Project I7:
Time Dependent Monitoring of Active Faults and Landslides Properties: Developing New Data Processing Approaches Based on Music Information Retrieval (MIR) Strategies

Reza Dokht Dolatabadi Esfahani

University of Potsdam
NatRiskChange Research Group

April 2019

Natural Hazards and Risks in a Changing World

Universität Potsdam

Outline

Introduction

Seismic data processing

Event detection

Introduction

Seismic data processing

Event detection

Moderate to large earthquake

Introduction

Seismic data processing

Event detection

- Moderate to large earthquake
- Weak earthquake
- Tremor
- Landslide

Introduction

Seismic data processing

- Event detection
  - Moderate to large earthquake
  - Weak earthquake
  - Tremor
  - Landslide
- First arrival picking

Introduction

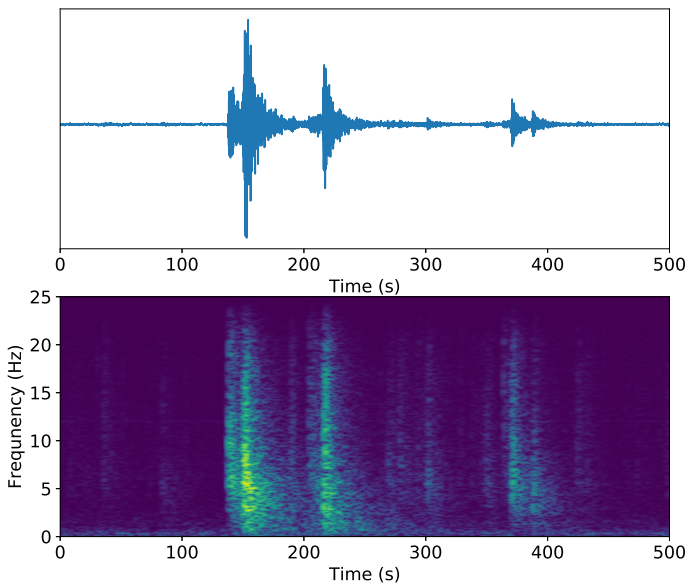
Seismic data processing

- Event detection
  - Moderate to large earthquake
  - Weak earthquake
  - Tremor
  - Landslide

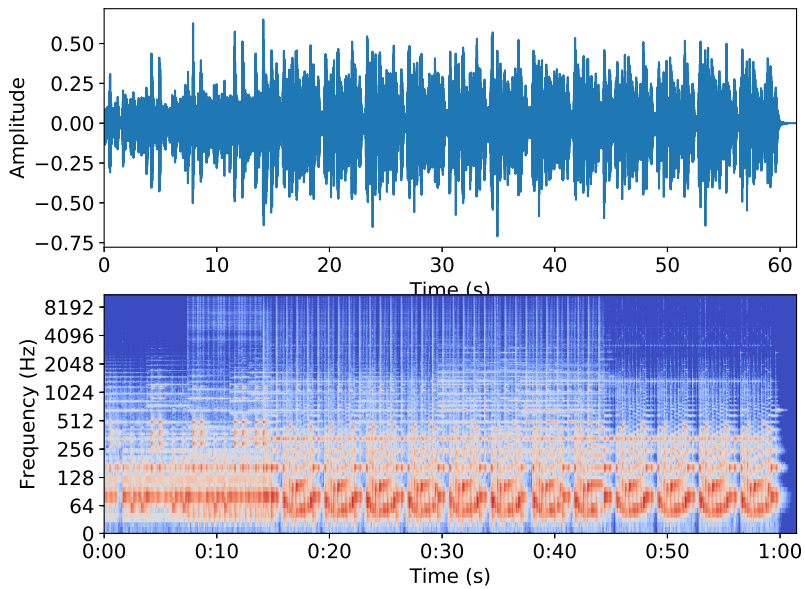
- First arrival picking
  - Determine first arrival time of detected event

