

Troubleshooting Neural Networks

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Content

Intro

Neural Networks

Industry 4.0 and NN

Project

Problems & Solutions

Intro

Seamless Analytics GmbH

- Gegründet 2018
- Machine Learning
 - Verantwortlich M.Sc. Marvin Follmann
- Big Data
 - Verantwortlich M.Sc. Daniel Müller

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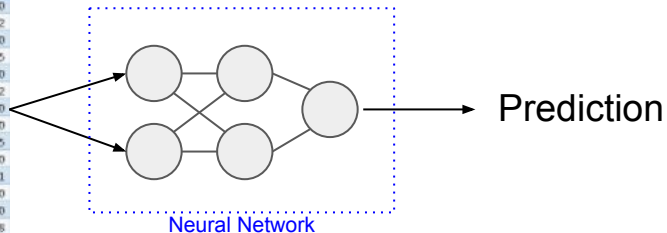
Problems & Solutions

Neural Networks

General

- Neural Networks (NN) are ...
 - “[...] computing systems vaguely inspired by biological neural networks.”
 - “[...] framework for many different machine learning algorithms [...]”
 - ⇒ systems which learn based on data without being explicitly programmed

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2	USA	Fuller	1/01/2011	10392	13	1,440.00
3	UK	Gloucester	2/01/2011	10397	17	716.72
4	UK	Bromley	2/01/2011	10771	18	344.00
5	USA	Finchley	3/01/2011	10393	16	2,556.95
6	USA	Finchley	3/01/2011	10394	10	442.00
7	UK	Gillingham	3/01/2011	10395	9	2,122.92
8	USA	Finchley	6/01/2011	10396	7	1,903.80
9	USA	Callahan	8/01/2011	10399	17	1,785.60
10	USA	Fuller	8/01/2011	10404	7	1,591.25
11	USA	Fuller	9/01/2011	10398	11	2,505.60
12	USA	Coghill	9/01/2011	10403	18	855.01
13	USA	Finchley	10/01/2011	10401	7	3,868.60
14	USA	Callahan	10/01/2011	10402	11	2,713.50
15	UK	Rayleigh	13/01/2011	10406	15	1,830.78
16	USA	Callahan	14/01/2011	10408	10	1,622.40



- Common Types: MLP, DNN, RNN (LSTM, GRU), CNN

Hyperparameter vs Parameter

Hyperparameter

- #Layer, #Neurons per Layer, ...
- Activations, Learning Rate, Loss Function, Optimizer, ...

Parameter

- Weights / Kernels / Filters /...
- Modified during training by Hyperparameters

Why Neural Networks?

- Algorithm cannot be programmed easily
 - Image Captioning: Describe a complex object mathematically to detect it in an image?
 - Neural Machine Translation: Define rules for translating text from A to B?
- Traditional approach is too expensive
 - Example: Classification



- When generalization is needed.

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Industry 4.0 and NN

Industrie 4.0 and NN

- Smart Manufacturing
 - Data about machine processes - automatic optimizations
- Predictive Maintenance
 - Data about machines and occurring problems - replace parts which will break soon
- Security
 - Data about usage of different resources - detect intruders
- Optimized Energy Management
 - Data about energy usage patterns
- Quality Assurance
 - Data about machine processes
- Autonomous Vehicles
 - e.g. robots for storage systems

