Perceptron Networks and Applications

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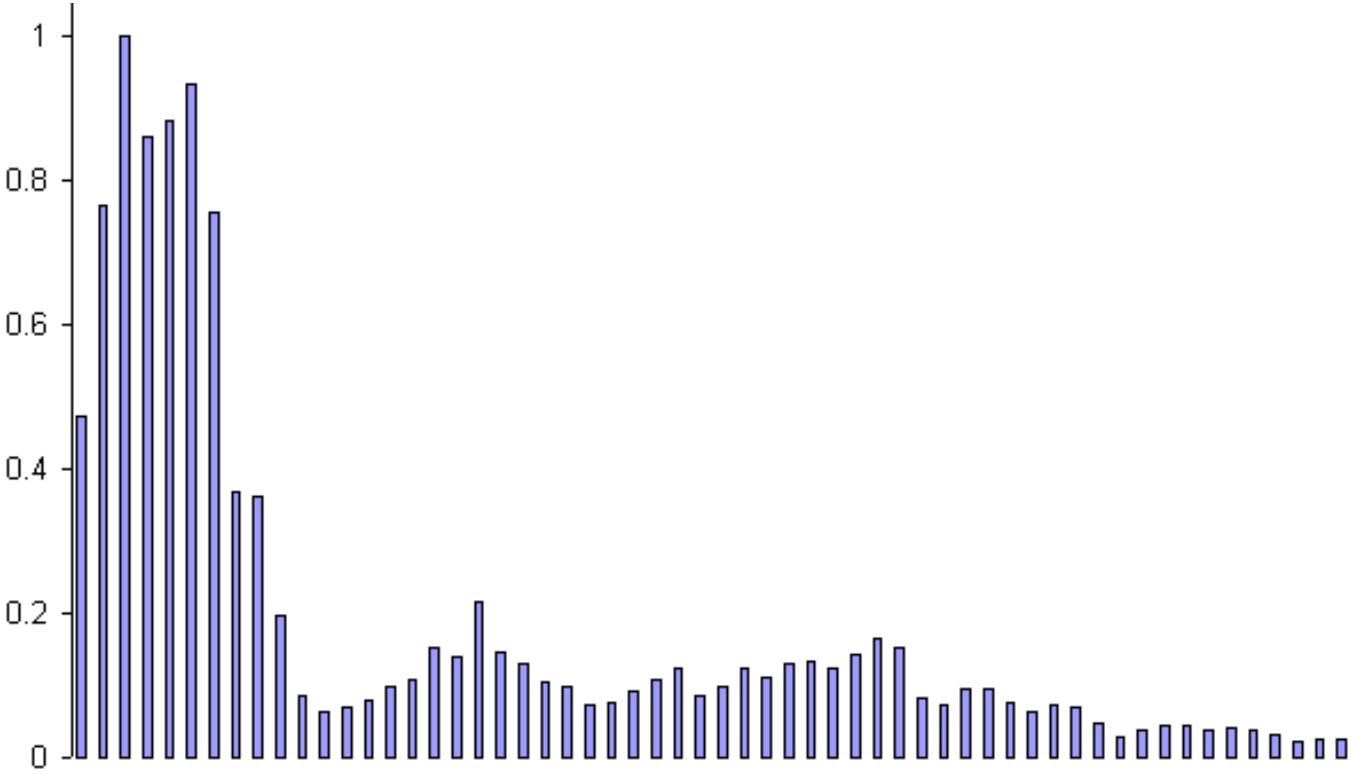
Content

- Speech recognition
- Character recognition
- Weaning from assisted ventilation
- Classification of myoelectric signals
- Classification of handwritten digits

