Regression neural networks. Application to speaker's age identification.

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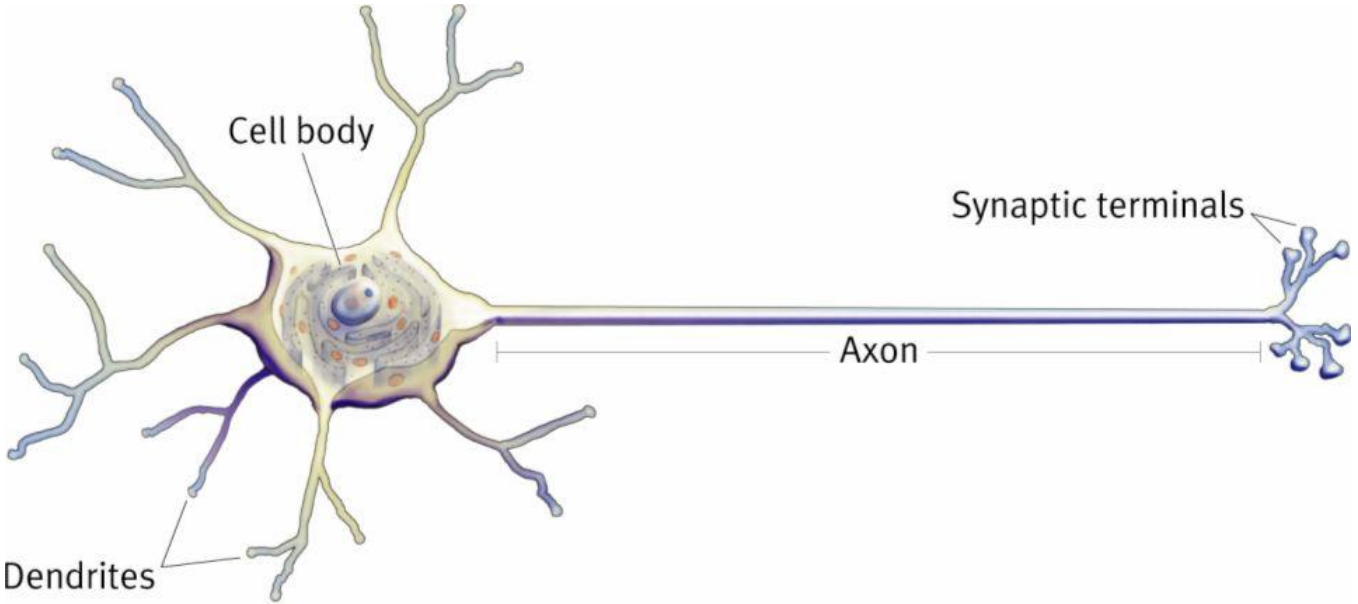
Regression problems

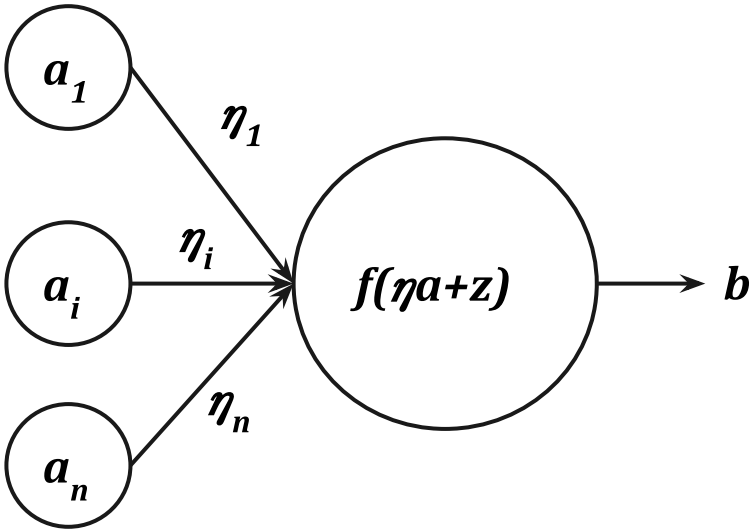
$$y=f(x,a)$$

- Linear
- Nonlinear
  - $f(x,a) = \Sigma a_i g_i(x)$, $g_i(x)$- nonlinear
  - $f(x,a)$ is nonlinear in respect to both x and a

