

Artificial Neural Network

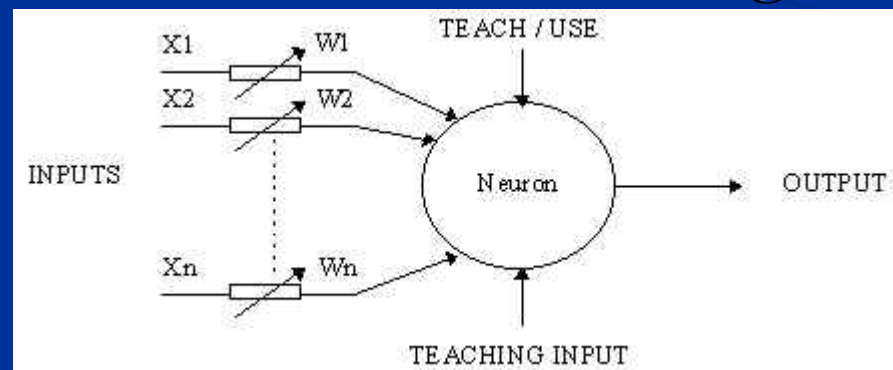
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Artificial Neural Network (ANN)

- An iterative learning technique from Artificial Intelligence (AI) that emulates the way human's biological nervous systems process information
- Learn by examples
- Composed of many nodes/neurons – parallel & interconnected via numerical weights

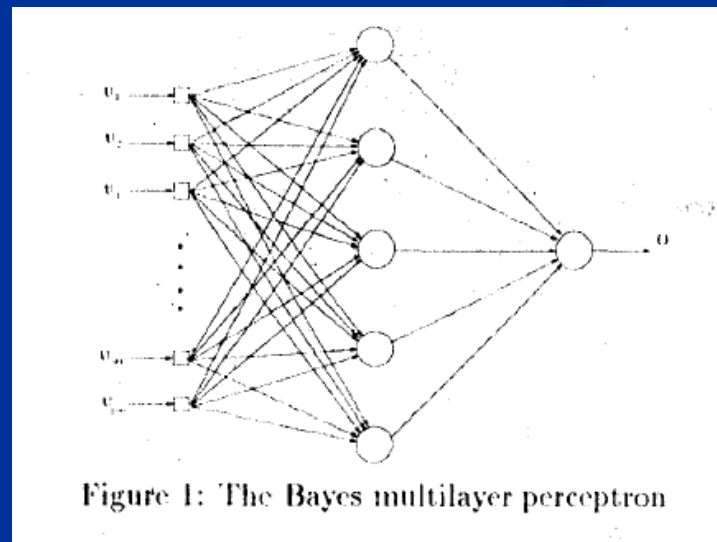


ANN (Contd.)

- Weights – Knowledge of the system
- Weighted inputs are summed to determine the activation level of the neuron
- ANN sum the weighted inputs and pass the result through a transfer function.
- Design of an ANN model depends on:
 - i. network architecture;
 - ii. node characteristics; and
 - iii. training algorithm.

ANN (Contd.)

- Supervised ANN classifiers – input and target pairs are provided to train the network – widely used in speech recognition.
- Unsupervised ANN classifiers - self-learning & involve the partitioning of the data in the feature space into subgroups where input & target pairs are not provided during training.



Experiment

Methodology

The list of signature features used is as follows:

- Total time to sign
- Number of pen-ups
- Length of signature
- Max velocity
- Min velocity
- Total time that $V_x > 0$
- Total time that $V_x < 0$
- Total time that $V_y > 0$
- Total time that $V_y < 0$
- Length of signature horizontally
- Length of signature vertically
- Area of signature

Experiment (Contd.)

3 sets of experiments:

- Identifying the system's ability to differentiate signatures between 2 users.
- Identifying the systems ability to classify the signatures of 4 different users.
- Identifying the systems ability to detect a forgery.

Experiment (Contd.)

Experiment 1

- 15 signatures were obtained from each user, A and B.
- 10 signatures from each user used to train the network and 5 from each user used to test the trained network.
- A is classified as “1” and B is classified as “0”.

Experiment 2

- 15 signatures were obtained from each user, A, B, C and D.
- 10 signatures from each user used to train the network and 5 from each user used to test the trained network.
- A, B, C and D are classified as “0, 0”, “0, 1”, “1, 0” and “1, 1” respectively.

Experiment (Contd.)

Experiment 3

- 30 signatures obtained from a user (genuine). 20 for training and 10 for testing.
- 30 signatures signed by 5 different people, copying the signature of the user (forgery). 20 for training and 10 for testing.
- The signature is classified as “genuine” if the output is higher than 0.8 and “forgery” if it is lower than 0.4. Others as “unknown”.

Experiment (Contd.)

Experiment 1 - Results

ANN output		Classification accuracy, Threshold = 0.5	
A	B	A	B
0.91	0.01	✓	✓
0.81	0.06	✓	✓
0.85	0.01	✓	✓
0.94	0.01	✓	✓
0.83	0.02	✓	✓

Type	Percentage
GAR	100%
FAR	0%

Experiment (Contd.)

Experiment 2 - Results

ANN output			
A	B	C	D
0.02, 0.14	0.01, 0.91	0.95, 0.30	0.98, 0.89
0.01, 0.12	0.02, 0.95	0.98, 0.13	0.96, 0.84
0.01, 0.30	0.09, 0.95	0.96, 0.31	0.97, 0.89
0.01, 0.16	0.03, 0.93	0.98, 0.18	0.98, 0.80
0.01, 0.19	0.07, 0.98	0.97, 0.16	0.97, 0.82

Classification of signature				Classification Accuracy, Threshold = 0.5			
A	B	C	D	A	B	C	D
0,0	0,1	1,0	1,1	√	√	√	√
0,0	0,1	1,0	1,1	√	√	√	√
0,0	0,1	1,0	1,1	√	√	√	√
0,0	0,1	1,0	1,1	√	√	√	√
0,0	0,1	1,0	1,1	√	√	√	√

Type	Percentage
GAR	100%
FAR	0%

Experiment (Contd.)

Experiment 3 - Results

Sample No.	ANN Output		Classification accuracy, threshold = 0.4, 0.8	
	Genuine	Forgery	Genuine	Forgery
1	0.94	0.01	√	√
2	0.82	0.01	√	√
3	0.93	0.01	√	√
4	0.57	0.12	Unknown	√
5	0.97	0.78	√	Unknown
6	0.53	0.072	Unknown	√
7	0.99	0.33	√	√
8	0.89	0.79	√	Unknown
9	0.95	0.08	√	√
10	0.95	0.01	√	√

Type	Percentage
GAR	90%
FAR	0%
FRR	0%
GRR	90%