

Assignment No	11
Title	Classification Algorithms
Objective	Naive Bayes, KNN, IB3, C4.5
Roll No	MCA2511

Naive Bayesian.R

```
> install.packages("e1071")
```

WARNING: Rtools is required to build R packages but is not currently installed. Please download and install the appropriate version of Rtools before proceeding:

<https://cran.rstudio.com/bin/windows/Rtools/>

also installing the dependency 'proxy'

```
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/proxy_0.4-27.zip'
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/e1071_1.7-16.zip'
package 'proxy' successfully unpacked and MD5 sums checked
package 'e1071' successfully unpacked and MD5 sums checked
```

The downloaded binary packages are in

```
C:\Users\MCA2511\AppData\Local\Temp\RtmpUPR1cj\downloaded_packages
> install.packages("caTools")
```

WARNING: Rtools is required to build R packages but is not currently installed. Please download and install the appropriate version of Rtools before proceeding:

<https://cran.rstudio.com/bin/windows/Rtools/>

also installing the dependency 'bitops'

```
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/bitops_1.0-9.zip'
```

```
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/caTools_1.18.3.zip'
package 'bitops' successfully unpacked and MD5 sums checked
package 'caTools' successfully unpacked and MD5 sums checked

The downloaded binary packages are in
  C:\Users\MCA2511\AppData\Local\Temp\RtmpUPR1cj\downloaded_packages
> install.packages("caret")
```

WARNING: Rtools is required to build R packages but is not currently installed. Please download and install the appropriate version of Rtools before proceeding:

<https://cran.rstudio.com/bin/windows/Rtools/>

also installing the dependencies 'listenv', 'parallelly', 'future', 'globals', 'shape', 'future.apply', 'numDeriv', 'progressr', 'SQUAREM', 'diagram', 'lava', 'tzdb', 'prodlim', 'timechange', 'iterators', 'Rcpp', 'clock', 'gower', 'hardhat', 'ipred', 'lubridate', 'purrr', 'sparsevctrs', 'tidyR', 'timeDate', 'foreach', 'ModelMetrics', 'plyr', 'pROC', 'recipes', 'reshape2'

```
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/listenv_0.10.0.zip'
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/parallelly_1.45.1.zip'
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/future_1.67.0.zip'
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/globals_0.18.0.zip'
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/shape_1.4.6.1.zip'
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/future.apply_1.20.0.zip'
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/numDeriv_2016.8-1.1.zip'
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/progressr_0.18.0.zip'
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/SQUAREM_2021.1.zip'
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/diagram_1.6.5.zip'
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/lava_1.8.2.zip'
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/tzdb_0.5.0.zip'
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/prodlim_2025.04.28.zip'
trying URL
```

```
'https://cran.rstudio.com/bin/windows/contrib/4.5/timechange_0.3.0.zip'  
trying URL  
'https://cran.rstudio.com/bin/windows/contrib/4.5/iterators_1.0.14.zip'  
trying URL  
'https://cran.rstudio.com/bin/windows/contrib/4.5/Rcpp_1.1.0.zip'  
trying URL  
'https://cran.rstudio.com/bin/windows/contrib/4.5/clock_0.7.3.zip'  
trying URL  
'https://cran.rstudio.com/bin/windows/contrib/4.5/gower_1.0.2.zip'  
trying URL  
'https://cran.rstudio.com/bin/windows/contrib/4.5/hardhat_1.4.2.zip'  
trying URL  
'https://cran.rstudio.com/bin/windows/contrib/4.5/iplpred_0.9-15.zip'  
trying URL  
'https://cran.rstudio.com/bin/windows/contrib/4.5/lubridate_1.9.4.zip'  
trying URL  
'https://cran.rstudio.com/bin/windows/contrib/4.5/purrr_1.2.0.zip'  
trying URL  
'https://cran.rstudio.com/bin/windows/contrib/4.5/sparsevctrs_0.3.4.zip'  
trying URL  
'https://cran.rstudio.com/bin/windows/contrib/4.5/tidyr_1.3.1.zip'  
trying URL  
'https://cran.rstudio.com/bin/windows/contrib/4.5/timeDate_4051.111.zip'  
trying URL  
'https://cran.rstudio.com/bin/windows/contrib/4.5/foreach_1.5.2.zip'  
trying URL  
'https://cran.rstudio.com/bin/windows/contrib/4.5/ModelMetrics_1.2.2.2.zip'  
trying URL  
'https://cran.rstudio.com/bin/windows/contrib/4.5/plyr_1.8.9.zip'  
trying URL  
'https://cran.rstudio.com/bin/windows/contrib/4.5/pROC_1.19.0.1.zip'  
trying URL  
'https://cran.rstudio.com/bin/windows/contrib/4.5/recipes_1.3.1.zip'  
trying URL  
'https://cran.rstudio.com/bin/windows/contrib/4.5/reshape2_1.4.5.zip'  
trying URL  
'https://cran.rstudio.com/bin/windows/contrib/4.5/caret_7.0-1.zip'  
package 'listenv' successfully unpacked and MD5 sums checked  
package 'parallelly' successfully unpacked and MD5 sums checked  
package 'future' successfully unpacked and MD5 sums checked  
package 'globals' successfully unpacked and MD5 sums checked  
package 'shape' successfully unpacked and MD5 sums checked  
package 'future.apply' successfully unpacked and MD5 sums checked  
package 'numDeriv' successfully unpacked and MD5 sums checked  
package 'progressr' successfully unpacked and MD5 sums checked  
package 'SQUAREM' successfully unpacked and MD5 sums checked  
package 'diagram' successfully unpacked and MD5 sums checked  
package 'lava' successfully unpacked and MD5 sums checked  
package 'tzdb' successfully unpacked and MD5 sums checked  
package 'prodlim' successfully unpacked and MD5 sums checked
```

```
package 'timechange' successfully unpacked and MD5 sums checked
package 'iterators' successfully unpacked and MD5 sums checked
package 'Rcpp' successfully unpacked and MD5 sums checked
package 'clock' successfully unpacked and MD5 sums checked
package 'gower' successfully unpacked and MD5 sums checked
package 'hardhat' successfully unpacked and MD5 sums checked
package 'ipred' successfully unpacked and MD5 sums checked
package 'lubridate' successfully unpacked and MD5 sums checked
package 'purrr' successfully unpacked and MD5 sums checked
package 'sparsevctrs' successfully unpacked and MD5 sums checked
package 'tidyverse' successfully unpacked and MD5 sums checked
package 'timeDate' successfully unpacked and MD5 sums checked
package 'foreach' successfully unpacked and MD5 sums checked
package 'ModelMetrics' successfully unpacked and MD5 sums checked
package 'plyr' successfully unpacked and MD5 sums checked
package 'pROC' successfully unpacked and MD5 sums checked
package 'recipes' successfully unpacked and MD5 sums checked
package 'reshape2' successfully unpacked and MD5 sums checked
package 'caret' successfully unpacked and MD5 sums checked
```

