

Performance Analysis

The potential of recordings in testing
quantitative aspects of music theories

Johanna Devaney

Schulich School of Music, McGill University

Center for Interdisciplinary Research in Music, Media and Technology

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INTRODUCTION

- Application of Music Information Retrieval methods to audio recordings
- Collection and modeling of performance data
- Assessment of quantitative aspects of music theories
- Study of intonation practices from audio recordings

TALK OVERVIEW

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- A brief history of empirical performance analysis

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- Perceptual testing and music theory
- Potential of empirical performance analysis for quantitative music theory

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- Ingemar Bengtsson and Alf Gabrielsson (1980) studied musical rhythm
- Bruno Repp (1992) studied ritardandi in piano performance

EMPIRICAL PERFORMANCE ANALYSIS

- Piano performance is widely studied due to
 - the large amount of solo repertoire
 - the instrument's percussive nature
 - the feasibility of using MIDI to measure performance data

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- Music Information Retrieval techniques allow for extraction of performance data from recorded signals

EXTRACTING PERFORMANCE DATA

- Music Information Retrieval
 - Robust polyphonic transcription is still an unsolved problem
 - However, there is a workaround when a score is available:
 1. align the MIDI score to audio
 2. use the MIDI score to guide the signal processing analysis to estimate accurate frequency information

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- Probabilistic machine learning approaches are useful for modeling data with a degree of variability

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- Schellenberg (1997) evaluated Narmour's Implication-Realization model

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- Larson and VanHandel (2005) evaluated Larson's theory of Musical Forces (2004)

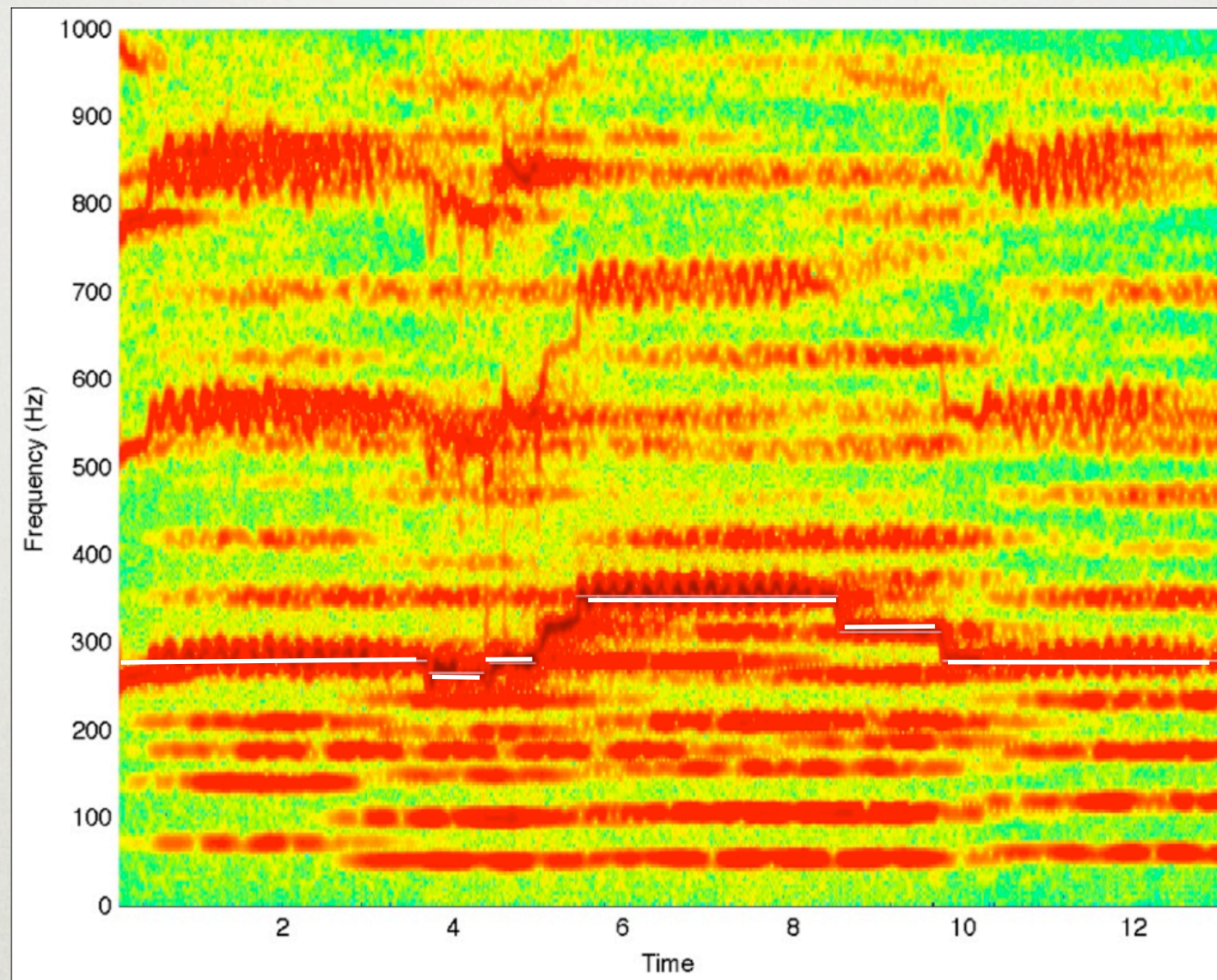
POTENTIAL FOR MUSIC THEORIES

- Lerdahl's theory of melodic attraction
 - Formalizes the tendency of a dissonant pitch to resolve to a consonant neighbour
 - Observes Bharucha's principle of proximity and stability
 - Partially analogous with Newton's law of gravitation

