



دانشگاه خوارزمی

دانشکده فنی و مهندسی

گزارش پروژه

نام و نام خانوادگی: آرمین صبورمقدم

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تاریخ: 24 بهمن ماه 1400

خلاصه مقاله در قالب دستنویس :

پایانرز دکتر لاهیانی

deciding factors for prediction : { ① family attributes
② academic attributes

مثال داده - 27

توسط نشر اطلاعات

کلاس‌های 21 فیلتر : رکورد 1227 { ① جمع نسی ③ اعتبار ④ فیلتر
② خانواده ④ آکادمیک

7 کلاس نمره شامل : $(A^+, A, B^+, B, C, D, F)$

bagging: use to sort the tuple randomly into different bags

while developing model $\xrightarrow[\text{as}]{\text{known}}$ bootstrap aggregation

all model bagging built in parallel $\xrightarrow{\text{for decision}}$ average is taken from all models

Random Forest is also an ensemble method which is an improved version of bagging
↓
creates multiple decision trees.

method of combining the decision of different algorithms require stacking algorithm

↓ need

k-fold cross-validation of the base model

less training time



SHAGHAYEGH

3.1

فاز اول

classification

MLP, J48, RART

high accuracy both large & small dataset

MLP: 1 input 1 hidden 1 output with Relu → صگر ای ریر
C4.5 غیر خطی میزنم

J48: developed by Ross Quinlan. it use to generate decision trees (C4.5) → it employ greedy search & top-down search to build decision tree. → این زرف کوان وین کی الگوریتم رام نمین ریند!

PART: developed version of ripper algorithm & C4.5 is partial decision tree algorithm that doesn't require global optimization (C4.5)
it help in building a partial decision tree with divide and conquer in each iteration

IBK
Naïve Bayes — Zero R
2: ensemble ^{تیم} Bagging - Boosting - voting

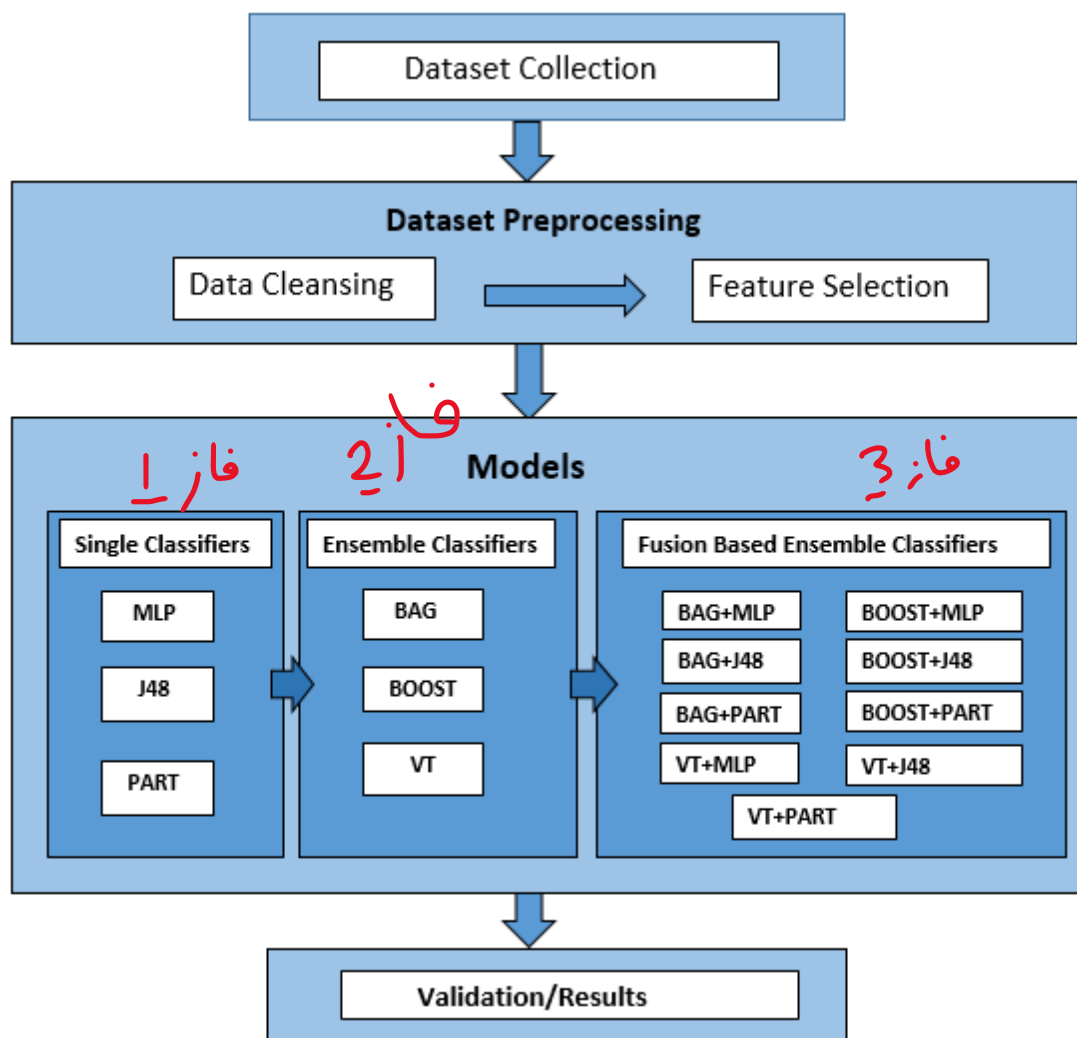
3: Hybrid Ensemble methods

4: Performance Comparison → 10-fold cross validation

accuracy - precision - recall - F-score وبسک وردن



نقشه راه:



توضیحات پیش پردازش:

ابتدا داده هایی که باعث میشوند مدل دچار خطا شود را حذف میکنیم در نتیجه سریع تر مدل آموزش نیز میبیند. استراتژی حذف داده ها بدین گونه است که کل داده ها بر 10 تقسیم میشوند و شبیه تکنیک cross_validation روی مدلی که آموزش سریع تری دارد (در اینجا از درخت C4.5 استفاده میشود) 120 بار اجرا میشود بدین صورت که 10 تای اول در نظر گرفته نمیشود و دقت برای رکورد های باقیمانده

محاسبه میشود سپس 10 تا داده دوم در نظر گرفته نمیشود و مدل مجدد روی باقی داده ها آموزش میبیند و دقت بدست میآید به همین ترتیب الی آخر. آن داده هایی که دقت های کمتری دارند (کمتر از 0.35) را از دیتاست حذف میکنیم. در این مثال اندیس های زیر حذف میشوند:

- Accuracy: 0.3407821229050279 با 10-20
- Accuracy: 0.3323943661971831 با 20-30
- Accuracy: 0.3494318181818182 با 30-40
- Accuracy: 0.335243553008596 با 40-50
- Accuracy: 0.34971098265895956 با 50-60
- Accuracy: 0.29737609329446063 با 60-70
- Accuracy: 0.3235294117647059 با 160-170
- Accuracy: 0.3439306358381503 با 170-180
- Accuracy: 0.3236151603498542 با 730-740
- Accuracy: 0.3205882352941177 با 740-750
- Accuracy: 0.3323442136498516 با 750-760
- Accuracy: 0.3323353293413174 با 780-790
- Accuracy: 0.3413897280966767 با 790-800
- Accuracy: 0.34146341463414637 با 1070-1018

انتخاب 16 ویژگی از 21 ویژگی :

برای هر ویژگی بطور مجزا مقدار GainRatio را بدست میآوریم و آن فیچر هایی که کمترین مقدار را دارند از ویژگی ها حذف میکنیم. این حذف کردن ضروری است چرا که از overfitting جلوگیری میکند.

مقدار GainRatio هر فیچر بترتیب از بیشترین به کمترین:

$$F.J = 0.010292 \rightarrow$$

$$DST = 0.008205 \rightarrow$$

$$Wants_to_take_higher_education = 0.007577 \rightarrow$$

In_a_relationship = 0.006724 ➤
Quality_of_family_relationships = 0.006567 ➤
Going_out_with_friends = 0.00638 ➤
P.C.S = 0.005347 ➤
Failures = 0.004954 ➤
M.E = 0.004635 ➤
Address = 0.003827 ➤
F.E = 0.003734 ➤
th_Class_Second_term_Grade9 = 0.003246 ➤
No_of_absences_from_class_in_a_month = 0.002574 ➤
Internet_access_at_home = 0.002437 ➤
th_Class_first_term_Grade9 = 0.001639 ➤
M.J = 0.001508 ➤
Grade_at_Class_8 = 0.000902 ➤
Attended_nursery_school = 0.000631 ➤
HTS_trave_ltime = 0.000609 ➤
Current_health_status = 0.000448 ➤
E.C = 0.000249 ➤
F.S = 0.00023 ➤

که فیچر های به رنگ قرمز حذف میشوند.

