Lab 2
Artificial Neural Networks and Deep Architectures

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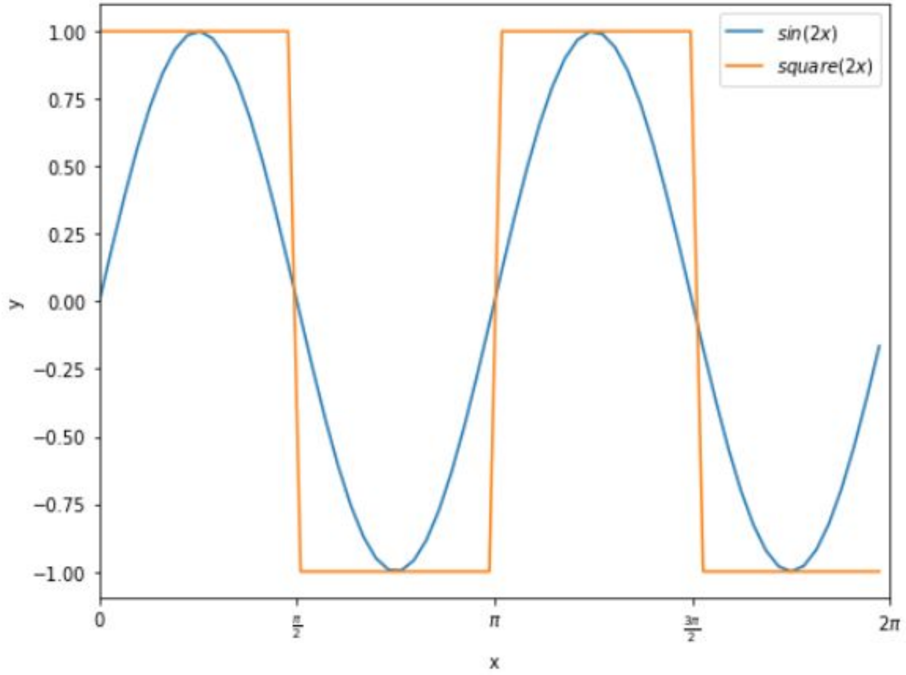
Function Approximation with RBF Networks



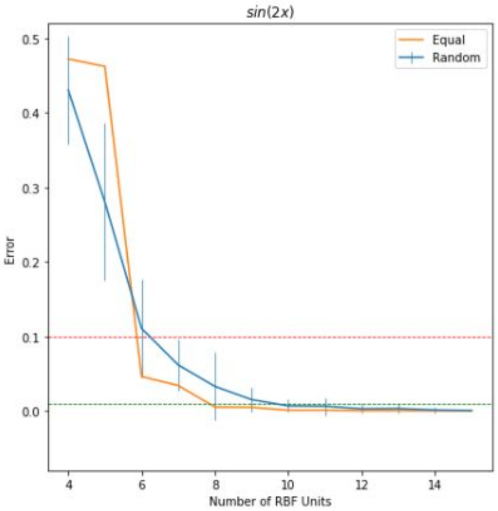
Clean Data

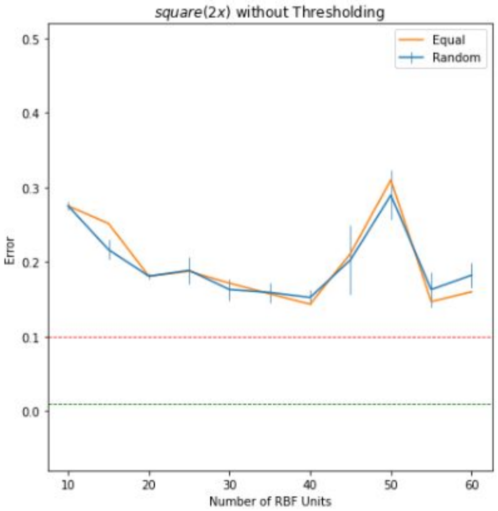
2 functions sampled in the interval [0, 2π] divided into two independent training and test sets:

sin(2x)

square(2x)

