JAVAFORUM 20 Jubiläum
1997-2017 stuttgart

bsi

Machine Learning

«A Gentle Introduction»

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«So what?
IBM’s chess system did
this 20 years ago?»
AlphaGo
Lee Sedol

nature International weekly journal of science

NATURE | LETTER

日本語要約

Human-level control through deep reinforcement learning

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

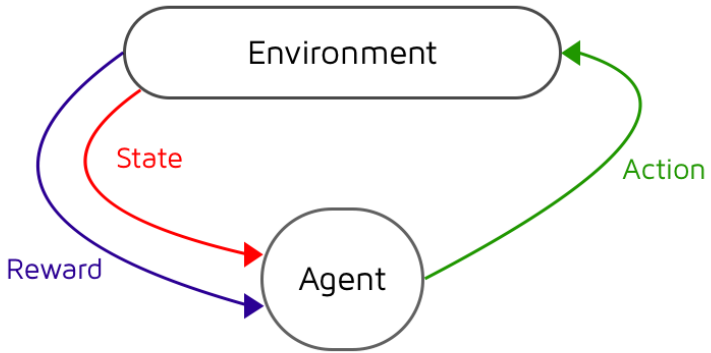
2014 Google buys DeepMind for $660m …

Nature **518**, 529–533 (26 February 2015) | doi:10.1038/nature14236
Received 10 July 2014 | Accepted 16 January 2015 | Published online 25 February 2015

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**

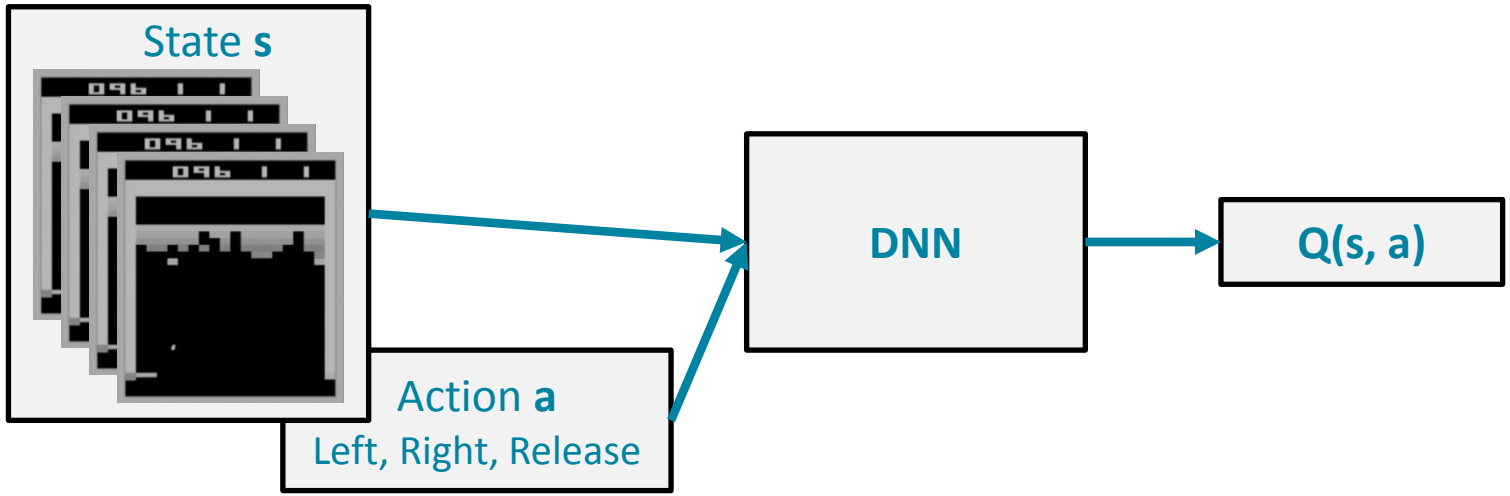
➔ **Q(s, a)** Highest sum of future **Rewards** for action **a** in state **s**

```
initialize Q randomly
set initial state s_0
repeat
   execute a to maximize Q(s_i, a)
   observe r and new state s_i+1
   set Q = update(Q, r, a, s_i+1)
   set s_i = s_i+1
until terminated
```

Deep Reinforcement Learning

Deep Q Learning (DQN)

- ➔ Q Learning
- ➔ Q(s, a) = **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

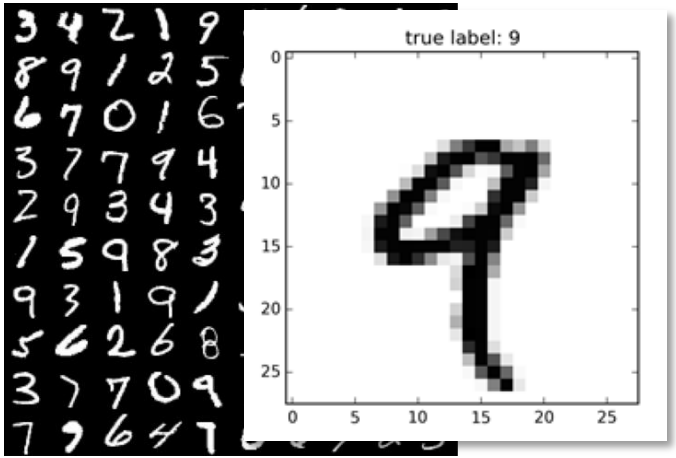
Challenges

- ➔ 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



862722,B,6.981,13.43,43.79,143.5,0.117,0.07568,0,0,0.193,0.07818,
862965,B,12.18,20.52,77.22,458.7,0.08013,0.04038,0.02383,0.0177,(
86211,**B**,12.18,17.84,77.79, …
862261,**B**,9.787,19.94,62.11, …
862485,**B**,11.6,12.84,74.34, …
862548,**M**,14.42,19.77,94.48, …
862009,**B**,13.45,18.3,86.6, …
864685,B,11.93,21.53,76.53,438.6,0.09768,0.07849,0.03328,0.02008,
864726,B,8.95,15.76,58.74,245.2,0.09462,0.1243,0.09263,0.02308,0.

