Chapter 1: Introduction

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Neural Networks Implementation and Application

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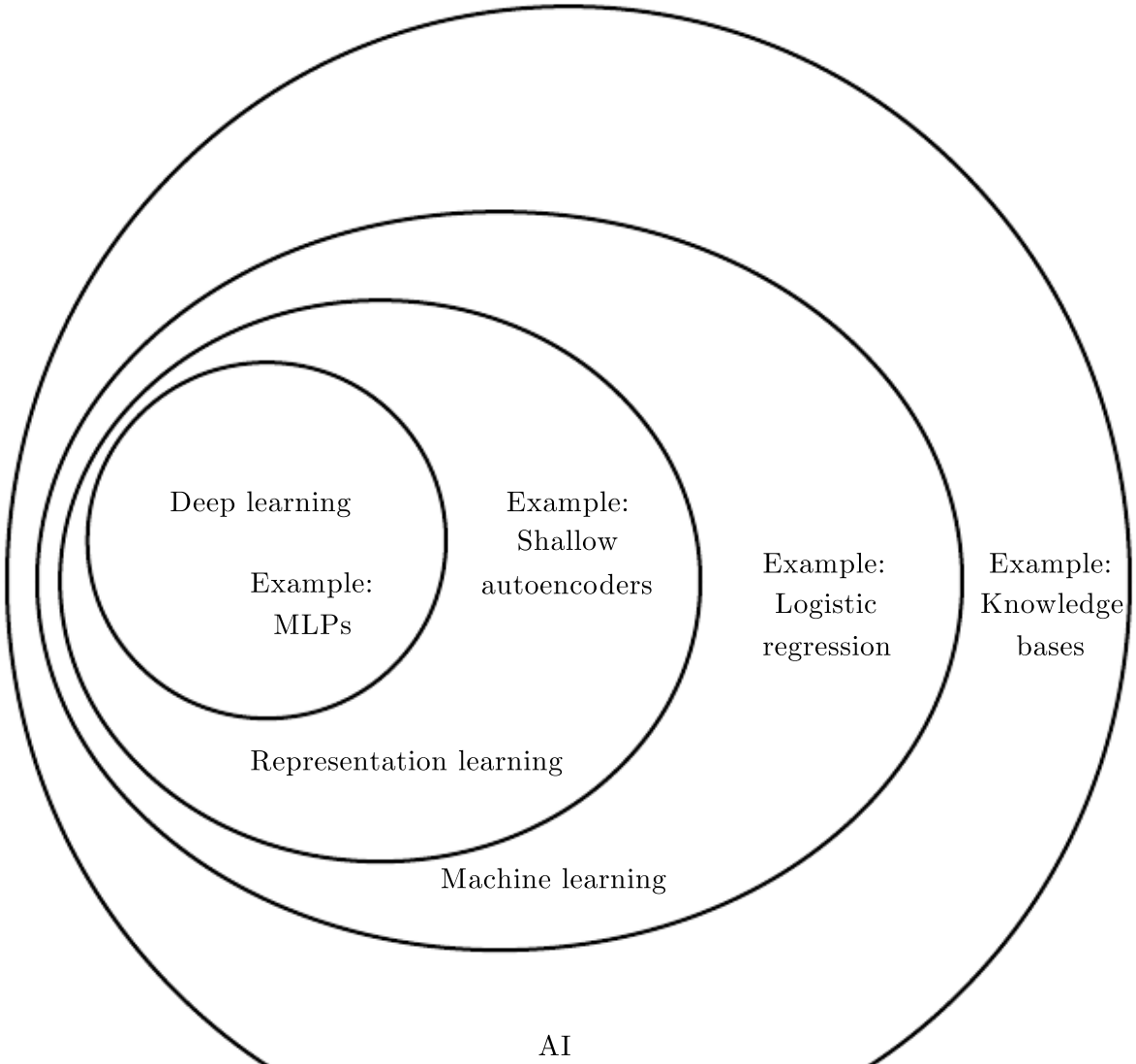
Outline

AI, ML and Deep Learning



Content

- Linear Algebra and Principal Component Analysis (PCA)
- Numerical Computation
- Machine Learning Basics
- Deep Feedforward Networks
- Regularization for Deep Learning
- Optimization for Training Deep Models
- Convolutional Networks
- Sequence Modeling: Recurrent and Recursive Nets
- Practical Methodology
- Applications
- Autoencoders
- Representation Learning

Based on http://www.deeplearningbook.org/

Content

- This lecture is meant for students in the 5th to 8th semester

Based on http://www.deeplearningbook.org/

Registration

- https://www.lsv.uni-saarland.de/fileadmin/registration/register.php
- Will form basis of mailing list, tutorial groups etc.
- Deadline: tomorrow morning 8:00am
- Don't confuse with HISPOS registration!

