What we can learn about musical performance practices by studying audio recordings

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Motivations.

A brief history 2
Quantitative approaches to performance analysis.

Extracting Performance Data from Recordings 3
MIDI-audio alignment for automatic analysis of recorded performances.

Experiments 4
Studies of intonation in the singing voice.

Conclusions 5
Summary and future directions.

Introduction

Why study musical performance?

- **Performances convey musicians' interpretations**
- **Performances are what listeners actually hear**
- **Studying performance can help us gain insight into**
  - commonality between performers
  - how an individual's performance practice evolves as they gain more experience
  - how performance practices evolve over time

Introduction

What do I mean by studying performance?

- **Using (live) recorded performances**
- **Measuring performance parameters**
  - timing
  - dynamics
  - **tuning**
  - timbre
- **Assessing relationship between performance of various parameters and musical materials**

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Quantitative Performance Analysis

A brief history

Pioneers

Binet and Courtier
Sears
Miller

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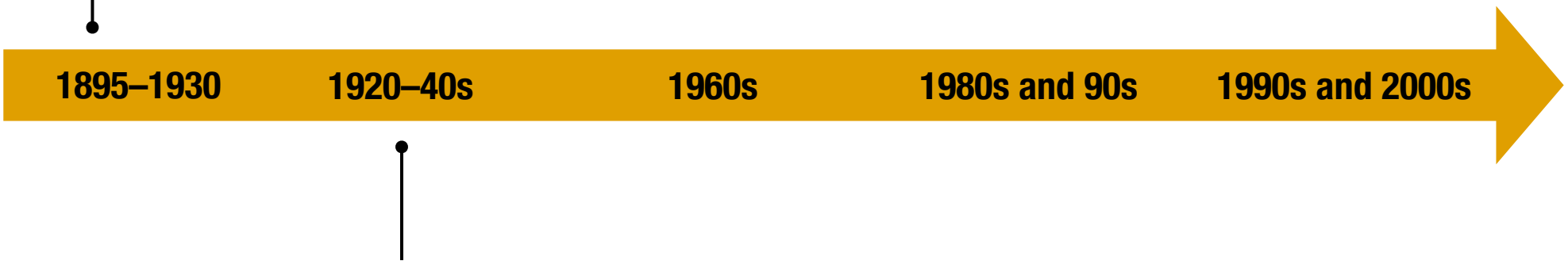
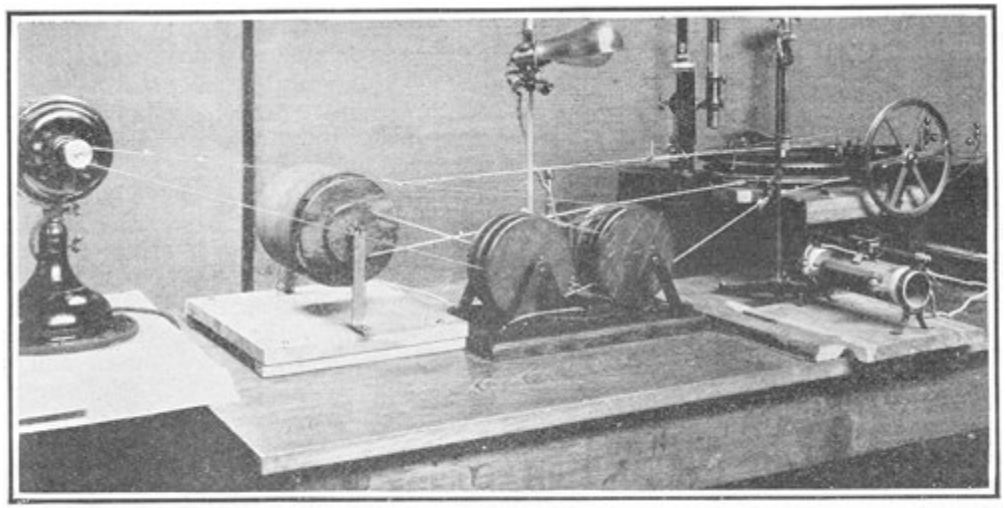


