Roi Herzig ID: 300360310 EMAIL:roeiherzig@mail.tau.ac.il

Moshe Raboh ID:300611878 EMAIL:shikorab@gmail.com

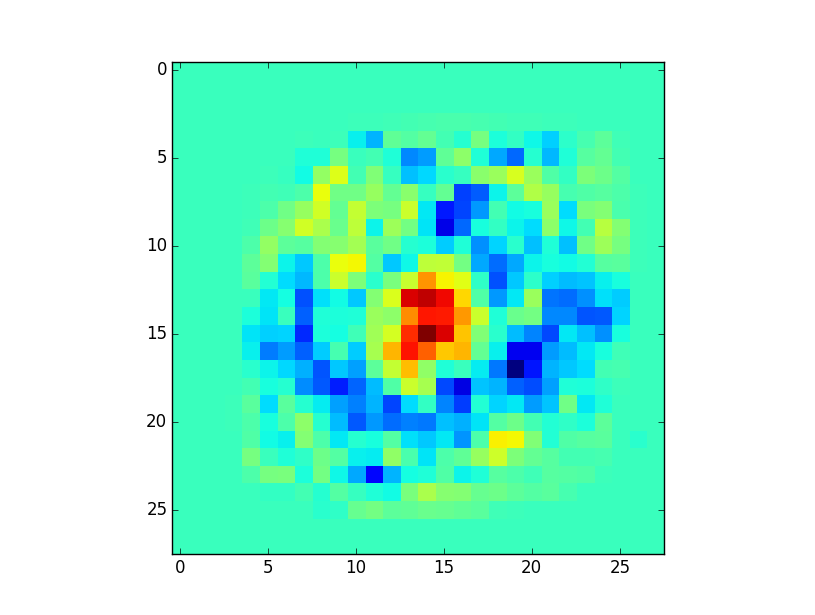
**Introduction To Machine Learning – EX 2**

1. **A:**Directory: " /specific/a/home/cc/students/csguests/roeiherzig/ML/EX2"See function "part\_a" in file "q1.py"

**TBD** as well as the 5% and 95% percentiles of the accuracies obtained. **B:**

Directory: " /specific/a/home/cc/students/csguests/roeiherzig/ML/EX2"See function "part\_b" in file "q1.py"

