Artificial Neural Networks

Exercise 2

Radial-Basis Function and Self Organization

3.2

* what is the lower bound for a number of training examples(N)?

That should be n

* + *N < n* : ∞ solutions
  + *N* = *n* : 1 solution
  + *N* > *n* : no solution (overdetermined system)
* What happens with the error if N=n? why?

It would be 0, since the weights will match up to fit the given data exact

* Under what condition, if any, does (4) have a solution in this case?

When n=N, the equations must be independent. Each training pattern active unique (different ) hidden neuron

* During training we use an error measure defined over the training examples. Is it good to use this measure when evaluating the performance of the network?

No . Test error is used for evaluating the performance of the network. Training error does not show the generalization ability.

4.1Approximation of sin(2x)

The function has 4 peaks and 2 start & stop points, so to approximate it we need at least 6 units.

Requires 6, 24, and 56 units to pass 0.1, 0.01, and 0.001 residual

By changing the input interval to (-pi/4 : 2pi –pi/4)we could approximate sin2x with 5 units





Approximation of square (2x)



Unit=60 good approximation

Unit =63 residual=1e-15 (n=N)

Requires ~60-63 units to pass 0.1, 0.01, 0.001 residual

Targets values are 0 or 1 🡪 Classification

Residual can be improved with sign-function transform on output (6 units 🡪 Residual 0)

RBF could solve the XOR problems. To perform the XOR classification in an RBF network, one must begin by deciding how many basis functions are needed. Given there are four training patterns and two classes, we could solve the problem.

**4.2 Online training using the delta rule (function= sin2x)**

Etha = 0.2, iteration= 20000 Etha = 0.2, iteration= 10000

Etha = 0.5, iteration= 20000 Etha = 3.7, iteration= 20000

Etha = 2.5, iteration= 20000 Etha = 3.5, iteration= 40000 (residual= 0.01) (very difficult and slow )

Online training using the delta rule(function= cos(pow2(x))& pow2(x)))

Etha = 3.7, iteration= 20000 Etha = 3.5, iteration= 20000

**5. RBF Placement by Self Organization**

5.1.1 Using Competitive Learning (CL) for vector Quantization, (one iteration)

units= 3 (Single winner = 1/0) units= 5(Single winner = 1/0)

5.1.2 Using Competitive Learning (CL) for vector Quantization, (Successive iterations)

units= 3(Single winner = 1/0) units= 5 (Single winner = 1/0)

Single winner = 1: Some circles are redundant.

* + Advantage: Fast since only one circle moves per iteration
  + Disadvantage: Can miss clusters
* Single winner = 0: All circles placed at clusters. Clusters with multiple circles divided among the circles into subclusters
  + Advantage: Better are finding all clusters
  + Disadvantage: Slower due to more operations per iteration

5.2.1 Using Expectation Maximization algorithm (EM) (one iteration)

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5.2.2 Using Expectation Maximization algorithm (EM) (Successive iterations)

units= 3(Single winner = 1/0) units= 5 (Single winner = 1/0)

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**6. Function Approximation for Noisy data**

units= 15 units= 15 with using low pass filter

 (filter order=150, f=0.95 pi)

units=30

* Optimal model complexity at ~15 units
* For more than ~25 units 🡪 Overtraining