Neural networks for time series analysis

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Day 3: overfitting, convolutional and recurrent nets

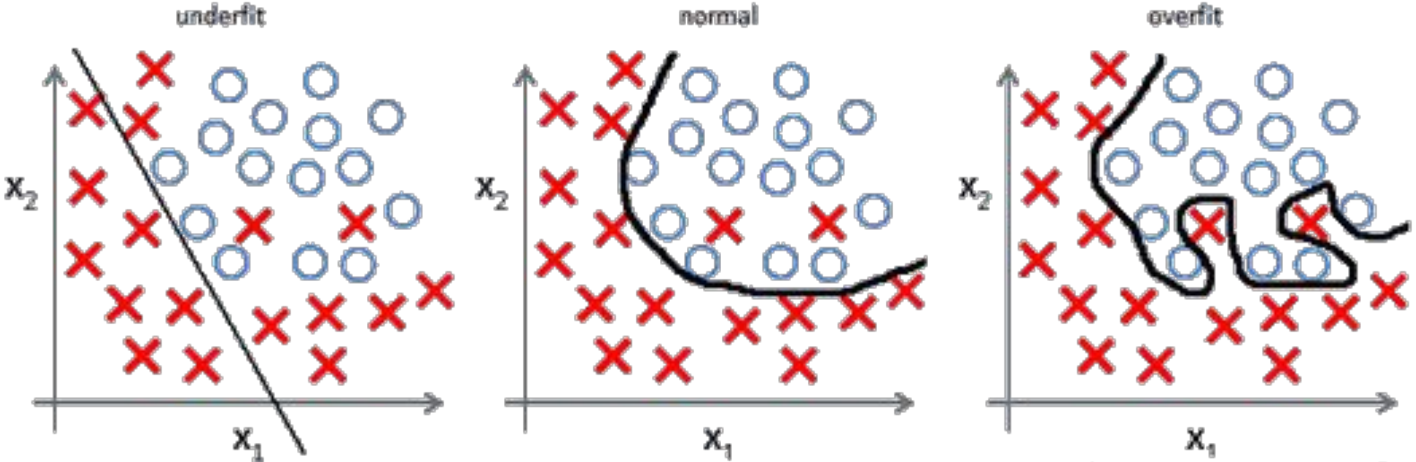
Introduction to machine learning and time series analysis

Data preparation and feedforward neural networks

Convolutional, recurrent neural networks and overfitting

Building a trading strategy and further applications

overfitting



$g(\theta_0 + \theta_1 x_1 + \theta_2 x_2)$

$g(\theta_0 + \theta_1 x_1 + \theta_2 x_2 + \theta_3 x_1^2 + \theta_4 x_2^2 + \theta_5 x_1 x_2)$

$$g(\theta_0 + \theta_1 x_1 + \theta_2 x_2 + \theta_3 x_1^2 + \theta_4 x_2^2 + \theta_5 x_1 x_2 + \theta_6 x_1^2 x_2 + \theta_7 x_1 x_2^2 + \theta_8 x_1^2 x_2^2 + \theta_9 x_1^3 + \dots)$$

