Evaluating Rule- and Examplar-Based Computational Approaches for Modeling Harmonic Function

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Introduction 1
Motivations.

Phrase model 2
Hierarchical analysis.

Rule-based system 3
Formalizing the information in the text.

Exemplar-based system 4
Modeling the annotated musical examples.

Conclusions 5
Summary and future directions.

Introduction

Empirical consideration of music theory pedagogy

- **Music theory texts provide prose and annotated example scores in order to explain analytical concepts**
- **These two pedagogical methods can be empirically compared by implementing**
  - a rule-based computational model derived from the written text
  - an exemplar-based computational model derived from the musical examples
- **This project uses the phrase model described in Steve Laitz's *The Complete Musician* for testing**

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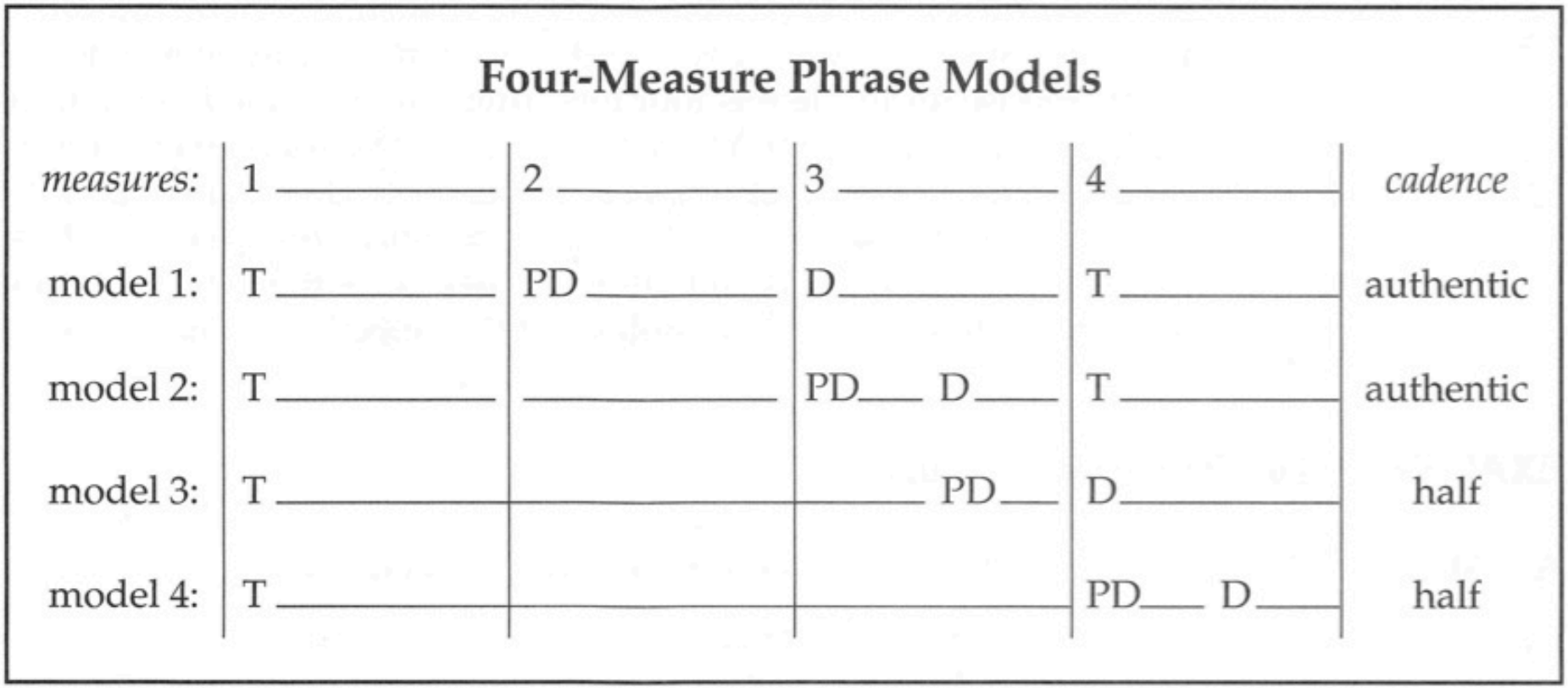
Phrase Model

