

Lab 3 report

2.1

1. c

2.2

1. a

[[1]]

[1] 0.10080922 0.10026060 0.08942532 0.09107118 0.07433823

2. a

[1] 0.01001234 0.09024825 0.07625840 0.08846523 0.08832808

3. b

1697-363

(0 Vs all: 1697, 1 Vs all: 363)

4. a,c (c is also right if this option does not mean only max c take lowest Etrain)

of support vectors: 494, 166, 59, 2

Etest: [1] 0.05896226 0.01886792 0.01886792 0.02122642

Etrain: [1] 0.03203075 0.006406150 0.003203075 0.003203075

there are two choices of c which can get lowest Etrain, not at max c only.

5. b

Q=2 Etrain:[1] 0.201153107 0.032030750 0.006406150 0.003203075

Q=5 Etrain: [1] 0.024343370 0.005124920 0.003203075 0.002562460

Q=2: #of support vectors: 1080,494,166,29

Q=5: #of support vectors: 221,92,38,22

Q=2: Etest: [1] 0.19811321 0.05896226 0.01886792 0.02122642

Q=5: Etest: [1] 0.03773585 0.01886792 0.02358491 0.02594340

2.3

1.d

2.a

- best parameters:

cost

0.1

- best performance: 0.003196962

- Detailed performance results:

cost error dispersion

1 1e-04 0.216519680 0.029963208

2 1e-03 0.036518047 0.013197018

3 1e-02 0.006402090 0.006034072

4 1e-01 0.003196962 0.004513521

5 1e+00 0.003196962 0.004513521

both $c=0.1$ and $c=1$ get the lowest error, so we take the smaller c here.

2.4

1.e

Etrain: [1] 0.005765535 0.003203075 0.002562460 0.001281230 0.000000000

2.a,b,c

Etest: [1] 0.01886792 0.01886792 0.01886792 0.02594340 0.02358491

big c tends to give a more unstable model fit

```
> choice1=c(0, 2, 4, 6, 8)
> trainError(choice1)
```

```
Call:
svm(formula = y_train ~ ., data = x_train[, -1], type = "C-classification",
     kernel = "polynomial",
     gamma = 1, coef0 = 1, degree = 2, cost = 0.01)
```

```
Parameters:
  SVM-Type:  C-classification
SVM-Kernel:  polynomial
      cost:  0.01
    degree:  2
      gamma:  1
    coef.0:  1
```

```
Number of Support Vectors: 1697

( 849 848 )
```

```
Number of Classes: 2
```

```
Levels:
-1 1
```

```
Call:
svm(formula = y_train ~ ., data = x_train[, -1], type = "C-classification",
     kernel = "polynomial",
     gamma = 1, coef0 = 1, degree = 2, cost = 0.01)
```

```
Parameters:
  SVM-Type:  C-classification
SVM-Kernel:  polynomial
      cost:  0.01
    degree:  2
      gamma:  1
    coef.0:  1
```

```
Number of Support Vectors: 1479

( 748 731 )
```

```
Number of Classes: 2
```

```
Levels:
-1 1
```

```
Call:
svm(formula = y_train ~ ., data = x_train[, -1], type = "C-classification",
     kernel = "polynomial",
     gamma = 1, coef0 = 1, degree = 2, cost = 0.01)
```

```
Parameters:
```

SVM-Type: C- classification
SVM-Kernel: polynomial
cost: 0.01
degree: 2
gamma: 1
coef.0: 1

Number of Support Vectors: 1324

(672 652)

Number of Classes: 2

Levels:
-1 1

Call:
svm(formula = y_train ~ ., data = x_train[, -1], type = "C- classification",
kernel = "polynomial",
gamma = 1, coef0 = 1, degree = 2, cost = 0.01)

Parameters:
SVM-Type: C- classification
SVM-Kernel: polynomial
cost: 0.01
degree: 2
gamma: 1
coef.0: 1

Number of Support Vectors: 1336

(664 672)

Number of Classes: 2

Levels:
-1 1

Call:
svm(formula = y_train ~ ., data = x_train[, -1], type = "C- classification",
kernel = "polynomial",
gamma = 1, coef0 = 1, degree = 2, cost = 0.01)

Parameters:
SVM-Type: C- classification
SVM-Kernel: polynomial
cost: 0.01
degree: 2
gamma: 1
coef.0: 1

Number of Support Vectors: 1104

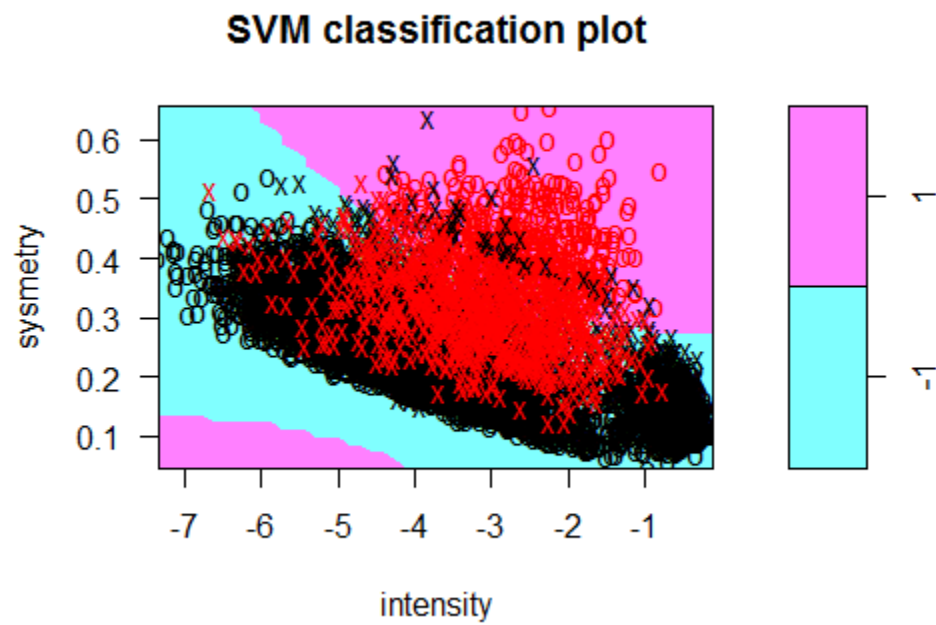
(562 542)

Number of Classes: 2

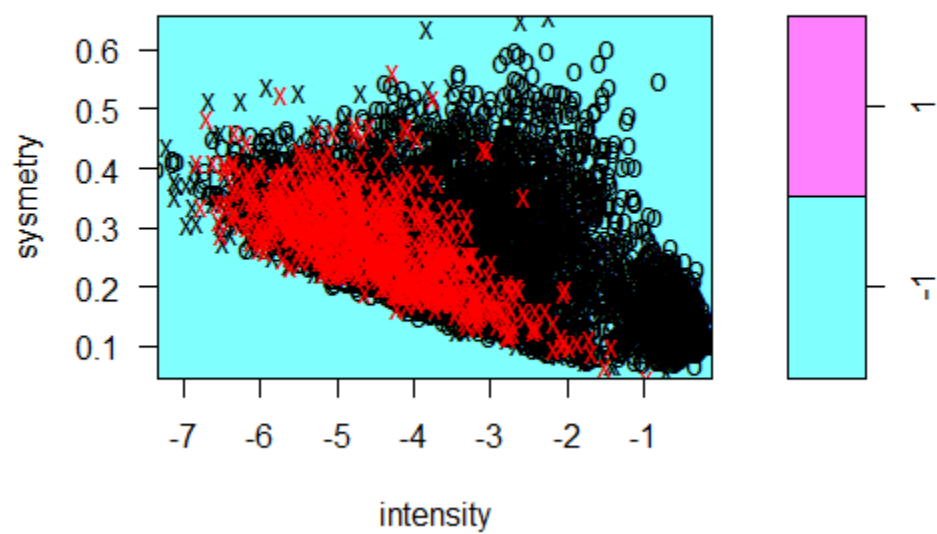
Levels:
-1 1

```
[[1]]  
[1] 0.10080922 0.10026060 0.08942532 0.09107118 0.07433823  
  
[[2]]  
[1] 0.10513204 0.09865471 0.09965122 0.08470354 0.08271051
```

