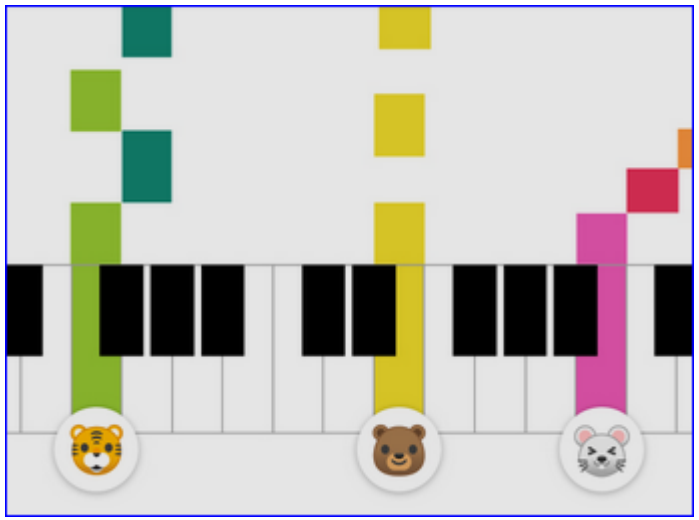
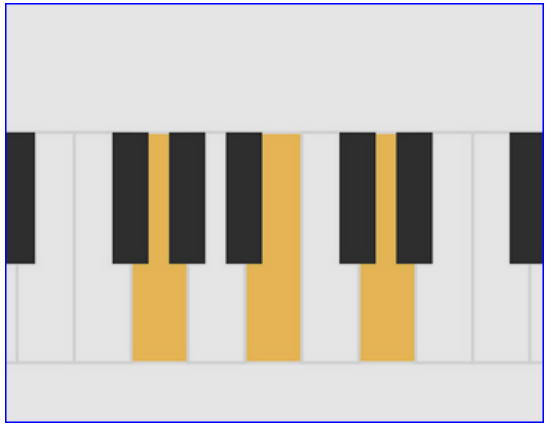
Audio-based AI approaches to music generation

Curtis Hawthorne, Anna Huang et al. (Google Magenta c.2017-2023).

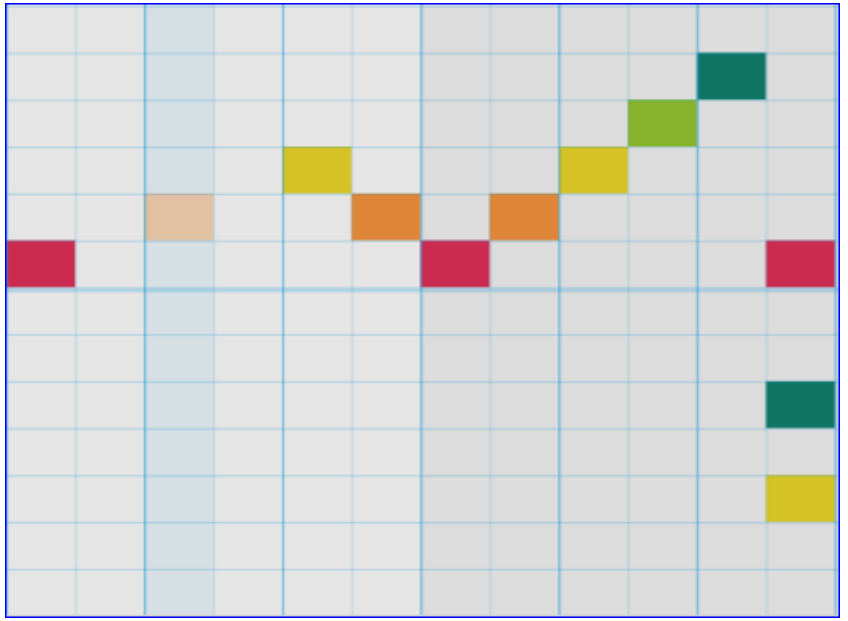
Other models: Chrome Music Lab

- Pedagogy, keyboard facilitation





SongMaker



Google Magenta

- https://magenta.tensorflow.org/blog
- Aim: to provide tools for novices
- Piano transcription: Hawthorne et al. (ISMIR 2021):
- https://archives.ismir.net/ismir2021/paper/000030.pdf
- Compare various datasets

