Assignment 1
CS 6375: Machine Learning, Spring 2016

Submitted by :

Himanshu Kandwal (hxk154230)

DATA SET I :

a) Decision Tree (without variance) :

Data Set	Variance	Accuracy (%)
Validation	No	72.300
Validation	Yes	72.850
Test	No	74.100
Test	Yes	74.550

Decision Tree :

```
XO = 0 :
 | XM = 0 :
 |  | XF = 0 :
 |  |  | XB = 0 :
 |  |  |  | XG = 0 : 0
 |  |  |  | XG = 1 :
 |  |  |  |  | XD = 0 :
 |  |  |  |  |  | XS = 0 : 0
 |  |  |  |  |  | XS = 1 :
 |  |  |  |  |  |  | XC = 0 : 1
 |  |  |  |  |  |  | XC = 1 :
 |  |  |  |  |  |  |  | XH = 0 : 1
 |  |  |  |  |  |  |  | XH = 1 : 1
 |  |  |  |  | XD = 1 :
 |  |  |  |  |  | XE = 0 : 0
 |  |  |  |  |  | XE = 1 :
 |  |  |  |  |  |  | XK = 0 : 1
 |  |  |  |  |  |  | XK = 1 : 1
 |  |  | XB = 1 :
 |  |  |  | XD = 0 : 0
 |  |  |  | XD = 1 :
 |  |  |  |  | XI = 0 : 0
 |  |  |  |  | XI = 1 :
 |  |  |  |  |  | XG = 0 : 0
 |  |  |  |  |  | XG = 1 : 0
 |  | XF = 1 : 0
 | XM = 1 :
 |  | XB = 0 :
 |  |  | XD = 0 :
```

```
|   |   |   | XG = 0 :
|   |   |   |   | XF = 0 : 0
|   |   |   |   | XF = 1 :
|   |   |   |   |   | XJ = 0 :
|   |   |   |   |   |   | XN = 0 : 1
|   |   |   |   |   |   | XN = 1 :
|   |   |   |   |   |   |   | XE = 0 :
|   |   |   |   |   |   |   |   | XK = 0 : 1
|   |   |   |   |   |   |   |   | XK = 1 : 1
|   |   |   |   |   |   |   | XE = 1 : 0
|   |   |   |   |   | XJ = 1 :
|   |   |   |   |   |   | XC = 0 :
|   |   |   |   |   |   |   | XT = 0 :
|   |   |   |   |   |   |   |   | XL = 0 :
|   |   |   |   |   |   |   |   |   | XE = 0 :
|   |   |   |   |   |   |   |   |   |   | XI = 0 : 1
|   |   |   |   |   |   |   |   |   |   | XI = 1 : 1
|   |   |   |   |   |   |   |   |   | XE = 1 : 1
|   |   |   |   |   |   |   |   | XL = 1 : 0
|   |   |   |   |   |   |   | XT = 1 : 1
|   |   |   |   |   |   | XC = 1 : 1
|   |   |   | XG = 1 :
|   |   |   |   | XU = 0 : 1
|   |   |   |   | XU = 1 :
|   |   |   |   |   | XI = 0 : 1
|   |   |   |   |   | XI = 1 : 1
|   |   | XD = 1 :
|   |   |   | XC = 0 :
|   |   |   |   | XF = 0 :
|   |   |   |   |   | XG = 0 : 0
|   |   |   |   |   | XG = 1 :
|   |   |   |   |   |   | XP = 0 :
|   |   |   |   |   |   |   | XS = 0 : 1
|   |   |   |   |   |   |   | XS = 1 : 1
|   |   |   |   |   |   | XP = 1 : 0
|   |   |   |   | XF = 1 :
|   |   |   |   |   | XJ = 0 : 1
|   |   |   |   |   | XJ = 1 :
|   |   |   |   |   |   | XE = 0 :
|   |   |   |   |   |   |   | XG = 0 :
|   |   |   |   |   |   |   |   | XI = 0 : 0
|   |   |   |   |   |   |   |   | XI = 1 : 0
|   |   |   |   |   |   |   | XG = 1 : 0
|   |   |   |   |   |   | XE = 1 :
|   |   |   |   |   |   |   | XT = 0 :
|   |   |   |   |   |   |   |   | XG = 0 : 0
|   |   |   |   |   |   |   |   | XG = 1 : 0
|   |   |   |   |   |   |   | XT = 1 : 1
|   |   |   | XC = 1 : 0
|   | XB = 1 :
|   |   | XI = 0 : 0
|   |   | XI = 1 :
|   |   |   | XC = 0 :
|   |   |   |   | XK = 0 :
|   |   |   |   |   | XP = 0 : 1
|   |   |   |   |   | XP = 1 :
|   |   |   |   |   |   | XS = 0 :
|   |   |   |   |   |   |   | XG = 0 : 1
|   |   |   |   |   |   |   | XG = 1 :
|   |   |   |   |   |   |   |   | XF = 0 : 1
|   |   |   |   |   |   |   |   | XF = 1 : 1
|   |   |   |   |   |   | XS = 1 : 0
|   |   |   |   | XK = 1 : 0
|   |   |   | XC = 1 : 0
```

```
XO = 1 :
 | XI = 0 :
 | | XM = 0 :
 | | | XQ = 0 :
 | | | | XF = 0 :
 | | | | | XH = 0 :
 | | | | | | XB = 0 : 0
 | | | | | | XB = 1 :
 | | | | | | | XC = 0 : 0
 | | | | | | | XC = 1 : 0
 | | | | | XH = 1 : 1
 | | | | XF = 1 : 0
 | | | XQ = 1 :
 | | | | XJ = 0 :
 | | | | | XN = 0 :
 | | | | | | XP = 0 : 1
 | | | | | | XP = 1 :
 | | | | | | | XB = 0 :
 | | | | | | | | XF = 0 : 1
 | | | | | | | | XF = 1 : 1
 | | | | | | | XB = 1 : 0
 | | | | | XN = 1 : 0
 | | | | XJ = 1 :
 | | | | | XL = 0 :
 | | | | | | XH = 0 : 0
 | | | | | | XH = 1 :
 | | | | | | | XK = 0 :
 | | | | | | | | XU = 0 : 0
 | | | | | | | | XU = 1 : 0
 | | | | | | | XK = 1 : 1
 | | | | | XL = 1 : 1
 | | XM = 1 :
 | | | XQ = 0 :
 | | | | XF = 0 :
 | | | | | XL = 0 :
 | | | | | | XC = 0 : 1
 | | | | | | XC = 1 :
 | | | | | | | XH = 0 : 1
 | | | | | | | XH = 1 :
 | | | | | | | | XU = 0 :
 | | | | | | | | | XB = 0 :
 | | | | | | | | | | XD = 0 : 0
 | | | | | | | | | | XD = 1 : 0
 | | | | | | | | | XB = 1 : 0
 | | | | | | | | XU = 1 : 1
 | | | | | XL = 1 :
 | | | | | | XC = 0 :
 | | | | | | | XB = 0 : 0
 | | | | | | | XB = 1 :
 | | | | | | | | XP = 0 : 1
 | | | | | | | | XP = 1 : 1
 | | | | | | XC = 1 : 1
 | | | | XF = 1 : 0
 | | | XQ = 1 : 0
 | XI = 1 :
 | | XT = 0 :
 | | | XH = 0 :
 | | | | XP = 0 :
 | | | | | XF = 0 : 0
 | | | | | XF = 1 :
 | | | | | | XQ = 0 :
 | | | | | | | XK = 0 : 1
 | | | | | | | XK = 1 :
 | | | | | | | | XC = 0 : 1
```

```
|   |   |   |   |   |   |   |   | XC = 1 : 1
|   |   |   |   |   |   |   | XQ = 1 :
|   |   |   |   |   |   |   |   | XK = 0 : 1
|   |   |   |   |   |   |   |   | XK = 1 : 1
|   |   |   |   | XP = 1 :
|   |   |   |   |   | XS = 0 :
|   |   |   |   |   |   | XD = 0 :
|   |   |   |   |   |   |   | XC = 0 :
|   |   |   |   |   |   |   |   | XJ = 0 :
|   |   |   |   |   |   |   |   |   | XN = 0 : 1
|   |   |   |   |   |   |   |   |   | XN = 1 : 1
|   |   |   |   |   |   |   |   | XJ = 1 :
|   |   |   |   |   |   |   |   |   | XB = 0 : 0
|   |   |   |   |   |   |   |   |   | XB = 1 :
|   |   |   |   |   |   |   |   |   |   | XG = 0 : 0
|   |   |   |   |   |   |   |   |   |   | XG = 1 : 0
|   |   |   |   |   |   |   | XC = 1 : 0
|   |   |   |   |   |   | XD = 1 :
|   |   |   |   |   |   |   | XM = 0 :
|   |   |   |   |   |   |   |   | XC = 0 : 0
|   |   |   |   |   |   |   |   | XC = 1 : 0
|   |   |   |   |   |   |   | XM = 1 : 1
|   |   |   |   |   | XS = 1 : 1
|   |   | XH = 1 :
|   |   |   | XJ = 0 :
|   |   |   |   | XC = 0 :
|   |   |   |   |   |   | XN = 0 : 1
|   |   |   |   |   |   | XN = 1 :
|   |   |   |   |   |   |   | XF = 0 :
|   |   |   |   |   |   |   |   | XG = 0 : 0
|   |   |   |   |   |   |   |   | XG = 1 : 0
|   |   |   |   |   |   |   | XF = 1 : 0
|   |   |   |   |   | XC = 1 :
|   |   |   |   |   |   | XM = 0 : 0
|   |   |   |   |   |   | XM = 1 :
|   |   |   |   |   |   |   | XF = 0 :
|   |   |   |   |   |   |   |   | XR = 0 : 0
|   |   |   |   |   |   |   |   | XR = 1 : 0
|   |   |   |   |   |   |   | XF = 1 : 1
|   |   |   | XJ = 1 :
|   |   |   |   |   | XS = 0 : 1
|   |   |   |   |   | XS = 1 :
|   |   |   |   |   |   | XG = 0 :
|   |   |   |   |   |   |   | XB = 0 : 0
|   |   |   |   |   |   |   | XB = 1 :
|   |   |   |   |   |   |   |   | XD = 0 : 1
|   |   |   |   |   |   |   |   | XD = 1 :
|   |   |   |   |   |   |   |   |   | XE = 0 : 1
|   |   |   |   |   |   |   |   |   | XE = 1 : 1
|   |   |   |   |   |   | XG = 1 :
|   |   |   |   |   |   |   | XC = 0 : 1
|   |   |   |   |   |   |   | XC = 1 :
|   |   |   |   |   |   |   |   | XD = 0 : 0
|   |   |   |   |   |   |   |   | XD = 1 : 0
|   | XT = 1 :
|   |   | XS = 0 :
|   |   |   | XQ = 0 :
|   |   |   |   | XK = 0 :
|   |   |   |   |   | XC = 0 :
|   |   |   |   |   |   | XR = 0 :
|   |   |   |   |   |   |   | XH = 0 :
|   |   |   |   |   |   |   |   | XE = 0 : 1
|   |   |   |   |   |   |   |   | XE = 1 : 1
|   |   |   |   |   |   |   | XH = 1 : 1
```

```
|  |  |  |  |  |  |  | XR = 1 :
|  |  |  |  |  |  |  |  | XB = 0 :
|  |  |  |  |  |  |  |  |  | XD = 0 : 1
|  |  |  |  |  |  |  |  |  | XD = 1 : 1
|  |  |  |  |  |  |  |  | XB = 1 : 0
|  |  |  |  |  |  | XC = 1 : 1
|  |  |  |  |  | XK = 1 :
|  |  |  |  |  |  | XD = 0 :
|  |  |  |  |  |  |  | XF = 0 : 1
|  |  |  |  |  |  |  | XF = 1 : 1
|  |  |  |  |  |  | XD = 1 : 0
|  |  |  | XQ = 1 :
|  |  |  |  | XM = 0 :
|  |  |  |  |  | XN = 0 :
|  |  |  |  |  |  | XU = 0 : 0
|  |  |  |  |  |  | XU = 1 : 0
|  |  |  |  |  | XN = 1 :
|  |  |  |  |  |  | XP = 0 :
|  |  |  |  |  |  |  | XB = 0 :
|  |  |  |  |  |  |  |  | XF = 0 : 1
|  |  |  |  |  |  |  |  | XF = 1 : 1
|  |  |  |  |  |  |  | XB = 1 : 1
|  |  |  |  |  |  | XP = 1 : 1
|  |  |  |  | XM = 1 : 0
|  |  | XS = 1 :
|  |  |  | XL = 0 :
|  |  |  |  | XD = 0 :
|  |  |  |  |  | XU = 0 : 1
|  |  |  |  |  | XU = 1 :
|  |  |  |  |  |  | XB = 0 :
|  |  |  |  |  |  |  | XE = 0 : 1
|  |  |  |  |  |  |  | XE = 1 :
|  |  |  |  |  |  |  |  | XC = 0 : 0
|  |  |  |  |  |  |  |  | XC = 1 : 0
|  |  |  |  |  |  | XB = 1 :
|  |  |  |  |  |  |  | XG = 0 :
|  |  |  |  |  |  |  |  | XH = 0 : 1
|  |  |  |  |  |  |  |  | XH = 1 : 1
|  |  |  |  |  |  |  | XG = 1 : 0
|  |  |  |  | XD = 1 :
|  |  |  |  |  | XG = 0 : 1
|  |  |  |  |  | XG = 1 : 1
|  |  |  | XL = 1 :
|  |  |  |  | XH = 0 :
|  |  |  |  |  | XD = 0 :
|  |  |  |  |  |  | XQ = 0 : 0
|  |  |  |  |  |  | XQ = 1 :
|  |  |  |  |  |  |  | XB = 0 : 1
|  |  |  |  |  |  |  | XB = 1 : 1
|  |  |  |  |  | XD = 1 :
|  |  |  |  |  |  | XB = 0 : 0
|  |  |  |  |  |  | XB = 1 : 0
|  |  |  |  | XH = 1 : 0
```

