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

Course Syllabus: Contemporary Topics in ErSE - ErSE 294

Division	Physical Science and Engineering Division
Course Number	ErSE 294
Course Title	Contemporary Topics in ErSE
Academic Semester	Fall
Academic Year	2018/2019
Semester Start Date	08/26/2018
Semester End Date	12/11/2018
Class Schedule (Days & Time)	09:00 AM - 10:30 AM | Sun Tue

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
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Teaching Assistant(s)

Name	Email

Course Information

Comprehensive Course Description	Overview of machine learning methods in geoscience. Supervised and unsupervised machine learning methods are overviewed. Topics include linear and non-linear support vector machines, kernel methods, perceptrons, fully-connected neural networks, convolutional neural networks, sparse coding, autoencoders, K-means clustering, logistic regression, regularization, gradient descent metods, and preconditioning. Machine learning applications in geoscience inlcude demultiple of seismic data, surface wave windowing, fault detection, lithology identification, traveltime picking, migration and inversion, and well-log analysis. Prerequisites for the course are PDEs, probability and statistics, and linear algebra. Knowledge of MATLAB and python is very helpful.
Course Description from Program Guide	The course covers a number of Machine Learning methods and their applications in solving geoscience problems. The main focus is on using supervised learning methods to solve geoscience problems, with an emphasis on the practical use of convolutional neural networks. At the end of the course, the diligent student will know how to design the architecture of a convolutional network and employ it in solving a particular geoscience problem. Students are expected to have experience in programming a high-level language such as MATLAB and have a background in partial differential equations and linear algebra.
Goals and Objectives	Overview of machine learning methods in geoscience. Supervised and unsupervised machine learning methods are overviewed. Topics include linear and non-linear support vector machines, kernel methods, perceptrons, fully-connected neural networks, convolutional neural networks, sparse coding, autoencoders, K-means clustering, logistic regression, regularization, gradient descent metods, and preconditioning. Machine learning applications in geoscience inlcude demultiple of seismic data, surface wave windowing, fault detection, lithology identification, traveltime picking, migration and inversion, and well-log analysis. Prerequisites for the course are PDEs, probability and statistics, and linear algebra. Knowledge of MATLAB and python is very helpful.
Required Knowledge	Prerequisites for the course are PDEs, probability and statistics, and linear algebra. Knowledge of MATLAB and python is very helpful.
Reference Texts	**Books:** Machine Learning Methods in Geoscience by Schuster and Pattern Recognition and Machine Learning, 2007, Bishop.

Method of evaluation	**25.00**% - Course Project(s) **25.00**% - Final exam **25.00**% - Midterm exam **25.00**% - Homework /Assignments
Nature of the assignments	Written assignments.
Course Policies	Projects to be presented along with a written report
Additional Information	https://csim.kaust.edu.sa/files/ErSE398/ErSE394.html

Tentative Course Schedule *(Time, topic/emphasis & resources)*		
Week	**Lectures**	**Topic**
1	Sun 08/26/2018	Machine learning overview
1	Tue 08/28/2018	Review: Gradient descent
2	Sun 09/02/2018	Review: PDFs, liklihood functions and probability
2	Tue 09/04/2018	Review: Sparsity inversion
3	Sun 09/09/2018	Supervised Learning: Sparse coding and neural networks
3	Tue 09/11/2018	Supervised Learning: Neural networks and perceptrons
4	Sun 09/16/2018	Supervised Learning: Logistic regression
4	Tue 09/18/2018	Supervised Learning: Fully connected neural networks
5	Sun 09/23/2018	Supervised Learning: NN design of surface wave windows
5	Tue 09/25/2018	Supervised Learning: NN design of seismic semblance analysis
6	Sun 09/30/2018	Supervised Learning: Convolutional neural networks I
6	Tue 10/02/2018	Supervised Learning: Convolutional neural networks II
7	Sun 10/07/2018	Supervised Learning: Convolutional neural network detection of faults
7	Tue 10/09/2018	Supervised Learning: convolutional neural network detection of earthquakes
8	Sun 10/14/2018	Supervised Learning: Convolutional neural network identification of rock lithology
8	Tue 10/16/2018	Unsupervised Learning: linear support vector machines
9	Sun 10/21/2018	Unsupervised Learning: non-linear support vector machines
9	Tue 10/23/2018	Unsupervised Learning: kernel support vector machines
10	Sun 10/28/2018	Unsupervised Learning: SVM design of surface-wave windows
10	Tue 10/30/2018	Unsupervised Learning: SVM demultiple of seismic data
11	Sun 11/04/2018	Unsupervised Learning: Cluster analysis
11	Tue 11/06/2018	Unsupervised Learning: Autoencoders
12	Sun 11/11/2018	Unsupervised Learning: Autoencoders (cont)
12	Tue 11/13/2018	Unsupervised Learning: Sparse Encoders
13	Sun 11/18/2018	Unsupervised Learning: Sparse Encoders (cont.)
13	Tue 11/20/2018	L1 Sparse Minimization and Neural Networks
14	Sun 11/25/2018	L1 Sparse Minimization and Neural Networks: Migration
14	Tue 11/27/2018	L1 Sparse Minimization and Neural Networks: FWI
15	Sun 12/02/2018	L1 Sparse Minimization and Neural Networks: Skeletonized Inversion
15	Tue 12/04/2018	L1 Sparse Minimization and Neural Networks: Skeletonized Inversion (cont.)
16	Sun 12/09/2018	Review
16	Tue 12/11/2018	Project Presentations

Note

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