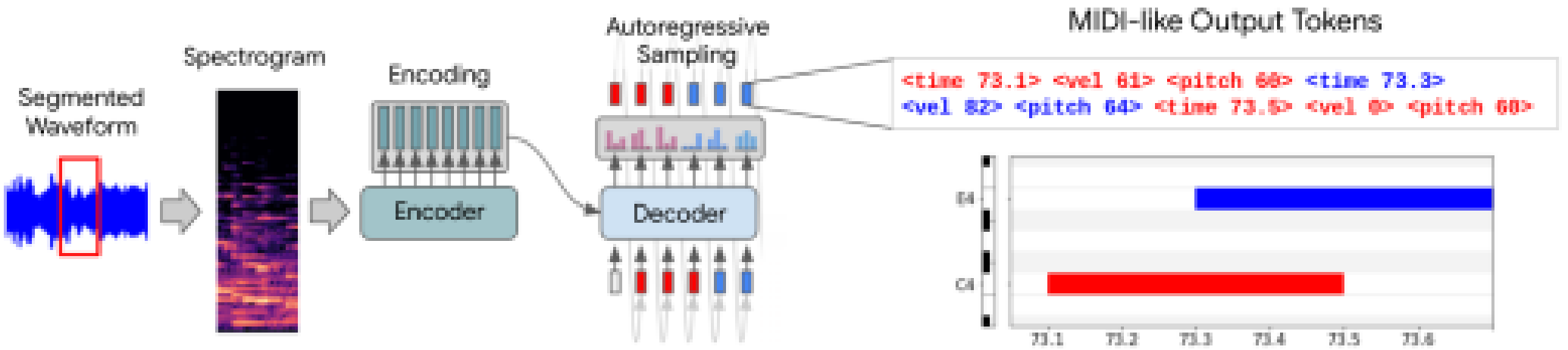
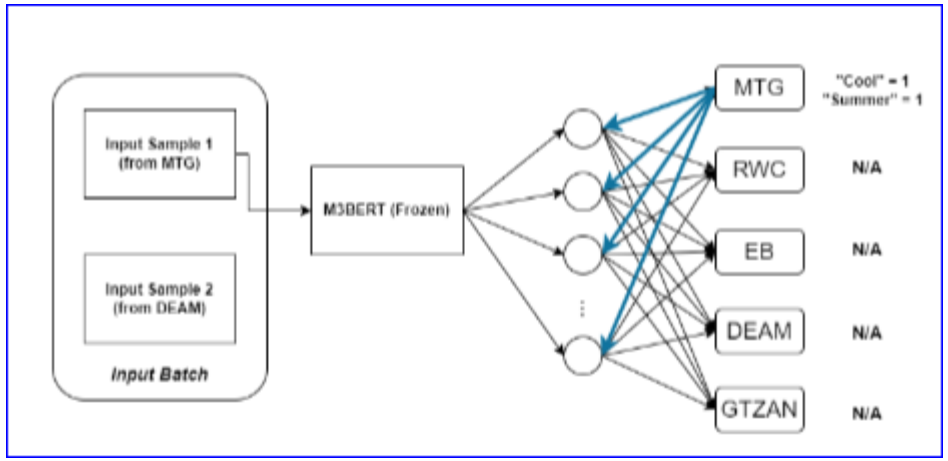


Figure 1. Our model is a generic encoder-decoder Transformer architecture where each input position contains a single spectrogram frame and each output position contains an event from our MIDI-like vocabulary. Outputs tokens are autoregressively sampled from the decoder, at each step taking the token with maximum probability.

