Score-informed Estimation of Pitch-Gliding and Vibrato in Trumpet and Saxophone Solos

Jakob Abeßer

Liszt School of Music, Weimar, Germany

Fraunhofer IDMT, Ilmenau, Germany

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Background

- **Jazzomat Research Project** (Liszt School of Music)

- Analysis of the **personal style** of jazz musicians

    - Micro-timing, dynamics, timbre, intonation, **articulation**

    - **Articulation techniques**

        - **Vibrato**

        - **Fall-off**

        - **Slide**

    - **Approach** → Analysis of the f_0-contour

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Dataset & Transcription

- **19 jazz solos** from the **Weimar Jazz Database**
  - Brown, Hawkins, Hubbard, Byas, Eldridge, Rollins
- **Manual solo transcriptions**
  - **Sonic Visualizer** used for annotation
  - Created & cross-checked by musicology & jazz students
  - **Note parameters** (MIDI pitch, onset, offset)
  - **Articulation** annotated as text layer

Dataset & Transcription

- Examples (Sonic Visualizer)

Articulation techniques in theory ...

- **Articulation techniques**

  - **Fall-off:** stationary part → move down
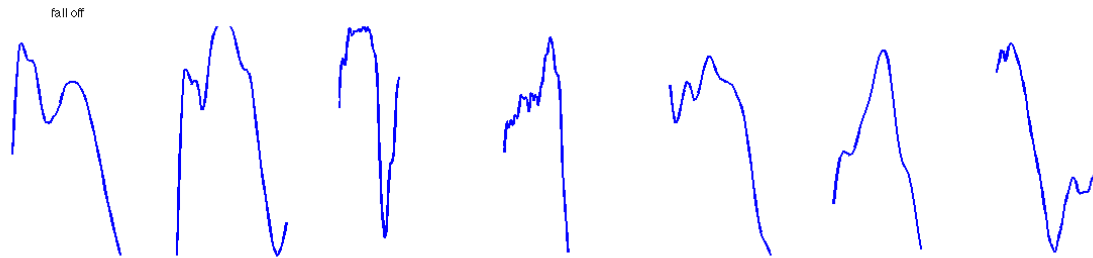
  - **Slide:** move up / down → stationary part
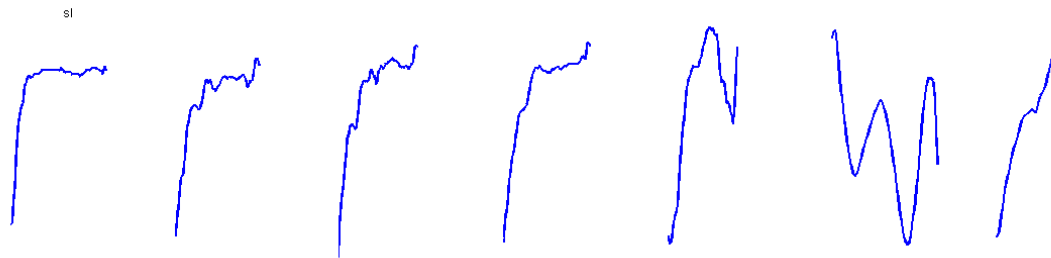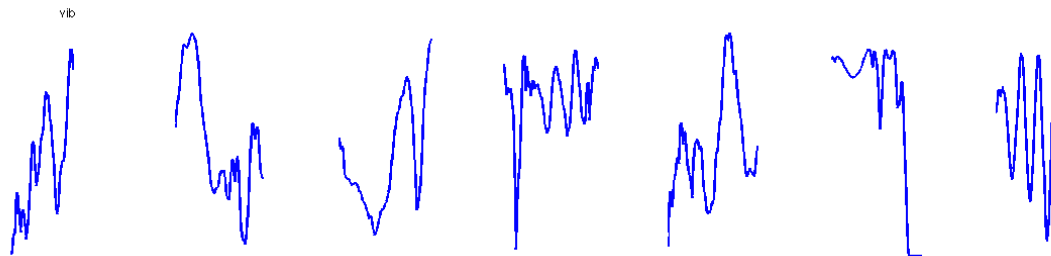
  - **Vibrato:** frequency modulation
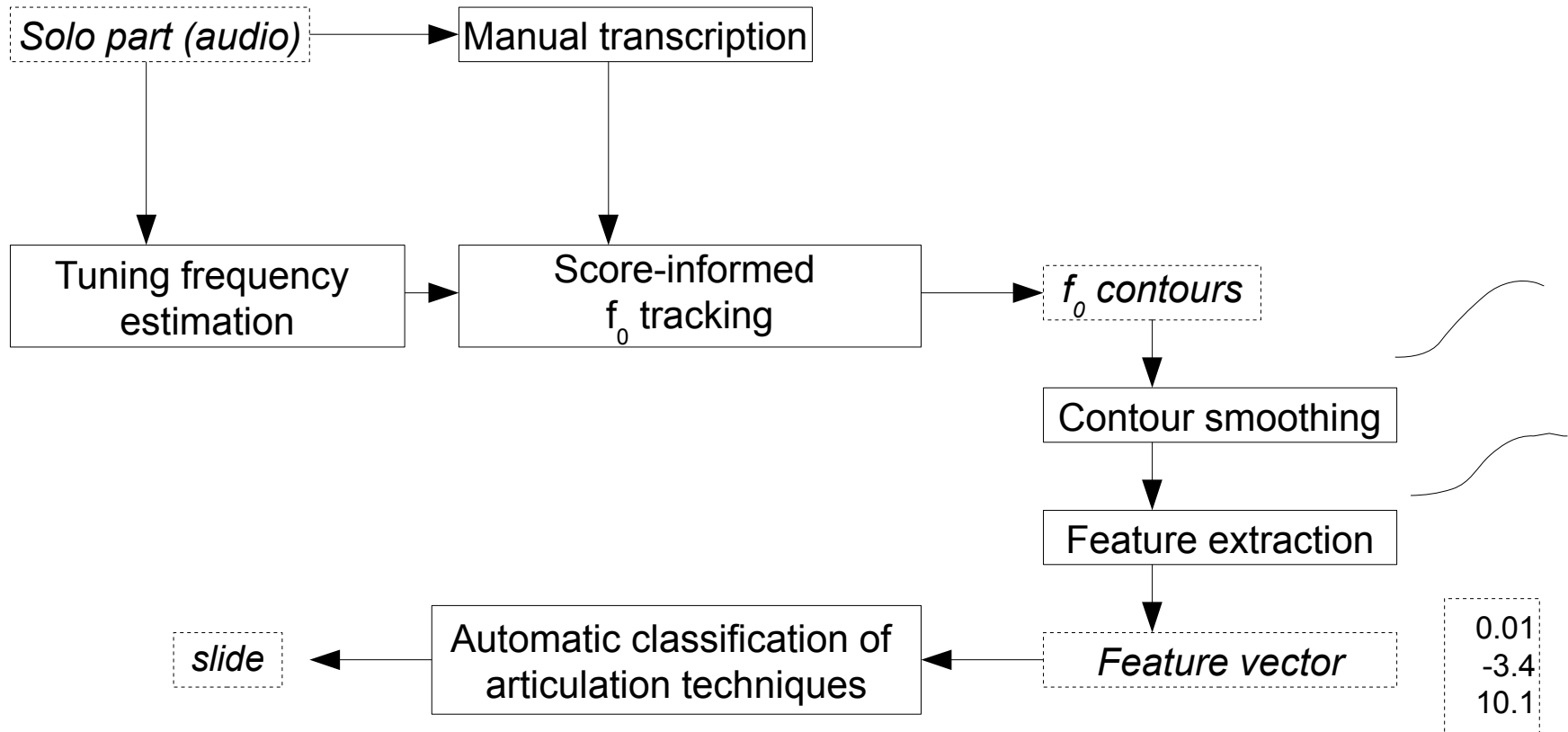
… and in reality

