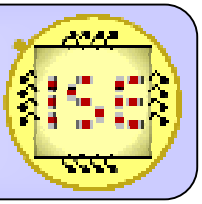
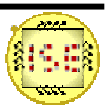


Digital Neural Network Hardware For Classification

Jiawei Yang

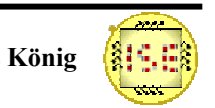
April, 2008

Prof. Dr.-Ing. Andreas König



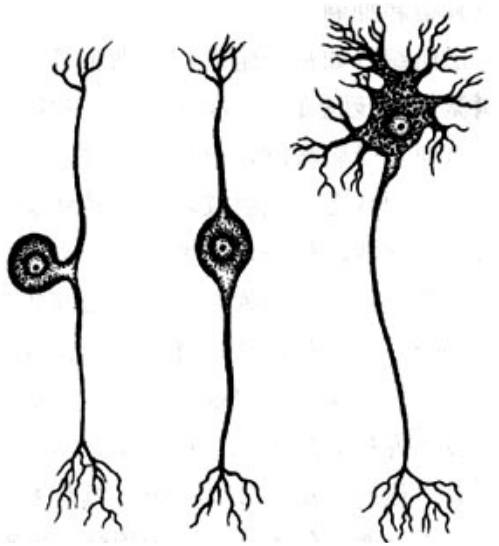
Overview

1. Introduction
    - *Motivation*
2. Parts of the Project
    - *Board*
    - *ZISC*
    - *Application*
    - *ZISC and QuickCog*
3. Conclusion

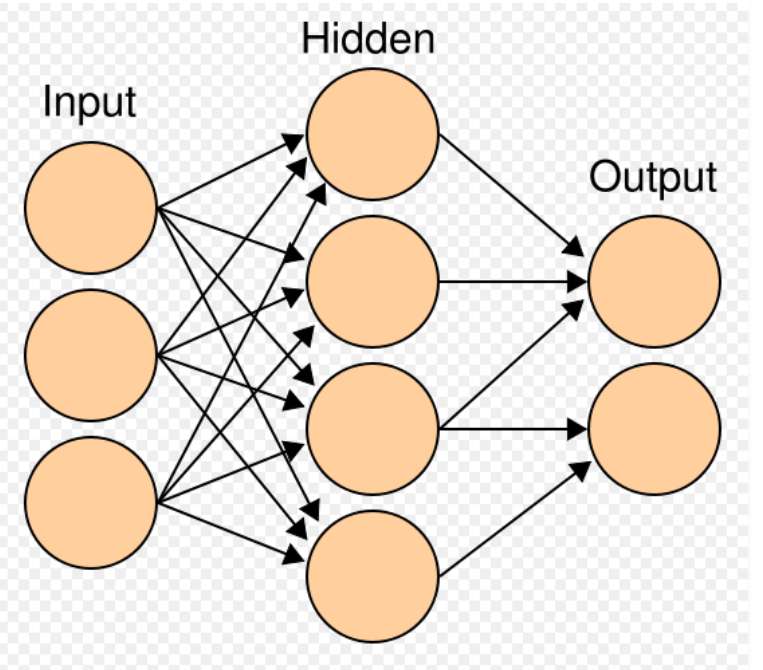


Motivation

- Neural Network



Neuron



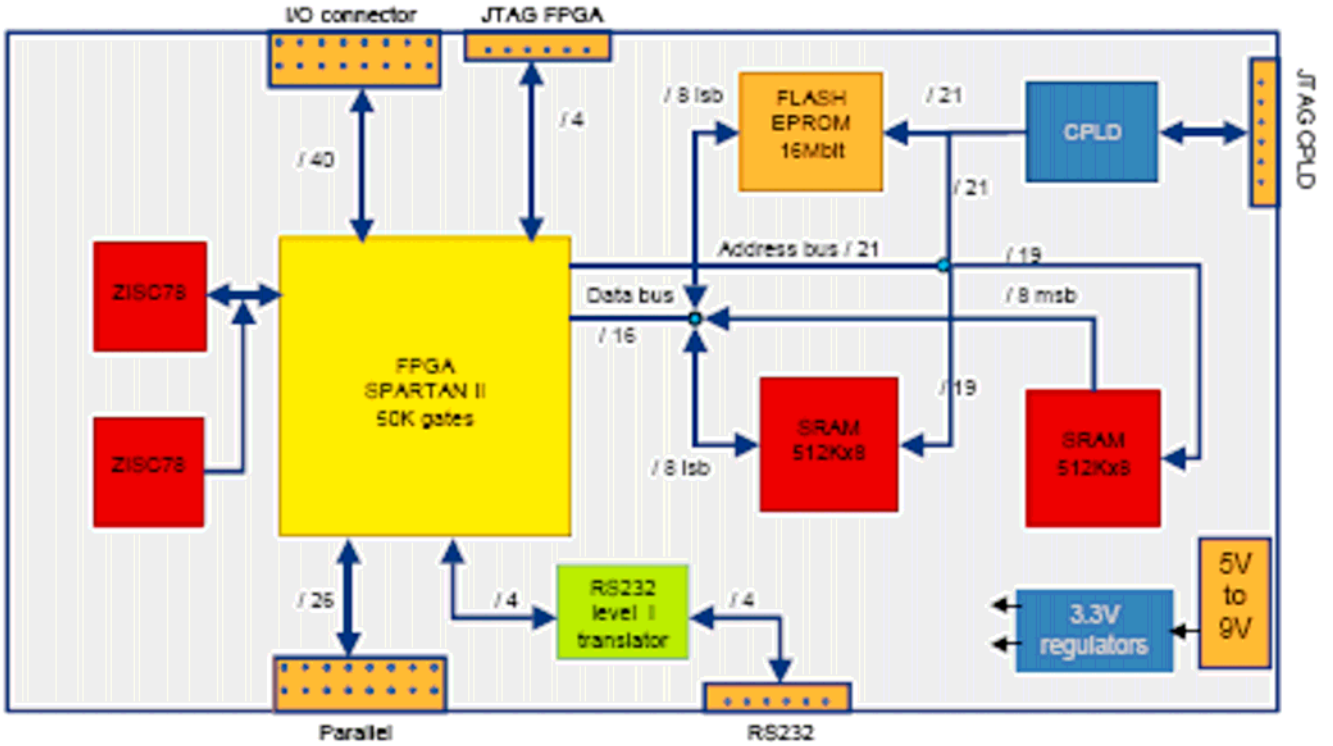
Neural Network

- Other advantages include:

