from 60 to 68 points	6 (six) (E)		
		from 69 to 76 points	7 (seven) (D)		
		from 77 to 84 points	8 (eight) (C)		
		from 85 to 92 points	9 (nine) (B)		
19.	Conditions for attending the final exam	Successful completion of activities 15.1 and 15.2			
20.	Language	Macedonian or English			
21.	Quality assessment	Internal evaluation and student pools			
22.	Literature				
	22.1.	Compulsory			
		No.	Author	Title	Publisher
		1.	Gokhan Bakır, Thomas Hofmann, Bernhard Schölkopf, Alexander J. Smola, Ben Taskar, S.V. N. Vishwanathan	Predicting Structured Data	MIT Press
		2.	Christopher M. Bishop	Pattern Recognition and Machine Learning	Springer
	3.				
	22.2.	Additional			
		No.	Author	Title	Publisher
		1.			
		2.			
3.					