فاز 1:

استفاده از MLP با دقت 83.877 درصد:

Weka Explorer

Preprocess Classify Cluster Associate Select attributes Visualize

Classifier: Choose **MultilayerPerceptron -L 0.3 -M 0.2 -N 500 -V 0 -S 0 -E 20 -H a**

Test options

☒ Use training set

☐ Supplied test set Set...

☐ Cross-validation Folds 10

☐ Percentage split % 66

More options...

(Nom) 9th_Class_Second_term_Grade

Start Stop

Result list (right-click for options)

- 14:09:07 - meta.MultiBoostAB
- 14:09:59 - meta.MultiBoostAB
- 19:40:28 - meta.Bagging
- 19:42:46 - meta.Bagging
- 19:42:52 - meta.Bagging
- 19:43:23 - meta.Bagging
- 19:43:39 - meta.Bagging
- 19:44:09 - meta.Bagging
- 19:44:34 - meta.Bagging
- 01:21:01 - meta.Bagging
- 01:22:06 - meta.Bagging
- 01:22:14 - meta.Bagging
- 01:22:28 - meta.Bagging
- 01:23:33 - functions.MultilayerPerceptron
- 01:30:49 - trees.J48
- 01:32:30 - rules.PART
- 01:32:53 - rules.PART
- 01:33:00 - rules.PART
- 01:33:13 - rules.PART
- 01:33:53 - rules.PART
- 01:33:55 - rules.PART
- 01:34:02 - rules.PART
- 01:34:53 - functions.MultilayerPerceptron

Status: OK

Classifier output

=== Summary ===

| | | |
|----------------------------------|-----------|----------|
| Correctly Classified Instances | 900 | 83.877 % |
| Incorrectly Classified Instances | 173 | 16.123 % |
| Kappa statistic | 0.7943 | |
| Mean absolute error | 0.056 | |
| Root mean squared error | 0.1952 | |
| Relative absolute error | 24.7338 % | |
| Root relative squared error | 58.0269 % | |
| Total Number of Instances | 1073 | |

=== Detailed Accuracy By Class ===

| | TP Rate | FP Rate | Precision | Recall | F-Measure | MCC | ROC Area | PRC Area | Class |
|---------------|---------|---------|-----------|--------|-----------|-------|----------|----------|-------|
| | 0.913 | 0.060 | 0.861 | 0.913 | 0.886 | 0.838 | 0.951 | 0.935 | A |
| | 0.923 | 0.060 | 0.830 | 0.923 | 0.874 | 0.833 | 0.956 | 0.929 | A+ |
| | 0.864 | 0.032 | 0.864 | 0.864 | 0.864 | 0.832 | 0.926 | 0.893 | B |
| | 0.792 | 0.026 | 0.836 | 0.792 | 0.813 | 0.783 | 0.894 | 0.819 | B+ |
| | 0.616 | 0.008 | 0.869 | 0.616 | 0.721 | 0.713 | 0.820 | 0.671 | C |
| | 0.419 | 0.008 | 0.619 | 0.419 | 0.500 | 0.498 | 0.809 | 0.363 | D |
| | 0.400 | 0.010 | 0.500 | 0.400 | 0.444 | 0.436 | 0.730 | 0.297 | F |
| Weighted Avg. | 0.839 | 0.043 | 0.836 | 0.839 | 0.834 | 0.799 | 0.919 | 0.856 | |

=== Confusion Matrix ===

| | a | b | c | d | e | f | g | <-- classified as |
|-----|-----|-----|-----|----|----|----|---|-------------------|
| 284 | 12 | 6 | 3 | 3 | 1 | 2 | 1 | a = A |
| 5 | 240 | 6 | 5 | 1 | 2 | 1 | 1 | b = A+ |
| 10 | 9 | 178 | 3 | 2 | 0 | 4 | 1 | c = B |
| 10 | 13 | 7 | 122 | 0 | 1 | 1 | 1 | d = B+ |
| 10 | 8 | 4 | 7 | 53 | 2 | 2 | 1 | e = C |
| 4 | 4 | 4 | 5 | 1 | 13 | 0 | 1 | f = D |
| 7 | 3 | 1 | 1 | 1 | 2 | 10 | 1 | g = F |

Log x 0

استفاده از J48 با دقت 70.92 درصد:

Weka Explorer

Preprocess Classify Cluster Associate Select attributes Visualize

Classifier: Choose **J48 -C 0.25 -M 2**

Test options

☒ Use training set

☐ Supplied test set Set...

☐ Cross-validation Folds 10

☐ Percentage split % 66

More options...

(Nom) 9th_Class_Second_term_Grade

Start Stop

Result list (right-click for options)

- 14:09:59 - meta.MultiBoostAB
- 19:40:28 - meta.Bagging
- 19:42:46 - meta.Bagging
- 19:42:52 - meta.Bagging
- 19:43:23 - meta.Bagging
- 19:43:39 - meta.Bagging
- 19:44:09 - meta.Bagging
- 19:44:34 - meta.Bagging
- 01:21:01 - meta.Bagging
- 01:22:06 - meta.Bagging
- 01:22:14 - meta.Bagging
- 01:22:28 - meta.Bagging
- 01:23:33 - functions.MultilayerPerceptron
- 01:30:49 - trees.J48
- 01:32:30 - rules.PART
- 01:32:53 - rules.PART
- 01:33:00 - rules.PART
- 01:33:13 - rules.PART
- 01:33:53 - rules.PART
- 01:33:55 - rules.PART
- 01:34:02 - rules.PART
- 01:34:53 - functions.MultilayerPerceptron
- 01:36:10 - trees.J48

Status: OK

Classifier output

=== Summary ===

| | | |
|----------------------------------|-----------|-----------|
| Correctly Classified Instances | 761 | 70.9226 % |
| Incorrectly Classified Instances | 312 | 29.0774 % |
| Kappa statistic | 0.6254 | |
| Mean absolute error | 0.1115 | |
| Root mean squared error | 0.2361 | |
| Relative absolute error | 49.2333 % | |
| Root relative squared error | 70.185 % | |
| Total Number of Instances | 1073 | |

=== Detailed Accuracy By Class ===

| | TP Rate | FP Rate | Precision | Recall | F-Measure | MCC | ROC Area | PRC Area | Class |
|---------------|---------|---------|-----------|--------|-----------|-------|----------|----------|-------|
| | 0.810 | 0.155 | 0.681 | 0.810 | 0.740 | 0.626 | 0.915 | 0.805 | A |
| | 0.823 | 0.116 | 0.695 | 0.823 | 0.754 | 0.670 | 0.933 | 0.773 | A+ |
| | 0.617 | 0.057 | 0.722 | 0.617 | 0.665 | 0.596 | 0.923 | 0.758 | B |
| | 0.636 | 0.035 | 0.754 | 0.636 | 0.690 | 0.646 | 0.953 | 0.786 | B+ |
| | 0.547 | 0.015 | 0.758 | 0.547 | 0.635 | 0.618 | 0.967 | 0.742 | C |
| | 0.484 | 0.003 | 0.833 | 0.484 | 0.612 | 0.627 | 0.983 | 0.716 | D |
| | 0.320 | 0.001 | 0.889 | 0.320 | 0.471 | 0.528 | 0.987 | 0.658 | F |
| Weighted Avg. | 0.709 | 0.090 | 0.718 | 0.709 | 0.703 | 0.631 | 0.934 | 0.774 | |

=== Confusion Matrix ===

| | a | b | c | d | e | f | g | <-- classified as |
|-----|-----|-----|----|----|----|---|---|-------------------|
| 252 | 34 | 17 | 7 | 1 | 0 | 0 | 1 | a = A |
| 34 | 214 | 5 | 5 | 1 | 1 | 0 | 1 | b = A+ |
| 43 | 23 | 127 | 9 | 2 | 1 | 1 | 1 | c = B |
| 23 | 15 | 12 | 98 | 5 | 1 | 0 | 1 | d = B+ |
| 11 | 14 | 9 | 5 | 47 | 0 | 0 | 1 | e = C |
| 5 | 4 | 4 | 2 | 1 | 15 | 0 | 1 | f = D |
| 2 | 4 | 2 | 4 | 5 | 0 | 8 | 1 | g = F |

Log x 0

استفاده از PART با دقت 77.35 درصد:

The screenshot shows the Weka Explorer interface with the PART classifier selected. The classifier output window displays the following summary and detailed accuracy by class.