Elaborate generation systems

- **Timothy Greer** et al., USC (2022): M3BERT
- Music generation via transformers; context aware



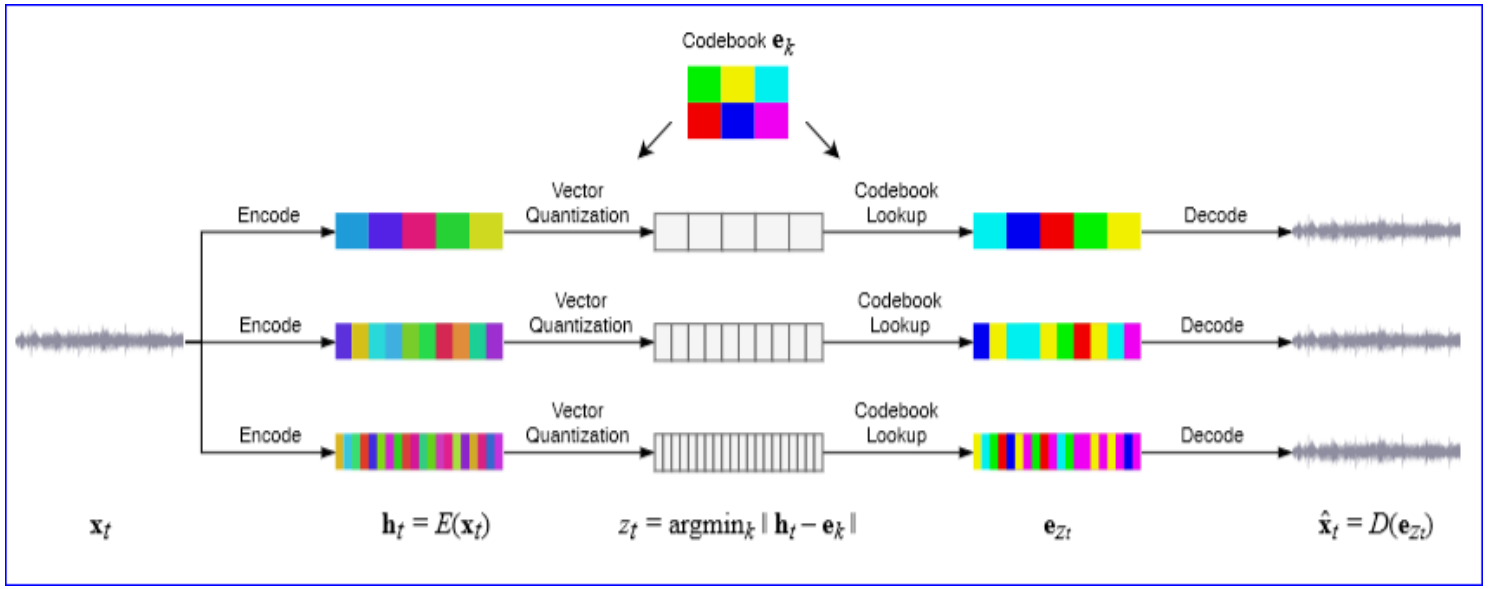
Cf. David Cope, *Experiments In Musical Intelligence*

https://www.researchgate.net/publication/363811441_Multi-modal_Multi-task_Music_BERT_A_Context-Aware_Music_Encoder_Based_on_Transformers/figures?lo=1