Speech recognition

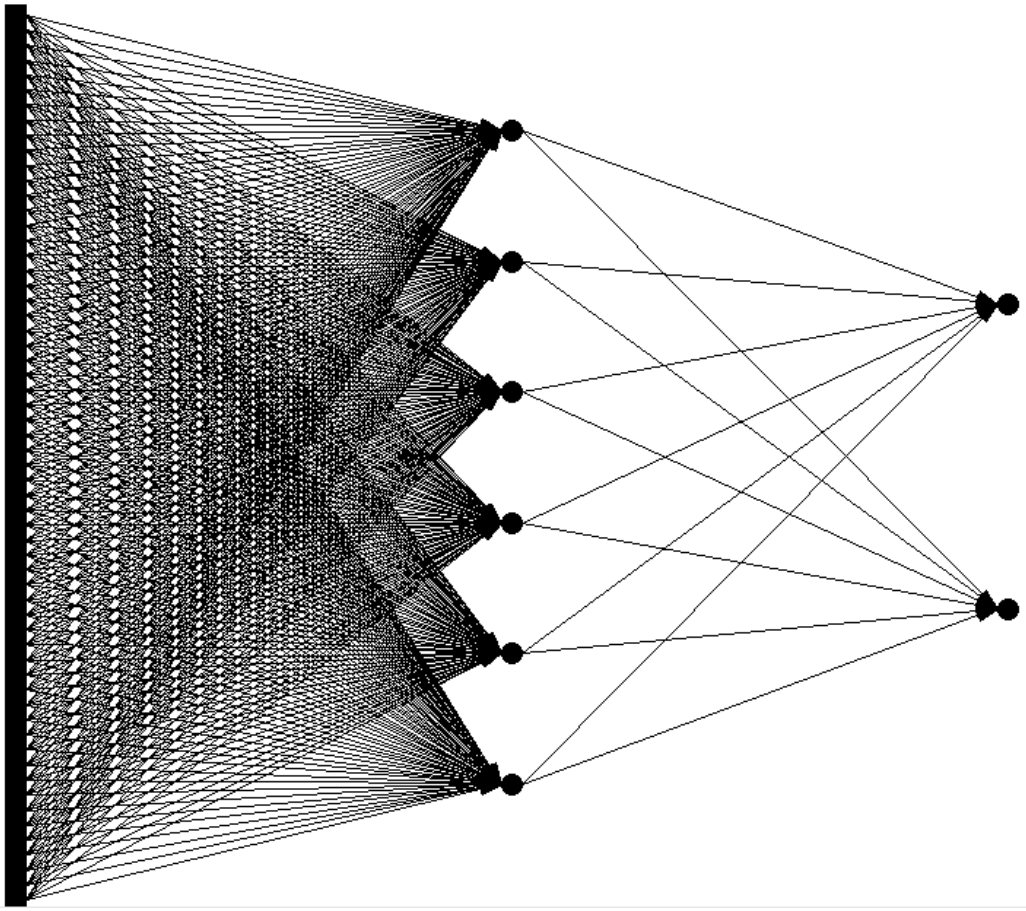
Problem: Teaching two different people to say the word ″merhaba″
1st person = Ahmet
2nd person = Mehmet

Let the frequency distribution be taken with 60 samples.
Each sample was obtained by taking a sample in the speech frequency range (0-4 KHz).



