Assignment 2

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Updated plan

- **Old plan:**
  three programming assignments:
  Assignment 1: Linear Models + MLP
  Assignment 2: Deep Neural Networks on GPU's
  Assignment 3: ***A DL Challenge***

- **New plan:**
  Assignments 2 and 3 merged together
  Deadline: 19 April (Wednesday evening)
  Deadline for self-evaluation: 1 May (Monday morning)
  Presentation of best papers: 3 May (Wednesday, 11:15)

Objectives of A2

1. Master 3 types of networks and learn some of their applications:
   - ***Convolutional***
   - ***Recurrent***
   - ***Autoencoders***
2. Master modern tools for training deep networks on GPUs (***Python + KERAS(Theano|Tensorflow***)).
3. **Learn how to apply "Deep Learning" to some interesting problems.**

A2: step-by-step

1. Get acquainted with TensorFlow or Theano and Keras by studying and running various programs/tutorials that are available on the internet
2. Select, for each type of networks (CNNs, RNNs, AutoEncoders), an interesting problem and produce a "proof-of-understanding" by:
   - *Describing the problem and the network(s) used in your experiments*
   - *Describing the data, the experiments, and the results of your experiments*

This step shouldn't cost you much time: just browse the internet, re-run some experiments, modifying data or network parameters and describe your findings in the report (up to 3 pages in total).

A2: the last step

3. The Challenge:

Find an original problem and/or a data set and apply "Deep Learning" to it. You are free to use any type of network – also those that were not covered during the course.

Some ad-hoc ideas:

- *"from ASCI to UNICODE" (e.g., French, Polish, German)*
- *"automatic extractions of equations from pdfs"*
- *"images of equations into Latex"*
- *"restoration of images"*
- *...*

A2: the report

1. *Spend most time and effort on the "challenge" part of A2. This part of the report shouldn't exceed **7 pages**. Only this part of your work will be evaluated by your peers. Don't forget to attach your code!*
2. Spend at most ***3 pages*** (one per network type) on providing "a proof of understanding" – it is a compulsory part (not graded) and the reviewers will only check if you actually produced such a "proof".
3. *Keep in mind that the grade for A2 will be mainly decided by your colleagues.*
4. *Get help/feedback from your "Instructors".*

Software

- Theano
  http://deeplearning.net/software/theano/

- TensorFlow
  https://www.tensorflow.org/

- Keras
  https://keras.io/

Hardware

- A GPU-server: duranium.liacs.nl (reachable from LIACS network or via ssh gateway gold.liacs.nl)
- For small data sets you may use “normal computers” – Theano, TensorFlow, Keras can be installed on Linux, Windows, Mac OS.
- Any PC with a modern NVIDIA GPU (with DDR5 RAM) would be much faster that a plain PC.
- On Wed. 22/03, 9:00: *intro to DSLab/duranium, etc.*

Resources

1. *Lots of examples implemented in KERAS:*
   https://github.com/fchollet/keras/tree/master/examples
   https://github.com/Yaffa1607/Tensorflow_HVASS

2. Popular data sets used in Deep Learning:
   http://deeplearning.net/datasets/

3. *Tutorials:*
   http://deeplearning.net/reading-list/tutorials/

   (!) https://www.youtube.com/user/hvasslabs

4. *Papers:*
   http://deeplearning.net/reading-list/

Examples

- Sequence to Sequence Learning
- “Reading Comprehension”
- Visualization of Kernels of Convolutional NNs
- “Google Deep Dream”
- OCR (images of short words, distorted fonts)
- Sentiment/Text analysis (IMDB data sets)
- www.kaggle.com/deepmatrix/imdb-5000-movie-dataset
- Text Generation
- Adversarial Examples
- ...