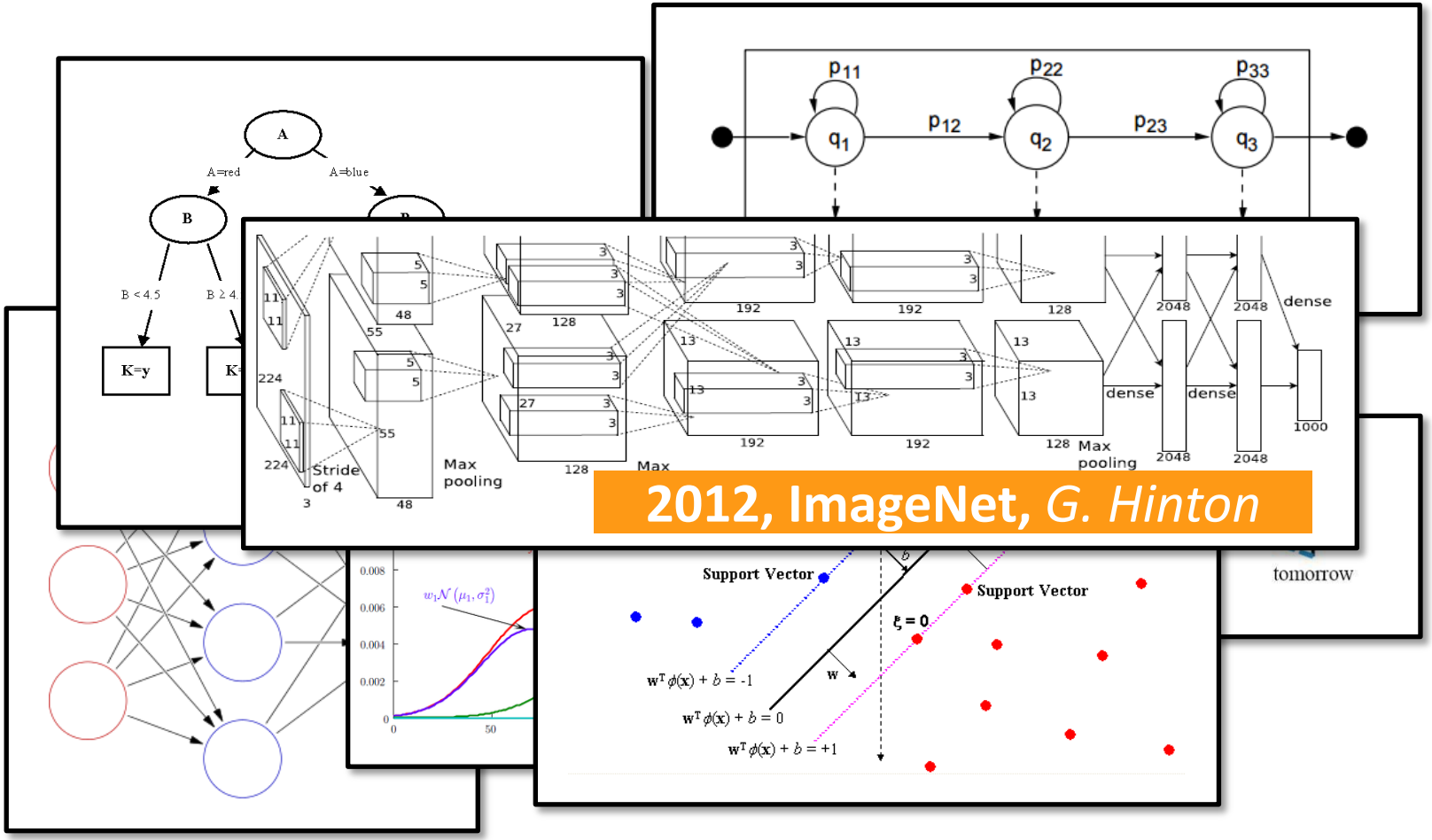
Rosemary, Rosmarinus officinalis

Data

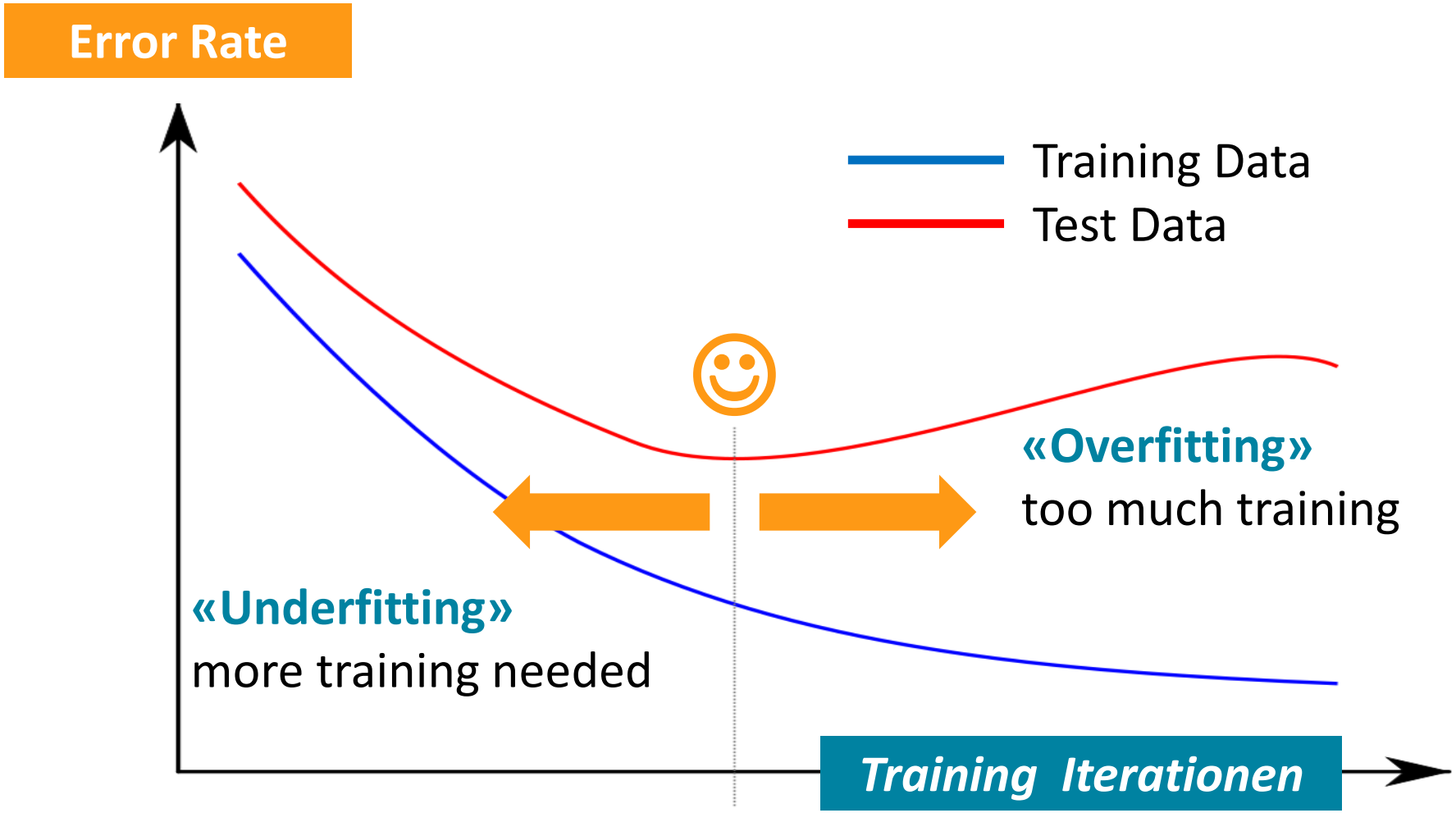
Models

Training and Evaluation

ML Topics


A
A=red
A=blue
B
B < 4.5
B ≥ 4
K=y
p11
p22
p33
p12
p23
q1
q2
q3
Stride of 4
Max pooling
Max
dense
2048
1000
2012, ImageNet, G. Hinton
Support Vector
Support Vector
ξ = 0
w
tomorrow

Data
Models
Training and Evaluation
ML Topics


Error Rate
Training Data
Test Data
«Overfitting»
too much training
«Underfitting»
more training needed
Training Iterationen

Data
Models
Training and Evaluation
ML Topics

CS 229
Machine Learning
Handout #2: Course Schedule

Syllabus

- **Introduction** (1 class)
  Basic concepts.

- **Supervised learning.** (7 classes)
  Supervised learning setup. LMS.
  Logistic regression. Perceptron. Exponential family.
  Generative learning algorithms. Gaussian discriminant analysis. Naive Bay
  Support vector machines.
  Model selection and feature selection.
  Ensemble methods: Bagging, boosting.
  Evaluating and debugging learning algorithms.

- **Learning theory.** (3 classes)
  Bias/variance tradeoff. Union and Chernoff/Hoeffding bounds.
  VC dimension. Worst case (online) learning.
  Practical advice on how to use learning algorithms.

- **Unsupervised learning.** (5 classes)
  Clustering. K-means.
  EM. Mixture of Gaussians.
  Factor analysis.
  PCA (Principal components analysis).
  ICA (Independent components analysis).

- **Reinforcement learning and control.** (4 classes)
  MDPs. Bellman equations.
  Value iteration and policy iteration.
  Linear quadratic regulation (LQR). LQG.
  Q-learning. Value function approximation.
  Policy search. Reinforce. POMDPs.