Motivation

Seismic record

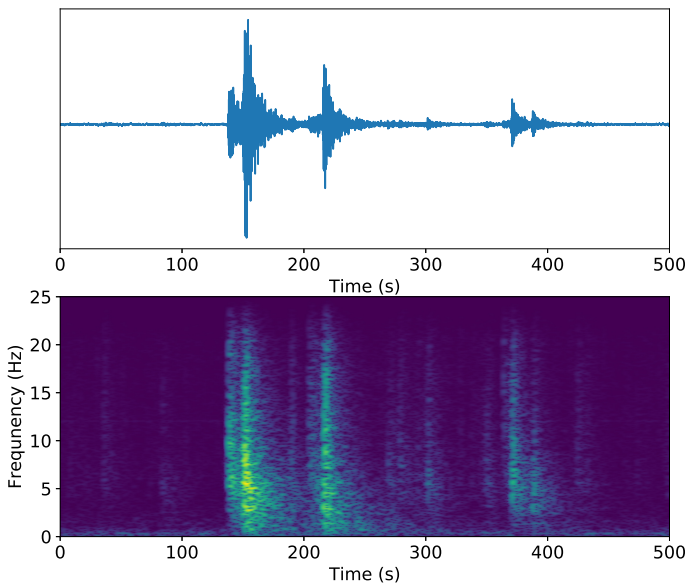


Audio record

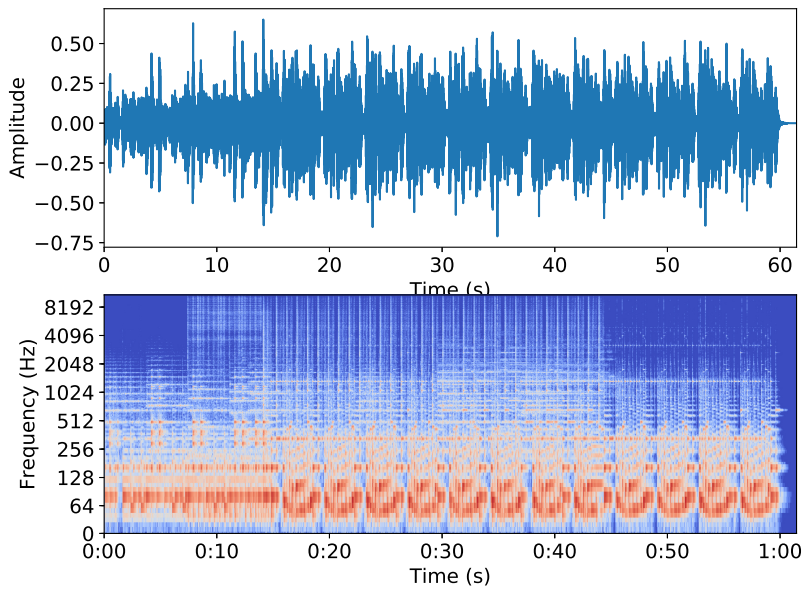


Motivation

Seismic record



Audio record



Music Information Retrieval

Music information retrieval

Goal

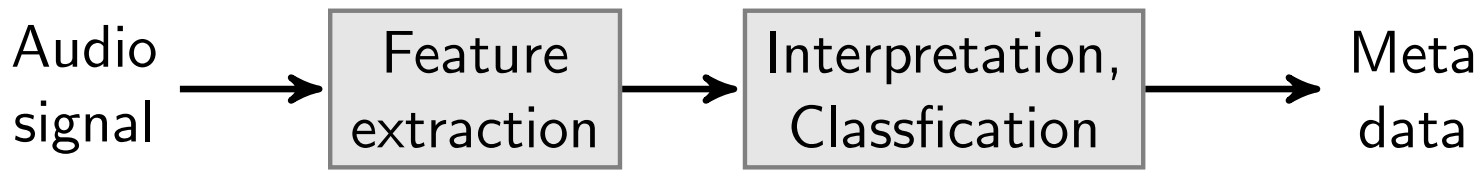
Analyze audio signal to extract information on musical content

