In [ ]:
```
This document shows the Julia programming language code for the following medical data
```

In [ ]:
```
Tinnitus data classification prediction accuracy results comparison on the testing dat
```

In [1]:
```
import Pkg; Pkg.add("DataFrames")
import Pkg; Pkg.add("CSV")
using CSV, DataFrames, Plots
```

```
    Updating registry at `C:\Users\zizhe\.julia\registries\General.toml`
   Resolving package versions...
   Installed OpenJpeg_jll ─── v2.4.0+0
   Installed ImageMagick_jll − v6.9.12+4
   Installed LittleCMS_jll ── v2.12.0+0
  No Changes to `C:\Users\zizhe\.julia\environments\v1.7\Project.toml`
    Updating `C:\Users\zizhe\.julia\environments\v1.7\Manifest.toml`
  [c73af94c] ↑ ImageMagick_jll v6.9.12+3 ⇒ v6.9.12+4
  [d3a379c0] + LittleCMS_jll v2.12.0+0
  [643b3616] + OpenJpeg_jll v2.4.0+0
Precompiling project...
  ✓ LittleCMS_jll
  ✓ OpenJpeg_jll
  ✓ ImageMagick_jll
  ✓ ImageMagick
  ✓ Images
  5 dependencies successfully precompiled in 27 seconds (370 already precompiled)
   Resolving package versions...
  No Changes to `C:\Users\zizhe\.julia\environments\v1.7\Project.toml`
  No Changes to `C:\Users\zizhe\.julia\environments\v1.7\Manifest.toml`
```

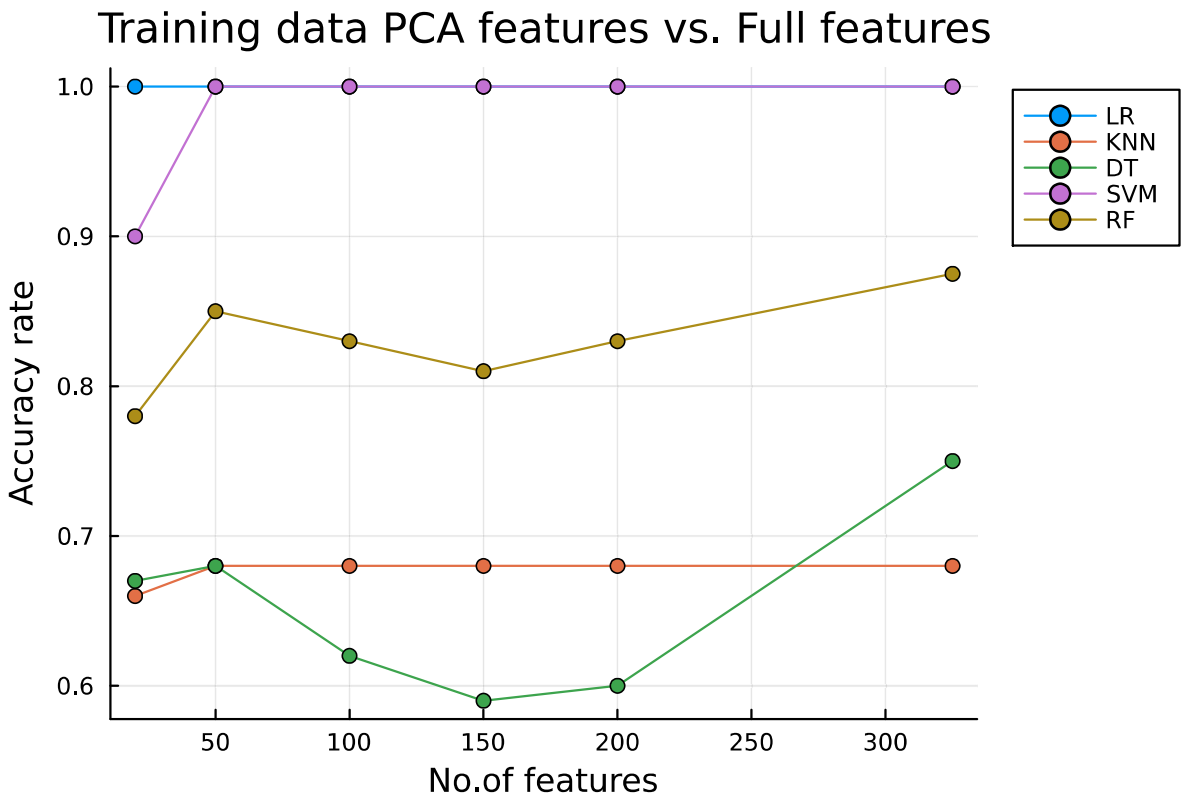
In [2]:
```
# load the PCA training data result
trPCA = CSV.read("C:/Users/Leo/Downloads/Training data PCA result in csv.csv", header=
```