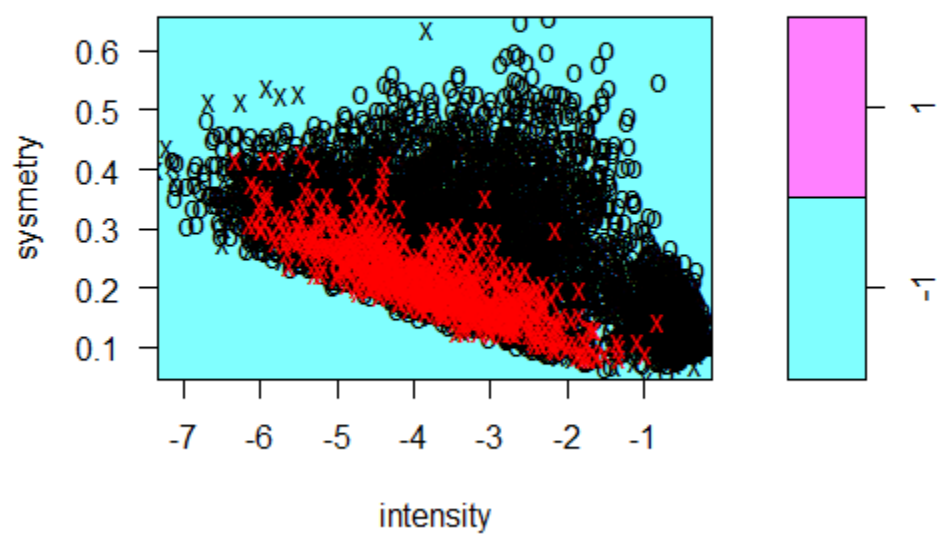
>



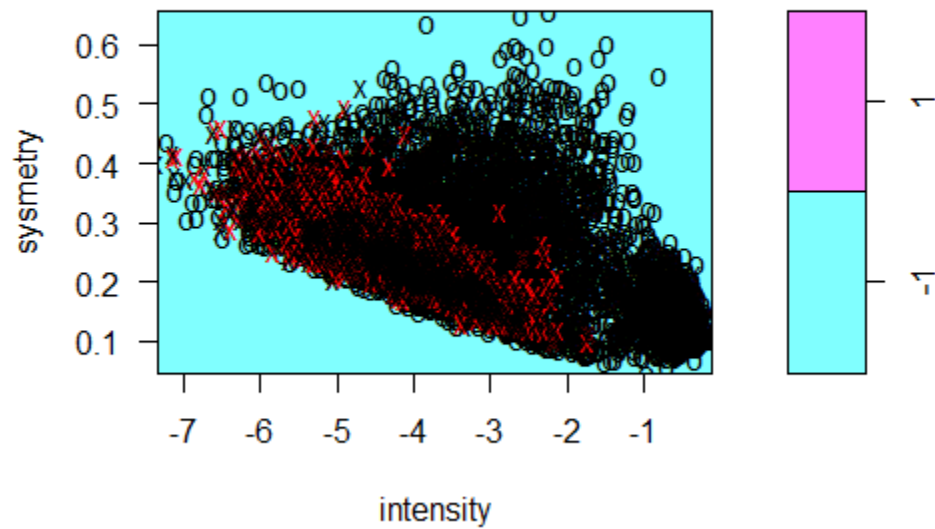
SVM classification plot



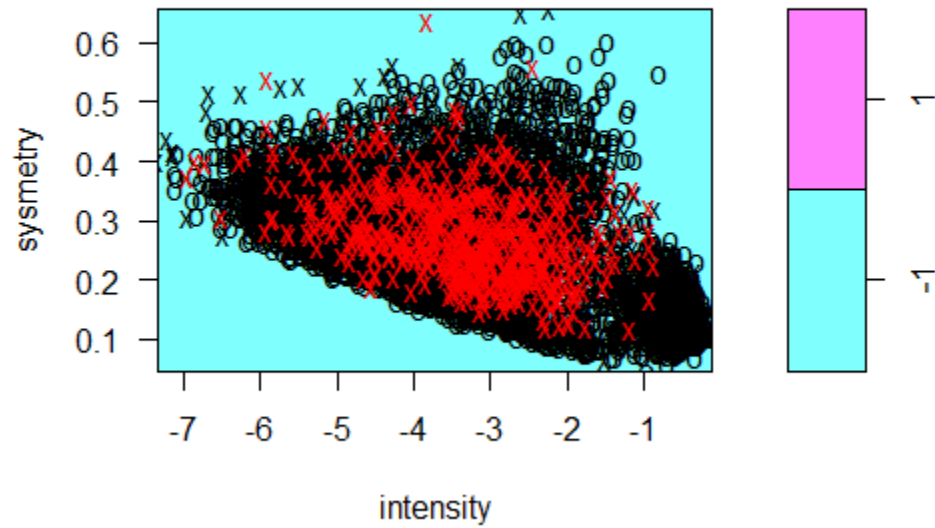
SVM classification plot



SVM classification plot



SVM classification plot



```
> choice2=c(1, 3, 5, 7, 9)
> trainError(choice2)
```

```
Call:
svm(formula = y_train ~ ., data = x_train[, -1], type = "C-classification", kernel =
"polynomial",
    gamma = 1, coef0 = 1, degree = 2, cost = 0.01)
```

```
Parameters:
  SVM-Type:  C-classification
SVM-Kernel:  polynomial
    cost:    0.01
  degree:    2
   gamma:    1
coef.0:      1
```

```
Number of Support Vectors:  363
( 181 182 )
```

```
Number of Classes:  2
```

```
Levels:
-1 1
```

```
Call:
svm(formula = y_train ~ ., data = x_train[, -1], type = "C-classification", kernel =
"polynomial",
    gamma = 1, coef0 = 1, degree = 2, cost = 0.01)
```

```
Parameters:
  SVM-Type:  C-classification
SVM-Kernel:  polynomial
    cost:    0.01
  degree:    2
   gamma:    1
coef.0:      1
```

```
Number of Support Vectors:  1331
( 673 658 )
```

```
Number of Classes:  2
```

```
Levels:
-1 1
```

```
Call:
svm(formula = y_train ~ ., data = x_train[, -1], type = "C-classification", kernel =
"polynomial",
    gamma = 1, coef0 = 1, degree = 2, cost = 0.01)
```

```
Parameters:
  SVM-Type:  C-classification
SVM-Kernel:  polynomial
```



```
cost: 0.01
degree: 2
gamma: 1
coef.0: 1
```

Number of Support Vectors: 1129

(573 556)

Number of Classes: 2

Levels:
-1 1

Call:
svm(formula = y_train ~ ., data = x_train[, -1], type = "C-classification", kernel =
"polynomial",
gamma = 1, coef0 = 1, degree = 2, cost = 0.01)

Parameters:
SVM-Type: C-classification
SVM-Kernel: polynomial
cost: 0.01
degree: 2
gamma: 1
coef.0: 1

Number of Support Vectors: 1333

(688 645)