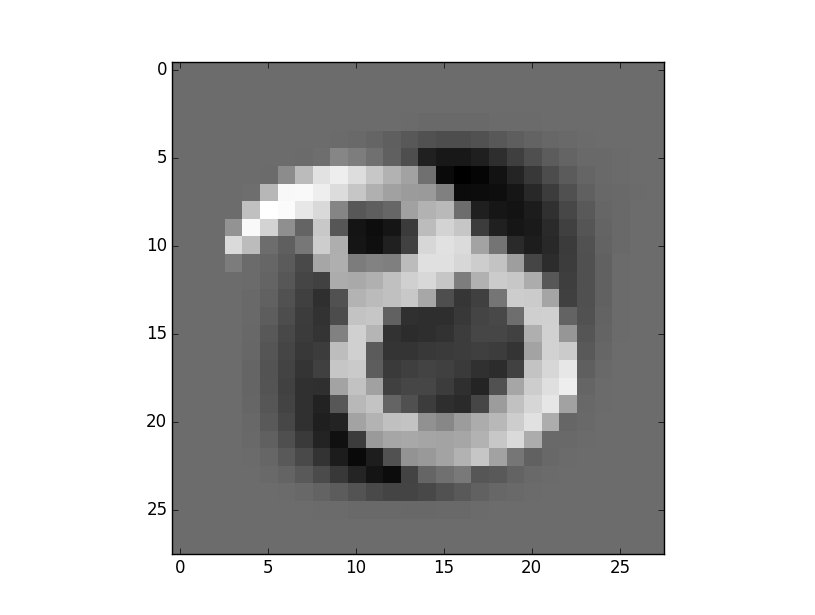
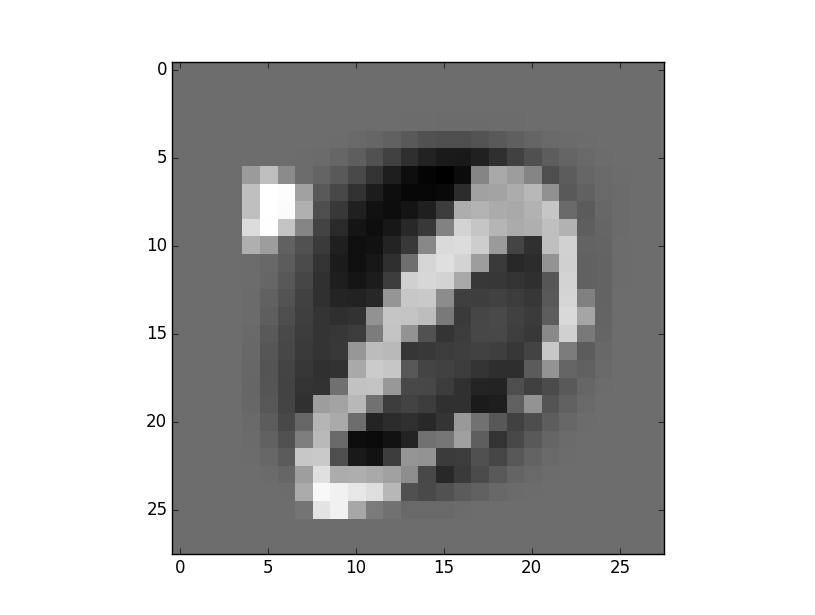
Name of the image: “part\_1b.png”



TBD - intuition

**C:**Directory: " /specific/a/home/cc/students/csguests/roeiherzig/ML/EX2"See function "part\_c" in file "q1.py"  
Mean accuracy of the full train samples: 99.13%

**D:**Directory: " /specific/a/home/cc/students/csguests/roeiherzig/ML/EX2"See function "part\_d" in file "q1.py"Image file: "part\_1d\_rotat0.png" and “part\_1d\_rotat8.png”

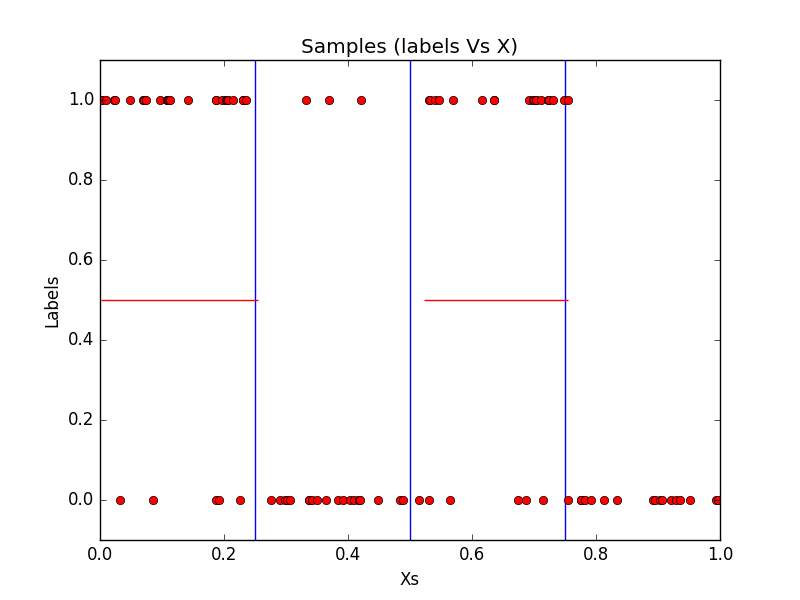


In both cases, we can see images are miss-classified because the images are distorted. We can see that our classifier is not invariant to some affine transformation such as scale, translation and rotation.