Absolute Residual Error vs Number of RBF Nodes



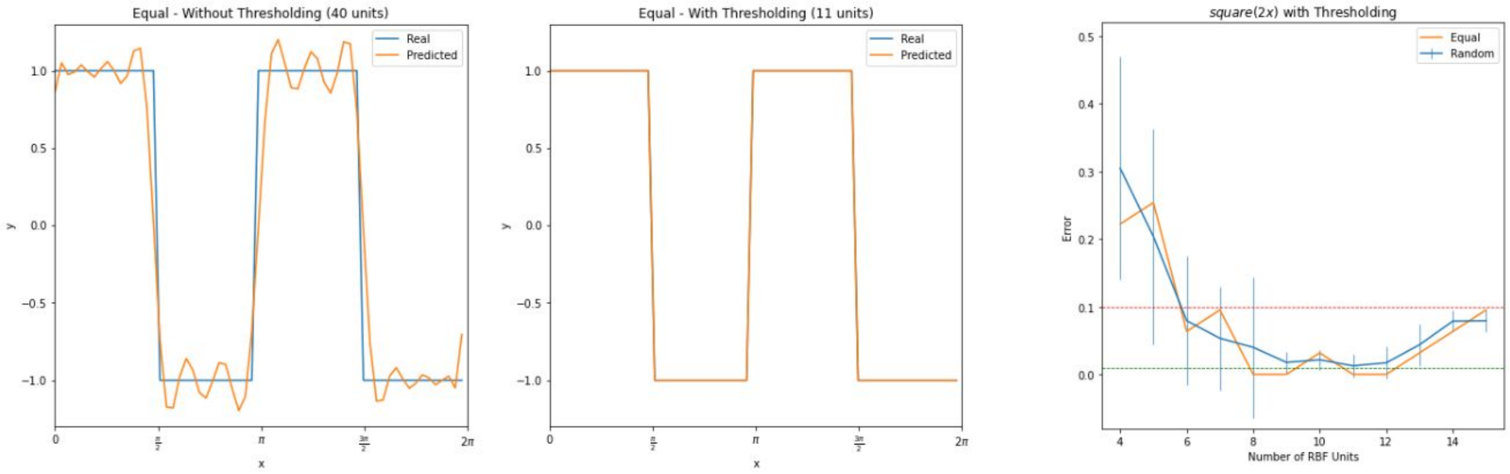


Below Error	0.1	0.01	0.001
RBFs	6	8	10

As the number of units increases, the error decreases

For square(2x) the error is never below 0.1

Thresholding *square(2x)*

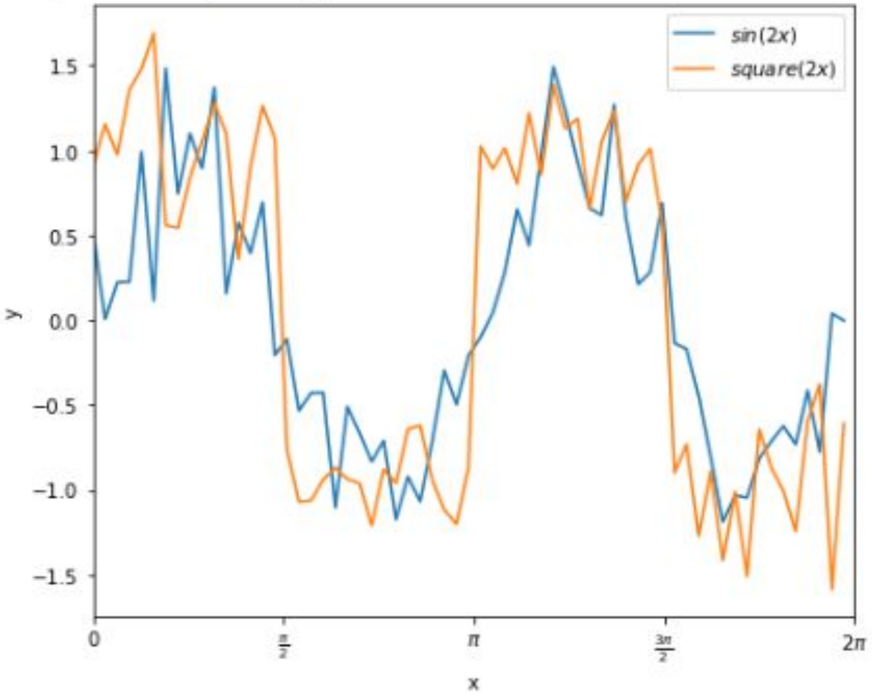


Below Error	0.1	0.0
RBFs	6	8

Thresholded: if pred ≥ 0 then pred_t = 1

otherwise pred_t = -1

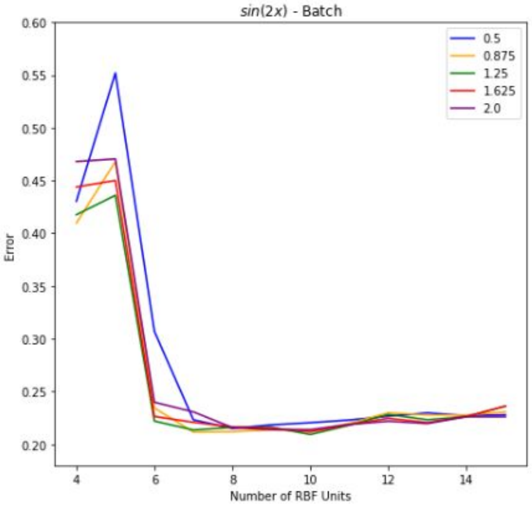
Function Approximation with RBF Networks