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 Natual Language Processing

Happy to show at #EclipseScout Booth

Anomaly Detection
WDBC Wisconsin Diagnostic Breast Cancer Data

Data

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

Model

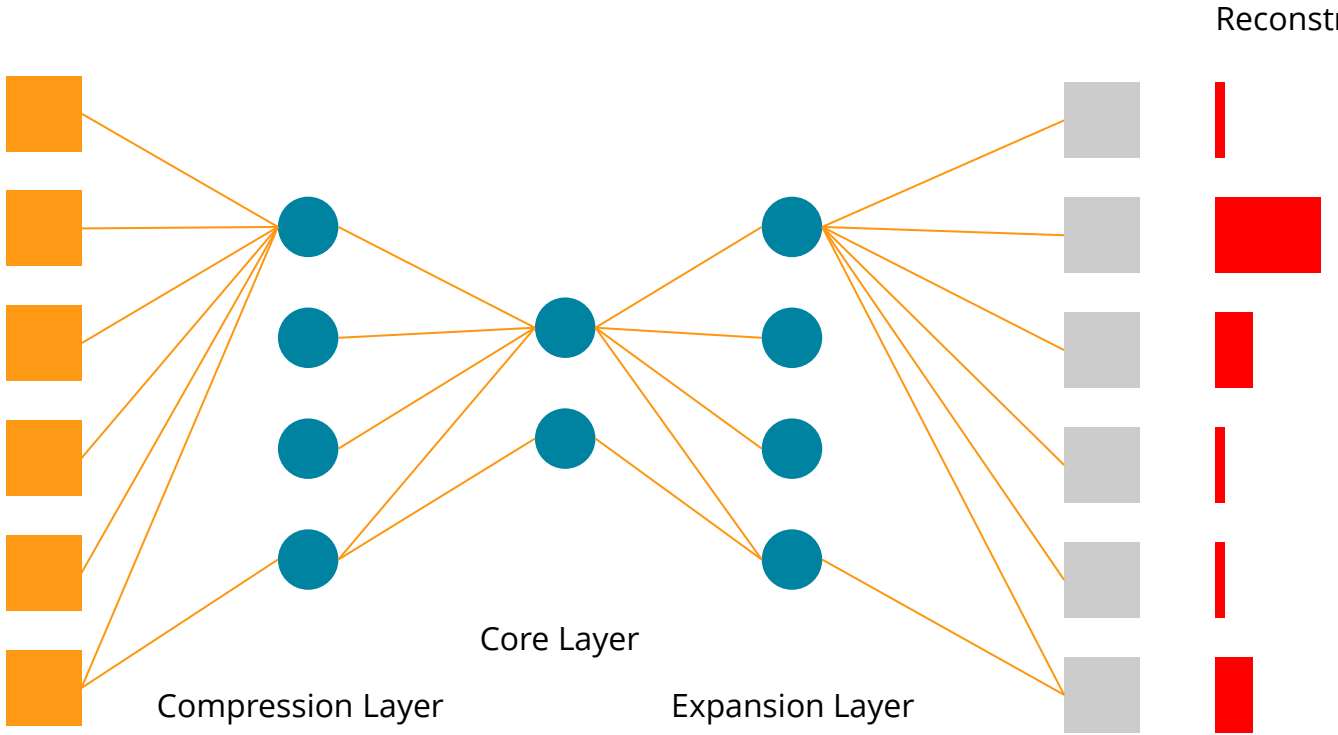
- Auto-encoder Network
- Only train on healthy data
- Use reconstruction error