University of Iowa
Seashore and colleagues

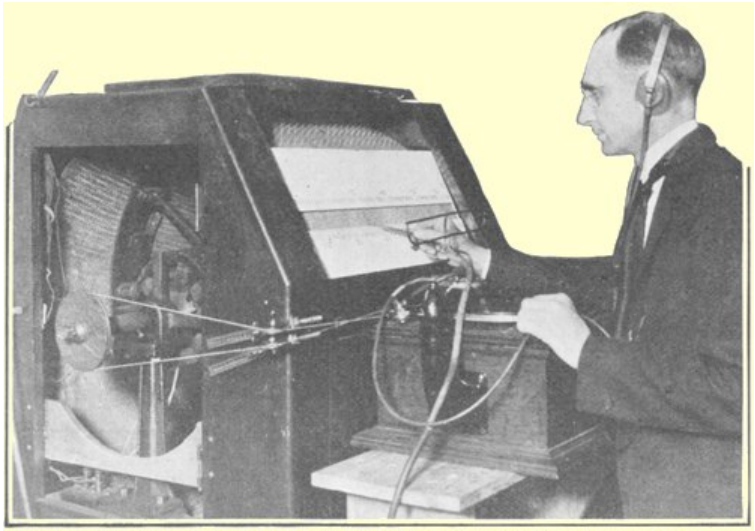
Quantitative Performance Analysis

University of Iowa

- **Carl Seashore (1938) and colleagues studied timing, dynamics, intonation, and vibrato in pianists, violinists, and singers**
  - Equipment: piano rolls, films of the movement of piano hammers during performance, phono-photographic apparati



Wave recorder for use with disk phonograph; the lever, acting like a pantograph, traces the waves on a revolving smoked drum