The downloaded binary packages are in

```
C:\Users\MCA2511\AppData\Local\Temp\RtmpUPR1cj\downloaded_packages
> library(e1071)
> library(caTools)
> library(caret)
```

Loading required package: ggplot2

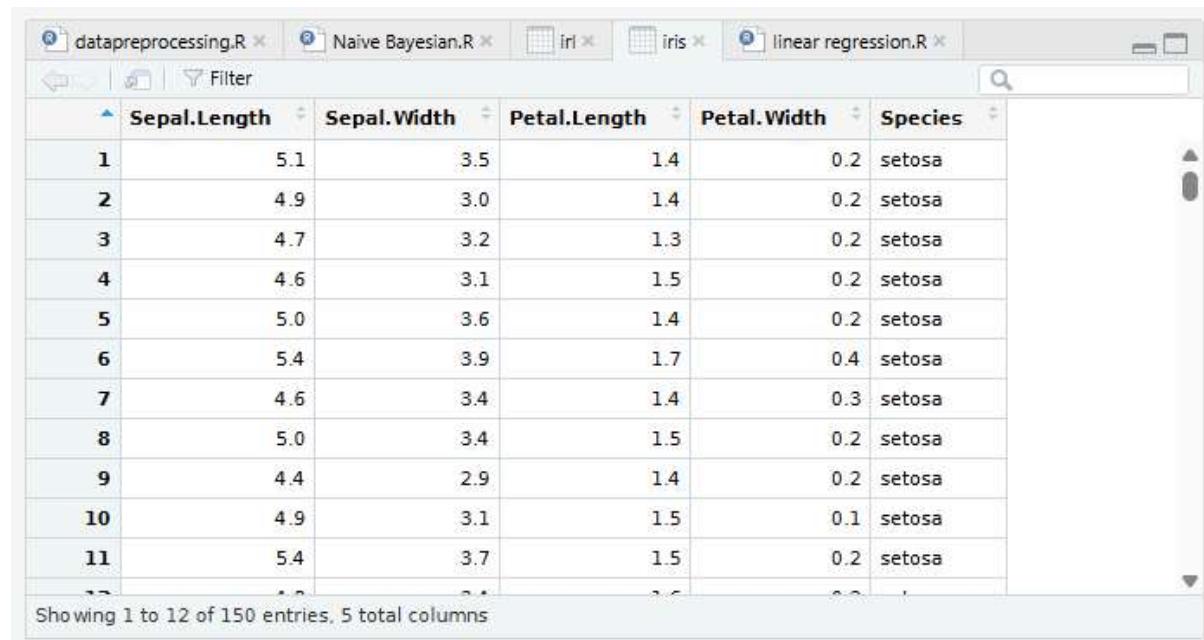
Attaching package: 'ggplot2'

