TOWARDS MULTI-INSTRUMENT DRUM TRANSCRIPTION

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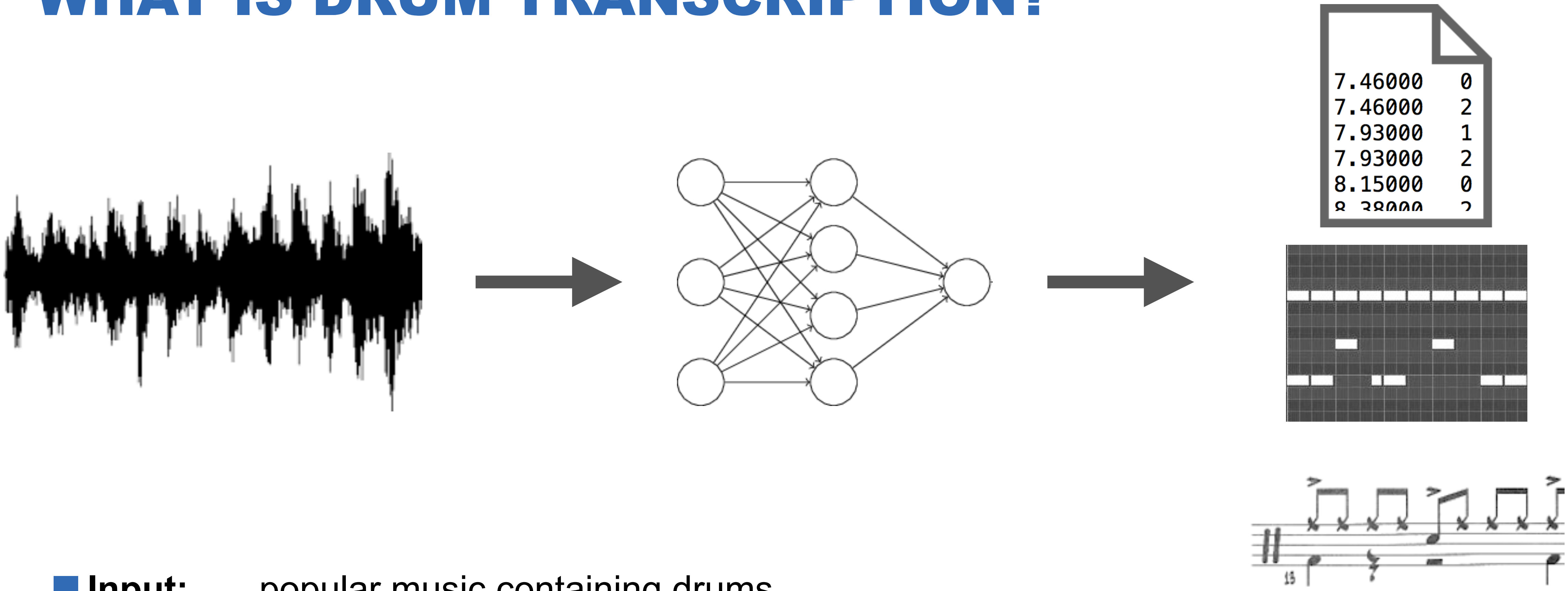
WHAT IS DRUM TRANSCRIPTION?

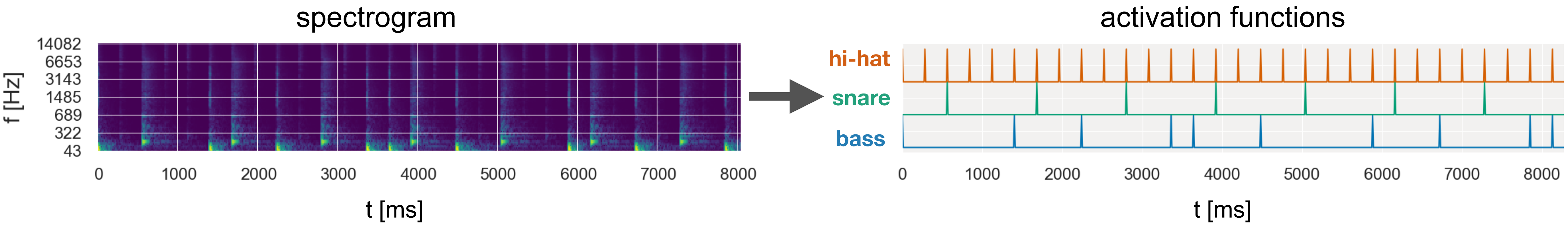


```
7.46000   0
7.46000   2
7.93000   1
7.93000   2
8.15000   0
8.38000   2
```

- **Input:** popular music containing drums
- **Output:** symbolic representation of notes played by drum instruments

STATE OF THE ART

- Current state-of-the-art systems:
  - End-to-end / **activation-function-based** approaches
  - **NN** based approaches and **NMF** approaches


spectrogram

activation functions

- Overview Article

  Wu, C.-W., Dittmar, C., Southall, C.,Vogl, R., Widmer, G., Hockman, J., Müller, M., Lerch, A.:
  “**An Overview of Automatic Drum Transcription**,” IEEE TASLP, vol. 26, no. 9, Sept. 2018.