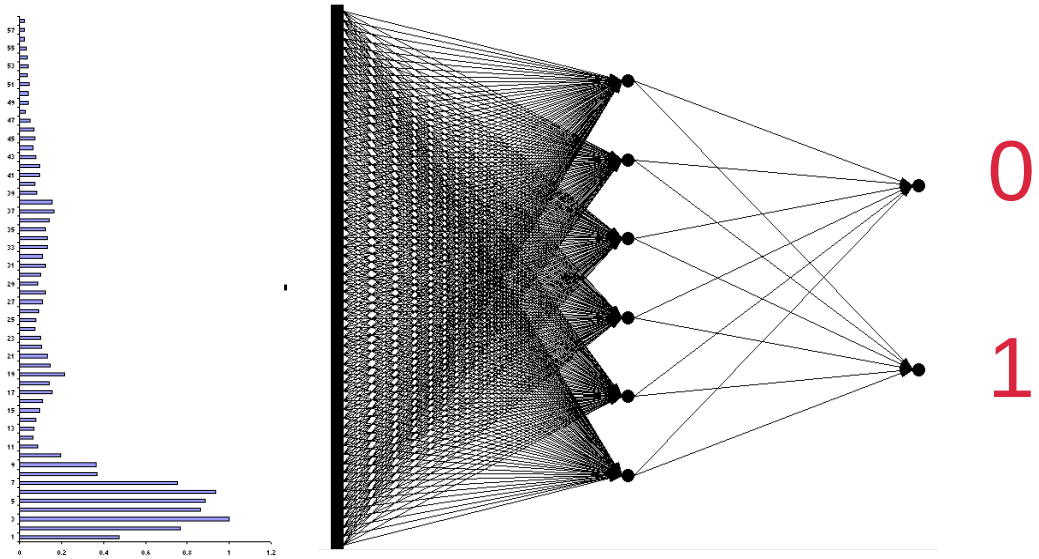
Speech recognition

Network structure = feed forward multi-layer
60 inputs (for each frequency sample)
1 hidden layer with 6 hidden nodes
2 outputs ("Ahmet" if 0-1, "Mehmet" if 1-0)