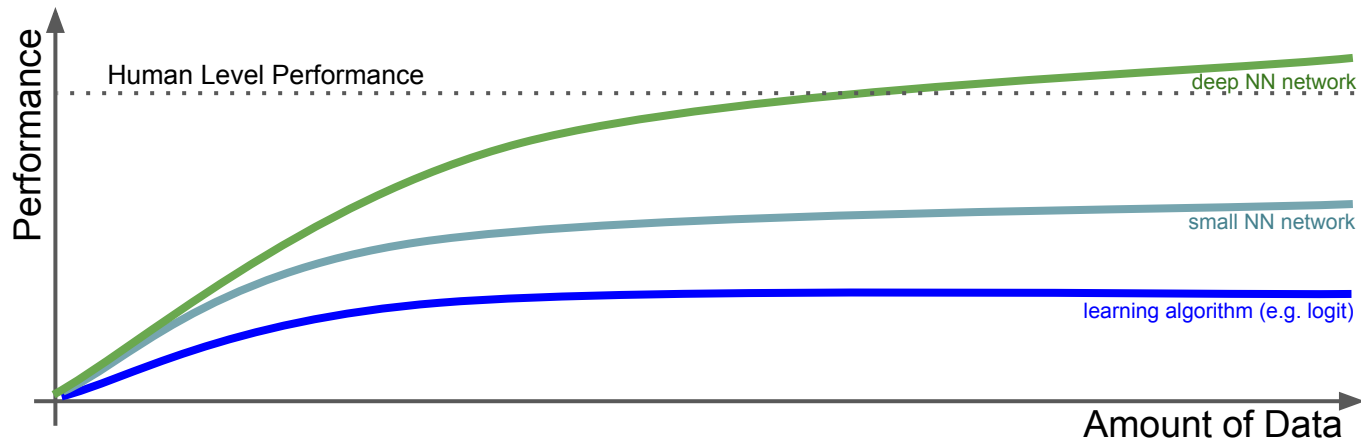
Industrie 4.0 and NN

- Smart Manufacturing
 - **Data** about machine processes - automatic optimizations
- Predictive Maintenance
 - **Data** about machines and occurring problems - replace parts which will break soon
- Security
 - **Data** about usage of different resources - detect intruders
- Optimized Energy Management
 - **Data** about energy usage patterns
- Quality Assurance
 - **Data** about machine processes
- Autonomous Vehicles
 - e.g. robots for storage systems

Data 

Why Deep Learning?

- + Data 8.5 EB (2008) \Rightarrow 40.000 EB (2015)
- + Hardware CPUs, GPUs, TPU (Google), ...
- + Algorithms CNTK, Tensorflow, Keras, ...



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Needed

- Experts with expertise ...
 - in the domain
 - who knows the processes
 - who can explain the collected data
 - in machine learning who is incorporated to the team
- Other Resources
 - Computing Power
 - Time
 - Effective Tools (Frameworks)
- Quality Management & Defined Goal
 - Goal needs to be defined

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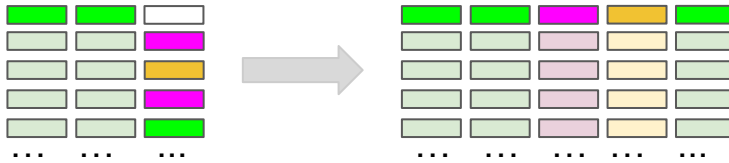
Project

Problems & Solutions

Problems & Solutions

Data Preparation / Data Conversion

Time Consuming Data Preparation / Data Conversion



Encoding?

Problem: Data can't be used as is. It needs to be transformed and encoded.

Amount of Data

Problem: Amount of data is too low

Solution: Collect data from different sources.