Definitions

- **Tonic function (T)**
  - at the beginning of a phrase it serves to establish the tonal center
  - at the end of a phrase it provides closure
- **Pre-dominant function (PD)**
  - prepares for the arrival of the dominant function
  - may not be present in short phrases
- **Dominant function (D)**
  - creates a sense of tension that is resolved by the return of the tonic function

Phrase model

Schematic



Four-Measure Phrase Models

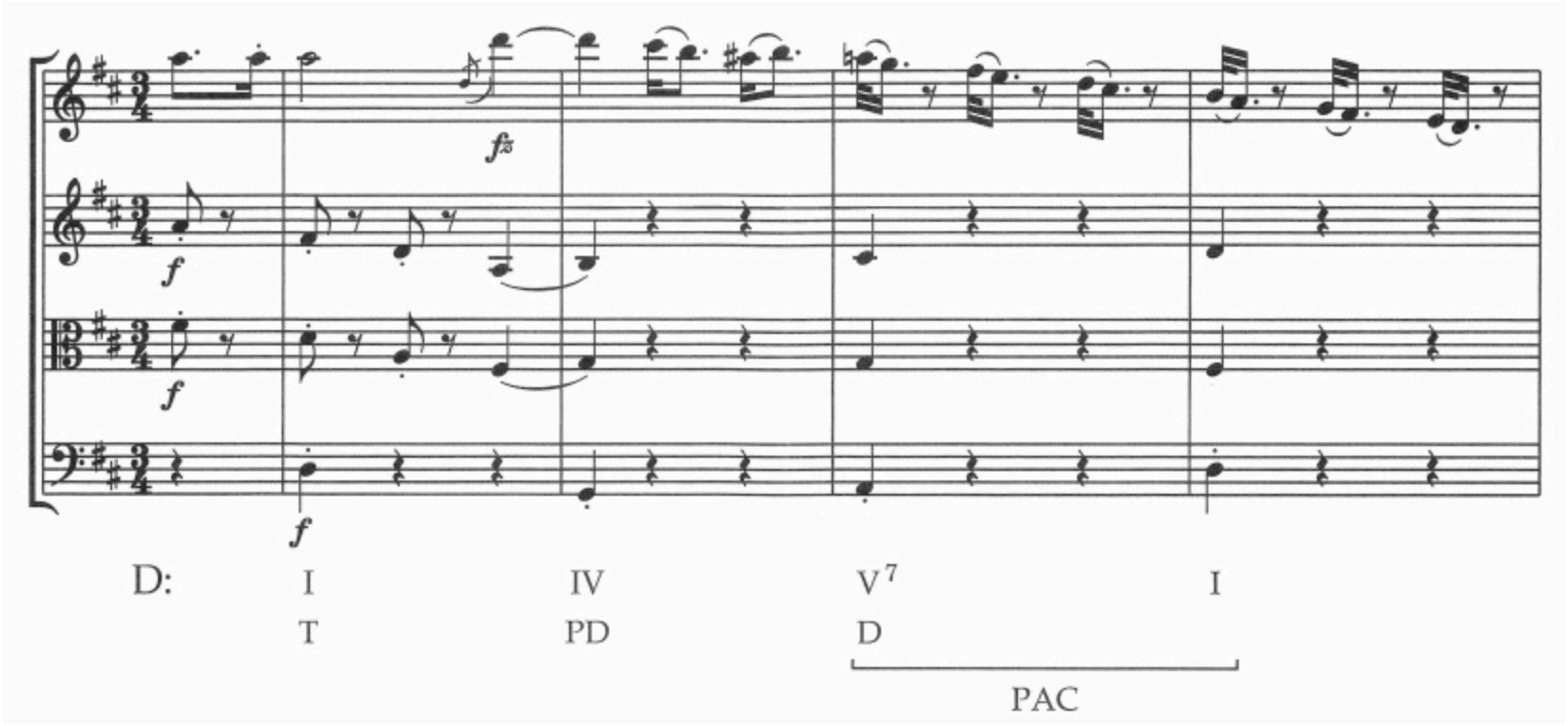
measures:	1	2	3	4	*cadence*
model 1:	T	PD	D	T	authentic
model 2:	T		PD D	T	authentic
model 3:	T			D	half
model 4:	T			PD D	half

