Practical Application 2

Machine Learning

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November 22, 2022

Problem Description

Dry Bean Dataset:

- 13611 instances
- 16 variables
- 7 classes
- Source

- Area
- Perimeter
- Major axis length
- Minor axis length
- Aspect ratio
- Eccentricity
- Convex area
- Equivalent diameter
- Extent
- Solidity
- Roundness
- Compactness
- ShapeFactor1
- ShapeFactor2
- ShapeFactor3
- ShapeFactor4

- Seker
- Barbunya
- Bombay
- Cali
- Dermosan
- Horoz
- Sira

Methodology

- Software: **Weka**
- Classification algorithms:
  - Logistic Regression
  - Naive Bayes
  - Tree Augmented Naive Bayes
  - Linear Discriminant Analysis
  - Fusion
  - Stacking
  - Bagging
  - Random Forest
  - Boosting
  - Naive Bayes Tree
  - Logistic Model Tress
- Feature Subset Selection
  - No FSS
  - Univariant Filter
  - Multivariant Filter
  - Wrapper Approach

Algorithm	Weka Function
Logistic Regression	functions.Logistic
Naive Bayes	bayes.NaiveBayes
Tree Augmented Naive Bayes	bayes.BayesNet
Linear Discriminant Analysis	functions.LDA
Fusion	meta.Vote
Stacking	meta.Stacking
Bagging	meta.Bagging
Random Forest	trees.RandomForest
Boosting	meta.AdaBoostM1
Naive Bayes Tree	trees.NBTree
Logistic Model Trees	trees.LMT

FSS algorithm	Weka Function
No FSS	-
Univariant Filter	attributeSelection.InfoGainAttributeEval
Multivariant Filter	attributeSelection.CfsSubsetEval
Wrapper Approach	attributeSelection.WrapperSubsetEval

Results

Selected Attributes

Attribute	No FSS	Univariant	Multivariant	Wrapper (Logistic)	Wrapper (Naive Bayes)	Wrapper (TAN)	Wrapper (LDA)	Wrapper (Fusion)	Wrapper (Stacking)	Wrapper (Bagging)	Wrapper (Random Forest)	Wrapper (Boosting)	Wrapper (NBTree)	Wrapper (LMT)
Area		●					●			●	●	●		●
Perimeter	●	●	●	●	●	●	●	●	●	●		●	●	●
MajorAxisLength	●	●	●	●					●		●			●
MinorAxisLength	●	●	●	●		●		●					●	
AspectRatio	●		●			●			●					
Eccentricity	●								●					
ConvexArea	●	●	●	●			●		●					●
EquivDiameter	●	●		●					●					●
Extent	●		●	●		●	●	●	●	●	●	●		
Solidity	●			●				●		●	●		●	●
Roundness	●		●	●	●	●		●	●	●	●		●	●
Compactness	●		●		●	●	●	●		●	●		●	
ShapeFactor1	●	●	●	●	●	●				●	●			
ShapeFactor2	●	●	●	●					●	●				●
ShapeFactor3	●										●	●		
ShapeFactor4	●		●	●	●	●	●	●	●	●	●		●	●
N attributes	16	8	11	11	5	8	6	7	10	9	9	4	6	9

Results

Classifier scores

Dataset	Logistic	Naive Bayes	TAN	LDA	Fusion	Stacking	Bagging	Random Forest	Boosting	NBTree	LMT
Original	92.60	89.71	91.47	90.18	91.26	91.28	89.72	92.52	89.71	89.57	92.49
Uni. Filter	92.14	84.09	89.90	89.22	90.00	90.29	84.03	91.04	84.09	87.67	91.94
Mult. Filter	92.57	90.20	91.24	90.05	91.58	91.74	90.31	92.47	90.20	90.63	92.41
Wr. (Logistic)	92.70	89.01	91.47	90.03	91.47	91.53	89.08	92.53	89.01	89.66	89.01
Wr. (N. Bayes)	92.09	91.23	91.54	89.84	89.01	91.77	91.21	92.16	91.23	91.55	92.16
Wr. (TAN)	92.36	90.76	91.60	89.83	91.72	91.62	90.80	92.33	90.76	90.69	92.27
Wr. (LDA)	92.30	88.23	90.42	91.17	91.35	91.56	88.34	91.74	88.23	89.57	92.35
Wr. (Fusion)	92.39	91.05	91.29	90.58	91.91	91.24	91.05	92.68	91.05	90.88	92.44
Wr. (Stacking)	92.55	89.42	91.66	89.86	91.38	92.20	89.45	92.46	89.42	89.97	92.41
Wr. (Bagging)	92.53	90.77	91.44	89.45	91.58	91.78	90.75	92.70	90.77	90.90	92.54
Wr. (R. Forest)	92.38	90.66	91.27	89.72	91.58	91.53	90.65	92.84	90.66	90.33	92.56
Wr. (Boosting)	91.12	80.83	89.60	88.85	89.39	89.69	80.89	91.11	80.83	89.48	91.42
Wr. (NBTree)	92.21	91.22	91.24	90.56	91.89	91.17	91.22	92.46	91.22	91.27	92.27
Wr. (LMT)	92.45	84.75	91.02	90.32	91.22	91.30	84.80	92.28	84.75	89.82	92.52