Sequence To Sequence Learning

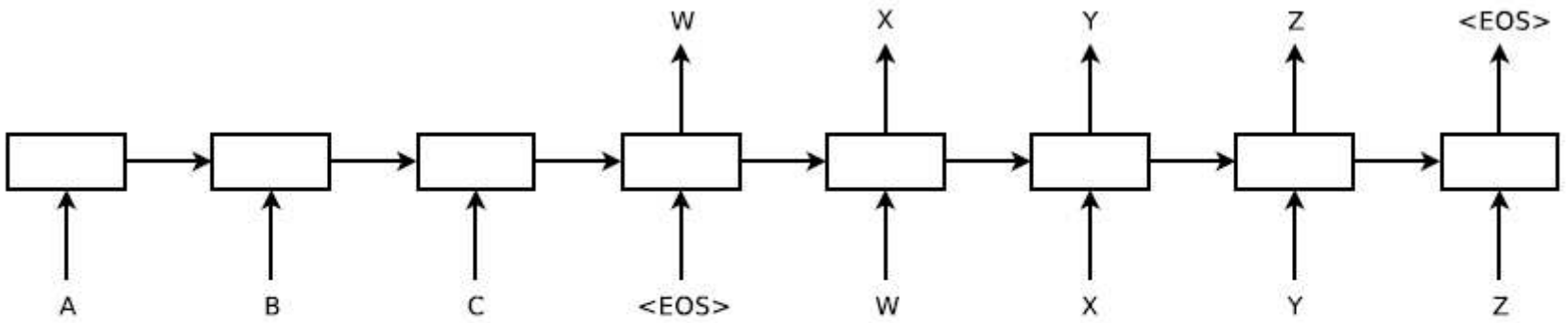


Figure 1: Our model reads an input sentence "ABC" and produces "WXYZ" as the output sentence. The model stops making predictions after outputting the end-of-sentence token. Note that the LSTM reads the input sentence in reverse, because doing so introduces many short term dependencies in the data that make the optimization problem much easier.

- English to French
- '3 + 5' to '8'

Reading Comprehension

Develop a NN to pass the "reading comprehension task"

Task 1: Single Supporting Fact

Mary went to the bathroom.
John moved to the hallway.
Mary travelled to the office.
Where is Mary? A:office

Task 2: Two Supporting Facts

John is in the playground.
John picked up the football.
Bob went to the kitchen.
Where is the football? A:playground

Task 3: Three Supporting Facts

John picked up the apple.
John went to the office.
John went to the kitchen.
John dropped the apple.
Where was the apple before the kitchen? A:office

Task 4: Two Argument Relations

The office is north of the bedroom.
The bedroom is north of the bathroom.
The kitchen is west of the garden.
What is north of the bedroom? A: office
What is the bedroom north of? A: bathroom

Task 5: Three Argument Relations

Mary gave the cake to Fred.
Fred gave the cake to Bill.
Jeff was given the milk by Bill.
Who gave the cake to Fred? A: Mary
Who did Fred give the cake to? A: Bill

Task 6: Yes/No Questions

John moved to the playground.
Daniel went to the bathroom.
John went back to the hallway.
Is John in the playground? A:no
Is Daniel in the bathroom? A:yes

