Artificial Neural Networks and Deep Architectures, DD2437

Short report on lab assignment 2

Radial basis functions, competitive learning and self-organisation

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1 Main objectives and scope of the assignment

Our major goals in the assignment were

- to build and perform training of RBF neural networks and implement competitive learning for unsupervised learning.
- to implement SOM algorithm, disscuss the role of neighbourhood and use SOM to fold high-dimensional spaces and cluster data.

2 Methods

We use Python to implement the RBF Neural Networks and solve the first problem of part 2. Matlab is used for solving the last two problems in part 2.

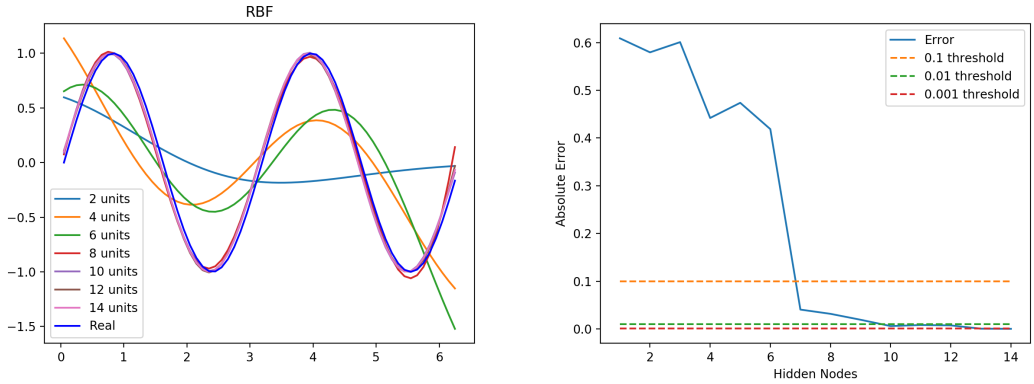
3 Results and discussion - Part I: RBF networks and Competitive Learning

In this report, we divide the results into two parts: Noise-free data and Noisy data. Both of this two kinds of data set will be used when doing bath mode learning and online learning.

3.1 Noise-free data

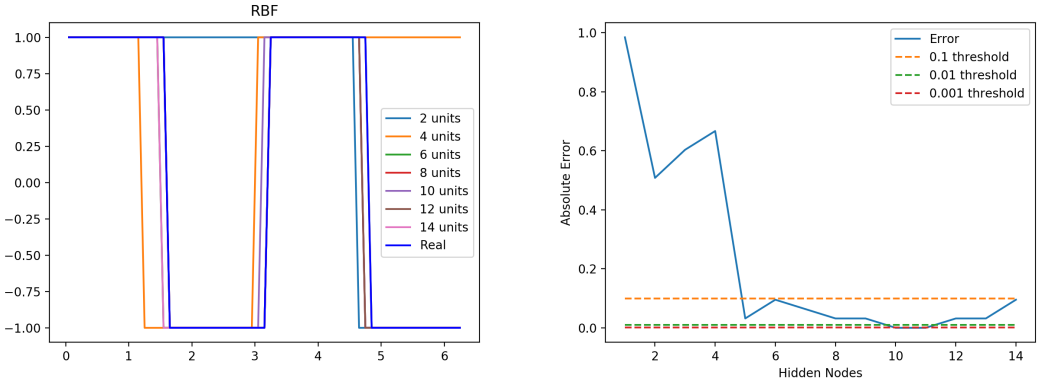
3.1.1 Batch mode training using least squares

We vary the number of units to obtain the absolute residual error below 0.1,0.01 and 0.001. For $sin(2x)$ function, we need 7, 10, 12 units to get the converge. For $square(2x)$ function, we need 5, 10, 11 units to get the converge. We transformed the output of RBF network to reduce the residual error: when output is larger than 0, we set the output to 1, when it's less than 0, we set the output to -1. This transform is particularly useful for classification.