b) Decision Tree (With variance) :

```
XB = 0 :
 |  XD = 0 :
 |  |  XG = 0 :
 |  |  |  XF = 0 : 0
 |  |  |  XF = 1 :
 |  |  |  |  XP = 0 :
 |  |  |  |  |  XI = 0 :
 |  |  |  |  |  |  XQ = 0 : 0
 |  |  |  |  |  |  XQ = 1 :
 |  |  |  |  |  |  |  XS = 0 :
 |  |  |  |  |  |  |  |  XO = 0 : 1
 |  |  |  |  |  |  |  |  XO = 1 :
 |  |  |  |  |  |  |  |  |  XH = 0 : 0
 |  |  |  |  |  |  |  |  |  XH = 1 :
 |  |  |  |  |  |  |  |  |  |  XM = 0 : 0
 |  |  |  |  |  |  |  |  |  |  XM = 1 : 0
 |  |  |  |  |  |  |  XS = 1 : 0
 |  |  |  |  |  XI = 1 :
 |  |  |  |  |  |  XQ = 0 :
 |  |  |  |  |  |  |  XM = 0 : 1
 |  |  |  |  |  |  |  XM = 1 :
 |  |  |  |  |  |  |  |  XU = 0 : 0
 |  |  |  |  |  |  |  |  XU = 1 :
 |  |  |  |  |  |  |  |  |  XJ = 0 :
 |  |  |  |  |  |  |  |  |  |  XN = 0 : 0
 |  |  |  |  |  |  |  |  |  |  XN = 1 : 0
 |  |  |  |  |  |  |  |  |  XJ = 1 : 1
 |  |  |  |  |  |  XQ = 1 :
 |  |  |  |  |  |  |  XR = 0 :
 |  |  |  |  |  |  |  |  XH = 0 : 1
 |  |  |  |  |  |  |  |  XH = 1 :
 |  |  |  |  |  |  |  |  |  XC = 0 : 1
 |  |  |  |  |  |  |  |  |  XC = 1 : 1
 |  |  |  |  |  |  |  XR = 1 : 0
 |  |  |  |  XP = 1 :
 |  |  |  |  |  XN = 0 :
 |  |  |  |  |  |  XO = 0 : 1
 |  |  |  |  |  |  XO = 1 :
 |  |  |  |  |  |  |  XM = 0 : 1
 |  |  |  |  |  |  |  XM = 1 :
 |  |  |  |  |  |  |  |  XH = 0 :
 |  |  |  |  |  |  |  |  |  XC = 0 : 1
 |  |  |  |  |  |  |  |  |  XC = 1 : 1
 |  |  |  |  |  |  |  |  XH = 1 : 0
 |  |  |  |  |  XN = 1 :
 |  |  |  |  |  |  XU = 0 :
 |  |  |  |  |  |  |  XC = 0 : 1
 |  |  |  |  |  |  |  XC = 1 :
 |  |  |  |  |  |  |  |  XH = 0 :
 |  |  |  |  |  |  |  |  |  XM = 0 :
 |  |  |  |  |  |  |  |  |  |  XE = 0 : 0
 |  |  |  |  |  |  |  |  |  |  XE = 1 : 0
 |  |  |  |  |  |  |  |  |  XM = 1 : 1
 |  |  |  |  |  |  |  |  XH = 1 :
 |  |  |  |  |  |  |  |  |  XL = 0 : 1
 |  |  |  |  |  |  |  |  |  XL = 1 : 1
 |  |  |  |  |  |  XU = 1 :
 |  |  |  |  |  |  |  XE = 0 : 0
 |  |  |  |  |  |  |  XE = 1 :
 |  |  |  |  |  |  |  |  XJ = 0 : 1
 |  |  |  |  |  |  |  |  XJ = 1 : 1
 |  |  XG = 1 :
```

```
|  |  | XJ = 0 :
|  |  |  | XI = 0 :
|  |  |  |  | XN = 0 :
|  |  |  |  |  | XU = 0 :
|  |  |  |  |  |  | XF = 0 : 1
|  |  |  |  |  |  | XF = 1 :
|  |  |  |  |  |  |  | XC = 0 : 1
|  |  |  |  |  |  |  | XC = 1 :
|  |  |  |  |  |  |  |  | XH = 0 : 1
|  |  |  |  |  |  |  |  | XH = 1 : 1
|  |  |  |  |  |  | XU = 1 : 0
|  |  |  |  |  | XN = 1 : 0
|  |  |  |  | XI = 1 :
|  |  |  |  |  | XC = 0 :
|  |  |  |  |  |  | XR = 0 :
|  |  |  |  |  |  |  | XK = 0 :
|  |  |  |  |  |  |  |  | XP = 0 : 0
|  |  |  |  |  |  |  |  | XP = 1 :
|  |  |  |  |  |  |  |  |  | XQ = 0 : 1
|  |  |  |  |  |  |  |  |  | XQ = 1 : 1
|  |  |  |  |  |  |  | XK = 1 :
|  |  |  |  |  |  |  |  | XH = 0 :
|  |  |  |  |  |  |  |  |  | XN = 0 : 1
|  |  |  |  |  |  |  |  |  | XN = 1 : 1
|  |  |  |  |  |  |  |  | XH = 1 : 1
|  |  |  |  |  |  | XR = 1 : 0
|  |  |  |  |  | XC = 1 :
|  |  |  |  |  |  | XM = 0 : 1
|  |  |  |  |  |  | XM = 1 : 1
|  |  | XJ = 1 :
|  |  |  | XT = 0 :
|  |  |  |  | XN = 0 :
|  |  |  |  |  | XE = 0 :
|  |  |  |  |  |  | XF = 0 : 1
|  |  |  |  |  |  | XF = 1 :
|  |  |  |  |  |  |  | XR = 0 : 0
|  |  |  |  |  |  |  | XR = 1 : 0
|  |  |  |  |  | XE = 1 : 1
|  |  |  |  | XN = 1 :
|  |  |  |  |  | XP = 0 : 1
|  |  |  |  |  | XP = 1 :
|  |  |  |  |  |  | XF = 0 :
|  |  |  |  |  |  |  | XE = 0 : 1
|  |  |  |  |  |  |  | XE = 1 : 1
|  |  |  |  |  |  | XF = 1 : 0
|  |  |  | XT = 1 :
|  |  |  |  | XK = 0 :
|  |  |  |  |  | XU = 0 :
|  |  |  |  |  |  | XQ = 0 :
|  |  |  |  |  |  |  | XF = 0 : 0
|  |  |  |  |  |  |  | XF = 1 :
|  |  |  |  |  |  |  |  | XI = 0 : 1
|  |  |  |  |  |  |  |  | XI = 1 : 1
|  |  |  |  |  |  | XQ = 1 : 1
|  |  |  |  |  | XU = 1 : 0
|  |  |  |  | XK = 1 :
|  |  |  |  |  | XC = 0 :
|  |  |  |  |  |  | XR = 0 :
|  |  |  |  |  |  |  | XP = 0 :
|  |  |  |  |  |  |  |  | XI = 0 : 1
|  |  |  |  |  |  |  |  | XI = 1 : 1
|  |  |  |  |  |  |  | XP = 1 : 1
|  |  |  |  |  |  | XR = 1 : 0
|  |  |  |  |  | XC = 1 : 1
```

```
| XD = 1 :
|  | XF = 0 :
|  |  | XG = 0 : 0
|  |  | XG = 1 :
|  |  |  | XC = 0 :
|  |  |  |  | XP = 0 :
|  |  |  |  |  | XL = 0 :
|  |  |  |  |  |  | XK = 0 : 1
|  |  |  |  |  |  | XK = 1 :
|  |  |  |  |  |  |  | XI = 0 : 0
|  |  |  |  |  |  |  | XI = 1 : 0
|  |  |  |  |  | XL = 1 : 0
|  |  |  |  | XP = 1 : 0
|  |  |  | XC = 1 : 0
|  | XF = 1 :
|  |  | XO = 0 :
|  |  |  | XM = 0 : 0