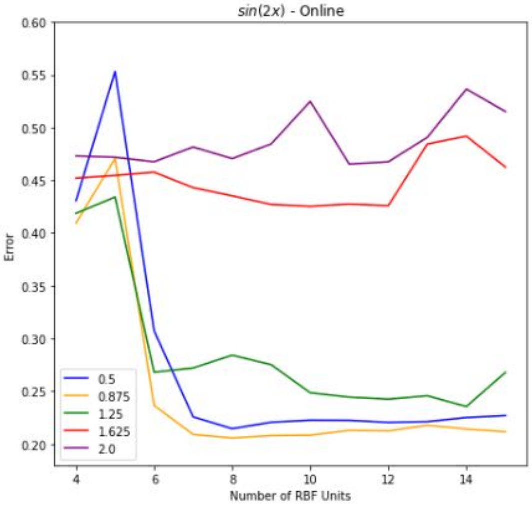


Noisy Data

Zero-mean Gaussian noise with the variance of 0.1 added to both functions, to both training and test data independently.

Variance Impact for Batch and Online Learning



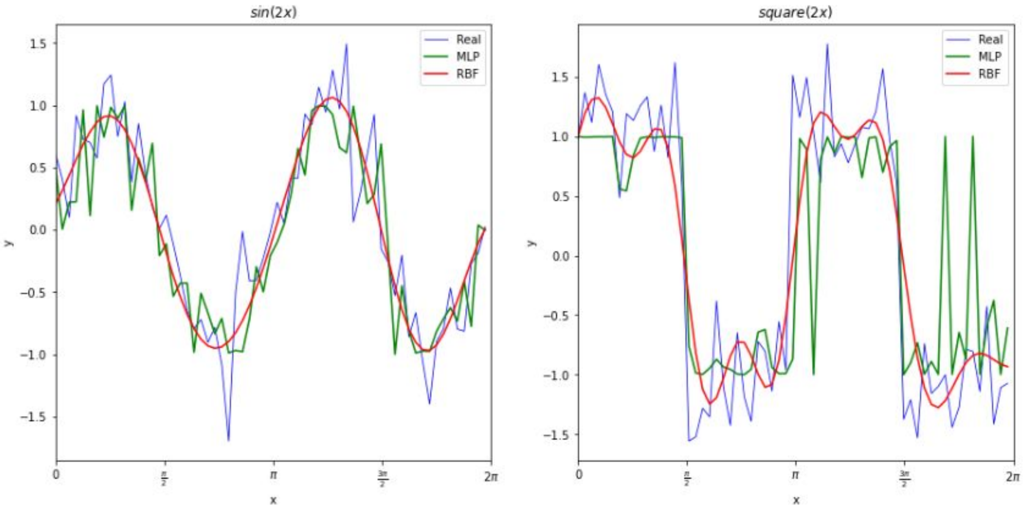


	Batch	**Online**
Initialization	Equal	Equal
Eta	-	0.05

For batch the variance doesn’t impact much

For online the highest variances are not able to describe the data even when the number of units increases