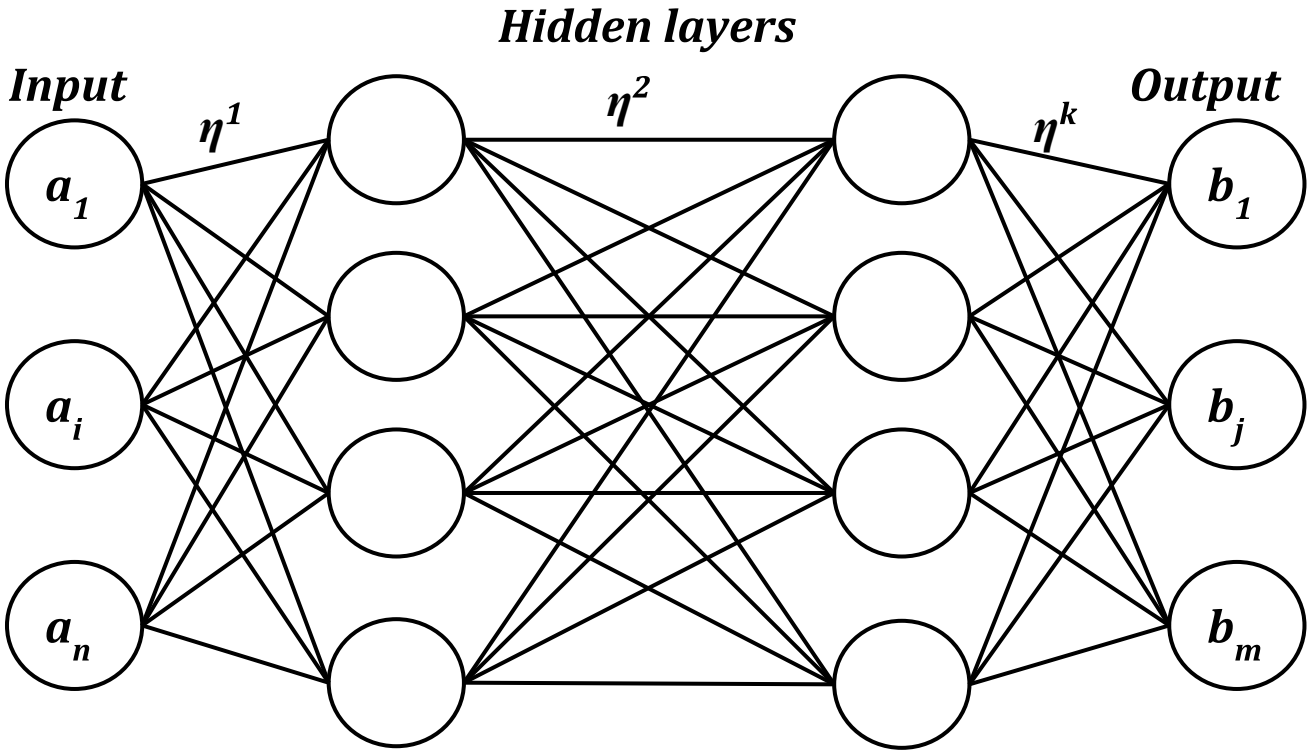
Biological inspiration



The artificial neuron



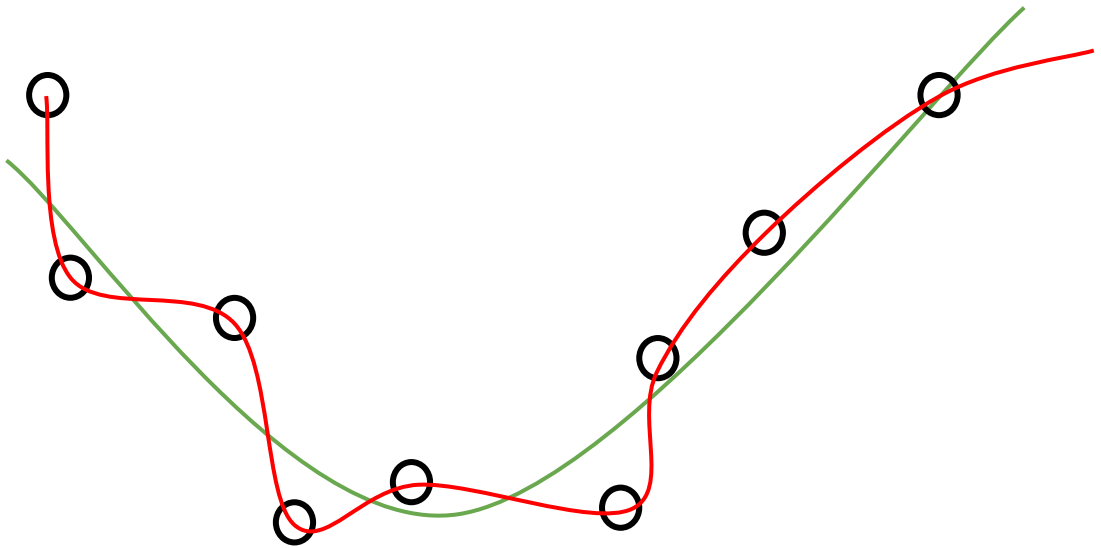
Multilayer perceptron



Network’s training

- Backpropagation algorithm
- Algorithms utilizing first-order derivative information of error surface
  - Stochastic gradient descent
- Algorithms utilizing higher-order derivative information of error surface