Speech recognition

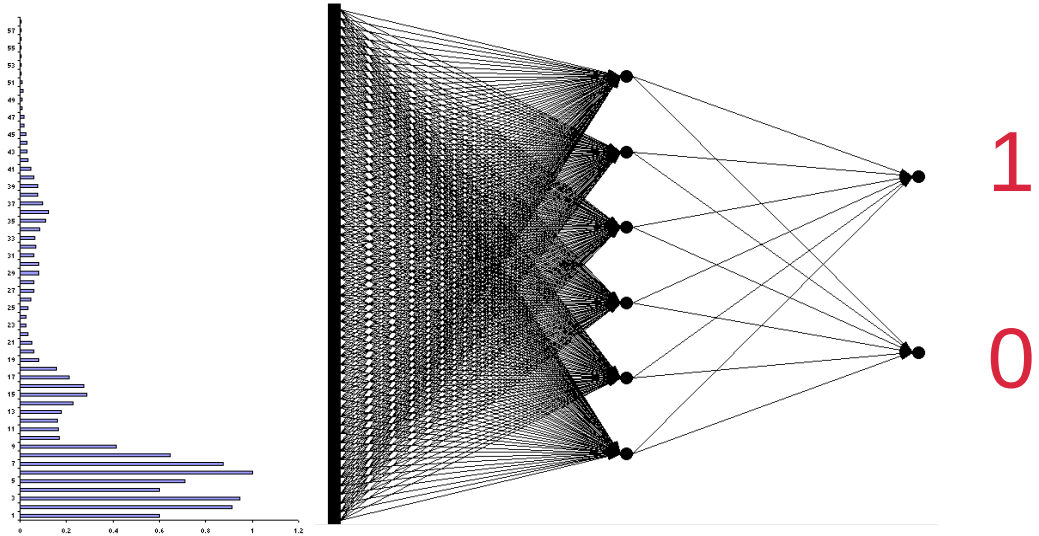
Ahmet



0

1

Mehmet

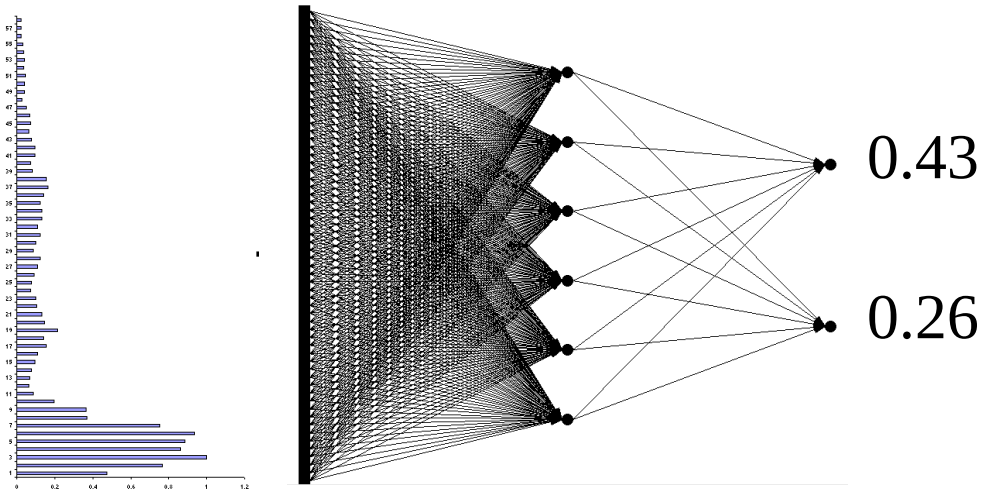


1

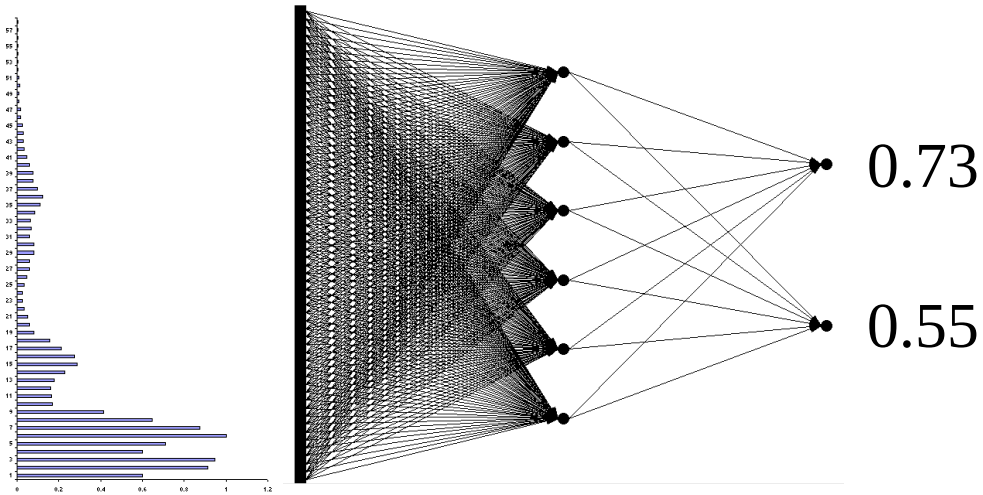
0

Speech recognition

Ahmet

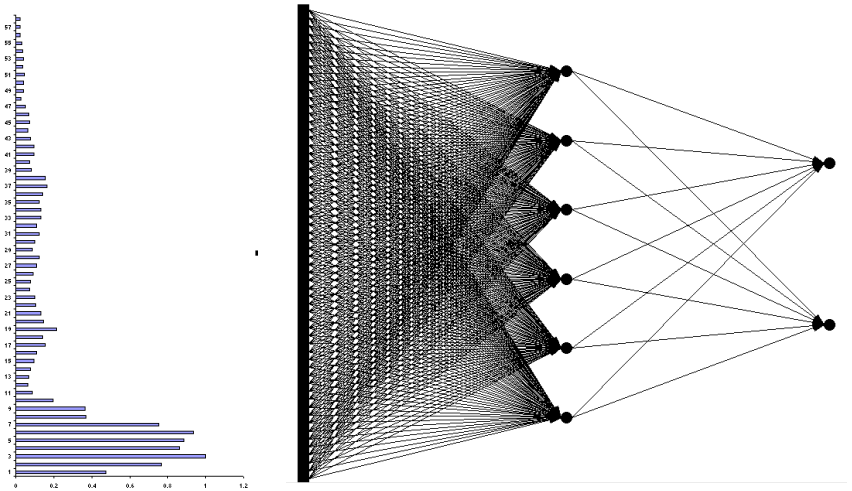


