جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Combinatorial Machine Learning - CS 361

Division	Computer, Electrical and Mathematical Sciences & Engineering
Course Number	CS 361
Course Title	Combinatorial Machine Learning
Academic Semester	Spring
Academic Year	2018/2019
Semester Start Date	01/27/2019
Semester End Date	05/23/2019
Class Schedule (Days & Time)	01:00 PM - 02:30 PM | Mon Thu

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Mikhail Moshkov	mikhail.moshkov@kaust.edu.sa	+966128080334	4108, 1, Al-Khawarizmi (bldg. 1)	Tuesday, 03:30 PM - 05:00 PM

Teaching Assistant(s)

Name	Email

Course Information

Comprehensive Course Description	The main difference between Combinatorial Machine Learning (CML) and Machine Learning (ML) is the following: usual ML is based of probability theory and mathematical statistics, and is oriented mainly on prediction problem, but in CML we concentrate on the study of classifiers as combinatorial objects, and we consider classifiers not only as predictors but also as algorithms and as a way for knowledge representation. The course covers tools for design and analysis of decision trees, decision rules and tests, their applications to supervised machine learning, and related topics including current results of research. The main contents are: introduction (basic notions and examples from applications); tools (relationships among decision trees, rules and tests; bounds on complexity of tests, decision rules and trees; algorithms for construction of tests, decision rules and trees); applications (supervised machine learning); some of the additional topics (decision tables with many-valued decisions; approximate decision trees, rules and tests; global and local approaches to the study of problems over infinite sets of attributes; applications to combinatorial optimization, fault diagnosis, pattern recognition, analysis of acyclic programs, data mining, and knowledge representation); current results of research.
Course Description from Program Guide	The course covers tools for design and analysis of decision trees, decision rules and tests, their applications to supervised machine learning, and related topics including current results of research. The main contents are: introduction (basic notions and examples from applications); tools (relationships among decision trees, rules and tests, bounds on complexity of tests, decision rules and trees, algorithms for construction of tests, decision rules and trees); applications (supervised machine learning); some of the additional topics (decision tables with many-valued decisions, approximate decision trees, rules and tests, global and local approaches to the study of problems over infinite sets of attributes, applications to combinatorial optimization, fault diagnosis, pattern recognition, analysis of acyclic programs, data mining and knowledge representation); current results of research.
Goals and Objectives	Understanding of relationships among decision trees, rules and tests, possibilitiy to use bounds on complexity and algorithms for construction of tests, decision rules and trees, acquaintance with software system Dagger.

Required Knowledge	-Basic knowledge in discrete mathematics -Course CS 260 “Design and Analysis of Algorithms” -Course CS 220 "Data Analytics"
Reference Texts	**Textbook:** Moshkov M., Zielosko B., Combinatorial Machine Learning: A Rough Set Approach. Studies in Computational Intelligence, Vol. 360, Springer, 2011 This textbook can be download at http://www.springerlink.com/content/978-3-642-20994-9#section=924878&page=1
Method of evaluation	**36.00**% - Others - Please specify **31.00**% - Midterm exam **33.00**% - Homework /Assignments
Nature of the assignments	Course work will consist of three homework assignments (33%), midterm exam (31%) and four laboratory works (36%).
Course Policies	Homework and laboratory works should be done individually not in groups.
Additional Information	

Tentative Course Schedule

(Time, topic/emphasis & resources)

Week	Lectures	Topic
1	Mon 01/28/2019 Thu 01/31/2019	**Introduction:** Main notions and examples from applications
2	Mon 02/04/2019 Thu 02/07/2019	**Introduction:** Main notions and examples from applications; **LW1:** Preparation of data for Dagger
3	Mon 02/11/2019 Thu 02/14/2019	**Tools:** Relationships among decision trees, rules and tests
4	Mon 02/18/2019 Thu 02/21/2019	**Tools:** Relationships among decision trees, rules and tests; **LW2:** Optimization of decision trees
5	Mon 02/25/2019 Thu 02/28/2019	**Tools:** Relationships among decision trees, rules and tests
6	Mon 03/04/2019 Thu 03/07/2019	**Tools:** Bounds on complexity of tests, decision rules and trees; **LW3:** Optimization of decision rules
7	Mon 03/11/2019 Thu 03/14/2019	**Tools:** Bounds on complexity of tests, decision rules and trees
8	Mon 03/18/2019 Thu 03/21/2019	**Tools:** Bounds on complexity of tests, decision rules and trees; **LW4:** Decision trees and rule systems as classifiers
9	Mon 03/25/2019 Thu 03/28/2019	**Tools:** Algorithms for construction of tests, decision rules and trees
10	Mon 04/01/2019 Thu 04/04/2019	**Tools:** Algorithms for construction of tests, decision rules and trees; **Midterm exam**
11	Mon 04/08/2019 Thu 04/11/2019	**Tools:** Algorithms for construction of tests, decision rules and trees; **HW1:** Lower and upper bounds on complexity of tests, decision trees and rules
12	Mon 04/15/2019 Thu 04/18/2019	**Applications:** Supervised machine learning
13	Mon 04/22/2019 Thu 04/25/2019	**Applications:** Supervised machine learning; **HW2:** Algorithms for construction of tests, decision rules and trees
14	Mon 04/29/2019 Thu 05/02/2019	**Applications:** Supervised machine learning
15	Mon 05/06/2019 Thu 05/09/2019	**Additional topics; HW3:** Approaches to supervised machine learning
16	Mon 05/13/2019 Thu 05/16/2019	**Current Research Results**
17	Mon 05/20/2019 Thu 05/23/2019	Final Exam Week

Note

The instructor reserves the right to make changes to this syllabus as necessary.