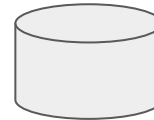
own data



third party



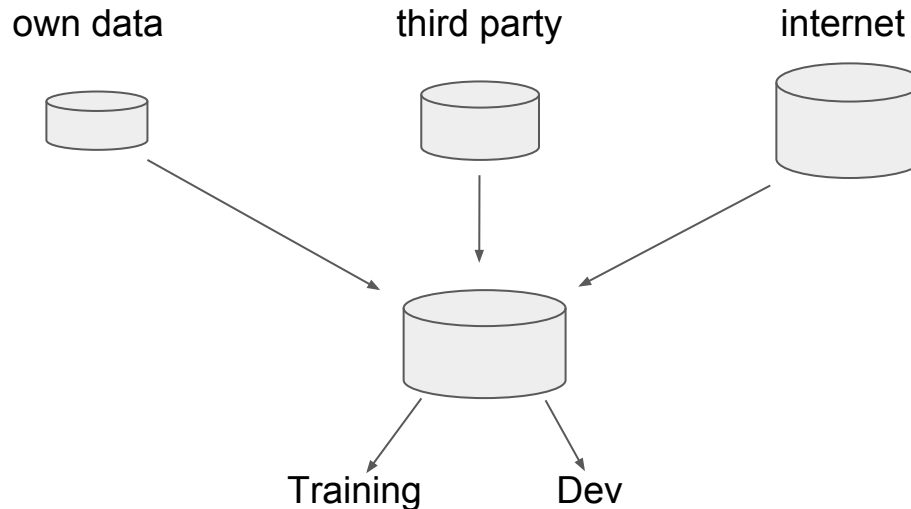
internet



Training and Validation Results don't fit

Problem: Data from different distribution

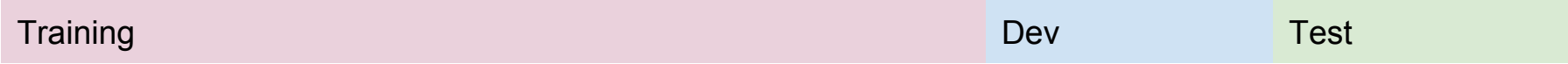
Solution: Data for training and validation should come from the same distribution.



How to Split Data?

Problem: Data can be splitted in different ways

Solution: Classic train-/dev-/test-set



Training

Dev

Test

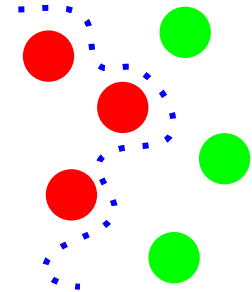
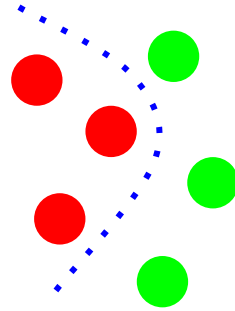
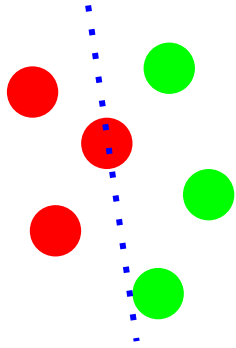
Training: Used for training only

Dev: Used for validation (sometimes “Validation” data set)

Test: Used for final evaluation of models (sometimes “Hold-out”)

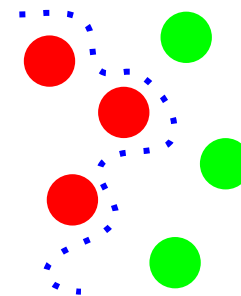
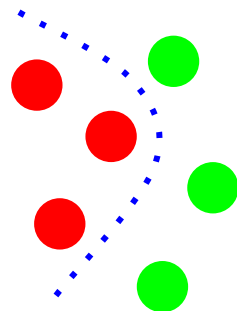
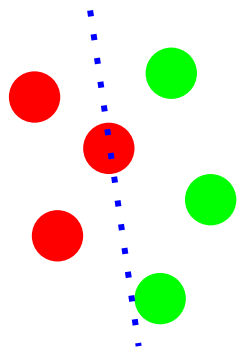
High Bias/Variance

“Bias - variance tradeoff”



High Bias/Variance

“Bias - variance tradeoff”



Errors

Train: 15.0%

Dev: 16.0%

0.5%

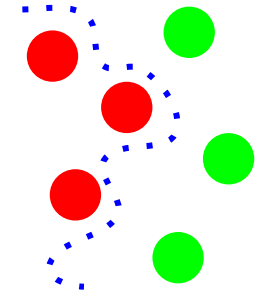
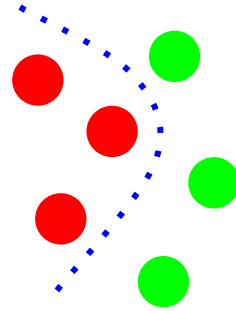
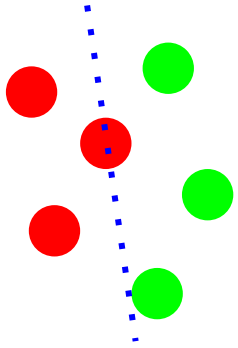
1.0%

1.0%

11.0%

High Bias/Variance

“Bias - variance tradeoff”