Mehmet



Speech recognition

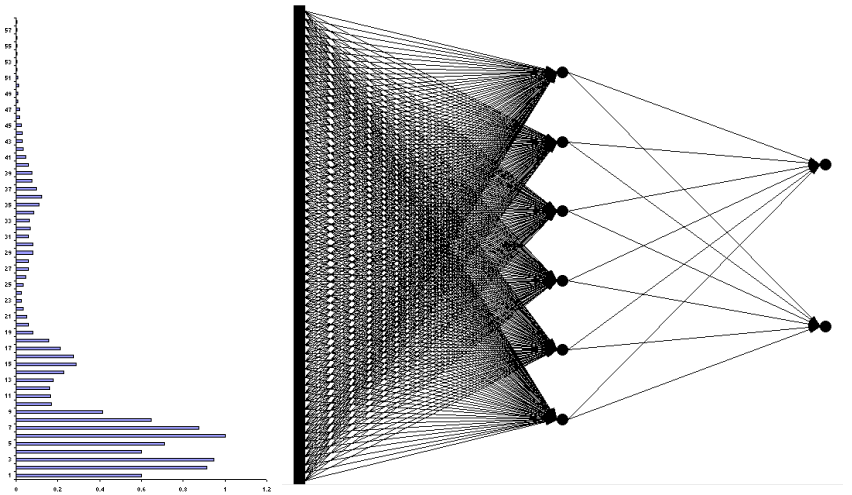
Ahmet



$|0.43 - 0| = 0.43$

$|0.26 - 1| = 0.74$

Mehmet

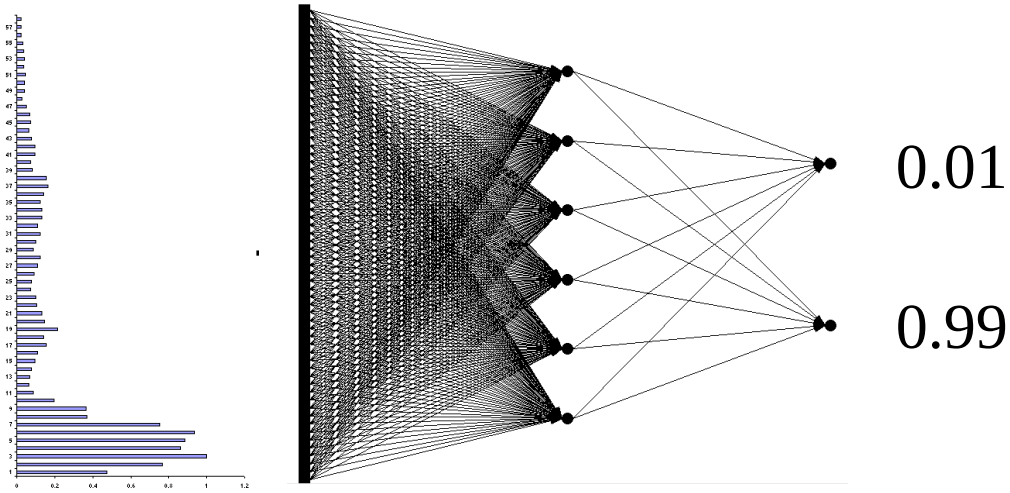


$|0.73 - 1| = 0.27$

$|0.55 - 0| = 0.55$