-Adaptive learning
-Self-Organisation
-Real Time Operation
-Fault Tolerance via Redundant Information Coding

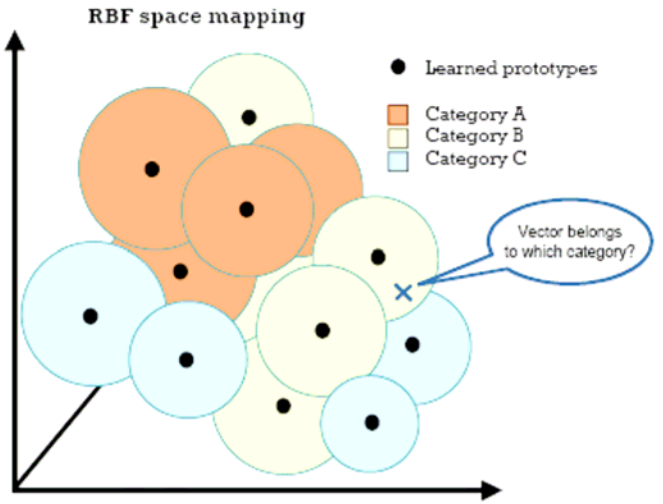
Board

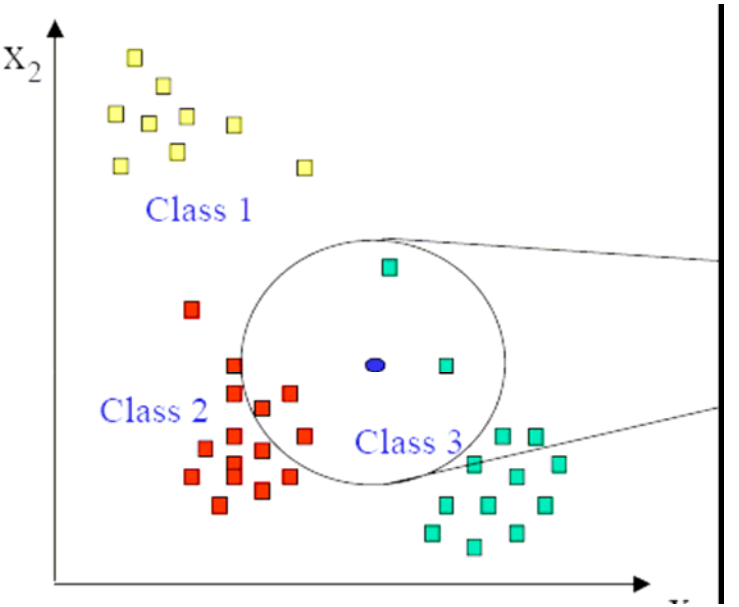
- **MUREN:**High-Speed Pattern Recognition Embedded Board Using a ZISC Neural Network



ZISC—Neural Model

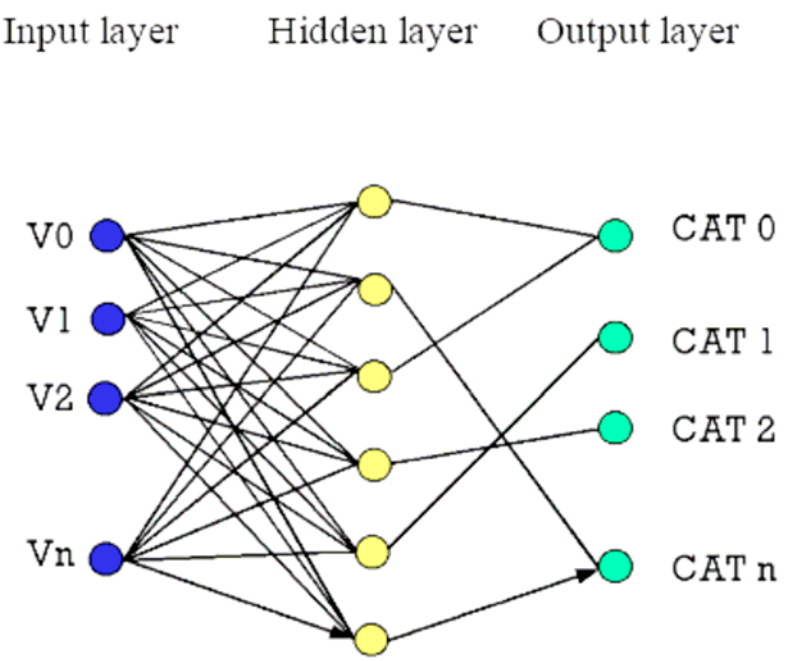
- ZISC: Zero Instruction Set Computing
  The neural network model can be a Radial Basis Function or K-Nearest Neighbor model. No need programming!