Note: we are trying to look for a bigger lecture hall.

Course home page

- Organizational information
- Slides
- Exercises sheet
- Supplementary material

Tutorials

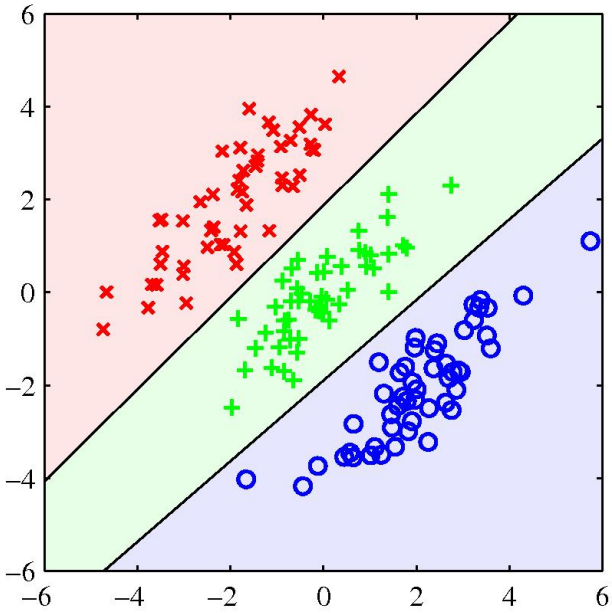
- We will have three groups and three tutors
  - Marius Mosbach <s9msmosb@stud.uni-saarland.de>
  - Rajarshi Biswas <s9rabisw@stud.uni-saarland.de>
  - Maksym Andriushchenko <s8mmandr@stud.uni-saarland.de>
- Time/day of the week will be determined by a doodle
- First exercises will be issued this week
- Will be distributed on mailing list
- Submissions in groups of three
- Attendance:2 bonus points
- For showing a solution in the tutorial: up to 2 bonus points per tutorial (maximum 4 bonus points in the complete semester)
- Pass threshold to be eligible for exam: 67%
- Two quizzes (need to pass both in order to be eligible to the exam)

Exam

- Don't forget to register in HISPOS in time!
- Date for exam: 6.2.17
- Time for exam: 14:00-16:00
- Location: C6 4; Room 10

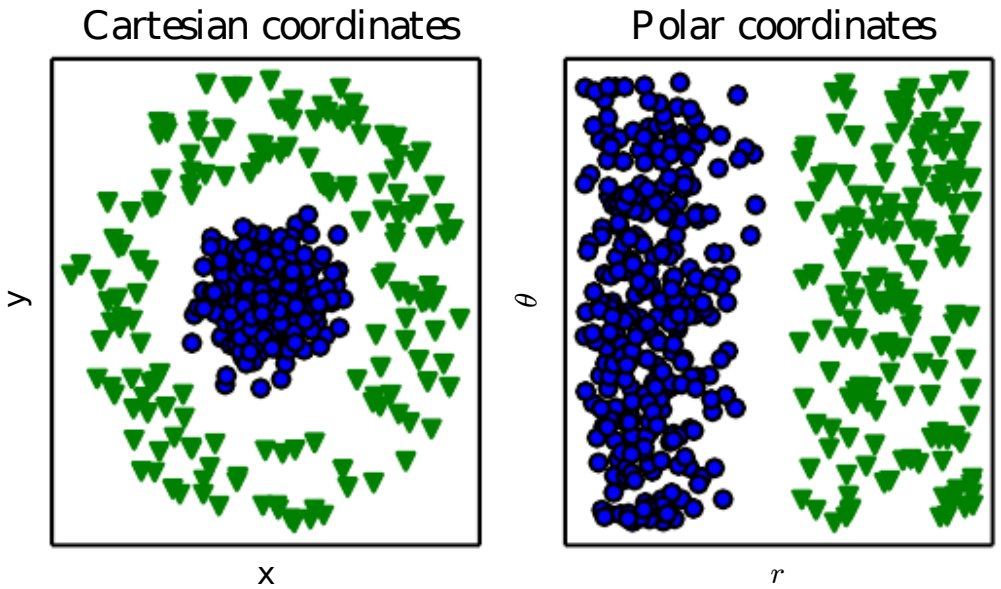
Machine Learning

- Task: classify object (assign label)
- Representation of objects as points in feature space
- Example of a three class problem in a 2-dimensional feature space:



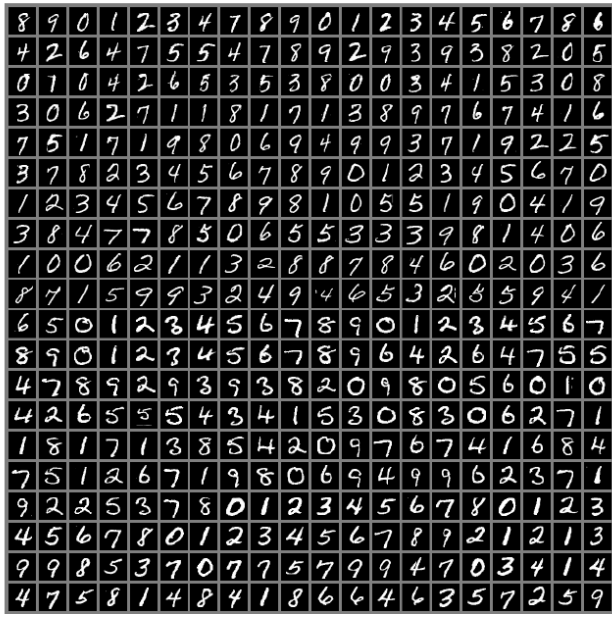
- Task rephrased: find decision boundary

Learning Representations



- Not all feature spaces are equally well suited for classification
- Change of coordinates makes problem linearly separable

MNIST: a popular data set



- Old and small
- Still a popular simple test case

Neutral Networks and Computation Graphs

Assume we have only two classes
Simple neural network:

- Classify as class 1 if $\sigma(\mathrm{w}^\top \mathrm{x}) \geq 0$
- σ is a non-linear function
- w weights (trained)
- x feature vector of object to be classified
- Representation of neural network as computation graph:

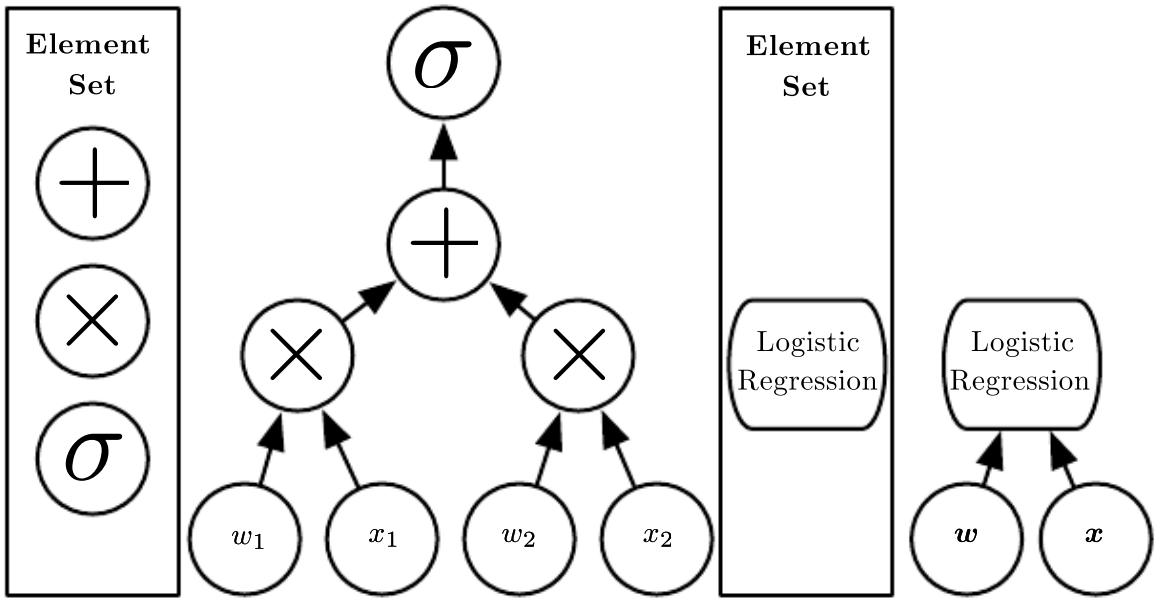
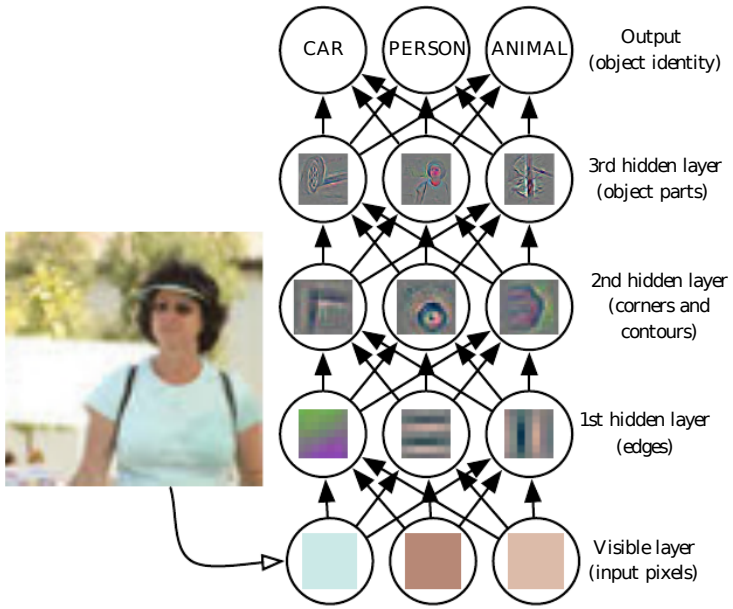