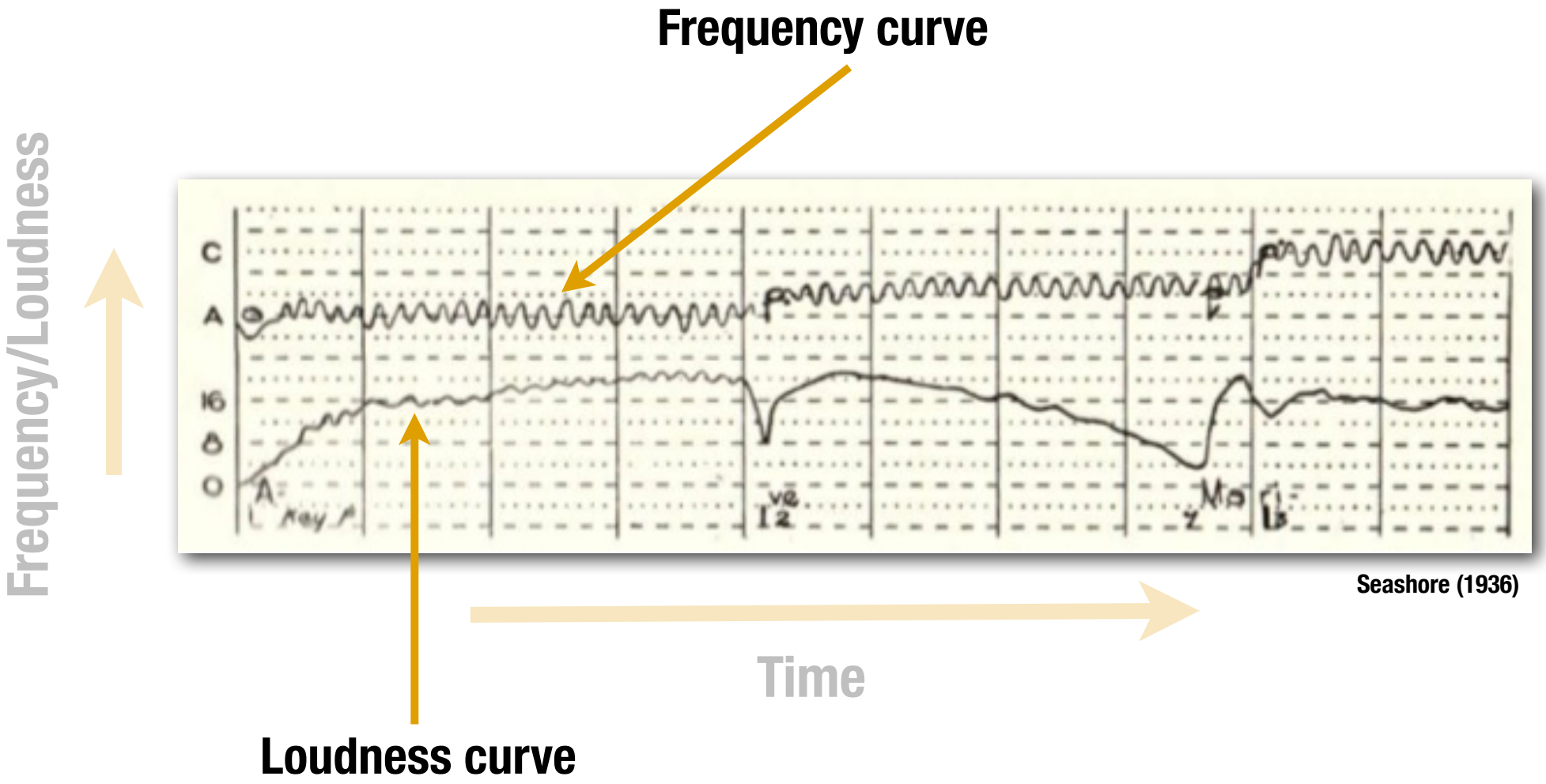


The tonoscope for analyzing the pitch of the tones on a disk phonograph record

Cary (1922)