Reading Comprehension

	Weakly Supervised		Uses External Resources	Strong Supervision (using supporting facts)						
TASK	N-gram Classifier	LSTM	Structured SVM *COREF+SRL features*	MemNN Weston et al. (2015)	MemNN *ADAPTIVE MEMORY*	MemNN *AM + N-GRAMS*	MemNN *AM + NONLINEAR*	MemNN *AM + NG + NL*	No. of ex. req. ≥ 95	Multi-Task Training
1 - Single Supporting Fact	36	50	99	100	100	100	100	100	250 ex.	100
2 - Two Supporting Facts	2	20	74	100	100	100	100	100	500 ex.	100
3 - Three Supporting Facts	7	20	17	20	**100**	**99**	**100**	**100**	500 ex.	**98**
4 - Two Arg. Relations	50	61	98	71	69	**100**	73	**100**	500 ex.	80
5 - Three Arg. Relations	20	70	83	83	83	86	86	**98**	1000 ex.	**99**
6 - Yes/No Questions	49	48	99	47	52	53	**100**	**100**	500 ex.	**100**
7 - Counting	52	49	69	68	78	86	83	85	FAIL	86
8 - Lists/Sets	40	45	70	77	90	88	94	91	FAIL	93
9 - Simple Negation	62	64	100	65	71	63	**100**	**100**	500 ex.	**100**
10 - Indefinite Knowledge	45	44	99	59	57	54	**97**	**98**	1000 ex.	**98**
11 - Basic Coreference	29	72	100	100	100	100	100	100	250 ex.	100
12 - Conjunction	9	74	96	100	100	100	100	100	250 ex.	100
13 - Compound Coref.	26	94	99	100	100	100	100	100	250 ex.	100
14 - Time Reasoning	19	27	99	99	100	99	100	99	500 ex.	99
15 - Basic Deduction	20	21	96	74	73	**100**	77	**100**	100 ex.	**100**
16 - Basic Induction	43	23	24	27	**100**	**100**	**100**	**100**	100 ex.	94
17 - Positional Reasoning	46	51	61	54	46	49	57	65	FAIL	72
18 - Size Reasoning	52	52	62	57	50	74	54	**95**	1000 ex.	93
19 - Path Finding	0	8	49	0	9	3	15	36	FAIL	19
20 - Agent's Motivations	76	91	95	100	100	100	100	100	250 ex.	100
Mean Performance	34	49	79	75	79	83	87	93		92