- Fall-off

- Slide

- Vibrato

# Proposed Method

Proposed Method

- **Reference Tuning Frequency Estimation**
    - **Tuning deviations** (instrument tuning, playback speed variations ...)
    - Analysis of **reference part** (without soloist playing)
    - Estimation of **reference tuning frequency** f_{ref}
        - Tuning estimation from **Chroma Toolbox for Matlab**
        - **Triangular filterbank** based on tuning hypothesis
        - **Modifications**: search range 440 Hz +/- ½ semitone, stepsize: 0.1 cent

Score-informed f$_0$ tracking
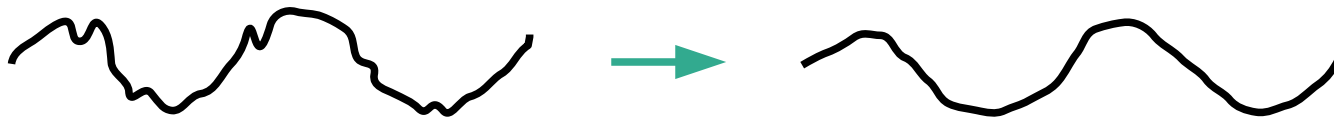
- **Procedure**
  - Finding **optimal starting location** for tracking
  - **Tracking** (fowards/backwards) based on **peak detection & proximity**
  - Example (Stompin' At The Savoy, Coleman Hawkins, saxophone)
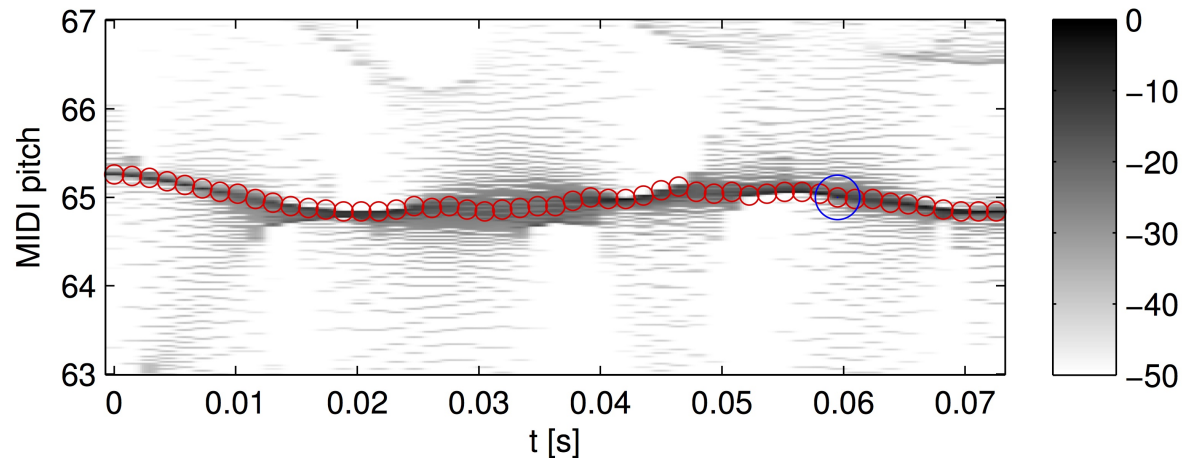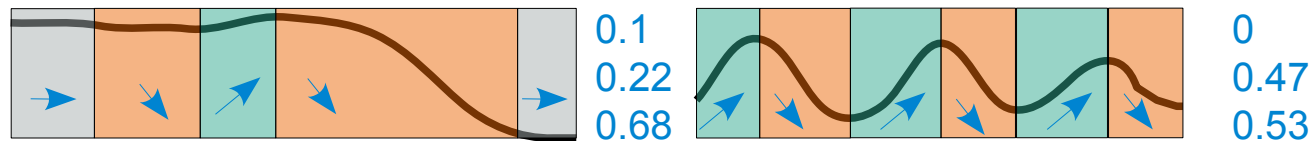
Feature Extraction

