Graph-based Symbolic Music Alignment

Seminar in Data Science

Nina Braunmiller
k11923286

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Overview

I. Introduction into the topic
II. Aims and approaches
III. Score tracking with Hidden Markov Models
IV. Open challenges
V. References

I. Introduction into the topic

- Symbolic music:
  - Symbolic representation of music in notation-based format
  - E.g. sheet of music with its concrete instructions how to perform
  - At the computer: e.g. MIDI files
- Note alignment:
  - Performing and target file given
  - follow track note per note by tagging the current note from performing file to target file

II. Aims and approaches

- Aims of research in context of this work:
  - Symbolic note alignment, here MIDI-to-score alignment
  - Online tracking
  - Polyphonic music
  - Graph-based alignment: aligning two pieces together with help of graph building. Graphs can be compared.

II. Methods and approaches

- Approaches discussed in the work:
  - Dynamic Time Warping (DTW)
  - Machine Learing to build comparable graphs
  - **Hidden Markov Models (HMM)**

III. Score tracking with Hidden Markov Models

Schwarz et al. (2004):

- Score model (high level):
  - Possible states: polyphonic, monophonic, rest, ghost
  - Considering note shifts due to file inaccuracy: one event has to last at least 30 ms to be considered as state

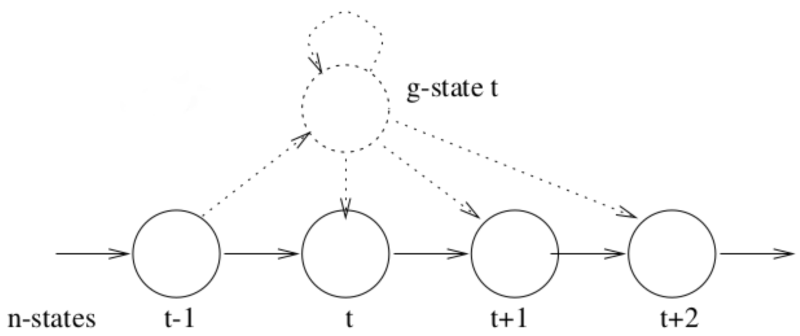

Figure 1: Score model state example for correct performance [3].

- Note model (low level):
  - For each score event
  - Possible states: attack, sustain, release

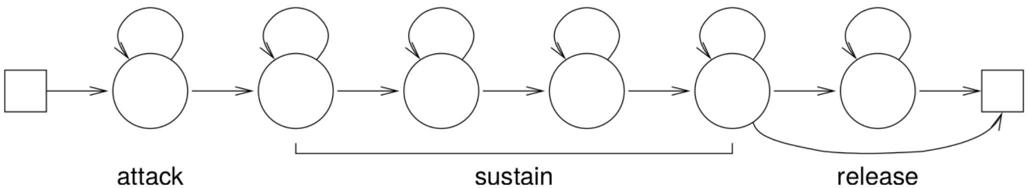

Figure 2: Note model state example [3].

Schwarz et al. (2004):

- Problem in matching expected and actual tempo

III. Score tracking with Hidden Markov Models

Gu & Raphael (2009):

- Learns model parameters which have an influence on predicted time of next event and predicted tempo

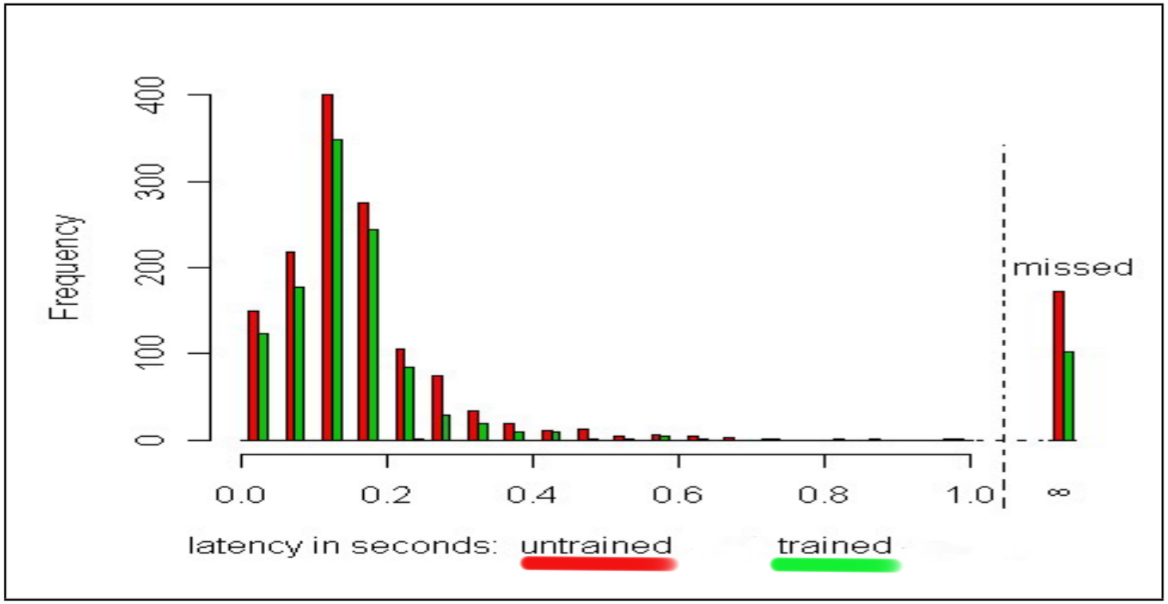

Figure 3: 1st movement of Rachmaninov 2nd piano concert – on basis of 4 encoded performances; training took place on the one-leave-out scheme [1].

IV. Open challenges

- Challenges:
  - Small content deviations in performance and target file
  - Symbolic notation‘s diverse tools not fixed to a concrete behavior rule but also interpreted by the performer
  - Missing automatic error correction of alignments
- Not perfect but successes

VI. References

[1] Gu, Y. & Raphael, C. (2009) Orchestral Accompaniment for a Reproducing Piano. In Proceeding of the International Computer Music Conference (ICMC09), pp. 501–504. Montreal, Canada. url: https://quod.lib.umich.edu/i/icmc/bbp2372.2009.113/1

[2] Peter, S., Cancino-Chacón, C.E., Karystinaios, E., Foscarin, F., McLeod, A. & Widmer, G. (in press) Automatic Note-Level Score-To-Performance Alignments in the ASAP Dataset. Transactions of the International Society for Music Information Retrieval (TISMIR).

[3] Schwarz, D., Orio, N. & Schnell, N. (2004) Robust Polyphonic Midi Score Following with Hidden Markov Models. In Proceedings of the International Computer Music Conference (ICMC), pp. 1–4. Miami, FL. url: https://quod.lib.umich.edu/i/icmc/bbp2372.2004.061/1

THANK YOU FOR YOUR ATTENTION