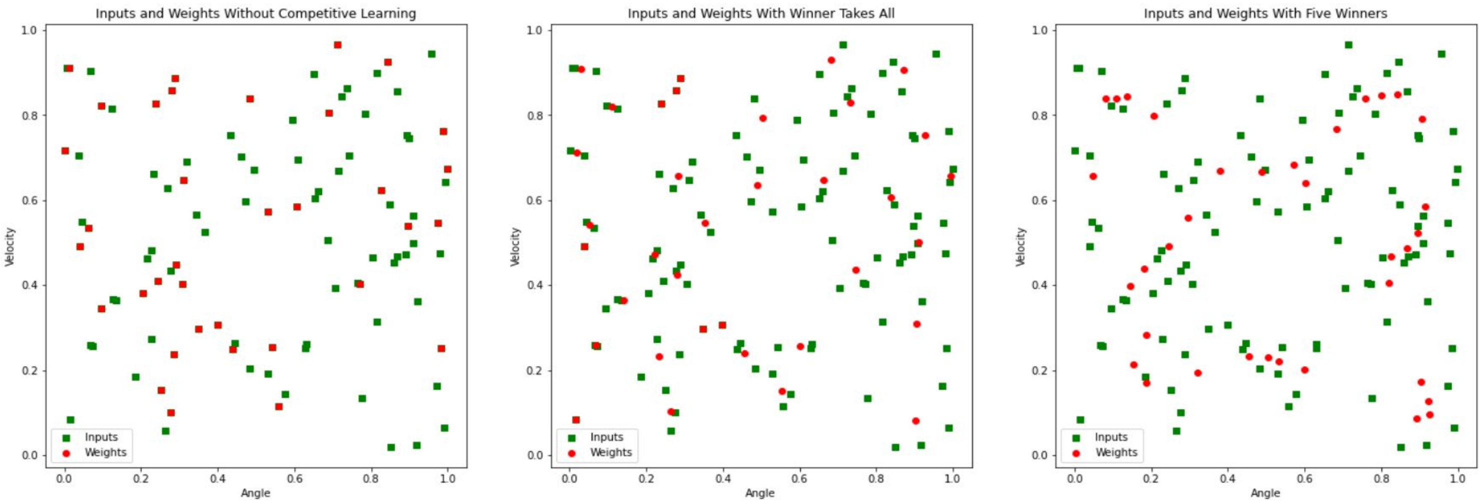
MLP vs RBF



	sin(2x)	square(2x)	time (avg.)
MLP	0.303	0.436	0.167s
RBF	0.209	0.361	0.027s

RBF captures less noise then MLP, hence its predictions are smoother and more accurate