Number of Classes: 2

Levels:
-1 1

Call:
svm(formula = y_train ~ ., data = x_train[, -1], type = "C-classification", kernel =
"polynomial",
gamma = 1, coef0 = 1, degree = 2, cost = 0.01)

Parameters:
SVM-Type: C-classification
SVM-Kernel: polynomial
cost: 0.01
degree: 2
gamma: 1
coef.0: 1

Number of Support Vectors: 1316

(672 644)

Number of Classes: 2

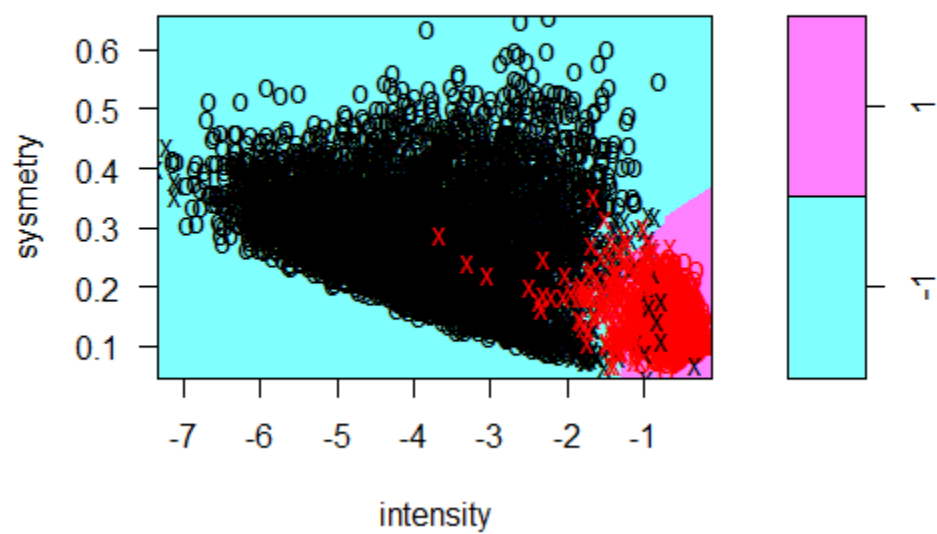
Levels:
-1 1

```
[[1]]  
[1] 0.01001234 0.09024825 0.07625840 0.08846523 0.08832808
```

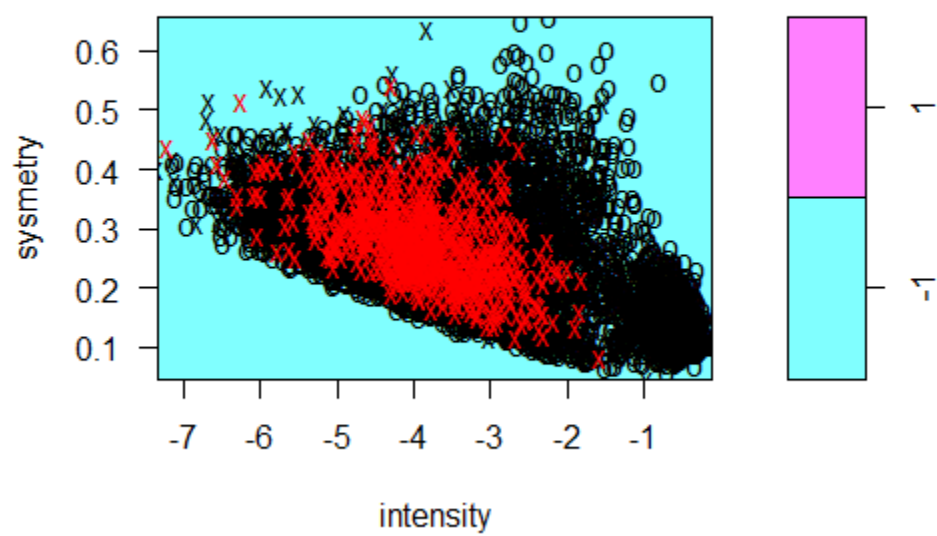
```
[[2]]  
[1] 0.01943199 0.08271051 0.07972098 0.07324365 0.08819133
```