Speech recognition

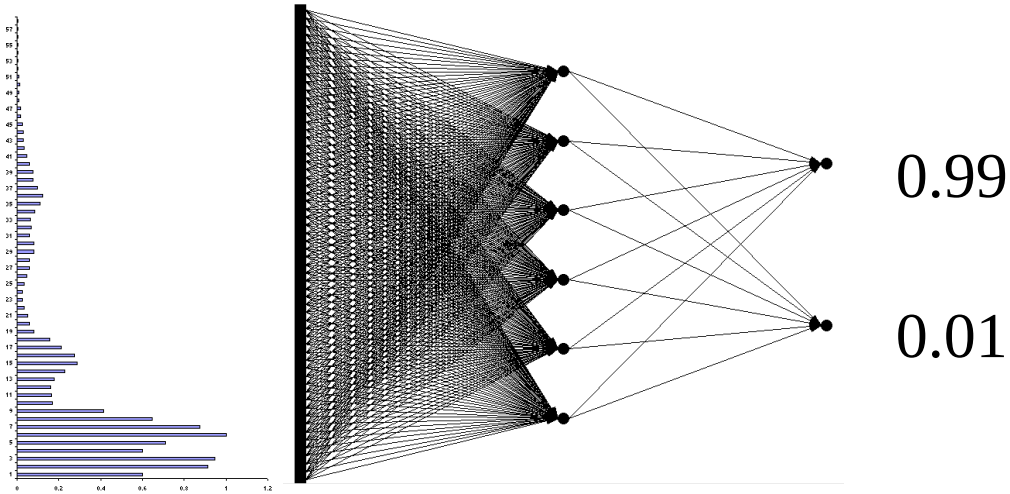
Ahmet



0.01

0.99

Mehmet



0.99

0.01

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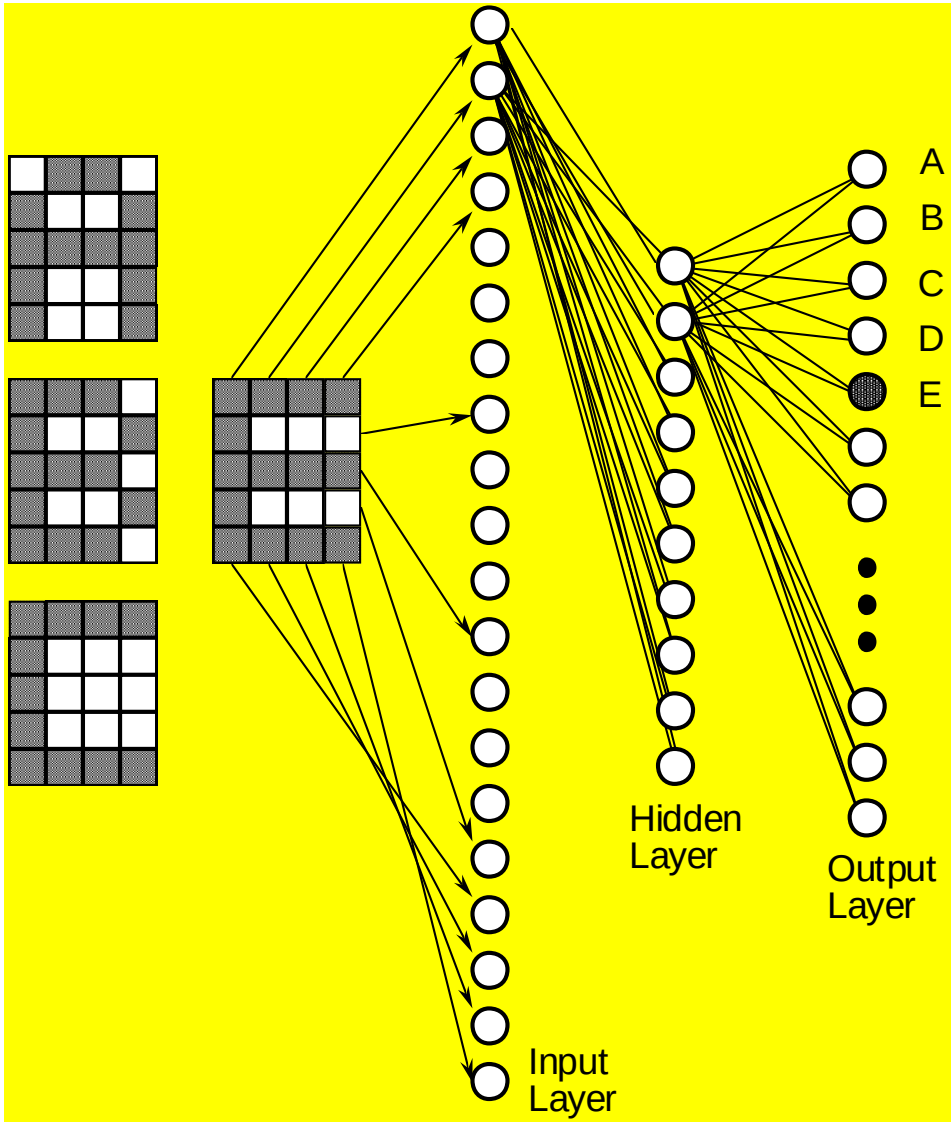
Character recognition