■ **Smoothing**

    ■ Low-pass filtering

        ■ Reduce influence of local tracking errors
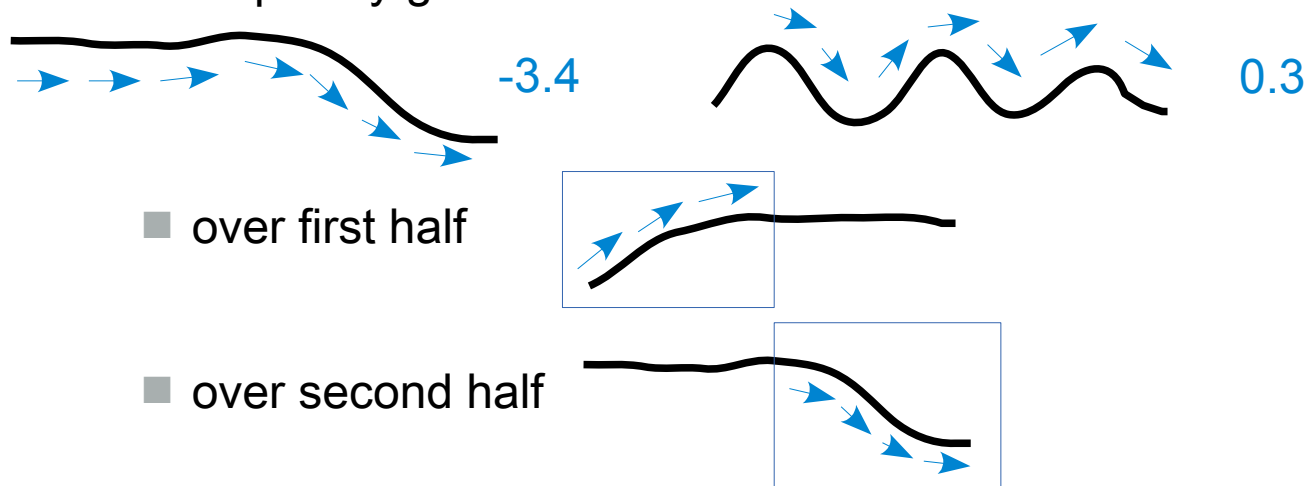
        ■ Make contours smoother

Feature Extraction

- **Frequency tendency**
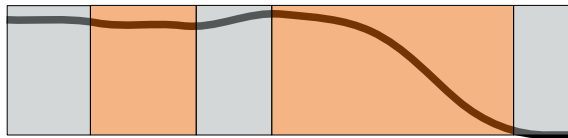 - Ratio of constant / ascending / descending segments

0.1
0.22
0.68

0
0.47
0.53

  - Median frequency gradient

-3.4

0.3

    - over first half

    - over second half
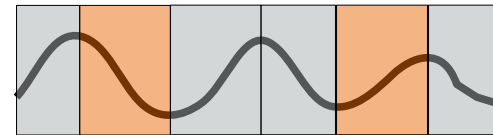
Feature Extraction

■ **Frequency tendency**

■ Fraction of longest segments → fluctuation vs. continuity

0.51   0.32
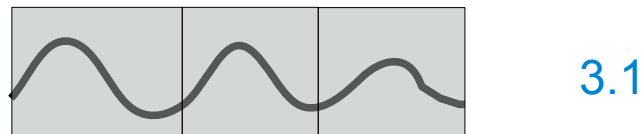
Feature Extraction

■ **Frequency modulation**

■ Modulation frequency (Hz)

6.73 (Hz)