Generative singing: Jukebox

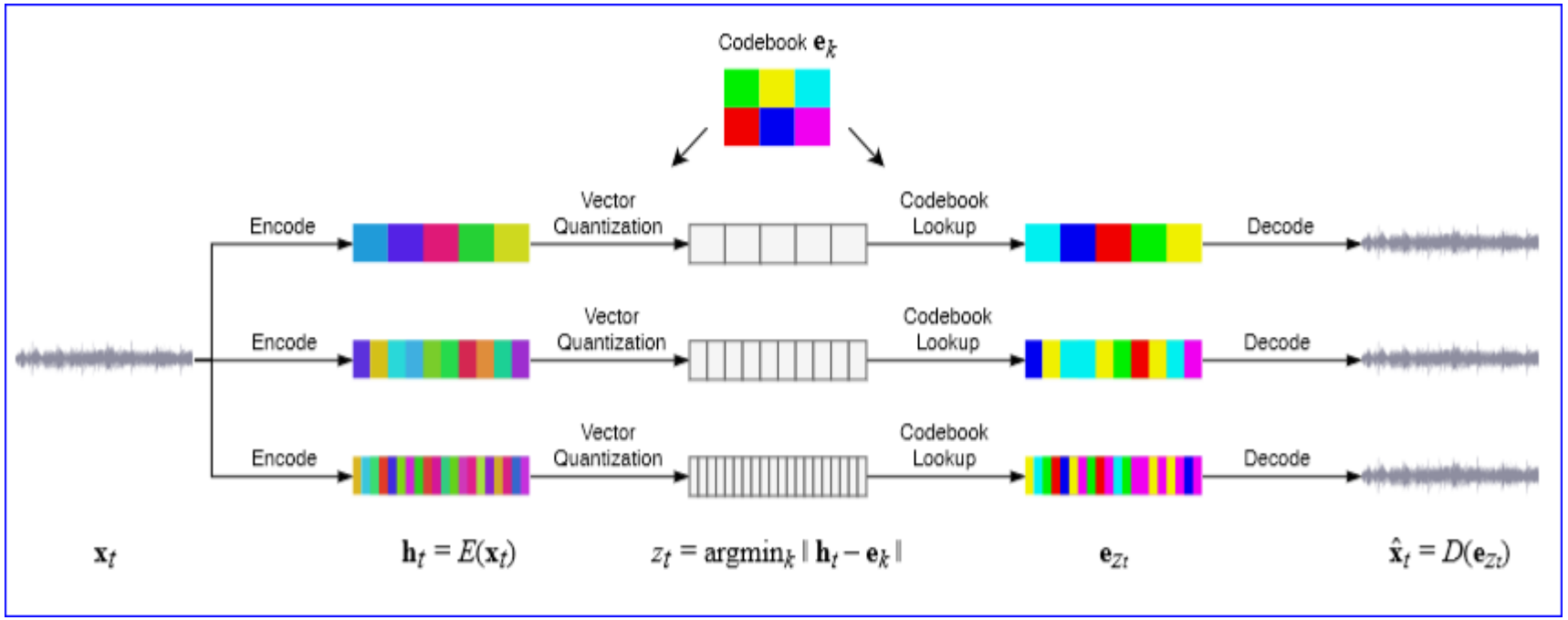
- openAI (2020)--https://arxiv.org/pdf/2005.00341.pdf
- https://openai.com/research/jukebox (Dhariwal et al.)
- Using transformers with text-to-audio approach

Cf. Sapp, Keyscapes



Text-to-music generation via DALL-E2

- Tiers of temporal resolution (cf. Craig Sapp, keyscapes)



MusicLM (Google)

- Emphasis on **audio quality** of generation (L-C Yang et al.)
- Preliminary writeup (MidiNet: ArXiv 2017)
  - Builds on Hawthorne et al, "'Sequence to sequence' transcription"
- https://arxiv.org/pdf/1703.10847.pdf

Hawthorne: Sequence-to-sequence studies

- Modeling music with NNs is difficult because it requires structures at many different time-scales.
- Developed the **MAESTRO** dataset to facilitate research.

https://doi.org/10.48550/arXiv.1810.12247

200 hours of paired audio and MIDI recordings from ten years of International Piano-e-Competition. [=MAESTRO]

Maestro Dataset (Curtis Hawthorne)

- Piano competition submission data (Wisconsin, Disklavier sunmissions)
- Vivian Shaylin Chen (SU, 2021): same datasets, different procedures—What performance traits produce best contest judgments?