Music information retrieval

Goal

Analyze audio signal to extract information on musical content

General flowchart

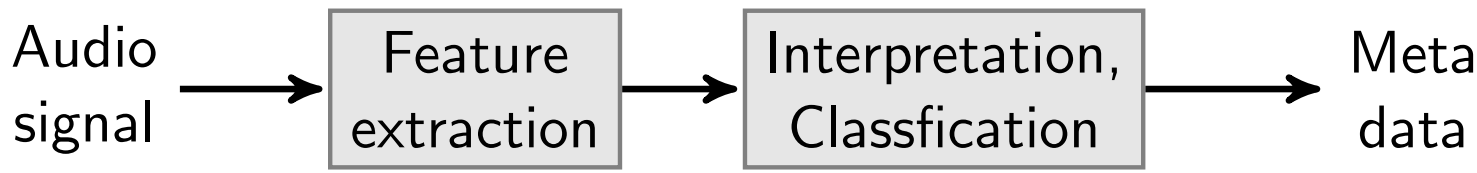


Music information retrieval

Goal

Analyze audio signal to extract information on musical content

General flowchart



Retrieval Tasks

- Onset detection
- Source seperation

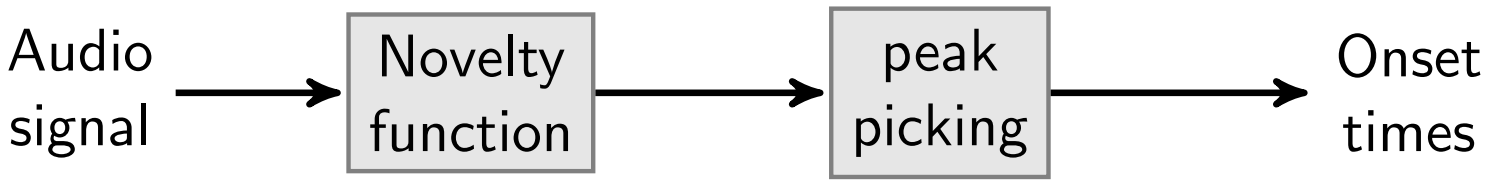
Onset detection

- Unknown number of voices and events
- Multiple event happen at one time