Out[2]: 6 rows × 7 columns

	Connectivity Features	Number of Features	LR	KNN	DT	SVM	RF
	String	Int64	Int64	Float64	Float64	Float64	Float64
1	Full features	325	1	0.68	0.75	1.0	0.875
2	PCA feature extraction	200	1	0.68	0.6	1.0	0.83
3	PCA feature extraction	150	1	0.68	0.59	1.0	0.81
4	PCA feature extraction	100	1	0.68	0.62	1.0	0.83
5	PCA feature extraction	50	1	0.68	0.68	1.0	0.85
6	PCA feature extraction	20	1	0.66	0.67	0.9	0.78

In [3]:
```
plot(trPCA[:,2],Matrix(trPCA[:,3:7]),xlabel="No.of features",ylabel="Accuracy rate",ma
```

Out[3]:



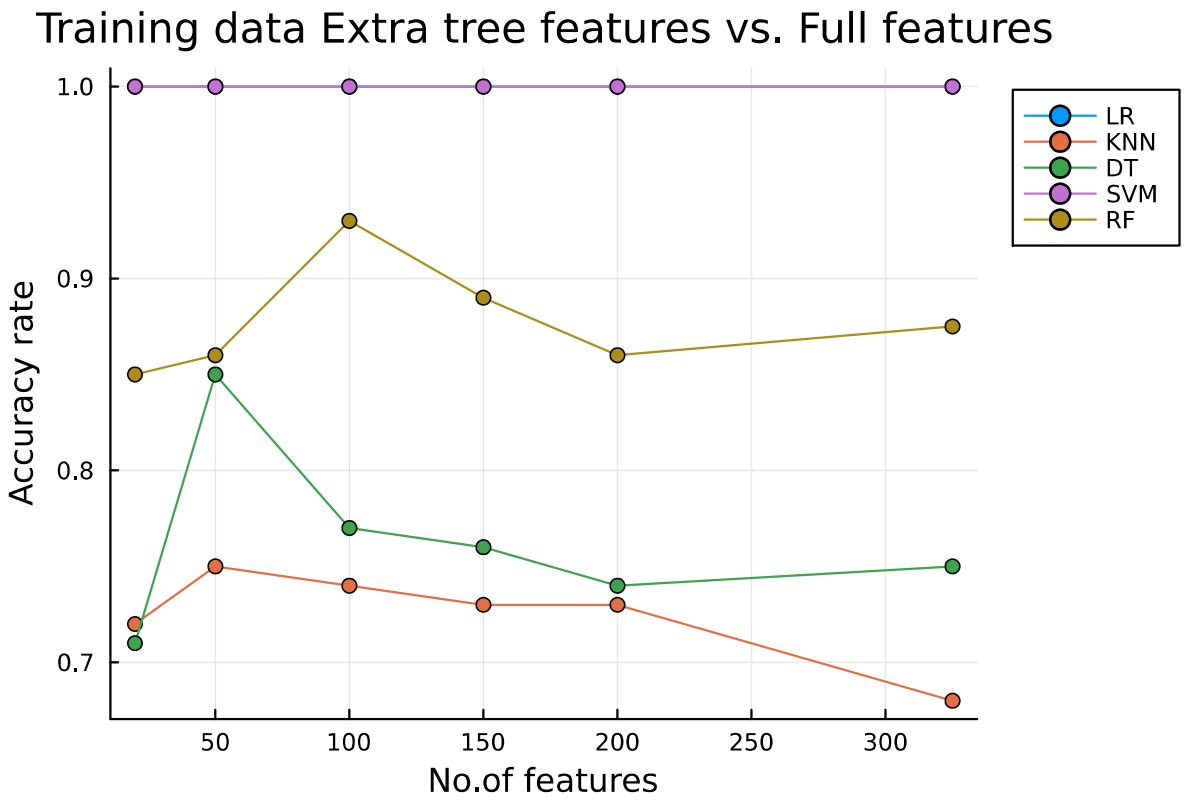
In [4]:
```
# load the extra tree training data result
trET = CSV.read("C:/Users/Leo/Downloads/Training data extra tree result in csv.csv", h
```

