Machine Learning Concepts & Algorithms

06.08.2020 - v37

ML1- Introduction to Machine Learning

- Motivation
  - Digitalisation
    - new revolution
  - Why ML now?
    - performance, big data, mathematics
  - AI in Germany
    - status
    - Situation of ML Germany ?
    - problems
    - "German Angst"
  - ML & Advanced Analytics (AA)
    - Six Levels in AA
    - Prescriptive Analytics
    - Predictive Analytics
    - Forecasting
    - Use AI for Creating Art
    - Use-Case 1: Advanced Analytics & Machine Learning (1/3)
  - Creating Art with AI
  - Use AI in Medicine
    - Google watch
- What is ML?
  - 3 major Types
    - linear
    - tree-based
    - Neural networks
- Homework
  - IBM, Google, Microsoft Azure ML
    - IBM Watson ML (in ML3)
    - YouTube Video of Andrew Ng

ML2- Concept Learning: Version Spaces & CE Algo.

- Candidate Elimination Algorithm
  - Homework
- Definition of Version Spaces
  - Theoretical Background
  - Examples

ML3-Superv.& Unsuperv. Learning

- Definition - What is ML?
  - Task T, Performance P, Experience E
  - Backgammon, Spam Mail,
  - Market Basket Analysis (MBA)
  - Tom Michtell 1997
- 10 Fundamental Terms
- Supervised <--> Unsupervised
  - supervised
    - Rote Learning
    - nearest-neighbor classifier
    - linear regression
    - Create Dataset with IBM Watson
  - unsupervised
    - Clustering
      - Customer Clustering
    - association rules
      - support, lift , confidence
      - Example Predictive MBA
      - Homework
- Ethics
  - homework
    - GI Regional Group BB/Stuttgart
  - unsupervised Deep NN
- K-Means Clustering
  - MS Azure ML Example
    - k-means algorithm on UCI Iris data
- Classification
  - Supervised Examples
    - K-NN Classification
    - Random Subspace Algorithms
    - Support vector Machine
    - Bayes Learning
    - Iris Dataset

ML4-Decision Tree

- Definition
  - node
  - branch
  - leaf
  - root
- Methods
  - ID3 (Entropy; InfoGain)
  - CART-Gini Index
    - definition
    - examples
  - Model "Playing Tennis" with ID3
    - homework
    - Frequency Matrix
  - Model "Playing Tennis" with Gini
    - homework
    - problem: missing training data
- Overfitting und Pruning
- Use Cases
  - Predictive Maintenance in Production
  - Calculate Decision Tree with Gini
  - Neuer Zweig
  - Python:
- "Playing Tennis" data set
  - Frequency Matrix
  - Data Set
  - Python program
    - Homework

ML5-simple Linear R. & multiple Linear Regr.

- simple Linear Regr. sSLR (k=1)
  - Definition R^2=SSE/SST
  - Interpretation and properties of R^2
  - Least Best Fit method to define c.coef. y=a+b.x
  - Interpretation of measure R^2
  - SLR Model
  - Neuer Zweig
- multiple Linear Regr. mLR (k >1)
  - Definition of mLR Method
    - Def. of Multiple Regr. Fct (k=2)
  - Definition of Adj.R^2
  - homework: calculate Adj.2
  - Least Best Fit method
- Dependent- & independent variables
- Linear regression examples
  - interpretation of the coefficients
  - manual sLR example
  - Python examples for sLR
  - Python pgm. for miLR example

ML6-Neural Networks: CNN

- CNN simulate Biological Neurons
- What is a Neuron?
- CNN - conv. operation on Image pixels
- CNN example for Image Recognition (image="2")
  - Convolutional
    - Filtering
    - ReLu
  - Pooling
    - Down sampling
  - Fully connected
    - connected to all activation layers
  - SoftMax
    - normalized exponential function
- General Architecture
  - Conv. Layer
  - Pooling
  - Fully Connected
  - Example: "Image Recognition"
- Use Cases
  - "Autonomes Fahren" (Daimler, Sindelfingen)
  - Power Forecasts (enercast/Kassel)
  - Semantic Search-Fact Finder (Omnikron, Pforzheim)
    - UCI -Semantic Search: "Predictive Market with Fact-Finder" (https://youtu.be/cGSuBKrlcw)
    - Machine Learning, FACT-Finder, smart Services, Web Business Transactions
  - Google AlphaGo
- MS Azure-"Letter Recognition"
  - not done

ML7 – BackPropagation for Neural Networks

- What is BackPropagation
  - Examples
- Simple Example of a Neural Network
- Exercise of an Example with Python
- Exercise of an Example with Manuall Calculation

ML8 – Support Vector Machines (SVM)

- Motivation and Definition of SVM
  - Kernel Trick
  - Data points are linearly separable in the space $(x_1^2, x_2^2, \sqrt{2}x_1x_2)$
  - We want to maximize $\sum_i \alpha_i - \frac{1}{2}\sum_{i,j} y_i y_j \alpha_i \alpha_j \langle F(\mathbf{x}_i) \cdot F(\mathbf{x}_j) \rangle$
  - Define $K(\mathbf{x}_i, \mathbf{x}_j) = \langle F(\mathbf{x}_i) \cdot F(\mathbf{x}_j) \rangle$
  - Cool thing : K is often easy to compute directly! Here, $K(\mathbf{x}_i, \mathbf{x}_j) = \langle \mathbf{x}_i \cdot \mathbf{x}_j \rangle^2$
- Linear Support Vector Machine (LSVM)
- Examples of SVM – Python Algorithm
- Exercises to Lesson ML8

Preparation for Examination

- Summary of Lecture
- Answer questions

Mindjet