Onset detection

- Unknown number of voices and events
- Multiple event happen at one time

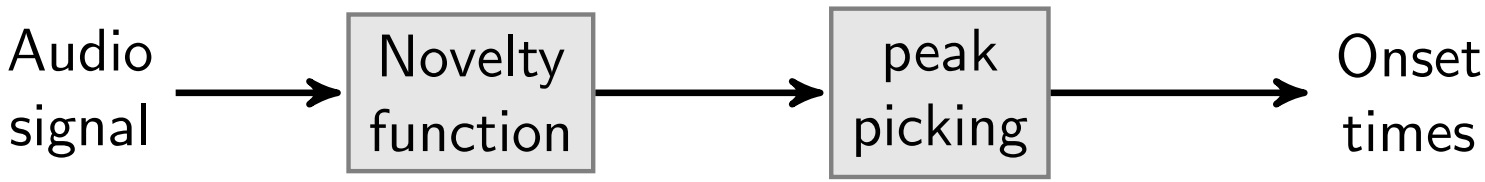
Onset detection



Onset detection

- Unknown number of voices and events
- Multiple event happen at one time

Onset detection



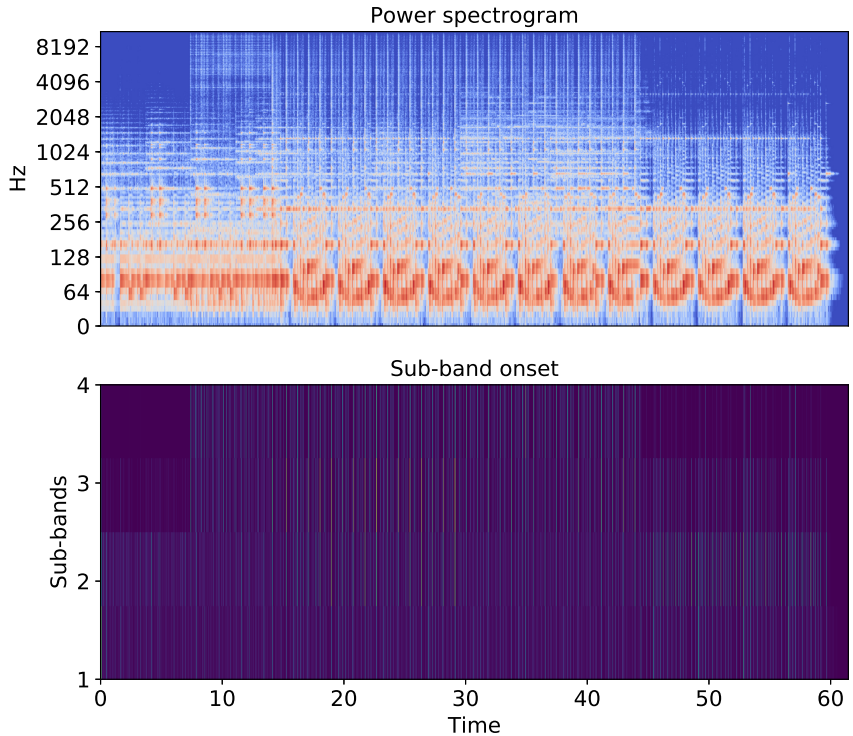
- Novelty function

  Measure of probability for new events
- peak picking

  Identify the most likely location for onsets