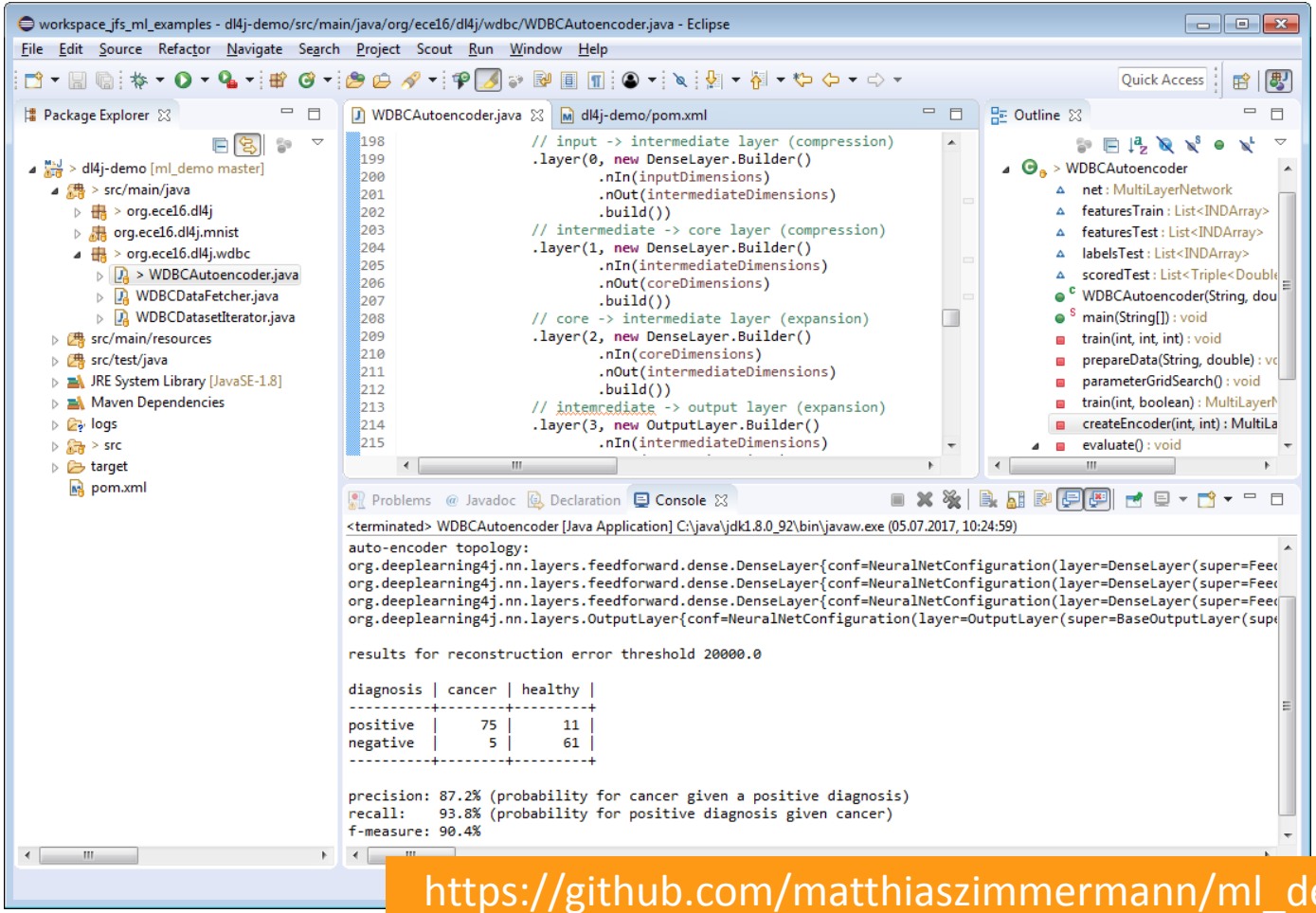
Deeplearning4j

- Deep Learning Library
- Open Source (Apache)
- Java

86211,B,12.18,17.84,77.79, …
862261,B,9.787,19.94,62.11, …
862485,B,11.6,12.84,74.34, …
862548,M,14.42,19.77,94.48, …
862009,B,13.45,18.3,86.6, …

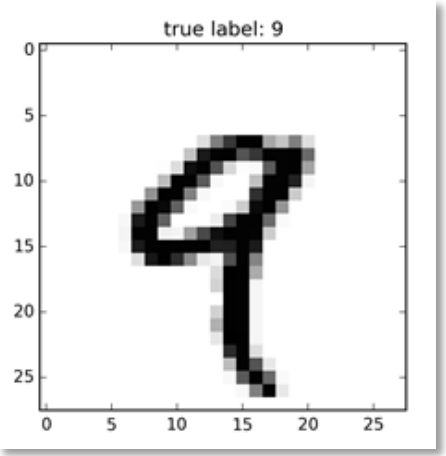
Auto-Encoder Network





https://github.com/matthiaszimmermann/ml_demo

Pattern Recognition
Handwritten Digits



Data

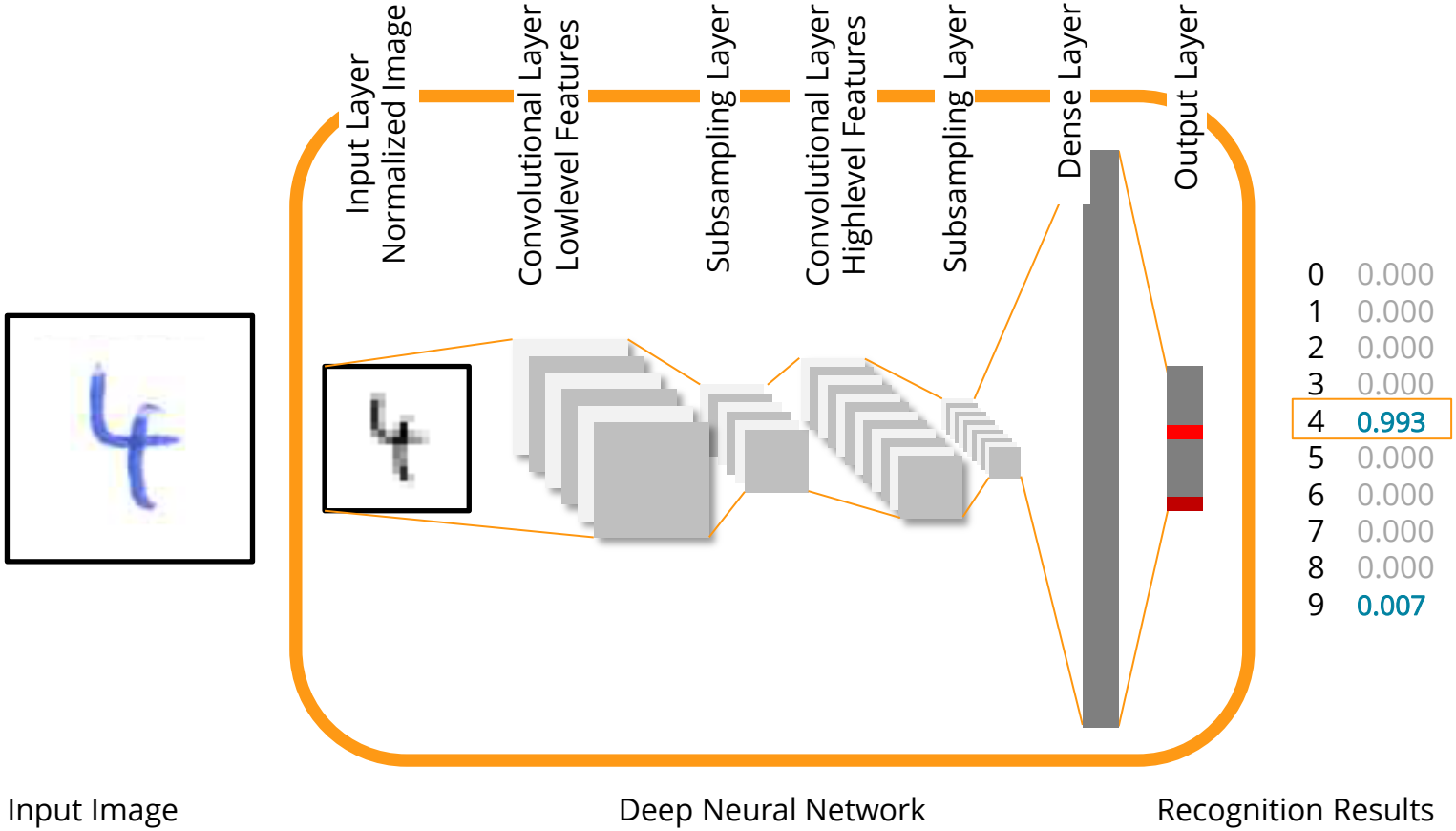
- Which digit is this?
- Collect our own data