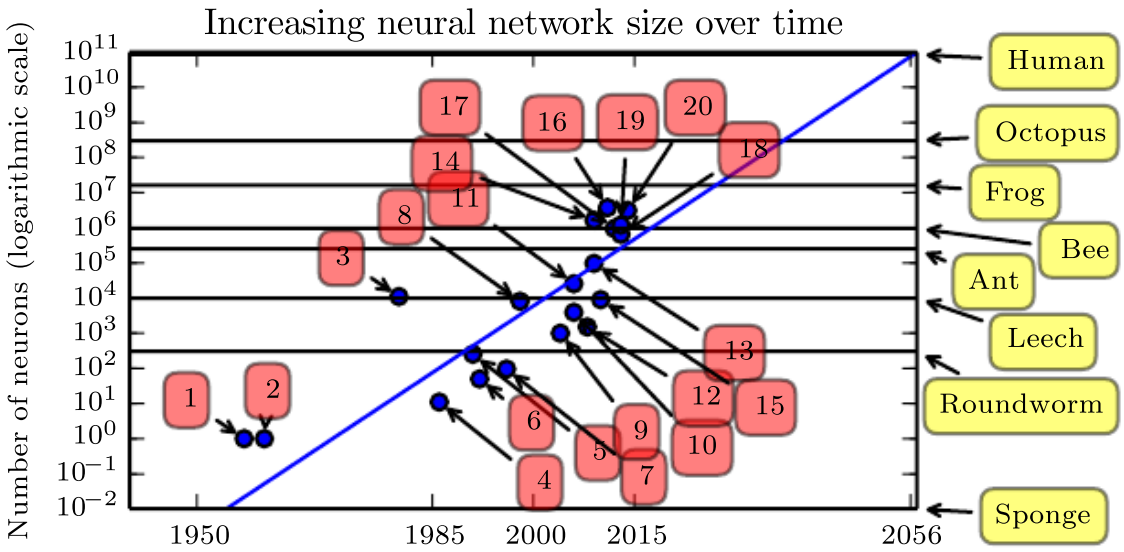
Illustration of a Deep Learning Model



Neural networks serve two purposes:

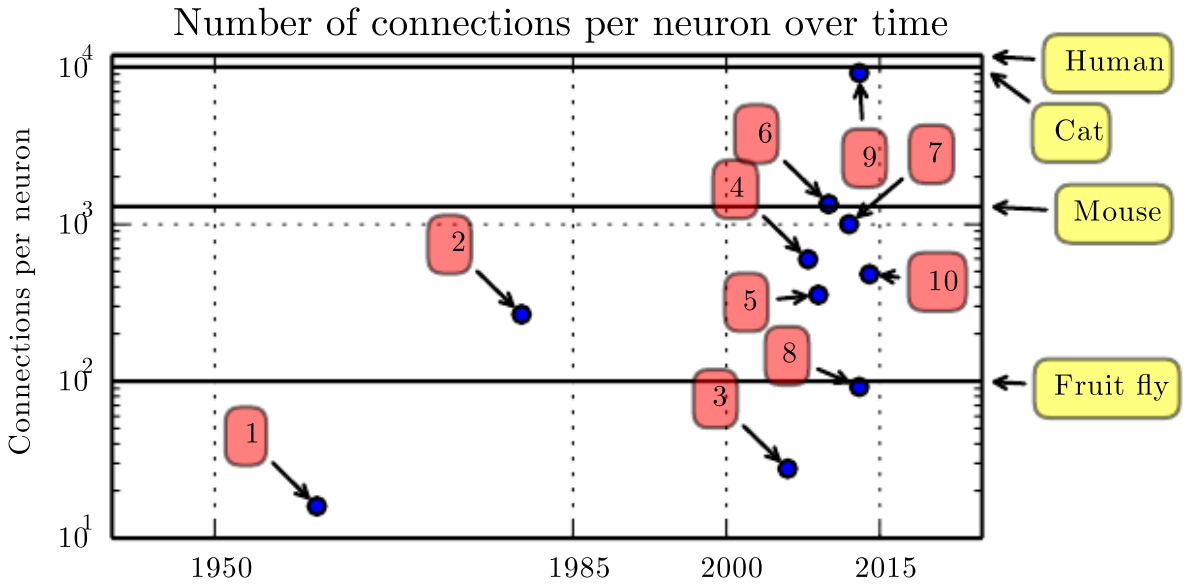
- Extract features
- Perform classification