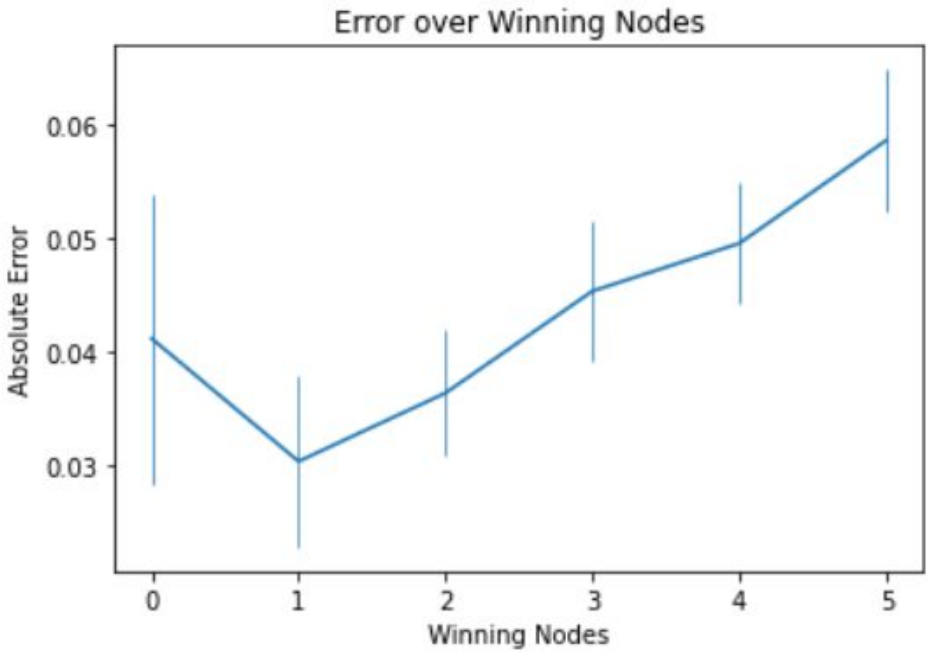
Competitive Learning



	Random	1 winner	5 winners
Error	0.041	0.030	0.059
std.	0.013	0.008	0.006

Random initialization fails to efficiently capture the data. The ”winner takes all” scheme better captures the data and multiple winners over represents denser clusters.

2D Function Approximation



Best Performance
Winner Takes All
Mean: 0.030
STD: 0.0075

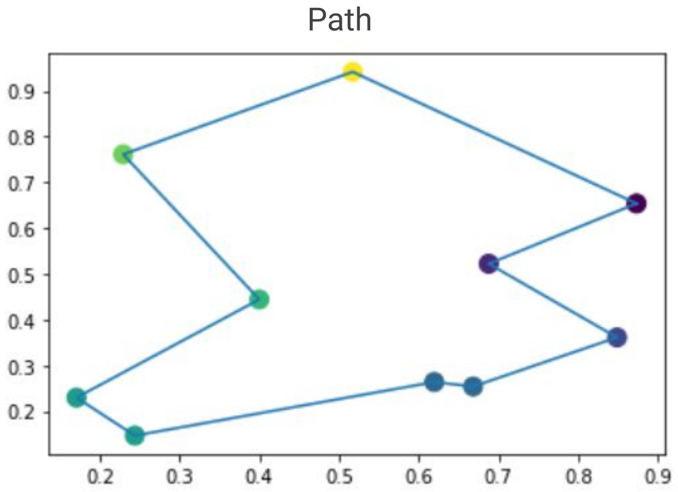
Topological Ordering of Animals with SOMs

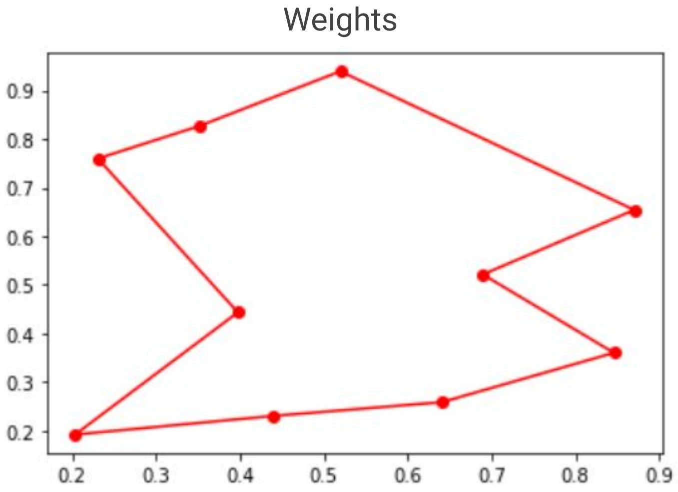
beetle	grasshopper	dragonfly	butterfly	moskito	housefly	spider	pelican
duck	penguin	ostrich	frog	seaturtle	crocodile	walrus	bear
hyena	ape	skunk	dog	lion	cat	rat	bat
rabbit	kangaroo	elephant	antilope	horse	camel	pig	giraffe

Neighbourhood decay	linear from 50 to 0
Learning Rate	0.2
Epochs	20

The animals gets sorted into a order where similar animals are placed next to each other