Model

- Deep Neural Network (LeNet-5)

Deeplearning4j

- Deep Learning Library
- Open Source (Apache)
- Java

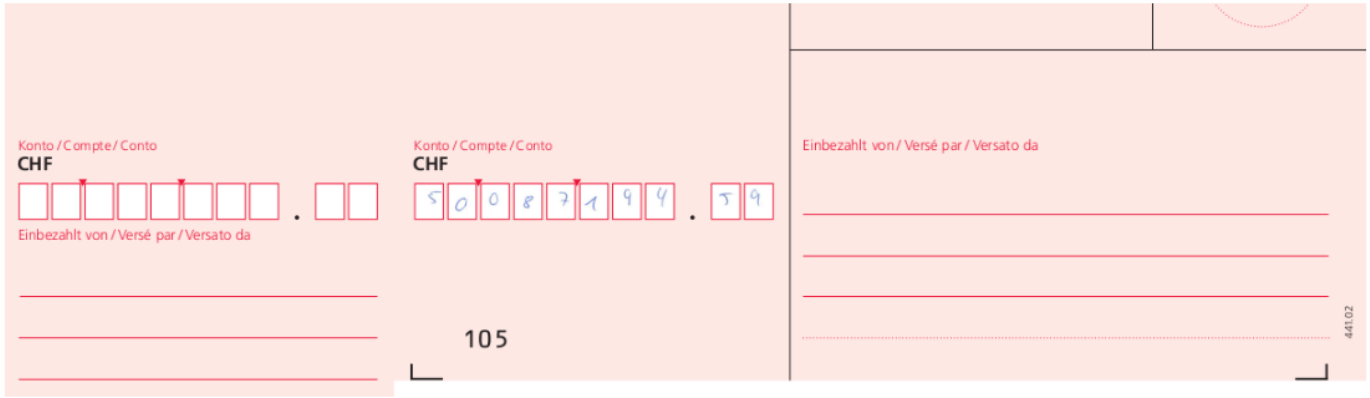

Input Layer
Normalized Image
Convolutional Layer
Lowlevel Features
Subsampling Layer
Convolutional Layer
Highlevel Features
Subsampling Layer
Dense Layer
Output Layer
0 0.000
1 0.000
2 0.000
3 0.000
4 0.993
5 0.000
6 0.000
7 0.000
8 0.000
9 0.007
Input Image
Deep Neural Network
Recognition Results