|  |  |  | XM = 1 :
|  |  |  |  | XC = 0 :
|  |  |  |  |  | XJ = 0 : 1
|  |  |  |  |  | XJ = 1 :
|  |  |  |  |  |  | XE = 0 :
|  |  |  |  |  |  |  | XG = 0 :
|  |  |  |  |  |  |  |  | XI = 0 : 0
|  |  |  |  |  |  |  |  | XI = 1 : 0
|  |  |  |  |  |  |  | XG = 1 : 0
|  |  |  |  |  |  | XE = 1 :
|  |  |  |  |  |  |  | XT = 0 :
|  |  |  |  |  |  |  |  | XG = 0 : 0
|  |  |  |  |  |  |  |  | XG = 1 : 0
|  |  |  |  |  |  |  | XT = 1 : 1
|  |  |  |  | XC = 1 : 0
|  |  | XO = 1 :
|  |  |  | XM = 0 :
|  |  |  |  | XC = 0 : 1
|  |  |  |  | XC = 1 :
|  |  |  |  |  | XJ = 0 : 1
|  |  |  |  |  | XJ = 1 : 1
|  |  |  | XM = 1 :
|  |  |  |  | XI = 0 : 0
|  |  |  |  | XI = 1 :
|  |  |  |  |  | XQ = 0 : 0
|  |  |  |  |  | XQ = 1 : 0
XB = 1 :
|  | XG = 0 :
|  |  | XO = 0 :
|  |  |  | XD = 0 : 0
|  |  |  | XD = 1 :
|  |  |  |  | XI = 0 : 0
|  |  |  |  | XI = 1 :
|  |  |  |  |  | XK = 0 :
|  |  |  |  |  |  | XS = 0 : 1
|  |  |  |  |  |  | XS = 1 :
|  |  |  |  |  |  |  | XF = 0 : 0
|  |  |  |  |  |  |  | XF = 1 : 0
|  |  |  |  |  | XK = 1 : 0
|  |  | XO = 1 :
|  |  |  | XF = 0 :
|  |  |  |  | XH = 0 :
|  |  |  |  |  | XP = 0 :
|  |  |  |  |  |  | XT = 0 : 0
|  |  |  |  |  |  | XT = 1 :
|  |  |  |  |  |  |  | XC = 0 : 0
|  |  |  |  |  |  |  | XC = 1 : 0
```

```
|   |   |   |   |   | XP = 1 :
|   |   |   |   |   |   | XD = 0 :
|   |   |   |   |   |   |   | XT = 0 : 1
|   |   |   |   |   |   |   | XT = 1 :
|   |   |   |   |   |   |   |   | XS = 0 : 1
|   |   |   |   |   |   |   |   | XS = 1 :
|   |   |   |   |   |   |   |   |   | XU = 0 : 0
|   |   |   |   |   |   |   |   |   | XU = 1 : 0
|   |   |   |   |   |   |   | XD = 1 :
|   |   |   |   |   |   |   |   | XS = 0 :
|   |   |   |   |   |   |   |   |   | XI = 0 : 1
|   |   |   |   |   |   |   |   |   | XI = 1 :
|   |   |   |   |   |   |   |   |   |   | XC = 0 :
|   |   |   |   |   |   |   |   |   |   |   | XE = 0 : 1
|   |   |   |   |   |   |   |   |   |   |   | XE = 1 : 1
|   |   |   |   |   |   |   |   |   |   | XC = 1 : 0
|   |   |   |   |   |   |   |   | XS = 1 : 0
|   |   |   | XH = 1 :
|   |   |   |   | XM = 0 :
|   |   |   |   |   | XK = 0 : 1
|   |   |   |   |   | XK = 1 :
|   |   |   |   |   |   | XL = 0 : 0
|   |   |   |   |   |   | XL = 1 : 0
|   |   |   |   | XM = 1 :
|   |   |   |   |   | XP = 0 :
|   |   |   |   |   |   | XS = 0 : 0
|   |   |   |   |   |   | XS = 1 :
|   |   |   |   |   |   |   | XI = 0 : 1
|   |   |   |   |   |   |   | XI = 1 :
|   |   |   |   |   |   |   |   | XE = 0 : 1
|   |   |   |   |   |   |   |   | XE = 1 : 1
|   |   |   |   |   | XP = 1 :
|   |   |   |   |   |   | XJ = 0 :
|   |   |   |   |   |   |   | XC = 0 : 1
|   |   |   |   |   |   |   | XC = 1 :
|   |   |   |   |   |   |   |   | XR = 0 : 0
|   |   |   |   |   |   |   |   | XR = 1 : 0
|   |   |   |   |   |   | XJ = 1 : 1
|   |   | XF = 1 :
|   |   |   | XM = 0 : 0
|   |   |   | XM = 1 :
|   |   |   |   | XN = 0 : 1
|   |   |   |   | XN = 1 :
|   |   |   |   |   | XH = 0 : 0
|   |   |   |   |   | XH = 1 : 0
| XG = 1 :
|   | XI = 0 :
|   |   | XO = 0 : 0
|   |   | XO = 1 :
|   |   |   | XM = 0 :
|   |   |   |   | XF = 0 :
|   |   |   |   |   | XS = 0 : 1
|   |   |   |   |   | XS = 1 : 1
|   |   |   |   | XF = 1 : 0
|   |   |   | XM = 1 : 0
|   | XI = 1 :
|   |   | XR = 0 :
|   |   |   | XT = 0 :
|   |   |   |   | XQ = 0 :
|   |   |   |   |   | XM = 0 :
|   |   |   |   |   |   | XE = 0 : 1
|   |   |   |   |   |   | XE = 1 : 1
|   |   |   |   |   | XM = 1 : 1
|   |   |   |   | XQ = 1 :
```

```
|  |  |  |  |  |  | X0 = 0 : 0
|  |  |  |  |  |  | X0 = 1 :
|  |  |  |  |  |  |  | XF = 0 : 0
|  |  |  |  |  |  |  | XF = 1 : 0
|  |  |  | XT = 1 :
|  |  |  |  | XK = 0 :
|  |  |  |  |  | XL = 0 :
|  |  |  |  |  |  | XE = 0 :
|  |  |  |  |  |  |  | XD = 0 : 1
|  |  |  |  |  |  |  | XD = 1 : 1
|  |  |  |  |  |  | XE = 1 : 1
|  |  |  |  |  | XL = 1 :
|  |  |  |  |  |  | XC = 0 :
|  |  |  |  |  |  |  | XU = 0 : 1
|  |  |  |  |  |  |  | XU = 1 :
|  |  |  |  |  |  |  |  | XD = 0 :
|  |  |  |  |  |  |  |  |  | XE = 0 : 0
|  |  |  |  |  |  |  |  |  | XE = 1 : 0
|  |  |  |  |  |  |  |  | XD = 1 : 0
|  |  |  |  |  |  |  | XC = 1 : 0
|  |  |  |  |  | XK = 1 : 0
|  |  | XR = 1 :
|  |  |  | X0 = 0 : 0
|  |  |  | X0 = 1 :
|  |  |  |  | XC = 0 : 0
|  |  |  |  | XC = 1 :
|  |  |  |  |  | XM = 0 :
|  |  |  |  |  |  | XD = 0 : 0
|  |  |  |  |  |  | XD = 1 : 0
|  |  |  |  |  | XM = 1 : 1
```