Summary

| Metric | Value | Percentage |
|----------------------------------|-----------|------------|
| Correctly Classified Instances | 830 | 77.3532 % |
| Incorrectly Classified Instances | 243 | 22.6468 % |
| Kappa statistic | 0.7105 | |
| Mean absolute error | 0.0912 | |
| Root mean squared error | 0.2136 | |
| Relative absolute error | 40.2888 % | |
| Root relative squared error | 63.4903 % | |
| Total Number of Instances | 1073 | |

Detailed Accuracy By Class

| Class | TP Rate | FP Rate | Precision | Recall | F-Measure | MCC | ROC Area | PRC Area |
|---------------|---------|---------|-----------|--------|-----------|-------|----------|----------|
| A | 0.865 | 0.100 | 0.780 | 0.865 | 0.820 | 0.743 | 0.956 | 0.891 |
| A+ | 0.835 | 0.071 | 0.789 | 0.835 | 0.811 | 0.749 | 0.964 | 0.884 |
| B | 0.757 | 0.062 | 0.743 | 0.757 | 0.750 | 0.690 | 0.954 | 0.812 |
| B+ | 0.708 | 0.029 | 0.801 | 0.708 | 0.752 | 0.715 | 0.967 | 0.827 |
| C | 0.674 | 0.021 | 0.734 | 0.674 | 0.703 | 0.679 | 0.975 | 0.757 |
| D | 0.548 | 0.005 | 0.773 | 0.548 | 0.642 | 0.642 | 0.988 | 0.692 |
| F | 0.160 | 0.002 | 0.667 | 0.160 | 0.258 | 0.320 | 0.980 | 0.433 |
| Weighted Avg. | 0.774 | 0.064 | 0.772 | 0.774 | 0.767 | 0.712 | 0.962 | 0.838 |

Confusion Matrix

| a | b | c | d | e | f | g | Classified as |
|-----|-----|-----|-----|----|----|---|---------------|
| 269 | 22 | 14 | 3 | 1 | 1 | 1 | a = A |
| 24 | 217 | 11 | 3 | 4 | 1 | 0 | b = A+ |
| 15 | 15 | 156 | 9 | 9 | 1 | 1 | c = B |
| 19 | 7 | 14 | 109 | 4 | 1 | 0 | d = B+ |
| 6 | 6 | 10 | 5 | 58 | 1 | 0 | e = C |
| 4 | 3 | 1 | 5 | 1 | 17 | 0 | f = D |
| 8 | 5 | 4 | 2 | 2 | 0 | 4 | g = F |

فاز 2:

استفاده از BAGGING با دقت 85.27 درصد:

The screenshot shows the Weka Explorer interface with the BAGGING classifier selected. The classifier output window displays the following summary and detailed accuracy by class.

Summary

| Metric | Value | Percentage |
|----------------------------------|-----------|------------|
| Correctly Classified Instances | 915 | 85.2749 % |
| Incorrectly Classified Instances | 158 | 14.7251 % |
| Kappa statistic | 0.7054 | |
| Mean absolute error | 0.353 | |
| Root mean squared error | 0.3775 | |
| Relative absolute error | 70.6131 % | |
| Root relative squared error | 75.4976 % | |
| Total Number of Instances | 1073 | |

Detailed Accuracy By Class

| Class | TP Rate | FP Rate | Precision | Recall | F-Measure | MCC | ROC Area | PRC Area |
|---------------|---------|---------|-----------|--------|-----------|-------|----------|----------|
| Male | 0.840 | 0.135 | 0.859 | 0.840 | 0.850 | 0.706 | 0.931 | 0.930 |
| Female | 0.865 | 0.160 | 0.847 | 0.865 | 0.856 | 0.706 | 0.931 | 0.935 |
| Weighted Avg. | 0.853 | 0.148 | 0.853 | 0.853 | 0.853 | 0.706 | 0.931 | 0.932 |

Confusion Matrix

| a | b | Classified as |
|-----|-----|---------------|
| 446 | 85 | a = Male |
| 73 | 469 | b = Female |

استفاده از MultiBoostAB با دقت 90.95 درصد:

Weka Explorer

Preprocess Classify Cluster Associate Select attributes Visualize

Classifier

Choose MultiBoostAB -C 3 -P 100 -S 1 -I 10 -W weka.classifiers.trees.J48 --- -C 0.25 -M 2

Test options

☒ Use training set

☐ Supplied test set Set...

☐ Cross-validation Folds 10

☐ Percentage split % 66

More options...

(Nom) 9th_Class_Second_term_Grade

Start Stop

Result list (right-click for options)

- 19:43:39 - meta.Bagging
- 19:44:09 - meta.Bagging
- 01:21:01 - meta.Bagging
- 01:22:06 - meta.Bagging
- 01:22:14 - meta.Bagging
- 01:22:28 - meta.Bagging
- 01:23:33 - functions.MultilayerPerceptron
- 01:30:49 - trees.J48
- 01:32:30 - rules.PART
- 01:32:53 - rules.PART
- 01:33:00 - rules.PART
- 01:33:13 - rules.PART
- 01:33:53 - rules.PART
- 01:33:55 - rules.PART
- 01:34:02 - rules.PART
- 01:34:53 - functions.MultilayerPerceptron
- 01:36:10 - trees.J48
- 01:40:31 - meta.Bagging
- 01:42:15 - meta.MultiBoostAB
- 01:42:40 - meta.Bagging
- 01:43:05 - meta.Bagging
- 01:46:21 - meta.MultiBoostAB

Status

OK Log x 0

Classifier output

=== Summary ===

| | | |
|----------------------------------|-----------|-----------|
| Correctly Classified Instances | 976 | 90.9599 % |
| Incorrectly Classified Instances | 97 | 9.0401 % |
| Kappa statistic | 0.8852 | |
| Mean absolute error | 0.0326 | |
| Root mean squared error | 0.1321 | |
| Relative absolute error | 14.3955 % | |
| Root relative squared error | 39.2643 % | |
| Total Number of Instances | 1073 | |

=== Detailed Accuracy By Class ===

| | TP Rate | FP Rate | Precision | Recall | F-Measure | MCC | ROC Area | FRC Area | Class |
|---------------|---------|---------|-----------|--------|-----------|-------|----------|----------|-------|
| | 0.936 | 0.056 | 0.871 | 0.936 | 0.902 | 0.862 | 0.991 | 0.978 | A |
| | 0.942 | 0.032 | 0.904 | 0.942 | 0.923 | 0.898 | 0.994 | 0.981 | A+ |
| | 0.879 | 0.015 | 0.933 | 0.879 | 0.905 | 0.884 | 0.995 | 0.980 | B |
| | 0.883 | 0.008 | 0.951 | 0.883 | 0.916 | 0.903 | 0.991 | 0.969 | B+ |
| | 0.884 | 0.004 | 0.950 | 0.884 | 0.916 | 0.909 | 0.998 | 0.984 | C |
| | 0.806 | 0.002 | 0.926 | 0.806 | 0.862 | 0.860 | 0.987 | 0.897 | D |
| | 0.880 | 0.002 | 0.917 | 0.880 | 0.898 | 0.896 | 0.999 | 0.974 | F |
| Weighted Avg. | 0.910 | 0.029 | 0.911 | 0.910 | 0.910 | 0.885 | 0.993 | 0.976 | |

=== Confusion Matrix ===

| | a | b | c | d | e | f | g | <-- classified as |
|-----|-----|-----|-----|----|----|----|---|-------------------|
| 291 | 11 | 8 | 1 | 0 | 0 | 0 | 0 | a = A |
| 10 | 245 | 1 | 1 | 2 | 0 | 1 | 1 | b = A+ |
| 14 | 5 | 181 | 3 | 2 | 0 | 1 | 1 | c = B |
| 8 | 8 | 2 | 136 | 0 | 0 | 0 | 0 | d = B+ |
| 3 | 2 | 2 | 1 | 76 | 2 | 0 | 1 | e = C |
| 6 | 0 | 0 | 0 | 0 | 25 | 0 | 1 | f = D |
| 2 | 0 | 0 | 1 | 0 | 0 | 22 | 1 | g = F |

استفاده از Voting با دقت 74.0913 درصد:

Weka Explorer

Preprocess Classify Cluster Associate Select attributes Visualize

Classifier

Choose Vote -S 1 -B "weka.classifiers.trees.J48 -C 0.25 -M 2" -B "weka.classifiers.trees.J48 -C 0.25 -M 2" -B "weka.classifiers.trees.J48 -C 0.25 -M 2" -B "weka.classifiers.rules.ZeroR" -R AVG

Test options

☒ Use training set

☐ Supplied test set Set...