data augmentation

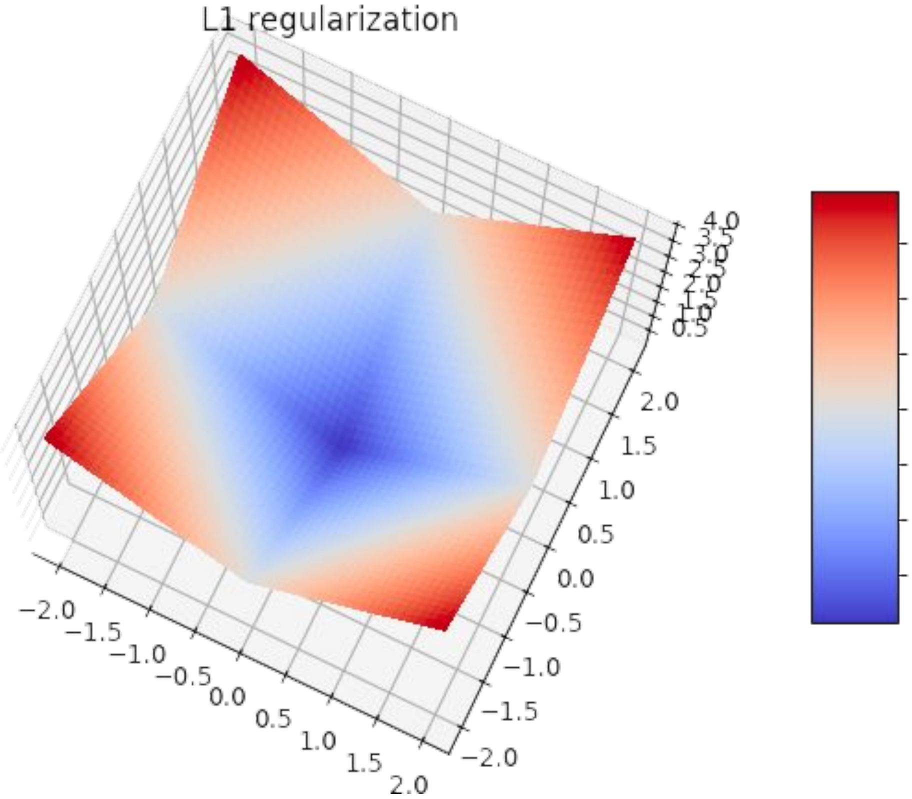
regularization

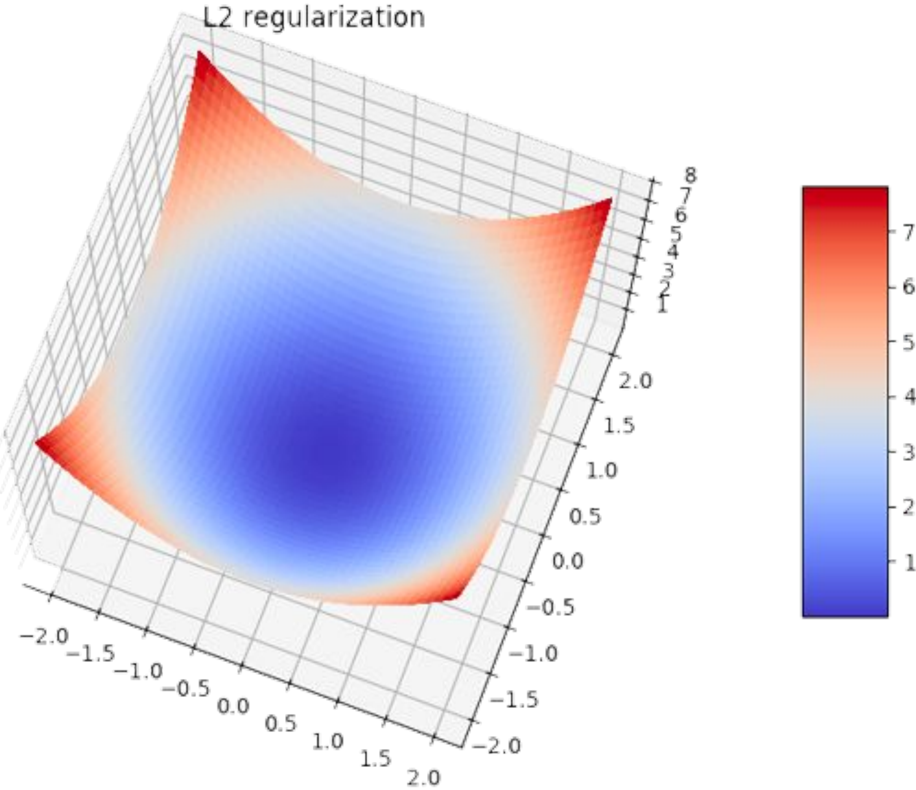
L1 Regularization

$$\text{Cost} = \sum_{i=0}^{N}(y_i - \sum_{j=0}^{M} x_{ij}W_j)^2 + \lambda \sum_{j=0}^{M} |W_j|$$