The following object is masked from 'package:e1071':

```
element
```

Loading required package: lattice

```
> View(iris)
```



	Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
1	5.1	3.5	1.4	0.2	setosa
2	4.9	3.0	1.4	0.2	setosa
3	4.7	3.2	1.3	0.2	setosa
4	4.6	3.1	1.5	0.2	setosa
5	5.0	3.6	1.4	0.2	setosa
6	5.4	3.9	1.7	0.4	setosa
7	4.6	3.4	1.4	0.3	setosa
8	5.0	3.4	1.5	0.2	setosa
9	4.4	2.9	1.4	0.2	setosa
10	4.9	3.1	1.5	0.1	setosa
11	5.4	3.7	1.5	0.2	setosa
12	4.8	3.4	1.6	0.2	setosa
13	4.8	3.0	1.4	0.1	setosa
14	4.3	3.0	1.1	0.1	setosa
15	5.8	4.0	1.2	0.2	setosa
16	5.7	4.4	1.5	0.4	setosa
17	5.4	3.9	1.3	0.4	setosa
18	5.1	3.5	1.4	0.3	setosa
19	5.7	3.8	1.7	0.3	setosa
20	5.1	3.8	1.5	0.3	setosa
21	5.4	3.4	1.7	0.2	setosa
22	5.1	3.7	1.5	0.4	setosa
23	4.6	3.6	1.0	0.2	setosa
24	5.1	3.3	1.7	0.5	setosa
25	4.8	3.4	1.9	0.2	setosa
26	5.0	3.0	1.6	0.2	setosa
27	5.0	3.4	1.6	0.4	setosa
28	5.2	3.5	1.5	0.2	setosa

```
> ir <- iris
> train = ir[1:100,]
> train
   Sepal.Length Sepal.Width Petal.Length Petal.Width Species
1          5.1        3.5         1.4       0.2    setosa
2          4.9        3.0         1.4       0.2    setosa
3          4.7        3.2         1.3       0.2    setosa
4          4.6        3.1         1.5       0.2    setosa
5          5.0        3.6         1.4       0.2    setosa
6          5.4        3.9         1.7       0.4    setosa
7          4.6        3.4         1.4       0.3    setosa
8          5.0        3.4         1.5       0.2    setosa
9          4.4        2.9         1.4       0.2    setosa
10         4.9        3.1         1.5       0.1    setosa
11         5.4        3.7         1.5       0.2    setosa
12         4.8        3.4         1.6       0.2    setosa
13         4.8        3.0         1.4       0.1    setosa
14         4.3        3.0         1.1       0.1    setosa
15         5.8        4.0         1.2       0.2    setosa
16         5.7        4.4         1.5       0.4    setosa
17         5.4        3.9         1.3       0.4    setosa
18         5.1        3.5         1.4       0.3    setosa
19         5.7        3.8         1.7       0.3    setosa
20         5.1        3.8         1.5       0.3    setosa
21         5.4        3.4         1.7       0.2    setosa
22         5.1        3.7         1.5       0.4    setosa
23         4.6        3.6         1.0       0.2    setosa
24         5.1        3.3         1.7       0.5    setosa
25         4.8        3.4         1.9       0.2    setosa
26         5.0        3.0         1.6       0.2    setosa
27         5.0        3.4         1.6       0.4    setosa
28         5.2        3.5         1.5       0.2    setosa
```

29	5.2	3.4	1.4	0.2	setosa
30	4.7	3.2	1.6	0.2	setosa
31	4.8	3.1	1.6	0.2	setosa
32	5.4	3.4	1.5	0.4	setosa
33	5.2	4.1	1.5	0.1	setosa
34	5.5	4.2	1.4	0.2	setosa
35	4.9	3.1	1.5	0.2	setosa
36	5.0	3.2	1.2	0.2	setosa
37	5.5	3.5	1.3	0.2	setosa
38	4.9	3.6	1.4	0.1	setosa
39	4.4	3.0	1.3	0.2	setosa
40	5.1	3.4	1.5	0.2	setosa
41	5.0	3.5	1.3	0.3	setosa
42	4.5	2.3	1.3	0.3	setosa
43	4.4	3.2	1.3	0.2	setosa
44	5.0	3.5	1.6	0.6	setosa
45	5.1	3.8	1.9	0.4	setosa
46	4.8	3.0	1.4	0.3	setosa
47	5.1	3.8	1.6	0.2	setosa
48	4.6	3.2	1.4	0.2	setosa
49	5.3	3.7	1.5	0.2	setosa
50	5.0	3.3	1.4	0.2	setosa
51	7.0	3.2	4.7	1.4	versicolor
52	6.4	3.2	4.5	1.5	versicolor
53	6.9	3.1	4.9	1.5	versicolor
54	5.5	2.3	4.0	1.3	versicolor
55	6.5	2.8	4.6	1.5	versicolor
56	5.7	2.8	4.5	1.3	versicolor
57	6.3	3.3	4.7	1.6	versicolor
58	4.9	2.4	3.3	1.0	versicolor
59	6.6	2.9	4.6	1.3	versicolor
60	5.2	2.7	3.9	1.4	versicolor
61	5.0	2.0	3.5	1.0	versicolor
62	5.9	3.0	4.2	1.5	versicolor
63	6.0	2.2	4.0	1.0	versicolor
64	6.1	2.9	4.7	1.4	versicolor
65	5.6	2.9	3.6	1.3	versicolor
66	6.7	3.1	4.4	1.4	versicolor
67	5.6	3.0	4.5	1.5	versicolor
68	5.8	2.7	4.1	1.0	versicolor
69	6.2	2.2	4.5	1.5	versicolor
70	5.6	2.5	3.9	1.1	versicolor
71	5.9	3.2	4.8	1.8	versicolor
72	6.1	2.8	4.0	1.3	versicolor
73	6.3	2.5	4.9	1.5	versicolor
74	6.1	2.8	4.7	1.2	versicolor
75	6.4	2.9	4.3	1.3	versicolor
76	6.6	3.0	4.4	1.4	versicolor
77	6.8	2.8	4.8	1.4	versicolor
78	6.7	3.0	5.0	1.7	versicolor
79	6.0	2.9	4.5	1.5	versicolor