  - Broyden–Fletcher–Goldfarb–Shanno algorithm

Overfitting prevention

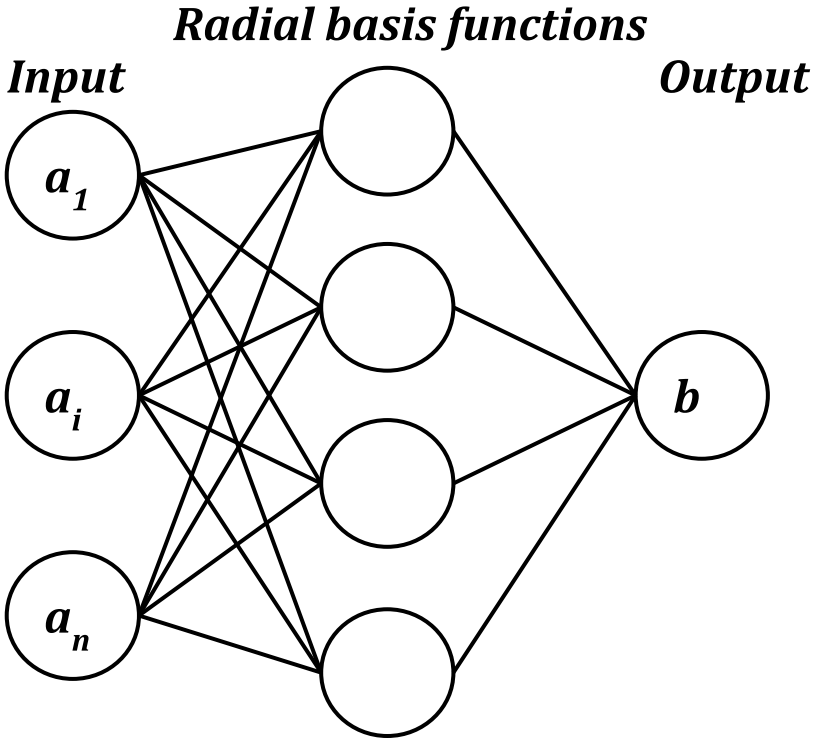


- Early stopping
- Dropout
- l_2-regularization

Drawbacks of MLP

- Large amount of data is needed
- For a reasonable performance great deal of training is needed
- The great amount of time is consumed for training