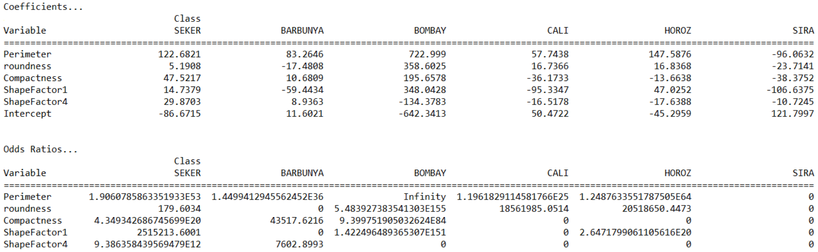
Results

Training time

Dataset	Logistic	Naive Bayes	TAN	LDA	Fusion	Stacking	Bagging	Random Forest	Boosting	NBTree	LMT
Original	57.5	0.02	0.14	0.02	0.17	1.67	0.19	3.99	1.17	11.51	14.38
Uni. Filter	2.39	0.01	0.06	0.01	0.07	0.7	0.09	3.1	0.61	5.83	10.58
Mult. Filter	3.89	0.01	0.09	0.01	0.11	1.06	0.15	3.18	0.84	7.17	11.41
Wr. (Logistic)	5.81	0.01	0.09	0.01	0.11	1.06	0.13	3.21	1.14	10.54	12.27
Wr. (N. Bayes)	1.37	0.01	0.03	0.01	0.04	0.45	0.08	2.38	0.46	1.92	8.39
Wr. (TAN)	2.18	0.01	0.06	0.01	0.07	0.74	0.1	3.14	0.51	6.52	9.58
Wr. (LDA)	1.99	0.01	0.04	0.01	0.07	0.53	0.08	2.48	0.39	2.9	13
Wr. (Fusion)	1.97	0.01	0.05	0.01	0.06	0.63	0.09	2.46	0.58	5.23	9.86
Wr. (Stacking)	2.69	0.01	0.07	0.01	0.09	0.92	0.12	3.21	0.99	8.71	10.74
Wr. (Bagging)	2.44	0.01	0.07	0.01	0.09	0.82	0.12	3.17	0.67	5.63	10.57
Wr. (R. Forest)	2.51	0.01	0.07	0.01	0.09	0.82	0.11	3.21	0.87	8.61	10.33
Wr. (Boosting)	0.97	0.01	0.03	0.01	0.03	0.36	0.06	2.18	0.46	1.43	8.26
Wr. (NBTree)	0.96	0.01	0.04	0.01	0.06	0.53	0.09	2.44	0.45	3.96	9.05
Wr. (LMT)	7.95	0.01	0.06	0.01	0.08	0.83	0.11	3.28	0.56	8.26	16.41

Results

Logistic Regression



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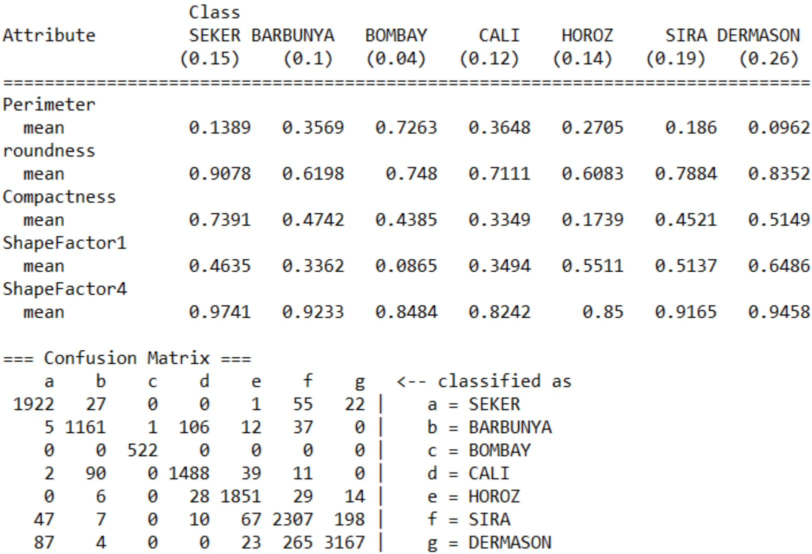
Coefficients...
                                Class
Variable                        SEKER               BARBUNYA                 BOMBAY                   CALI                  HOROZ                   SIRA
========================================================================================================================================================
Perimeter                    122.6821                83.2646                722.999                57.7438               147.5876               -96.0632
roundness                      5.1908               -17.4808               358.6025                16.7366                16.8368               -23.7141
Compactness                   47.5217                10.6809               195.6578               -36.1733               -13.6638               -38.3752
ShapeFactor1                  14.7379               -59.4434               348.0428               -95.3347                47.0252              -106.6375
ShapeFactor4                  29.8703                 8.9363              -134.3783               -16.5178               -17.6388               -10.7245
Intercept                    -86.6715                11.6021              -642.3413                50.4722               -45.2959               121.7997