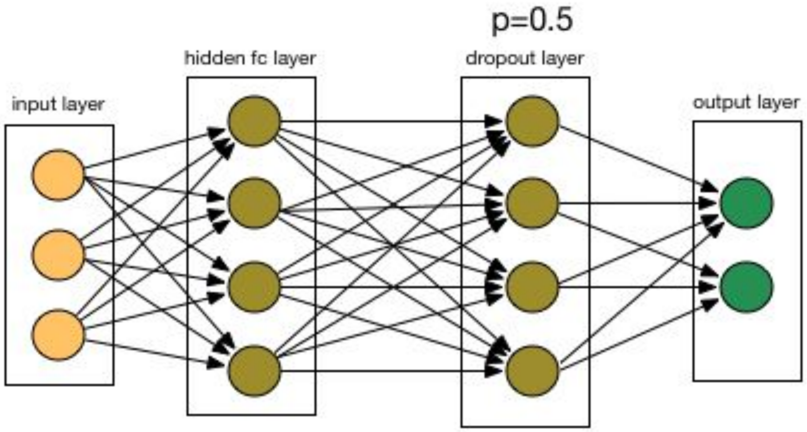
L2 Regularization

$$\text{Cost} = \underbrace{\sum_{i=0}^{N}(y_i - \sum_{j=0}^{M} x_{ij}W_j)^2}_{\text{Loss function}} + \lambda \underbrace{\sum_{j=0}^{M} W_j^2}_{\text{Regularization Term}}$$


L1 regularization
−2.0 −1.5 −1.0 −0.5 0.0 0.5 1.0 1.5 2.0
−2.0 −1.5 −1.0 −0.5 0.0 0.5 1.0 1.5 2.0
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
0.5 1.0 1.5 2.0 2.5 3.0 3.5


L2 regularization
−2.0 −1.5 −1.0 −0.5 0.0 0.5 1.0 1.5 2.0
−2.0 −1.5 −1.0 −0.5 0.0 0.5 1.0 1.5 2.0
1 2 3 4 5 6 7 8