ZISC—Network

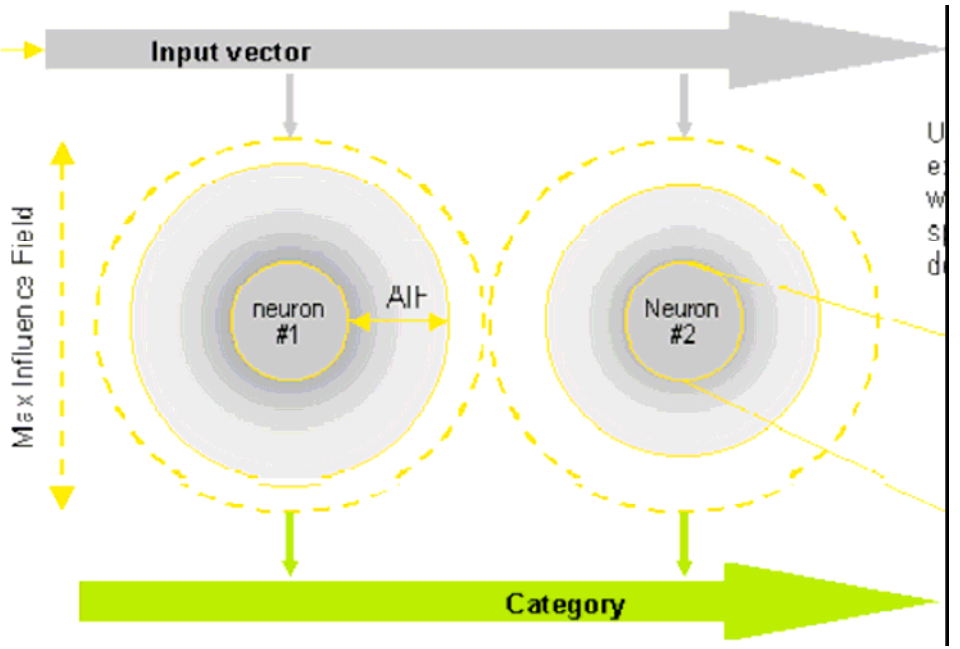
- **RBF neural network model**



RBF-like Network Topology

ZISC—Field

- Actual Influence Field (AIF)
- Maximum Influence Field (MAF)
- Minimum Influence Field (MIF)



ZISC—Field

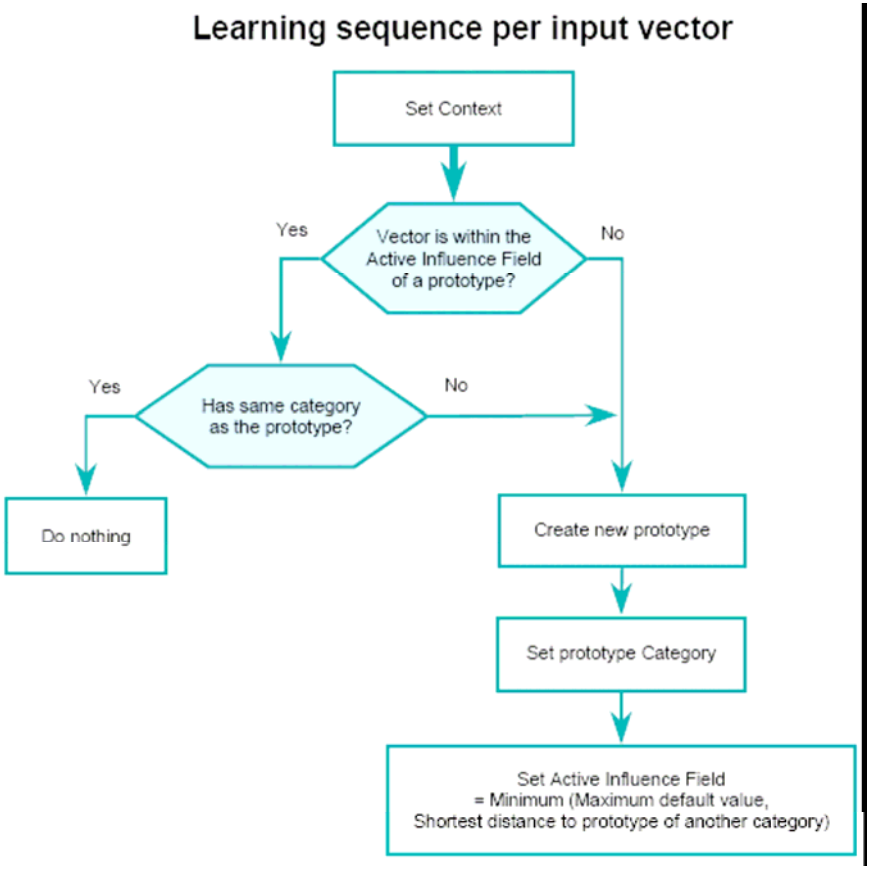
- **The Active Influence Field (AIF)**
  Defines the space around a given prototype where generalization can occur.

- **The Maximum Influence Field (Maxif)**
  Defines the largest influence field value that can be assigned to a neuron newly committed following the learning of a new prototype.

- **The Minimum Influence Field (Minif)**
  Defines the value below which an influence field shrinks.