>

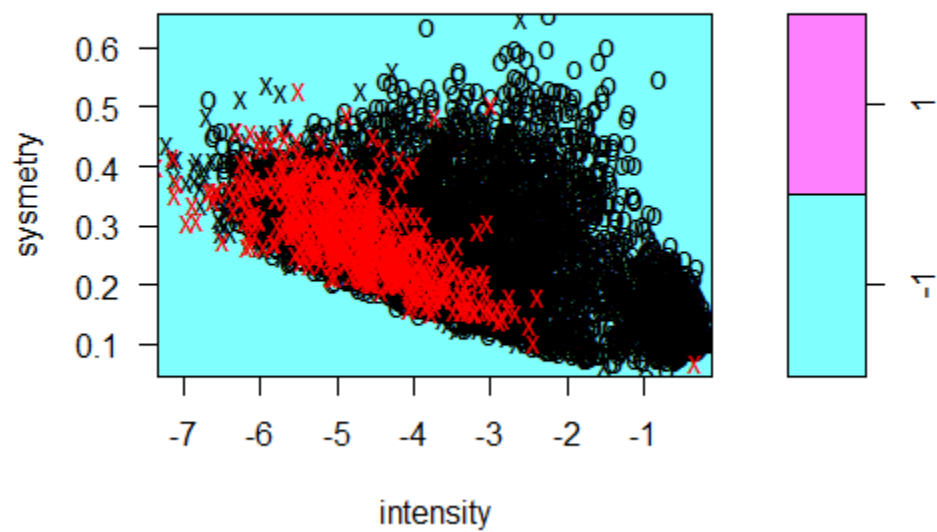
SVM classification plot



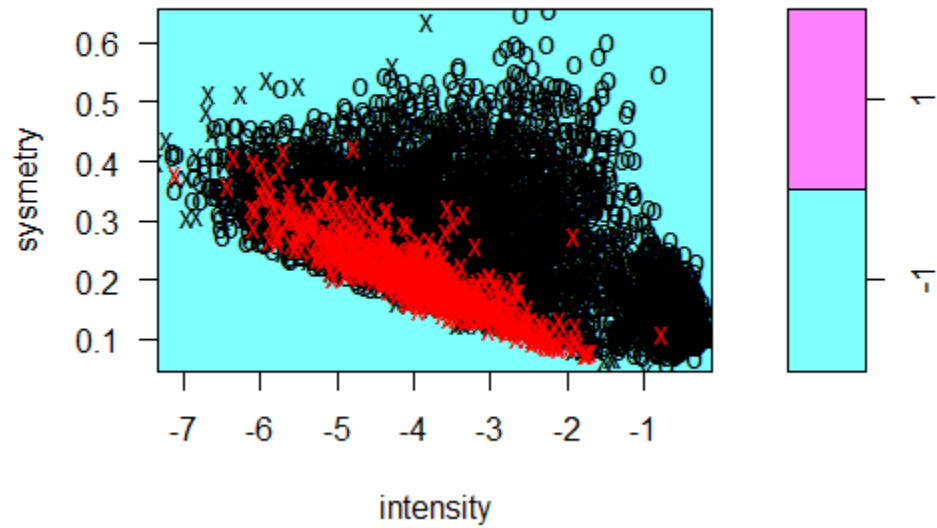
SVM classification plot

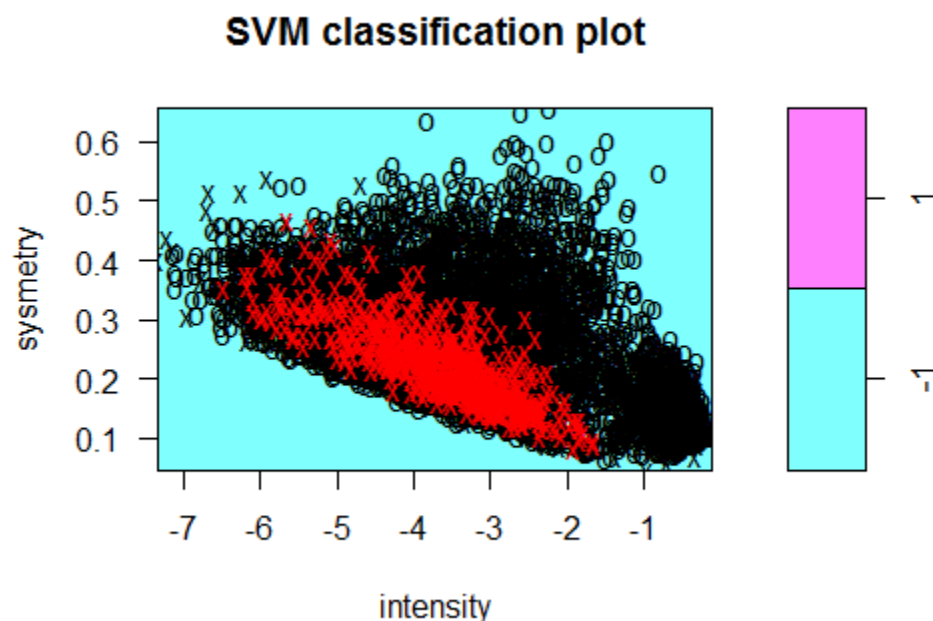


SVM classification plot



SVM classification plot





```
> choice3=c(0.001, 0.01, 0.1, 1)
> Error(choice3)
```

```
Call:
svm(formula = y_train ~ ., data = x_train_1[, -1], type = "C-classification",
     kernel = "polynomial", gamma = 1, coef0 = 1, degree = 2, cost = e)
```

```
Parameters:
  SVM-Type:  C-classification
SVM-Kernel: polynomial
   cost:    0.001
 degree:    2
  gamma:    1
coef.0:     1
```

```
Number of Support Vectors:  494
( 247 247 )
```

```
Number of Classes:  2
```

```
Levels:
-1 1
```

```
Call:
svm(formula = y_train ~ ., data = x_train_1[, -1], type = "C-classification",
```

```
kernel = "polynomial", gamma = 1, coef0 = 1, degree = 2, cost = e)
```

Parameters:

```
SVM-Type: C-classification
SVM-Kernel: polynomial
cost: 0.01
degree: 2
gamma: 1
coef.0: 1
```

Number of Support Vectors: 166

(83 83)

Number of Classes: 2

Levels:

-1 1

Call:

```
svm(formula = y_train ~ ., data = x_train_1[, -1], type = "C-classification",
     kernel = "polynomial", gamma = 1, coef0 = 1, degree = 2, cost = e)
```

Parameters:

```
SVM-Type: C-classification
SVM-Kernel: polynomial
cost: 0.1
degree: 2
gamma: 1
coef.0: 1
```

Number of Support Vectors: 59

(30 29)

Number of Classes: 2

Levels:

-1 1

Call:

```
svm(formula = y_train ~ ., data = x_train_1[, -1], type = "C-classification",
     kernel = "polynomial", gamma = 1, coef0 = 1, degree = 2, cost = e)
```

Parameters:

```
SVM-Type: C-classification
SVM-Kernel: polynomial
cost: 1
degree: 2
gamma: 1
coef.0: 1
```

Number of Support Vectors: 29

(14 15)

Number of Classes: 2

Levels:

-1 1

[[1]]

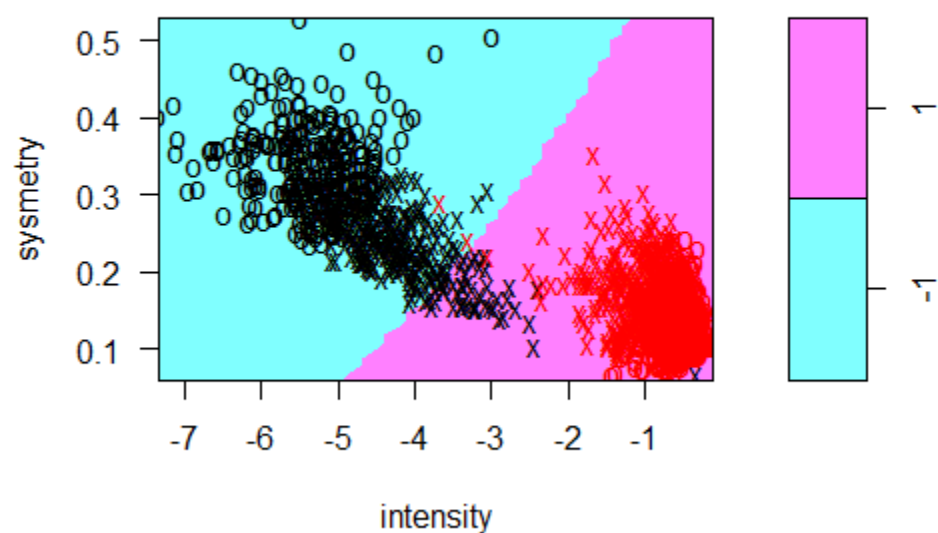
[1] 0.032030750 0.006406150 0.003203075 0.003203075

[[2]]

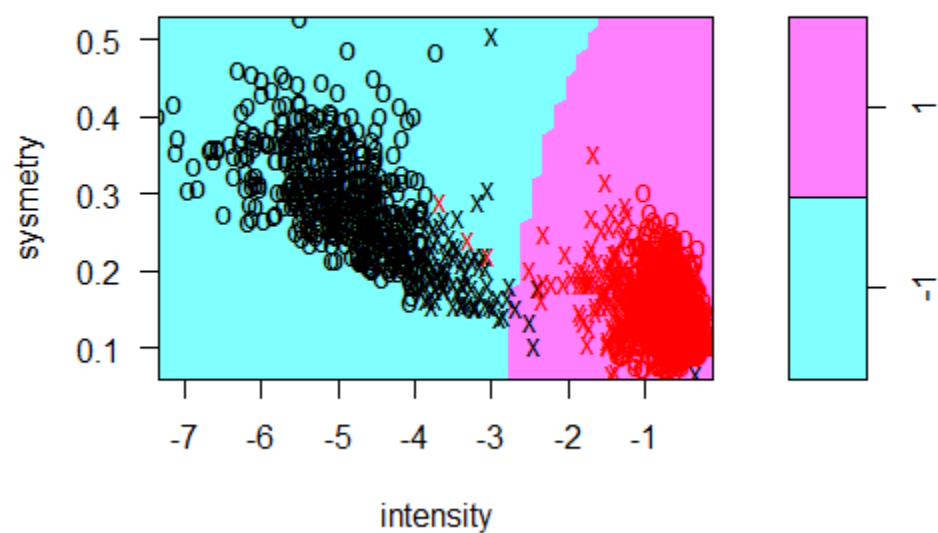
[1] 0.05896226 0.01886792 0.01886792 0.02122642