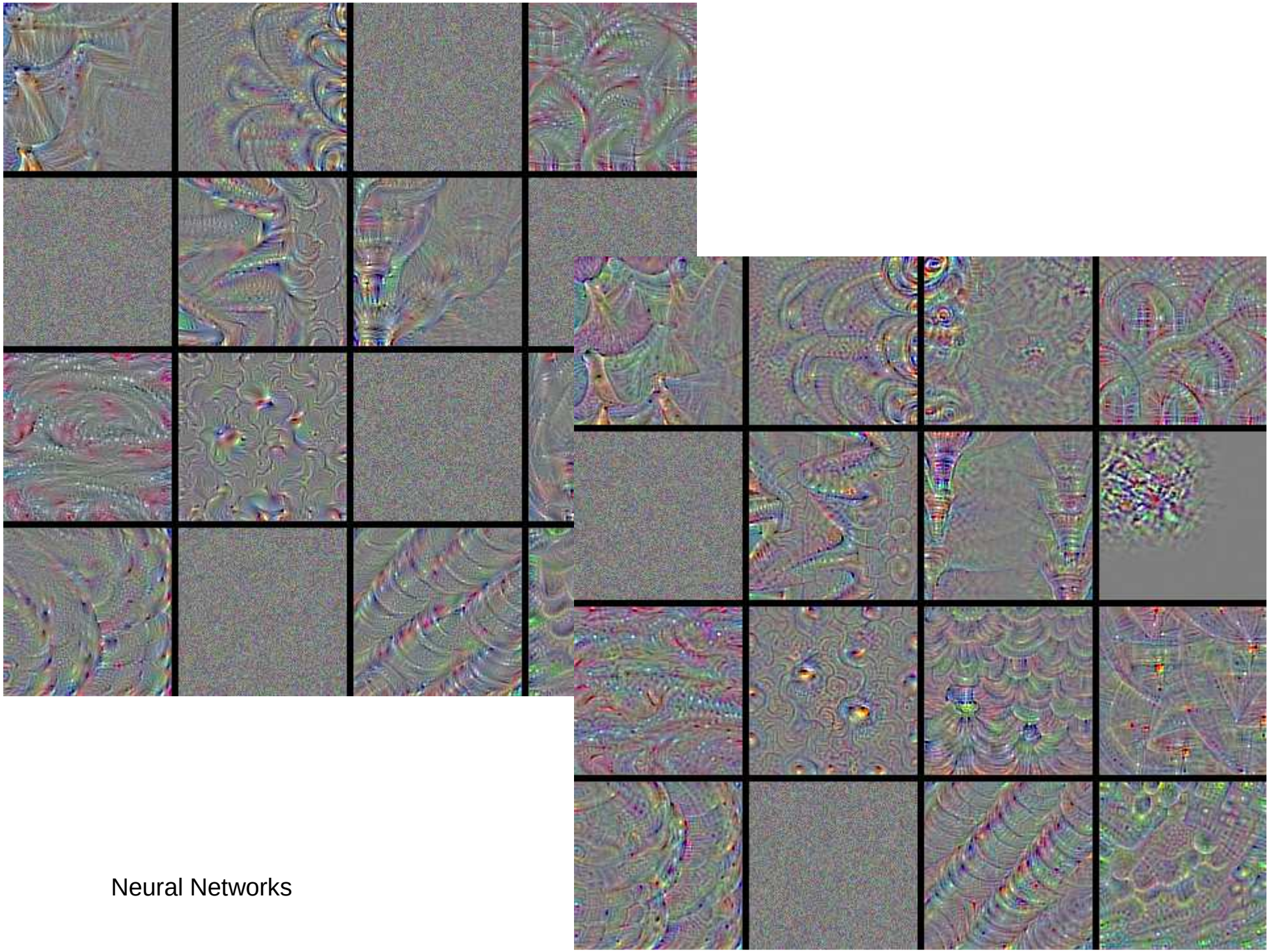
Visualization of Kernels of CNNs

- Train a CNNs (*or download it from the internet!*)
- Select a kernel you want to “understand”
- Search for an input image that strongly activates the selected kernel

  => optimization problem!

- Apply “inverted backpropagation”: input nodes play a role of weights; weights play a role of a “fixed input”

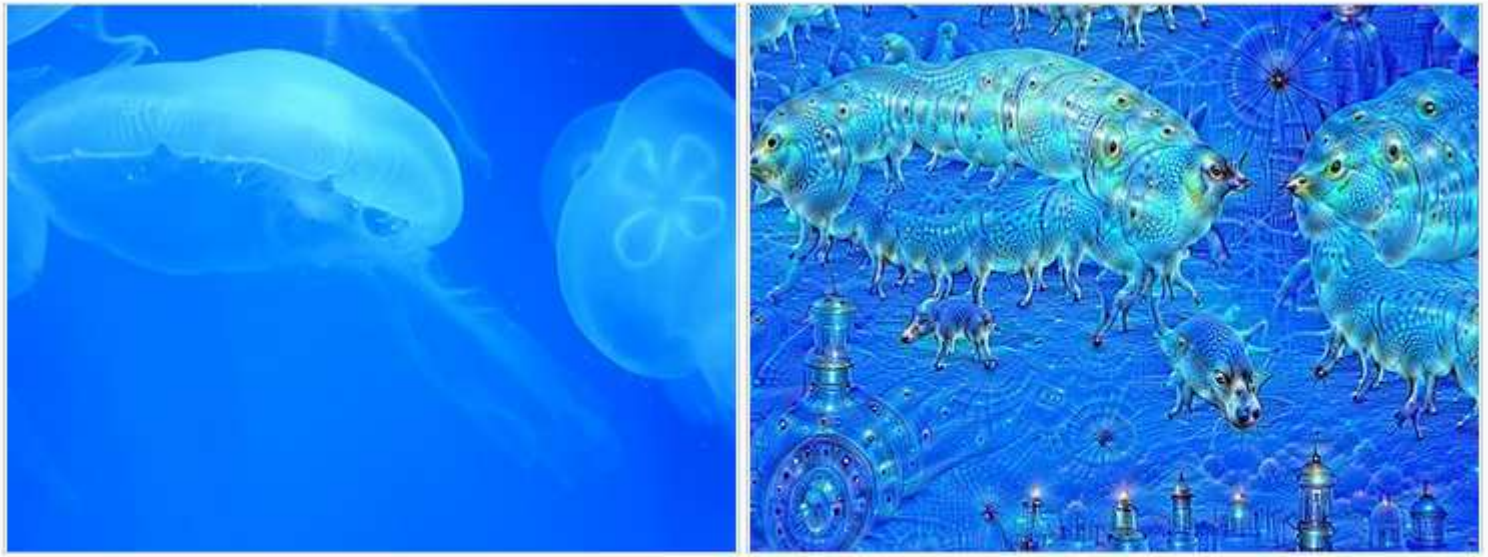
https://jacobgil.github.io/deeplearning/filter-visualizations