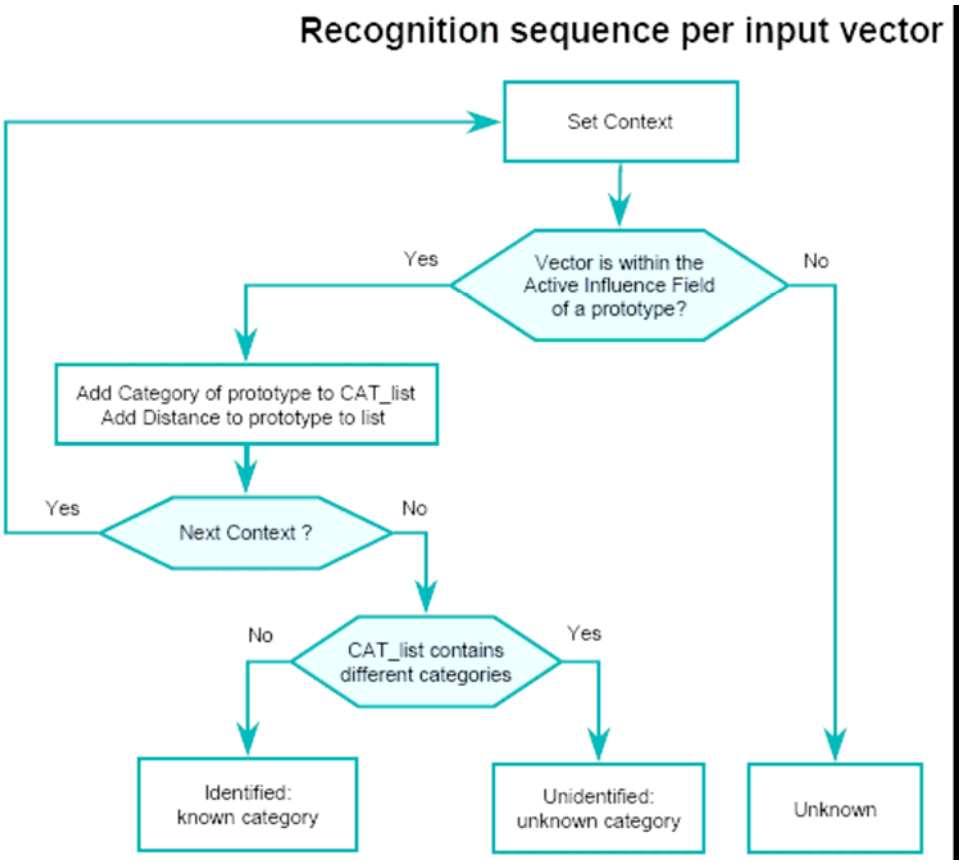
ZISC—Training

- Three Steps: Learning, Testing, Recognition/Classification



ZISC—Recognition

- Recognition/Classification



ZISC—Problem

- Where Unidentified classification comes from?

  Several prototypes with different categories but overlapping Active Influence

  Field due to a reduction limited to the Minimum Influence.

  Different identification of a vector under different context (i.e. sub-networks).

- How can we solve?

  Use KNN!

C_WIZARD

- Classification Software C_WIZARD
- C_WIZARD is designed to build, evaluate and fine-tune a ZISC-based recognition engine.
- Four Mode ：Learn, Test, Recognition, View
- Data Files

Comma separated value (CSV) format:

Context value	Category value	Vector components
(1-byte)	(2-byte)*	(64-byte)

Application —Create Input Files

- We used the Breast cancer data.
- classes: 2; samples: 683; features: 10
- Jung-Ying Wang from the National Taiwan University has used the BP neural network to classify the Breast cancer data with 10-fold cross-validation.
- Data Mining Analysis (breast-cancer data)

  http://www.csie.ntu.edu.tw/~p88012/AI-final.pdf
- The correctly classified is 95.1684%.
- The incorrectly classified is 4.8316%.

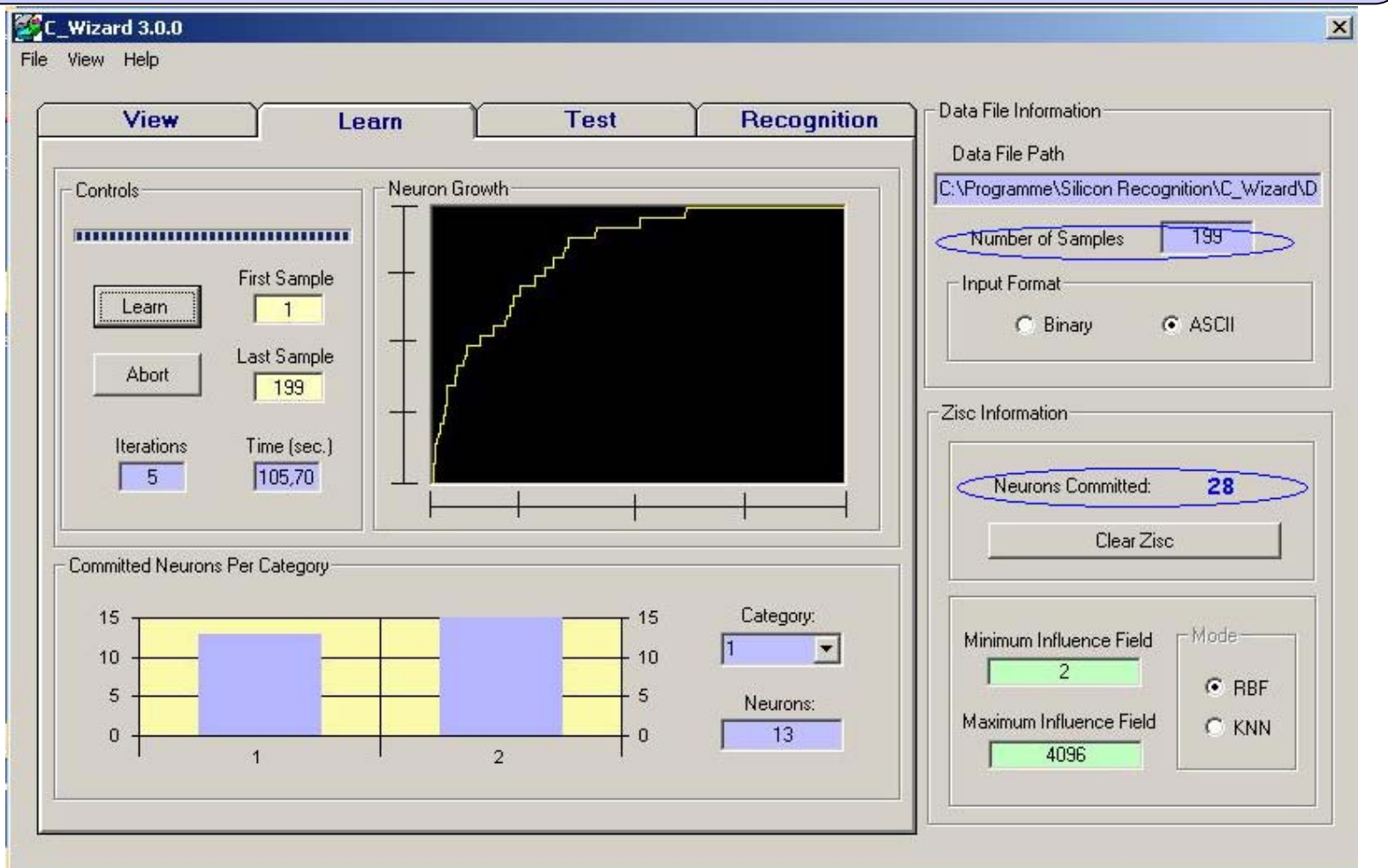
Application —Create Input Files

- First, change the data into the ASCII form in Matlab
- Normalization: 0-255
- Create Context, Category and Vector
- Learn samples : 199, Test samples:199, Recognition: 171