■ Modulation range (cent)
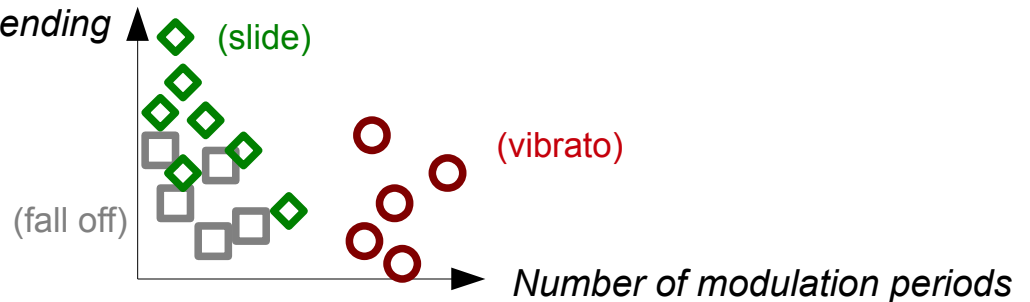
60.4 (cent)

■ Number of modulation periods

3.1

Experiment → 1-vs-N Feature Selection

- Feature selection → rank features based on class separability

  - **Example**

    Ratio of ascending segments

    (slide)

    (vibrato)

    (fall off)

    Number of modulation periods

  - **Vibrato vs. N**

    Rank 2

    (slide)

    (vibrato)

    (fall off)

    Rank 1

  - **Slide vs. N**

    Rank 1

    (slide)

    (vibrato)

    (fall off)

    Rank 2
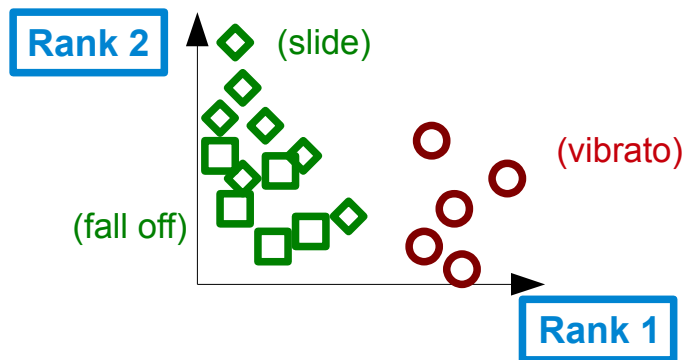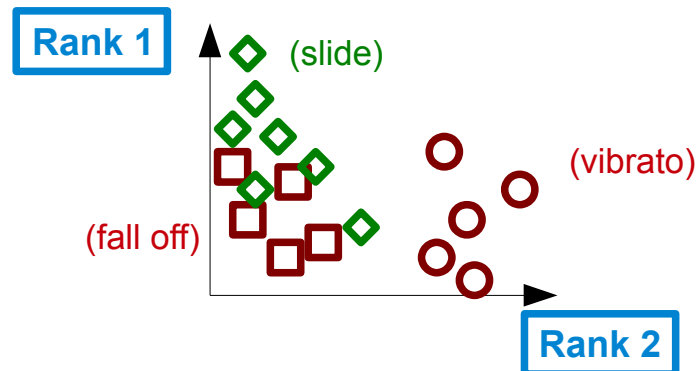
Experiment → 1-vs-N Feature Selection