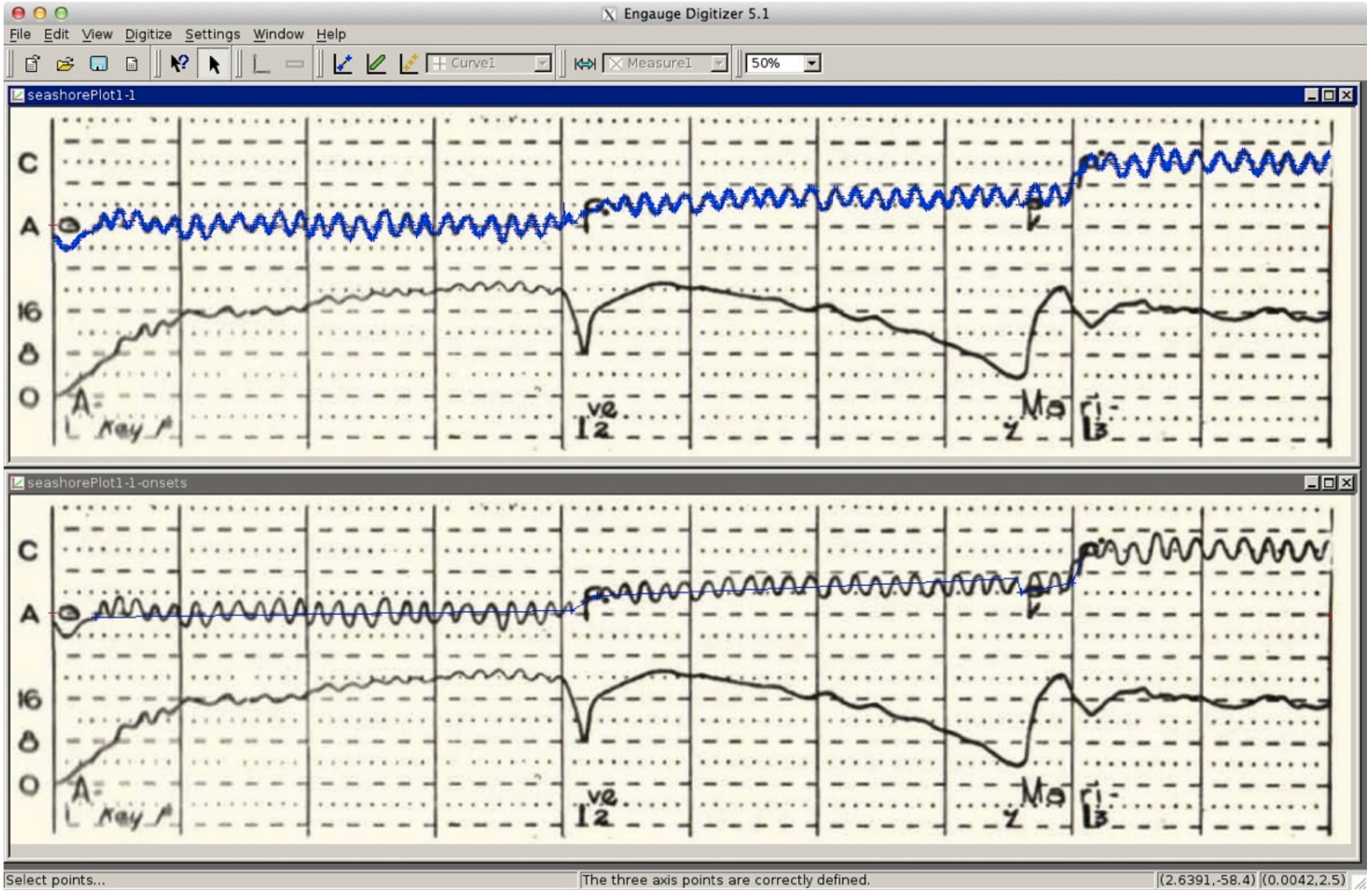
Performance Scores

University of Iowa



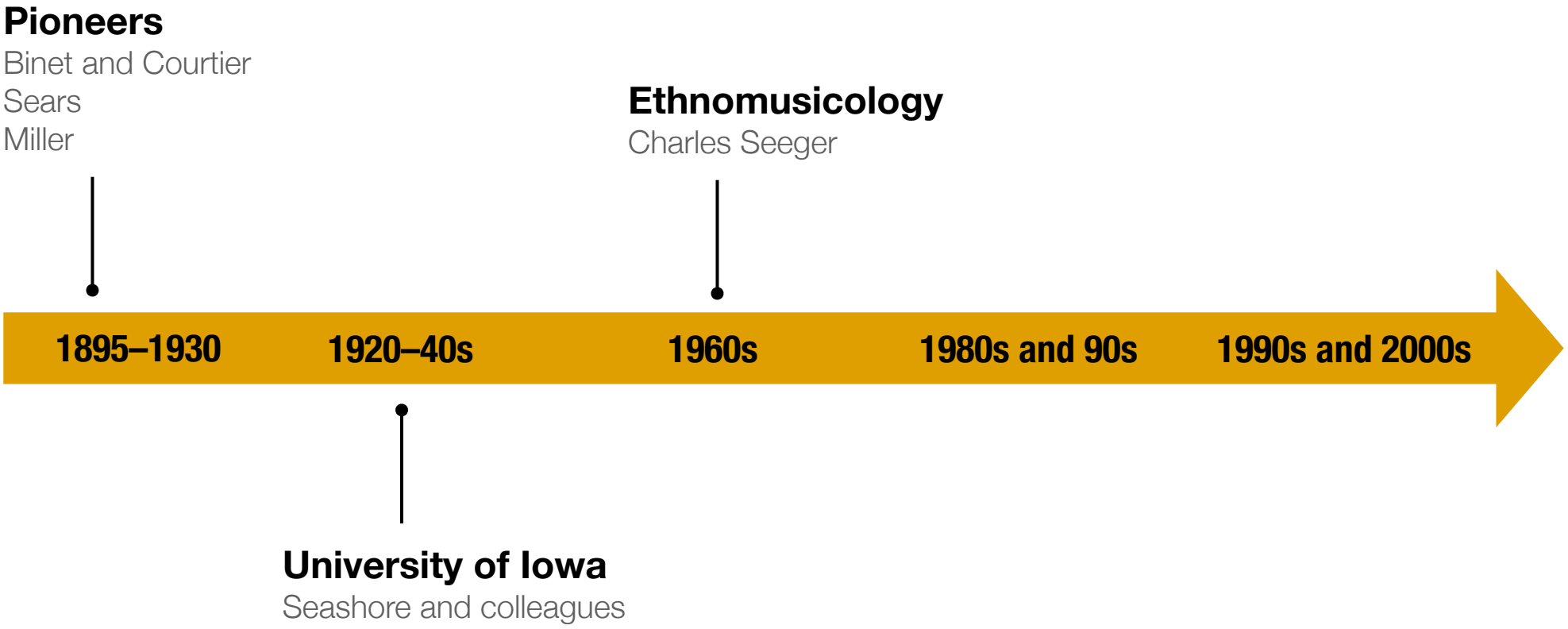
Performance Scores

Digitizing the data



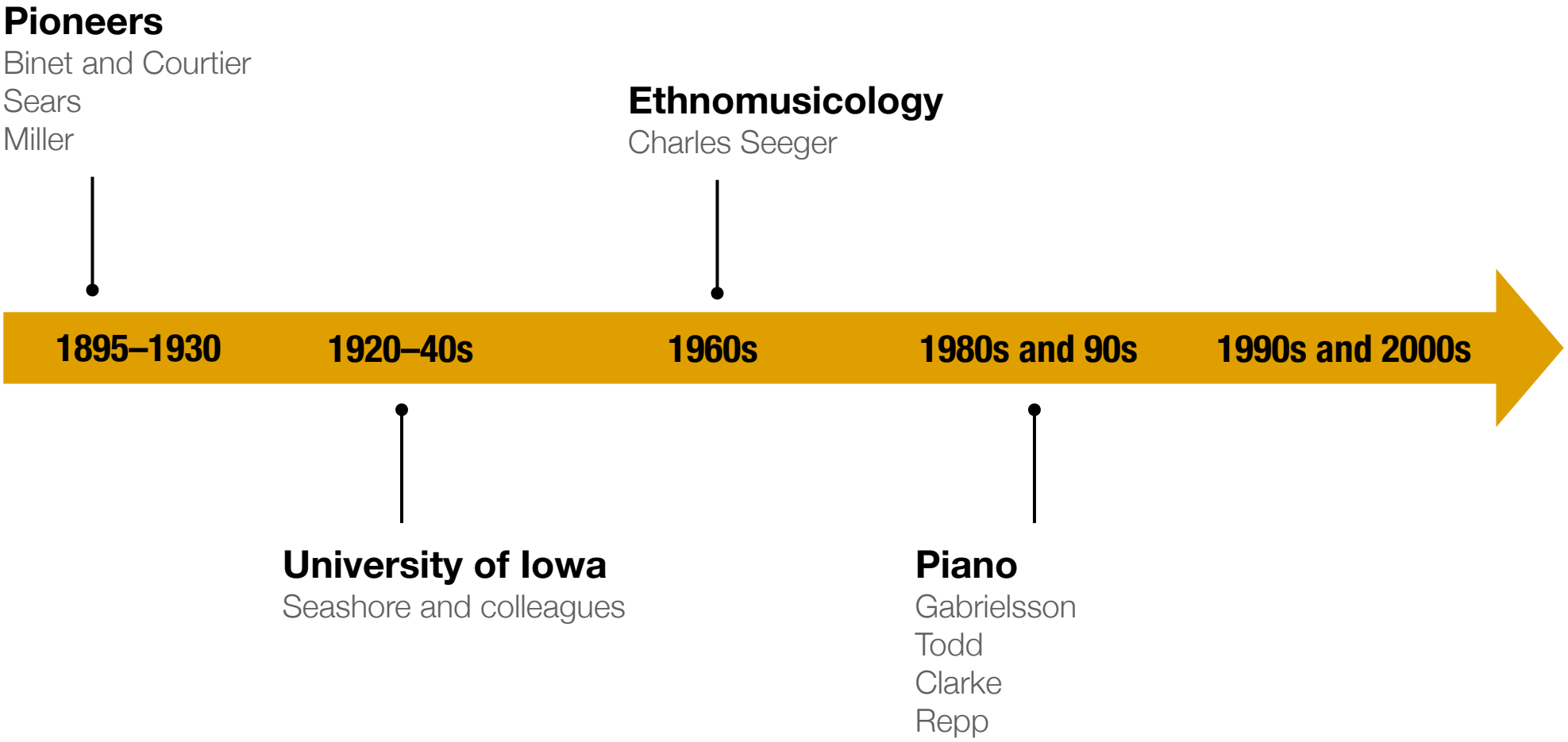
Quantitative Performance Analysis