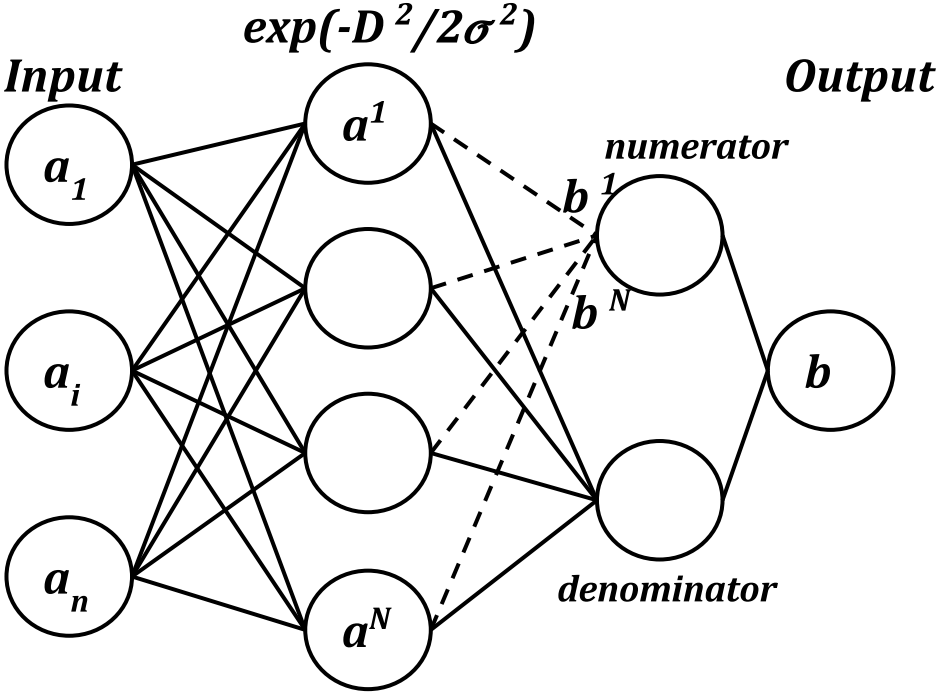
Radial basis function networks



$$b(a)=\Sigma\eta_j\varrho(||a-c_j||),$$

$$\varrho(||a-c_j||)=exp(-\beta_j||a-c_j||)$$

General regression NN



$$b(a)=\frac{\Sigma b^{j}\exp(-D^{2}_{j}/2\sigma^{2})}{\Sigma\exp(-D^{2}_{j}/2\sigma^{2})}$$