Neural Networks

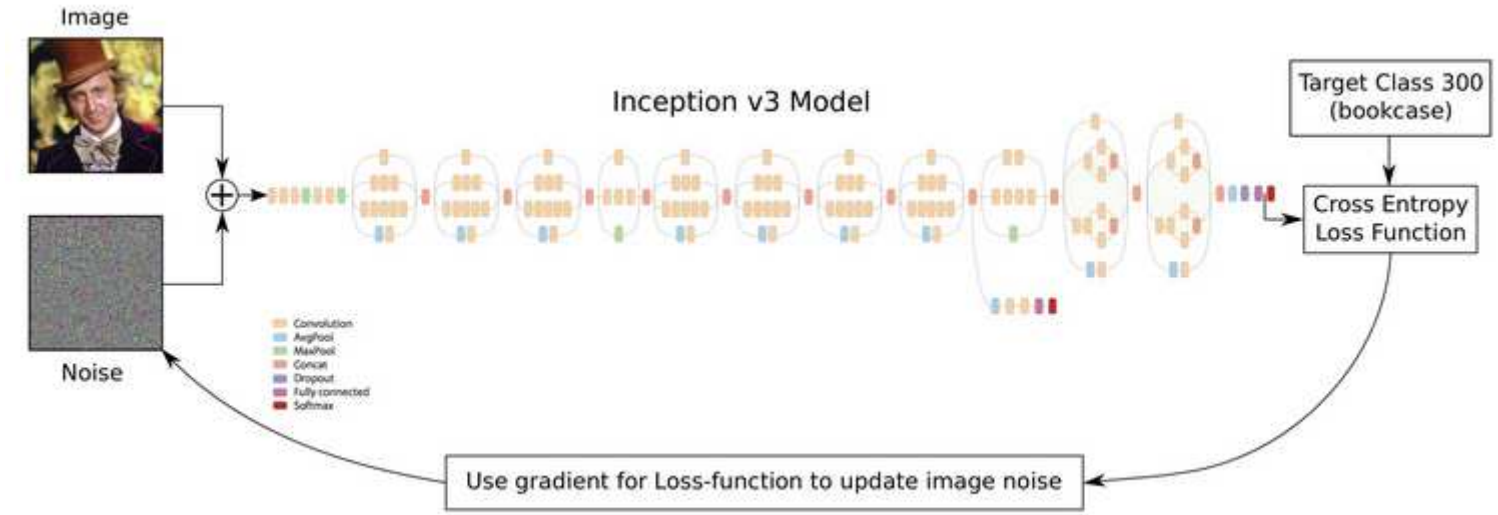
Deep Dream (check Wikipedia)

- Take a trained ImageNet (or something similar)
- Provide an input image (e.g., “a castle”)
- Smoothly change the input so it could be classified as a “fish”
- optimization problem => SGD
- Spectacular effects !



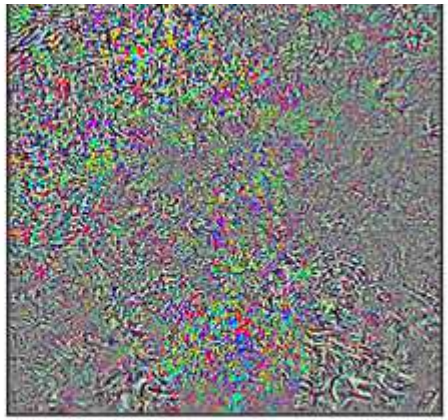
The same image before (left) and after (right) applying ten iterations of DeepDream

Adversarial Examples



Original Image:
bow tie (97.22%)