80	5.7	2.6	3.5	1.0	versicolor
81	5.5	2.4	3.8	1.1	versicolor
82	5.5	2.4	3.7	1.0	versicolor
83	5.8	2.7	3.9	1.2	versicolor
84	6.0	2.7	5.1	1.6	versicolor
85	5.4	3.0	4.5	1.5	versicolor
86	6.0	3.4	4.5	1.6	versicolor
87	6.7	3.1	4.7	1.5	versicolor
88	6.3	2.3	4.4	1.3	versicolor
89	5.6	3.0	4.1	1.3	versicolor
90	5.5	2.5	4.0	1.3	versicolor
91	5.5	2.6	4.4	1.2	versicolor
92	6.1	3.0	4.6	1.4	versicolor
93	5.8	2.6	4.0	1.2	versicolor
94	5.0	2.3	3.3	1.0	versicolor
95	5.6	2.7	4.2	1.3	versicolor
96	5.7	3.0	4.2	1.2	versicolor
97	5.7	2.9	4.2	1.3	versicolor
98	6.2	2.9	4.3	1.3	versicolor
99	5.1	2.5	3.0	1.1	versicolor
100	5.7	2.8	4.1	1.3	versicolor

```
> test = ir[101:150, ]
```

```
> test
```

	Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
101	6.3	3.3	6.0	2.5	virginica
102	5.8	2.7	5.1	1.9	virginica
103	7.1	3.0	5.9	2.1	virginica
104	6.3	2.9	5.6	1.8	virginica
105	6.5	3.0	5.8	2.2	virginica
106	7.6	3.0	6.6	2.1	virginica
107	4.9	2.5	4.5	1.7	virginica
108	7.3	2.9	6.3	1.8	virginica
109	6.7	2.5	5.8	1.8	virginica
110	7.2	3.6	6.1	2.5	virginica
111	6.5	3.2	5.1	2.0	virginica
112	6.4	2.7	5.3	1.9	virginica
113	6.8	3.0	5.5	2.1	virginica
114	5.7	2.5	5.0	2.0	virginica
115	5.8	2.8	5.1	2.4	virginica
116	6.4	3.2	5.3	2.3	virginica
117	6.5	3.0	5.5	1.8	virginica
118	7.7	3.8	6.7	2.2	virginica
119	7.7	2.6	6.9	2.3	virginica
120	6.0	2.2	5.0	1.5	virginica
121	6.9	3.2	5.7	2.3	virginica
122	5.6	2.8	4.9	2.0	virginica
123	7.7	2.8	6.7	2.0	virginica
124	6.3	2.7	4.9	1.8	virginica
125	6.7	3.3	5.7	2.1	virginica
126	7.2	3.2	6.0	1.8	virginica
127	6.2	2.8	4.8	1.8	virginica

128	6.1	3.0	4.9	1.8	virginica
129	6.4	2.8	5.6	2.1	virginica
130	7.2	3.0	5.8	1.6	virginica
131	7.4	2.8	6.1	1.9	virginica
132	7.9	3.8	6.4	2.0	virginica
133	6.4	2.8	5.6	2.2	virginica
134	6.3	2.8	5.1	1.5	virginica
135	6.1	2.6	5.6	1.4	virginica
136	7.7	3.0	6.1	2.3	virginica
137	6.3	3.4	5.6	2.4	virginica
138	6.4	3.1	5.5	1.8	virginica
139	6.0	3.0	4.8	1.8	virginica
140	6.9	3.1	5.4	2.1	virginica
141	6.7	3.1	5.6	2.4	virginica
142	6.9	3.1	5.1	2.3	virginica
143	5.8	2.7	5.1	1.9	virginica
144	6.8	3.2	5.9	2.3	virginica
145	6.7	3.3	5.7	2.5	virginica
146	6.7	3.0	5.2	2.3	virginica
147	6.3	2.5	5.0	1.9	virginica
148	6.5	3.0	5.2	2.0	virginica
149	6.2	3.4	5.4	2.3	virginica
150	5.9	3.0	5.1	1.8	virginica

```
> model = naiveBayes(Species~, data=train)
> model
```

Naive Bayes Classifier for Discrete Predictors

Call:

```
naiveBayes.default(x = X, y = Y, laplace = laplace)
```

A-priori probabilities:

Y

```
setosa versicolor virginica
0.5 0.5 0.0
```

Conditional probabilities:

Sepal.Length

```
Y [,1] [,2]
setosa 5.006 0.3524897
versicolor 5.936 0.5161711
virginica NA NA
```

Sepal.Width

```
Y [,1] [,2]
setosa 3.428 0.3790644
versicolor 2.770 0.3137983
virginica NA NA
```

