CS771: Machine Learning
Assignment 1

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Part 1

For a single 32-bit PUF, we can guess the output by taking the sign of

$$\frac{1+\text{sign}(W^\top X+b)}{2}$$

where $X=[x_1,x_2,\ldots,x_{32}]$ and $x_i=1-2c_i$. (c_i denotes the input $(0,1)$ for multiplexer.)

For both PUFs, the output is given by:

$$\Delta=(((w_1)^TX+b_1)-((w_1)^TX+b_2)),$$

Let's consider the following calculations:

$$W=w_1-w_2$$

and

$$b=b_1-b_2$$

Output is decide by sign of $(W^TX+b)^2-\tau^2$ (as given in Question(squaring))

Including b in weight itself

Thus, increasing the dimension of X by 1.

$\therefore$ output is decided by the sign of $(W^TX)^2-\tau^2$

$$(W^TX)^2-\tau^2\Rightarrow\sum_{i=0}^{32}(w_ix_i)^2+\sum_{i=0}^{32}\sum_{j\neq i}^{32}w_iw_jx_ix_j-\tau^2$$

$$\because x_i=1\text{or }-1\Rightarrow x_i^2=1$$

$$\therefore\sum_{i=0}^{32}(w_ix_i)^2-\tau^2=\sum_{i=0}^{32}w_i^2-\tau^2=b\prime$$

$$\text{also, }\sum_{i=0}^{32}\sum_{j\neq i}^{32}w_iw_jx_ix_j=(W')^TX'$$

$$W'=2[w_0\cdot w_1,w_1\cdot w_2,\ldots,w_{31}\cdot w_{32}]$$

$$X'=\phi(X)=[x_0\cdot x_1,x_1\cdot x_2,\ldots,x_{31}\cdot x_{32}]$$

$\Rightarrow$ Here, X' is our feature vector of dimension:

$$\binom{33}{2}=528$$

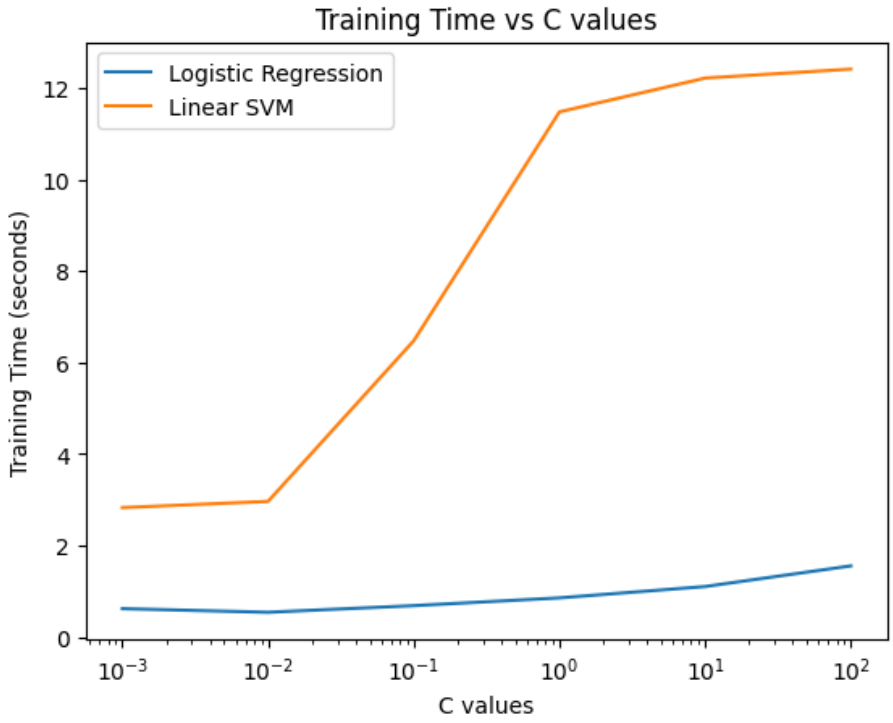
.