DATA SET II :

a) Decision Tree (without variance) :

Data Set	Variance	Accuracy (%)
Validation	No	75.667
Validation	Yes	76.667
Test	No	72.500
Test	Yes	76.667

Decision Tree :

```
XI = 0 :
| XU = 0 :
|  | XQ = 0 :
|  |  | XF = 0 :
|  |  |  | XO = 0 :
|  |  |  |  | XB = 0 :
|  |  |  |  |  | XJ = 0 : 0
|  |  |  |  |  | XJ = 1 :
|  |  |  |  |  |  | XG = 0 : 1
|  |  |  |  |  |  | XG = 1 : 1
|  |  |  |  | XB = 1 : 0
|  |  |  | XO = 1 :
|  |  |  |  | XB = 0 :
|  |  |  |  |  | XD = 0 :
|  |  |  |  |  |  | XM = 0 : 0
|  |  |  |  |  |  | XM = 1 : 0
|  |  |  |  |  | XD = 1 : 0
|  |  |  |  | XB = 1 :
|  |  |  |  |  | XH = 0 :
|  |  |  |  |  |  | XL = 0 : 1
|  |  |  |  |  |  | XL = 1 :
|  |  |  |  |  |  |  | XS = 0 :
|  |  |  |  |  |  |  |  | XJ = 0 :
|  |  |  |  |  |  |  |  |  | XC = 0 : 1
|  |  |  |  |  |  |  |  |  | XC = 1 : 1
|  |  |  |  |  |  |  |  | XJ = 1 : 1
|  |  |  |  |  |  |  | XS = 1 : 0
|  |  |  |  |  | XH = 1 : 1
|  |  | XF = 1 : 0
|  | XQ = 1 :
|  |  | XB = 0 :
|  |  |  | XT = 0 :
|  |  |  |  | XL = 0 :
|  |  |  |  |  | XR = 0 :
|  |  |  |  |  |  | XN = 0 :
|  |  |  |  |  |  |  | XG = 0 : 1
|  |  |  |  |  |  |  | XG = 1 :
|  |  |  |  |  |  |  |  | XP = 0 : 1
|  |  |  |  |  |  |  |  | XP = 1 :
|  |  |  |  |  |  |  |  |  | XC = 0 :
|  |  |  |  |  |  |  |  |  |  | XE = 0 : 1
|  |  |  |  |  |  |  |  |  |  | XE = 1 : 1
```

```
| | | | | | | | | | XC = 1 : 0
| | | | | | | | XN = 1 : 0
| | | | | | | XR = 1 : 1
| | | | | | XL = 1 :
| | | | | | | XF = 0 : 0
| | | | | | | XF = 1 :
| | | | | | | | XC = 0 :
| | | | | | | | | XH = 0 : 1
| | | | | | | | | XH = 1 :
| | | | | | | | | | XE = 0 : 0
| | | | | | | | | | XE = 1 : 0
| | | | | | | | XC = 1 :
| | | | | | | | | XJ = 0 : 0
| | | | | | | | | XJ = 1 :
| | | | | | | | | | XK = 0 : 1
| | | | | | | | | | XK = 1 :
| | | | | | | | | | | XM = 0 : 0
| | | | | | | | | | | XM = 1 : 0
| | | | XT = 1 :
| | | | | XO = 0 : 1
| | | | | XO = 1 :
| | | | | | XM = 0 :
| | | | | | | XH = 0 :
| | | | | | | | XL = 0 : 0
| | | | | | | | XL = 1 :
| | | | | | | | | XC = 0 :
| | | | | | | | | | XD = 0 : 1
| | | | | | | | | | XD = 1 : 1
| | | | | | | | | XC = 1 : 1
| | | | | | | XH = 1 : 1
| | | | | | XM = 1 : 0
| | | XB = 1 :
| | | | XO = 0 : 0
| | | | XO = 1 :
| | | | | XM = 0 :
| | | | | | XF = 0 :
| | | | | | | XP = 0 :
| | | | | | | | XL = 0 :
| | | | | | | | | XC = 0 : 1
| | | | | | | | | XC = 1 :
| | | | | | | | | | XK = 0 :
| | | | | | | | | | | XE = 0 :
| | | | | | | | | | | | XD = 0 :
| | | | | | | | | | | | | XG = 0 :
| | | | | | | | | | | | | | XH = 0 : 0
| | | | | | | | | | | | | | XH = 1 :
| | | | | | | | | | | | | | | XJ = 0 : 0
| | | | | | | | | | | | | | | XJ = 1 :
| | | | | | | | | | | | | | | | XN = 0 :
| | | | | | | | | | | | | | | | | XR = 0 :
| | | | | | | | | | | | | | | | | | XS = 0 :
| | | | | | | | | | | | | | | | | | | XT = 0 : 0
| | | | | | | | | | | | | | | | | | | XT = 1 : 0
| | | | | | | | | | | | | | | | | | XS = 1 : 0
| | | | | | | | | | | | | | | | | XR = 1 : 0
| | | | | | | | | | | | | | | | XN = 1 : 0
| | | | | | | | | | | | | XG = 1 : 0
| | | | | | | | | | | | XD = 1 : 0
| | | | | | | | | | | XE = 1 : 0
| | | | | | | | | | XK = 1 : 1
| | | | | | | | XL = 1 : 0
| | | | | | | XP = 1 : 1
| | | | | | XF = 1 : 0
| | | | | XM = 1 : 0
```

```
| XU = 1 :
|  | XG = 0 :
|  |  | XS = 0 :
|  |  |  | XB = 0 :
|  |  |  |  | XF = 0 : 0
|  |  |  |  | XF = 1 :
|  |  |  |  |  | XQ = 0 : 0
|  |  |  |  |  | XQ = 1 :
|  |  |  |  |  |  | XC = 0 : 1
|  |  |  |  |  |  | XC = 1 :
|  |  |  |  |  |  |  | XH = 0 :
|  |  |  |  |  |  |  |  | XD = 0 : 1
|  |  |  |  |  |  |  |  | XD = 1 : 1
|  |  |  |  |  |  |  | XH = 1 :
|  |  |  |  |  |  |  |  | XJ = 0 :
|  |  |  |  |  |  |  |  |  | XN = 0 : 0
|  |  |  |  |  |  |  |  |  | XN = 1 : 0
|  |  |  |  |  |  |  |  | XJ = 1 : 1
|  |  |  | XB = 1 :
|  |  |  |  | XO = 0 : 0
|  |  |  |  | XO = 1 :
|  |  |  |  |  | XJ = 0 :
|  |  |  |  |  |  | XC = 0 : 0
|  |  |  |  |  |  | XC = 1 :
|  |  |  |  |  |  |  | XD = 0 : 1
|  |  |  |  |  |  |  | XD = 1 : 1
|  |  |  |  |  | XJ = 1 : 1
|  |  | XS = 1 :
|  |  |  | XO = 0 : 0
|  |  |  | XO = 1 :
|  |  |  |  | XL = 0 :
|  |  |  |  |  | XN = 0 :
|  |  |  |  |  |  | XJ = 0 : 0
|  |  |  |  |  |  | XJ = 1 : 0
|  |  |  |  |  | XN = 1 : 1
|  |  |  |  | XL = 1 : 0
|  | XG = 1 : 0
XI = 1 :
 | XK = 0 :
 |  | XC = 0 :
 |  |  | XS = 0 :
 |  |  |  | XG = 0 :
 |  |  |  |  | XM = 0 : 1
 |  |  |  |  | XM = 1 :
 |  |  |  |  |  | XT = 0 : 1
 |  |  |  |  |  | XT = 1 :
 |  |  |  |  |  |  | XL = 0 :
 |  |  |  |  |  |  |  | XP = 0 : 1
 |  |  |  |  |  |  |  | XP = 1 :