Out[4]: 6 rows × 7 columns

	Connectivity Features	Number of Features	LR	KNN	DT	SVM	RF
	String	Int64	Int64	Float64	Float64	Int64	Float64
1	Full features	325	1	0.68	0.75	1	0.875
2	Extra tree top features	200	1	0.73	0.74	1	0.86
3	Extra tree top features	150	1	0.73	0.76	1	0.89
4	Extra tree top features	100	1	0.74	0.77	1	0.93
5	Extra tree top features	50	1	0.75	0.85	1	0.86
6	Extra tree top features	20	1	0.72	0.71	1	0.85

In [5]:
```
plot(trET[:,2],Matrix(trET[:,3:7]),xlabel="No.of features",ylabel="Accuracy rate",mark
```

Out[5]:



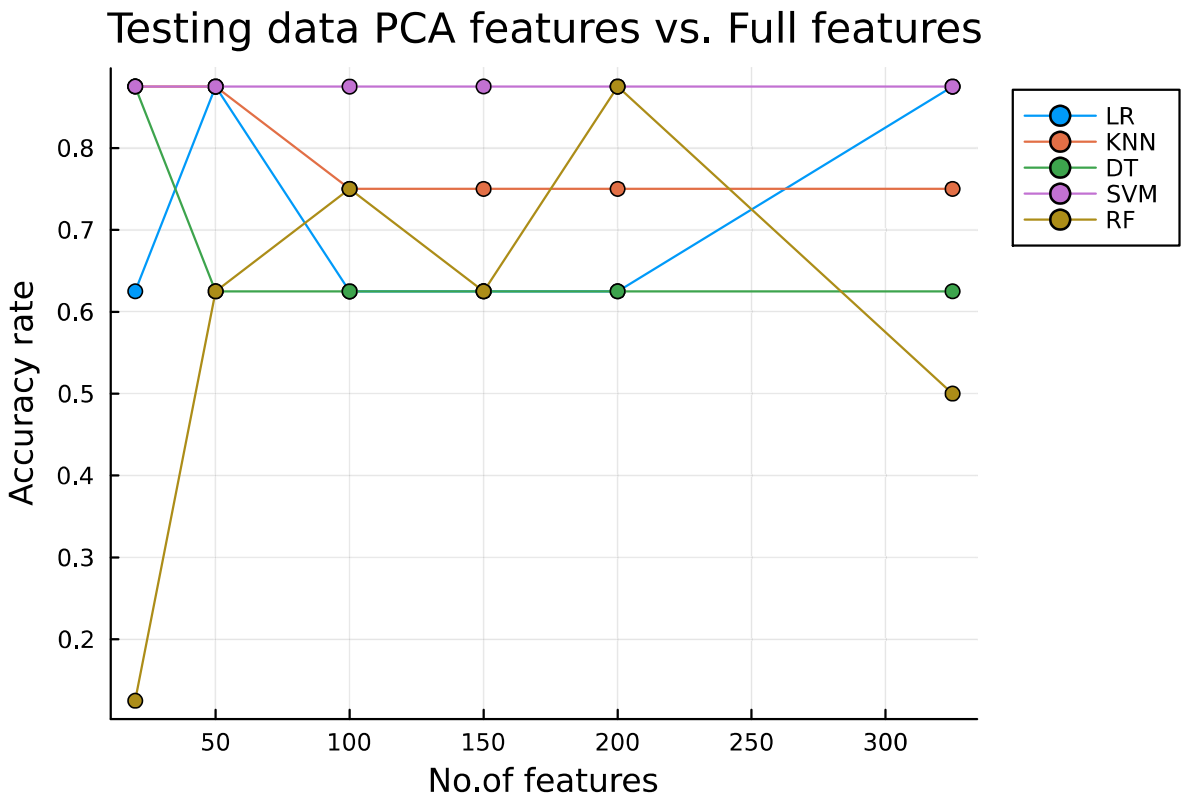
In [6]:
```
# load the PCA testing data result
tePCA  = CSV.read("C:/Users/Leo/Downloads/Testing data PCA result in csv.csv", header=
```