☐ Cross-validation Folds 10

☐ Percentage split % 66

More options...

(Nom) 9th_Class_Second_term_Grade

Start Stop

Result list (right-click for options)

- 19:44:09 - meta.Bagging
- 01:21:01 - meta.Bagging
- 01:22:06 - meta.Bagging
- 01:22:14 - meta.Bagging
- 01:22:28 - meta.Bagging
- 01:23:33 - functions.MultilayerPerceptron
- 01:30:49 - trees.J48
- 01:32:30 - rules.PART
- 01:32:53 - rules.PART
- 01:33:00 - rules.PART
- 01:33:13 - rules.PART
- 01:33:53 - rules.PART
- 01:33:55 - rules.PART
- 01:34:02 - rules.PART
- 01:34:53 - functions.MultilayerPerceptron
- 01:36:10 - trees.J48
- 01:40:31 - meta.Bagging
- 01:42:15 - meta.MultiBoostAB
- 01:42:40 - meta.Bagging
- 01:43:05 - meta.Bagging
- 01:46:21 - meta.MultiBoostAB
- 01:48:27 - meta.Vote

Status

OK Log x 0

Classifier output

=== Summary ===

| | | |
|----------------------------------|-----------|-----------|
| Correctly Classified Instances | 795 | 74.0913 % |
| Incorrectly Classified Instances | 278 | 25.9087 % |
| Kappa statistic | 0.6684 | |
| Mean absolute error | 0.1337 | |
| Root mean squared error | 0.2351 | |
| Relative absolute error | 59.0566 % | |
| Root relative squared error | 69.888 % | |
| Total Number of Instances | 1073 | |

=== Detailed Accuracy By Class ===

| | TP Rate | FP Rate | Precision | Recall | F-Measure | MCC | ROC Area | FRC Area | Class |
|---------------|---------|---------|-----------|--------|-----------|-------|----------|----------|-------|
| | 0.823 | 0.136 | 0.711 | 0.823 | 0.763 | 0.660 | 0.925 | 0.824 | A |
| | 0.800 | 0.093 | 0.732 | 0.800 | 0.765 | 0.686 | 0.942 | 0.804 | A+ |
| | 0.665 | 0.046 | 0.774 | 0.665 | 0.715 | 0.657 | 0.937 | 0.796 | B |
| | 0.714 | 0.030 | 0.797 | 0.714 | 0.753 | 0.716 | 0.966 | 0.836 | B+ |
| | 0.733 | 0.024 | 0.724 | 0.733 | 0.728 | 0.705 | 0.977 | 0.786 | C |
| | 0.516 | 0.005 | 0.762 | 0.516 | 0.615 | 0.618 | 0.986 | 0.705 | D |
| | 0.200 | 0.001 | 0.833 | 0.200 | 0.323 | 0.403 | 0.986 | 0.571 | F |
| Weighted Avg. | 0.741 | 0.078 | 0.746 | 0.741 | 0.736 | 0.670 | 0.944 | 0.803 | |

=== Confusion Matrix ===

| | a | b | c | d | e | f | g | <-- classified as |
|-----|-----|-----|-----|----|----|---|---|-------------------|
| 256 | 33 | 13 | 5 | 2 | 1 | 1 | 1 | a = A |
| 34 | 208 | 6 | 6 | 5 | 1 | 0 | 1 | b = A+ |
| 33 | 22 | 137 | 8 | 5 | 1 | 0 | 1 | c = B |
| 17 | 13 | 9 | 110 | 4 | 1 | 0 | 1 | d = B+ |
| 9 | 5 | 7 | 2 | 63 | 0 | 0 | 1 | e = C |
| 7 | 2 | 1 | 3 | 2 | 16 | 0 | 1 | f = D |
| 4 | 1 | 4 | 4 | 6 | 1 | 5 | 1 | g = F |

فاز 3:

استفاده از ترکیب BAG+MLP با دقت 91.70 درصد:

Weka Explorer

Preprocess Classify Cluster Associate Select attributes Visualize

Classifier

Choose Bagging -P 100 -S 1 -num-slots 1 -I 10 -W weka.classifiers.functions.MultilayerPerceptron -L 0.3 -M 0.2 -N 500 -V 0 -S 0 -E 20 -H s

Test options

☒ Use training set

☐ Supplied test set Set...

☐ Cross-validation Folds 10

☐ Percentage split % 66

More options...

(Nom) 9th_Class_Second_term_Grade

Start Stop

Result list (right-click for options)

19:44:34 - meta.Bagging

01:21:01 - meta.Bagging

01:22:06 - meta.Bagging

01:22:14 - meta.Bagging

01:22:28 - meta.Bagging

01:23:33 - functions.MultilayerPerceptron

01:30:49 - trees.J48

01:32:30 - rules.PART

01:32:53 - rules.PART

01:33:00 - rules.PART

01:33:13 - rules.PART

01:33:53 - rules.PART

01:35:55 - rules.PART

01:34:02 - rules.PART

01:34:53 - functions.MultilayerPerceptron

01:36:10 - trees.J48

01:40:31 - meta.Bagging

01:42:15 - meta.MultiBoostAB

01:42:40 - meta.Bagging

01:43:05 - meta.Bagging

01:46:21 - meta.MultiBoostAB

01:48:27 - meta.Vote

01:51:29 - meta.Bagging

Status

OK

Log x 0

Classifier output

=== Summary ===

| | | |
|----------------------------------|-----------|-----------|
| Correctly Classified Instances | 984 | 91.7055 % |
| Incorrectly Classified Instances | 89 | 8.2945 % |
| Kappa statistic | 0.8943 | |
| Mean absolute error | 0.0984 | |
| Root mean squared error | 0.1783 | |
| Relative absolute error | 43.461 % | |
| Root relative squared error | 53.0178 % | |
| Total Number of Instances | 1073 | |

=== Detailed Accuracy By Class ===

| | TP Rate | FP Rate | Precision | Recall | F-Measure | MCC | ROC Area | PRC Area | Class |
|---------------|---------|---------|-----------|--------|-----------|-------|----------|----------|-------|
| | 0.971 | 0.054 | 0.880 | 0.971 | 0.924 | 0.892 | 0.995 | 0.990 | A |
| | 0.923 | 0.025 | 0.923 | 0.923 | 0.923 | 0.898 | 0.990 | 0.979 | A+ |
| | 0.951 | 0.015 | 0.938 | 0.951 | 0.945 | 0.931 | 0.998 | 0.990 | B |
| | 0.909 | 0.011 | 0.933 | 0.909 | 0.921 | 0.908 | 0.990 | 0.971 | B+ |
| | 0.826 | 0.005 | 0.934 | 0.826 | 0.877 | 0.868 | 0.994 | 0.950 | C |
| | 0.548 | 0.000 | 1.000 | 0.548 | 0.708 | 0.736 | 0.998 | 0.965 | D |
| | 0.720 | 0.000 | 1.000 | 0.720 | 0.837 | 0.846 | 0.997 | 0.942 | F |
| Weighted Avg. | 0.917 | 0.026 | 0.920 | 0.917 | 0.915 | 0.896 | 0.994 | 0.980 | |

=== Confusion Matrix ===

| | a | b | c | d | e | f | g | <-- classified as |
|-----|-----|-----|-----|----|----|----|---|-------------------|
| 302 | 3 | 1 | 2 | 3 | 0 | 0 | 0 | a = A |
| 12 | 240 | 5 | 3 | 0 | 0 | 0 | 0 | b = A+ |
| 5 | 4 | 196 | 1 | 0 | 0 | 0 | 0 | c = B |
| 7 | 5 | 2 | 140 | 0 | 0 | 0 | 0 | d = B+ |
| 5 | 6 | 2 | 2 | 71 | 0 | 0 | 0 | e = C |
| 8 | 1 | 2 | 1 | 2 | 17 | 0 | 0 | f = D |
| 4 | 1 | 1 | 1 | 0 | 0 | 18 | 0 | g = F |

استفاده از ترکیب BAG+PART با دقت 91.98 درصد:

Weka Explorer

Preprocess Classify Cluster Associate Select attributes Visualize

Classifier

Choose Bagging -P 100 -S 1 -num-slots 1 -I 10 -W weka.classifiers.rules.PART -C 0.25 -M 2

Test options

☒ Use training set

☐ Supplied test set Set...

