Deep Learning Models for Games

Bachelor Thesis Session – September 2015

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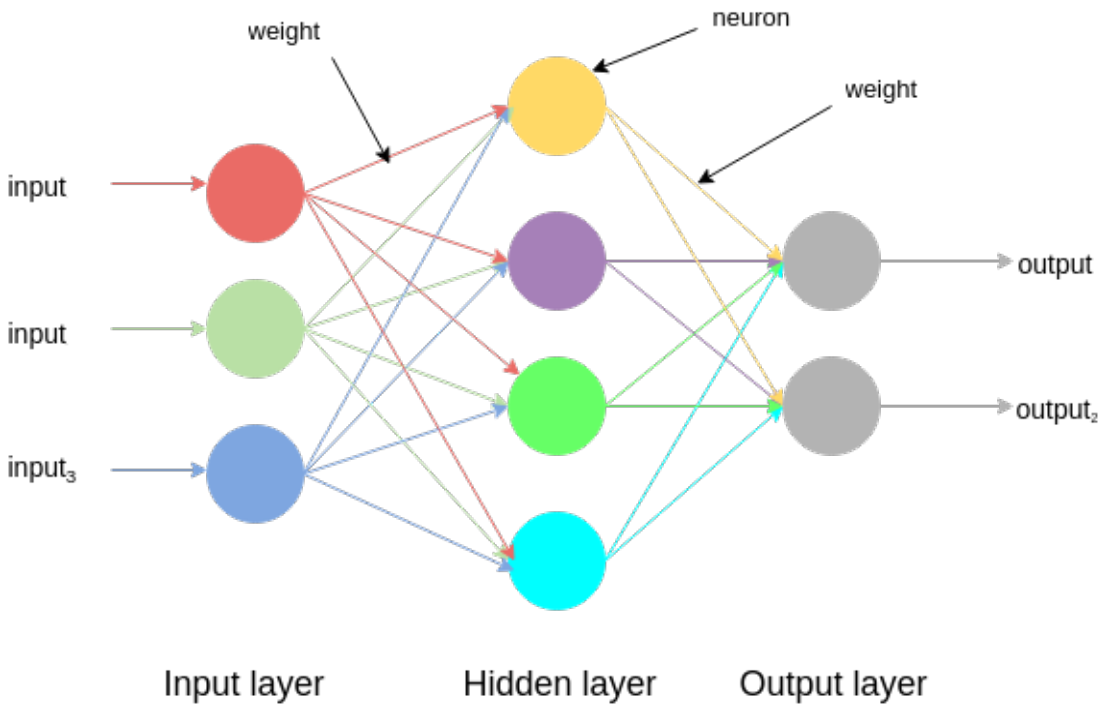
Motivation

Deep Learning

- find models capable of generalization
- extract from low-level(edges,colors) to high-level(combination of rudimentary features) features
- reduce programming burden
- applicability: cancer classification, autonomous cars, object recognition from images

Once upon a time...

