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A method for detecting coronary artery stenosis based on ECG signals

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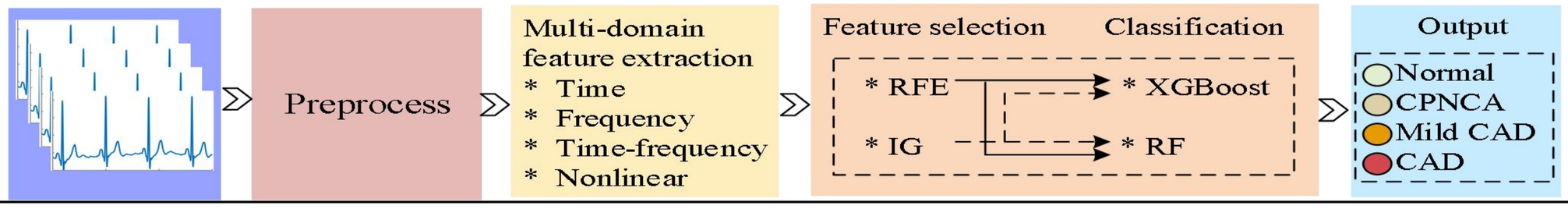
Objective: This study aims to correctly classifypatients with varying degrees of coronary artery stenosis (VDCAS) by utilizing multi-domain features fusion of single-lead 5-minute ECG signals and machine learning methods, so as to provide reference for physicians to diagnose the CAD development process.

Method:



Results:

(1) Results of feature selection

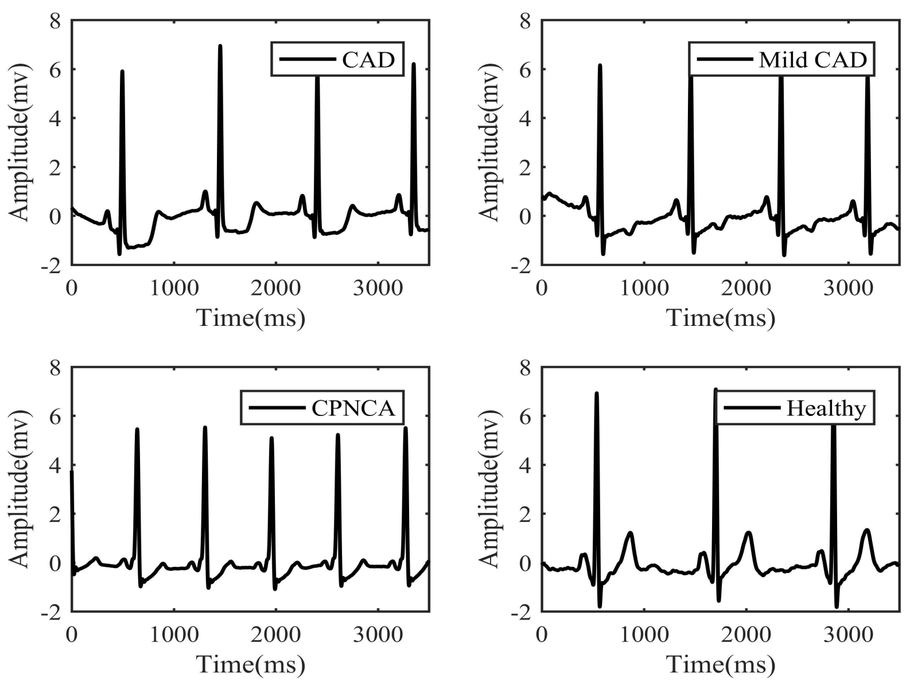


Figure 1. The ECG signals of different subjects,including (a) CAD patient, (b) mild CAD patient, (c) CPNCA patient, and (d) healthy patient.