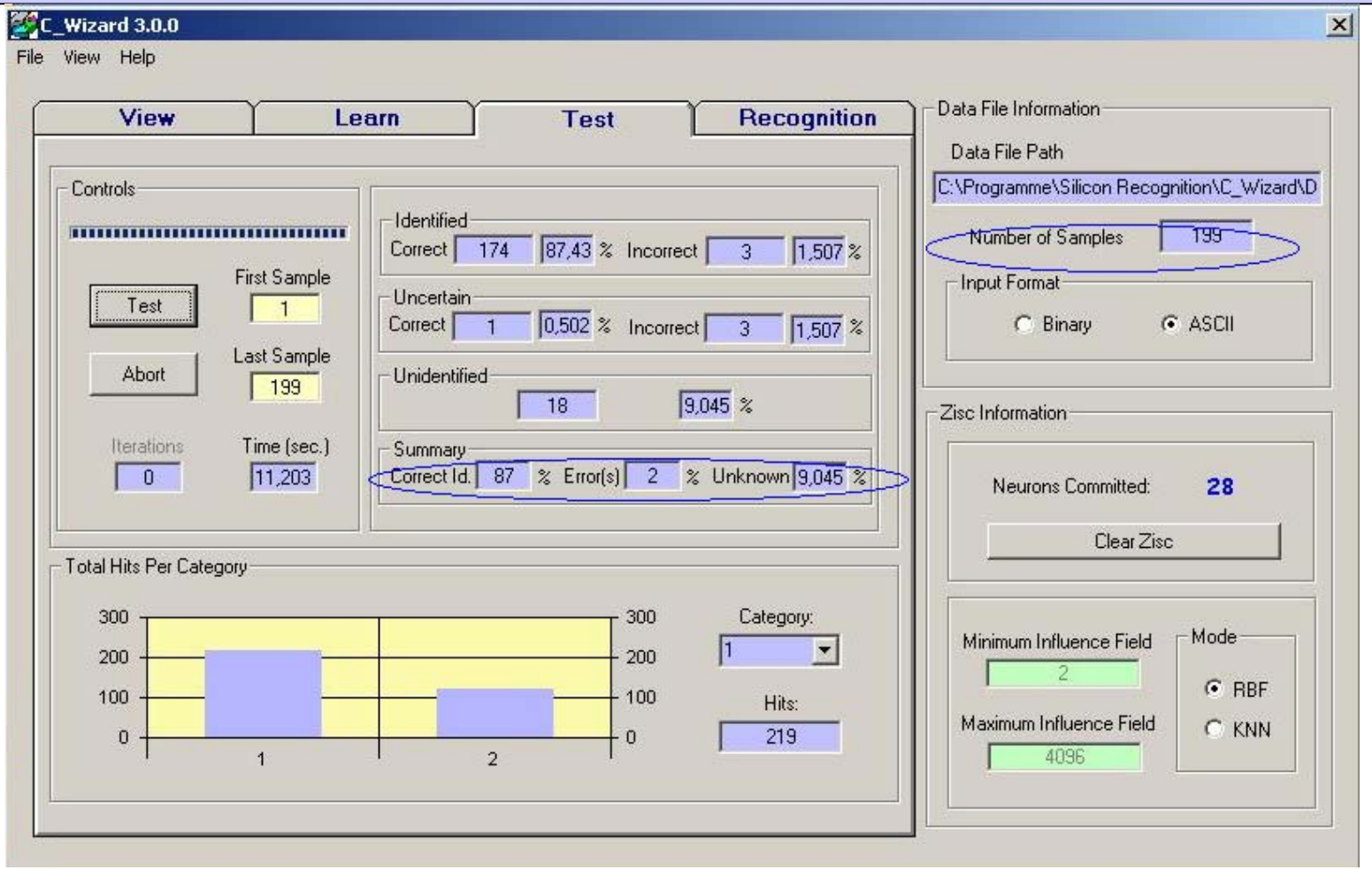
	A	B	C	D	E	F	G	H	I	J
1	17.99	20.57	19.69	11.42	20.29	12.45	18.25	13.71	13	12.46
2	10.38	17.77	21.25	20.38	14.34	15.7	19.98	20.83	21.82	24.04
3	122.8	132.9	130	77.58	135.1	82.57	119.6	90.2	87.5	83.97

	A	B	C	D	E	F	G	H	I	J	K
1	0	1	29.979	97.447	28.758	13.618	119.18	45.639	12.977	19.062	84.614
2	0	1	96.417	86.667	91.121	59.134	72.699	26.703	11.633	24.575	58.598
3	0	1	59.245	98.827	57.446	31.4	103.82	48.353	15.265	27.617	123.51
4	0	1	73.607	51.742	73.728	40.724	126.31	84.176	27.292	39.416	116.81
5	0	1	59.728	101.93	57.693	31.92	103.71	46.234	19.884	25.449	80.879
6	0	1	93.038	36.823	95.914	55.446	116.19	128.45	86.633	79.846	132.14