>

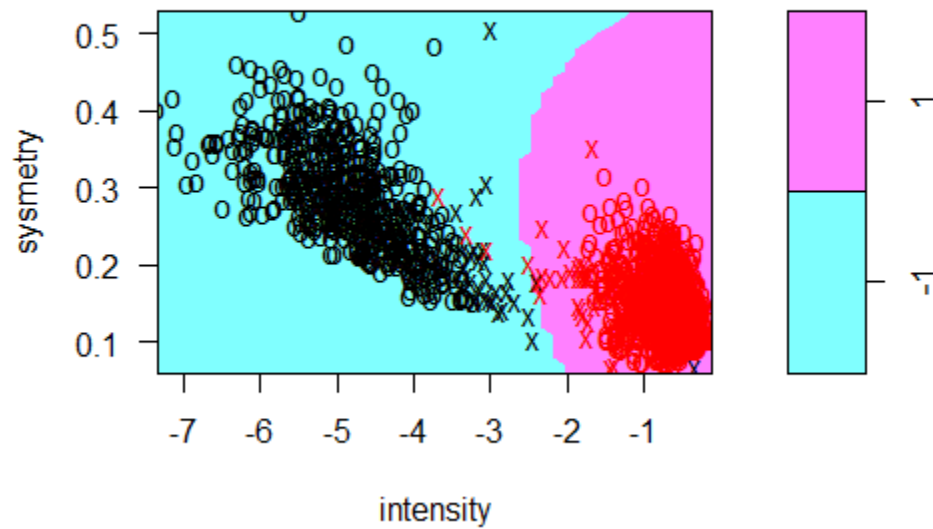
SVM classification plot



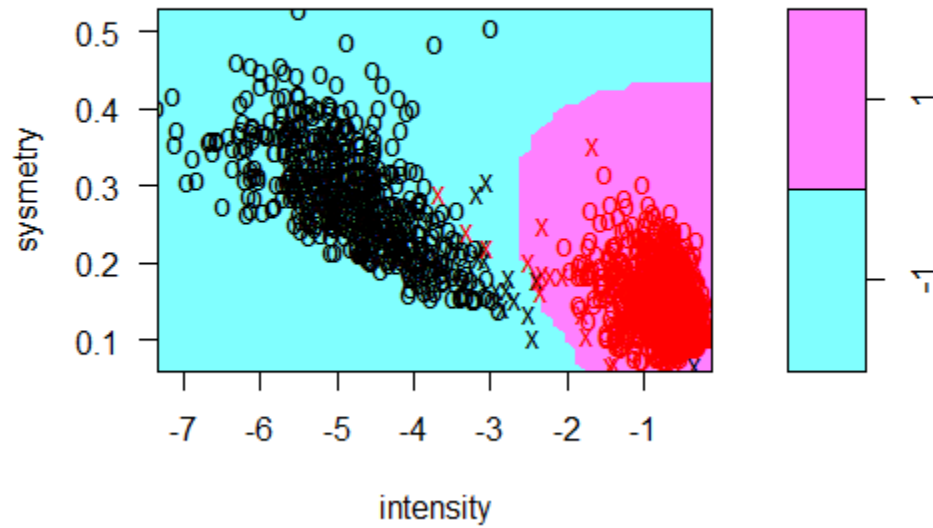
SVM classification plot



SVM classification plot



SVM classification plot



```
> choice3_1=c(0.0001, 0.001, 0.01, 1)
> Error(choice3_1)
```

```
Call:
svm(formula = y_train ~ ., data = x_train_1[, -1], type = "C-classification",
     kernel = "polynomial", gamma = 1, coef0 = 1, degree = 2, cost = e)
```

Parameters:

SVM-Type: C-classification
SVM-Kernel: polynomial
cost: 1e-04
degree: 2
gamma: 1
coef.0: 1

Number of Support Vectors: 1080

(540 540)

Number of Classes: 2

Levels:
-1 1

Call:
svm(formula = y_train ~ ., data = x_train_1[, -1], type = "C-classification",
kernel = "polynomial", gamma = 1, coef0 = 1, degree = 2, cost = e)

Parameters:
SVM-Type: C-classification
SVM-Kernel: polynomial
cost: 0.001
degree: 2
gamma: 1
coef.0: 1

Number of Support Vectors: 494

(247 247)

Number of Classes: 2

Levels:
-1 1

Call:
svm(formula = y_train ~ ., data = x_train_1[, -1], type = "C-classification",
kernel = "polynomial", gamma = 1, coef0 = 1, degree = 2, cost = e)

Parameters:
SVM-Type: C-classification
SVM-Kernel: polynomial
cost: 0.01
degree: 2
gamma: 1
coef.0: 1

Number of Support Vectors: 166

(83 83)

Number of Classes: 2

Levels:
-1 1

Call:
svm(formula = y_train ~ ., data = x_train_1[, -1], type = "C-classification",
kernel = "polynomial", gamma = 1, coef0 = 1, degree = 2, cost = e)

Parameters:
SVM-Type: C-classification
SVM-Kernel: polynomial
cost: 1
degree: 2
gamma: 1
coef.0: 1

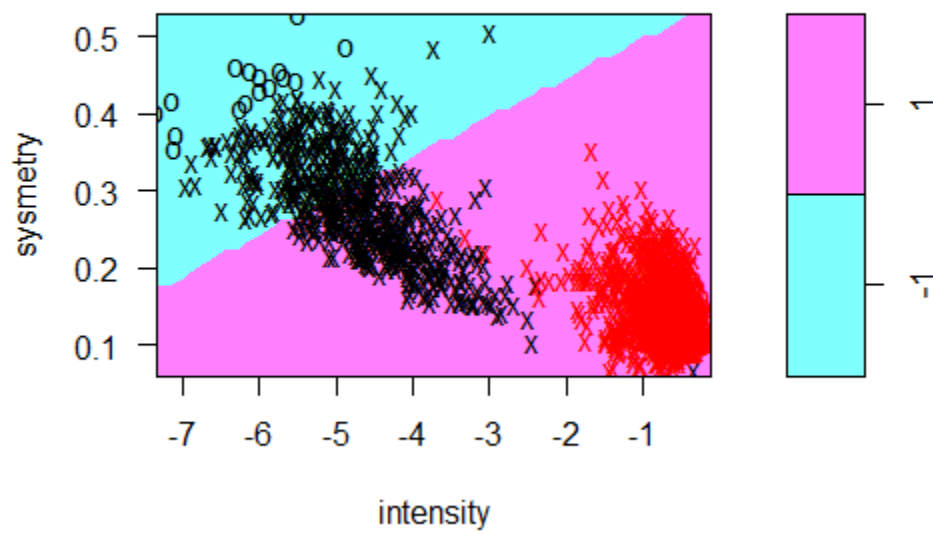
Number of Support Vectors: 29
(14 15)

Number of Classes: 2

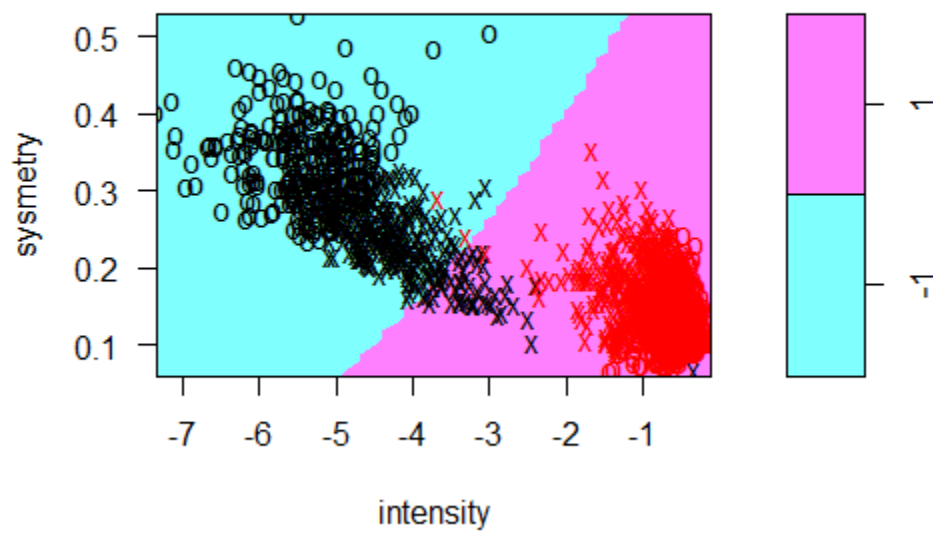
Levels:
-1 1

```
[[1]]  
[1] 0.201153107 0.032030750 0.006406150 0.003203075  
  
[[2]]  
[1] 0.19811321 0.05896226 0.01886792 0.02122642
```