**2.**

**A:**Directory: " /specific/a/home/cc/students/csguests/roeiherzig/ML/EX1"Function "part\_a" in file "UnionOfInterval.py"

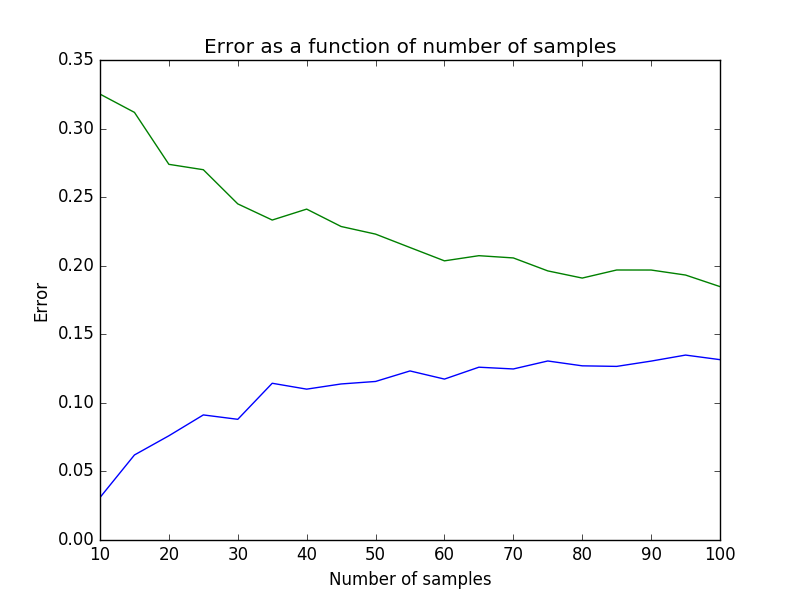
The image file name: "partA.png"

****

The red lines are the intervals (the result of function "find\_best\_intervals" with k = 2.  
The blue lines are vertical lines is x=0.25, 0.5, 1.

**B:**

Given the distribution, the hypothesis with the smallest error will be hypothesis of 2 intervals ((0, 0.25), (0.5, 0.75)).  
The error is 15% (2\*0.25\*0.2 + 2\*0.25\*0.1 = 0.15)

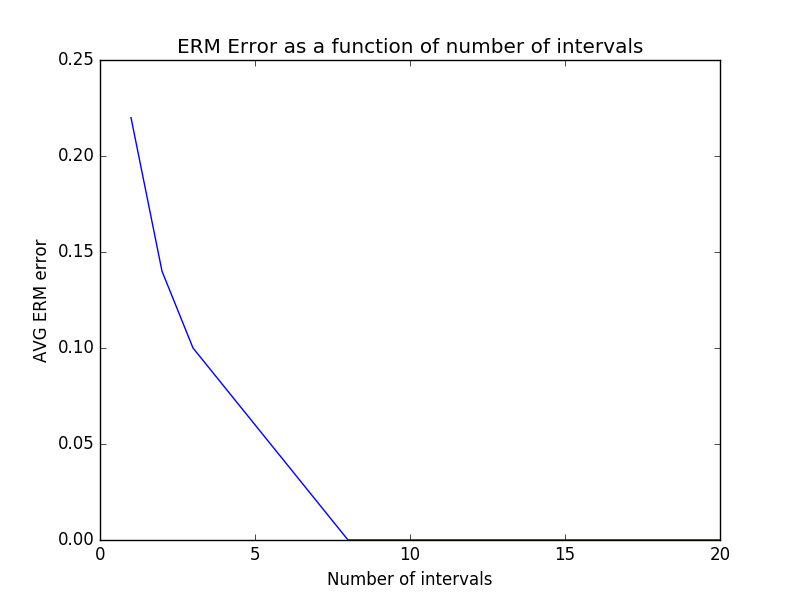
**C:**Directory: " /specific/a/home/cc/students/csguests/roeiherzig/ML/EX1"True error function: "calc\_true\_error" in file"UnionOfInterval.py".  
The experiment function: "part\_c" in file "UnionOfInterval.py".  
The image file name is "partC.png" ****The green line is the true error as a function of m.  
The blue line is the empirical error as a function of m.