- reinforcement learning: Q-Learning
- deep neural networks

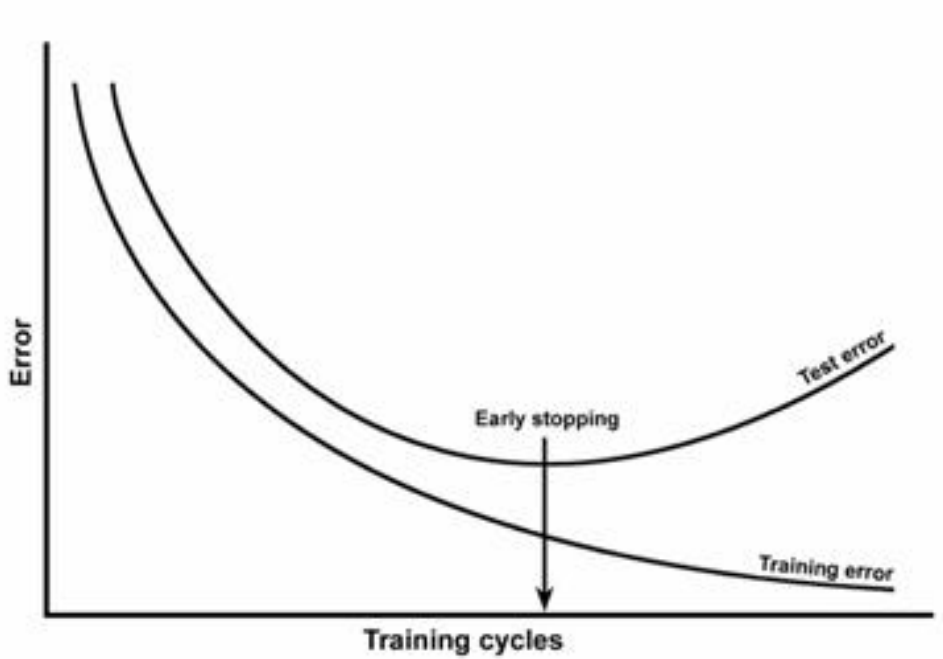


Preprocessing, Model, Loss function

- color space: RGB, YUV, grayscale
- data normalization 0..1, contrast normalization
- activation functions
  - hidden layer vs output layer
  - tanh, sigmoid, ReLU
- how many layers/features, what type of layers
- loss function: classification(binary/multi-class) or regression?
- gradient descent **vs** stochastic gradient descent

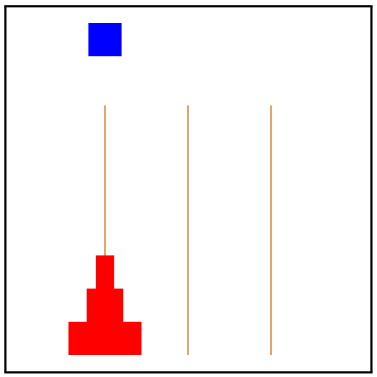
Train and test

- split dataset for training and testing
- when to stop training?

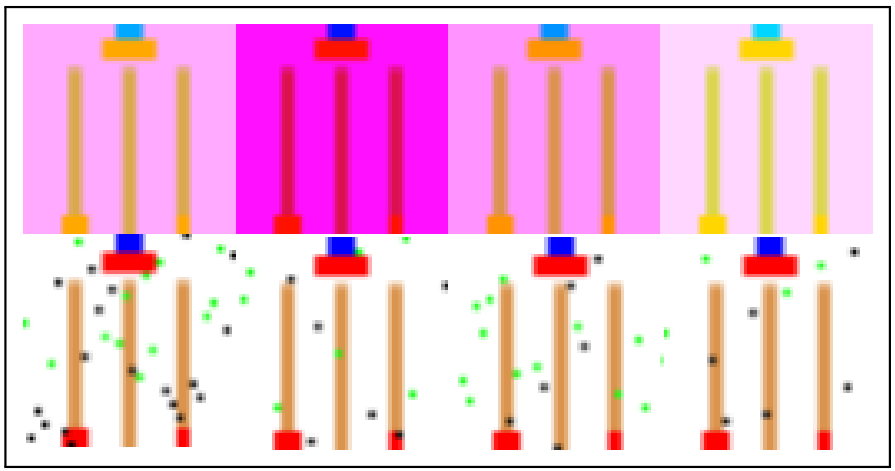


Source:
http://documentation.statsoft.com/statisticahelp.aspx?path=sann/overview/sannoverviewsnetworkgeneralization

Once upon a time...



Tower of Hanoi (first state)