Out[6]: 6 rows × 7 columns (omitted printing of 1 columns)

	Connectivity Features	Number of Features	LR	KNN	DT	SVM
	String	Int64	Float64	Float64	Float64	Float64
1	Full features	325	0.875	0.75	0.625	0.875
2	PCA feature extraction	200	0.625	0.75	0.625	0.875
3	PCA feature extraction	150	0.625	0.75	0.625	0.875
4	PCA feature extraction	100	0.625	0.75	0.625	0.875
5	PCA feature extraction	50	0.875	0.875	0.625	0.875
6	PCA feature extraction	20	0.625	0.875	0.875	0.875

In [7]:
```
plot(tePCA[:,2],Matrix(tePCA[:,3:7]),xlabel="No.of features",ylabel="Accuracy rate",ma
```

Out[7]:



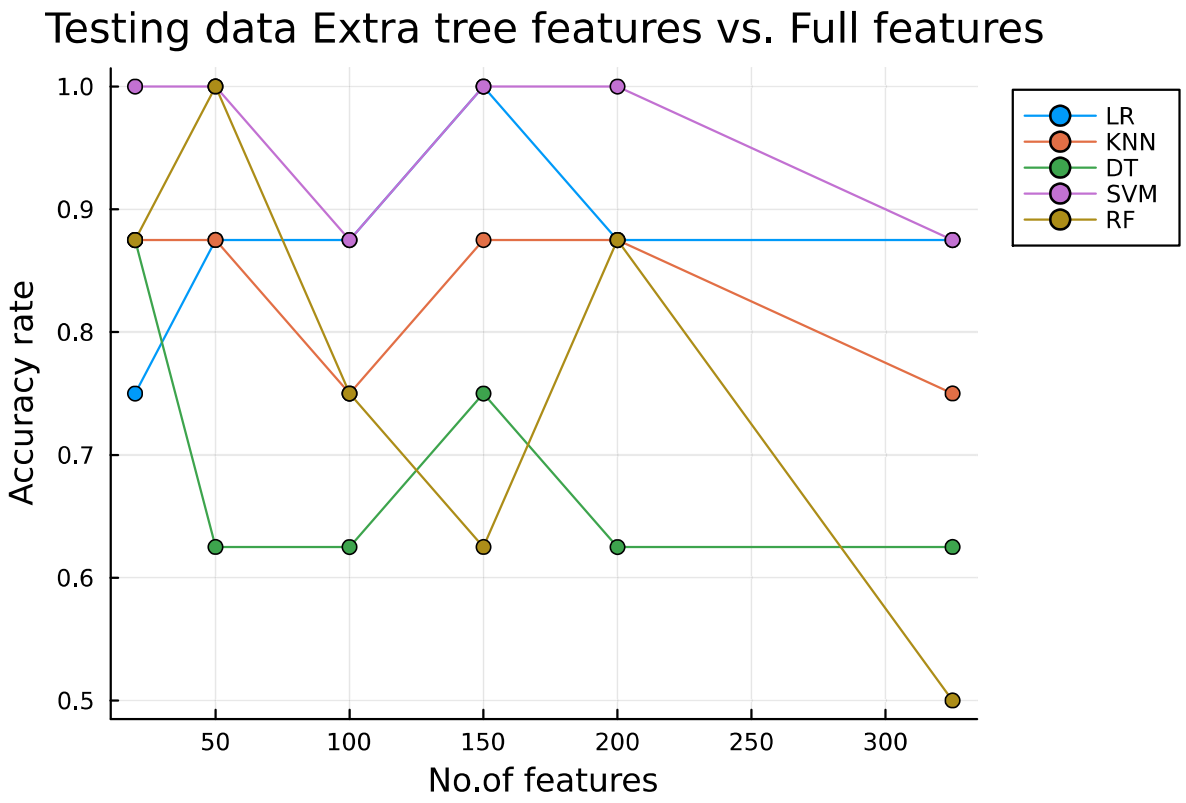
In [8]:
```
# load the extra tree training data result
teET = CSV.read("C:/Users/Leo/Downloads/Testing data extra tree result in csv.csv", he
```

Out[8]: 6 rows × 7 columns (omitted printing of 1 columns)