Size of neural networks



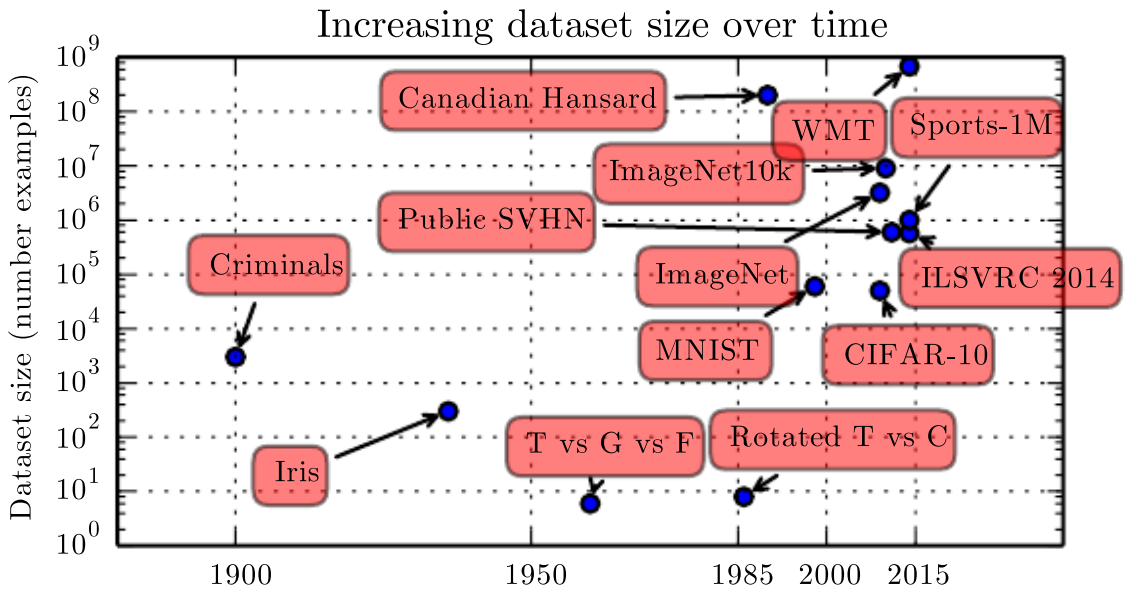
- Size doubles every 2.4 years

Number of connections per neuron



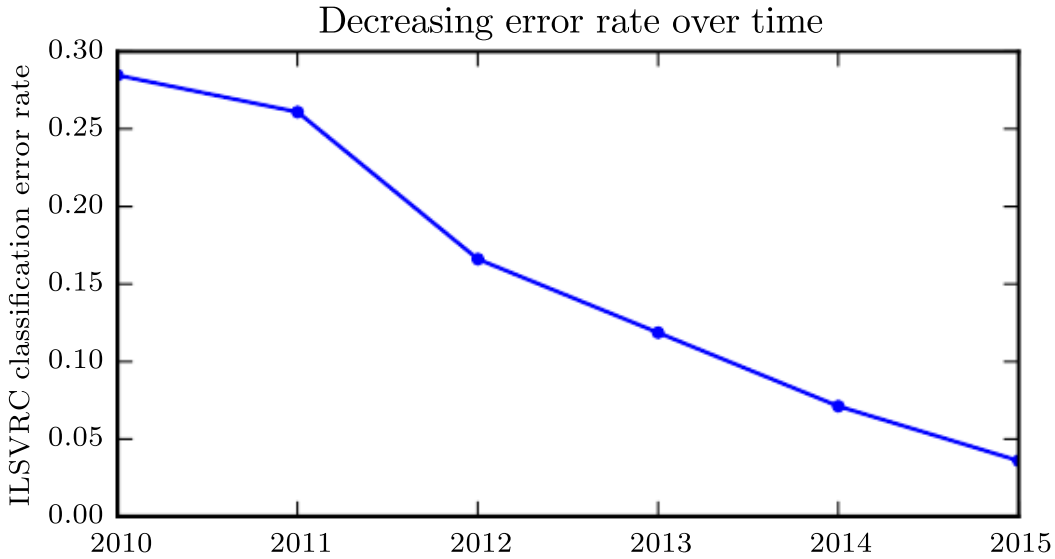
- Up to human connectivity
- Only weak correlation with time

Increase in Size of Datasets



- Increasing with time
- Language domain (machine translation) uses largest corpora

Performance on ImageNet



- Warning: this is only true for image domain
- In the language area the improvements are much smaller

Summary

- Classification: find a decision boundary in feature space
- Neural networks perform feature extraction and classification
- Success due to larger computers, more data, toolkits and the confidence that they work
- Downside: little hard facts known about neural networks and artefacts (e.g. wiggles in decision boundary/adversarial examples)

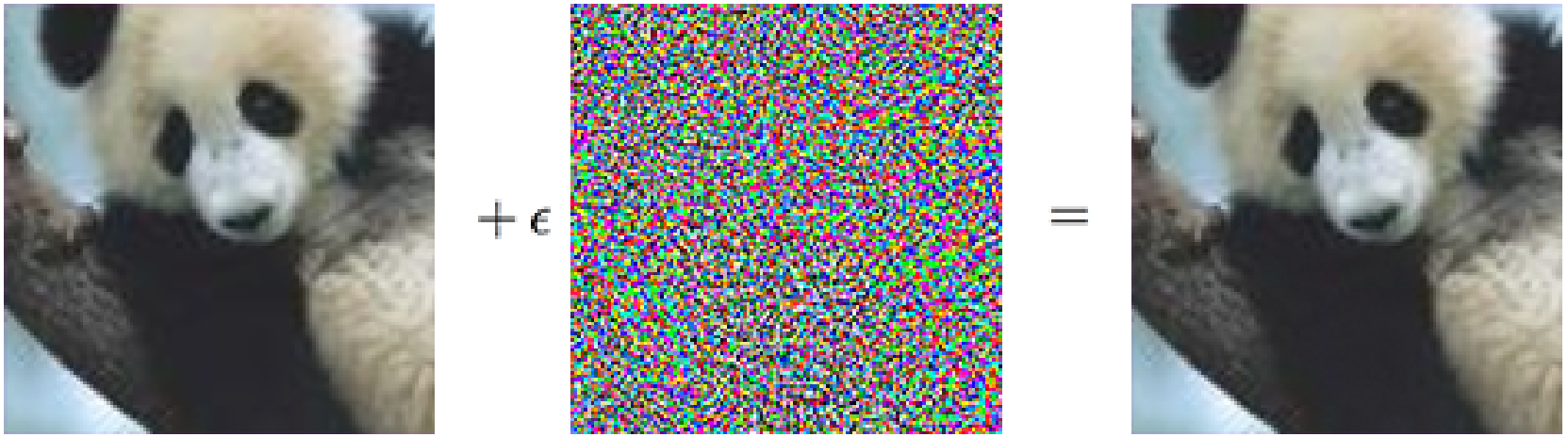


Figure : Adversarial example by Karpathy et al.)