- Fall off
  - Ratio of descending segments (>)
  - Fraction of longest segments (>)
- Slide
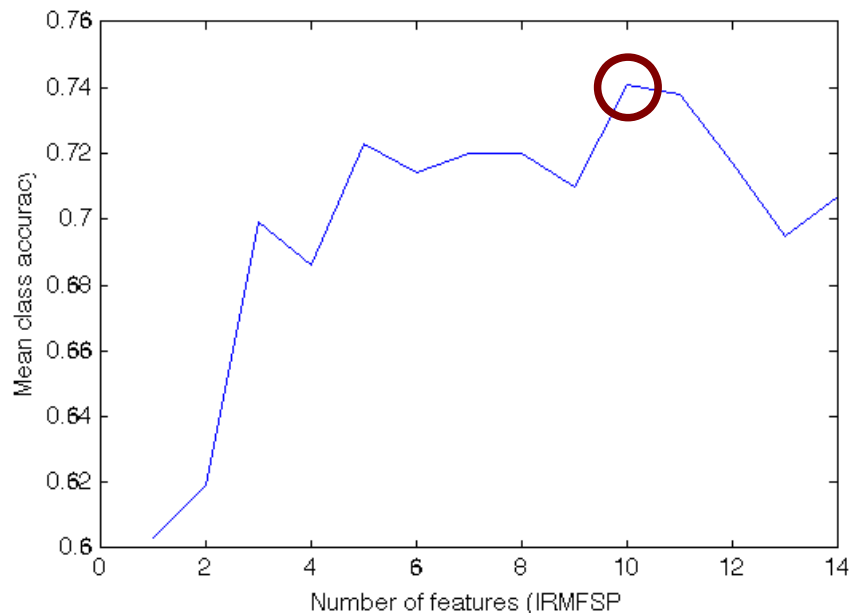 - Number of descending segments (<)
  - Fraction of longest segments (>)
- Vibrato
  - Number of modulation periods (>)
  - Fraction of longest segments (<)
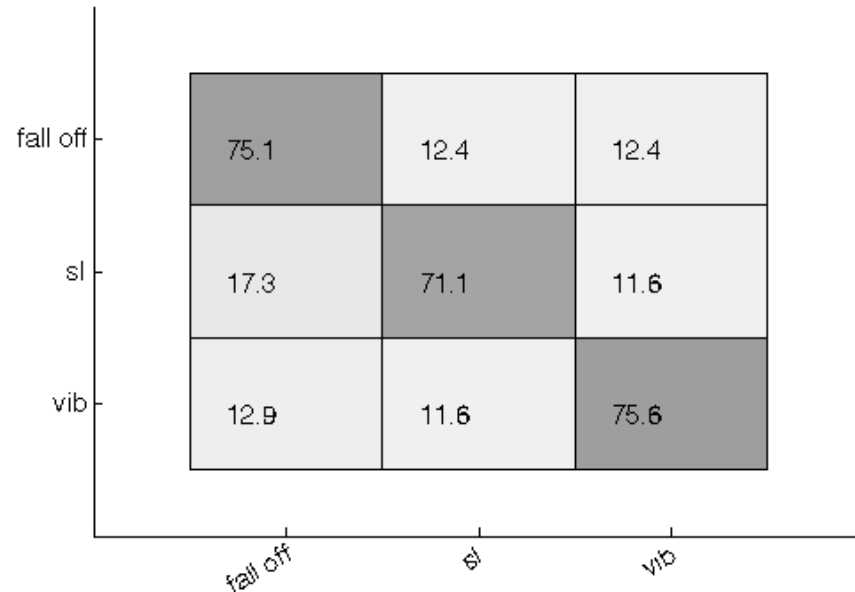 - Modulation range (cent) (>)

Evaluation → Automatic Classification

- 20-fold cross-validation

    - 20 x experiment: Take 19/20 for training and test on 1/20

- Mean class accuracy vs. Number of features (feature selection)

Evaluation → Automatic Classification

- Confusion matrix (best configuration)

Results

- Score-informed tracking of f0 contours

- Set of features to characterize

  - Contour tendency

  - Frequency modulation

- Discriminative properties of articulation techniques slide, fall off, vibrato confirmed

- Automatic classification with a mean accuracy of 70.3 %

Open Issues

- Annotation

    - Articulations may exceed note boundaries (e.g., slide in)

    - Include articulation techniques bend & straight

    - Multi-class annotations (e.g., slide + vibrato)

    - Subclasses ?

        - "... the Coltrane: /-\, the quick bend: /\, the Murray /~\/-~\ … "

- Tracking errors (interference from other harmonic instruments)

- Generic prediction model ↔ Models optimized to

    - Artist

    - Instrument

Thank you!

- Questions?