Laitz, p 201

Phrase model

Simple example

Haydn, String Quartet in D major, "The Frog," op. 50, no. 6, Hob 111.49, Menuetto

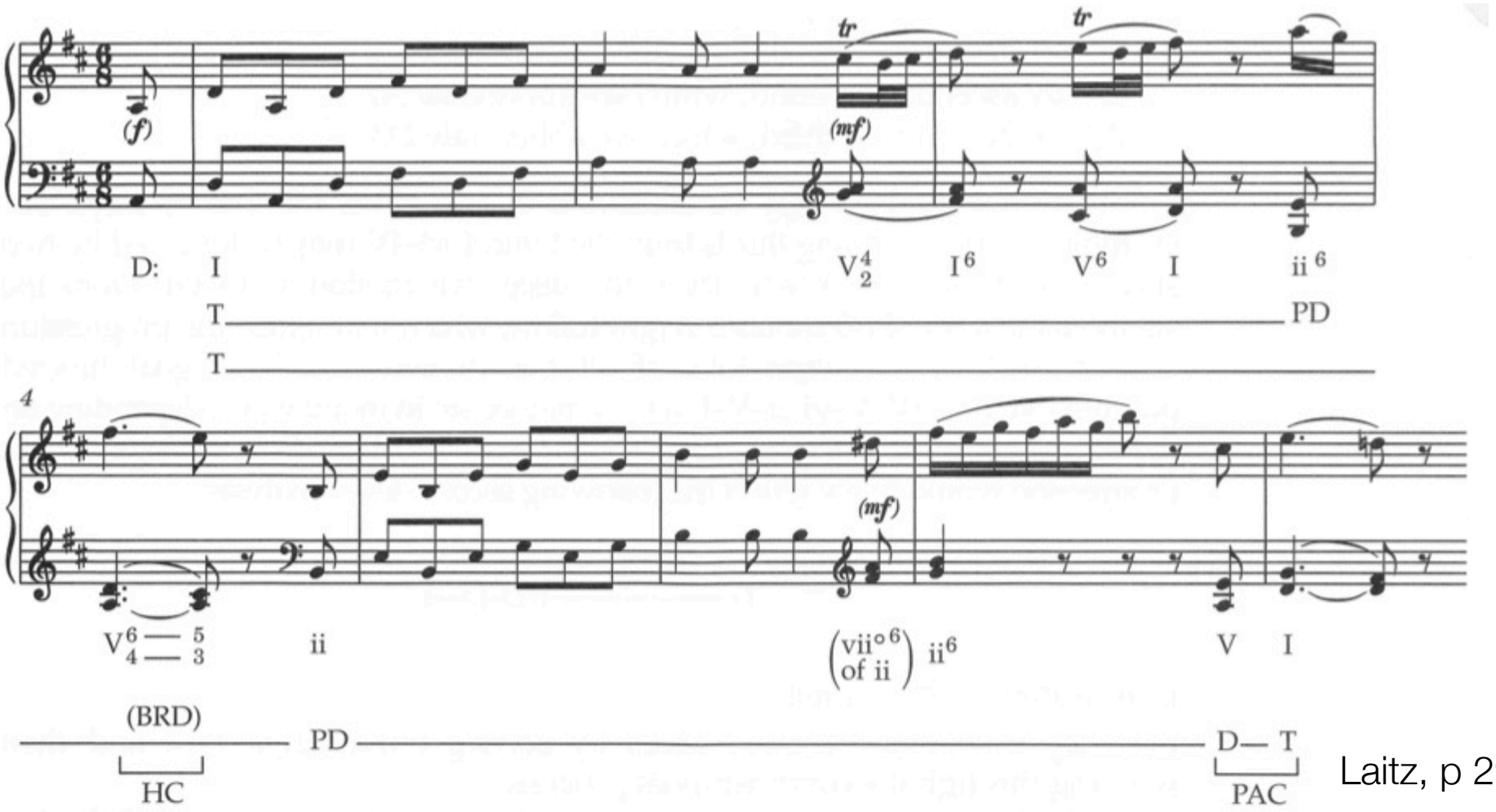


Laitz, p 201

Phrase model

Complex example

Mozart, Piano Sonata in D major, K. 576, Allegro



Laitz, p 293

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Formalizing the rules

Translating text into encodable rules

- **25 rules were derived from the Laitz chapters on diatonic harmony (Ch. 7–14)**
- **Example**
  - “I6 is an ideal choice for a passing chord between ii and ii6. The I6 chord is subordinate to the prevailing pre-dominant” p. 256
  - IF currentChord == I6 AND previousChord == ii AND nextCHORD == ii6
    THEN currentFunction == predominant

Results

Rules-based system

	Tonic	Predominant	Dominant
Precision	0.95	0.76	0.69
Recall	0.86	0.88	0.89
F1 Scores	0.90	0.81	0.79

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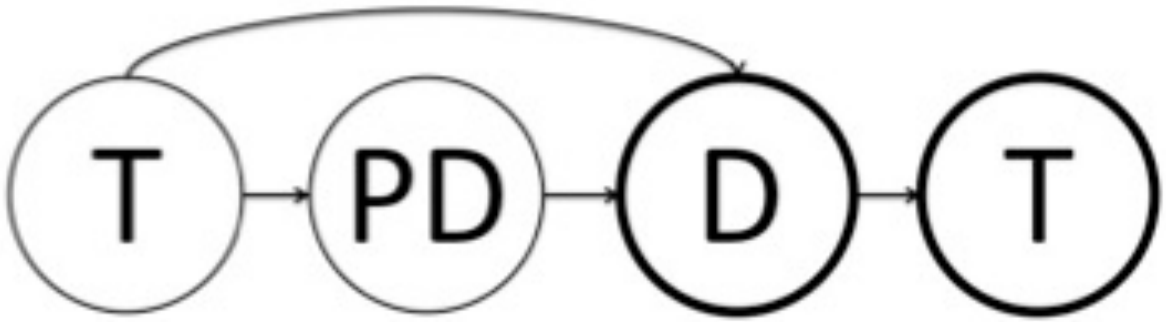
Summary of the exemplar data

- 128 phrases
- 841 chords labels
  - 565 had a tonic function (67%)
  - 131 had a pre-dominant function (16%)
  - 145 had a dominant function (17%)
- 97 (76%) ended on a tonic function
  - 95 with authentic cadences, ending on I or i
  - 2 with deceptive cadences, ending on vi or VI
- 31 (24%) end on a dominant function