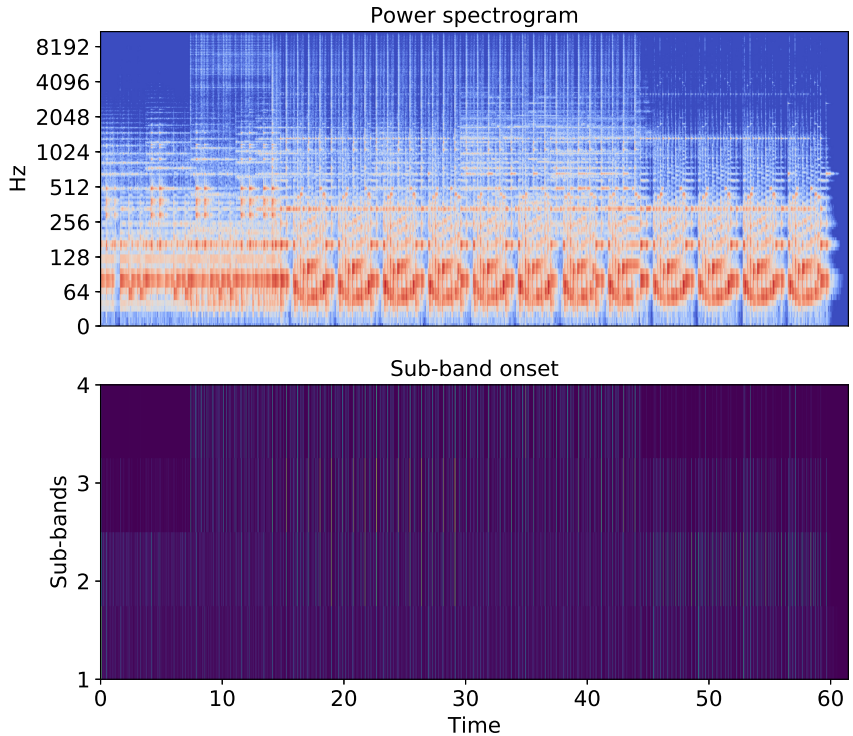
Onset detection method

- Flux novelty function



Onset detection method

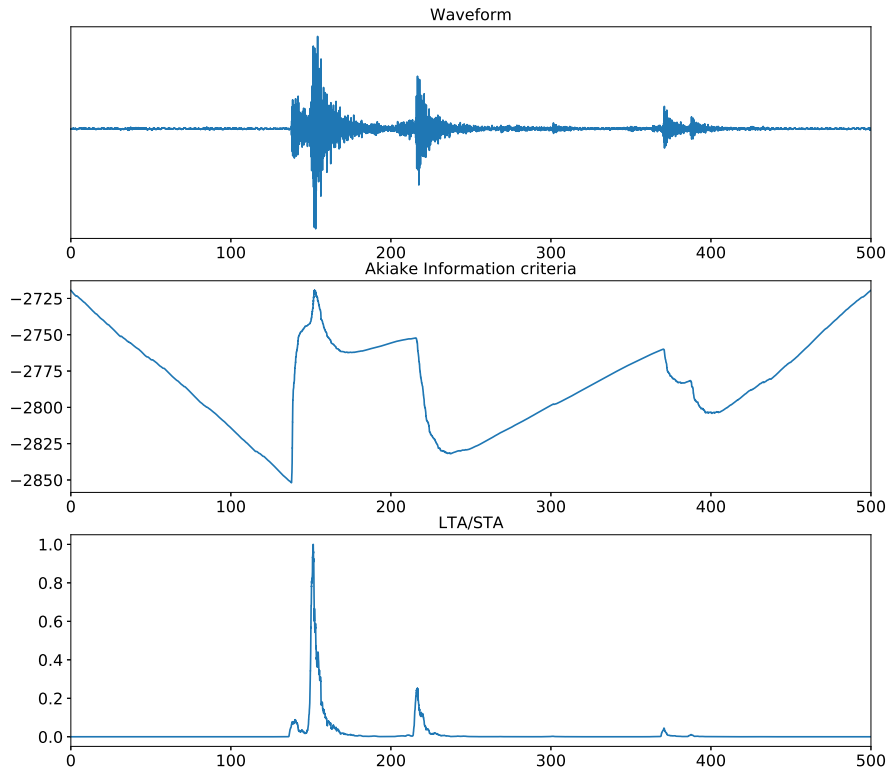
- Flux novelty function



- Neural network novelty function

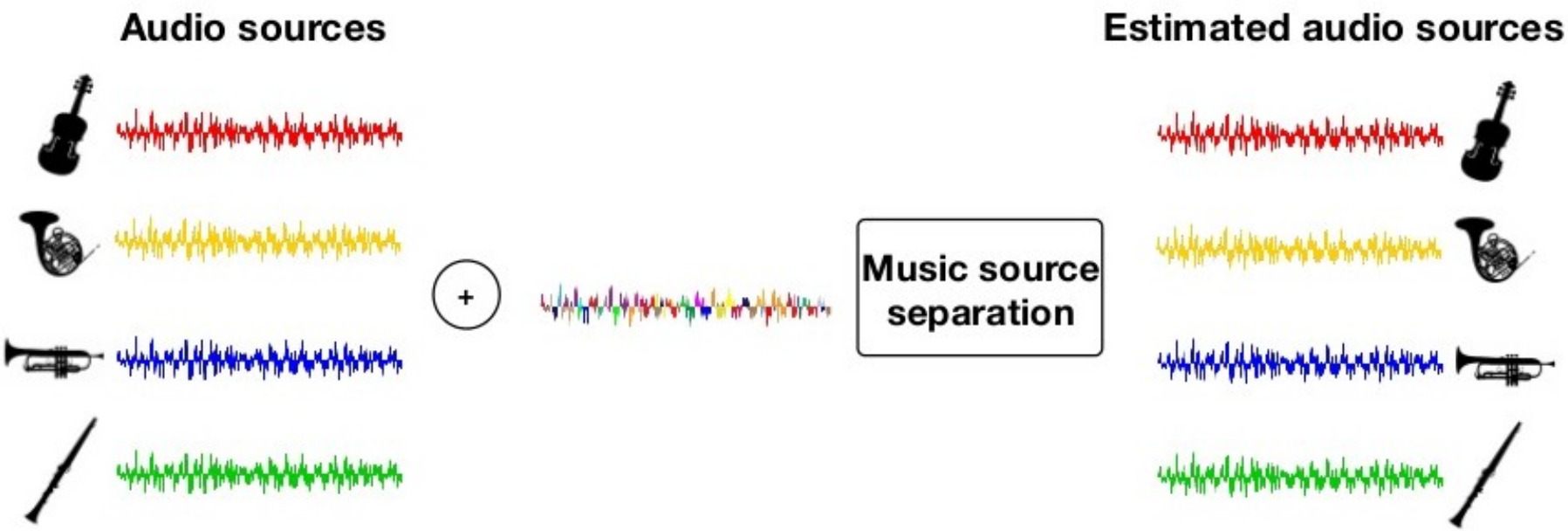
First arrival picking in seismology

- STA/LTA
- Akaike information criterion



Source separation

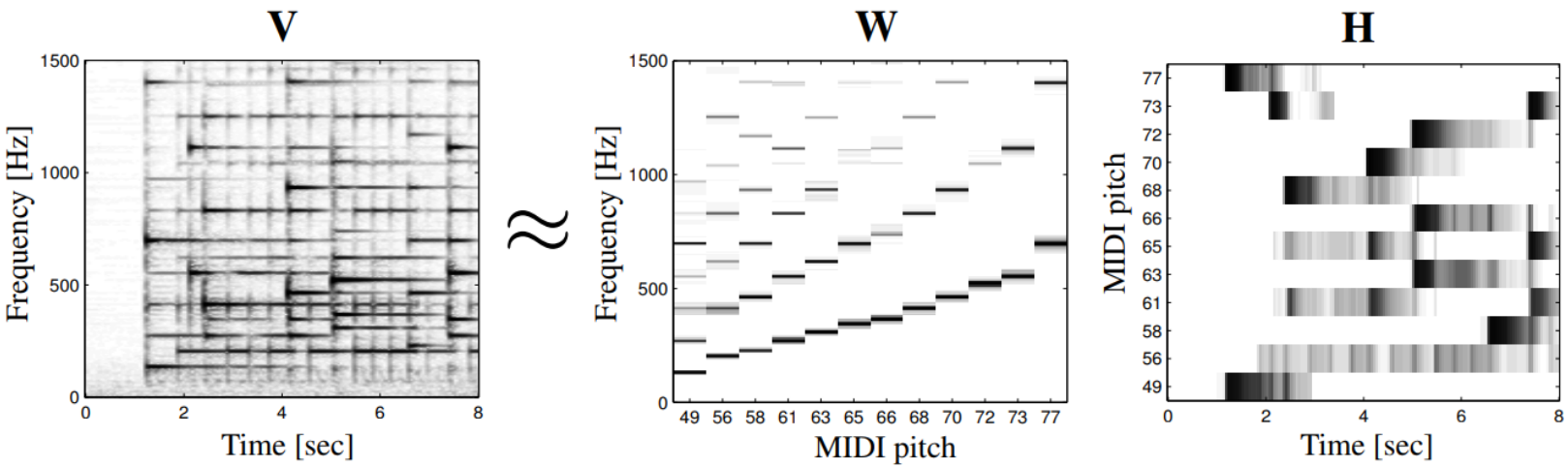
Separation of speech, music sounds, background noise,...