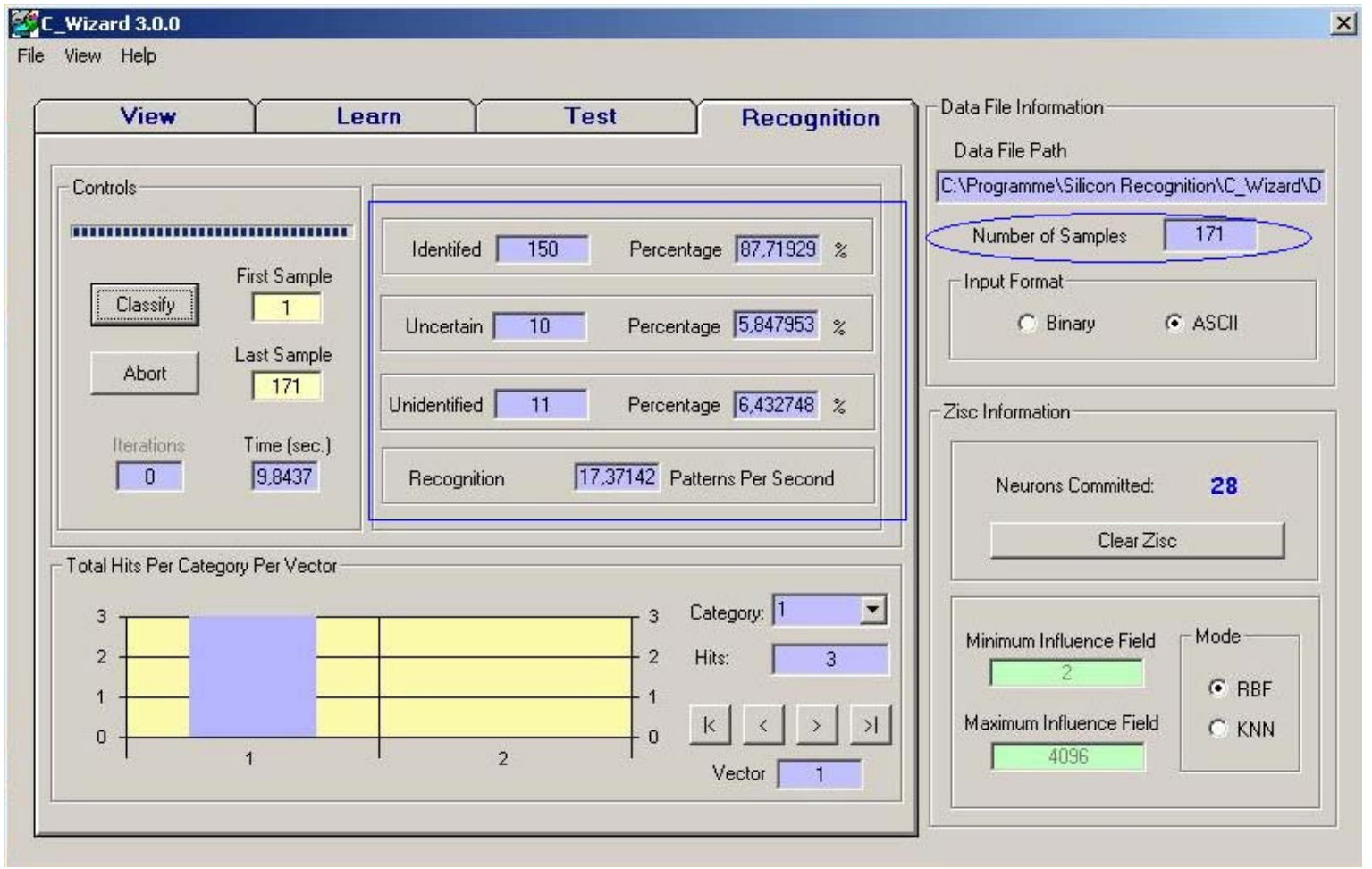
Application—Learn



Application—Test



Application—Recognition/Classification

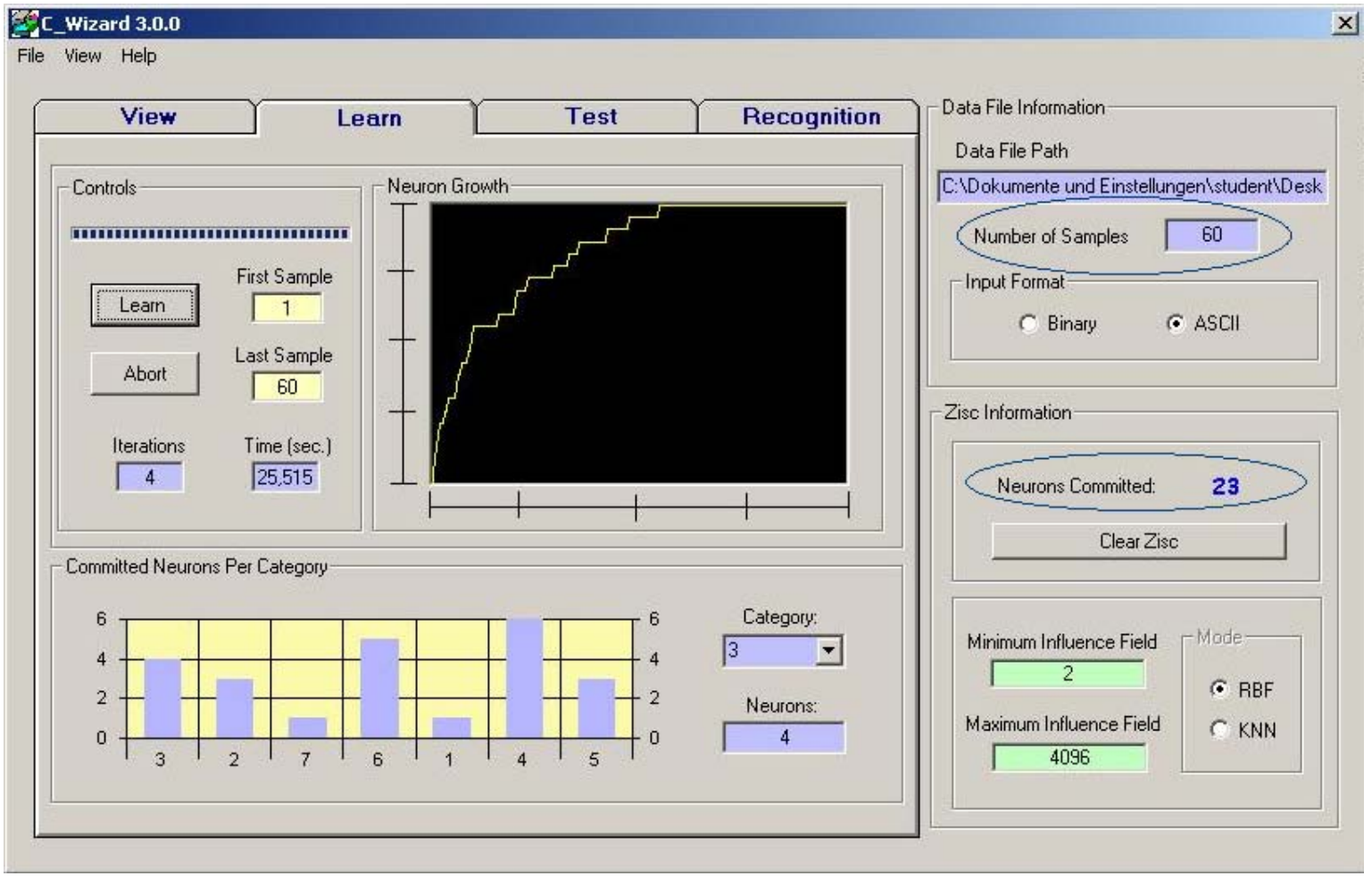


Letter Recognition

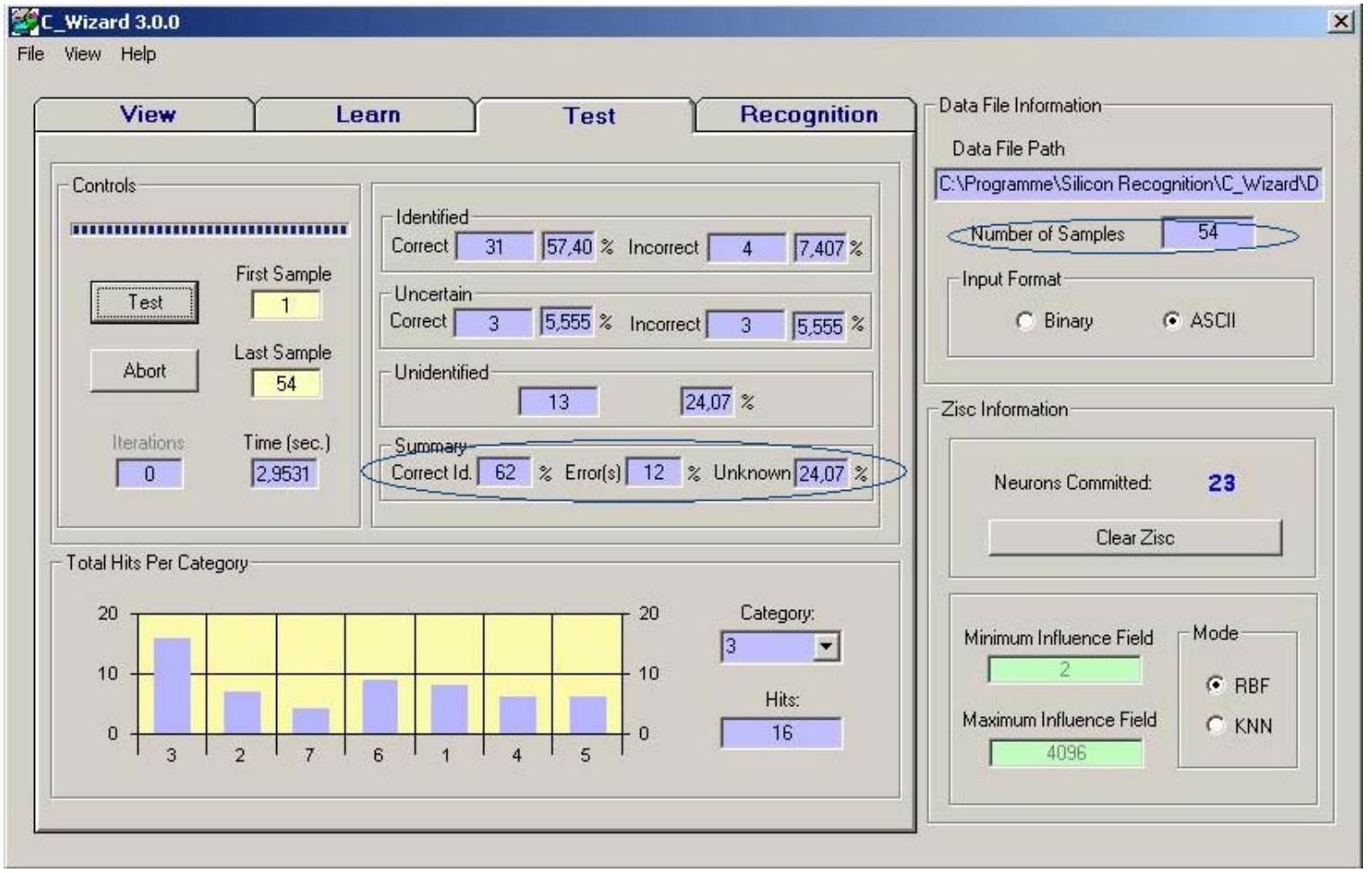
- I used the Letter Image Data which I have classify in the sensor signal processing project:

  An Image Processing Application on QuickCog and Matlab: "Letter Recognition"
- classes: 7; samples: 126; features: 35
- I divide the whole data into 4 sets: learn (60 samples), test (54 samples), recognition (12 samples).