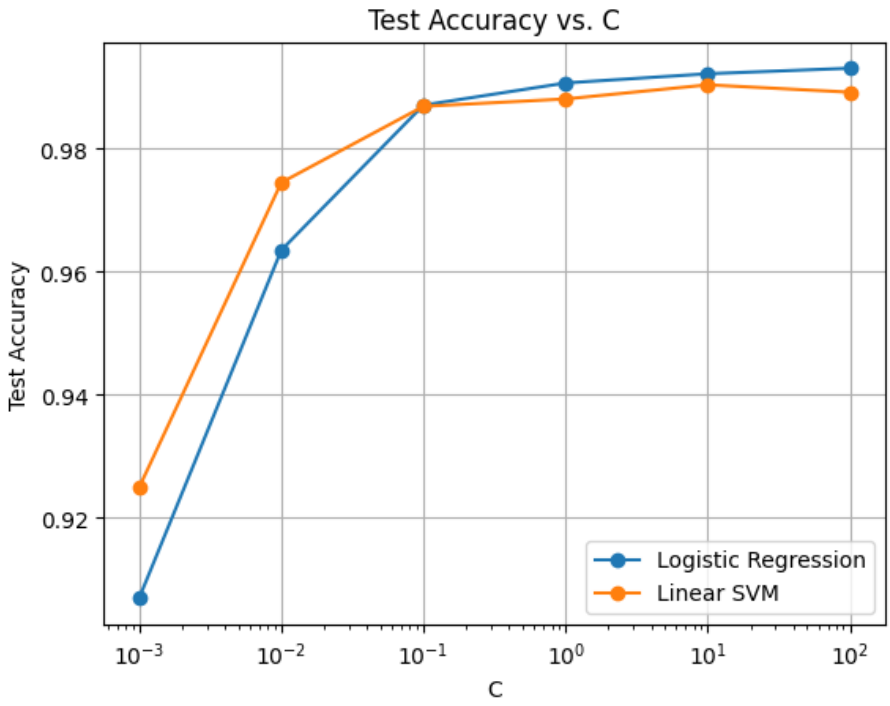
And our final output is decided by,

$$\frac{1+\text{sign}(W'^\top X'+b')}{2}$$

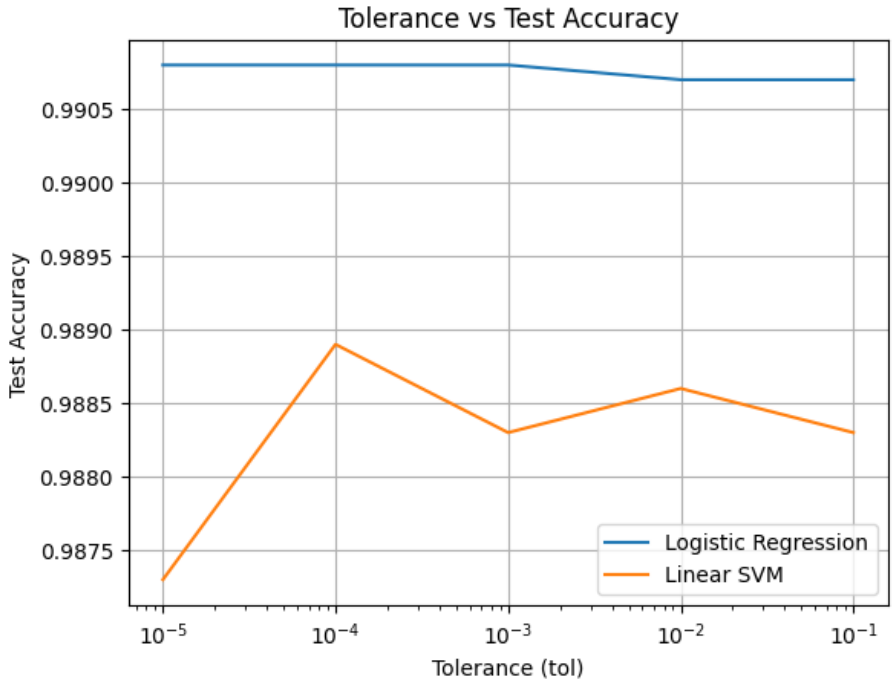
Part 3 - B

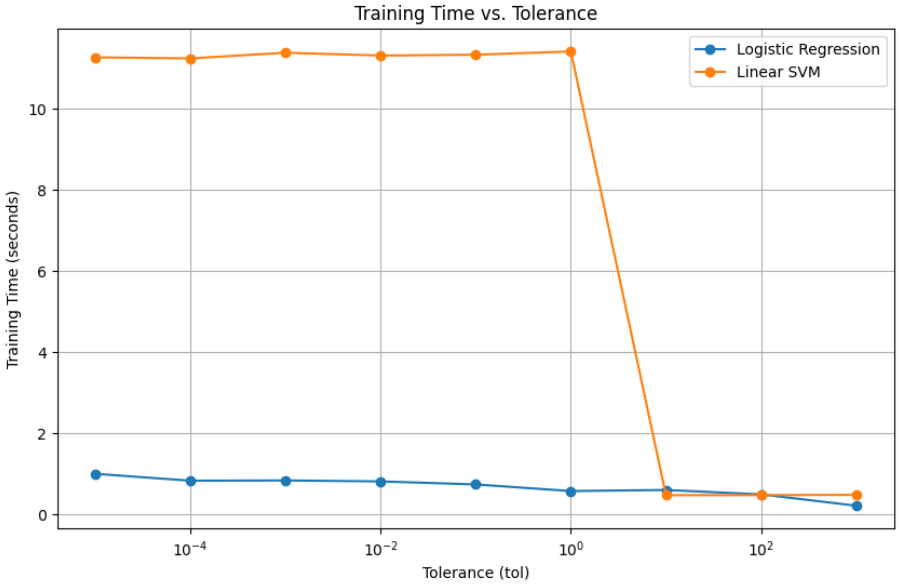
B


Training Time vs C values
Logistic Regression
Linear SVM
Training Time (seconds)
0
2
4
6
8
10
12
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
C values


Test Accuracy vs. C
Test Accuracy
0.98
0.96
0.94
0.92
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
C
Logistic Regression
Linear SVM

Part 3 - C


Tolerance vs Test Accuracy
Test Accuracy
0.9905
0.9900
0.9895
0.9890
0.9885
0.9880
0.9875
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
Tolerance (tol)
Logistic Regression
Linear SVM


Training Time vs. Tolerance
Training Time (seconds)
10
8
6
4
2
0
10^{-4}
10^{-2}
10^{0}
10^{2}
Tolerance (tol)
Logistic Regression
Linear SVM