Trial Course Schedule (01/19/2021)

**Topics to Be Covered:**

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| 1. Required Fundamentals of Machine Learning  * **Linear Algebra** Vector, matrix and tensor; inner-product, cross-product; norm of vector and matrix; basis and subspace; transformation and projection; Eigen-decomposition and Singular Value Decomposition of a matrix, LU Decomposition, QR Decomposition/Factorization, Symmetric Matrices, Orthogonalization & Orthonormalization, Matrix Operations, Projections, Eigenvalues & Eigenvectors, Vector Spaces and Norms; * **Probability and Statistics** (4240: principle of data analytics) Combinatorics, Probability Rules & Axioms, Bayes’ Theorem, Random Variables, Variance and Expectation, Conditional and Joint Distributions, Standard Distributions (Bernoulli, Binomial, Multinomial, Uniform and Gaussian), Moment Generating Functions, Maximum Likelihood Estimation (MLE), Prior and Posterior, Maximum a Posteriori Estimation (MAP) and Sampling Methods.; * **Multi-variate calculus and optimization** Differential and Integral Calculus, Partial Derivatives, Vector-Values Functions, Directional Gradient, Hessian, Jacobian; * **Information Theory** entropy (Shannon entropy, Renyi, etc.), information gain; gini index, purity * **Automatic logic reasoning** propositional logic and predicate logic * **Framework for machine learning: TensorFlow 2 (TF2), and Keras.** * Week 1-3: Basis of Machine Learning * Roadmap, classroom policy, and grading policy of CPSC4430/5440 * Overview of Machine Learning theories and applications * Related fundamentals:  1. Linear algebra: vector, matrix, tensor, space 2. Partial derivation and optimization 3. Information science: entropy and information gain  * **Regression:**  1. linear regression, 2. logistic regression, 3. stepwise regression, 4. multivariate adaptive regression splines, and 5. locally estimated scatterplot smoothing    * **Supervised Learning**      1. Decision tree and random forest      2. Classification    * **Unsupervised Learning**      1. Clustering: K-Means, K-Nearest Neighbor, Hierarchical Clustering    * **Dimensionality Reduction**      1. Related fundamentals: Eigenvalue and Singular Value Decomposition (linear algebra)      2. Principal Component Analysis (PCA) (Phyton Sklearn PCA demo, by Tucker) 6. Week 4-6: Bayesian Analysis and Hidden Markov Method    * **Related fundamentals:**      1. Probability: Combinatorics, Probability Rules & Axioms, Bayes’ Theorem, Random Variables, Variance and Expectation, Conditional and Joint Distributions, Standard Distributions (Bernoulli, Binomial, Multinomial, Uniform and Gaussian), Moment Generating Functions, Maximum Likelihood Estimation (MLE), Prior and Posterior, Maximum a Posteriori Estimation (MAP) and Sampling Methods.      2. Automatic logic reasoning: propositional and predicate logic    * **Association Rule Learning:**Apriori algorithm and Eclat algorithm (4240)    * **Naïve Bayes**    * **Bayesian Believe Network (BBN)**    * **Bayesian Network (BN)**    * **Hidden Markov Method (HMM) (6th week)** 7. **Week 7: Term Exam (I)** 8. Week 7-10: Deep Learning    * **Related Concepts and Fundamentals: multi-variate calculus and optimization**      1. Differential and Integral Calculus, Derivative and Partial Derivatives, sum, product and chain-rules, scalar-value function and Vector-Values Functions, Directional Gradient, Hessian, Jacobian, Laplacian and Lagragian Distribution.      2. Optimization: Steepest gradient descent and Quasi-Newton    * **How to develop a deep neural network using Keras (Mr. Ledesma)**    * **Computational Graph and Data-flow graph**    * **Backward Propagation:**      1. forward pass and      2. backward pass    * **Multiple-Layer Perceptron Neural Network (MLP)**    * **Convolutional Neural Network**    * **AutoEncoder (by Dax)**    * **Recurrent Neural Network** 9. Week 11-15: Advanced Deep Learning    * **Generative Adversarial Network (GAN):**constructor and discriminator    * Neural network structure (Mr. Ledesma) (Already talked by Dax)    * **Reinforcement Learning**      1. Value-based: DQN      2. policy-based: A3C    * **Graph Neural Network** 10. **Week 15: Term Exam II** 11. Week 16: final project poster and report |