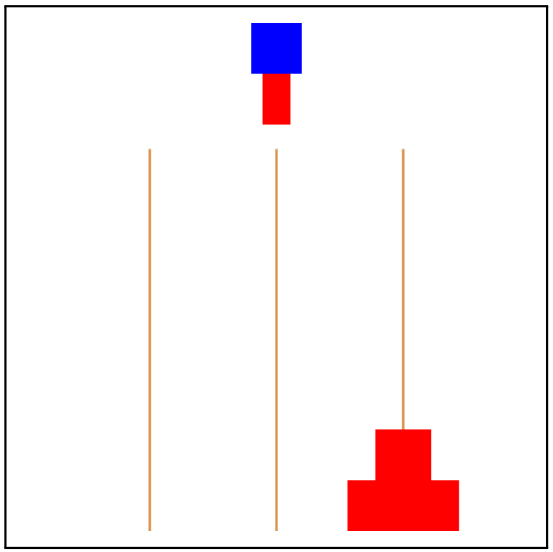


Dataset with noise added and color changed

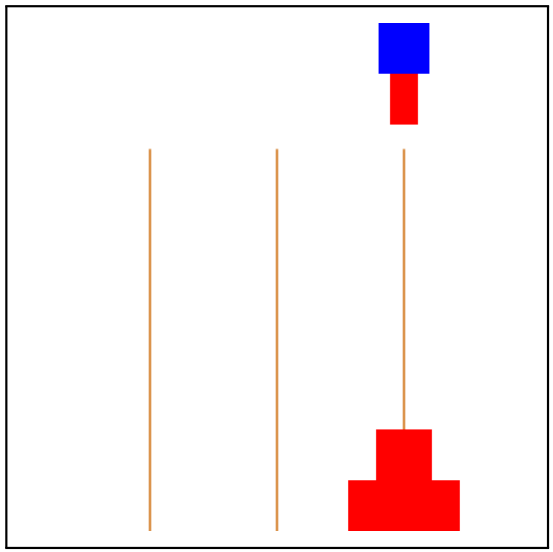
- game: Tower of Hanoi
- reinforcement learning: Q-Learning
- deep neural networks: predict values from Q-Learning
- machine learning framework: Torch based on Lua

Q-Learning

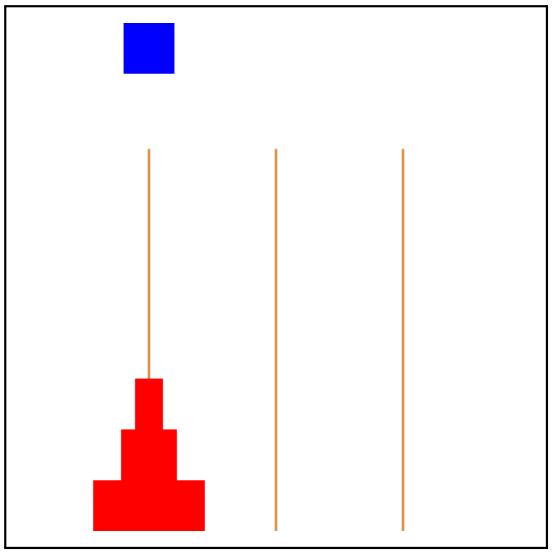
- finds optimal policy for action-value function
- $Q(s,a) = Q(s,a) + \alpha \cdot (r + \gamma \cdot \max_a Q(s', a') - Q(s, a))$