(a) (b)

Figure 1: RBF networks and absolute error with $sin(2x)$ function

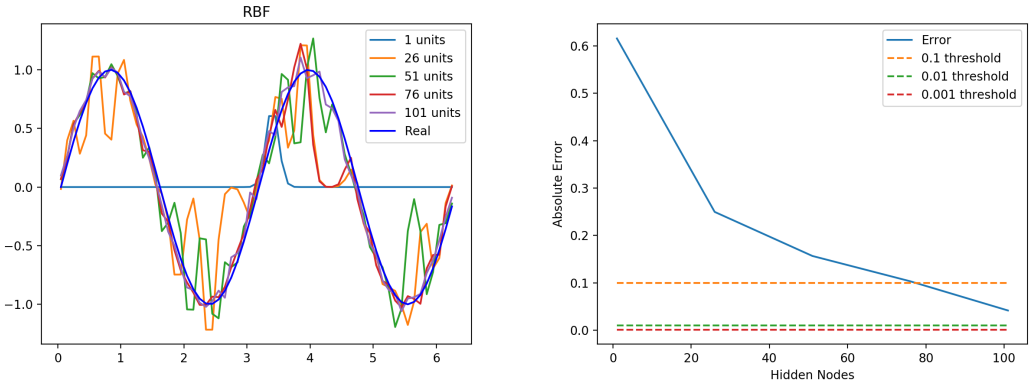


(a) (b)

Figure 2: RBF networks and absolute error with $square(2x)$ function

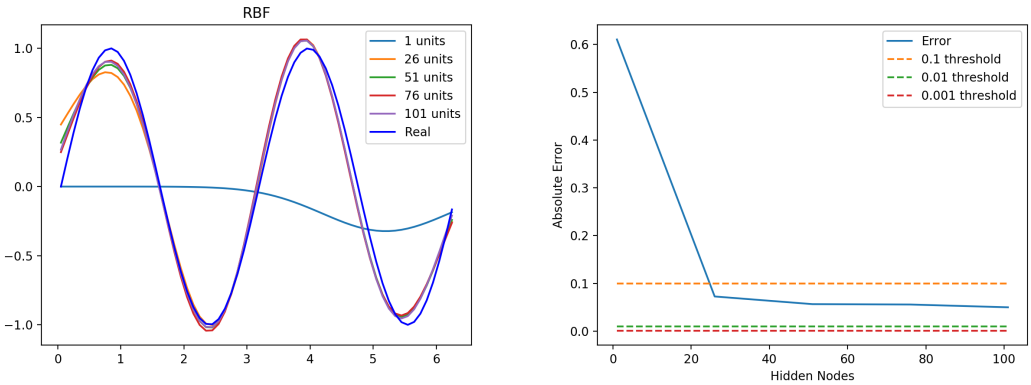
3.1.2 Online learning with delta rule

We adjusted parameter σ of RBF network, the value of σ depends on the data.If the data are widely separated, it's reasonable to choose a larger width to cover more data points as much as possible. If the data are very close, then we should choose a smaller width. σ decides the width.



(a) (b)

Figure 3: $\sigma = 0.1$



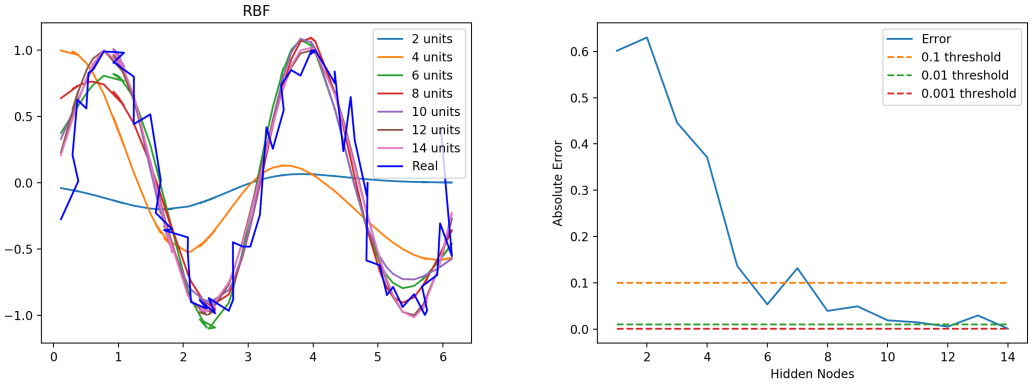
(a) (b)