Petal.Length

```
Y [,1] [,2]
```

```

setosa      1.462 0.173664
versicolor 4.260 0.469911
virginica   NA      NA

          Petal.Width
Y           [,1]     [,2]
setosa      0.246 0.1053856
versicolor 1.326 0.1977527
virginica   NA      NA

> test$Species
[1] virginica virginica virginica virginica virginica virginica virginica
[8] virginica virginica virginica virginica virginica virginica virginica
[15] virginica virginica virginica virginica virginica virginica virginica
[22] virginica virginica virginica virginica virginica virginica virginica
[29] virginica virginica virginica virginica virginica virginica virginica
[36] virginica virginica virginica virginica virginica virginica virginica
[43] virginica virginica virginica virginica virginica virginica virginica
[50] virginica
Levels: setosa versicolor virginica
> model

Naive Bayes Classifier for Discrete Predictors

Call:
naiveBayes.default(x = x, y = Y, laplace = laplace)

A-priori probabilities:
Y
setosa versicolor virginica
0.5      0.5      0.0

Conditional probabilities:
          Sepal.Length
Y           [,1]     [,2]
setosa      5.006 0.3524897
versicolor 5.936 0.5161711
virginica   NA      NA

          Sepal.Width
Y           [,1]     [,2]
setosa      3.428 0.3790644
versicolor 2.770 0.3137983
virginica   NA      NA

          Petal.Length
Y           [,1]     [,2]
setosa      1.462 0.173664
versicolor 4.260 0.469911
virginica   NA      NA

```

```

Petal.Width
Y      [,1]      [,2]
setosa   0.246  0.1053856
versicolor 1.326  0.1977527
virginica    NA       NA

> test$Species
[1] virginica virginica virginica virginica virginica virginica virginica
[8] virginica virginica virginica virginica virginica virginica virginica
[15] virginica virginica virginica virginica virginica virginica virginica
[22] virginica virginica virginica virginica virginica virginica virginica
[29] virginica virginica virginica virginica virginica virginica virginica
[36] virginica virginica virginica virginica virginica virginica virginica
[43] virginica virginica virginica virginica virginica virginica virginica
[50] virginica
Levels: setosa versicolor virginica
> train$Species
[1] setosa      setosa      setosa      setosa      setosa      setosa
[7] setosa      setosa      setosa      setosa      setosa      setosa
[13] setosa     setosa      setosa      setosa      setosa      setosa
[19] setosa     setosa      setosa      setosa      setosa      setosa
[25] setosa     setosa      setosa      setosa      setosa      setosa
[31] setosa     setosa      setosa      setosa      setosa      setosa
[37] setosa     setosa      setosa      setosa      setosa      setosa
[43] setosa     setosa      setosa      setosa      setosa      setosa
[49] setosa     setosa      versicolor  versicolor  versicolor  versicolor
[55] versicolor  versicolor  versicolor  versicolor  versicolor  versicolor
[61] versicolor  versicolor  versicolor  versicolor  versicolor  versicolor
[67] versicolor  versicolor  versicolor  versicolor  versicolor  versicolor
[73] versicolor  versicolor  versicolor  versicolor  versicolor  versicolor
[79] versicolor  versicolor  versicolor  versicolor  versicolor  versicolor
[85] versicolor  versicolor  versicolor  versicolor  versicolor  versicolor
[91] versicolor  versicolor  versicolor  versicolor  versicolor  versicolor
[97] versicolor  versicolor  versicolor
Levels: setosa versicolor virginica
> pred=predict(model,test)
> table(pred)
pred
  setosa versicolor virginica
    0        50        0
> table(test$Species)

  setosa versicolor virginica
    0        0        50
> table(train$Species)

  setosa versicolor virginica
    50        50        0
> #shuffle iris file
> irl = ir[sample(nrow(ir)),]
> View(irl)

```

	Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
60	5.2	2.7	3.9	1.4	versicolor
63	6.0	2.2	4.0	1.0	versicolor
27	5.0	3.4	1.6	0.4	setosa
61	5.0	2.0	3.5	1.0	versicolor
90	5.5	2.5	4.0	1.3	versicolor
38	4.9	3.6	1.4	0.1	setosa
105	6.5	3.0	5.8	2.2	virginica
28	5.2	3.5	1.5	0.2	setosa
47	5.1	3.8	1.6	0.2	setosa
59	6.6	2.9	4.6	1.3	versicolor
35	4.9	3.1	1.5	0.2	setosa
125	7.0	3.0	5.6	2.2	virginica

Showing 1 to 12 of 150 entries, 5 total columns

```
> train = irl[1:100,]
> test = irl[101:150,]
> model = naiveBayes(Species~., data = train)
> pred = predict(model, test)
> table(pred)

pred
  setosa versicolor virginica
    17       19        14

> table(train$Species)

Species
  setosa versicolor virginica
    50       50        50

> table(test$Species)

Species
  setosa versicolor virginica
    17       19        14
```

KNN.R

```
> install.packages("class")
```

Restarting R session...

```
> install.packages("class")
```

WARNING: Rtools is required to build R packages but is not currently installed. Please download and install the appropriate version of Rtools before proceeding:

```
https://cran.rstudio.com/bin/windows/Rtools/
```

```
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/class_7.3-23.zip'
Content type 'application/zip' length 100235 bytes (97 KB)
downloaded 97 KB
```

```
package 'class' successfully unpacked and MD5 sums checked
```

The downloaded binary packages are in

```
C:\Users\MCA2511\AppData\Local\Temp\RtmpuSPdoP\downloaded_packages
```

```
> library(class)
```

```
> table(iris$Species)
```

	setosa	versicolor	virginica
50	50	50	

```
> str(iris$Species)
```

```
Factor w/ 3 levels "setosa", "versicolor", ... : 1 1 1 1 1 1 1 1 1 1 ...
```

```
> head(iris)
```

	Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
1	5.1	3.5	1.4	0.2	setosa
2	4.9	3.0	1.4	0.2	setosa
3	4.7	3.2	1.3	0.2	setosa
4	4.6	3.1	1.5	0.2	setosa
5	5.0	3.6	1.4	0.2	setosa
6	5.4	3.9	1.7	0.4	setosa

```
> ir = iris
```

```
> train = ir[1:100,]
```

```
> irl = ir[sample(nrow(ir)),]
```

```
> head(irl)
```

	Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
33	5.2	4.1	1.5	0.1	setosa
46	4.8	3.0	1.4	0.3	setosa
54	5.5	2.3	4.0	1.3	versicolor
13	4.8	3.0	1.4	0.1	setosa
73	6.3	2.5	4.9	1.5	versicolor
27	5.0	3.4	1.6	0.4	setosa

```
> normalize <- function(x) {
+   return((x-min(x)/(max(x)-min(x))))
+ }
```

```
> iris_n <- as.data.frame(lapply(irl[,c(1,2,3,4)],normalize))
```

```

> str(iris_n)
'data.frame': 150 obs. of 4 variables:
 $ Sepal.Length: num 4.01 3.61 4.31 3.61 5.11 ...
 $ Sepal.Width : num 3.27 2.17 1.47 2.17 1.67 ...
 $ Petal.Length: num 1.33 1.23 3.83 1.23 4.73 ...
 $ Petal.Width : num 0.0583 0.2583 1.2583 0.0583 1.4583 ...
> iris_train <- iris_n[1:129,]
> iris_test <- iris_n[130:150,]
> iris_train_target <- iris[1:129,5]
> iris_test_target <- iris[130:150,5]
> iris_train_target
 [1] setosa    setosa    setosa    setosa    setosa    setosa
 [7] setosa    setosa    setosa    setosa    setosa    setosa
[13] setosa    setosa    setosa    setosa    setosa    setosa
[19] setosa    setosa    setosa    setosa    setosa    setosa
[25] setosa    setosa    setosa    setosa    setosa    setosa
[31] setosa    setosa    setosa    setosa    setosa    setosa
[37] setosa    setosa    setosa    setosa    setosa    setosa
[43] setosa    setosa    setosa    setosa    setosa    setosa
[49] setosa    setosa    versicolor versicolor versicolor versicolor
[55] versicolor versicolor versicolor versicolor versicolor versicolor
[61] versicolor versicolor versicolor versicolor versicolor versicolor
[67] versicolor versicolor versicolor versicolor versicolor versicolor
[73] versicolor versicolor versicolor versicolor versicolor versicolor
[79] versicolor versicolor versicolor versicolor versicolor versicolor
[85] versicolor versicolor versicolor versicolor versicolor versicolor
[91] versicolor versicolor versicolor versicolor versicolor versicolor
[97] versicolor versicolor versicolor versicolor virginica virginica
[103] virginica virginica virginica virginica virginica virginica
[109] virginica virginica virginica virginica virginica virginica
[115] virginica virginica virginica virginica virginica virginica
[121] virginica virginica virginica virginica virginica virginica
[127] virginica virginica virginica
Levels: setosa versicolor virginica
> dim(iris_train)
[1] 129 4
> dim(iris_test)
[1] 21 4
> model <- knn(iris_train, iris_test, cl=iris_train_target, k=13)
> model
 [1] setosa    setosa    versicolor versicolor setosa    setosa
 [7] versicolor setosa    setosa    setosa    versicolor versicolor
[13] versicolor setosa    versicolor versicolor versicolor setosa
[19] versicolor setosa    versicolor
Levels: setosa versicolor virginica
> table(iris_test_target,model)
            model
iris_test_target setosa versicolor virginica
  setosa          0      0      0
  versicolor      0      0      0
  virginica      10     11      0

```

ID3.R

```
> install.packages("class")
```

Restarting R session...

```
> install.packages("class")
```

WARNING: Rtools is required to build R packages but is not currently installed. Please download and install the appropriate version of Rtools before proceeding:

```
https://cran.rstudio.com/bin/windows/Rtools/
```

```
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/class_7.3-23.zip'
Content type 'application/zip' length 100235 bytes (97 KB)
downloaded 97 KB
```

```
package 'class' successfully unpacked and MD5 sums checked
```

The downloaded binary packages are in

```
C:\Users\MCA2511\AppData\Local\Temp\RtmpuSPdoP\downloaded_packages
```

```
> library(class)
> table(iris$Species)
```

	setosa	versicolor	virginica
50	50	50	

```
> str(iris$Species)
```

```
Factor w/ 3 levels "setosa","versicolor",... : 1 1 1 1 1 1 1 1 1 ...
```

```
> head(iris)
```

	Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
1	5.1	3.5	1.4	0.2	setosa
2	4.9	3.0	1.4	0.2	setosa
3	4.7	3.2	1.3	0.2	setosa
4	4.6	3.1	1.5	0.2	setosa
5	5.0	3.6	1.4	0.2	setosa
6	5.4	3.9	1.7	0.4	setosa

```
> ir = iris
```

```
> train = ir[1:100,]
```

```
> irl = ir[sample(nrow(ir)),]
```

```
> head(irl)
```

	Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
33	5.2	4.1	1.5	0.1	setosa
46	4.8	3.0	1.4	0.3	setosa
54	5.5	2.3	4.0	1.3	versicolor
13	4.8	3.0	1.4	0.1	setosa
73	6.3	2.5	4.9	1.5	versicolor
27	5.0	3.4	1.6	0.4	setosa

```
> normalize <- function(x) {
+   return((x-min(x)/(max(x)-min(x))))}
```

```

+ }
> iris_n <- as.data.frame.(lapply(irl[,c(1,2,3,4)],normalize))

Error in as.data.frame.(lapply(irl[, c(1, 2, 3, 4)], normalize)) :
  could not find function "as.data.frame."

> iris_n <- as.data.frame.(lapply(irl[,c(1,2,3,4)],normalize))

Error in as.data.frame.(lapply(irl[, c(1, 2, 3, 4)], normalize)) :
  could not find function "as.data.frame."

> iris_n <- as.data.frame(lapply(irl[,c(1,2,3,4)],normalize))
> str(iris_n)
'data.frame':   150 obs. of  4 variables:
 $ Sepal.Length: num  4.01 3.61 4.31 3.61 5.11 ...
 $ Sepal.Width : num  3.27 2.17 1.47 2.17 1.67 ...
 $ Petal.Length: num  1.33 1.23 3.83 1.23 4.73 ...
 $ Petal.Width : num  0.0583 0.2583 1.2583 0.0583 1.4583 ...
> iris_train <- iris_n[1:129,]
> iris_test <- iris_n[130:150,]
> iris_train_target <- iris[1:129,5]
> iris_test_target <- iris[130:150,5]
> iris_train_target
 [1] setosa    setosa    setosa    setosa    setosa    setosa
 [7] setosa    setosa    setosa    setosa    setosa    setosa
[13] setosa    setosa    setosa    setosa    setosa    setosa
[19] setosa    setosa    setosa    setosa    setosa    setosa
[25] setosa    setosa    setosa    setosa    setosa    setosa
[31] setosa    setosa    setosa    setosa    setosa    setosa
[37] setosa    setosa    setosa    setosa    setosa    setosa
[43] setosa    setosa    setosa    setosa    setosa    setosa
[49] setosa    setosa    versicolor versicolor versicolor versicolor
[55] versicolor versicolor versicolor versicolor versicolor versicolor
[61] versicolor versicolor versicolor versicolor versicolor versicolor
[67] versicolor versicolor versicolor versicolor versicolor versicolor
[73] versicolor versicolor versicolor versicolor versicolor versicolor
[79] versicolor versicolor versicolor versicolor versicolor versicolor
[85] versicolor versicolor versicolor versicolor versicolor versicolor
[91] versicolor versicolor versicolor versicolor versicolor versicolor
[97] versicolor versicolor versicolor versicolor virginica  virginica
[103] virginica  virginica  virginica  virginica  virginica  virginica
[109] virginica  virginica  virginica  virginica  virginica  virginica
[115] virginica  virginica  virginica  virginica  virginica  virginica
[121] virginica  virginica  virginica  virginica  virginica  virginica
[127] virginica  virginica  virginica
Levels: setosa versicolor virginica
> dim(iris_train)
[1] 129    4
> dim(iris_test)

```

```
[1] 21 4
> model <- knn(iris_train, iris_test, cl=iris_train_target, k=13)
> model
[1] setosa      setosa      versicolor versicolor setosa      setosa
[7] versicolor setosa      setosa      setosa      versicolor versicolor
[13] versicolor setosa      versicolor versicolor versicolor setosa
[19] versicolor setosa      versicolor
Levels: setosa versicolor virginica
> table(iris_test_target,model)
            model
iris_test_target setosa versicolor virginica
    setosa          0        0        0
    versicolor      0        0        0
    virginica       10       11        0
> #Install and load required packages
> install.packages("rpart")
```

WARNING: Rtools is required to build R packages but is not currently installed. Please download and install the appropriate version of Rtools before proceeding:

```
https://cran.rstudio.com/bin/windows/Rtools/
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/rpart_4.1.24.zip'
Content type 'application/zip' length 716753 bytes (699 KB)
downloaded 699 KB

package 'rpart' successfully unpacked and MD5 sums checked
```

The downloaded binary packages are in
C:\Users\MCA2511\AppData\Local\Temp\RtmpuSPdoP\downloaded_packages
> install.packages("rpart.plot")

WARNING: Rtools is required to build R packages but is not currently installed. Please download and install the appropriate version of Rtools before proceeding:

```
https://cran.rstudio.com/bin/windows/Rtools/
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/rpart.plot_3.1.3.zip'
Content type 'application/zip' length 1039550 bytes (1015 KB)
downloaded 1015 KB

package 'rpart.plot' successfully unpacked and MD5 sums checked
```

The downloaded binary packages are in
C:\Users\MCA2511\AppData\Local\Temp\RtmpuSPdoP\downloaded_packages
> library(rpart)
> library(rpart.plot)