 |  |  |  |  |  |  |  |  | XB = 0 : 0
 |  |  |  |  |  |  |  |  | XB = 1 : 0
 |  |  |  |  |  |  | XL = 1 :
 |  |  |  |  |  |  |  | XP = 0 : 0
 |  |  |  |  |  |  |  | XP = 1 :
 |  |  |  |  |  |  |  |  | XQ = 0 : 1
 |  |  |  |  |  |  |  |  | XQ = 1 :
 |  |  |  |  |  |  |  |  |  | XB = 0 : 0
 |  |  |  |  |  |  |  |  |  | XB = 1 : 0
 |  |  |  | XG = 1 :
 |  |  |  |  | XO = 0 : 1
 |  |  |  |  | XO = 1 :
 |  |  |  |  |  | XH = 0 : 0
 |  |  |  |  |  | XH = 1 :
 |  |  |  |  |  |  | XL = 0 : 0
```

```
|   |   |   |   |   |   |   | XL = 1 : 0
|   |   | XS = 1 :
|   |   |   | XR = 0 :
|   |   |   |   | XN = 0 : 1
|   |   |   |   | XN = 1 :
|   |   |   |   |   | XH = 0 :
|   |   |   |   |   |   | XJ = 0 :
|   |   |   |   |   |   |   | XM = 0 :
|   |   |   |   |   |   |   |   | XD = 0 : 1
|   |   |   |   |   |   |   |   | XD = 1 : 1
|   |   |   |   |   |   |   | XM = 1 : 1
|   |   |   |   |   |   | XJ = 1 : 1
|   |   |   |   |   | XH = 1 :
|   |   |   |   |   |   | XT = 0 : 0
|   |   |   |   |   |   | XT = 1 :
|   |   |   |   |   |   |   | XF = 0 : 1
|   |   |   |   |   |   |   | XF = 1 : 1
|   |   |   | XR = 1 :
|   |   |   |   | XG = 0 :
|   |   |   |   |   | XM = 0 :
|   |   |   |   |   |   | XH = 0 : 0
|   |   |   |   |   |   | XH = 1 :
|   |   |   |   |   |   |   | XB = 0 : 1
|   |   |   |   |   |   |   | XB = 1 :
|   |   |   |   |   |   |   |   | XF = 0 : 0
|   |   |   |   |   |   |   |   | XF = 1 : 0
|   |   |   |   |   | XM = 1 :
|   |   |   |   |   |   | XD = 0 : 1
|   |   |   |   |   |   | XD = 1 : 1
|   |   |   |   | XG = 1 : 0
|   | XC = 1 :
|   |   | XD = 0 :
|   |   |   | XS = 0 :
|   |   |   |   | XF = 0 :
|   |   |   |   |   | XB = 0 : 0
|   |   |   |   |   | XB = 1 :
|   |   |   |   |   |   | XE = 0 : 1
|   |   |   |   |   |   | XE = 1 : 1
|   |   |   |   | XF = 1 :
|   |   |   |   |   | XP = 0 : 1
|   |   |   |   |   | XP = 1 :
|   |   |   |   |   |   | XH = 0 : 1
|   |   |   |   |   |   | XH = 1 :
|   |   |   |   |   |   |   | XL = 0 :
|   |   |   |   |   |   |   |   | XJ = 0 : 1
|   |   |   |   |   |   |   |   | XJ = 1 :
|   |   |   |   |   |   |   |   |   | XN = 0 : 1
|   |   |   |   |   |   |   |   |   | XN = 1 : 1
|   |   |   |   |   |   |   | XL = 1 : 0
|   |   |   | XS = 1 :
|   |   |   |   | XJ = 0 :
|   |   |   |   |   | XM = 0 : 0
|   |   |   |   |   | XM = 1 :
|   |   |   |   |   |   | XQ = 0 :
|   |   |   |   |   |   |   | XB = 0 : 1
|   |   |   |   |   |   |   | XB = 1 :
|   |   |   |   |   |   |   |   | XF = 0 :
|   |   |   |   |   |   |   |   |   | XH = 0 : 1
|   |   |   |   |   |   |   |   |   | XH = 1 : 1
|   |   |   |   |   |   |   |   | XF = 1 : 1
|   |   |   |   |   |   | XQ = 1 : 0
|   |   |   |   | XJ = 1 :
|   |   |   |   |   | XO = 0 :
|   |   |   |   |   |   | XF = 0 :
```

```
|  |  |  |  |  |  |  |  | XE = 0 : 1
|  |  |  |  |  |  |  |  | XE = 1 : 1
|  |  |  |  |  |  |  | XF = 1 : 1
|  |  |  |  |  |  | XO = 1 :
|  |  |  |  |  |  | XR = 0 :
|  |  |  |  |  |  |  | XB = 0 :
|  |  |  |  |  |  |  |  | XH = 0 : 1
|  |  |  |  |  |  |  |  | XH = 1 : 1
|  |  |  |  |  |  |  | XB = 1 : 1
|  |  |  |  |  |  | XR = 1 : 1
|  |  | XD = 1 :
|  |  |  | XF = 0 : 0
|  |  |  | XF = 1 :
|  |  |  |  | XO = 0 : 0
|  |  |  |  | XO = 1 :
|  |  |  |  |  | XP = 0 : 1
|  |  |  |  |  | XP = 1 : 1
| XK = 1 :
|  | XD = 0 :
|  |  | XT = 0 :
|  |  |  | XF = 0 :
|  |  |  |  | XB = 0 :
|  |  |  |  |  | XR = 0 : 0
|  |  |  |  |  | XR = 1 :
|  |  |  |  |  |  | XO = 0 : 1
|  |  |  |  |  |  | XO = 1 :
|  |  |  |  |  |  |  | XL = 0 : 0
|  |  |  |  |  |  |  | XL = 1 : 0
|  |  |  |  | XB = 1 :
|  |  |  |  |  | XO = 0 : 1
|  |  |  |  |  | XO = 1 : 1
|  |  |  | XF = 1 :
|  |  |  |  | XO = 0 : 1
|  |  |  |  | XO = 1 :
|  |  |  |  |  | XH = 0 :
|  |  |  |  |  |  | XL = 0 :
|  |  |  |  |  |  |  | XE = 0 : 0
|  |  |  |  |  |  |  | XE = 1 :
|  |  |  |  |  |  |  |  | XG = 0 : 0
|  |  |  |  |  |  |  |  | XG = 1 : 0
|  |  |  |  |  |  | XL = 1 : 1
|  |  |  |  |  | XH = 1 :
|  |  |  |  |  |  | XE = 0 : 1
|  |  |  |  |  |  | XE = 1 :
|  |  |  |  |  |  |  | XL = 0 : 0
|  |  |  |  |  |  |  | XL = 1 : 0
|  |  | XT = 1 :
|  |  |  | XB = 0 :
|  |  |  |  | XC = 0 :
|  |  |  |  |  | XM = 0 : 1
|  |  |  |  |  | XM = 1 :
|  |  |  |  |  |  | XJ = 0 : 0
|  |  |  |  |  |  | XJ = 1 :
|  |  |  |  |  |  |  | XE = 0 : 1
|  |  |  |  |  |  |  | XE = 1 : 1
|  |  |  |  | XC = 1 :
|  |  |  |  |  | XH = 0 : 1
|  |  |  |  |  | XH = 1 :
|  |  |  |  |  |  | XL = 0 : 1
|  |  |  |  |  |  | XL = 1 :
|  |  |  |  |  |  |  | XN = 0 : 0
|  |  |  |  |  |  |  | XN = 1 : 0
|  |  |  | XB = 1 : 0
|  | XD = 1 : 0
```

