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Discrimination of Seismic Event Based on Waveform Characteristics of Different Seismic Phases

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INTRODUCTION

Discriminating the event type with seismic waveforms is a vital part of the verification work. One important implementation uses machine learning algorithms to process the characteristics of seismic waveform in the time-frequency domain.

METHODS/DATA

SVM, Fisher, and Bayesian probability methods were utilized for the event type discrimination. More than 500 seismic events with a magnitude below 3.0 ML around Beijing were collected in the categories of: natural earthquake, blasting and mining goaf collapse.

START

RESULTS

For the current research data, it is found that the SVM method exhibits the highest classification accuracy, followed by the Fisher and the Bayesian method.

CONCLUSION

The discrimination accuracy based on P wave and S wave is lower than the accuracy based on mean characteristics of events. The latter can be improved by adding the ratio parameter of P and S wave characteristics.

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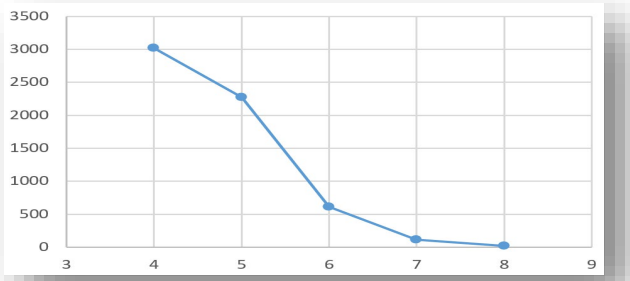
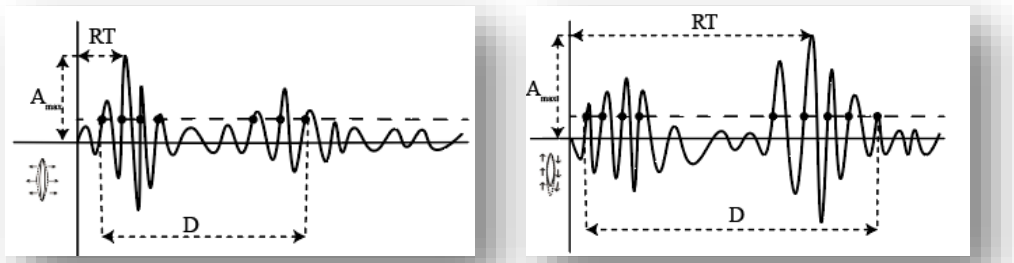
Introduction

There are many microseismic events such as artificial blasting, natural earthquake, and collapse of mining goaf occurring every day. And the number of these events shows an exponential increase as the magnitude decreases. Therefore, Machine Learning approach is highly preferred due to the great increase in repetitive labor intensity. Perfectly unambiguous indicator with threshold is desired to classify event types, despite the differences in the characteristics of seismic phases between different types.



Monitored seismic event number with magnitude



Waveform from different seismic event types

INTRODUCTION
OBJECTIVES
METHODS/DATA
RESULTS
CONCLUSION

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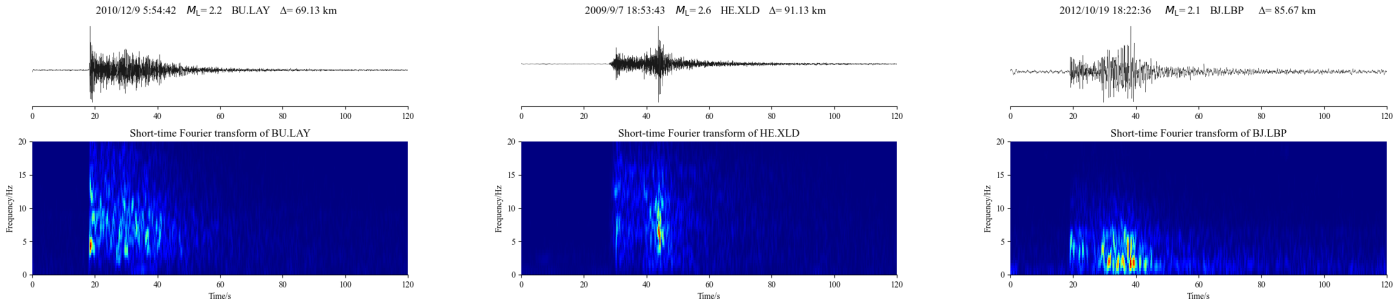
Objectives

Although the monitored events number is large for the same event type, the recorded waveforms(traces) differ in the end because of the different propagation paths, energy magnitudes, and source mechanisms.

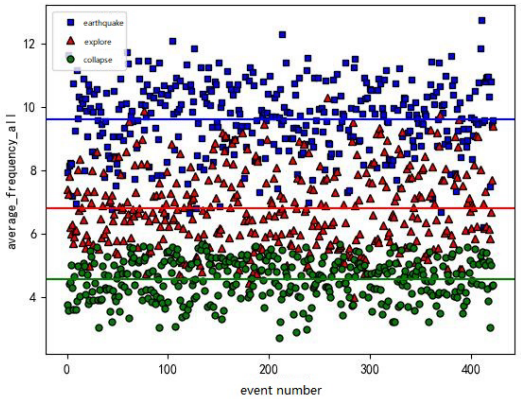
Therefore, this research attempts to analyze the ability of P/S phases characteristics in event type discrimination with three machine learning methods.