- Feed forward multi-layer network
- Backpropagation learning method



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Weaning from assisted ventilation

- Weaning respiratory support to a patient is a very critical decision.
- This requires evaluation whether the patient can breathe on his own.
- Premature weaning can harm a patient, while weaning too late implies unnecessary expense.
- Traditional methods are unreliable or extremely expensive and the equipment is not available in most hospitals.
- Ideally, a physician would like to make these decisions based on variables.
- Peak negative inspiratory pressure, respiratory rate, unassisted minute ventilation and tidal volume have been obtained from patients.

Weaning from assisted ventilation

- The training set in 21 weaning trials given in table.

Training set for the respiratory weaning problem. In the notation used, NIF = negative inspiratory pressure (cm. H2O); VT = tidal volume; and RR = respiratory rate (breaths/minute).

NIF	VT	RR	Weaning Effort	NIF	VT	RR	Weaning Effort
-24	300	24	success	-30	250	30	success
-30	500	17	failure	-42	950	13	success
-23	300	29	success	-12	220	32	failure
-26	265	44	failure	-20	124	33	failure
-18	370	32	failure	-42	750	24	success
-22	350	30	failure	-32	530	21	success
-10	320	29	failure	-40	916	22	success
-60	650	16	success	-30	500	19	success
-20	225	46	failure	-25	412	30	failure
-24	276	38	failure	-28	400	38	failure
-15	270	40	failure				

- In the data set, weaning attempts had been successful in nine instances and unsuccessful in 12.
- This set was used to train a neural network.

Weaning from assisted ventilation

- The neural network approach successfully solved the desired classification task using a network with one hidden layer.
- A 3-2-1 feedforward network was trained on this data ($\eta = 0.9$). Data was first normalized to make all values between 0 and 1, using the transformations.

$$x_1 = (\text{NIF} + 60)/50, \quad x_2 = (\text{VT} - 100)/900, \quad x_3 = (\text{RR} - 10)/40$$

- x values are used for inputs.
- The ANN is a binary classifier.

Weaning from assisted ventilation

- The network succeeded in classifying all training data correctly, in less than 2,000 epochs.

Numbers and percentages of correct classification on the training set.

	Predicted **Success**	Predicted **Failure**	Total	Correctly Classified
Success	9	0	9	100%
Failure	0	12	12	100%
Total	9	12	21	100%

- After 2000 iterations, the network has learned all of both success and failure classes correctly.

Weaning from assisted ventilation

- Nine other weaning efforts were made and these data constitute the test set.
- Three patients were weaned unsuccessful, six cases were weaned successfully.
- The test set was used only to measure the performance of the trained neural network.

Test data, asterisk indicates misclassified case.

NIF	VT	RR	Weaning Effort
-40	465	23	success
-15	450	25	failure
-22	400	41	failure
-28	310	24	failure*
-48	380	24	success
-34	530	28	success
-40	740	19	success
-42	550	27	success
-55	480	19	success

Weaning from assisted ventilation

- The network has one error on the test set.
- One failure case was classified wrongly.
- The total correctly classified samples have an 88.9% success rate.

Numbers and percentages of correct classification on the test set.