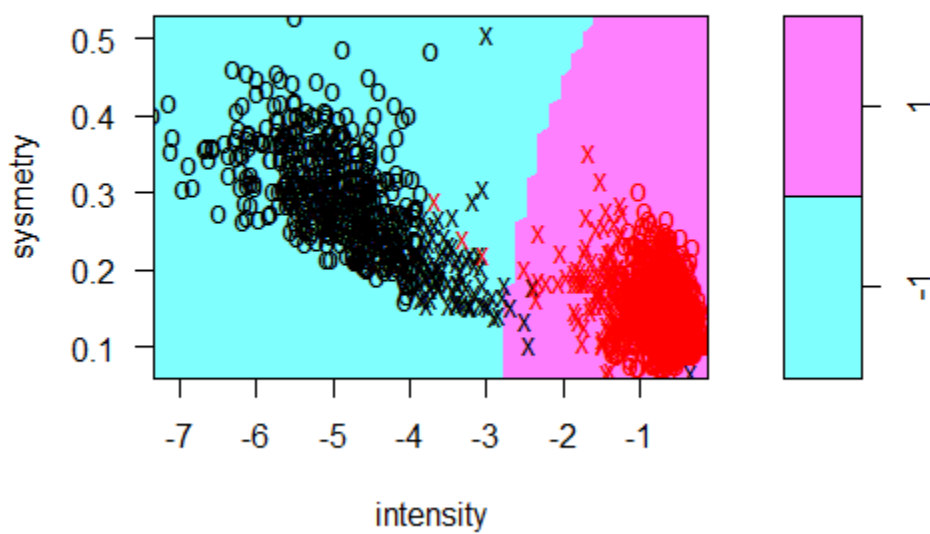
SVM classification plot



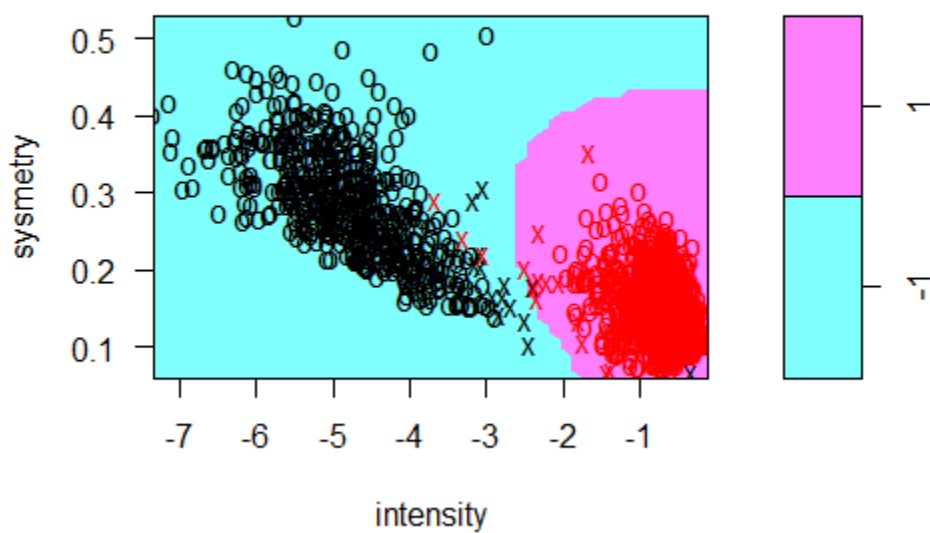
SVM classification plot



SVM classification plot



SVM classification plot



>

> choi ce4=c(0.001, 0.01, 0.1, 1)
> Error(choi ce4)

```
Call:
svm(formula = y_train ~ ., data = x_train_1[, -1], type = "C-classification",
     kernel = "polynomial", gamma = 1, coef0 = 1, degree = 5, cost = e)
```

```
Parameters:
  SVM-Type:  C-classification
SVM-Kernel: polynomial
      cost:  0.001
      degree: 5
      gamma:  1
    coef.0:  1
```

```
Number of Support Vectors:  221

( 109 112 )
```

```
Number of Classes:  2
```

```
Levels:
-1 1
```

```
Call:
svm(formula = y_train ~ ., data = x_train_1[, -1], type = "C-classification",
     kernel = "polynomial", gamma = 1, coef0 = 1, degree = 5, cost = e)
```

```
Parameters:
  SVM-Type:  C-classification
SVM-Kernel: polynomial
      cost:  0.01
      degree: 5
      gamma:  1
    coef.0:  1
```

```
Number of Support Vectors:  92

( 45 47 )
```

```
Number of Classes:  2
```

```
Levels:
-1 1
```

```
Call:
svm(formula = y_train ~ ., data = x_train_1[, -1], type = "C-classification",
     kernel = "polynomial", gamma = 1, coef0 = 1, degree = 5, cost = e)
```

```
Parameters:
  SVM-Type:  C-classification
SVM-Kernel: polynomial
      cost:  0.1
      degree: 5
      gamma:  1
    coef.0:  1
```

Number of Support Vectors: 38

(19 19)

Number of Classes: 2

Levels:

-1 1

Call:

```
svm(formula = y_train ~ ., data = x_train_1[, -1], type = "C-classification",  
     kernel = "polynomial", gamma = 1, coef0 = 1, degree = 5, cost = e)
```

Parameters:

```
SVM-Type: C-classification  
SVM-Kernel: polynomial  
cost: 1  
degree: 5  
gamma: 1  
coef.0: 1
```

Number of Support Vectors: 22

(11 11)

Number of Classes: 2

Levels:

-1 1

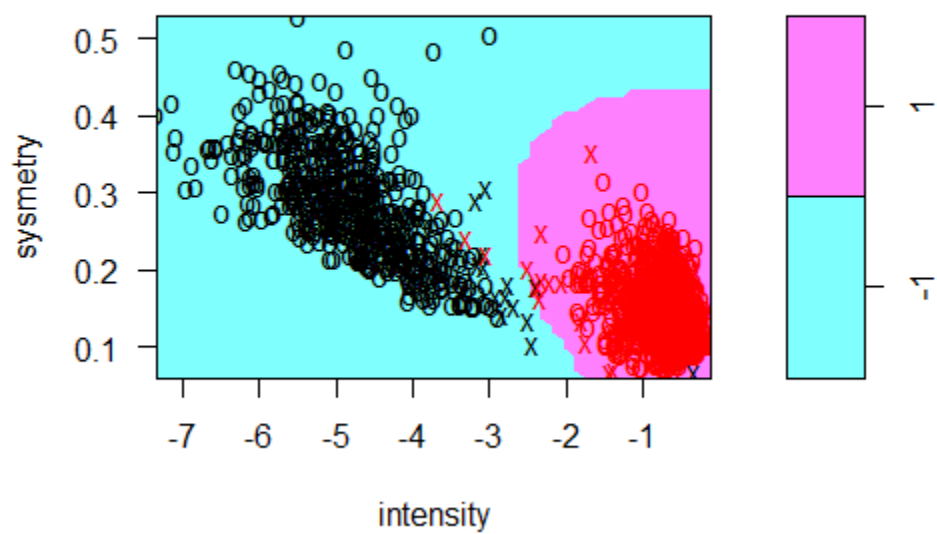
```
[[1]]
```

```
[1] 0.024343370 0.005124920 0.003203075 0.002562460
```

