99901135 Machine Learning: From Basic Knowledge to Practical Applications

1. **Lecture Hours: 32**
2. **Laboratory Hours: 0**
3. **Colloquia Hours: 0**
4. **Individual Study Hours: 32**
5. **Credits: 2**
6. **Occurrence：Summer semester**
7. **Prerequisite(s): Higher mathematics**

8. **Course Description:** Machine learning is one of the fastest developing subfields in artificial intelligence that empowers computers to learn from data. This course will start with introducing the fundamental working principles of many classical machine learning methods, including linear regression, support vector machines, decision trees, neural networks， etc. Based on neural networks, more advanced deep learning models will also be introduced, such as convolutional neural networks, long short-term memory models, variational auto-encoder, generative adversarial networks and transformers. These algorithms are explained through solving real-world problems, mainly in healthcare and computer vision applications.

9. **Course Outcomes:**
   (1) Understand the working principles of machine learning methods.
   (2) Gain practical experience in developing and evaluating machine learning models in Python programming language.
   (3) Develop and apply machine learning methods to real-world applications.
   (4) Improve technical writing and presentation skills in English.

10. **Course Content, Laboratories and Laboratory Hours, Colloquia Hours:**
    1. Introduction and Mathematics for Machine Learning (3 hours)
       1.1 Introduction
       1.2 Linear algebra & differentiation
       1.3 Probability theory
    2. Data Acquisition, Processing and Analysis (3 hours)
       2.1 Data pre-processing & feature representation
       2.2 Feature selection

2.3 Dimensionality reduction

3. Supervised Machine Learning Models (4 hours)
   3.1 Linear models (Linear/logistic regression)
   3.2 SVM, soft SVM and Kernel SVM
   3.3 Decision trees
   3.4 Artificial neural networks
4. Model Evaluation and Practical Issues (2 hours)
   4.1 Experimental design and evaluation metrics
   4.2 Practical issues
5. Unsupervised Learning (2 hours)
   5.1 Working principles
   5.2 Clustering Analysis
6. Convolutional Neural Networks (4 hours)
   6.1 Working principles
   6.2 Applications
7. Generative Models (4 hours)
   7.1 Auto-encoder
   7.2 Generative Adversarial Networks
8. Reinforcement Learning (3 hours)
   8.1 Markov Decision Process
   8.2 Q-Learning
   8.3 Policy Gradients
9. Sequence Models (4 hours)
   9.1 RNN and LSTM
   9.2 Transformers
10. Challenges and Trends in Machine Learning (3 hours)

11. Grading:

Homework: 10%

In-class Quizzes: 20%

Written Report: 70%

12. **Text & Reference Book:**

- "Pattern Recognition and Machine Learning" by Christopher M. Bishop. A classical ML book that introduces conventional ML methods (for some students). ISBN-13:

978-0387310732, 1st edition, Springer, 2007.

- "Deep Learning" by Ian Goodfellow and Yoshua Bengio. Advanced theoretical content for deep learning (for some students). ISBN-13: 978-0387310732. The MIT Press, 1st edition, 2016.
- "Machine Learning Yearning" by Andrew NG. Practical ML/DL tips (for all students). Free book, 2019.

13. **Course Lecturer：**

Meng Lv

Course Lecturer：

附录：英文课程教学大纲模板