☐ Cross-validation Folds 10

☐ Percentage split % 66

More options...

(Nom) 9th_Class_Second_term_Grade

Start Stop

Result list (right-click for options)

01:21:01 - meta.Bagging

01:22:06 - meta.Bagging

01:22:14 - meta.Bagging

01:22:28 - meta.Bagging

01:23:33 - functions.MultilayerPerceptron

01:30:49 - trees.J48

01:32:30 - rules.PART

01:32:53 - rules.PART

01:33:00 - rules.PART

01:33:13 - rules.PART

01:33:53 - rules.PART

01:34:02 - rules.PART

01:34:53 - functions.MultilayerPerceptron

01:36:10 - trees.J48

01:40:31 - meta.Bagging

01:42:15 - meta.MultiBoostAB

01:42:40 - meta.Bagging

01:43:05 - meta.Bagging

01:46:21 - meta.MultiBoostAB

01:48:27 - meta.Vote

01:51:29 - meta.Bagging

01:54:29 - meta.Bagging

Status

OK

Log x 0

Classifier output

=== Summary ===

| | | |
|----------------------------------|-----------|-----------|
| Correctly Classified Instances | 987 | 91.9851 % |
| Incorrectly Classified Instances | 86 | 8.0149 % |
| Kappa statistic | 0.8981 | |
| Mean absolute error | 0.1167 | |
| Root mean squared error | 0.199 | |
| Relative absolute error | 51.5349 % | |
| Root relative squared error | 59.1584 % | |
| Total Number of Instances | 1073 | |

=== Detailed Accuracy By Class ===

| | TP Rate | FP Rate | Precision | Recall | F-Measure | MCC | ROC Area | PRC Area | Class |
|---------------|---------|---------|-----------|--------|-----------|-------|----------|----------|-------|
| | 0.955 | 0.051 | 0.884 | 0.955 | 0.918 | 0.884 | 0.989 | 0.974 | A |
| | 0.938 | 0.023 | 0.928 | 0.938 | 0.933 | 0.912 | 0.989 | 0.970 | A+ |
| | 0.947 | 0.013 | 0.947 | 0.947 | 0.947 | 0.934 | 0.994 | 0.978 | B |
| | 0.903 | 0.010 | 0.939 | 0.903 | 0.921 | 0.908 | 0.993 | 0.972 | B+ |
| | 0.860 | 0.006 | 0.925 | 0.860 | 0.892 | 0.883 | 0.996 | 0.951 | C |
| | 0.710 | 0.000 | 1.000 | 0.710 | 0.830 | 0.839 | 0.999 | 0.975 | D |
| | 0.640 | 0.002 | 0.889 | 0.640 | 0.744 | 0.749 | 0.998 | 0.922 | F |
| Weighted Avg. | 0.920 | 0.025 | 0.921 | 0.920 | 0.919 | 0.899 | 0.992 | 0.971 | |

=== Confusion Matrix ===

| | a | b | c | d | e | f | g | <-- classified as |
|-----|-----|-----|-----|----|----|----|---|-------------------|
| 297 | 8 | 2 | 2 | 2 | 0 | 0 | 0 | a = A |
| 13 | 244 | 2 | 1 | 0 | 0 | 0 | 0 | b = A+ |
| 7 | 3 | 195 | 1 | 0 | 0 | 0 | 0 | c = B |
| 8 | 3 | 2 | 135 | 2 | 0 | 0 | 0 | d = B+ |
| 4 | 2 | 3 | 3 | 74 | 0 | 0 | 0 | e = C |
| 4 | 1 | 0 | 1 | 1 | 22 | 2 | 0 | f = D |
| 3 | 2 | 2 | 1 | 1 | 0 | 16 | 0 | g = F |

استفاده از ترکیب BAG+J48 با دقت 91.42 درصد:

Weka Explorer

Preprocess Classify Cluster Associate Select attributes Visualize

Classifier: Choose **Bagging - P 100 - S 1 - num-slots 1 - I 10 - W weka.classifiers.trees.J48 - -C 0.25 -M 2**

Test options:
☒ Use training set
☐ Supplied test set Set...
☐ Cross-validation Folds 10
☐ Percentage split % 66
More options...

(Nom) 9th_Class_Second_term_Grade

Start Stop

Result list (right-click for options):
01:22:06 - meta.Bagging
01:22:14 - meta.Bagging
01:22:28 - meta.Bagging
01:23:33 - functions.MultilayerPerceptron
01:30:49 - trees.J48
01:32:30 - rules.PART
01:32:53 - rules.PART
01:33:00 - rules.PART
01:33:13 - rules.PART
01:33:53 - rules.PART
01:33:55 - rules.PART
01:34:02 - rules.PART
01:34:53 - functions.MultilayerPerceptron
01:36:10 - trees.J48
01:40:31 - meta.Bagging
01:42:15 - meta.MultiBoostAB
01:42:40 - meta.Bagging
01:43:05 - meta.Bagging
01:46:21 - meta.MultiBoostAB
01:48:27 - meta.Vote
01:51:29 - meta.Bagging
01:54:29 - meta.Bagging
01:55:02 - meta.Bagging

Status: OK

Classifier output:

=== Summary ===

| | | |
|----------------------------------|-----------|-----------|
| Correctly Classified Instances | 981 | 91.4259 % |
| Incorrectly Classified Instances | 92 | 8.5741 % |
| Kappa statistic | 0.8911 | |
| Mean absolute error | 0.1151 | |
| Root mean squared error | 0.1976 | |
| Relative absolute error | 50.8345 % | |
| Root relative squared error | 58.737 % | |
| Total Number of Instances | 1073 | |

=== Detailed Accuracy By Class ===

| | TP Rate | FP Rate | Precision | Recall | F-Measure | MCC | ROC Area | FRC Area | Class |
|---------------|---------|---------|-----------|--------|-----------|-------|----------|----------|-------|
| | 0.945 | 0.047 | 0.891 | 0.945 | 0.917 | 0.883 | 0.987 | 0.973 | A |
| | 0.927 | 0.036 | 0.893 | 0.927 | 0.909 | 0.880 | 0.986 | 0.952 | A+ |
| | 0.922 | 0.014 | 0.941 | 0.922 | 0.931 | 0.915 | 0.995 | 0.983 | B |
| | 0.896 | 0.010 | 0.939 | 0.896 | 0.917 | 0.904 | 0.994 | 0.972 | B+ |
| | 0.860 | 0.004 | 0.949 | 0.860 | 0.902 | 0.896 | 0.997 | 0.964 | C |
| | 0.806 | 0.000 | 1.000 | 0.806 | 0.893 | 0.895 | 0.999 | 0.969 | D |
| | 0.760 | 0.002 | 0.905 | 0.760 | 0.826 | 0.826 | 0.998 | 0.941 | F |
| Weighted Avg. | 0.914 | 0.027 | 0.916 | 0.914 | 0.914 | 0.891 | 0.991 | 0.968 | |

=== Confusion Matrix ===

| | a | b | c | d | e | f | g | <-- classified as |
|---|-----|-----|-----|-----|----|----|----|-------------------|
| a | 294 | 11 | 3 | 2 | 1 | 0 | 0 | a = A |
| b | 11 | 241 | 4 | 3 | 1 | 0 | 0 | b = A+ |
| c | 7 | 7 | 190 | 1 | 0 | 0 | 1 | c = B |
| d | 7 | 7 | 0 | 138 | 2 | 0 | 0 | d = B+ |
| e | 6 | 2 | 2 | 1 | 74 | 0 | 1 | e = C |
| f | 4 | 1 | 0 | 1 | 0 | 25 | 0 | f = D |
| g | 1 | 1 | 3 | 1 | 0 | 0 | 19 | g = F |

Log x 0

استفاده از ترکیب VT+MLP با دقت 84.62 درصد:

Weka Explorer

Preprocess Classify Cluster Associate Select attributes Visualize

Classifier: Choose **Vote - S 1 - B "weka.classifiers.functions.MultilayerPerceptron -L 0.3 -M 0.2 -N 500 -V 0 -S 0 -E 20 -H s" -B "weka.classifiers.functions.MultilayerPerceptron -L 0.3 -M 0.2 -N 500 -V 0 -S 0 -E 20"**

Test options:
☒ Use training set
☐ Supplied test set Set...
☐ Cross-validation Folds 10
☐ Percentage split % 66
More options...

