Xebia Academy

Xebia

AI and Machine Learning

Course Outline

Bachelor of Engineering, Computer Science

Specialization- AI and Machine Learning

Semester 1

Foundational Courses

1. Introduction to Machine Learning & AI
2. Objectives of ML
3. Taxonomy of ML
4. Human Learning & Machine Learning
5. A Role for Learning
6. Machine Learning Architectures
   -Data Collection
   -Normalization
   -Dimensionality Reduction
   -Data Augmentation
   -Data Conversion
   -Modelling/Grid Search/Cross Validation
   -Visualization
7. Strong Methods & Weak methods
8. Python 3 overview
9. Tinker a little with Linear Algebra
10. Play with Statistics and Probability
11. Going deeper into Scientific computation with Python using Numpy, Scipy, Matplotlib
12. The Chinese Room
13. HAL- A Fantasy or Reality?

Semester 2

Functional Python Programming, Handle your Data

1. Setting up the Python environment
   -Introduction to the Command-line Interface
   -Python3 Installation
   -Code Editor
2. Python console and Python programs
3. Programming with Python
4. Python3 Basics: Numbers and Expressions
5. Python3 Basics: Strings and Functions
6. Python3: Variables

7. Python3 Numbers, Strings, and Variables
8. Python3: Taking input
9. Python3: If Statements
10. Python3 Comparisons and If statements
11. Python3: Lists
12. Python 3: Loops
13. Python 3: Dictionaries and Tuples
14. Python3 Lists and Dictionaries
15. Python3: Functions
16. Python3 Functions
17. Data Handling & Cleaning
18. Python3 Strings
19. Strings, Sequences and Functions
20. Python3 Lists and Loops (Advanced)
21. Lists, Sets and Practice Problems
22. Python3 Sorting and File input-output
23. Python3 Dictionaries (Advanced)
24. Hands-on Project: Word CountPro
25. Python3 Modules and Command-line execution
26. Python3 Utilities
27. Hands-on Project: Web Scraping with Python

Semester 3

Dive deep into ML

Basic to Advanced Neural Networks

1. Analogy with the Human Brain
2. Architecture of ANN
3. Types of Learning in ANN
4. Rosenblatt's Perceptron & Backpropagation Algorithm
5. Gradient Descent Algorithm
6. Boltzmann Machines
7. Deep Belief Networks
8. Autoencoders
9. Associative Memory
10. Multilingual Bottleneck
11. Convolutional Neural Network (CNN)
12. Recurrent Neural Network (RNN)- unidirectional, bidirectional, Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU)
13. Generative Adversarial Networks

Supervised Learning

1. Gradient descent
2. Regression techniques
3. Regularized Regression
4. Classification techniques
5. Ensemble methods
6. Multilevel Classification
7. Nearest Neighbour search and K-means clustering
8. Decision trees
9. Naive Bayes
10. Random Forest Classifiers

Numerical Optimization

1. Multivariate functions
2. Mathematical foundations for Numerical Optimization-Newton's method, Iterative method, Problem of Huge Hessians, Quasi Newton, Broyden-Fletcher-Goldfarb-Shano Update (BFGS Update)

(Industry Based Case study of the above Concepts)

Semester 4

Unsupervised Learning

1. Dimensionality reduction
2. Clustering
3. Neural Networks

Features

1. Features and Importance
2. Feature scaling
3. The Curse of Dimensionality
4. SVD and Principal Component Analysis

(Industry Based Case study of the above Concepts)

Semester 5

Linear Algebra, Stats & Numpy

1. Mathematics review (Linear Algebra and Statistics)
2. Linear Algebra: Vectors, Matrices and their properties
3. Statistics: Central Tendency metrics, Dispersion and Correlation
4. Linear Algebra and Statistics
5. Introduction to NumPy
6. Hands-on Assignment: Data Exploration with NumPy

Statistical NLP

1. Open Source NLP Libraries such as Apache OpenNLP, NLTK, MALLET
2. Natural Language Processing Use Cases
3. Bag of Words Model
4. TF-IDF: Vector representation of Text
5. POS Tagging
6. Named Entity Recognition
7. Tokenization
8. Stop Words
9. Word Vectorizer
10. Text Classification (Topic Categorization, Spam filtering
11. Hands-on Assignment: Sentiment Classification with Naive Bayes
12. Topic modeling with LDA
13. Machine Learning in the Context of NLP & Text Analytics
14. Supervised Machine Learning for NLP & Text Analytics
15. Unsupervised Machine Learning for NLP & Text Analytics