Anagnostes

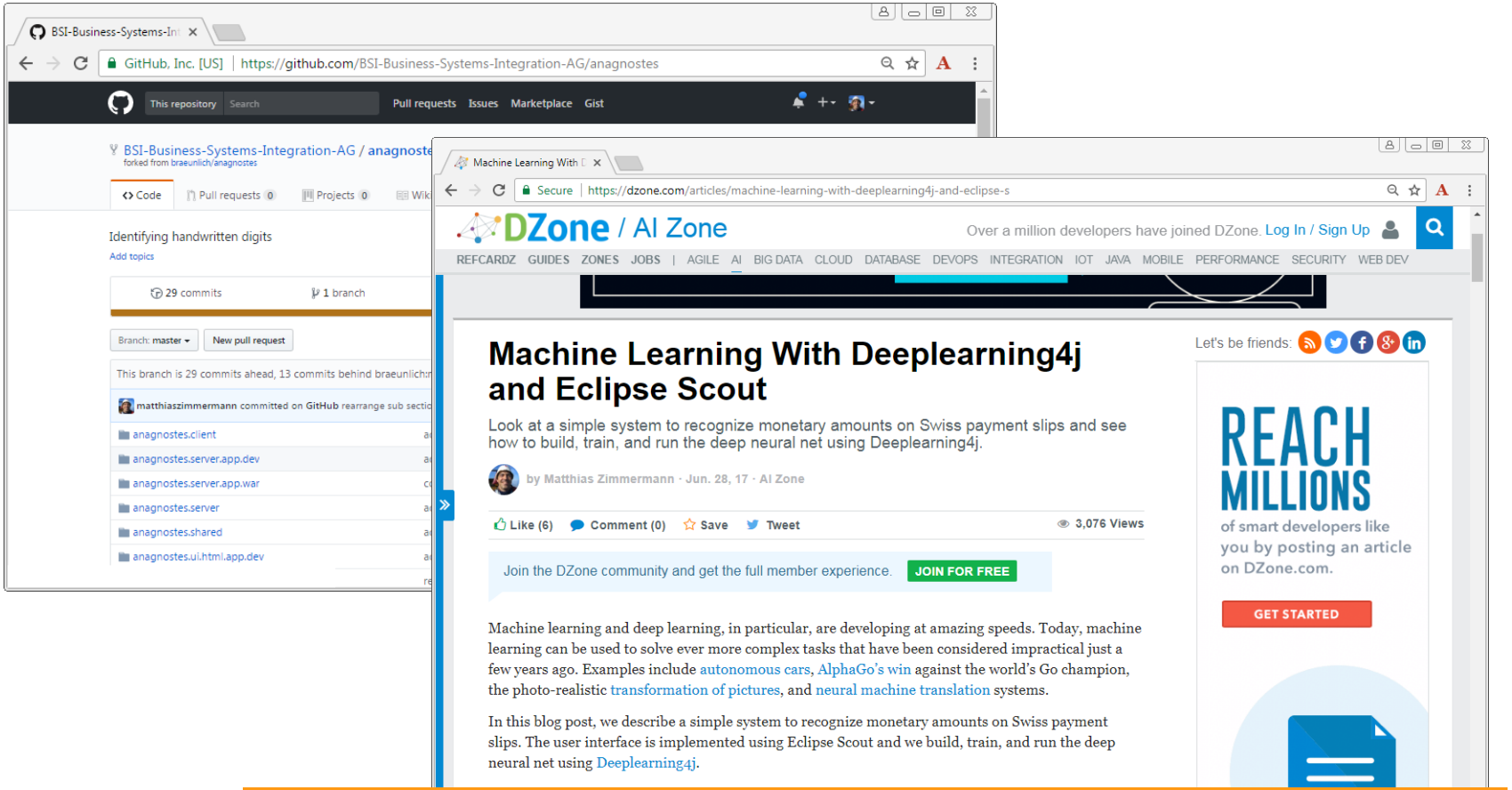
localhost:8086

0021_CH4M

Next Scan



5	0	0	8	7	1	9	4	.	5	4
1.000	0.991	0.992	1.000	1.000	1.000	0.821	0.934	-	0.805	0.582



https://github.com/BSI-Business-Systems-Integration-AG/anagnostes

Recent Advances

2014, Stanford

Deep Visual-Semantic Alignments for Generating Image Descriptions

construction worker in orange safety vest is working on road.

two young girls are playing with lego toy.

boy is doing backflip on wakeboard.

nificantly outpe
and on a new d

http://cs.stanford.edu/people/karpathy/deepimagesent/devisagen.pdf

Deep Photo Style Transfer

2017 Cornell + Adobe

(a) Input image

(e) Reference style image

(d) Our result

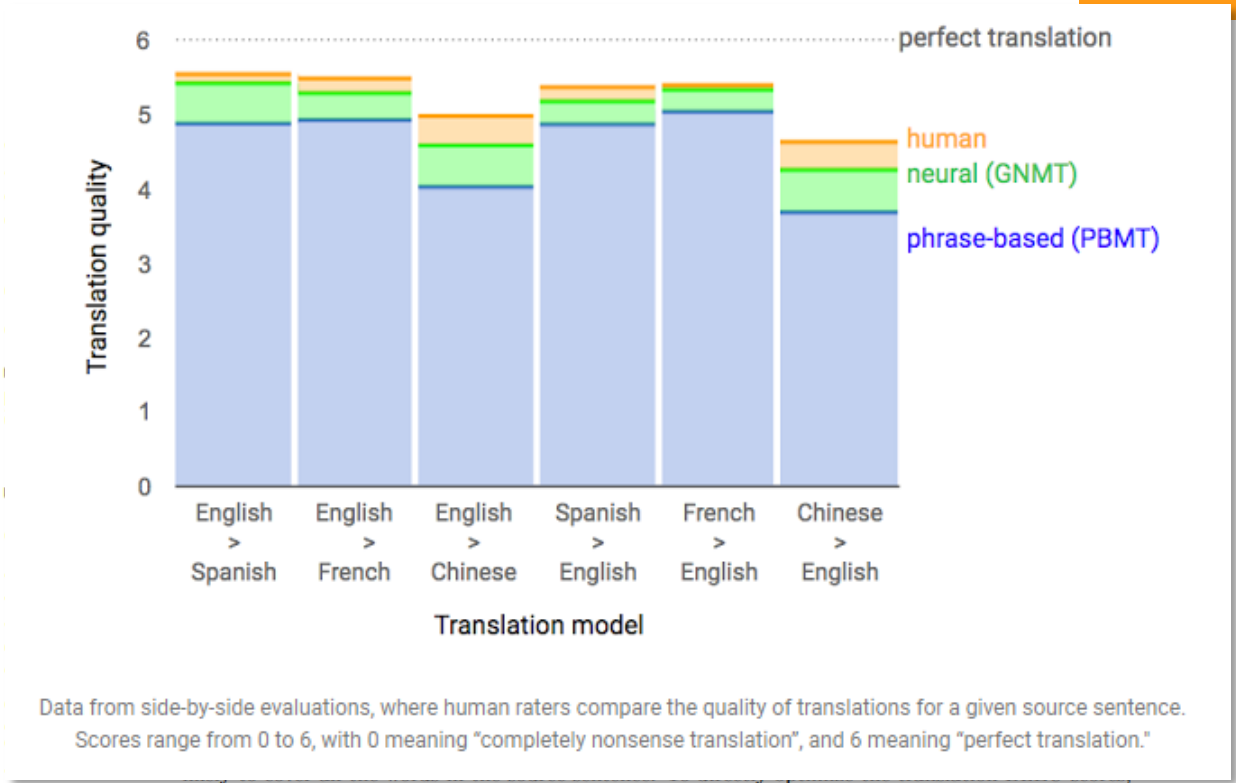
that separates style from the content of an image by consid-

retouched with a different intent. So far, existing techniques

https://arxiv.org/abs/1703.07511

Google's Neural Machine Translation System: Bridging the Gap between Human and Machine Translation

2016, Google



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."