b) Decision Tree (With variance) :

```
XB = 0 :
 | XC = 0 :
 | | XF = 0 :
 | | | XG = 0 : 0
 | | | XG = 1 :
 | | | | XS = 0 : 0
 | | | | XS = 1 :
 | | | | | XL = 0 : 1
 | | | | | XL = 1 :
 | | | | | | XU = 0 : 1
 | | | | | | XU = 1 :
 | | | | | | | XJ = 0 : 0
 | | | | | | | XJ = 1 :
 | | | | | | | | XE = 0 : 1
 | | | | | | | | XE = 1 : 1
 | | XF = 1 :
 | | | XS = 0 :
 | | | | XQ = 0 :
 | | | | | XI = 0 : 0
 | | | | | XI = 1 :
 | | | | | | XH = 0 :
 | | | | | | | XN = 0 : 0
 | | | | | | | XN = 1 :
 | | | | | | | | XO = 0 : 1
 | | | | | | | | XO = 1 :
 | | | | | | | | | XG = 0 : 0
 | | | | | | | | | XG = 1 : 0
 | | | | | | XH = 1 :
 | | | | | | | XL = 0 : 1
 | | | | | | | XL = 1 :
 | | | | | | | | XD = 0 : 0
 | | | | | | | | XD = 1 : 0
 | | | | XQ = 1 :
 | | | | | XG = 0 : 1
 | | | | | XG = 1 :
 | | | | | | XJ = 0 : 1
 | | | | | | XJ = 1 :
 | | | | | | | XD = 0 : 0
 | | | | | | | XD = 1 : 0
 | | | XS = 1 :
 | | | | XP = 0 :
 | | | | | XI = 0 :
 | | | | | | XU = 0 :
 | | | | | | | XR = 0 : 0
 | | | | | | | XR = 1 : 0
 | | | | | | XU = 1 : 0
 | | | | | XI = 1 :
 | | | | | | XT = 0 : 1
 | | | | | | XT = 1 :
 | | | | | | | XQ = 0 :
 | | | | | | | | XE = 0 :
 | | | | | | | | | XK = 0 : 0
 | | | | | | | | | XK = 1 : 0
 | | | | | | | | XE = 1 : 1
 | | | | | | | XQ = 1 :
 | | | | | | | | XE = 0 : 0
 | | | | | | | | XE = 1 : 0
 | | | | XP = 1 :
 | | | | | XD = 0 :
 | | | | | | XO = 0 :
 | | | | | | | XQ = 0 : 0
 | | | | | | | XQ = 1 :
```

```
|  |  |  |  |  |  |  |  | XN = 0 : 0
|  |  |  |  |  |  |  |  | XN = 1 : 0
|  |  |  |  |  |  |  | XO = 1 :
|  |  |  |  |  |  |  |  | XK = 0 : 1
|  |  |  |  |  |  |  |  | XK = 1 :
|  |  |  |  |  |  |  |  | XE = 0 : 0
|  |  |  |  |  |  |  |  | XE = 1 : 0
|  |  |  |  |  | XD = 1 : 0
| XC = 1 :
|  | XD = 0 :
|  |  | XF = 0 :
|  |  |  | XS = 0 : 0
|  |  |  | XS = 1 :
|  |  |  |  | XG = 0 : 0
|  |  |  |  | XG = 1 :
|  |  |  |  |  | XL = 0 : 1
|  |  |  |  |  | XL = 1 :
|  |  |  |  |  |  | XP = 0 : 0
|  |  |  |  |  |  | XP = 1 :
|  |  |  |  |  |  |  | XJ = 0 :
|  |  |  |  |  |  |  |  | XH = 0 : 1
|  |  |  |  |  |  |  |  | XH = 1 :
|  |  |  |  |  |  |  |  |  | XO = 0 : 0
|  |  |  |  |  |  |  |  |  | XO = 1 : 0
|  |  |  |  |  |  |  | XJ = 1 : 1
|  |  | XF = 1 :
|  |  |  | XI = 0 :
|  |  |  |  | XQ = 0 : 0
|  |  |  |  | XQ = 1 :
|  |  |  |  |  | XU = 0 :
|  |  |  |  |  |  | XN = 0 :
|  |  |  |  |  |  |  | XE = 0 :
|  |  |  |  |  |  |  |  | XL = 0 : 0
|  |  |  |  |  |  |  |  | XL = 1 :
|  |  |  |  |  |  |  |  |  | XH = 0 : 1
|  |  |  |  |  |  |  |  |  | XH = 1 :
|  |  |  |  |  |  |  |  |  |  | XG = 0 : 0
|  |  |  |  |  |  |  |  |  |  | XG = 1 :
|  |  |  |  |  |  |  |  |  |  |  | XK = 0 : 0
|  |  |  |  |  |  |  |  |  |  |  | XK = 1 : 0
|  |  |  |  |  |  |  | XE = 1 : 1
|  |  |  |  |  |  | XN = 1 : 1
|  |  |  |  |  | XU = 1 :
|  |  |  |  |  |  | XH = 0 : 0
|  |  |  |  |  |  | XH = 1 :
|  |  |  |  |  |  |  | XJ = 0 :
|  |  |  |  |  |  |  |  | XN = 0 : 0
|  |  |  |  |  |  |  |  | XN = 1 : 0
|  |  |  |  |  |  |  | XJ = 1 : 1
|  |  |  | XI = 1 :
|  |  |  |  | XO = 0 :
|  |  |  |  |  | XG = 0 :
|  |  |  |  |  |  | XR = 0 : 1
|  |  |  |  |  |  | XR = 1 : 1
|  |  |  |  |  | XG = 1 : 1
|  |  |  |  | XO = 1 :
|  |  |  |  |  | XT = 0 :
|  |  |  |  |  |  | XH = 0 :
|  |  |  |  |  |  |  | XN = 0 : 1
|  |  |  |  |  |  |  | XN = 1 :
|  |  |  |  |  |  |  |  | XJ = 0 :
|  |  |  |  |  |  |  |  |  | XM = 0 : 1
|  |  |  |  |  |  |  |  |  | XM = 1 : 1
|  |  |  |  |  |  |  |  | XJ = 1 : 0
```

```
|  |  |  |  |  |  |  | XH = 1 : 1
|  |  |  |  |  |  | XT = 1 :
|  |  |  |  |  |  |  | XH = 0 : 1
|  |  |  |  |  |  |  | XH = 1 :
|  |  |  |  |  |  |  |  | XG = 0 :
|  |  |  |  |  |  |  |  |  | XR = 0 : 1
|  |  |  |  |  |  |  |  |  | XR = 1 : 1
|  |  |  |  |  |  |  |  | XG = 1 : 0
|  | XD = 1 :
|  |  | XP = 0 : 0
|  |  | XP = 1 :
|  |  |  | XS = 0 :
|  |  |  |  | XM = 0 :
|  |  |  |  |  | XJ = 0 : 0
|  |  |  |  |  | XJ = 1 :
|  |  |  |  |  |  | XF = 0 : 1
|  |  |  |  |  |  | XF = 1 : 1
|  |  |  |  | XM = 1 :
|  |  |  |  |  | XG = 0 :
|  |  |  |  |  |  | XJ = 0 : 0
|  |  |  |  |  |  | XJ = 1 : 0
|  |  |  |  |  | XG = 1 : 0
|  |  |  | XS = 1 : 0
XB = 1 :
|  XD = 0 :
|  |  XO = 0 : 0
|  |  XO = 1 :
|  |  |  XI = 0 :
|  |  |  |  XF = 0 :
|  |  |  |  |  XM = 0 :
|  |  |  |  |  |  XU = 0 :
|  |  |  |  |  |  |  XP = 0 :
|  |  |  |  |  |  |  |  XL = 0 :
|  |  |  |  |  |  |  |  |  XC = 0 : 1
|  |  |  |  |  |  |  |  |  XC = 1 :
|  |  |  |  |  |  |  |  |  |  XK = 0 :