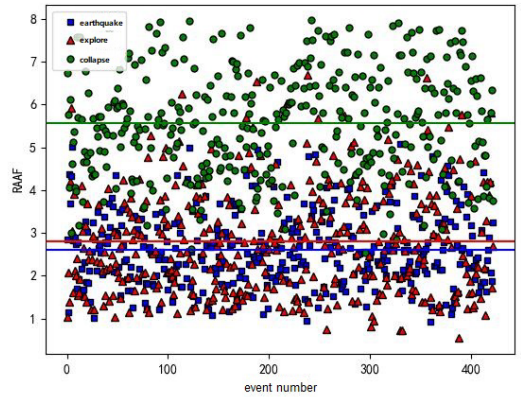
Methods/data

- **SVM, Fisher, and Bayesian probability methods** were utilized for the event type discrimination.
- Seismic events with a magnitude below 3.0 ML around Beijing were collected in the categories of: **natural earthquake**, **blasting** and **goaf collapse**.
- Characters from **the whole stream, P/S phases** and **ratio of P/S phases** were applied to investigate the accuracy.



Seismic event of blasting, natural earthquakes, and goaf collapse





Schematic of the distribution of some applied characteristics

INTRODUCTION
OBJECTIVES
METHODS/DATA
RESULTS
CONCLUSION

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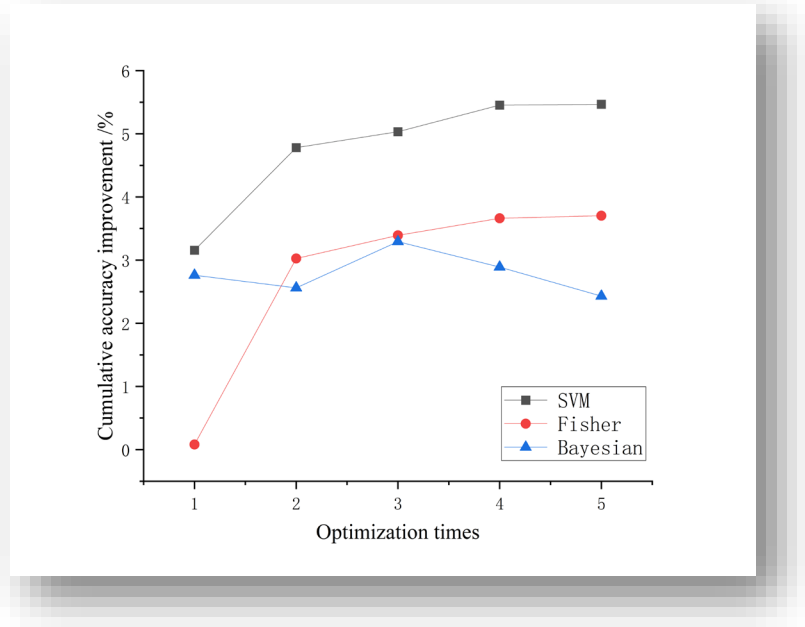
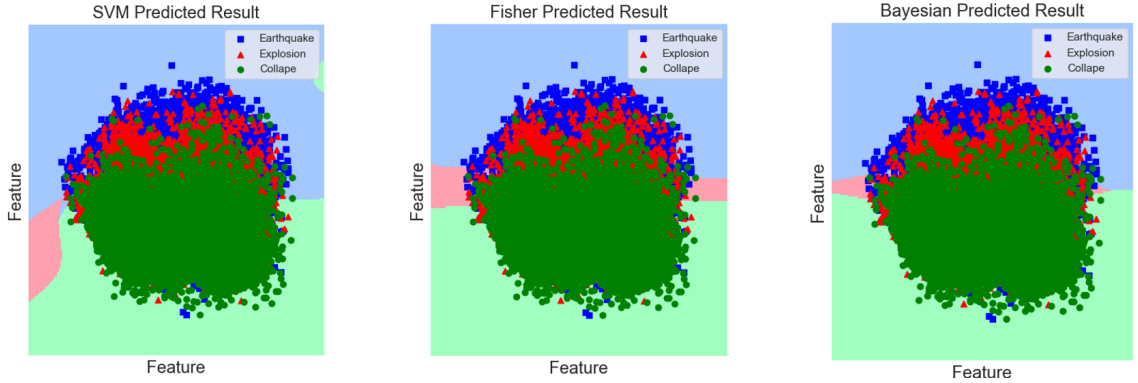
Results



Variation of discrimination accuracy with different waveform characteristics

- For the current research data, it is found that the **SVM method exhibits the highest classification accuracy**, followed by the Fisher and the Bayesian method.



Example of the discrimination results of the three methods (dimensionality reduction for visualization)

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Conclusion

- The discrimination accuracy based on P wave or S wave is lower than the accuracy based on the whole waveform.
- The discrimination accuracy can be improved by adding the ratio parameter of P and S wave characteristics.

References

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