dropout

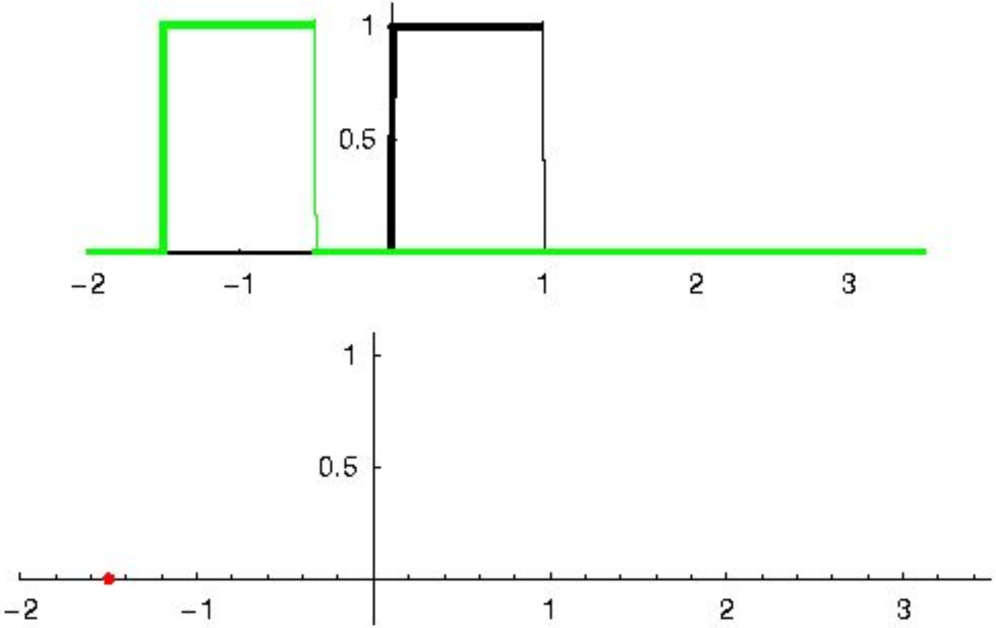


Training time

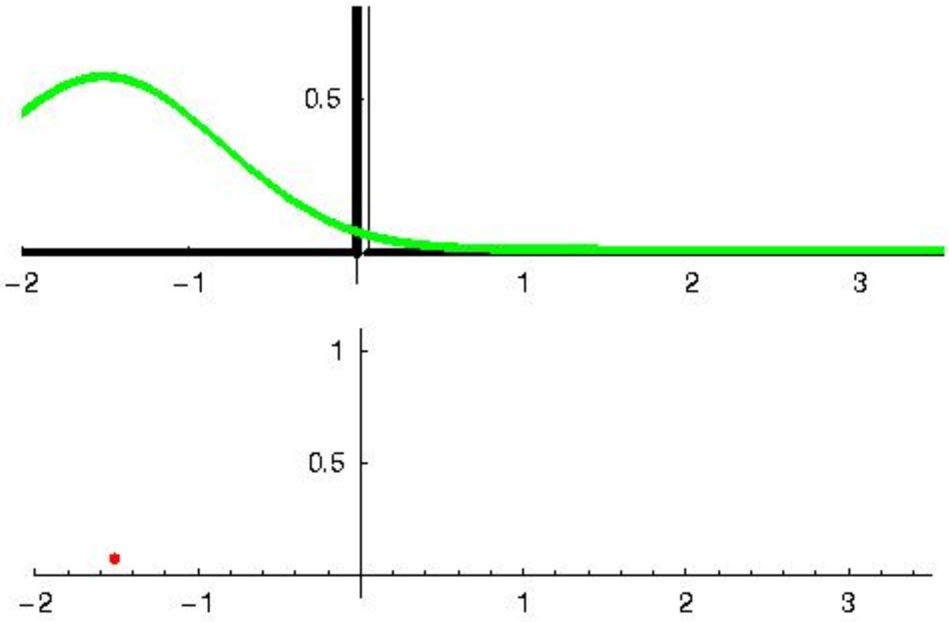
noise augmentation

convolutional neural nets

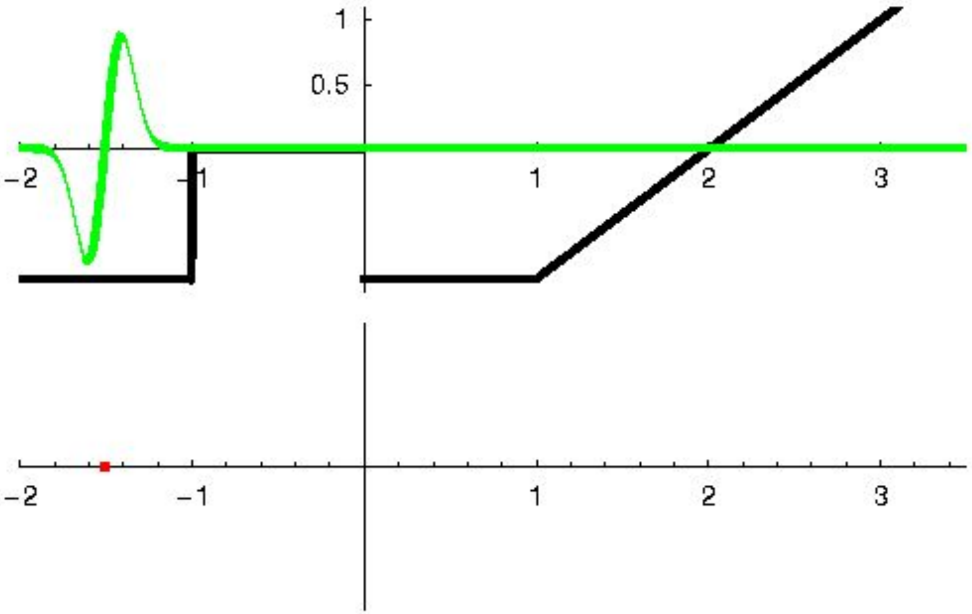
Convolution of a block with a block



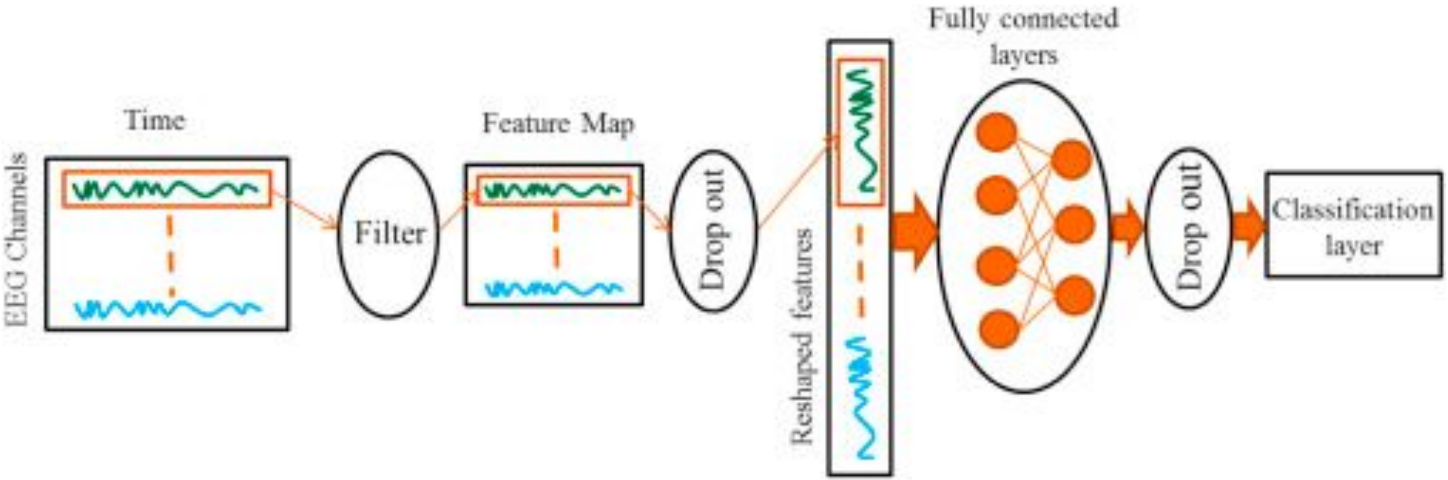