Vivian Chen: Chopin “Waterfall” Etude contestants

Ardeeva vs Sun (No. 2): treatment of sixteenth notes with respect to evenness, consistency

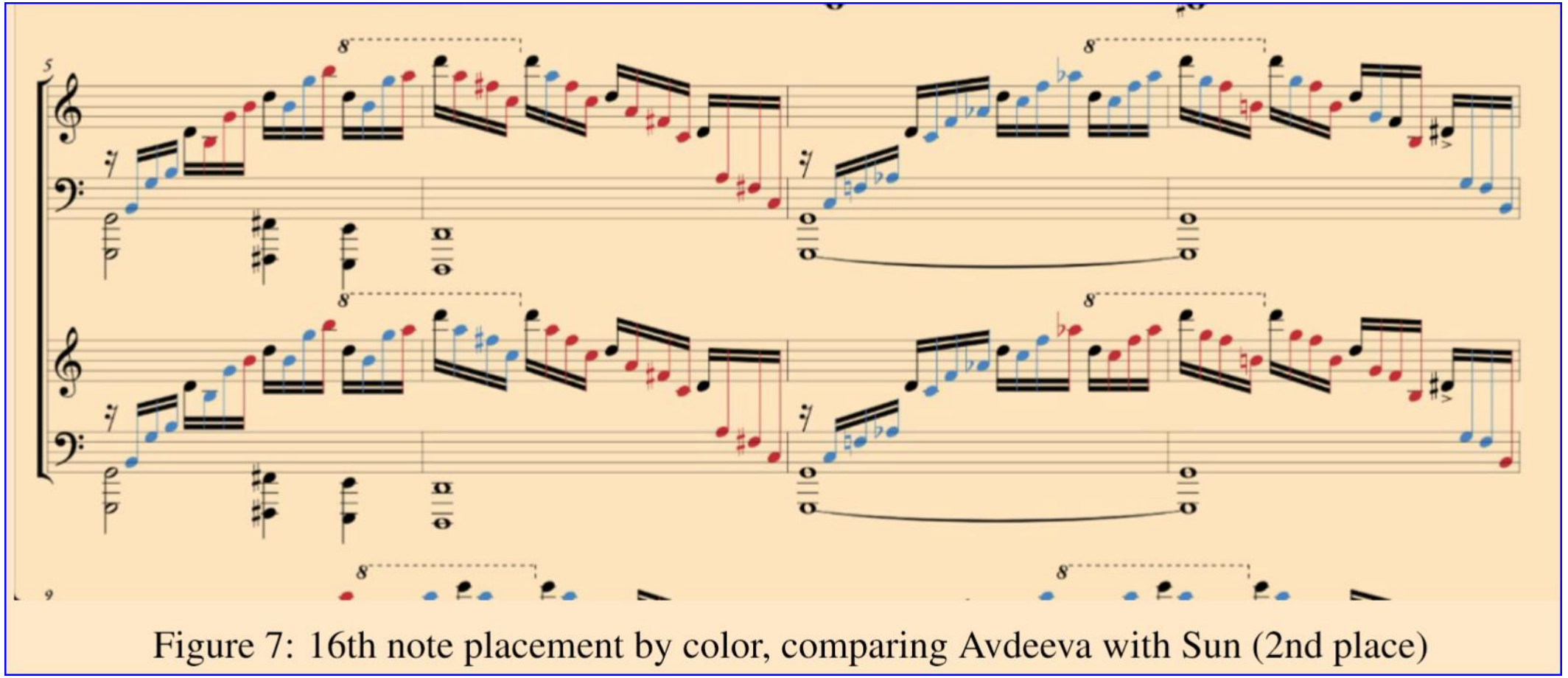


Figure 7: 16th note placement by color, comparing Avdeeva with Sun (2nd place)

Chen: Onset velocity and tempo curves (2021)