Learn


C_Wizard 3.0.0
File View Help
View
Learn
Test
Recognition
Controls
Learn
Abort
First Sample
1
Last Sample
60
Iterations
4
Time (sec.)
25,515
Neuron Growth
Committed Neurons Per Category
6
4
2
0
3 2 7 6 1 4 5
Category:
3
Neurons:
4
Data File Information
Data File Path
C:\Dokumente und Einstellungen\student\Desk
Number of Samples
60
Input Format
Binary
ASCII
Zisc Information
Neurons Committed:
23
Clear Zisc
Minimum Influence Field
2
Maximum Influence Field
4096
Mode
RBF
KNN

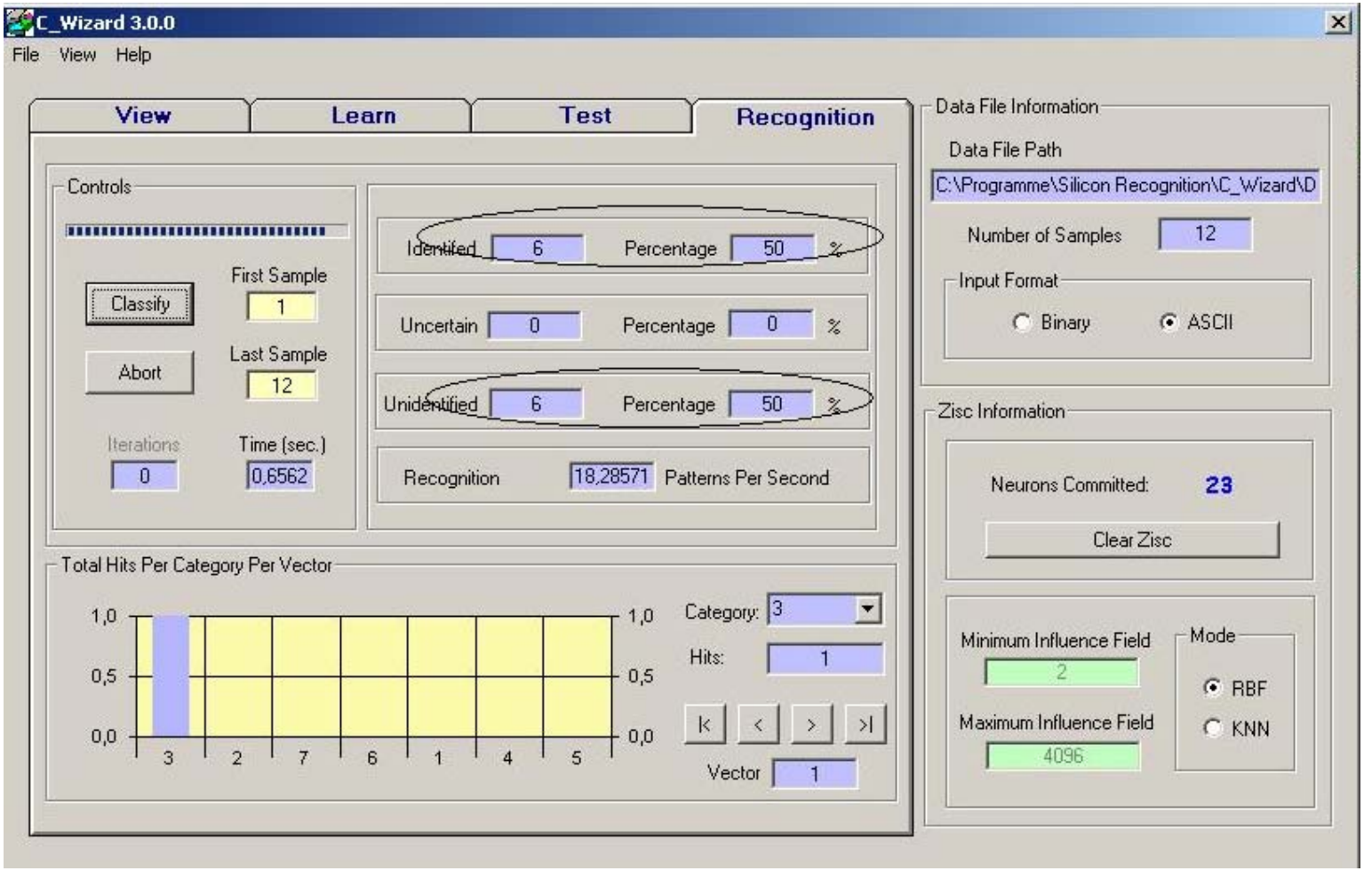
Test


C_Wizard 3.0.0
File View Help
View
Learn
Test
Recognition
Controls
Test
Abort
First Sample
1
Last Sample
54
Iterations
0
Time (sec.)
2,9531
Identified
Correct 31 57,40 % Incorrect 4 7,407 %
Uncertain
Correct 3 5,555 % Incorrect 3 5,555 %
Unidentified
13 24,07 %
Summary
Correct Id. 62 % Error(s) 12 % Unknown 24,07 %
Total Hits Per Category
20
10
0
3 2 7 6 1 4 5
Category:
3
Hits:
16
Data File Information
Data File Path
C:\Programme\Silicon Recognition\C_Wizard\D
Number of Samples 54
Input Format
Binary
ASCII
Zisc Information
Neurons Committed: 23
Clear Zisc
Minimum Influence Field
2
Maximum Influence Field
4096
Mode
RBF
KNN

Change Maxif and Minif

- Change the Maxif and Minif
- Maxif: 300,1000,2000,5000,10000.
- Minif: 0.1,0.001,1,5,10.
- If Maxif is small, the result will be worse.
- If Maxif is larger than 1000, the result is no change.
- Changing Minif makes no change.
- Keep the default Maxif and Minif.

Recognition



Result

- ZISC Result
- Identified: 62%
- Uncertain: 5.55%
- Unidentified: 24.07%
- Compare with QuickCog
- learn (60 samples), test (54 samples), D:\Program Files\QuickCog\QuickCog.exe
- Identified: 85.185 %
- Uncertain: 0%
- Unidentified: 14.81%

Conclusion

- The goal of the project is to classify data with the hardware neural network.
- I use the breast cancer data and the letter data I have used in the project of sensor signal processing in QuickCog.
- Compare with the software computing, the hardware neural network
- Don't need programming.
- Memory Requirements

  2 SRAM of 512Kx8-bit for general-purpose data storage

  Flash EPROM to store a configuration file
- Running Time: Fast
- Real Time Application

  Neural Network: Parallel Process

  PC Programs: Sequential Computing

Thank You for your attention!