UP = 90,6534
DOWN = 86,8787
LEFT = 89,1867
RIGHT = 94,2824

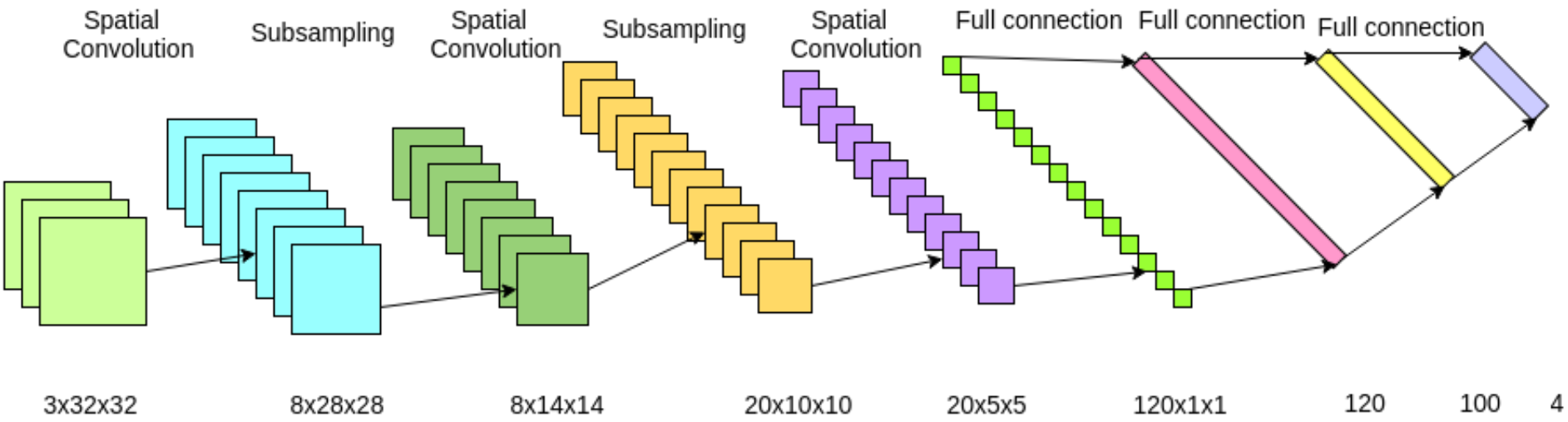


UP = 97,6530
DOWN = 100,0000
LEFT = 93,8538
RIGHT = 92,5261

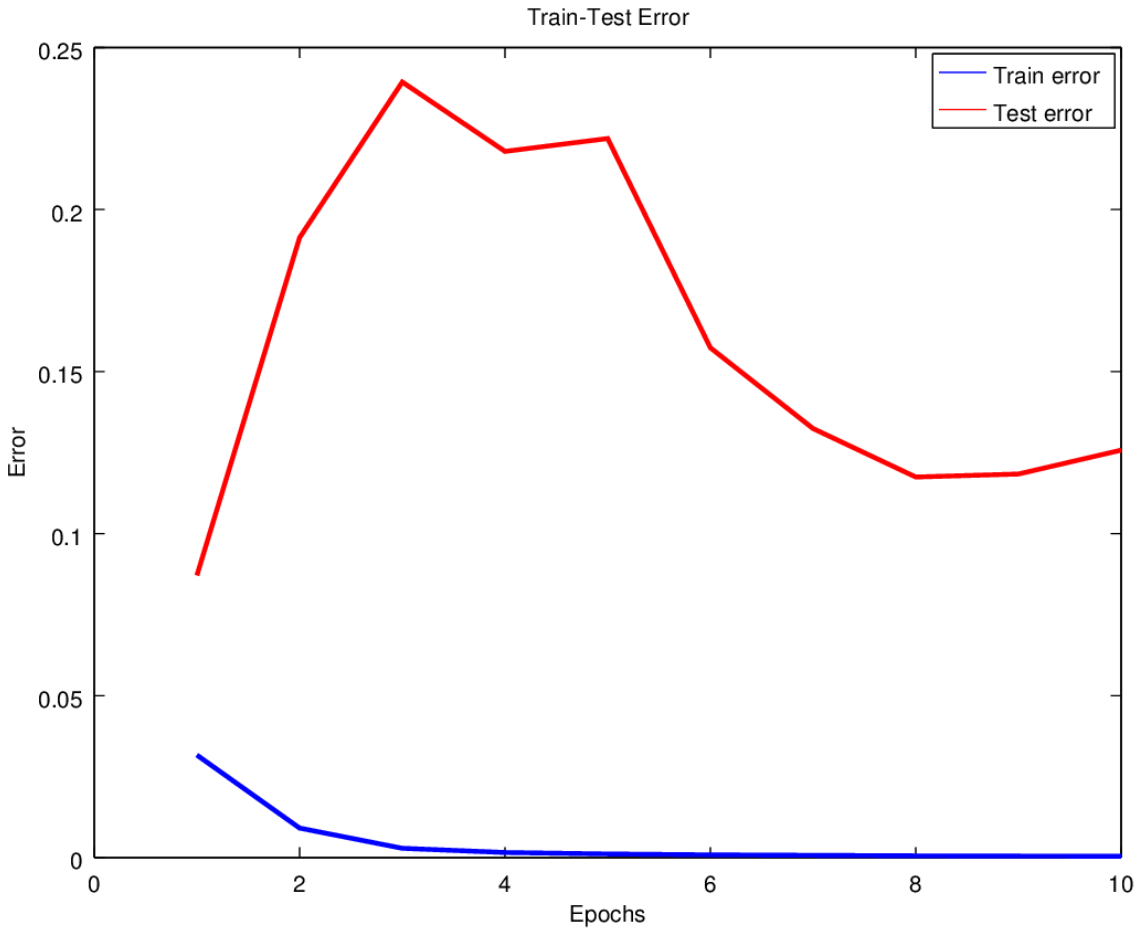


UP = 26,3520
DOWN = 23,8452
LEFT = 23,8897