Figure 4: $\sigma = 1$

3.2 noisy data

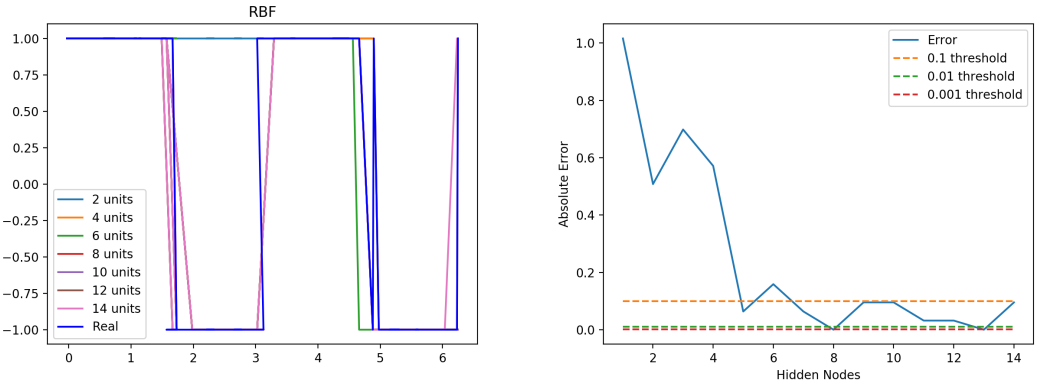
3.2.1 Batch mode training using least squares

When we added noise to data set, more units needed to reduce the absolute error to 0.



(a) (b)

Figure 5: RBF networks and absolute error with $sin(2x)$ function

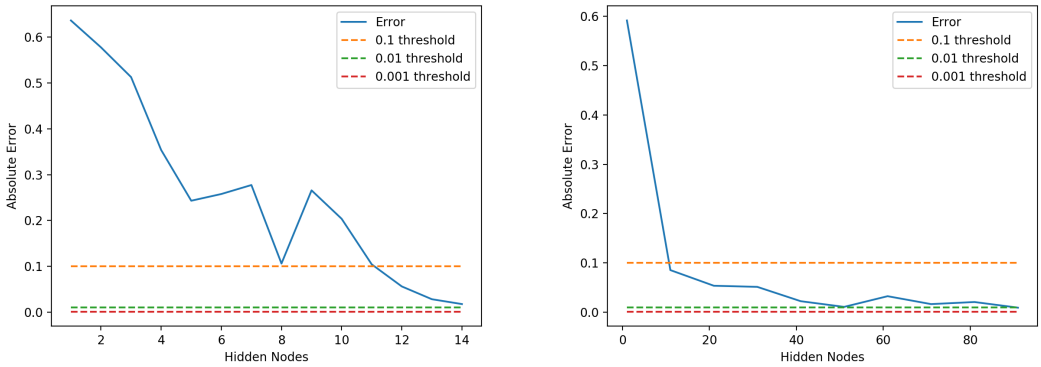


(a) (b)

Figure 6: RBF networks and absolute error with $square(2x)$ function

3.2.2 Online learning with delta rule

When we applied online learning to noisy data set, it needs more units and more epoch to reduce error.



(a) $sin(2x)$ (b) $square(2x)$

Figure 7: Error with different function

3.3 Competitive learning for RBF unit initialisation *(ca. 1 page)*

Competitive learning with more than one winner is a way of avoiding dead units.