	Connectivity Features	Number of Features	LR	KNN	DT	SVM
	String	Int64	Float64	Float64	Float64	Float64
1	Full features	325	0.875	0.75	0.625	0.875
2	Extra tree top features	200	0.875	0.875	0.625	1.0
3	Extra tree top features	150	1.0	0.875	0.75	1.0
4	Extra tree top features	100	0.875	0.75	0.625	0.875
5	Extra tree top features	50	0.875	0.875	0.625	1.0
6	Extra tree top features	20	0.75	0.875	0.875	1.0

In [9]:
```
plot(teET[:,2],Matrix(teET[:,3:7]),xlabel="No.of features",ylabel="Accuracy rate",mark
```

Out[9]:



In [ ]:

In [ ]:

In [10]:
```
# load the full testing data result
te = CSV.read("C:/Users/Leo/Downloads/Testing data result in csv.csv", header=true,Dat
```

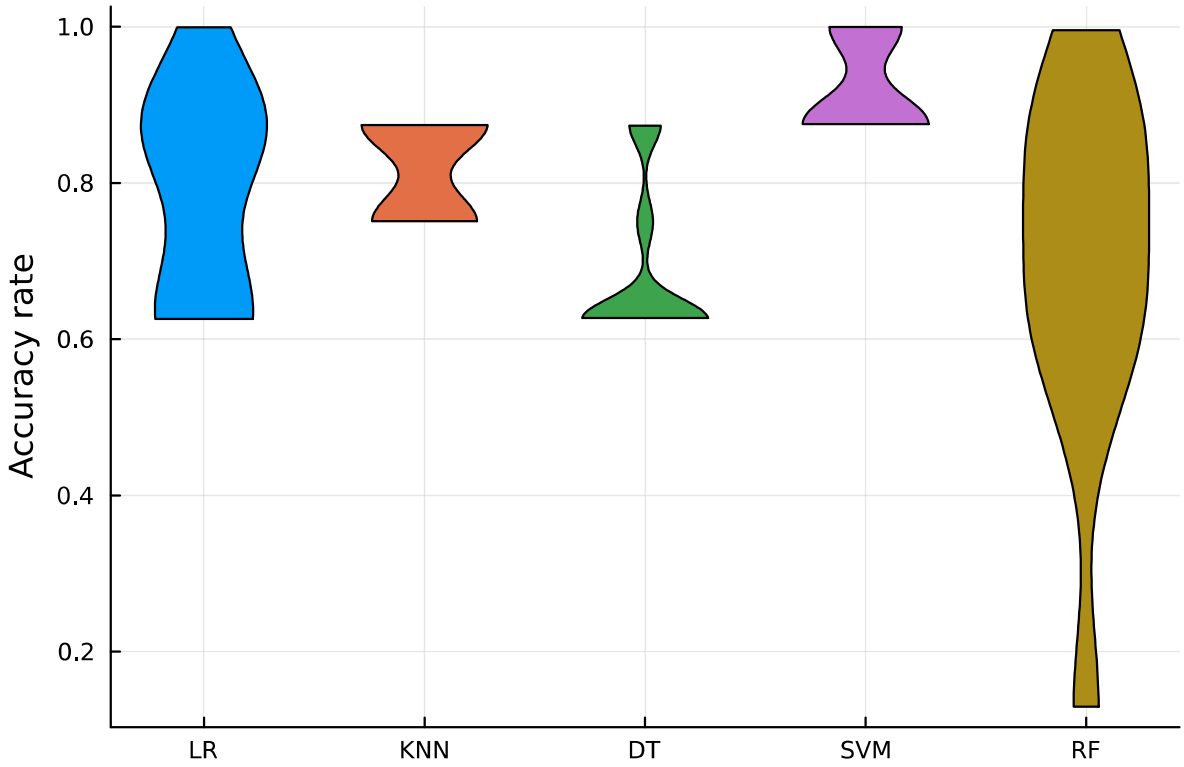
Out[10]: 11 rows × 7 columns (omitted printing of 1 columns)