(Nom) 9th_Class_Second_term_Grade

Start Stop

Result list (right-click for options):
01:22:28 - meta.Bagging
01:23:33 - functions.MultilayerPerceptron
01:30:49 - trees.J48
01:32:30 - rules.PART
01:32:53 - rules.PART
01:33:00 - rules.PART
01:33:13 - rules.PART
01:33:53 - rules.PART
01:33:55 - rules.PART
01:34:02 - rules.PART
01:34:53 - functions.MultilayerPerceptron
01:36:10 - trees.J48
01:40:31 - meta.Bagging
01:42:15 - meta.MultiBoostAB
01:42:40 - meta.Bagging
01:43:05 - meta.Bagging
01:46:21 - meta.MultiBoostAB
01:48:27 - meta.Vote
01:51:29 - meta.Bagging
01:54:29 - meta.Bagging
01:55:02 - meta.Bagging
01:56:00 - meta.Vote
01:57:01 - meta.Vote

Status: OK

Classifier output:

=== Summary ===

| | | |
|----------------------------------|-----------|-----------|
| Correctly Classified Instances | 908 | 84.6226 % |
| Incorrectly Classified Instances | 165 | 15.3774 % |
| Kappa statistic | 0.804 | |
| Mean absolute error | 0.051 | |
| Root mean squared error | 0.1885 | |
| Relative absolute error | 22.5077 % | |
| Root relative squared error | 56.0459 % | |
| Total Number of Instances | 1073 | |

=== Detailed Accuracy By Class ===

| | TP Rate | FP Rate | Precision | Recall | F-Measure | MCC | ROC Area | FRC Area | Class |
|---------------|---------|---------|-----------|--------|-----------|-------|----------|----------|-------|
| | 0.952 | 0.050 | 0.886 | 0.952 | 0.918 | 0.884 | 0.969 | 0.937 | A |
| | 0.888 | 0.043 | 0.868 | 0.888 | 0.878 | 0.839 | 0.944 | 0.914 | A+ |
| | 0.893 | 0.038 | 0.848 | 0.893 | 0.870 | 0.839 | 0.950 | 0.918 | B |
| | 0.766 | 0.027 | 0.825 | 0.766 | 0.795 | 0.762 | 0.888 | 0.829 | B+ |
| | 0.733 | 0.023 | 0.733 | 0.733 | 0.733 | 0.709 | 0.873 | 0.760 | C |
| | 0.290 | 0.007 | 0.563 | 0.290 | 0.383 | 0.392 | 0.690 | 0.318 | D |
| | 0.280 | 0.004 | 0.636 | 0.280 | 0.389 | 0.414 | 0.821 | 0.359 | F |
| Weighted Avg. | 0.846 | 0.038 | 0.838 | 0.846 | 0.839 | 0.808 | 0.928 | 0.867 | |

=== Confusion Matrix ===

| | a | b | c | d | e | f | g | <-- classified as |
|---|-----|-----|-----|-----|----|---|---|-------------------|
| a | 296 | 9 | 3 | 1 | 2 | 0 | 0 | a = A |
| b | 11 | 231 | 8 | 3 | 5 | 1 | 1 | b = A+ |
| c | 8 | 3 | 184 | 7 | 3 | 1 | 0 | c = B |
| d | 8 | 11 | 6 | 118 | 9 | 2 | 0 | d = B+ |
| e | 5 | 3 | 8 | 4 | 63 | 1 | 2 | e = C |
| f | 5 | 5 | 5 | 5 | 1 | 9 | 1 | f = D |
| g | 1 | 4 | 3 | 5 | 3 | 2 | 7 | g = F |

Log x 0

استفاده از ترکیب VT+PART با دقت درصد:

Weka Explorer

Preprocess Classify Cluster Associate Select attributes Visualize

Classifier

Choose **Vote** -S 1 -B "weka.classifiers.rules.PART -C 0.25 -M 2" -B "weka.classifiers.rules.PART -C 0.25 -M 2" -B "weka.classifiers.rules.PART -C 0.25 -M 2" -B "weka.classifiers.rules.ZeroR" -R AVG

Test options

☒ Use training set

☐ Supplied test set Set...

☐ Cross-validation Folds 10

☐ Percentage split % 66

More options...

(Nom) 9th_Class_Second_term_Grade

Start Stop

Result list (right-click for options)

- 01:22:14 - meta.Bagging
- 01:22:28 - meta.Bagging
- 01:23:33 - functions.MultilayerPerceptron
- 01:30:49 - trees.J48
- 01:32:30 - rules.PART
- 01:32:53 - rules.PART
- 01:33:00 - rules.PART
- 01:33:13 - rules.PART
- 01:33:53 - rules.PART
- 01:33:55 - rules.PART
- 01:34:02 - rules.PART
- 01:34:53 - functions.MultilayerPerceptron
- 01:36:10 - trees.J48
- 01:40:31 - meta.Bagging
- 01:42:15 - meta.MultiBoostAB
- 01:42:40 - meta.Bagging
- 01:43:05 - meta.Bagging
- 01:46:21 - meta.MultiBoostAB
- 01:48:27 - meta.Vote
- 01:51:29 - meta.Bagging
- 01:54:29 - meta.Bagging
- 01:55:02 - meta.Bagging
- 01:56:00 - meta.Vote

Status OK

Log x 0

Classifier output

=== Summary ===

| | | |
|----------------------------------|----------|----------|
| Correctly Classified Instances | 844 | 78.658 % |
| Incorrectly Classified Instances | 229 | 21.342 % |
| Kappa statistic | 0.7287 | |
| Mean absolute error | 0.1227 | |
| Root mean squared error | 0.22 | |
| Relative absolute error | 54.208 % | |
| Root relative squared error | 65.406 % | |
| Total Number of Instances | 1073 | |

=== Detailed Accuracy By Class ===

| | TP Rate | FP Rate | Precision | Recall | F-Measure | MCC | ROC Area | FRC Area | Class |
|---------------|---------|---------|-----------|--------|-----------|-------|----------|----------|-------|
| a | 0.839 | 0.088 | 0.796 | 0.839 | 0.817 | 0.740 | 0.954 | 0.885 | A |
| b | 0.835 | 0.060 | 0.816 | 0.835 | 0.825 | 0.768 | 0.963 | 0.883 | A+ |
| c | 0.786 | 0.057 | 0.768 | 0.786 | 0.777 | 0.723 | 0.961 | 0.842 | B |
| d | 0.753 | 0.030 | 0.806 | 0.753 | 0.779 | 0.743 | 0.971 | 0.858 | B+ |
| e | 0.756 | 0.028 | 0.699 | 0.756 | 0.726 | 0.702 | 0.978 | 0.755 | C |
| f | 0.419 | 0.005 | 0.722 | 0.419 | 0.531 | 0.541 | 0.985 | 0.614 | D |
| g | 0.400 | 0.003 | 0.769 | 0.400 | 0.526 | 0.548 | 0.985 | 0.613 | F |
| Weighted Avg. | 0.787 | 0.058 | 0.786 | 0.787 | 0.783 | 0.731 | 0.964 | 0.848 | |

=== Confusion Matrix ===

| | a | b | c | d | e | f | g | <-- classified as |
|---|-----|-----|-----|-----|----|----|----|-------------------|
| a | 261 | 23 | 11 | 10 | 4 | 1 | 1 | a = A |
| b | 22 | 217 | 12 | 3 | 5 | 1 | 0 | b = A+ |
| c | 15 | 12 | 162 | 8 | 7 | 2 | 0 | c = B |
| d | 16 | 4 | 8 | 116 | 7 | 1 | 2 | d = B+ |
| e | 7 | 5 | 9 | 0 | 65 | 0 | 0 | e = C |
| f | 3 | 1 | 6 | 4 | 4 | 13 | 0 | f = D |
| g | 4 | 4 | 3 | 3 | 1 | 0 | 10 | g = F |

استفاده از ترکیب VT+J48 با دقت 74.09 درصد:

Weka Explorer

Preprocess Classify Cluster Associate Select attributes Visualize

Classifier

Choose **Vote** -S 1 -B "weka.classifiers.trees.J48 -C 0.25 -M 2" -B "weka.classifiers.trees.J48 -C 0.25 -M 2" -B "weka.classifiers.trees.J48 -C 0.25 -M 2" -R AVG

Test options

☒ Use training set

☐ Supplied test set Set...