|  |  |  |  |  |  |  |  |  |  |  XE = 0 :
|  |  |  |  |  |  |  |  |  |  |  |  XG = 0 :
|  |  |  |  |  |  |  |  |  |  |  |  |  XH = 0 : 0
|  |  |  |  |  |  |  |  |  |  |  |  |  XH = 1 :
|  |  |  |  |  |  |  |  |  |  |  |  |  |  XJ = 0 : 0
|  |  |  |  |  |  |  |  |  |  |  |  |  |  XJ = 1 :
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  XN = 0 :
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  XQ = 0 : 0
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  XQ = 1 :
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  XR = 0 :
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  XS = 0 :
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  XT = 0 : 0
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  XT = 1 : 0
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  XS = 1 : 0
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  XR = 1 : 0
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  XN = 1 : 0
|  |  |  |  |  |  |  |  |  |  |  |  |  |  XG = 1 : 0
|  |  |  |  |  |  |  |  |  |  |  |  |  XE = 1 : 0
|  |  |  |  |  |  |  |  |  |  |  |  XK = 1 : 1
|  |  |  |  |  |  |  |  |  XL = 1 : 0
|  |  |  |  |  |  |  |  XP = 1 : 1
|  |  |  |  |  |  |  XU = 1 :
|  |  |  |  |  |  |  |  XC = 0 : 0
|  |  |  |  |  |  |  |  XC = 1 :
|  |  |  |  |  |  |  |  |  XG = 0 : 0
|  |  |  |  |  |  |  |  |  XG = 1 : 0
|  |  |  |  |  |  XM = 1 :
|  |  |  |  |  |  |  XQ = 0 :
```

```
|   |   |   |   |   |   |   | XJ = 0 :
|   |   |   |   |   |   |   |   | XH = 0 : 0
|   |   |   |   |   |   |   |   | XH = 1 :
|   |   |   |   |   |   |   |   |   | XE = 0 : 1
|   |   |   |   |   |   |   |   |   | XE = 1 : 1
|   |   |   |   |   |   |   | XJ = 1 :
|   |   |   |   |   |   |   |   | XK = 0 : 0
|   |   |   |   |   |   |   |   | XK = 1 : 0
|   |   |   |   |   |   | XQ = 1 : 0
|   |   |   | XF = 1 : 0
|   |   | XI = 1 :
|   |   |   | XR = 0 :
|   |   |   |   | XE = 0 :
|   |   |   |   |   | XK = 0 :
|   |   |   |   |   |   | XM = 0 : 1
|   |   |   |   |   |   | XM = 1 : 1
|   |   |   |   |   | XK = 1 : 0
|   |   |   |   | XE = 1 :
|   |   |   |   |   | XG = 0 : 1
|   |   |   |   |   | XG = 1 :
|   |   |   |   |   |   | XQ = 0 :
|   |   |   |   |   |   |   | XP = 0 :
|   |   |   |   |   |   |   |   | XC = 0 : 1
|   |   |   |   |   |   |   |   | XC = 1 : 1
|   |   |   |   |   |   |   | XP = 1 : 1
|   |   |   |   |   |   | XQ = 1 : 0
|   |   |   | XR = 1 :
|   |   |   |   | XJ = 0 :
|   |   |   |   |   | XQ = 0 :
|   |   |   |   |   |   | XM = 0 : 0
|   |   |   |   |   |   | XM = 1 :
|   |   |   |   |   |   |   | XT = 0 : 1
|   |   |   |   |   |   |   | XT = 1 :
|   |   |   |   |   |   |   |   | XF = 0 :
|   |   |   |   |   |   |   |   |   | XH = 0 : 1
|   |   |   |   |   |   |   |   |   | XH = 1 : 1
|   |   |   |   |   |   |   |   | XF = 1 : 1
|   |   |   |   |   | XQ = 1 : 0
|   |   |   |   | XJ = 1 :
|   |   |   |   |   | XP = 0 :
|   |   |   |   |   |   | XC = 0 : 1
|   |   |   |   |   |   | XC = 1 : 1
|   |   |   |   |   | XP = 1 : 1
| XD = 1 :
|   | XK = 0 :
|   |   | XC = 0 :
|   |   |   | XI = 0 :
|   |   |   |   | XF = 0 :
|   |   |   |   |   | XO = 0 : 0
|   |   |   |   |   | XO = 1 :
|   |   |   |   |   |   | XT = 0 :
|   |   |   |   |   |   |   | XH = 0 : 1
|   |   |   |   |   |   |   | XH = 1 : 1
|   |   |   |   |   |   | XT = 1 :
|   |   |   |   |   |   |   | XH = 0 : 1
|   |   |   |   |   |   |   | XH = 1 :
|   |   |   |   |   |   |   |   | XM = 0 : 0
|   |   |   |   |   |   |   |   | XM = 1 : 0
|   |   |   |   | XF = 1 : 0
|   |   |   | XI = 1 :
|   |   |   |   | XS = 0 :
|   |   |   |   |   | XO = 0 : 1
|   |   |   |   |   | XO = 1 :
|   |   |   |   |   |   | XM = 0 : 0
```

```
|  |  |  |  |  |  |  | XM = 1 : 0
|  |  |  |  |  | XS = 1 :
|  |  |  |  |  |  | XP = 0 :
|  |  |  |  |  |  | XM = 0 :
|  |  |  |  |  |  |  | XJ = 0 : 1
|  |  |  |  |  |  |  | XJ = 1 : 1
|  |  |  |  |  |  | XM = 1 :
|  |  |  |  |  |  |  | XO = 0 : 1
|  |  |  |  |  |  |  | XO = 1 :
|  |  |  |  |  |  |  |  | XN = 0 : 0
|  |  |  |  |  |  |  |  | XN = 1 : 0
|  |  |  |  |  |  | XP = 1 : 0
|  |  | XC = 1 :
|  |  |  | XQ = 0 :
|  |  |  |  | XS = 0 :
|  |  |  |  |  | XO = 0 : 1
|  |  |  |  |  | XO = 1 : 1
|  |  |  |  | XS = 1 : 0
|  |  |  | XQ = 1 : 0
|  | XK = 1 :
|  |  | XO = 0 : 0
|  |  | XO = 1 :
|  |  |  | XI = 0 :
|  |  |  |  | XT = 0 :
|  |  |  |  |  | XP = 0 :
|  |  |  |  |  |  | XE = 0 : 0
|  |  |  |  |  |  | XE = 1 : 0
|  |  |  |  |  | XP = 1 : 1
|  |  |  |  | XT = 1 : 0
|  |  |  | XI = 1 : 0
```