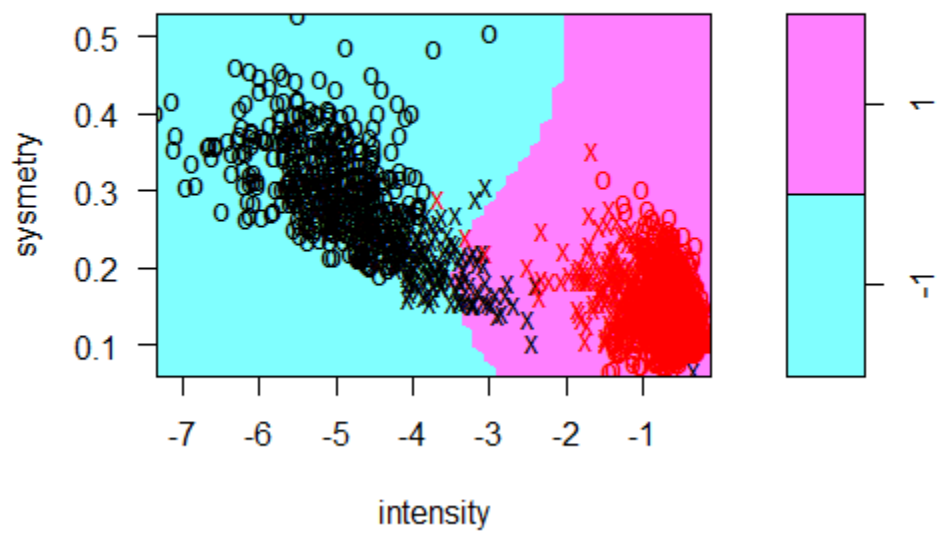
```
[[2]]
```

```
[1] 0.03773585 0.01886792 0.02358491 0.02594340
```

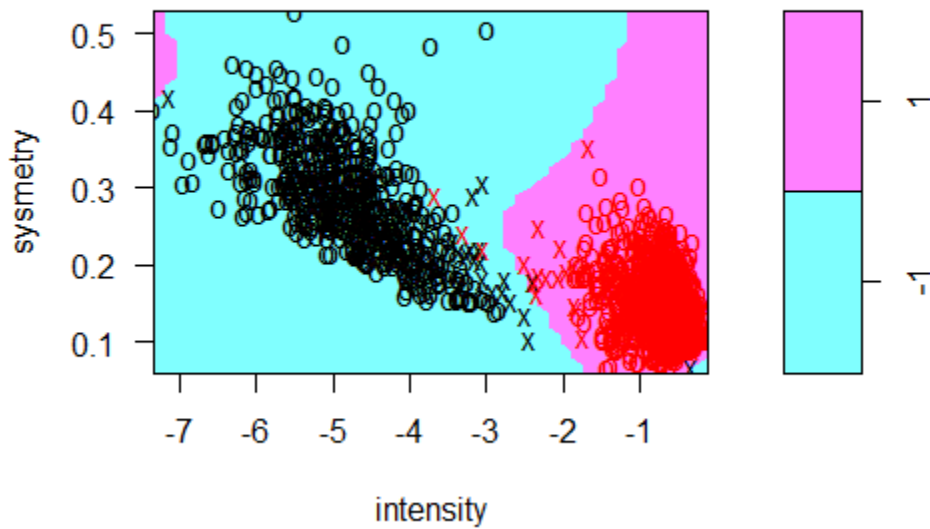
SVM classification plot



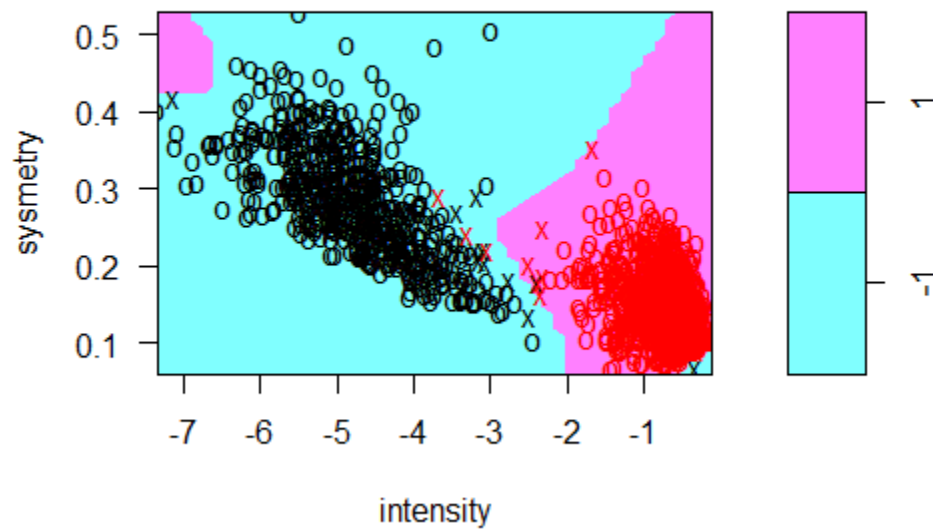
SVM classification plot



SVM classification plot



SVM classification plot



```
> summary(tune.out)
```

Parameter tuning of 'svm':

- sampling method: 10-fold cross validation

- best parameters:

cost
0.1

- best performance: 0.003196962

- Detailed performance results:

	cost	error	dispersion
1	1e-04	0.216519680	0.029963208
2	1e-03	0.036518047	0.013197018
3	1e-02	0.006402090	0.006034072
4	1e-01	0.003196962	0.004513521
5	1e+00	0.003196962	0.004513521

>

> choice5=c(0.01, 1, 100, 10000, 1000000)
> GError(choice5)

Call:

```
svm(formula = y_train ~ ., data = x_train_1[, -1], type = "C-classification",  
     kernel = "radial", gamma = 1, cost = e)
```

Parameters:

SVM-Type: C-classification
SVM-Kernel: radial
cost: 0.01
gamma: 1

Number of Support Vectors: 514

(257 257)

Number of Classes: 2

Levels:

-1 1

Call:

```
svm(formula = y_train ~ ., data = x_train_1[, -1], type = "C-classification",  
     kernel = "radial", gamma = 1, cost = e)
```

Parameters:

SVM-Type: C-classification
SVM-Kernel: radial
cost: 1
gamma: 1

Number of Support Vectors: 40

(22 18)

Number of Classes: 2

Levels:
-1 1

Call:
svm(formula = y_train ~ ., data = x_train_1[, -1], type = "C-classification",
kernel = "radial", gamma = 1, cost = e)

Parameters:
SVM-Type: C-classification
SVM-Kernel: radial
cost: 100
gamma: 1

Number of Support Vectors: 23
(14 9)

Number of Classes: 2

Levels:
-1 1

Call:
svm(formula = y_train ~ ., data = x_train_1[, -1], type = "C-classification",
kernel = "radial", gamma = 1, cost = e)

Parameters:
SVM-Type: C-classification
SVM-Kernel: radial
cost: 10000
gamma: 1

Number of Support Vectors: 16
(8 8)

Number of Classes: 2

Levels:
-1 1

Call:
svm(formula = y_train ~ ., data = x_train_1[, -1], type = "C-classification",
kernel = "radial", gamma = 1, cost = e)