☐ Cross-validation Folds 10

☐ Percentage split % 66

More options...

(Nom) 9th_Class_Second_term_Grade

Start Stop

Result list (right-click for options)

- 01:23:33 - functions.MultilayerPerceptron
- 01:30:49 - trees.J48
- 01:32:30 - rules.PART
- 01:32:53 - rules.PART
- 01:33:00 - rules.PART
- 01:33:13 - rules.PART
- 01:33:53 - rules.PART
- 01:33:55 - rules.PART
- 01:34:02 - rules.PART
- 01:34:53 - functions.MultilayerPerceptron
- 01:36:10 - trees.J48
- 01:40:31 - meta.Bagging
- 01:42:15 - meta.MultiBoostAB
- 01:42:40 - meta.Bagging
- 01:43:05 - meta.Bagging
- 01:46:21 - meta.MultiBoostAB
- 01:48:27 - meta.Vote
- 01:51:29 - meta.Bagging
- 01:54:29 - meta.Bagging
- 01:55:02 - meta.Bagging
- 01:56:00 - meta.Vote
- 01:57:01 - meta.Vote
- 02:05:40 - meta.Vote

Status OK

Log x 0

Classifier output

=== Summary ===

| | | |
|----------------------------------|-----------|-----------|
| Correctly Classified Instances | 795 | 74.0913 % |
| Incorrectly Classified Instances | 278 | 25.9087 % |
| Kappa statistic | 0.6684 | |
| Mean absolute error | 0.1028 | |
| Root mean squared error | 0.2267 | |
| Relative absolute error | 45.4088 % | |
| Root relative squared error | 67.4039 % | |
| Total Number of Instances | 1073 | |

=== Detailed Accuracy By Class ===

| | TP Rate | FP Rate | Precision | Recall | F-Measure | MCC | ROC Area | FRC Area | Class |
|---------------|---------|---------|-----------|--------|-----------|-------|----------|----------|-------|
| a | 0.823 | 0.136 | 0.711 | 0.823 | 0.763 | 0.660 | 0.925 | 0.825 | A |
| b | 0.800 | 0.093 | 0.732 | 0.800 | 0.765 | 0.686 | 0.942 | 0.805 | A+ |
| c | 0.665 | 0.046 | 0.774 | 0.665 | 0.715 | 0.657 | 0.937 | 0.797 | B |
| d | 0.714 | 0.030 | 0.797 | 0.714 | 0.753 | 0.716 | 0.966 | 0.836 | B+ |
| e | 0.733 | 0.024 | 0.724 | 0.733 | 0.728 | 0.705 | 0.977 | 0.789 | C |
| f | 0.516 | 0.005 | 0.762 | 0.516 | 0.615 | 0.618 | 0.986 | 0.706 | D |
| g | 0.200 | 0.001 | 0.833 | 0.200 | 0.323 | 0.403 | 0.986 | 0.571 | F |
| Weighted Avg. | 0.741 | 0.078 | 0.746 | 0.741 | 0.736 | 0.670 | 0.944 | 0.804 | |

=== Confusion Matrix ===

| | a | b | c | d | e | f | g | <-- classified as |
|---|-----|-----|-----|-----|----|----|---|-------------------|
| a | 256 | 33 | 13 | 5 | 2 | 1 | 1 | a = A |
| b | 34 | 208 | 6 | 6 | 5 | 1 | 0 | b = A+ |
| c | 33 | 22 | 137 | 8 | 5 | 1 | 0 | c = B |
| d | 17 | 13 | 9 | 110 | 4 | 1 | 0 | d = B+ |
| e | 9 | 5 | 7 | 2 | 63 | 0 | 0 | e = C |
| f | 7 | 2 | 1 | 3 | 2 | 16 | 0 | f = D |
| g | 4 | 1 | 4 | 4 | 6 | 1 | 5 | g = F |

استفاده از ترکیب MB+MLP با دقت 97.8 درصد:

Weka Explorer

Preprocess **Classify** Cluster Associate Select attributes Visualize

Classifier Choose **MultiBoostAB -C 3 -P 100 -S 1 -I 10 -W weka.classifiers.functions.MultilayerPerceptron ---L 0.3 -M 0.2 -N 500 -V 0 -S 0 -E 20 -H a**

Test options
☒ Use training set
☐ Supplied test set Set...
☐ Cross-validation Folds 10
☐ Percentage split % 66
 More options...

(Nom) 9th_Class_Second_term_Grade

Start Stop

Result list (right-click for options)

- 01:30:49 - trees.J48
- 01:32:30 - rules.PART
- 01:32:53 - rules.PART
- 01:33:00 - rules.PART
- 01:33:13 - rules.PART
- 01:33:53 - rules.PART
- 01:33:55 - rules.PART
- 01:34:02 - rules.PART
- 01:34:53 - functions.MultilayerPerceptron
- 01:36:10 - trees.J48
- 01:40:31 - meta.Bagging
- 01:42:15 - meta.MultiBoostAB
- 01:42:40 - meta.Bagging
- 01:43:05 - meta.Bagging
- 01:46:21 - meta.MultiBoostAB
- 01:48:27 - meta.Vote
- 01:51:29 - meta.Bagging
- 01:54:29 - meta.Bagging
- 01:55:02 - meta.Bagging
- 01:56:00 - meta.Vote
- 01:57:01 - meta.Vote
- 02:05:40 - meta.Vote
- 02:07:29 - meta.MultiBoostAB

Status OK

Classifier output

=== Summary ===

| | | |
|----------------------------------|-----------|-----------|
| Correctly Classified Instances | 1050 | 97.8565 % |
| Incorrectly Classified Instances | 23 | 2.1435 % |
| Kappa statistic | 0.9729 | |
| Mean absolute error | 0.0066 | |
| Root mean squared error | 0.064 | |
| Relative absolute error | 2.9199 % | |
| Root relative squared error | 19.0134 % | |
| Total Number of Instances | 1073 | |

=== Detailed Accuracy By Class ===

| | TP Rate | FP Rate | Precision | Recall | F-Measure | MCC | ROC Area | PRC Area | Class |
|---------------|---------|---------|-----------|--------|-----------|-------|----------|----------|-------|
| | 0.984 | 0.010 | 0.975 | 0.984 | 0.979 | 0.971 | 0.999 | 0.999 | A |
| | 0.992 | 0.010 | 0.970 | 0.992 | 0.981 | 0.975 | 1.000 | 0.999 | A+ |
| | 0.990 | 0.002 | 0.990 | 0.990 | 0.990 | 0.988 | 1.000 | 1.000 | B |
| | 0.987 | 0.005 | 0.968 | 0.987 | 0.977 | 0.974 | 1.000 | 0.998 | B+ |
| | 0.965 | 0.000 | 1.000 | 0.965 | 0.982 | 0.981 | 1.000 | 1.000 | C |
| | 0.871 | 0.000 | 1.000 | 0.871 | 0.931 | 0.931 | 1.000 | 0.995 | D |
| | 0.800 | 0.000 | 1.000 | 0.800 | 0.889 | 0.892 | 1.000 | 0.998 | F |
| Weighted Avg. | 0.979 | 0.007 | 0.979 | 0.979 | 0.978 | 0.973 | 1.000 | 0.999 | |

=== Confusion Matrix ===

| | a | b | c | d | e | f | g | <-- classified as |
|-----|-----|-----|-----|----|----|----|---|-------------------|
| 306 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | a = A |
| 1 | 258 | 1 | 0 | 0 | 0 | 0 | 0 | b = A+ |
| 1 | 0 | 204 | 1 | 0 | 0 | 0 | 0 | c = B |
| 1 | 1 | 0 | 152 | 0 | 0 | 0 | 0 | d = B+ |
| 1 | 1 | 1 | 0 | 83 | 0 | 0 | 0 | e = C |
| 3 | 1 | 0 | 0 | 0 | 27 | 0 | 0 | f = D |
| 1 | 2 | 0 | 2 | 0 | 0 | 20 | 0 | g = F |

Log x 0

استفاده از ترکیب MB+PART با دقت 93.28 درصد:

Weka Explorer

Preprocess **Classify** Cluster Associate Select attributes Visualize

Classifier Choose **MultiBoostAB -C 3 -P 100 -S 1 -I 10 -W weka.classifiers.rules.PART ---C 0.25 -M 2**

Test options
☒ Use training set
☐ Supplied test set Set...
☐ Cross-validation Folds 10
☐ Percentage split % 66
 More options...