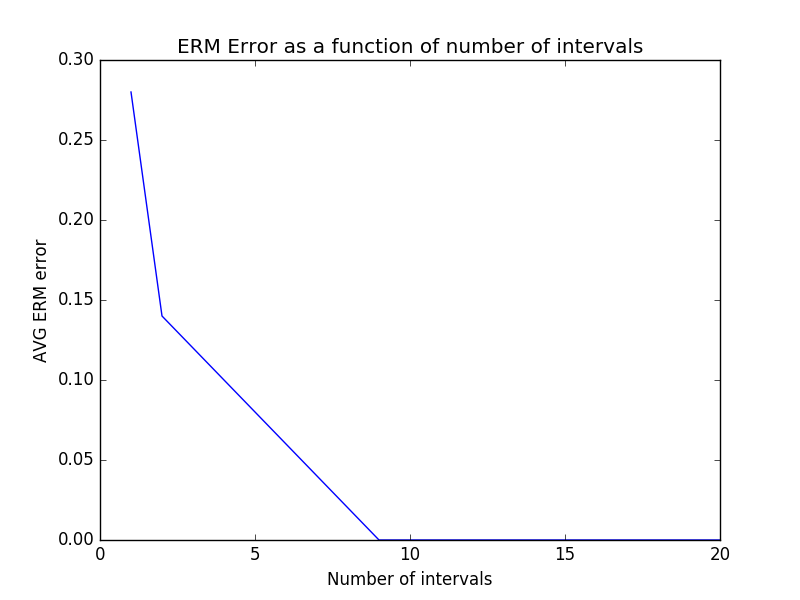
As we can see:

The empirical error increasing when m grows. When m is small, there are small amount of samples, sparse, so it is easier to find intervals with better results (smaller error) compared to the true hypothesis (on these samples only of course)**.** In such a case the ERM overfits.

The true error decreasing when m is grows. The true hypothesis best fit to the theoretical distribution. The samples will better reflect the theoretical distribution when m is big. **D:**Directory: " /specific/a/home/cc/students/csguests/roeiherzig/ML/EX1"

Function name "part\_d\_and\_e(t = 1, file\_name="partD.png")" in file "UnionOfInterval.py".  
Image file is "partD.png"

The error decreasing when k growth. When single interval allows to reduce the error with at least one (when the error != 0 of course).  
K\* will is any k bigger then 8. Of course K\* is not a good choice since it overfits the samples.  


E:  
Directory: " /specific/a/home/cc/students/csguests/roeiherzig/ML/EX1"  
Function name "part\_d\_and\_e(t = 100, file\_name="partE.png")" in file "UnionOfInterval.py".  
Image file is "partE.png"  


F:   
Directory: " /specific/a/home/cc/students/csguests/roeiherzig/ML/EX1"  
function name: part\_f() in file in file "UnionOfInterval.py".

Given a new data set with m=50, we would perform cross validation in the following way:  
- Get the best hypothesis per k from section D.  
- Compare the hypothesis labels with the true labels of the new dataset (validation data set).  
- Pick the best hypothesis (the lowest number of errors over the new data set).

This cross validation will allow us to avoid from model which overfit the original sample from section D.  
Indeed with relatively small number of samples we were able to find a hypothesis which is very close to the theoretical best hypothesis. (same number of intervals and overlapping intervals).  
intervals = (0.005, 0.24), (0.49, 0.72)

Error = 0.14

Note:  
Dividing the samples to a bigger number of training samples vs validation samples might produce better results.