A brief history



Quantitative Performance Analysis

A brief history



Quantitative Performance Analysis

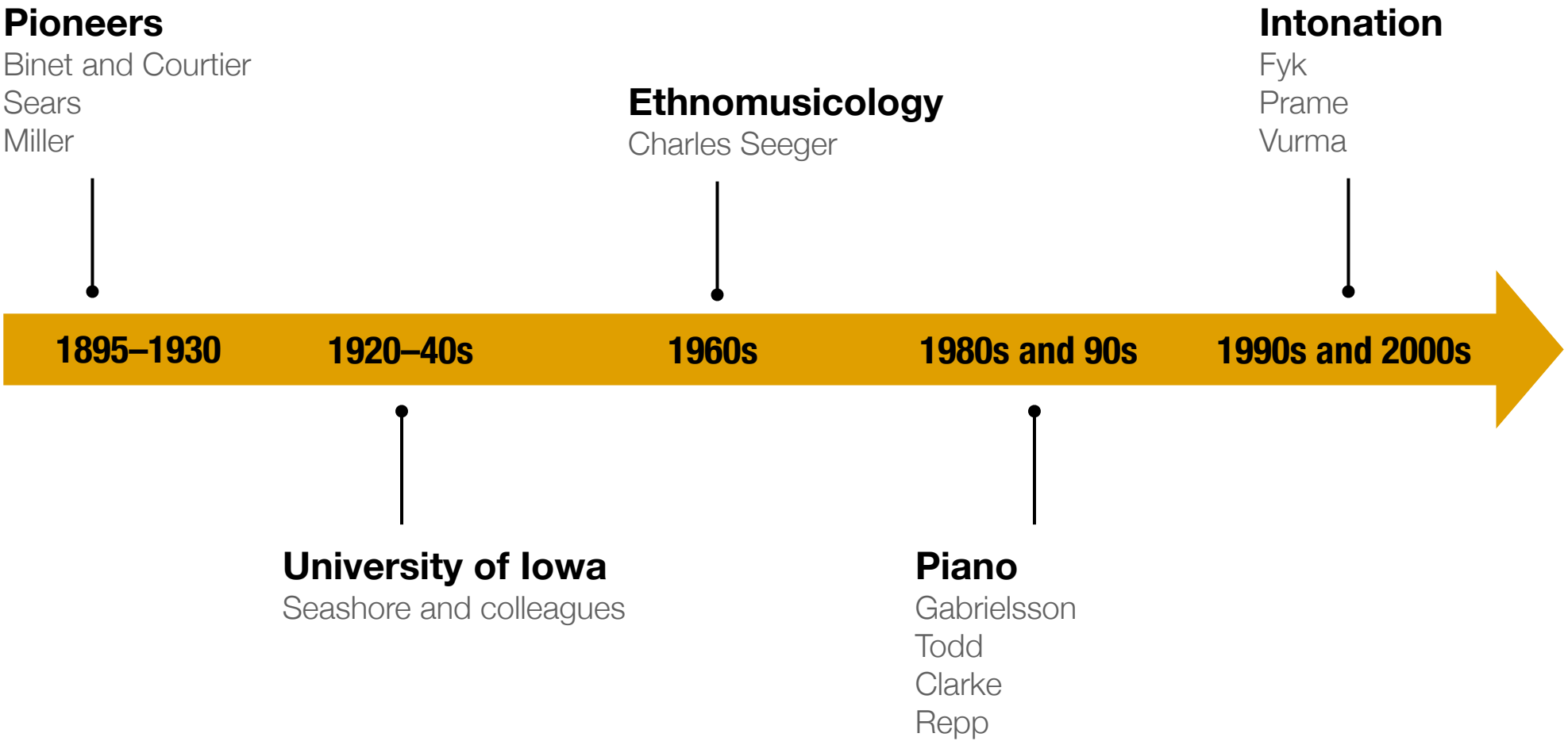
Popularity of the piano

- Large amount of solo repertoire