POTENTIAL FOR MUSIC THEORIES

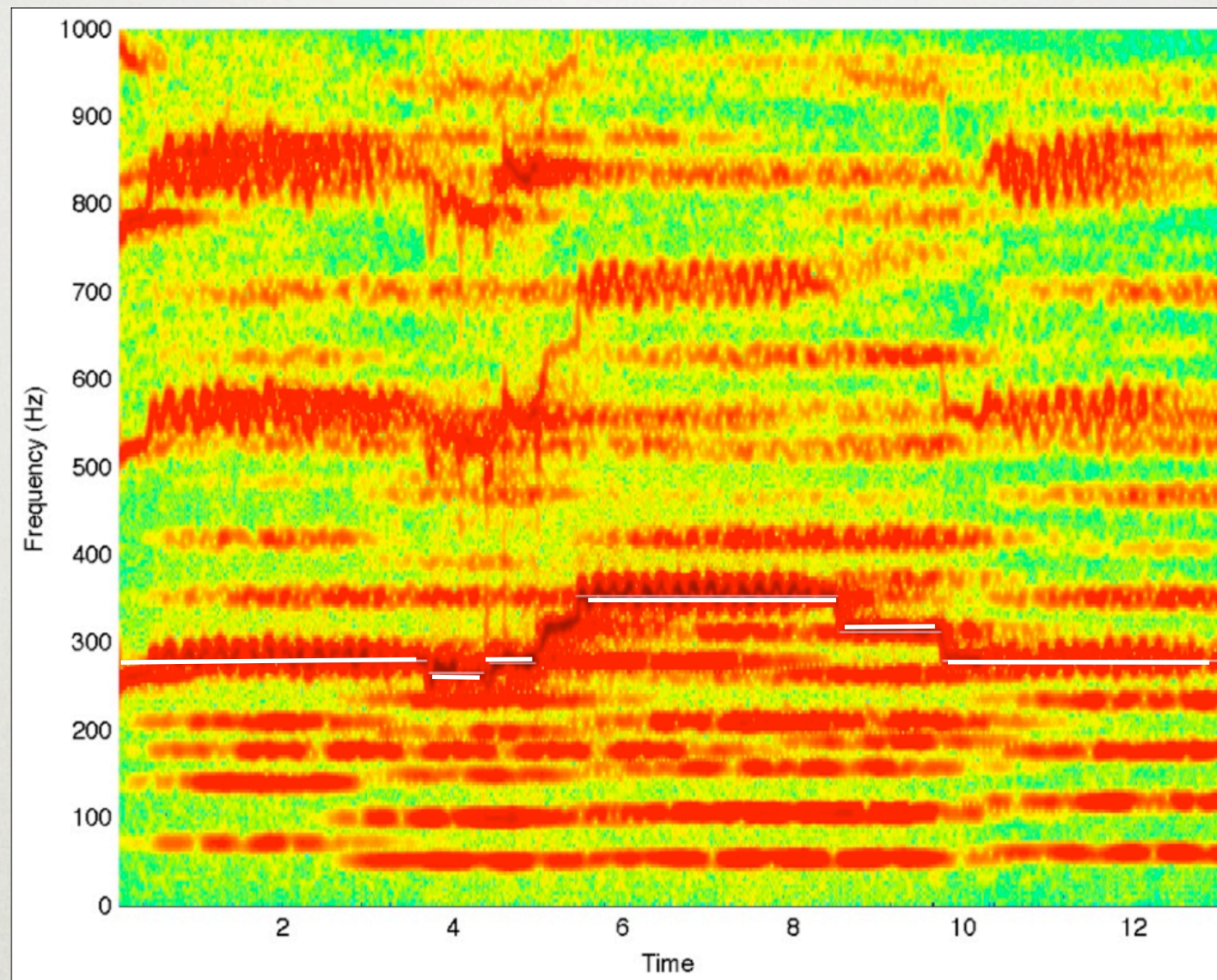
- Larson's theory of musical forces
 - rooted in Lackoff and Jonson's notion of embedded metaphors (1980)
 - like Lerdahl's attractions it is rooted in the psychological principles of proximity and stability
 - based on the Gestalt principle of good continuation

POTENTIAL FOR MUSIC THEORIES



Spectrogram of opening of Schubert's "Ave Maria"
White lines indicate estimated fundamental frequencies,
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Estimated frequencies for the opening and closing “Ave Maria” statements.

mm. 1-2.1	A-	Ve	Ma-	ri-	—		a
	Db	C	Db	F	Eb		Db
(cents)	91	70	420	210	196		
mm. 11-12.1	A-	Ve	Ma-	ri-	—		a
	Db	C	Db	F	Eb		Db
(cents)	83	58	450	190	226		

Melodic attraction calculations from Lerdahl’s and Larson’s systems.

	Lerdahl	Larson
Leading tone -> tonic	C -> Db $4/2 \times 1/1^2 = 4/2 = 2$	N/A
Tonic -> leading tone	Db -> C $2/4 \times 1/1^2 = 1/4 = 0.5$	Bb -> C -> Db $1 + (1/4^2 - 1/1^2) + 1 = 1.0625$
Supertonic -> tonic	Eb -> Db $4/2 \times 1/2^2 = 0.5$	F -> Eb -> Db $1 + (1/2^2 - 1/2^2) + 1 = 2$

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CONCLUSIONS

- Potential of empirical evaluation of performance has only recently begun to be realised
- Music Information Retrieval methods are valuable for collecting and modeling performance data from audio recordings for this purpose

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