Collective winners, non-winners

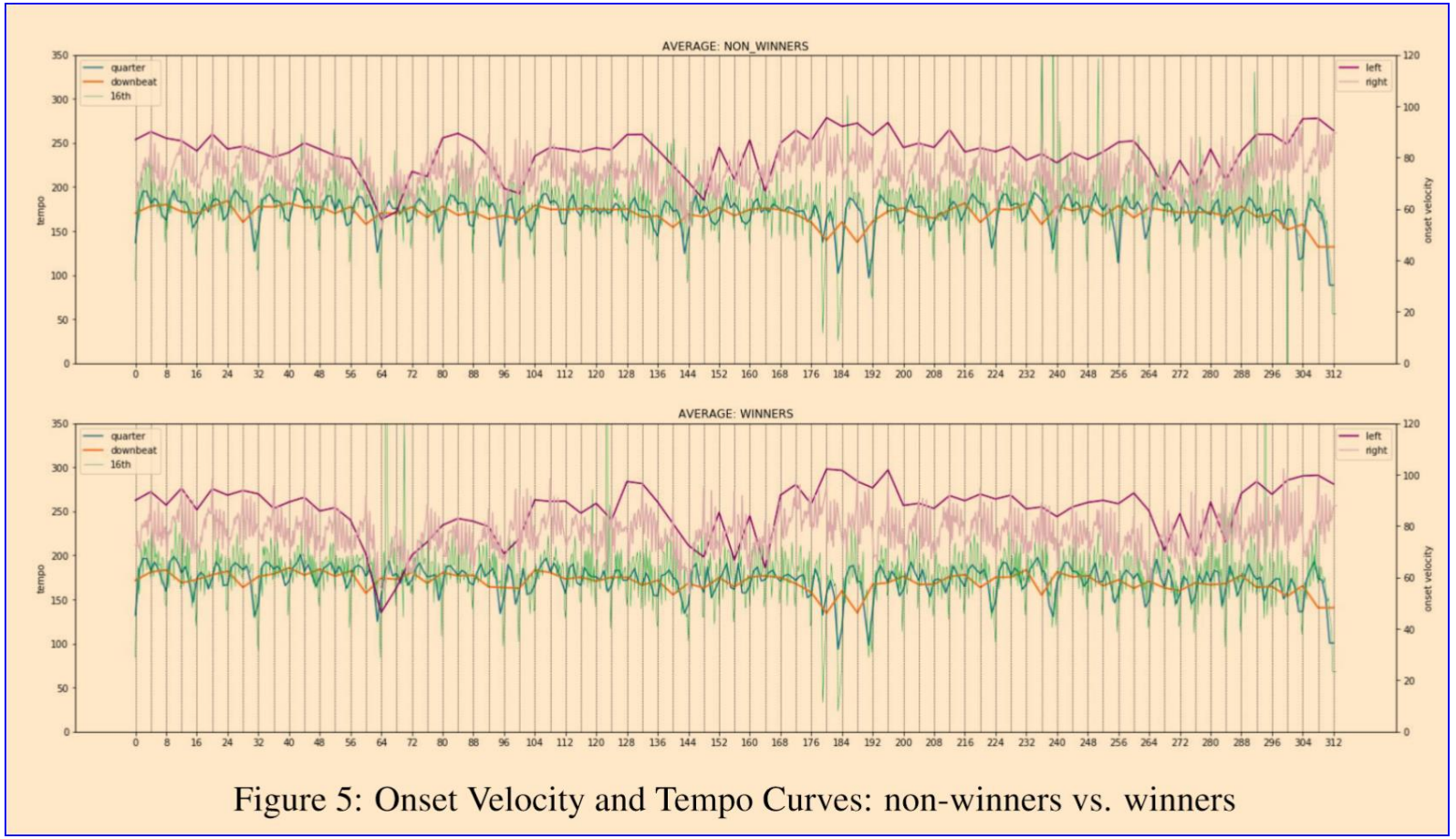
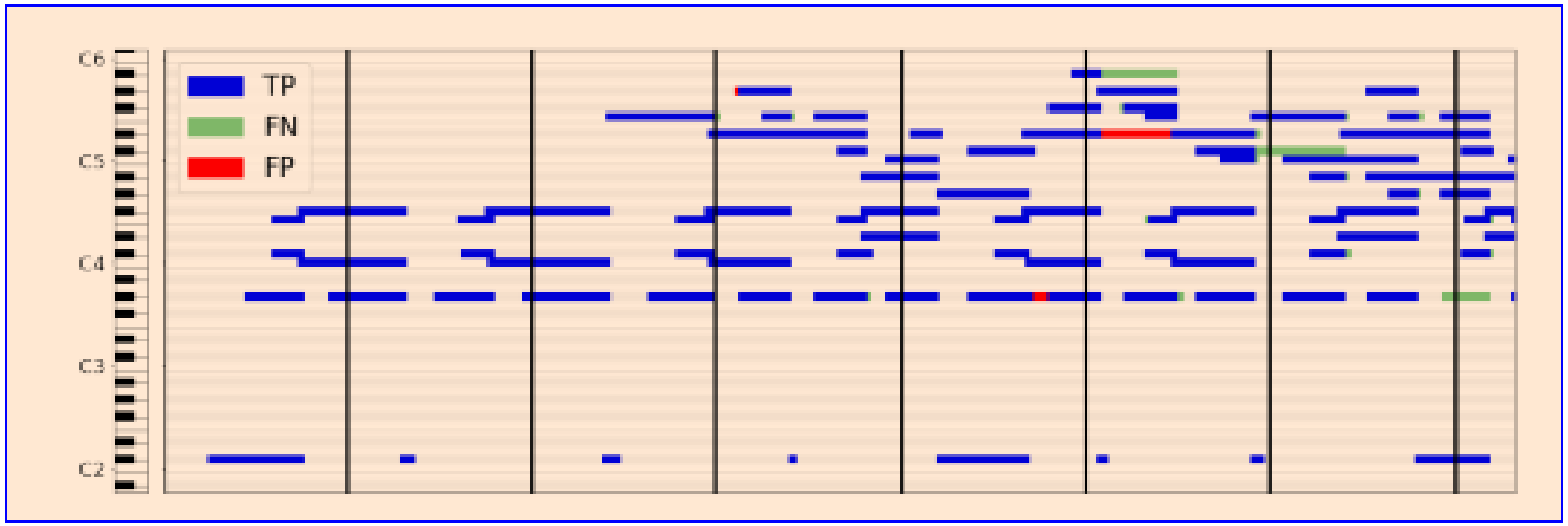