	Connectivity Features	Number of Features	LR	KNN	DT	SVM
	String	Int64	Float64	Float64	Float64	Float64
1	Full features	325	0.875	0.75	0.625	0.875
2	PCA feature extraction	200	0.625	0.75	0.625	0.875
3	PCA feature extraction	150	0.625	0.75	0.625	0.875
4	PCA feature extraction	100	0.625	0.75	0.625	0.875
5	PCA feature extraction	50	0.875	0.875	0.625	0.875
6	PCA feature extraction	20	0.625	0.875	0.875	0.875
7	Extra tree top features	200	0.875	0.875	0.625	1.0
8	Extra tree top features	150	1.0	0.875	0.75	1.0
9	Extra tree top features	100	0.875	0.75	0.625	0.875
10	Extra tree top features	50	0.875	0.875	0.625	1.0
11	Extra tree top features	20	0.75	0.875	0.875	1.0

In [11]:
```
Pkg.add("StatsPlots"); using StatsPlots
violin(["LR"], te[:,3], label=nothing, ylabel="Accuracy rate")
violin!(["KNN"], te[:,4], label=nothing)
violin!(["DT"], te[:,5], label=nothing)
violin!(["SVM"], te[:,6], label=nothing)
violin!(["RF"], te[:,7], label=nothing)
```

```
  Resolving package versions...
 No Changes to `C:\Users\zizhe\.julia\environments\v1.7\Project.toml`
 No Changes to `C:\Users\zizhe\.julia\environments\v1.7\Manifest.toml`
```

Out[11]:



In [12]:
```
using Statistics
mean(te[:,3]),std(te[:,3])
```

Out[12]:
```
(0.7840909090909091, 0.13796409282523808)
```

In [13]:
```
mean(te[:,4]),std(te[:,4])
```

Out[13]:
```
(0.8181818181818182, 0.06527912098338667)
```

In [14]:
```
mean(te[:,5]),std(te[:,5])
```

Out[14]:
```
(0.6818181818181818, 0.10252494153309054)
```

In [15]:
```
mean(te[:,6]),std(te[:,6])
```

Out[15]:
```
(0.9204545454545454, 0.06306562238868912)
```

In [16]:
```
mean(te[:,7]),std(te[:,7])
```

Out[16]:
```
(0.6931818181818182, 0.239554510782752)
```

In [17]:
```
# as their variance are different, so use UnequalVarianceTTest
import Pkg; Pkg.add("HypothesisTests")
using HypothesisTests

UnequalVarianceTTest(te[:,3], te[:,4])
```

```
   Resolving package versions...
  No Changes to `C:\Users\zizhe\.julia\environments\v1.7\Project.toml`
  No Changes to `C:\Users\zizhe\.julia\environments\v1.7\Manifest.toml`
```

Out[17]:
```
Two sample t-test (unequal variance)
------------------------------------
Population details:
    parameter of interest:   Mean difference
    value under h_0:         0
    point estimate:          -0.0340909
    95% confidence interval: (-0.1326, 0.06444)

Test summary:
    outcome with 95% confidence: fail to reject h_0
    two-sided p-value:           0.4708

Details:
    number of observations:   [11,11]
    t-statistic:              -0.740797197487194
    degrees of freedom:       14.263894781501907
    empirical standard error: 0.04601921984390133
```

In [18]:
```
# statistical test between LR and KNN
MannWhitneyUTest(te[:,3], te[:,4])
```

Out[18]:
```
Approximate Mann-Whitney U test
-------------------------------
Population details:
    parameter of interest:   Location parameter (pseudomedian)
    value under h_0:         0
    point estimate:          0.0

Test summary:
    outcome with 95% confidence: fail to reject h_0
    two-sided p-value:           0.6435

Details:
    number of observations in each group: [11, 11]
    Mann-Whitney-U statistic:             53.5
    rank sums:                            [119.5, 133.5]
    adjustment for ties:                  1590.0
    normal approximation (μ, σ):          (-7.0, 14.0433)
```

In [19]:
```
#above test all got "fail to reject h_0", since the null hyposis is the means of the t
#the result fail to reject h_0" means there is at least 95% confidence that accuracy r
#logistic regression classifier and KNN are statistically identical! Both classifier a
```

In [20]:
```
# statistical test between decision tree and KNN
UnequalVarianceTTest(te[:,4], te[:,5])
```

Out[20]:
```
Two sample t-test (unequal variance)
-----------------------------------
Population details:
    parameter of interest:   Mean difference
    value under h_0:         0
    point estimate:          0.136364
    95% confidence interval: (0.05903, 0.2137)

Test summary:
    outcome with 95% confidence: reject h_0
    two-sided p-value:           0.0017

Details:
    number of observations:   [11,11]
    t-statistic:              3.721042037676257
    degrees of freedom:       16.963613550815555
    empirical standard error: 0.03664662612862977
```