- Instrument's percussive nature
- Feasibility of using specially equipped pianos (e.g., MIDI)
  - cannot study existing recordings
  - new recordings are typically done in a lab environment

Bosendorfer SE piano at BRAMS, Montreal

Quantitative Performance Analysis

A brief history



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Studying Audio Recordings

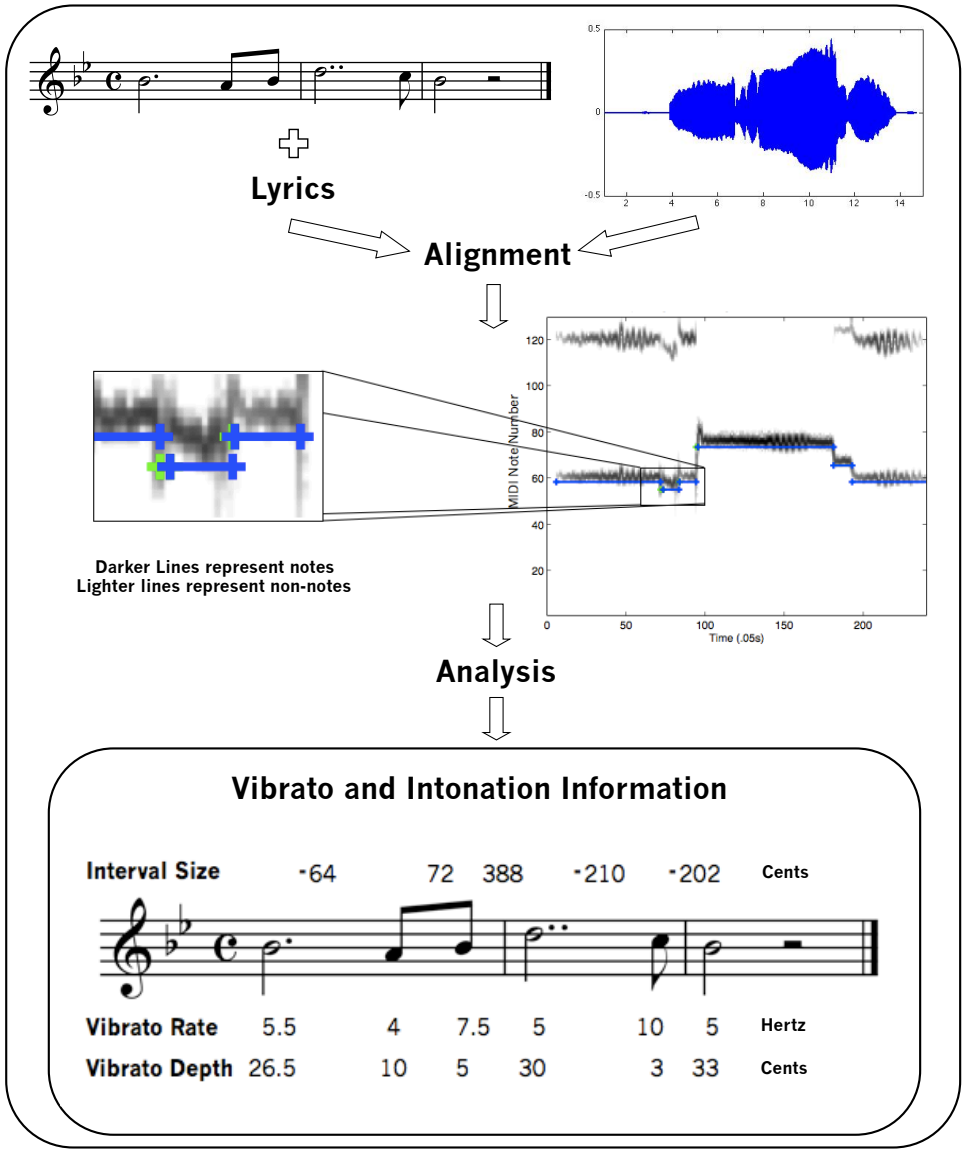
Advantages and challenges of extracting data