Cyclic Tour with SOMs



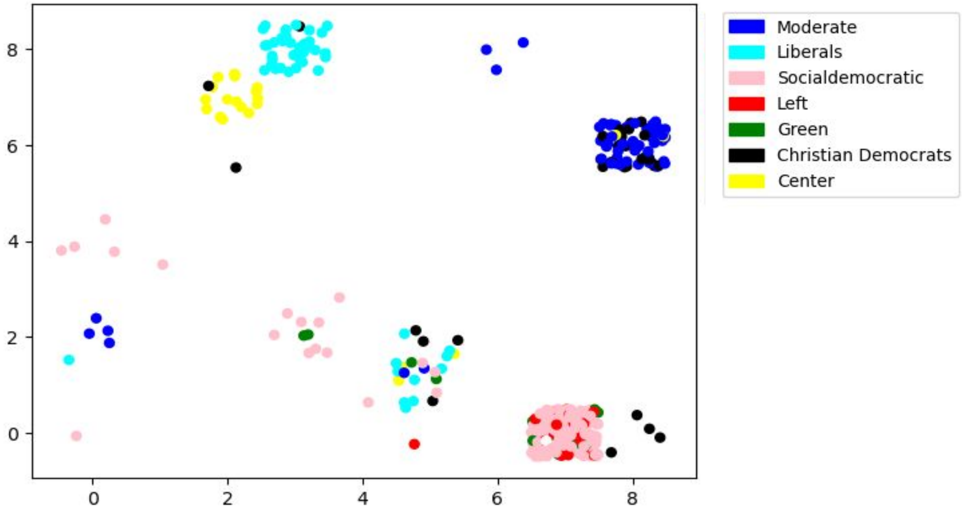


Learning Rate	0.2
Neighbourhood Decay	Linear from 2 towards 0

Efficient solution found

Weights correspond quite well to the cities

Clustering with SOMs

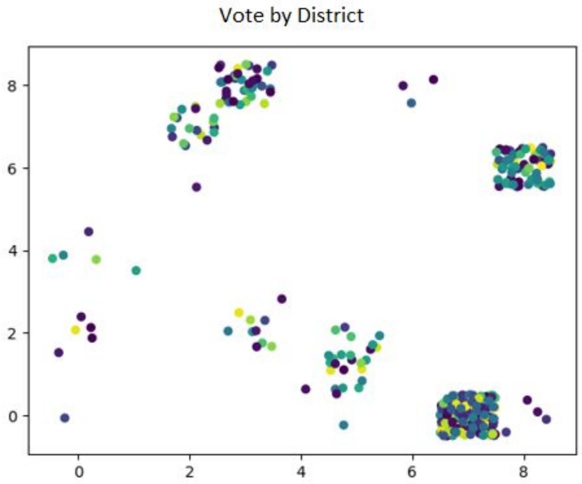


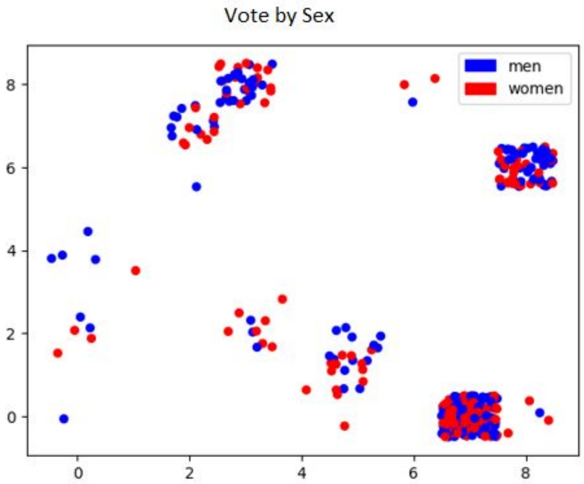
Learning Rate	0.2
Neighbourhood Decay	Linear from 4 to 0

Each politician is sent to their closest node (with a small shift)

Quite strong voting trend among the same party and in between some parties.

Clustering with SOMs





Learning Rate	0.2
Neighbourhood Decay	Linear from 4 to 0

We do not observe such strong trend among genders and districts.

Final Remarks

- RBF Networks combine Supervised and Unsupervised techniques
- “Winner-takes-all” scheme for Competitive Learning seems to perform better than “Multiple Winners” if data is evenly distributed
- SOM can be used in multiple aspects, are sensitive to initialisation and the learning should be monitored so that it captures both large and small scale pattern.

Thank you!