Image + Noise:
bow tie (0.00%)
bookcase (99.72%)



Amplified Noise

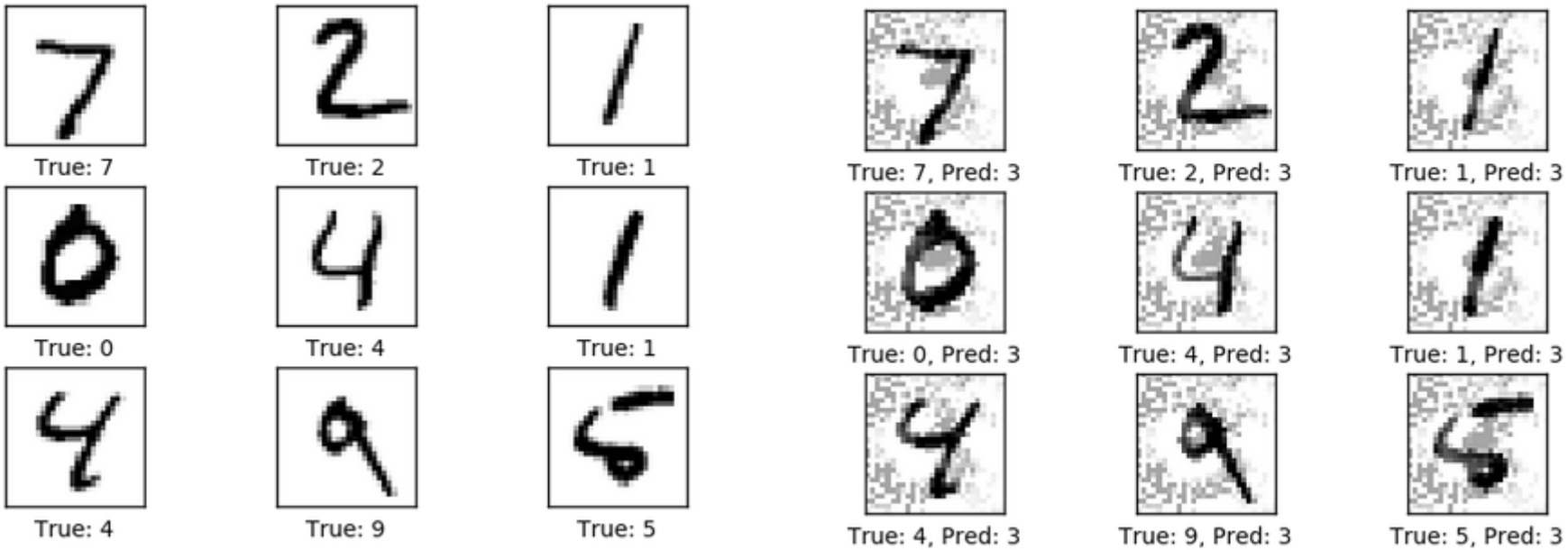
Noise min: -3.000, max: 3.000, mean: -0.000, std: 1.309

Adversarial Examples: MNIST

Accuracy drop from 99% to 11% accuracy (over test set)

https://github.com/Yaffa1607/Tensorflow_HVASS/blob/master/12_Adversarial_Noise_MNIST.ipynb

More: http://cs231n.github.io/understanding-cnn/



Automatic Text Generation

- Train a RNN on a collection of documents
- The network learns to predict next word(s)
  (better: probability distribution of "next word")
- Apply the network to an initial phrase to generate more text

- More Idea's:
  - try this approach on the Europarl text corpora
  - author recognition
  - detection of unusual phrases ("cheating"?)
  - detection of a "change of style / rhetoric" (e.g. for politicians)
  - ...

- Text Summarization https://arxiv.org/abs/1506.01057

Theano, TensorFlow, Keras

- Install Theano or TensorFlow (TF is a default)
- Install Keras
- Follow Tutorials and Examples from
  - Keras
    https://keras.io/
  - Github:
    https://github.com/fchollet/keras/tree/master/examples