$$D^{2}_{j}=(a-a^{j})^{T}(a-a^{j})$$

Examples of regression problems solved by NN

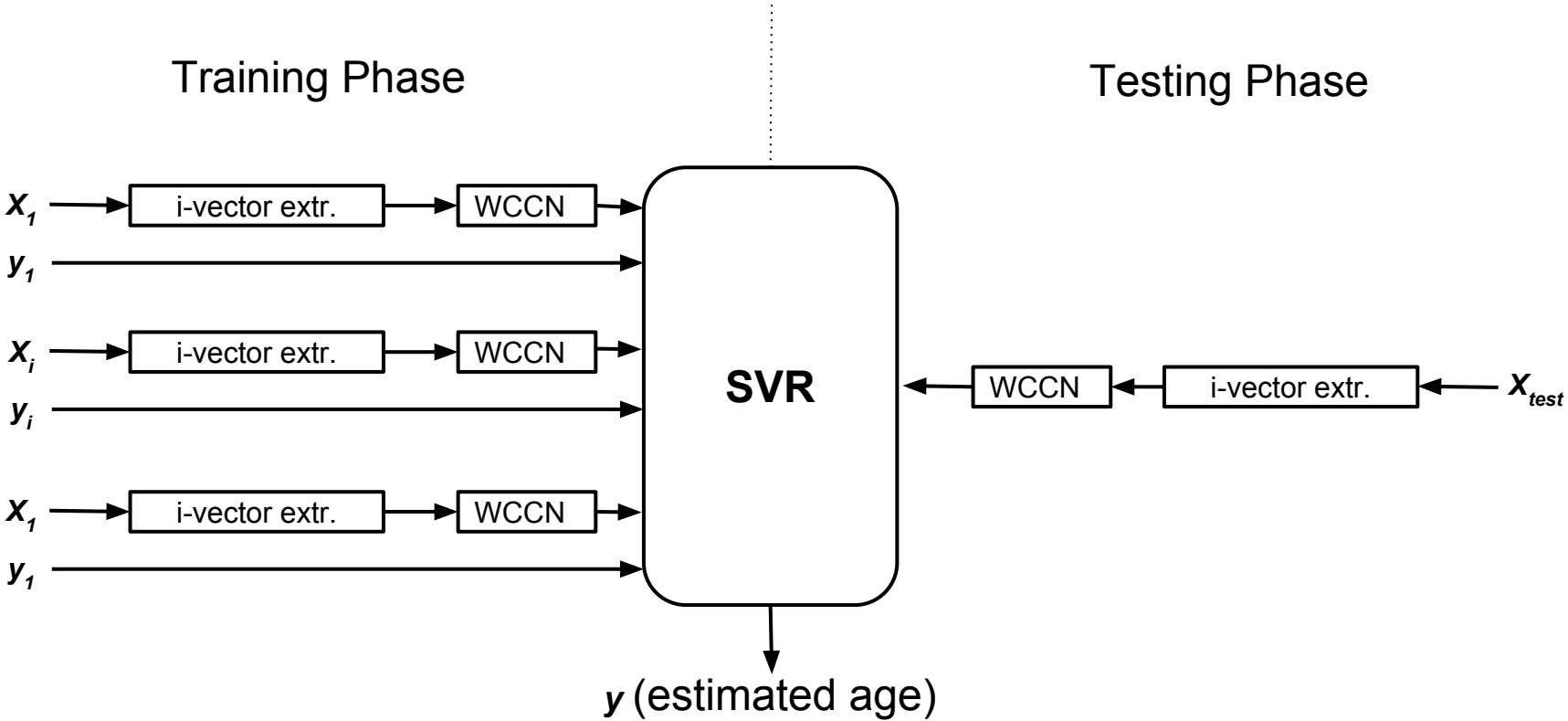
- Foreign exchange forecasting and trading
- Forecasting plant disease by leaf wetness prediction
- Flow forecasting

Automatic speaker's age identification

$S_{tr} = (X_1, Y_1), \ldots, (X_P, Y_P)$, X_p and Y_p - the p-th speech utterance and its age label

The goal is to create a system, which will predict, for an unseen utterance X_{test}, its label Y_{test} accurately.

State-of-the-art baseline approach



Neural network system description

- i-vectors
- WCCN
- NN-backend
  - MLP with single hidden layer (1024 neurons)
  - Minimum squared error objective function
  - SGD training algorithm
  - l_2 -regularization

Results

	MAE (females)	MAE (males)
Baseline method	5.75	6.65
NN-based method	**5.49**	**6.35**

Mean absolute error (MAE) in years for female and male speakers of NIST SRE 2008, NIST SRE 2010 datasets

Thank you!

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