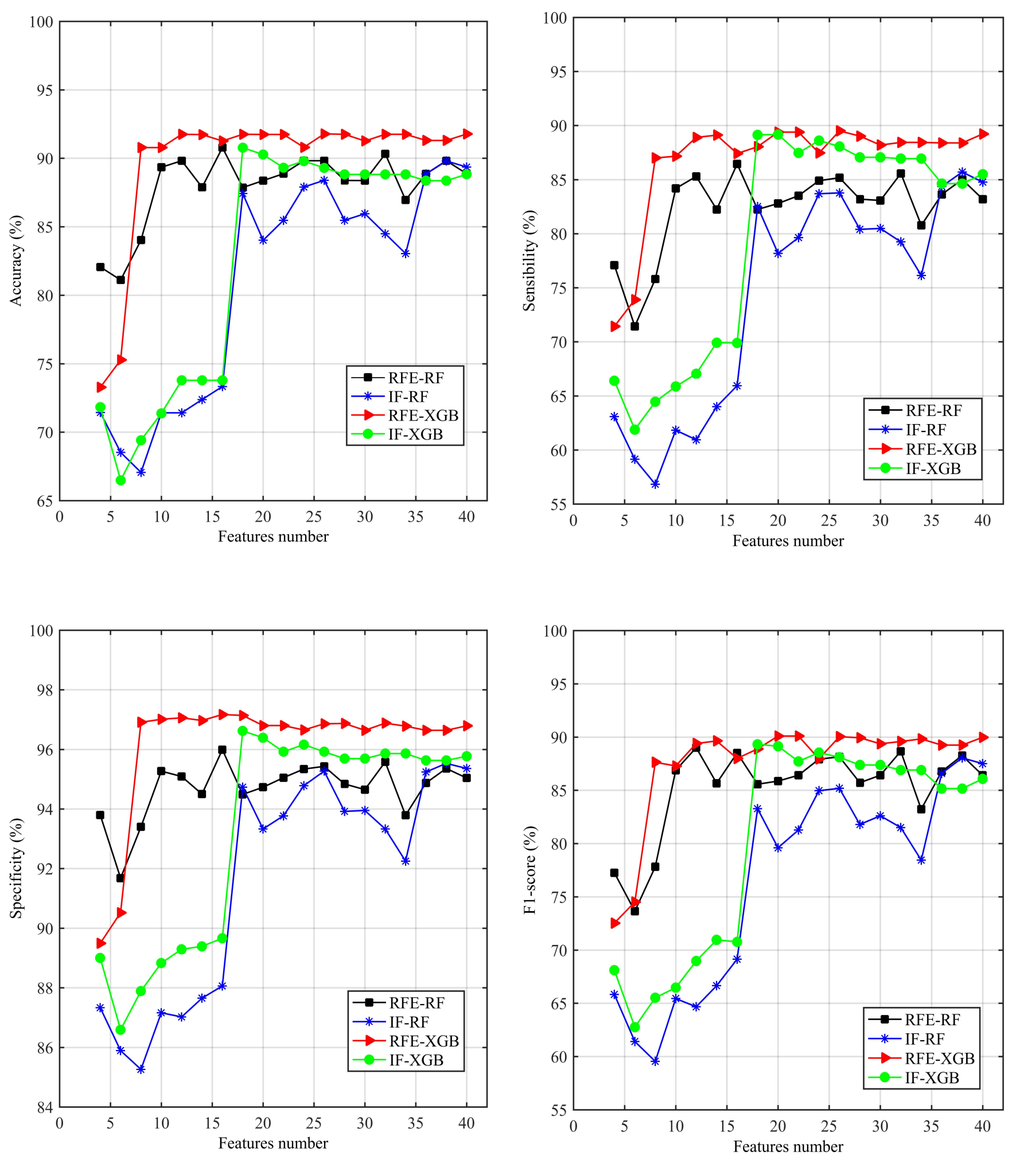


Figure 2. Classification results comparison of different feature numbers: (a) Accuracy; (b) Sensitivity; (c) Specificity; (d) F1-score.

(2) Classification results

Table 1 The comparison results of the two classifications

	Lable	Sensitive (%)	Specificity (%)	F1-score (%)	Accuracy (%)
RF	0 vs 3	90.00±13.33	90.0±14.91	94.18±7.91	97.69±3.07
XGB	0 vs 3	**100.0±0.00**	**93.33±9.13**	**99.02±1.19**	**98.46±1.88**

* Data are expressed as mean ± SD. Label 0 for health group, 3 for CAD group.

Table 2 The comparison results of the three classifications

	Lable	Sensitive (%)	Specificity(%)	F1-score (%)	Accuracy (%)
RF	0	97.53±2.01	82.35±9.84	92.97±2.40	-
	1	78.18±10.33	96.68±2.10	83.06±7.07	-
	2	83.33±10.54	100.00±0.00	90.54±6.34	-
	Mean	86.34±6.04	93.01±2.94	88.86±4.42	90.26±3.48
XGB	0	98.33±2.04	83.52±7.80	93.77±1.59	-
	1	78.18±7.60	98.67±1.63	85.34±8.90	-
	2	86.67±6.47	98.85±1.39	89.31±7.04	-
	Mean	**87.72±2.03**	**93.68±1.89**	**89.47±1.49**	**91.27±1.85**

* Data are expressed as mean ± SD. Label 0 for healthy group, 1 for patients with luminal narrowing 1-49%, and 2 for patients with luminal narrowing≥50%.

Table 3 The comparison results of the four classifications

	Lable	Sensitive (%)	Specificity (%)	F1-score (%)	Accuracy (%)
RF	0	73.33±10.60	99.42±1.14	80.84±8.89	-
	1	88.57±10.69	98.84±1.42	90.73±5.84	-
	2	100.00±0.00	86.92±5.44	93.48±2.54	-
	3	83.88±5.01	98.78±1.48	88.96±4.32	-
	Mean	86.44±3.92	95.99±1.16	88.50±3.79	90.78±2.32
XGB	0	90.00±8.16	97.71±2.13	88.67±5.90	-
	1	90.95±7.43	99.42±1.14	93.77±3.20	-
	2	98.00±4.00	92.55±6.85	95.13±3.01	-
	3	78.61±9.54	97.53±3.01	82.81±7.42	-
	Mean	**89.39±3.05**	**96.80±1.28**	**90.09±2.62**	**91.74±2.50**

* Data are expressed as mean ± SD. Label 0 for health group, 1for CPNCA group, 2 for mild CAD group, 3 for CAD group.

Conclusions:

- Multi-domain features fusion analysis of ECG signals can effectively excavate the hidden information of VDCAS.
- RFE combined with XGboost algorithm is effective in distinguishing VDCAS patients.

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