Karlsruher Institut für Technologie

Institut für
Thermische Strömungsmaschinen
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ITS

Winter Term 2021
18.10.2021 - 12.02.2022
Term projects: 02.12.21 - 10.02.22

Data Driven Engineering 1
Machine Learning for Dynamical Systems

Basics

1. Basics: An Ode to Learning — 21.10.21
   - 1.1. The Flow of the Lecture
   - 1.2. A holistic view on AI and ML
   - 1.3. Data-Driven Dynamical Systems
   - 1.4. Machine Learning: Overview, Means and Goals
   - 1.5. Contemporary Examples

Fundamentals

2. Analysis of Static Datasets I: Regression and Classification — 28.10.21
   - 2.1. Supervised ML Landscape
   - 2.2. Regression — 04.11.21
     - 2.2.1. Lasso
     - 2.2.2. Elastic Net
     - 2.2.3. SVM
     - 2.2.4. Bayesian Ridge Regression
   - 2.3. Classification — 11.11.21
     - 2.3.1. Logistic Regression
     - 2.3.2. Gradient Decent
     - 2.3.3. Random Forests
     - 2.3.4. Boosting
3. Analysis of Static Datasets II: Clustering and Dimensionality Reduction — 18.11.21
   - 3.1. Unsupervised ML
   - 3.2. Clustering
     - 3.2.1. K-Means
     - 3.2.2. Hierarchical Clustering
     - 3.2.3. DBSCAN
   - 3.3. Dimensionality Reduction — 25.11.21
     - 3.3.1. Sparsity and Compressed Sensing
     - 3.3.2. Linear projection
       - 3.3.2.1. SVD, PCA
     - 3.3.3. Manifold learning

3.3.3.1. Isometric mapping, MDS, LLE
3.3.4. Dictionary Learning
3.3.5. Independent Component Analysis

ML for Dynamical Systems

4. Deep Learning for Dynamical Systems	02.12.21
4.1. The Perceptron and Building DNN	
4.2. Activation Functions	
4.3. Training NN: Backpropagation, Learning Rate, Regularization	
5. Sequence Modeling	09.12.21
5.1. Statistical models	
5.2. Neural Networks for Dynamical Systems	16.12.21
5.3. Recurrent Neural Networks	
5.4. Gated Cells: Long Short-Term Memory (LSTM)	
6. Generative Modeling	23.12.21
6.1. Latent Variables and Sparsity	
6.2. Representation Learning	
6.3. Autoencoders	
6.4. Variational Autoencoders (VAEs)	13.01.22
6.5. Generative Adversarial Network (GAN)	20.01.22
7. Machine Learning Control	27.01.22
7.1. Data-Driven Dynamical Systems	
7.2. Model Reduction and Linear System Identification	
7.3. Sparse Identification of Nonlinear Dynamics and Control	
8. Emerging Concepts and the Outlook	03.02.22
9. Project Q&A Sessions	10.02.22