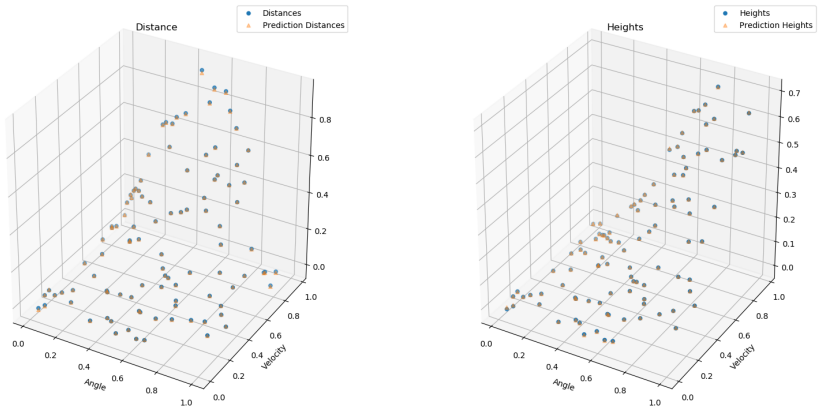


Figure 8: RBF network with the use of CL for positioning the RBF units to approximate a two-dimensional function.

Figure 8 demonstrates the capability of a network to represent a two dimensional function.

4 Results and discussion - Part II: Self-organising maps *(ca. 2 pages)*

4.1 Topological ordering of animal species

As the figure below shows the SOM can be used to assign a natural order to objects.

```
(base) n183-p245:lab2 yuhu$ /Library/Frameworks/Python.framework/Versions/3.7/bin/python3 /Users/yuhu/Desktop/p3-ann/lab/Ar
ks-and-Deep-Architectures/lab2/som.py
["'antelop'\t\n", "'ape'\t\n", "'bat'\t\n", "'bear'\t\n", "'beetle'\t\n", "'butterfly'\t\n", "'camel'\t\n", "'cat'\t\n", "'
'\t\n", "'dragonfly'\t\n", "'duck'\t\n", "'elephant'\t\n", "'frog'\t\n", "'giraffe'\t\n", "'grasshopper'\t\n", "'horse'\n",
na'\t\n", "'kangaroo'\t\n", "'lion'\t\n", "'moskito'\t\n", "'ostrich'\t\n", "'pelican'\t\n", "'penguin'\t\n", "'pig'\t\n",
\t\n", "'seaturtle'\t\n", "'skunk'\t\n", "'spider'\t\n", "'walrus'"]
[[8.32257177e-08 1.12751609e-26 4.25672390e-02 ... 7.70663196e-26
  4.28212024e-26 1.63881165e-02]
 [1.38663614e-08 4.91225646e-28 2.56170506e-02 ... 1.42812395e-27
  2.49433843e-24 4.00280966e-02]
 [8.87447130e-09 9.47201109e-29 1.53605898e-01 ... 2.55934840e-28
  1.10516156e-24 4.00266038e-02]
 ...
 [2.22256812e-13 1.00000000e+00 4.55511389e-15 ... 4.55896368e-03
  9.95441036e-01 6.62462899e-02]
 [3.02166555e-13 1.00000000e+00 2.86244170e-13 ... 7.12124865e-03
  9.92878751e-01 8.50341556e-02]
 [5.37618880e-13 1.00000000e+00 1.63315152e-14 ... 7.12124865e-03
  9.92878751e-01 8.50341556e-02]]
[28  0 17  0 94 91 33  7 51  4 99 69 18 56 33 96 43 87  0 22  7 85 61 66
 63 39 25 13 48  4 78 10]
["'ape'\t\n" "'bear'\t\n" "'hyena'\t\n" "'dog'\t\n" "'skunk'\t\n"
 "'cat'\t\n" "'lion'\t\n" "'walrus'" "'rat'\t\n" "'bat'\t\n"
 "'elephant'\t\n" "'kangaroo'\t\n" "'rabbit'\t\n" "'antelop'\t\n"
 "'camel'\t\n" "'giraffe'\t\n" "'pig'\t\n" "'horse'\n" "'seaturtle'\t\n"
 "'crocodile'\t\n" "'frog'\t\n" "'ostrich'\t\n" "'penguin'\t\n"
 "'pelican'\t\n" "'duck'\t\n" "'spider'\t\n" "'moskito'\t\n"
 "'housefly'\n" "'butterfly'\t\n" "'beetle'\t\n" "'grasshopper'\t\n"
 "'dragonfly'\t\n"]
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Figure 9: result