	Predicted Success	Predicted Failure	Total	Correctly Classified
Success	6	0	6	100%
Failure	1	2	3	66.7%
Total	7	2	9	88.9%

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Classification of myoelectric signals

- Myoelectric signals are electrical signals that correspond to muscle movements in humans.
- These can be measured on the surface of the skin.
- This example considers classification of such signals into three groups.
- These groups of signals translate directly into movements of specific parts of the body.
- The signal measurements contain significant amounts of noise.
- Hence perfect classification is impossible.

Classification of myoelectric signals

- The training data set contains 332 samples.
- The data were obtained from the human skin surface.
- The first four columns indicates the input values, the last column indicates the class.
- Output of the network decides whether the signal obtained from the output is myoelectric signal.

0.138	-0.168	-0.289	0.193	1
0.255	-0.029	0.134	-0.163	1
0.044	0.003	0.048	-0.017	0
-0.030	0.003	-0.050	0.028	0
-0.001	0.019	0.016	0.023	0
-0.009	0.008	-0.008	0.018	0
...	...	...	...	

Classification of myoelectric signals

- The results of training a 2-5-3 feedforward network on this data with $\eta = 0.9$.

Iteration No.	Fraction of samples misclassified	MSE
100	0.159639	0.213797
200	0.150602	0.189983
300	0.132530	0.172497
400	0.135542	0.170050
500	0.132530	0.168683
600	0.132530	0.168227
700	0.129518	0.167203
800	0.129518	0.167318
900	0.129518	0.167395
1,000	0.126506	0.167376
2,000	0.123494	0.166275
3,000	0.129518	0.165759
4,000	0.123494	0.151863
5,000	0.123494	0.151121
6,000	0.117470	0.151182
7,000	0.111446	0.150595
8,000	0.111446	0.150215
9,000	0.111446	0.149949
10,000	0.111446	0.149668
11,000	0.114458	0.149576
12,000	0.114458	0.149664
13,000	0.111446	0.146705
14,000	0.114458	0.149832
15,000	0.111446	0.147453
16,000	0.114458	0.149184
17,000	0.111446	0.147182
18,000	0.114458	0.147353
19,000	0.114458	0.147297
20,000	0.114458	0.147962

Classification of myoelectric signals

- At the end of 20,000 iterations, 38 samples remain misclassified.

Performance of a neural network for the myoelectric signals data.

Actual class in which network places sample:	1	2	3
Desired Target Class			
Class 1	75	5	0
Class 2	3	88	9
Class 3	2	19	131

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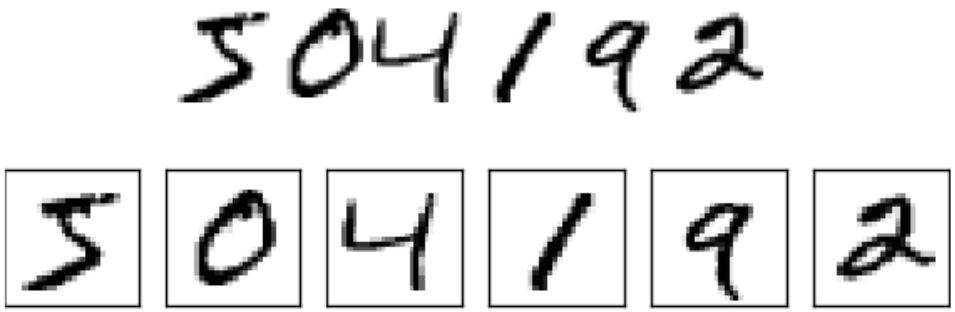
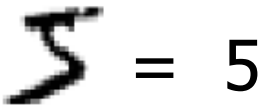
Classification of handwritten digits

- We can split the problem of recognizing handwritten digits into two sub-problems.
- First, we'd like a way of breaking an image containing many digits into a sequence of separate images, each containing a single digit.



- In the MNIST data set, each digit has 28x28 = 784 pixels (number of neurons in the input layer).
- Second, classifying individual digits.



Classification of handwritten digits

- A three layer neural network was used (784-15-10).