Figure 5: Onset Velocity and Tempo Curves: non-winners vs. winners

MAESTRO: Piano roll rendering of Chopin's Berceuse op 57



https://chopinscores.org/pl/partytura/283

Harthorne et al., ISMIR 2021

- Piano transcription: "sequence-to-sequence" task
- Transcribing multiple instruments:
- cf. https://magenta.tensorflow.org/transcription-with-transformers

Critics of Emmy, AI approaches in general

Failure to find AI superior to human composition among trained listeners (Tom Collins, Springer Verlag, April 2023)

- Collins article:
- https://link.springer.com/article/10.1007/s10994-023-06309-w
- Discusses MAESTRO and other recent datasets
- 50 well trained subjects
- First movement of classical-period string quartets (Haydn, Mozart, Beethoven) if in fast tempo
- Also used expressive MIDI data from Yamaha Disklaviers
- Collins uses MAIA Markov (non-deep learning) model

Collins's Criteria for evaluation

- Stylistic success
- Aesthetic pleasure
- Repetition
- Melody
- Harmony
- Rhythm

All criteria are rated higher for natural examples than for artificial examples.

Tom Collins et al (UK, 2011…)

- Assessments of algorithmic composition methods
- Computational models of musical style
- Databases offering clusters of similar works
  - Haydn/Mozart string quartets [qq.themefinder.org] cf. Kempfert
  - Chopin Mazurkas [N. Cook mazurka recordings]
- Procedural approaches [IEEE]
  - Sequential
  - Structural

Tom Collins et al York U. (2011…)

- 2023, ML, col 1789:
- “The **lack of full source code** and description of how the