RIGHT = 22,8827

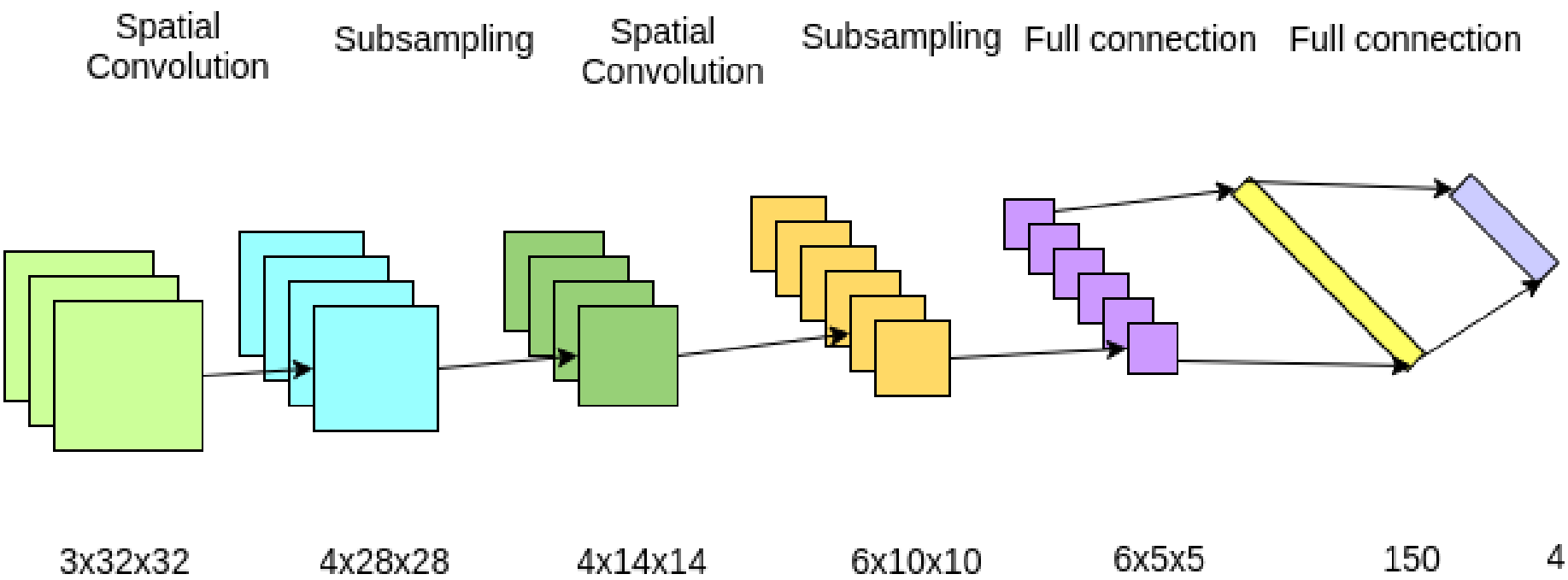
Model


Spatial Convolution
Subsampling
Spatial Convolution
Subsampling
Spatial Convolution
Full connection
Full connection
Full connection
3x32x32
8x28x28
8x14x14
20x10x10
20x5x5
120x1x1
120
100
4