In [21]:
```
MannWhitneyUTest(te[:,4], te[:,5])
```

Out[21]:
```
Approximate Mann-Whitney U test
-------------------------------
Population details:
    parameter of interest:   Location parameter (pseudomedian)
    value under h_0:         0
    point estimate:          0.25

Test summary:
    outcome with 95% confidence: reject h_0
    two-sided p-value:           0.0038

Details:
    number of observations in each group: [11, 11]
    Mann-Whitney-U statistic:             102.5
    rank sums:                            [168.5, 84.5]
    adjustment for ties:                  1218.0
    normal approximation (μ, σ):          (42.0, 14.3295)
```

In [22]:
```
# above test all got "reject h_0", since the null hyposis is the means of the two grou
# the result reject h_0" means there is at least 95% confidence that accuracy rates of
# from the plot, we can see the accuracy rate of KNN is better
```

In [23]:
```
# statistical test between SVM and KNN
UnequalVarianceTTest(te[:,4], te[:,6])
```

Out[23]:
```
Two sample t-test (unequal variance)
-----------------------------------
Population details:
    parameter of interest:   Mean difference
    value under h_0:         0
    point estimate:          -0.102273
    95% confidence interval: (-0.1594, -0.04518)

Test summary:
    outcome with 95% confidence: reject h_0
    two-sided p-value:           0.0013

Details:
    number of observations:   [11,11]
    t-statistic:              -3.7370465934182957
    degrees of freedom:       19.976247030878863
    empirical standard error: 0.027367260406346124
```

In [24]:
```
MannWhitneyUTest(te[:,4], te[:,6])
```

Out[24]:
```
Approximate Mann-Whitney U test
-------------------------------
Population details:
    parameter of interest:   Location parameter (pseudomedian)
    value under h_0:         0
    point estimate:          0.0

Test summary:
    outcome with 95% confidence: reject h_0
    two-sided p-value:           0.0037

Details:
    number of observations in each group: [11, 11]
    Mann-Whitney-U statistic:             21.0
    rank sums:                            [87.0, 166.0]
    adjustment for ties:                  2364.0
    normal approximation (μ, σ):          (-39.5, 13.4284)
```

In [25]:
```
# above test all got "reject h_0", since the null hyposis is the means of the two grou
# the result reject h_0" means there is at least 95% confidence that accuracy rates of
# from the plot, we can see the accuracy rate of SVM is better
```

In [26]:
```
# statistical test between SVM and random forest
UnequalVarianceTTest(te[:,6], te[:,7])
```

Out[26]:
```
Two sample t-test (unequal variance)
-----------------------------------
Population details:
    parameter of interest:   Mean difference
    value under h_0:         0
    point estimate:          0.227273
    95% confidence interval: (0.06355, 0.391)

Test summary:
    outcome with 95% confidence: reject h_0
    two-sided p-value:           0.0108

Details:
    number of observations:   [11,11]
    t-statistic:              3.042903097250921
    degrees of freedom:       11.379512195121952
    empirical standard error: 0.0746894396597954
```

In [27]:
```
MannWhitneyUTest(te[:,6], te[:,7])
```

Out[27]:
```
Approximate Mann-Whitney U test
-------------------------------
Population details:
    parameter of interest:   Location parameter (pseudomedian)
    value under h_0:         0
    point estimate:          0.125

Test summary:
    outcome with 95% confidence: reject h_0
    two-sided p-value:           0.0049

Details:
    number of observations in each group: [11, 11]
    Mann-Whitney-U statistic:             101.5
    rank sums:                            [167.5, 85.5]
    adjustment for ties:                  1140.0
    normal approximation (μ, σ):          (41.0, 14.3887)
```

In [28]:
```
# above test all got "reject h_0", since the null hyposis is the means of the two grou
# the result reject h_0" means there is at least 95% confidence that accuracy rates of
# classifier and random forest are statistically different!
# from the plot, we can see the accuracy rate of SVM is better
```

In [ ]:
```
# After a few T test and MannWhitneyUTest, we can see the accuracy rate of SVM classif
# statistically different from the other classifiers
# from the plot, we can see SVM is the classifier that has the highest prediction accu
```