Source separation methods

Matrix decomposition

- Non-negative matrix factorization

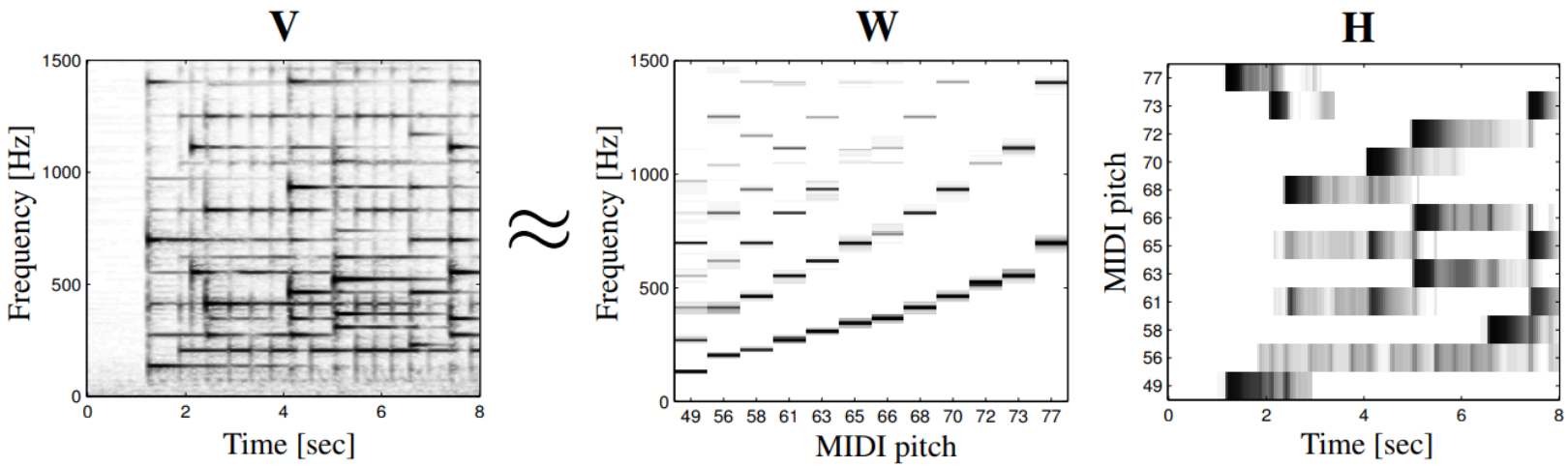


Muller et.al

Source separation methods

Matrix decomposition

- Non-negative matrix factorization



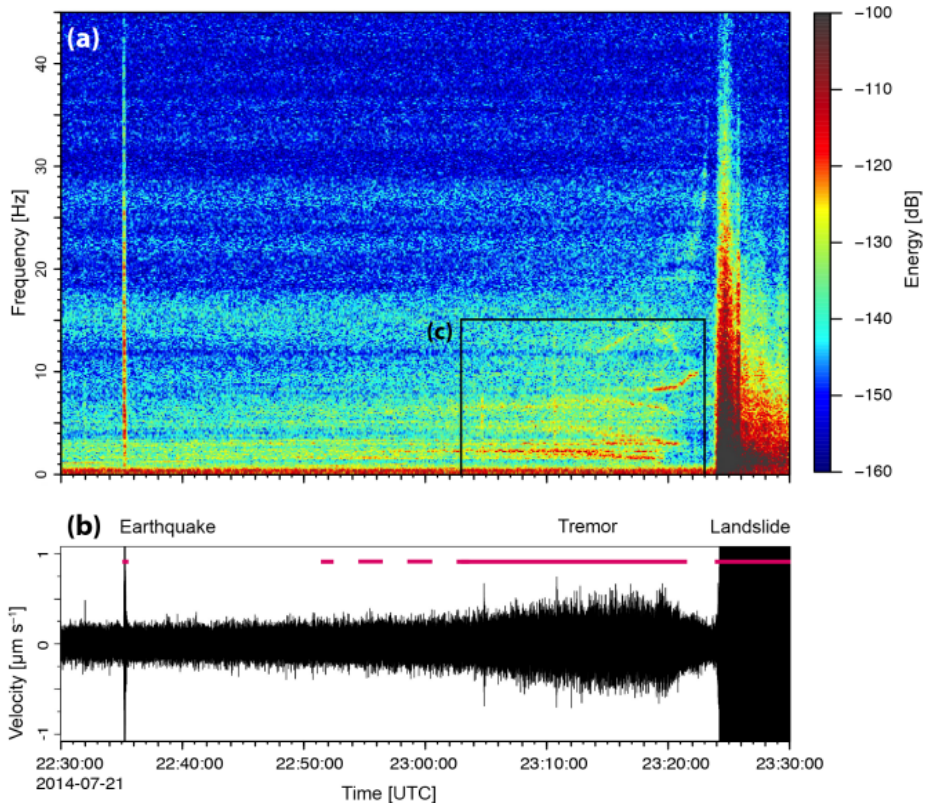
Muller et.al

Deep learning methods

- Auto-encoding

Seismic source separation

- Harmonic events
  - Tremor
- Percussion events
  - Landslide
  - Earthquake



Askja caldera landslide (July 2014), Schöpa et al.

Ph.D. plan

- Onset detection
  1. Apply MIR onset detection methods on seismic data
  3. Compare STA/LTA and Akaike information criterion methods with spectrogram novelity function
- Source separation
  2. Apply NMF to Real data to separate different waves
  3. Apply Autoencoding method to seismic data to separate different waves

Dimensionality estimation of ground motion data

- The aim of ground motion equation is to estimate the level of ground motion

Dimensionality estimation of ground motion data

- The aim of ground motion equation is to estimate the level of ground motion

$$\mathbf{y} = \mathbf{f}(\mathbf{x}) + \sigma$$

- **y**: Ground motion parameter (PGA, PGV, FAS, and ...)
- **x**: Explanatory parameters such as Magnitude, distance, stress drop, and ...
- σ: erorr term