Post - Pruned Accuracies

L value	K value	Dataset	Variance	Original Accuracy	Pruned Accuracy
100	10	1	no	72.30	**74.00**
100	10	1	yes	72.850	**73.00**
100	5	1	no	72.30	**74.60**
100	5	1	yes	72.850	**73.650**
200	15	2	no	75.667	**77.500**
200	15	2	yes	76.667	**76.667**
300	17	2	no	75.667	**77.333**
300	17	2	yes	76.667	**76.333**
500	12	2	no	75.667	**77.500**
500	12	1	yes	72.850	**73.750**

Console Output :

Sample Command :

java DecisionTreeAlgorithm 100 10 ./data_sets1/training_set.csv ./data_sets1/validation_set.csv ./data_sets1/test_set.csv no

```
Himanshus-MacBook-Pro:Source Heman$ java DecisionTreeAlgorithm 100 10 ./data_sets1/training_set.csv ./data_sets1/validation_set.csv ./data_sets1/test_set.csv no
 Validation data accuracy [without variance] : 72.300
 Validation data accuracy [with variance] : 72.850
 Test data accuracy [without variance] : 74.100
 Test data accuracy [with variance] : 74.550
 Best Decision Tree accuracy (without variance) : 74.00
 Best Decision Tree accuracy (with variance) : 73.00
Himanshus-MacBook-Pro:Source Heman$ java DecisionTreeAlgorithm 100 5 ./data_sets1/training_set.csv ./data_sets1/validation_set.csv ./data_sets1/test_set.csv no
 Validation data accuracy [without variance] : 72.300
 Validation data accuracy [with variance] : 72.850
 Test data accuracy [without variance] : 74.100
 Test data accuracy [with variance] : 74.550
 Best Decision Tree accuracy (without variance) : 74.600
 Best Decision Tree accuracy (with variance) : 73.650
Himanshus-MacBook-Pro:Source Heman$ java DecisionTreeAlgorithm 200 15 ./data_sets2/training_set.csv ./data_sets2/validation_set.csv ./data_sets2/test_set.csv no
 Validation data accuracy [without variance] : 75.667
 Validation data accuracy [with variance] : 76.667
 Test data accuracy [without variance] : 72.500
 Test data accuracy [with variance] : 76.667
 Best Decision Tree accuracy (without variance) : 77.500
 Best Decision Tree accuracy (with variance) : 76.667
Himanshus-MacBook-Pro:Source Heman$ java DecisionTreeAlgorithm 300 17 ./data_sets2/training_set.csv ./data_sets2/validation_set.csv ./data_sets2/test_set.csv no
 Validation data accuracy [without variance] : 75.667
 Validation data accuracy [with variance] : 76.667
 Test data accuracy [without variance] : 72.500
 Test data accuracy [with variance] : 76.667
 Best Decision Tree accuracy (without variance) : 77.333
 Best Decision Tree accuracy (with variance) : 76.333
Himanshus-MacBook-Pro:Source Heman$ java DecisionTreeAlgorithm 500 12 ./data_sets2/training_set.csv ./data_sets2/validation_set.csv ./data_sets2/test_set.csv no
 Validation data accuracy [without variance] : 75.667
 Validation data accuracy [with variance] : 76.667
 Test data accuracy [without variance] : 72.500
 Test data accuracy [with variance] : 76.667
 Best Decision Tree accuracy (without variance) : 77.500
 Best Decision Tree accuracy (with variance) : 77.00
Himanshus-MacBook-Pro:Source Heman$ java DecisionTreeAlgorithm 500 12 ./data_sets1/training_set.csv ./data_sets1/validation_set.csv ./data_sets1/test_set.csv no
 Validation data accuracy [without variance] : 72.300
 Validation data accuracy [with variance] : 72.850
 Test data accuracy [without variance] : 74.100
 Test data accuracy [with variance] : 74.550
 Best Decision Tree accuracy (without variance) : 74.050
 Best Decision Tree accuracy (with variance) : 73.750
```