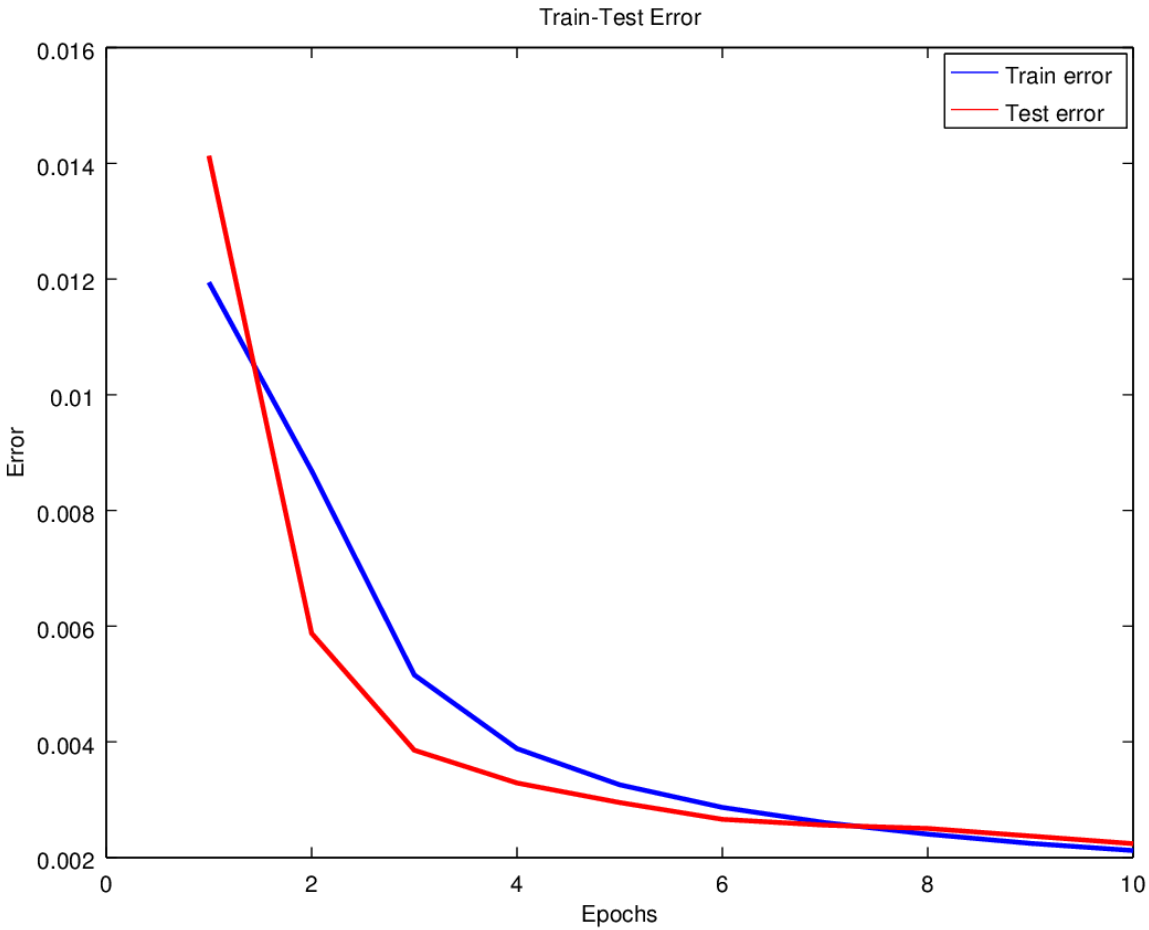
Results


Train-Test Error
Train error
Test error
Error
Epochs
0.25
0.2
0.15
0.1
0.05
0
0
2
4
6
8
10

Model


Spatial Convolution
Subsampling
Spatial Convolution
Subsampling
Full connection
Full connection
3x32x32
4x28x28
4x14x14
6x10x10
6x5x5
150
4

Results


Train-Test Error
Train error
Test error
Error
Epochs
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
2
4
6
8
10

Future work

- implement Q-Network
- test algorithm on dynamic environments or games where the state of the universe is not fully observed
- make Nao capable of playing Tic-Tac-Toe
- after all tasks mentioned above are done, use all the information gathered for cancer classification, etc.

Conclusions

Source:
http://xkcd.com/

QA

Questions and Answers

Thank you for your attention!