we consider refining the models by using reinforcement learning, but we found that the improvement in the BLEU scores did not reflect in the human evaluation. On the WMT'14 English-to-French and

https://research.googleblog.com/2016/09/a-neural-network-for-machine.html

2016, Erlangen, Max-Plank, Stanford

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

Justus Thies[1], *Michael Zollhöfer*[2], *Marc Stamminger*[1], *Christian Theobalt*[2], *Matthias Nießner*[3]

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

CVPR 2016 (Oral)

http://www.graphics.stanford.edu/~niessner/thies2016face.html

Reenactment is th
mation transfer between source and target. The mouth inte-
sensor to a target actor. The target sequence can be any

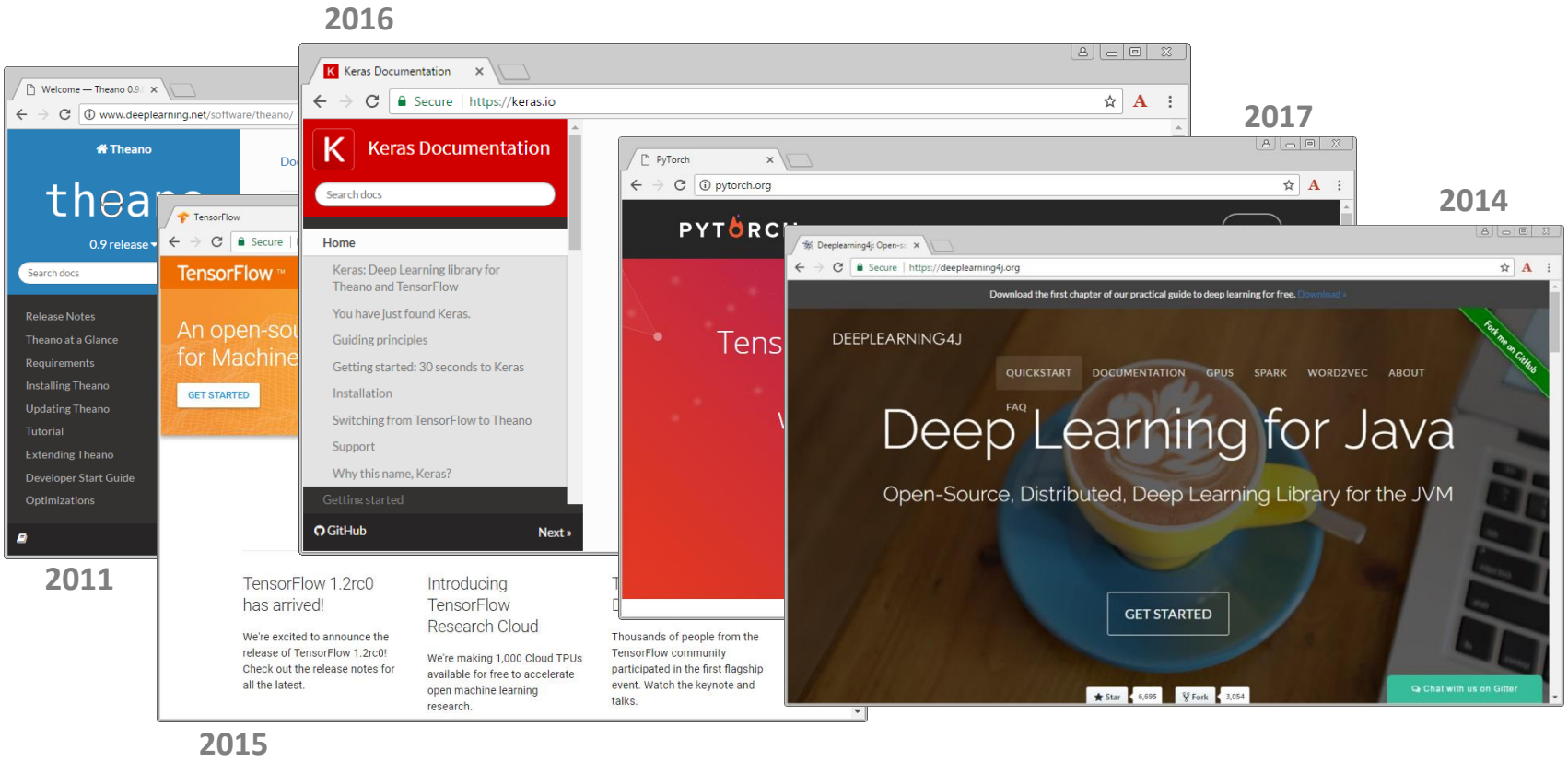
Modern Art «Turing Test»

2017, Reutgers, Facebook, …

706.07068v1 [cs.AI] 21 Jun 2017

https://www.technologyreview.com/s/608195/machine-creativity-beats-some-modern-art/

ML Libraries



Food for Thought

ML performance >= Human Levels (2017)

Games Backgammon 1979, chess 1997, Jeopardy! 2011,
Atari games 2014, Go 2016, Poker (Texas Hold'em) 2017

Visual CAPTCHAs 2005, face recognition 2007,
traffic sign reading 2011, ImageNet 2015,
lip-reading 2016

Other Age estimation from pictures 2013, personality judgement from Facebook «likes» 2014, conversational speech recognition 2016, contemporary art, 2017

Artificial Intelligence and Robotics + Add to myFT

AI and robots threaten to unleash mass unemployment, scientists warn

Intelligent machines will soon replace human workers in all sectors of economy

Read latest:

Market grows for 'regtech', or AI for regulation

OCTOBER 14, 2016

Positive Outcomes

Statement by Lee Sedol

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?

Socalizing

➔ 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