Semester 6

Deep Learning

1. Introduction to Deep Learning
2. Neural Architectures and Training
3. Deep learning methods
4. Convolutional Neural Networks
5. GoogLe Net
6. Dimensions revisited: The Auto-encoder
7. Recurrent and Combined Architectures
8. Support Vector Machines
9. Deep Learning using Tensorflow
10. How to work on Deep Learning using FREE GPUS on Google Colab

PE1

Feature Selection & Feature Engineering

1. Scikit learn toy datasets
2. Creating training & test datasets
3. Managing Categorical Data
4. Managing Missing Features
5. Data Scaling & Normalization
6. Feature Selection & Filtering
7. PCA
   -Non negative matrix factorization
   -Sparse PCA
   -Kernel PCA
8. Atom Extraction & Dictionary Learning

Recommendation Systems

1. What are recommendation engines?
2. How does a recommendation engine work?

    -Data collection
    -Data storage
    -Filtering the data
3. Naïve User Based Systems
4. Content based systems

5. Content based filtering
6. Collaborative filtering
7 Model free(or Memory based) Collaborative Filtering
8. Model based Collaborative Filtering
    - SVD Strategy
    - Alternating Least Squares Strategy
9. Case study in Python using the MovieLens dataset
10. Building collaborative filtering model from scratch
11. Building Simple popularity and collaborative filtering model using Turicreate
12. Introduction to matrix factorization
13. Building a recommendation engine using matrix factorization
14. Evaluation metrics for recommendation engines

    -Recall
    -Precision
    -RMSE (Root Mean Squared Error)
    -Mean Reciprocal Rank
    -MAP at k (Mean Average Precision at cutoff k)
    -NDCG (Normalized Discounted Cumulative Gain)

Semester 7

Sequential NLP

1. Introduction to Sequential data
2. RNNs and its mechanisms
3. Vanishing & Exploding gradients in RNN
4. Time series analysis
5. LSTMs
6. LSTMs with attention mechanism
7. GRUs - Gated recurrent unit
8. Case study: Machine Translation
9. Case study: Sentiment analysis

(Industry Based Case study of the above Concepts)

Semester 8

Computer Vision

1. Introduction to Computer Vision & Open CV
2. Install OpenCV + Dlib on Ubuntu 18 (C++ & Python)/ Install OpenCV on Windows using Script (C++ & Python)/ Install OpenCV on Ubuntu (Python only)/ Install OpenCV on Windows (Python only)
3. OpenCV Basics
4. Image Processing & Instagram Filters
5. Facial Landmark Detection using Dlib
6. Image Classification and Object Detection
7. Siamese Networks
8. Semantic segmentation

(Industry Based Case study of the above Concepts)

Search Methodologies

1. Problem Solving as Search
2. Data Driven or Goal Driven Search
3. Generate & Test
4. Depth First Search & Breadth First Search
5. Properties of Search Methods
   -Complexity
   -Completeness
   -Irrevocability
   -Optimality
6. Why humans use Depth First Search

-Traversing a Maze
- Searching for a Gift

7. Implementing Depth First Search & Breadth First Search
8. Example: Web Spidering
9. Depth First Iterative Deepening
10. Heuristic Based Search
    -Informed & Uninformed Methods
    - Choosing a good heuristic
    - The 8-Puzzle
    - Monotonocity
    -Example: Modified Travelling Salesman Problem

11. Hill Climbing

    - Steepest Ascent Hill Climbing
    - Foothills, Plateaus & Ridges

12. Best First Search
13. Beam Search

Major Project /Hands-On Projects/Applications of DS & ML

1. One supervised Machine Learning project
2. One unsupervised Machine Learning project
3. One advanced visualization project
4. One NLP project
5. One Computer Vision Project

Languages and tools

Python

Data libraries like Pandas, Numpy, Scipy

Python ML library scikit-learn

Python visualization library Matplotlib

NLP library NLTK

Tensor Flow

Keras

Open CV, DLib

NLTK