1.2. Overview over Supervised Learning Models

Lecture based on "Dive into Deep Learning" **http://D2L.AI** (Zhang et al., 2020)

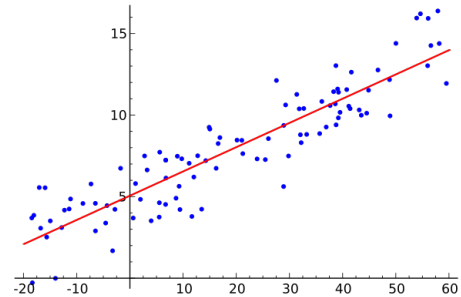
Prof. Dr. Christoph Lippert

Digital Health & Machine Learning

Linear regression

- Predict continuous output variable (e.g. insulin level)
- Linear relationship between input and output values.

$$y = f(x; \boldsymbol{\theta})$$
$$= \underbrace{b + w \cdot x}_{\text{a linear model}}$$

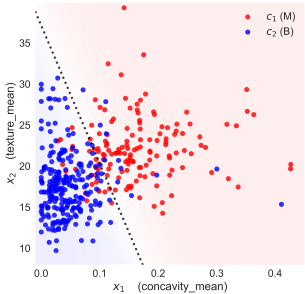


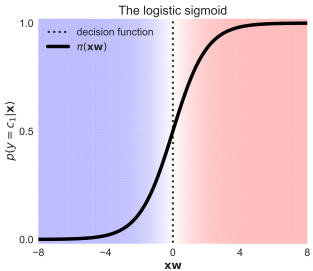
(C.M. Bishop, Pattern Recognition and Machine Learning)

Logistic regression

- Predict discrete category Y (e.g. disease vs. healthy)
- Linear class separation.
- Replace output of linear regression by sigmoid function σ

$$p(Y = 1; x; \boldsymbol{\theta}) = \sigma(b + \mathbf{wx})$$

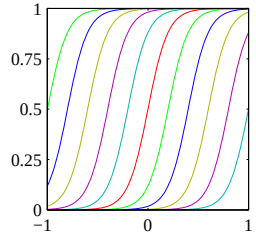




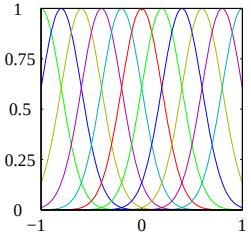
Basis functions regression

- Replace features x by non-linear functions $\phi(x)$.
- Use linear regression to learn non-linear function on $\phi(x)$

$$y = b + \mathbf{w}\boldsymbol{\phi}(\mathbf{x}) + \epsilon$$



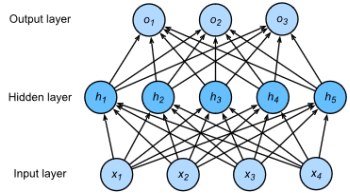
$$\phi = \sigma(x)$$



$$\phi = RBF(x)$$

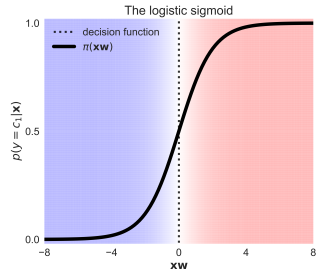
(C.M. Bishop, Pattern Recognition and Machine Learning)

Feed forward neural networks



Also known as **Multi Layer Perceptrons**.
Idea: Stack multiple layers of (linear) models with simple non-linearities (e.g. sigmoid σ) to perform
The outputs of one layer are treated as basis functions for next layer.

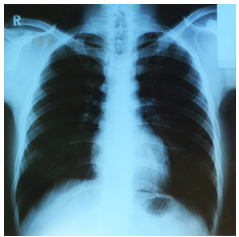
- non-linear Classification
- non-linear Regression

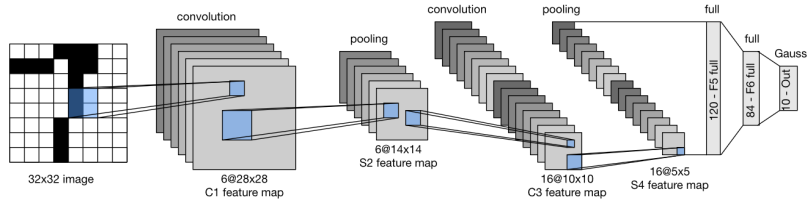


Convolutional Neural Networks

Location-invariant neural network parameters (filters) allow pattern recognition on images

- slide same weight matrix over image (convolution)
- detect local patterns
- Example applications:
  - image classification
  - object detection

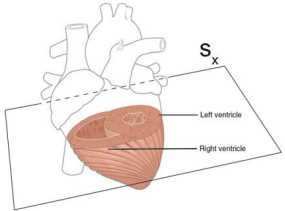




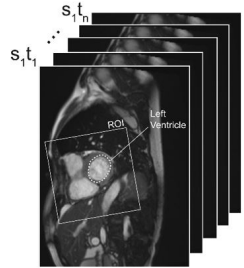
Multi-Label Classification

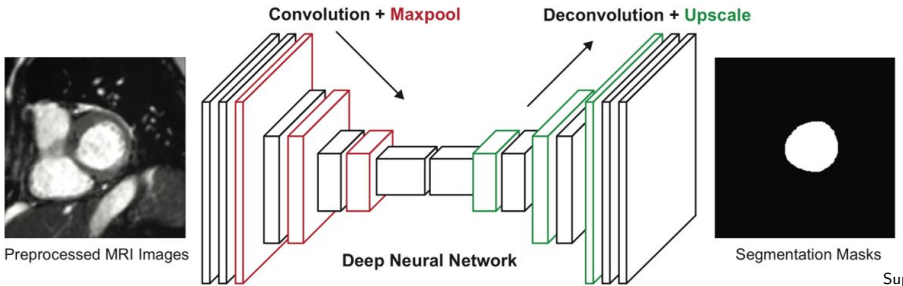



Semantic Segmentation



Cine-MRI to Determine Ejection Fraction



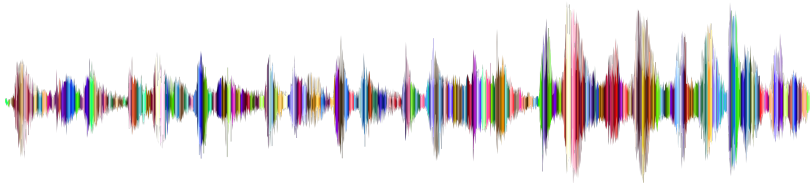


Sequence Learning

- Tagging and Parsing

```
Tom has dinner in Washington with Sally.
Ent  -    -    -     Ent       -    Ent
```

- Speech Recognition



Output: -D-e-e-p- L-ea-r-ni-ng-

- Text to speech
- Machine Translation

```
German:           Haben Sie sich schon dieses grossartige Lehrwerk angeschaut?
English:          Did you already check out this excellent tutorial?
Wrong alignment:  Did you yourself already this excellent tutorial looked-at?
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Summary

- Linear Models vs. non-linear models
- Regression
- Classification
  - Single-class vs. Multi-class vs. Multi-label
  - Tagging
  - Sequence Prediction
  - Segmentation Masks