Dimensionality estimation of ground motion data

- The aim of ground motion equation is to estimate the level of ground motion

$$\mathbf{y} = \mathbf{f}(\mathbf{x}) + \sigma$$

- **y**: Ground motion parameter (PGA, PGV, FAS, and ...)
- **x**: Explanatory parameters such as Magnitude, distance, stress drop, and ...
- σ: erorr term
- Problem: Most GMPEs have many independent parameter to explain the data

Dimensionality estimation of ground motion data

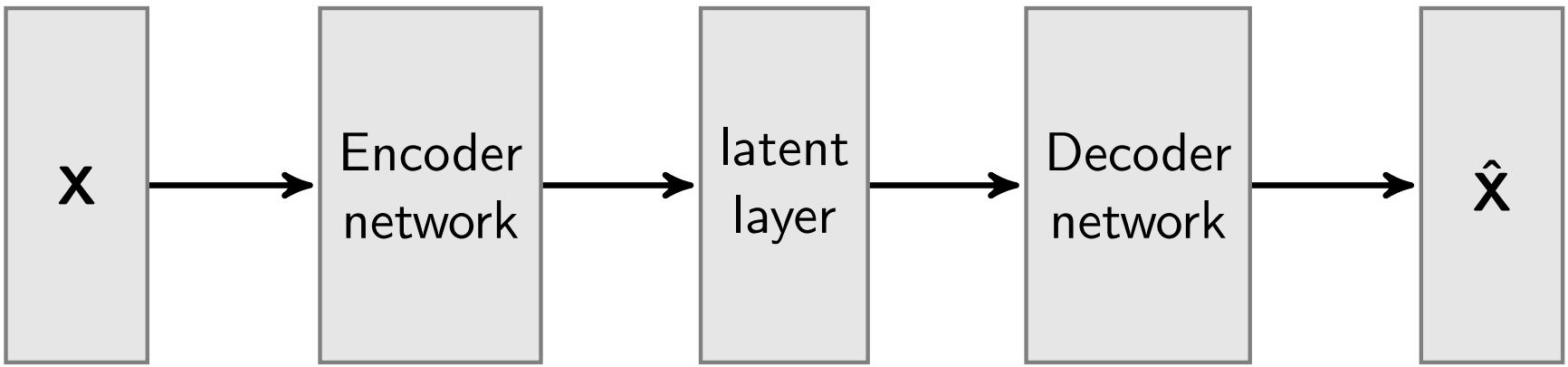
- The aim of ground motion equation is to estimate the level of ground motion

$$\mathbf{y} = \mathbf{f}(\mathbf{x}) + \sigma$$

- **y**: Ground motion parameter (PGA, PGV, FAS, and ...)
- **x**: Explanatory parameters such as Magnitude, distance, stress drop, and ...
- σ: erorr term
- Problem: Most GMPEs have many independent parameter to explain the data
- Goal: Find out the optimum number of model parameters for data

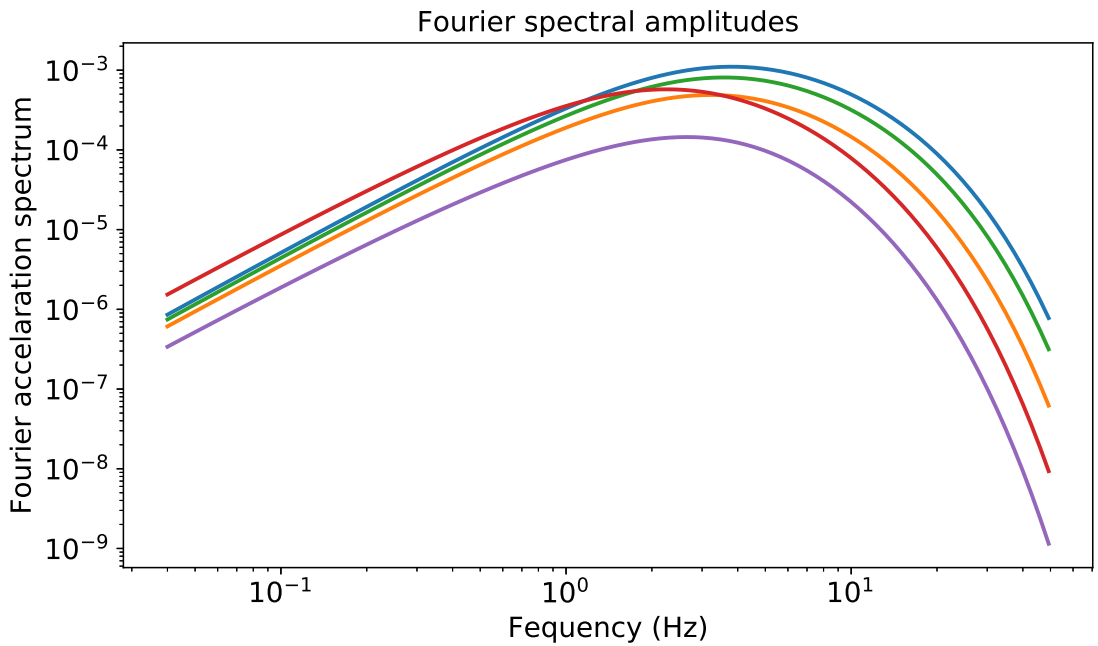
Autoencoding method

Compress data into latent-space representation and reconstruct data from this representation