(Nom) 9th_Class_Second_term_Grade

Start Stop

Result list (right-click for options)

- 01:32:30 - rules.PART
- 01:32:53 - rules.PART
- 01:33:00 - rules.PART
- 01:33:13 - rules.PART
- 01:33:53 - rules.PART
- 01:33:55 - rules.PART
- 01:34:02 - rules.PART
- 01:34:53 - functions.MultilayerPerceptron
- 01:36:10 - trees.J48
- 01:40:31 - meta.Bagging
- 01:42:15 - meta.MultiBoostAB
- 01:42:40 - meta.Bagging
- 01:43:05 - meta.Bagging
- 01:46:21 - meta.MultiBoostAB
- 01:48:27 - meta.Vote
- 01:51:29 - meta.Bagging
- 01:54:29 - meta.Bagging
- 01:55:02 - meta.Bagging
- 01:56:00 - meta.Vote
- 01:57:01 - meta.Vote
- 02:05:40 - meta.Vote
- 02:07:29 - meta.MultiBoostAB
- 02:10:58 - meta.MultiBoostAB

Status OK

Classifier output

=== Summary ===

| | | |
|----------------------------------|-----------|-----------|
| Correctly Classified Instances | 1001 | 93.2898 % |
| Incorrectly Classified Instances | 72 | 6.7102 % |
| Kappa statistic | 0.9149 | |
| Mean absolute error | 0.026 | |
| Root mean squared error | 0.1153 | |
| Relative absolute error | 11.4877 % | |
| Root relative squared error | 34.2704 % | |
| Total Number of Instances | 1073 | |

=== Detailed Accuracy By Class ===

| | TP Rate | FP Rate | Precision | Recall | F-Measure | MCC | ROC Area | PRC Area | Class |
|---------------|---------|---------|-----------|--------|-----------|-------|----------|----------|-------|
| | 0.952 | 0.038 | 0.911 | 0.952 | 0.931 | 0.902 | 0.991 | 0.978 | A |
| | 0.962 | 0.023 | 0.929 | 0.962 | 0.945 | 0.927 | 0.993 | 0.986 | A+ |
| | 0.937 | 0.008 | 0.965 | 0.937 | 0.951 | 0.939 | 0.998 | 0.993 | B |
| | 0.909 | 0.009 | 0.946 | 0.909 | 0.927 | 0.915 | 0.998 | 0.988 | B+ |
| | 0.907 | 0.006 | 0.929 | 0.907 | 0.918 | 0.911 | 0.998 | 0.981 | C |
| | 0.871 | 0.002 | 0.931 | 0.871 | 0.900 | 0.898 | 0.999 | 0.964 | D |
| | 0.680 | 0.001 | 0.944 | 0.680 | 0.791 | 0.798 | 0.997 | 0.930 | F |
| Weighted Avg. | 0.933 | 0.020 | 0.934 | 0.933 | 0.932 | 0.915 | 0.995 | 0.983 | |

=== Confusion Matrix ===

| | a | b | c | d | e | f | g | <-- classified as |
|-----|-----|-----|-----|----|----|----|---|-------------------|
| 296 | 7 | 3 | 4 | 0 | 1 | 0 | 0 | a = A |
| 8 | 250 | 1 | 0 | 1 | 0 | 0 | 0 | b = A+ |
| 7 | 3 | 193 | 2 | 1 | 0 | 0 | 0 | c = B |
| 8 | 4 | 0 | 140 | 2 | 0 | 0 | 0 | d = B+ |
| 0 | 3 | 2 | 1 | 78 | 1 | 1 | 1 | e = C |
| 2 | 1 | 0 | 1 | 0 | 27 | 0 | 0 | f = D |
| 4 | 1 | 1 | 0 | 2 | 0 | 17 | 0 | g = F |

Log x 0

استفاده از ترکیب MB+J48 با دقت 90.95 درصد:

Classifier
Choose **MultiBoostAB - C 3 - P 100 - S 1 - I 10 - W weka.classifiers.trees.J48 -- -C 0.25 -M 2**

Test options
☒ Use training set
☐ Supplied test set Set...
☐ Cross-validation Folds 10
☐ Percentage split % 66
 More options...

(Nom) 9th_Class_Second_term_Grade

Start Stop

Result list (right-click for options)
 01:32:53 - rules.PART
 01:33:00 - rules.PART
 01:33:13 - rules.PART
 01:33:53 - rules.PART
 01:33:55 - rules.PART
 01:34:02 - rules.PART
 01:34:53 - functions.MultilayerPerceptron
 01:36:10 - trees.J48
 01:40:31 - meta.Bagging
 01:42:15 - meta.MultiBoostAB
 01:42:40 - meta.Bagging
 01:43:05 - meta.Bagging
 01:46:21 - meta.MultiBoostAB
 01:48:27 - meta.Vote
 01:51:29 - meta.Bagging
 01:54:29 - meta.Bagging
 01:55:02 - meta.Bagging
 01:56:00 - meta.Vote
 01:57:01 - meta.Vote
 02:05:40 - meta.Vote
 02:07:29 - meta.MultiBoostAB
 02:10:58 - meta.MultiBoostAB
 02:11:35 - meta.MultiBoostAB

Classifier output

=== Summary ===

| | | |
|----------------------------------|-----------|-----------|
| Correctly Classified Instances | 976 | 90.9599 % |
| Incorrectly Classified Instances | 97 | 9.0401 % |
| Kappa statistic | 0.8852 | |
| Mean absolute error | 0.0326 | |
| Root mean squared error | 0.1321 | |
| Relative absolute error | 14.3955 % | |
| Root relative squared error | 39.2643 % | |
| Total Number of Instances | 1073 | |

=== Detailed Accuracy By Class ===

| | TP Rate | FP Rate | Precision | Recall | F-Measure | MCC | ROC Area | PRC Area | Class |
|---------------|---------|---------|-----------|--------|-----------|-------|----------|----------|-------|
| | 0.936 | 0.056 | 0.871 | 0.936 | 0.902 | 0.862 | 0.991 | 0.978 | A |
| | 0.942 | 0.032 | 0.904 | 0.942 | 0.923 | 0.898 | 0.994 | 0.981 | A+ |
| | 0.879 | 0.015 | 0.933 | 0.879 | 0.905 | 0.884 | 0.995 | 0.980 | B |
| | 0.883 | 0.008 | 0.951 | 0.883 | 0.916 | 0.903 | 0.991 | 0.969 | B+ |
| | 0.884 | 0.004 | 0.950 | 0.884 | 0.916 | 0.909 | 0.998 | 0.984 | C |
| | 0.806 | 0.002 | 0.926 | 0.806 | 0.862 | 0.860 | 0.987 | 0.897 | D |
| | 0.880 | 0.002 | 0.917 | 0.880 | 0.898 | 0.896 | 0.999 | 0.974 | F |
| Weighted Avg. | 0.910 | 0.029 | 0.911 | 0.910 | 0.910 | 0.885 | 0.993 | 0.976 | |

=== Confusion Matrix ===

| | a | b | c | d | e | f | g | <-- classified as |
|--------|-----|-----|-----|-----|----|----|----|-------------------|
| a = A | 291 | 11 | 8 | 1 | 0 | 0 | 0 | |
| b = A+ | 10 | 245 | 1 | 1 | 2 | 0 | 1 | |
| c = B | 14 | 5 | 181 | 3 | 2 | 0 | 1 | |
| d = B+ | 8 | 8 | 2 | 136 | 0 | 0 | 0 | |
| e = C | 3 | 2 | 2 | 1 | 76 | 2 | 0 | |
| f = D | 6 | 0 | 0 | 0 | 0 | 25 | 0 | |
| g = F | 2 | 0 | 0 | 1 | 0 | 0 | 22 | |

Status
OK

Log x 0

نمایش تمامی فازها در قالب نمودار و مقایسه‌ی هر کدام:

در مرحله اول، سه طبقه‌بندی‌کننده SINGLE شامل پرسپترون چندلایه (MLP)، J48، و PART به همراه سه الگوریتم مجموعه تثبیت‌شده شامل (BAG) Bagging، (MB) MultiBoost، و Voting (VT) به طور مستقل در نمودار زیر نشان داده شده‌اند. برای افزایش بیشتر عملکرد طبقه‌بندی‌کننده‌های فوق، 9 مدل دیگر با ادغام طبقه‌بندی‌کننده‌های تکی و گروهی توسعه یافتند. نتایج ارزیابی نشان داد که MultiBoost با MLP با دستیابی به دقت 97.8٪ F از بقیه بهتر عمل کرد.