- Advantages
  - Allows for existing recordings to be studied
- Challenges
  - Difficulty of extracting data accurately
  - Questions of how to model the extracted data in a perceptually meaningful way

AMPACT

Automatic Music Performance Analysis and Comparison Toolkit

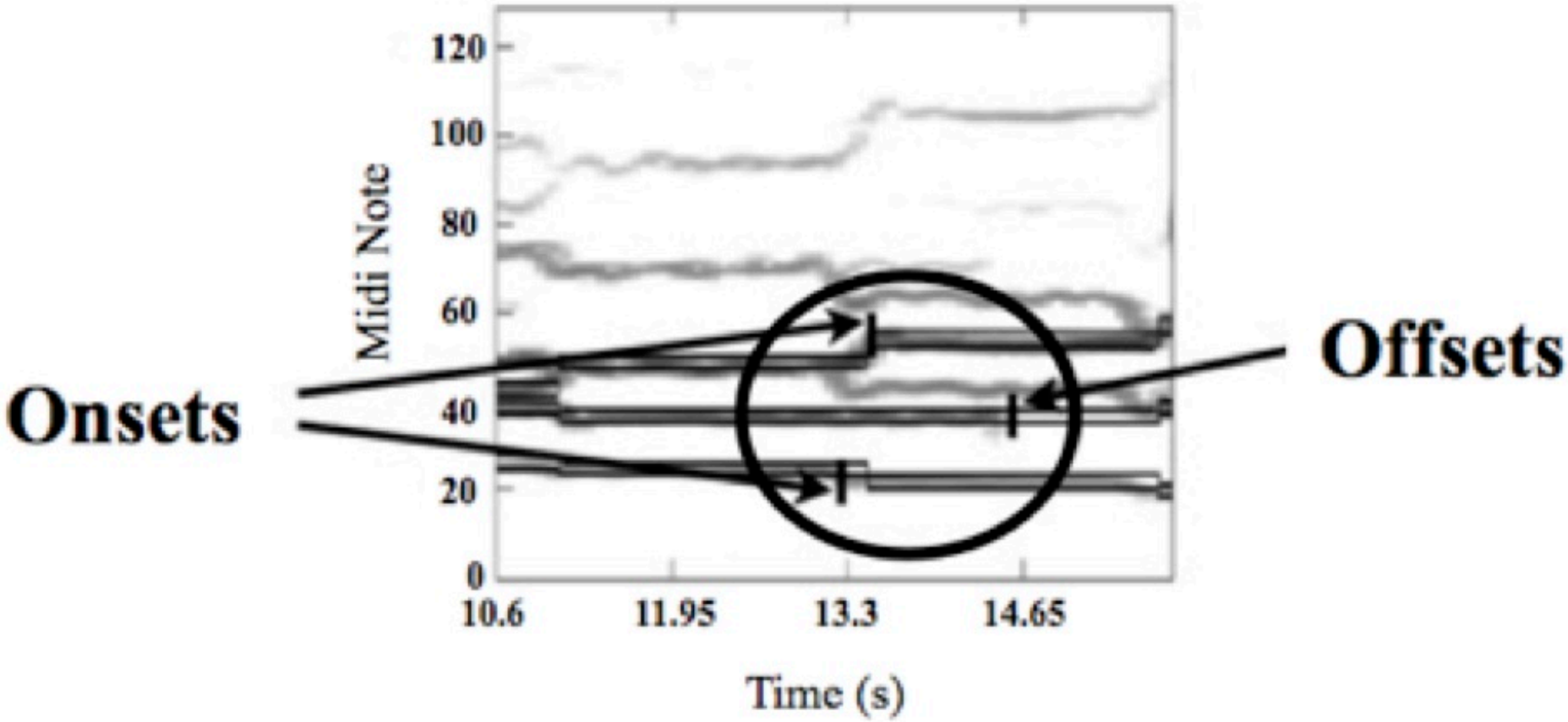
www.ampact.org



Devaney, Mandel, and Fujinaga (2012)

Moving towards polyphonic recordings

Still using MIDI-audio alignment



How to extract pitch and loudness data still an open question

Devaney (2014)

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Experiments with Performers

Why study the singing voice?

- In its most basic form singing is innate and universal
  - Training and enculturation refine specific practices of singing
- The voice is one of the most expressive instruments
- Singing research is complementary to speech research

Solo Singing

Overview

- Musical Material
  - Schubert's "Ave Maria"
    - 3x a cappella & 3x accompanied
- Singers
  - 6 non-professional singers: undergraduate vocal majors
  - 6 professional singers: possess at least one graduate-level degree in voice performance
- Melodic semitones and whole tones analyzed
- Singers listened to and approved their own recordings

Devaney, Mandel, Ellis and Fujinaga (2011)
Devaney, Wild, and Fujinaga (2011)

Ensemble Singing

Overview

- Musical Material
  - 3-part chord progression by Giambattista Benedetti
  - 4-part piece by Praetorius (“Es ist ein Ros entsprungen”)
- Singers
  - combinations of professional SATB ensemble who performed with a conductor
- Melodic semitones and whole tones analyzed in different vertical (harmonic) contexts
- Conductor listened to and approved the recordings

Commonality between performers

Observable trends

- **TUNING SYSTEMS**
  - No strict adherence, on average smaller than equal temperament (more so for semitones than whole tones)
- **HARMONIC CONTEXT**
  - **Solo singing**
    - Non-pros exhibited a significant difference between semitones in leading tone and non-leading tone contexts
  - **Ensemble singing**
    - **Benedetti**: Melodic whole tones sung over a P5 were 15 cents larger on average than those sung over a M3
    - **Praetorius**: Vertical intervals in cadential contexts were significantly closer to Just Intonation than those in non-cadential contexts

Is there an effect of training?

Professions versus non-professions in solo experiment

- **EFFECT OF TRAINING**
  - **Accompaniment**
    - Non-pros' accompanied semitones were 3 cents larger than *a cappella* semitones
  - **Consistency**
    - Pros were more consistent with one another
  - **Interval size**
    - Pros' semitones were 6 cents larger on average (closer to equal temperament)

Meta-analysis example

Comparative analysis of Seashore and contemporary data

	H. Seashore *N = 418*	Devaney et al. 2011 *N = 3981*
Ascending semitones	96 (*SD* = 24)	**96** **(*SD* = 20)**
Descending semitones	99 (*SD* = 24)	93 (*SD* = 18)
Ascending whole tones	192 (*SD* = 23)	198 (*SD* = 18)
Descending whole tones	197 (*SD* = 20)	201 (*SD* = 19)

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Summary

Where we have been

- **This talk has**
  - provided a brief overview of the history of quantitative performance analysis
  - highlighted some of the challenges of automatically extracting performance data from recordings and how to address them
  - summarized some of my findings on vocal intonation practices in the western art music tradition

Future Work

Where I am going

- **Developing more robust tools for automatic extraction of performance data from recordings**
  - making the current tools more reliable and more accessible to other researchers
- **More contextualized experiments**
  - focused experiments about interactions in ensembles
  - studying existing recordings of a singer performing the same piece at different points in their career
- **Integrating more qualitative information**
  - performers intentionality
  - listener perception/reception

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- School of Music and College of Arts and Sciences (OSU)
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Thank you!

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