Parameters:

SVM-Type: C- classification
SVM-Kernel: radial
cost: 1e+06
gamma: 1

Number of Support Vectors: 15

(9 6)

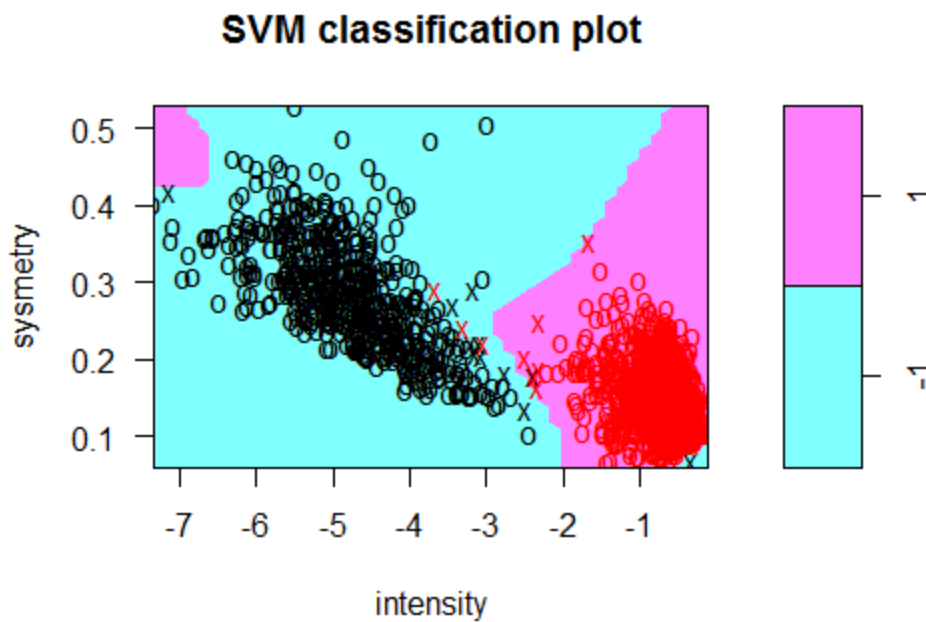
Number of Classes: 2

Levels:
-1 1

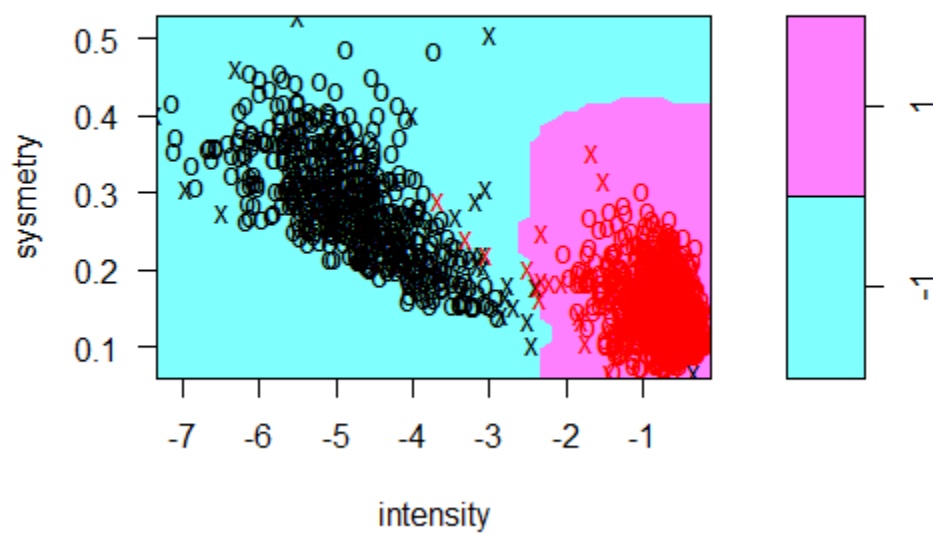
```
[[1]]  
[1] 0.005765535 0.003203075 0.002562460 0.001281230 0.000000000
```

```
[[2]]  
[1] 0.01886792 0.01886792 0.01886792 0.02594340 0.02358491
```

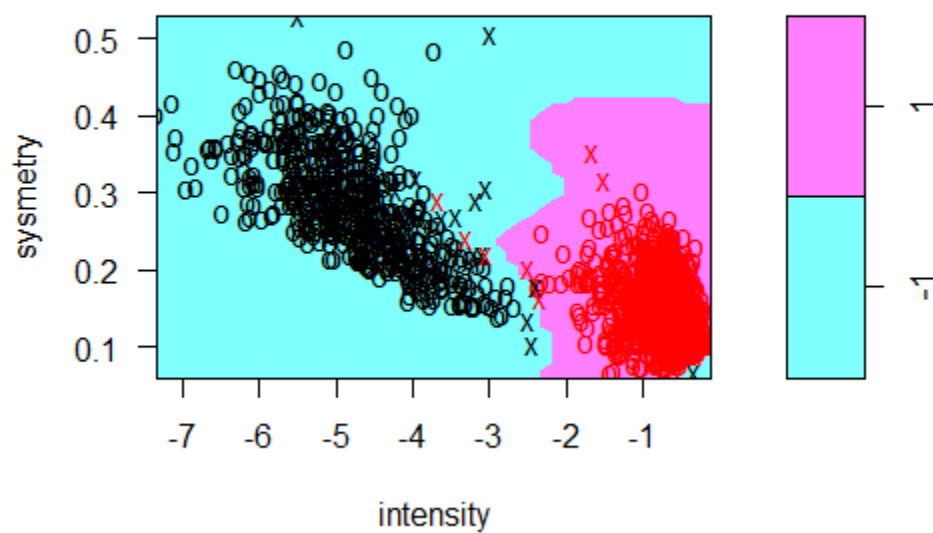
>



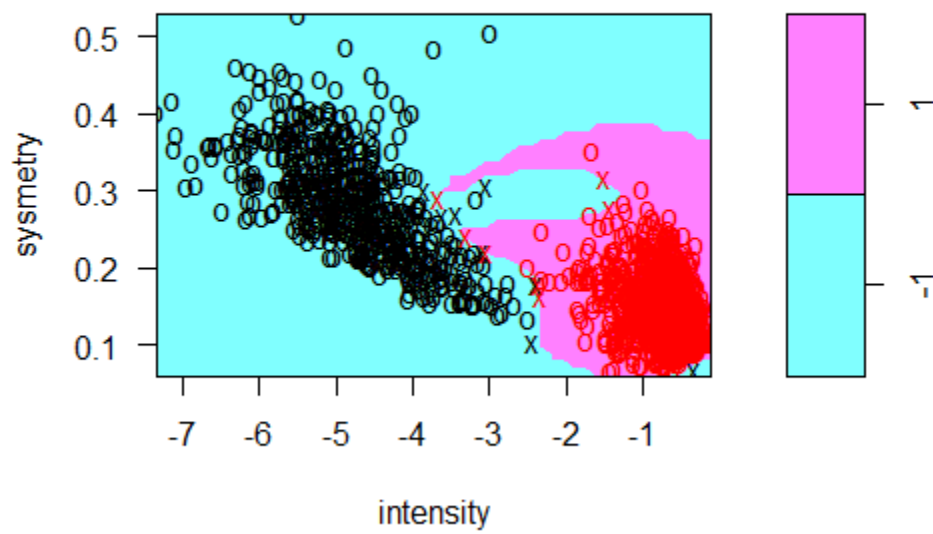
SVM classification plot



SVM classification plot



SVM classification plot



SVM classification plot

