Machine Learning Foundations and Applications 3-0-0

Week 1: [3 hrs lecture] Introduction to Machine Learning –

(a) supervised/unsupervised learning/semi-supervised learning, features
(b) ML problems in the domain of Computer Vision and NLP (eg. Object classification, object detection, document classification)
(c) First ML algorithm: K-nearest neighbors

Week 2: [3 hrs lecture] Mathematics Primer–

(a) Brush-up of Linear Algebra
(b) Brush-up of Probability
(c) Optimization using Gradient Descent

Week 3: [3 hrs lecture] Basic algorithms for supervised learning

(a) Bayes and Naïve Bayes
(b) Decision Trees
(c) Loss functions, performance measures of classification algorithms

Week 4: [3 hrs lecture] Basic algorithms for unsupervised learning

(a) K-means clustering and variants, performance measures
(b) Agglomerative/Hierarchical Clustering, spectral clustering
(c) Dimensionality Reduction via PCA

Week 5: [3 hrs lecture] Simple applications on image and text data

(a) Representation of image and text data (pixels, word tokenization)
(b) Bag-of-words representations
(c) Image/Document classification using Naïve Bayes classifier

Week 6 [3 hrs lecture] More supervised learning

(a) Ensemble classification, Bagging
(b) Random Forest and Adaboost
(c) Linear and logistic regression, Ridge Regression

Week 7: [3 hrs lecture] Linear and Non-linear classifiers

(a) Perceptron
(b) Support Vector Machines
(c) Kernelization for SVM, K-means, PCA

Week 8: [3 hrs lecture] Probabilistic Models

(a) Concept of generative models and latent variable models
(b) Parameter estimation (MLE and Bayesian)

(c) E-M algorithm for Gaussian Mixture Models

Week 9: [3 hrs lecture] Generative Models for Sequential Data

(a) Hidden Markov Model with inference and parameter estimation
(b) Application of HMM for speaker diarization in audio streams, Viterbi algorithm
(c) Generative models in hydrology (eg. Stochastic weather generator)

Week 10: [3 hrs lecture] More on Generative Models

(a) MCMC approaches to inference, Gibbs Sampling
(b) Topic Models, Latent Dirichlet Allocation

Week 11: [3 hrs lecture] Neural Networks

(a) Neural Networks and Backpropagation
(b) Introduction to principles of CNN and RNN

Week 12: [3 hrs lecture] Conclusion

(a) Overview of semi-supervised learning, online learning and adversarial learning

Laboratory

1. Introduction to using cloud. Pointers to Python, numpy
2. Basic handling of image/video data in Python. Image smoothing/denoising
3. Basic handling of textual data in Python. Document classification
4. Implementation of Naïve Bayes classifier and Decision Tree
5. Implementation of clustering algorithms. Eigenfaces for face recognition
6. Image classification, Automatic Typo discovery in text documents
7. Multiclass classification. Random Forest and Adaboost.
8. Sentence sentiment classification
9. SVM. Protein sequence classification using SVMs with various Kernels.
10. Kernelized kmeans
11. Audio Sequence Segmentation using GMM and HMM. Stochastic Weather generation
12. LDA algorithm, for topic discovery in a text corpus

13. Introduction to a Deep Learning platforms – Keras /Tensorflow/mxnet