Larger Network
Train Longer

More Data
Regularization

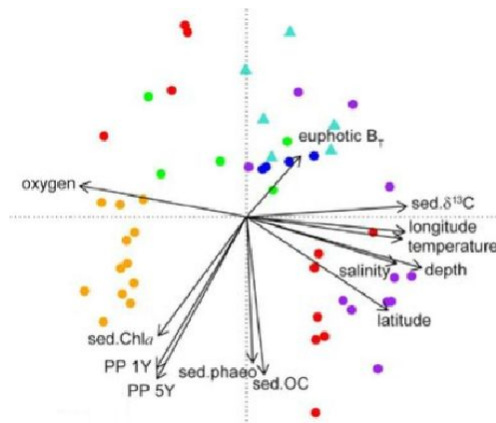
High Dimensional Data

Problem: Data has many dimensions, some of them might not be necessary

Solution: Use an **Auto-Encoder** with different encoding widths

Can be used for producing a denser representation of inputs before classification.

In contrast to PCA: can be non-linear

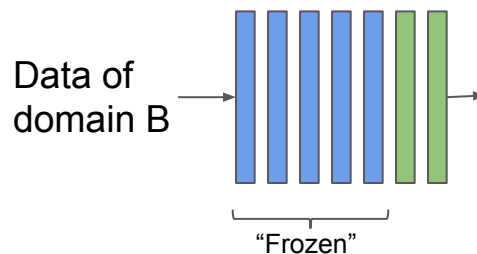
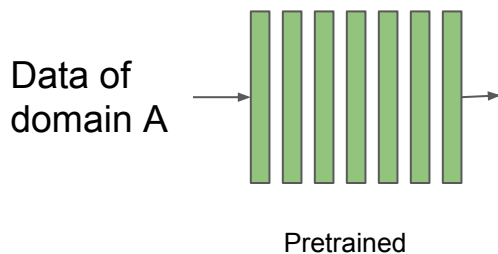


No Sufficient Hardware, “too Much” Data

Problem: Training a deep NN can take much time

Solution: Use a Dev-Set for model development
Use transfer learning with pre-trained models

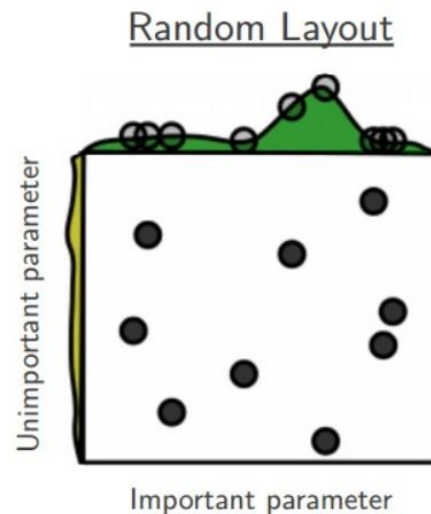
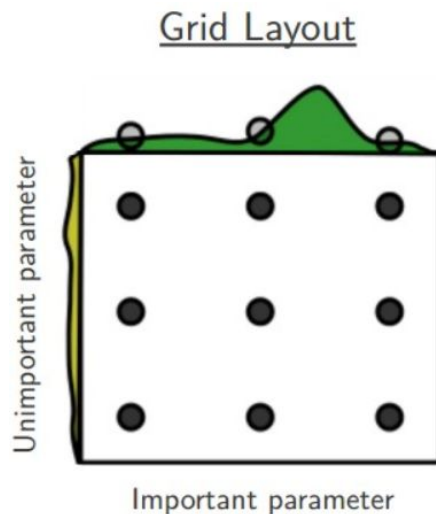
Especially for visual and language problems there are many pretrained models.



Finding Good Hyperparameters

Problems: Finding good hyperparameters itself is a problem

Solution: Random Search or more advanced techniques



Which model works best?

Problem: Losses are low, but each model has advantages and disadvantages.

Solution: Single evaluation metric (+ other factors)

Should be defined at the beginning.

The “average” of Precision and Recall is a good metric for comparing models.

e.g. F1-Score

Thank you

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