Machine Learning
«A Gentle Introduction»

@ZimMatthias  Matthias Zimmermann
BSI Business Systems Integration AG
«So what? IBM’s chess system did this 20 years ago?»
Human level control through deep reinforcement learning

Volodymyr Mnih, Koray Kavukcuoglu, David Silver, Andrei A. Rusu, Joel Veness, Marc G. Bellemare, Alex Graves, Martin Riedmiller, Andreas K. Fidjeland, Georg Ostrovski, Charles Beattie, Amir Sadik, Ioannis Antonoglou, Helen King, Dharshan Kumaran, Daan Wierstra, Shane Legg & Demis Hassabis

Nature 518, 529–533 (26 February 2015) | doi:10.1038/nature14236
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2014 Google buys DeepMind for $660m ...
Deep Reinforcement Learning

Markov Decision Process

- **Environment** (Atari Breakout)
- **Agent** performing **Actions** (Left, Right, Release Ball)
- **State** (Bricks, location / direction of ball, ...)
- **Rewards** (A Brick is hit)
Deep Reinforcement Learning

Q-Learning (simplified)

Markov Decision Process

Q(s, a) Highest sum of future Rewards for action a in state s

initialize Q randomly
set initial state s₀
repeat
    execute a to maximize Q(sᵢ, a)
    observe r and new state sᵢ₊₁
    set Q = update(Q, r, a, sᵢ₊₁)
    set sᵢ = sᵢ₊₁
until terminated
Deep Reinforcement Learning

Deep Q Learning (DQN)

- Q Learning
- $Q(s, a) = \text{Deep Neural Network (DNN)}$
- Retrain DNN regularly (using it’s own experience)
... Agenda

- ML Concepts
- Demos
- Recent Advances
- Food for Thought
Machine Learning Concepts
Data
Models
Training and Evaluation
ML Topics
Getting the Data

Challenges

- Getting the **RIGHT** data for the task
- And **LOTs** of it
- There is never enough data ...

Real World Lessons

- Data is crucial for successful ML projects
- Most boring and timeconsuming task
- Most underestimated task
1245 NEGATIVE \ shallow, noisy and pretentious.
14575 POSITIVE \ one of the most splendid entertainments to emerge from the French film industry in years.
Data Models
Training and Evaluation
ML Topics
2012, ImageNet, G. Hinton
Data Models

Training and Evaluation

ML Topics
Error Rate

- «Underfitting»: more training needed
- «Overfitting»: too much training

- Training Data
- Test Data

Training Iterationen
Data Models
Training and Evaluation
ML Topics
Supervised Learning
- Learning from Examples
- Right Answers are known

Unsupervised Learning
- Discover Structure in Data
- Anomaly Detection/Data Compression

Reinforcement Learning
- Interaction with Dynamic Environment
Demo Time
Demos

Demo 1 Unsupervised Learning
- Anomaly Detection
- Breast Cancer Data
- Auto-encoder

Demo 2 Supervised Learning
- Pattern recognition
- Handwritten character recognition
- Convolutional neural network

Demo 3 Natural Language Processing
Happy to show at #EclipseScout Booth
Anomaly Detection
WDAC Wisconsin Diagnostic Breast Cancer Data

Data
- Breast Tissue Features (floats)
- «12.86,18,83.19,506.3,0.09934, ... »

Model
- Auto-encoder Network
- Only train on healthy data
- Use reconstruction error

DeepLearning4j
- Deep Learning Library
- Open Source (Apache)
- Java
Auto-Encoder Network

- Input Features
- Compression Layer
  - Core Layer
  - Expansion Layer
- Reconstructed Features
- Reconstruction Error
auto-encoder topology:

```
org.deeplearning4j.nn.layers.feedforward.dense.DenseLayer<
  conf=NeuralNetConfiguration(layer=DenseLayer)<super
    FeedForwardConfiguration>

results for reconstruction error threshold 20000.0

diagnosis | cancer | healthy
positive    | 75     | 11
negative    | 5      | 62

precision: 87.2% (probability for cancer given a positive diagnosis)
recall: 93.0% (probability for positive diagnosis given cancer)
F-measure: 90.4%
```

https://github.com/matthiaszimmermann/ml_demo
Pattern Recognition
Handwritten Digits

Data
➔ Which digit is this?
➔ Collect our own data

Model
➔ Deep Neural Network (LeNet-5)

Deeplearning4j
➔ Deep Learning Library
➔ Open Source (Apache)
➔ Java
Machine Learning With Deeplearning4j and Eclipse Scout

Look at a simple system to recognize monetary amounts on Swiss payment slips and see how to build, train, and run the deep neural net using Deeplearning4j.

by Matthias Zimmermann - Jun. 28, 17 - AI Zone

Machine learning and deep learning, in particular, are developing at amazing speeds. Today, machine learning can be used to solve ever more complex tasks that have been considered impractical just a few years ago. Examples include autonomous cars, AlphaGo’s win against the world’s Go champion, the photo-realistic transformation of pictures, and neural machine translation systems.

In this blog post, we describe a simple system to recognize monetary amounts on Swiss payment slips. The user interface is implemented using Eclipse Scout and we build, train, and run the deep neural net using Deeplearning4j.
Deep Visual-Semantic Alignments for Generating Image Descriptions

Deep Photo Style Transfer

(a) Input image

(b) Our result

(c) Reference style image
Google's Neural Machine Translation System: Bridging the Gap between Human and Machine Translation

Data from side-by-side evaluations, where human raters compare the quality of translations for a given source sentence. Scores range from 0 to 6, with 0 meaning "completely nonsense translation", and 6 meaning "perfect translation."

Face2Face: Real-time Face Capture and Reenactment of RGB Videos

Justus Thies¹, Michael Zollhöfer², Marc Stamminger¹, Christian Theobalt², Matthias Nießner³

¹University of Erlangen-Nuremberg
²Max-Planck-Institute for Informatics
³Stanford University

CVPR 2016 (Oral)

http://www.graphics.stanford.edu/~niessner/thies2016face.html
Modern Art «Turing Test»

2017, Reutgers, Facebook, ...

ML Libraries
Food for Thought
### ML performance $\geq$ Human Levels (2017)

<table>
<thead>
<tr>
<th>Category</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other</td>
<td>Age estimation from pictures 2013, personality judgement from Facebook «likes» 2014, conversational speech recognition 2016, contemporary art, 2017</td>
</tr>
</tbody>
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AI and robots threaten to unleash mass unemployment, scientists warn

Intelligent machines will soon replace human workers in all sectors of economy
Lee replied that playing against the machine had rekindled his passion for Go. As with Fan Hui, AlphaGo had opened his eyes to a new side of the game. “I have improved already,” Lee said. “It has given me new ideas.” He has not lost a match since.
Learn more?

Socializing
» Go to talks, conferences, Meetups

Increase Context
» Twitter, Blogs, ...
» arxiv.org (state of the art ML publications)

Doing
» GitHub (deeplearning4j/deeplearning4j,
  BSI-Business-Systems-Integration-AG/anagnostes, ...)
» For the latest frameworks: learn Python ;-)
Thanks!

@ZimMatthias