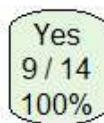
```

> #Create a sample dataset
> data <- data.frame(
+   Outlook = c("Sunny", "Sunny", "Overcast", "Rain", "Rain", "Rain", "Overcast",
+   +
+   "Sunny", "Sunny", "Rain", "Sunny", "Overcast", "Overcast", "Rain"),
+   Temperature = c("Hot", "Hot", "Hot", "Mild", "Cool", "Cool", "Cool",
+   +
+   "Mild", "Cool", "Mild", "Mild", "Mild", "Hot", "Mild"),
+   Humidity = c("High", "High", "High", "High", "Normal", "Normal", "Normal",
+   +
+   "High", "Normal", "Normal", "Normal", "High", "Normal", "High"),
+   Wind = c("Weak", "Strong", "Weak", "Weak", "Weak", "Strong", "Strong",
+   +
+   "Weak", "Weak", "Strong", "Strong", "Weak", "Strong"),
+   PlayTennis = c("No", "No", "Yes", "Yes", "Yes", "No", "Yes",
+   +
+   "No", "Yes", "Yes", "Yes", "Yes", "Yes", "No")
+ )
> #Build ID3 Decision Tree
> model <- rpart(PlayTennis ~ Outlook + Temperature + Humidity + Wind,
+   +
+   data = data,
+   +
+   method = "class",
+   +
+   parms = list(split = "information")) #ID3 uses information
gain
> #Display model Summary
> print(model)
n= 14

node), split, n, loss, yval, (yprob)
* denotes terminal node

1) root 14 5 Yes (0.3571429 0.6428571) *
> #Plot decision tree
> rpart.plot(model, type = 3, extra = 102, fallen.leaves = TRUE)

```



C4.5.R

```
> #Install and load required packages
> install.packages("RWeka")
```

WARNING: Rtools is required to build R packages but is not currently installed. Please download and install the appropriate version of Rtools before proceeding:

<https://cran.rstudio.com/bin/windows/Rtools/>

also installing the dependency 'RWekajars'

```
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/RWekajars_3.9.3-2.zip'
trying URL
'https://cran.rstudio.com/bin/windows/contrib/4.5/RWeka_0.4-46.zip'
package 'RWekajars' successfully unpacked and MD5 sums checked
package 'RWeka' successfully unpacked and MD5 sums checked
```

The downloaded binary packages are in

```
C:\Users\MCA2511\AppData\Local\Temp\Rtmpiu3tLx\downloaded_packages
> library(RWeka)
> #Step 1: Create a sample dataset
> data <- data.frame(
+   Outlook = c("Sunny", "Sunny", "Overcast", "Rain", "Rain", "Rain", "Overcast",
+   "Sunny", "Sunny", "Rain", "Sunny", "Overcast", "Rain"),
+   Temperature = c("Hot", "Hot", "Hot", "Mild", "Cool", "Cool",
+   "Mild", "Cool", "Mild", "Mild", "Mild", "Hot", "Mild"),
+   Humidity = c("High", "High", "High", "High", "Normal", "Normal",
+   "Normal", "Normal", "Normal", "Normal", "High", "Normal", "High"),
+   Wind = c("Weak", "Strong", "Weak", "Weak", "Weak", "Strong", "Strong",
+   "Weak", "Weak", "Weak", "Strong", "Strong", "Weak", "Strong"),
+   PlayTennis = c("No", "No", "Yes", "Yes", "Yes", "No", "Yes",
+   "No", "Yes", "Yes", "Yes", "Yes", "Yes", "No"))
+
> #Step 2: Convert all String columns to factors
> data[] <- lapply(data, as.factor)

> #Step 3: Train c4.5 model(j48)
> model <- J48(PlayTennis ~ Outlook + Temperature + Humidity + Wind, data =
data)
> #Step 4: View model Summary
> summary(model)

==== Summary ====
```

Incorrectly Classified Instances	0	0	%
Kappa statistic	1		
Mean absolute error	0		
Root mean squared error	0		
Relative absolute error	0	0	%
Root relative squared error	0	0	%
Total Number of Instances	14		

==== Confusion Matrix ===

```
a b    <-- classified as
5 0 | a = No
0 9 | b = Yes
> install.packages("partykit")
```

WARNING: Rtools is required to build R packages but is not currently installed. Please download and install the appropriate version of Rtools before proceeding:

<https://cran.rstudio.com/bin/windows/Rtools/>

also installing the dependencies 'libcoin', 'mvtnorm', 'inum'
 trying URL
['https://cran.rstudio.com/bin/windows/contrib/4.5/libcoin_1.0-10.zip'](https://cran.rstudio.com/bin/windows/contrib/4.5/libcoin_1.0-10.zip)
 trying URL
['https://cran.rstudio.com/bin/windows/contrib/4.5/mvtnorm_1.3-3.zip'](https://cran.rstudio.com/bin/windows/contrib/4.5/mvtnorm_1.3-3.zip)
 trying URL
['https://cran.rstudio.com/bin/windows/contrib/4.5/inum_1.0-5.zip'](https://cran.rstudio.com/bin/windows/contrib/4.5/inum_1.0-5.zip)
 trying URL
['https://cran.rstudio.com/bin/windows/contrib/4.5/partykit_1.2-24.zip'](https://cran.rstudio.com/bin/windows/contrib/4.5/partykit_1.2-24.zip)
 package 'libcoin' successfully unpacked and MD5 sums checked
 package 'mvtnorm' successfully unpacked and MD5 sums checked
 package 'inum' successfully unpacked and MD5 sums checked
 package 'partykit' successfully unpacked and MD5 sums checked

The downloaded binary packages are in
 C:\Users\MCA2511\AppData\Local\Temp\Rtmpiu3tLx\downloaded_packages
> library(partykit)

```
Loading required package: grid
Loading required package: libcoin
Loading required package: mvtnorm
```

```
> plot(as.party(model))
```