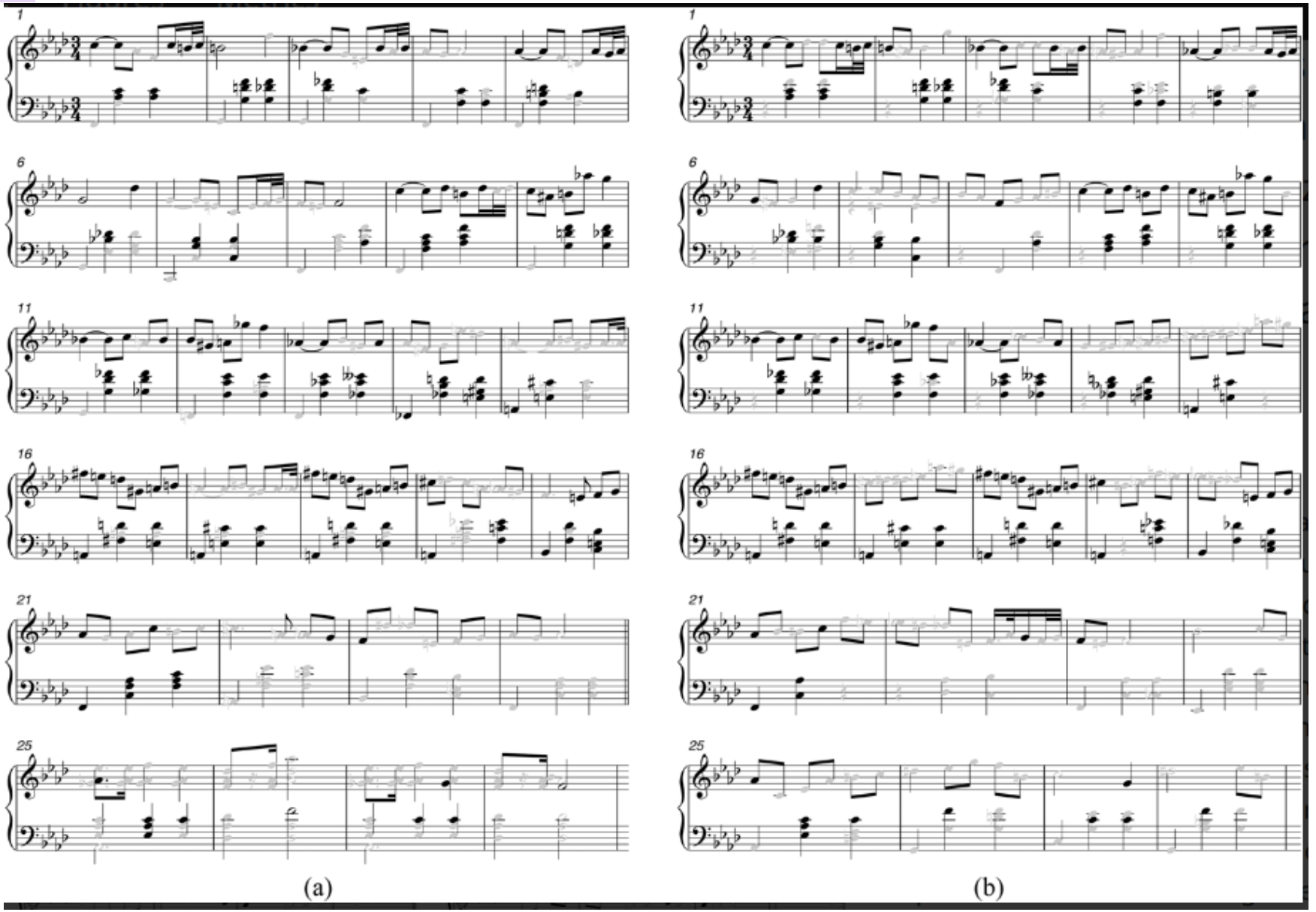
model works has attracted criticism and called the EMI project into question “ (Wiggins, 2008; Collins et al., 2016).

- Collins’ description of the process focuses on “**nesting a Markov generator in another form that inherits a long-term repetitive structure** (MAIA)”.

Collins

- https://www.cambridge.org/core/journals/ai-edam/article/developing-and-evaluating-computational-models-of-musical-style/2D13038AEC3BB894F1345C63F74F6CF4

Emmy vs Chopin



Classifying users for Spotify recommendations

- Spotify: https://www.wsj.com/video/series/wsj-explains/how-spotify-knows-what-you-want-to-hear-next/E91EB935-C3EE-42FF-B41A-246614F8F1A1?mod=hp_listb_pos1 (WSJ, 16 April 2023)

- Explains layers of computation in building personal recommendations