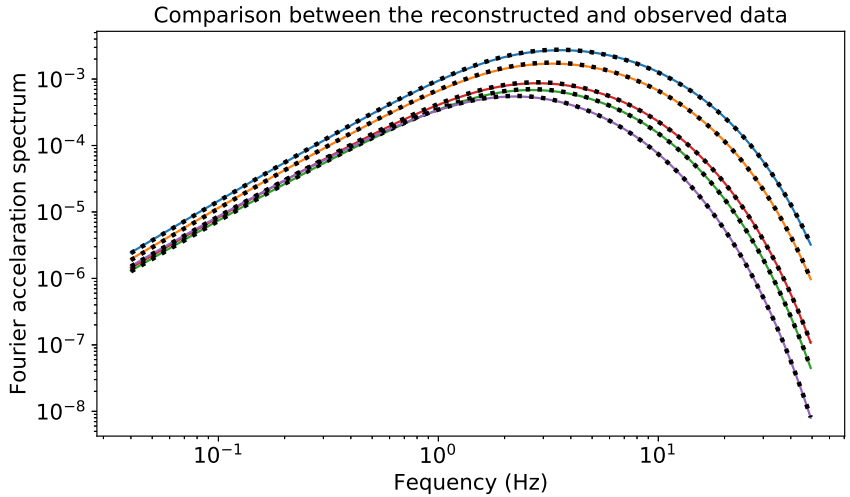
Synthetic results

- Simulating synthetic data with two variable
  - Magnitude
  - Distance



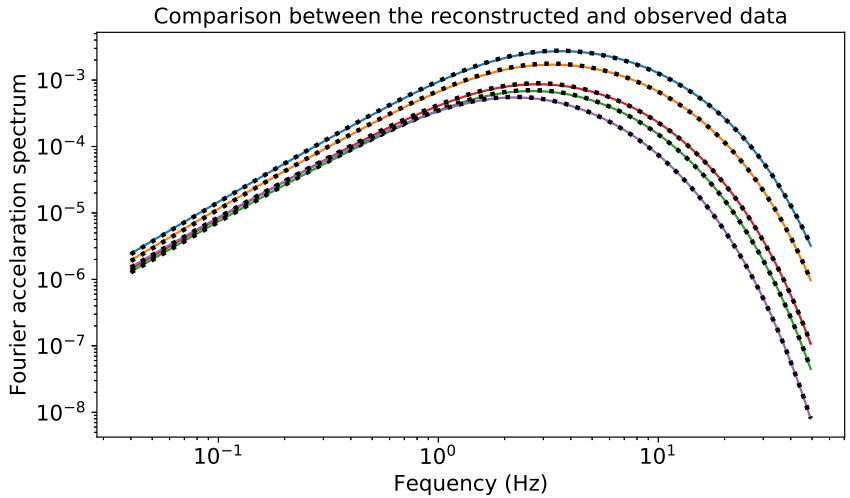
Results

- Reconstructed and observed data

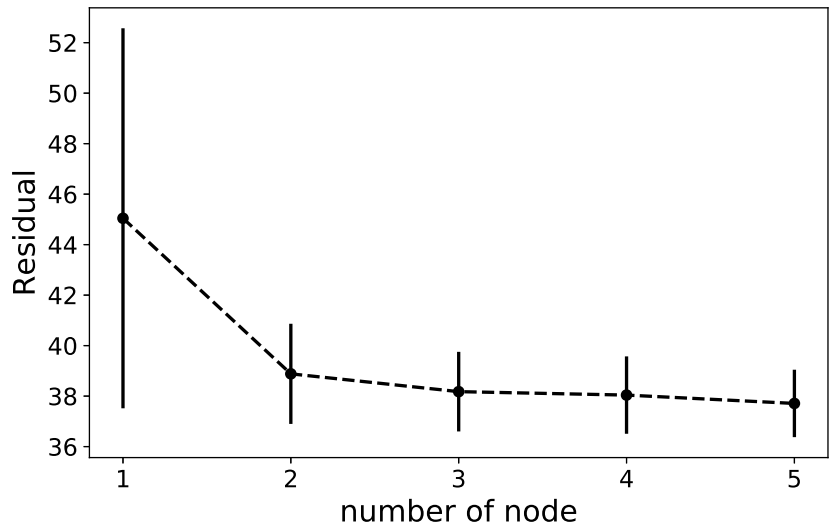


Results

- Reconstructed and observed data



- Residual error based on number of node in latent layer



Thank you