Convolution of a spike with a gaussian



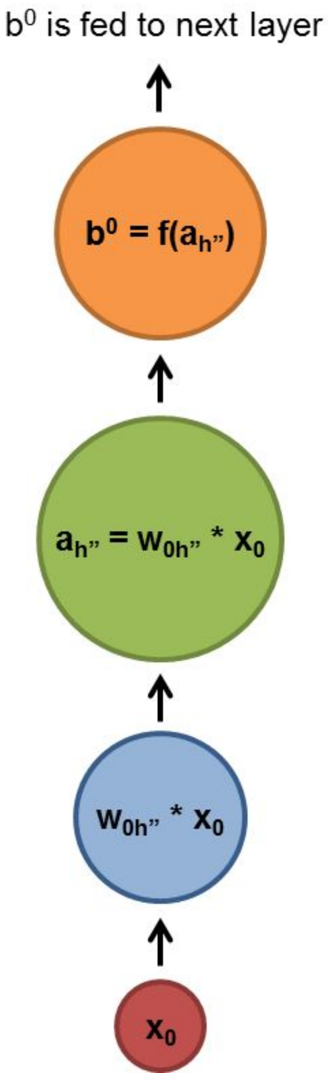
edge detection

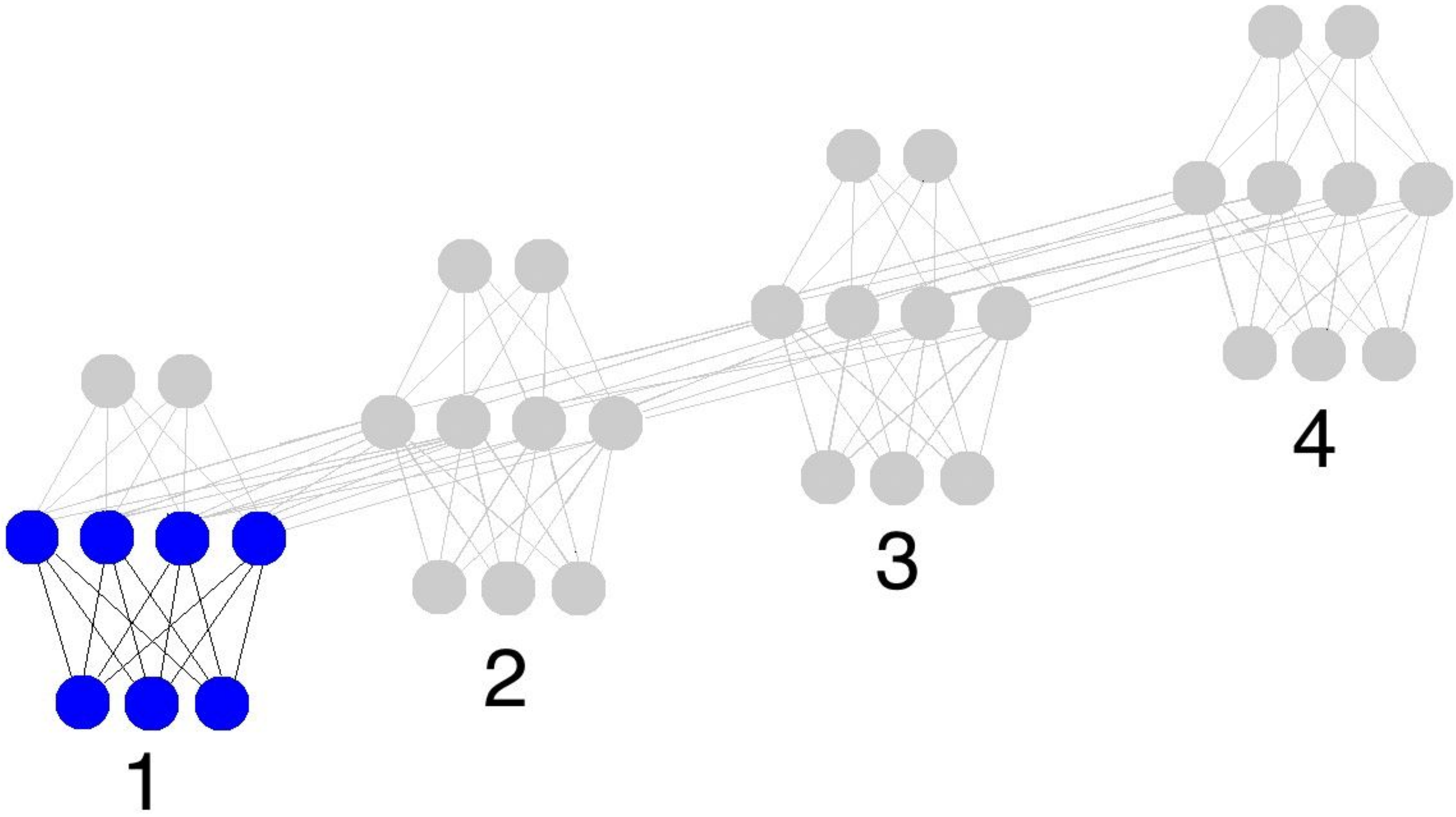


$$(f * g)(x) \quad \stackrel{\text{def}}{=} \int\limits_{-\infty}^{\infty} f(y)\, g(x-y)\, dy = \int\limits_{-\infty}^{\infty} f(x-y)\, g(y)\, dy.$$


Time
EEG Channels
Filter
Feature Map
Drop out
Reshaped features
Fully connected layers
Drop out
Classification layer

recurrent neural nets


b^0 is fed to next layer
$b^0 = f(a_{h''})$
$a_{h''} = w_{0h''} * x_0$
$w_{0h''} * x_0$
x_0


1
2
3
4