Odds Ratios...
                                Class
Variable                        SEKER               BARBUNYA                 BOMBAY                   CALI                  HOROZ                   SIRA
========================================================================================================================================================
Perimeter       1.9060785863351933E53  1.4499412945562452E36               Infinity  1.1961829114581766E25  1.2487633551787505E64                      0
roundness                    179.6034                      0  5.483927383541303E155          18561985.0514          20518650.4473                      0
Compactness      4.349342686745699E20             43517.6216   9.399751905032624E84                      0                      0                      0
ShapeFactor1             2515213.6001                      0  1.422496489365307E151                      0  2.6471799061105616E20                      0
ShapeFactor4     9.386358439569479E12              7602.8993                      0                      0                      0                      0
```

Results

Naive Bayes

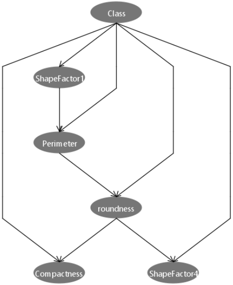


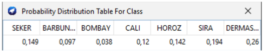
```
                  Class
Attribute         SEKER BARBUNYA   BOMBAY     CALI    HOROZ     SIRA DERMASON
                 (0.15)    (0.1)   (0.04)   (0.12)   (0.14)   (0.19)   (0.26)
===============================================================================
Perimeter
  mean            0.1389   0.3569   0.7263   0.3648   0.2705    0.186   0.0962
roundness
  mean            0.9078   0.6198    0.748   0.7111   0.6083   0.7884   0.8352
Compactness
  mean            0.7391   0.4742   0.4385   0.3349   0.1739   0.4521   0.5149
ShapeFactor1
  mean            0.4635   0.3362   0.0865   0.3494   0.5511   0.5137   0.6486
ShapeFactor4
  mean            0.9741   0.9233   0.8484   0.8242     0.85   0.9165   0.9458

=== Confusion Matrix ===
    a    b    c    d    e    f    g   <-- classified as
 1922   27    0    0    1   55   22 |    a = SEKER
    5 1161    1  106   12   37    0 |    b = BARBUNYA
    0    0  522    0    0    0    0 |    c = BOMBAY
    2   90    0 1488   39   11    0 |    d = CALI
    0    6    0   28 1851   29   14 |    e = HOROZ
   47    7    0   10   67 2307  198 |    f = SIRA
   87    4    0    0   23  265 3167 |    g = DERMASON
```

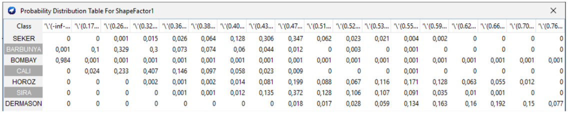
Results

Tree Augmented Naive Bayes




Probability Distribution Table For Class

SEKER	BARBUN...	BOMBAY	CALI	HOROZ	SIRA	DERMAS...
0,149	0,097	0,038	0,12	0,142	0,194	0,26


Probability Distribution Table For ShapeFactor1

Class	'\'(-inf-...	'\'(0.17...	'\'(0.26...	'\'(0.32...	'\'(0.36...	'\'(0.38...	'\'(0.40...	'\'(0.43...	'\'(0.47...	'\'(0.51...	'\'(0.52...	'\'(0.53...	'\'(0.55...	'\'(0.59...	'\'(0.62...	'\'(0.66...	'\'(0.70...	'\'(0.76...
SEKER	0	0	0,001	0,015	0,026	0,064	0,128	0,306	0,347	0,062	0,023	0,021	0,004	0,002	0	0	0	0
BARBUNYA	0,001	0,1	0,329	0,3	0,073	0,074	0,06	0,044	0,012	0	0,003	0	0,001	0	0	0	0	0
BOMBAY	0,984	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001
CALI	0	0,024	0,233	0,407	0,146	0,097	0,058	0,023	0,009	0	0	0	0,001	0	0	0	0	0
HOROZ	0	0	0	0,002	0,001	0,002	0,014	0,081	0,199	0,088	0,067	0,116	0,171	0,128	0,063	0,055	0,012	0
SIRA	0	0	0	0	0,001	0,001	0,012	0,135	0,372	0,128	0,106	0,107	0,091	0,035	0,01	0,001	0	0
DERMASON	0	0	0	0	0	0	0	0	0,018	0,017	0,028	0,059	0,134	0,163	0,16	0,192	0,15	0,077

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