  - all half cadences, ending on V

Exemplar Model

Hidden-Markov model

- **Observations:** chord labels
- **Predictions:** states
- **State space:**



Results

Exemplar system

	Tonic	Predominant	Dominant
Precision	0.93	0.92	0.89
Recall	0.97	0.78	0.80
F1 Scores	0.95	0.85	0.85

Rules	0.90	0.81	0.79

Results

Comparison between systems

Rules	Tonic	Predominant	Dominant
Precision	0.95	0.76	0.69
Recall	0.86	0.88	0.89
F1 Scores	0.90	0.81	0.79

Exemplar	Tonic	Predominant	Dominant
Precision	0.93	0.92	0.89
Recall	0.97	0.78	0.80
F1 Scores	0.95	0.85	0.85

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Summary

Rules versus exemplar-based systems

- **Both systems demonstrated varying degrees of success at predicting the correct function labels given a sequence of chords**
- **The difference between the precision and recall values indicate that the rule based system is over assigning the tonic function at the expense of the other functions and that the exemplar-based system is doing the opposite (though not to the same extent)**

Future Work

Improving/expanding

- **Test on the Laitz workbook**
- **Incorporate metrical information**
- **Expand to include modulation and chromatic harmonies**
- **Run similar experiments with the Clendinning and Marvin textbook, *The Musician*'s *Guide to Theory and Analysis***

Thank you!