Modeling Melodic Improvisation in Turkish Folk Music Using Variable-Length Markov Models

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Introduction

- A **database** consisting transcriptions of non-metered improvisations (uzun havas) in Turkish folk music.
  - The frst symbolic, machine readable database of uzun havas
- A system, which **predicts the improvised melodic progressions** in Turkish folk music.
  - The first application of predictive modeling in Turkish folk music
  - The first usage of Variable-Length Markov Models (VLMMs) and Multiple Viewpoints Modeling (MVM) in traditional Turkish music

Motivation

- **Musical improvisation** is a complex phenomenon.
  - **Semantic gap** between current MIR research & human anticipation. [1]
  - Previous work on Western melodies showed that variable-length n-gram models and human judgments of melodic continuation are highly correlated. [2]
  - Search for clues about how we **anticipate** music outside the "Occidental" constraints
- Build a **predictive/generative system** to open a path for
  - Machine performers
  - Meta-composers
  - Educational tools
- Research involving **world musics** might:
  - Deepen knowledge of universal versus genre-specific aspects of music
  - Allow to truly evaluate the generality of various modeling strategies
  - Help to break the **Occidental inclinations** in the MIR community

Turkish Folk Music

- In Western music, an octave is divided into 12 intervals..
- In Turkish folk music, there are typically **17 not-well-tempered pitches** played in an octave (Table 1).

Fret #	Note	Fret #	Note	Fret #	Note
0	A	6	$C\sharp$	12	$F\sharp^3$
1	$B\flat$	7	D	13	$F\sharp$
2	$B\flat^2$	8	$E\flat$	14	G
3	B	9	$E\flat^2$	15	$A\flat$
4	C	10	E	16	$A\flat^2$
5	$C\sharp^3$	11	F	17	A

Table 1: The notes and the fret numbers in the lowest string group of bağlama in the *bağlama tuning*. $\flat^2$ and $\sharp^3$'s indicate the quarter tones.

- Melodic structure of Turkish folk music is explainable by **makam** theory.

UZUN HAVA

- A structured **improvisation** form in Turkish folk music
- *Improvised parts are played* ***usûlsüz*** **(non-metered)**
- Typically sung by a single **vocalist** who also plays ***bağlama***

Figure 1:Aşık Veysel, one of the most famous Turkish folk music artists of 20th century, playing his bağlama

Listen to an example!

Uzun Hava Humdrum Database

- Built with the help of **Prof. Erdal Tuğcular** (Department of Music Education, Gazi University, Ankara, Turkey)
- Currently **77 songs, 10849 notes & 8 makams** encoded in **Humdrum** **kern format. (new data added)
- Aimed to:
  - Reduce the **lack** of machine-readable databases in world musics
  - Ease the analysis of Turkish folk music in **cross-cultural** and **cross-genre** music research, especially in research dealing with **improvisation.**

Uzun Hava Humdrum Database

Computational Modeling [3]

- Based on ***n*-gram** modeling and **variable-length Markov models**
- Melodic sequences are represented in **multiple viewpoints.** [4]
- VLMM's stored in **Prediction Suffix Trees** (PSTs) for performance (Figure 2)
- **1/N smoothing** applied to regulate between the generality of lower orders & specifity of higher orders
- Uses **escape probabilites** to tackle the zero frequency problem
- Incorporates **short-** and **long-term models** to make predictions particular to the song being predicted, while adhereing to the musical style in general

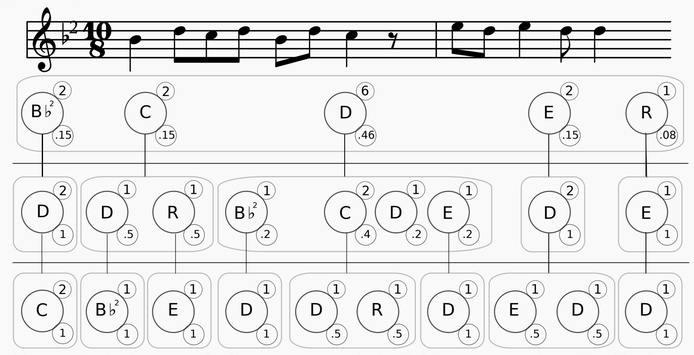

Figure 2: A short melodic except and the PST representing the Markov models of Notes-with-Cents viewpoint with a maximum order of 2, trained on the excerpt. Bubbles on the top right and bottom right of each node denotes the count and the probability of the node respectively.

Experiment & Evaluation

- Framework implemented in **C++ as a Max/MSP external**
- Comparison of viewpoints defined for Western music [4] and *makam* theory.

Viewpoint	Explanation
Duration	Duration of the note
Note	Midi number corresponding to the note
NoteWCents	Viewpoint denoting the "true" symbol in Turkish folk music in note and cent deviation, i.e. the floating midi number
Note⊗Dur	Cross type combining note and duration
NoteWCents⊗Dur	Cross type combining note with cent deviation and duration

Table 2: Viewpoints used in the experiment.

- Applied **leave-one-out cross-validation** for evaluation
- Probability of the true symbol, p_t at time t, predicted at time *t-1* is recorded.
- From probabilities, **average** and **median cross-entropies** are calculated and converted to **perplexities** for the whole experiment and in the song level.

$$H_c \approx -\frac{1}{N}\sum_{t=1}^{N}\log_2(p_t) \qquad P = 2^{H_c}$$

Results & Discussion

- Perplexities obtained from predictions of the system are **remarkably lower.**
  - The system **is successful** in predicting melodic progression of *uzun havas*.
- Extending the possible target pitches from Western music to Turkish music, slightly increases perplexity values.
  - MVs are able to **model the context-specific pitches in makams**, and distinguish the quarter notes from the neighboring notes virtually **without any penalty**.
- Perplexity decreases **monotonically** with increasing order.
  - **Order 14** is optimal.
- STM **outperforms** LTM and combined model.
  - Melodies in the transcriptions are heavily **structured**.

	Duration		Note		NoteWCents		Note⊗Dur		NoteWCents⊗Dur	
	Average	Median	Average	Median	Average	Median	Average	Median	Average	Median
Priors	6.12	3.76	11.9	7.97	12.71	7.98	171.76	171.32	148.39	148.16
LTM	3.88	2.23	5.56	4.13	5.87	4.21	30.17	20.06	31.84	21.21
Combined	3.55	1.93	4.64	3.17	4.70	3.21	15.67	10.40	16.23	10.68
STM	2.96	1.94	4.13	2.96	4.16	3.00	6.68	5.30	6.69	5.30

Table 3: Average and median perplexities for Duration, Note, NoteWCents, Note⊗Dur and NoteWCents⊗Dur for order 14

Future Work & Conclusion

- This work is partially extended in [5]:
  - Incorporated more viewpoints: **contour, scale degree, melodic interval** and **additional cross types**
- To do:
  - More viewpoints: **fermata, usul, makam, pitch-class**...
  - Extending the research to audio domain using variable-length hidden Markov models (VLHMM)
  - Cognitive experiments to check relevance between the predictions and human anticipation.

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