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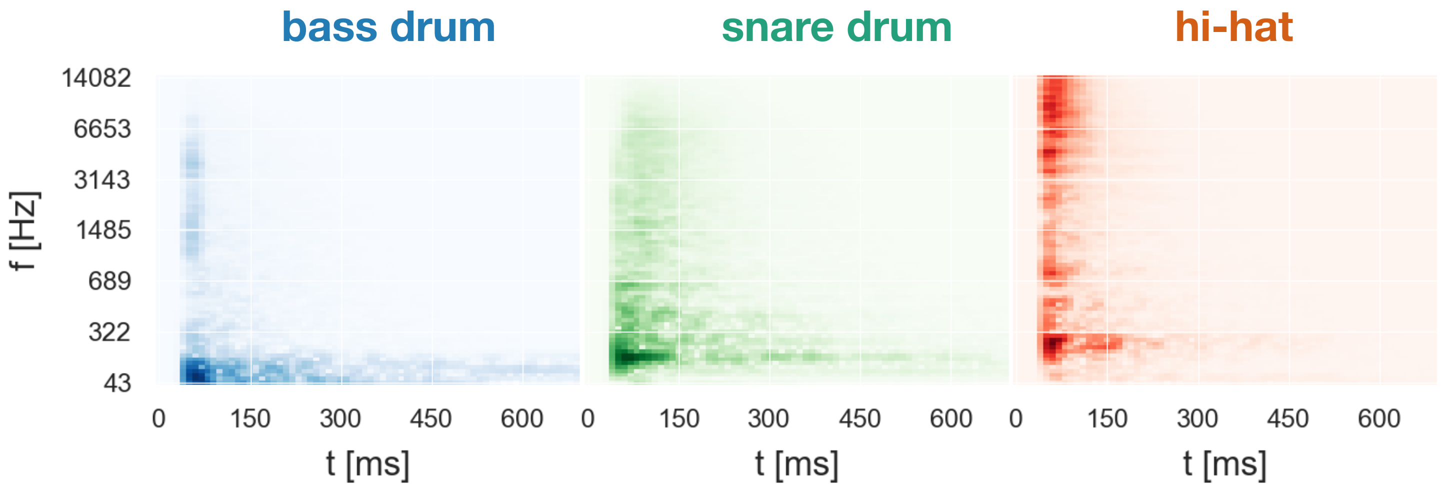

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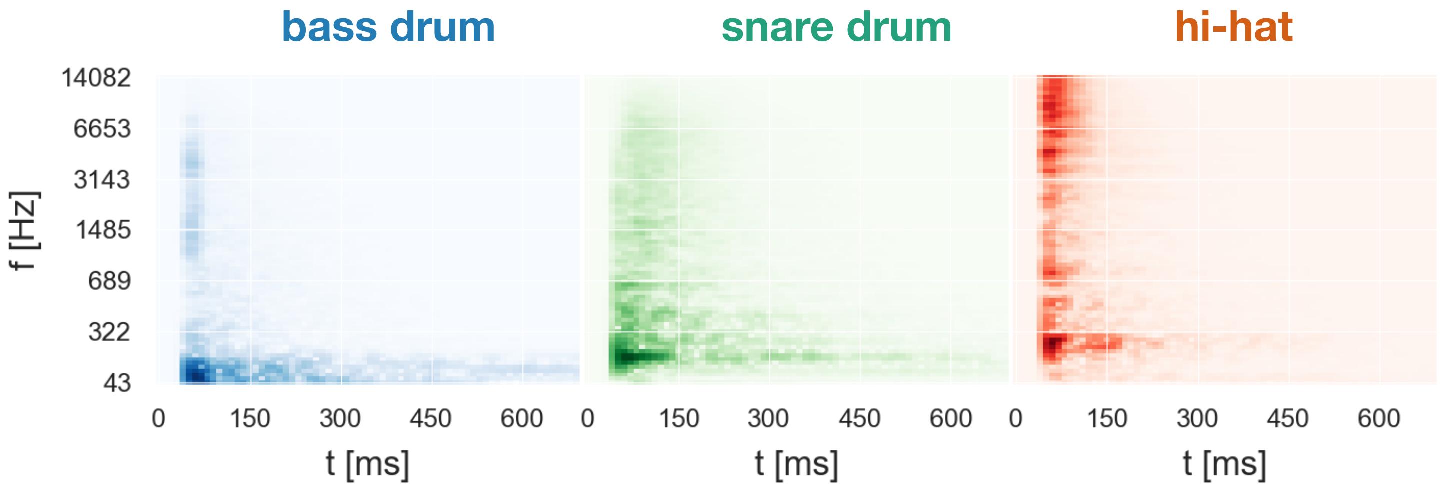

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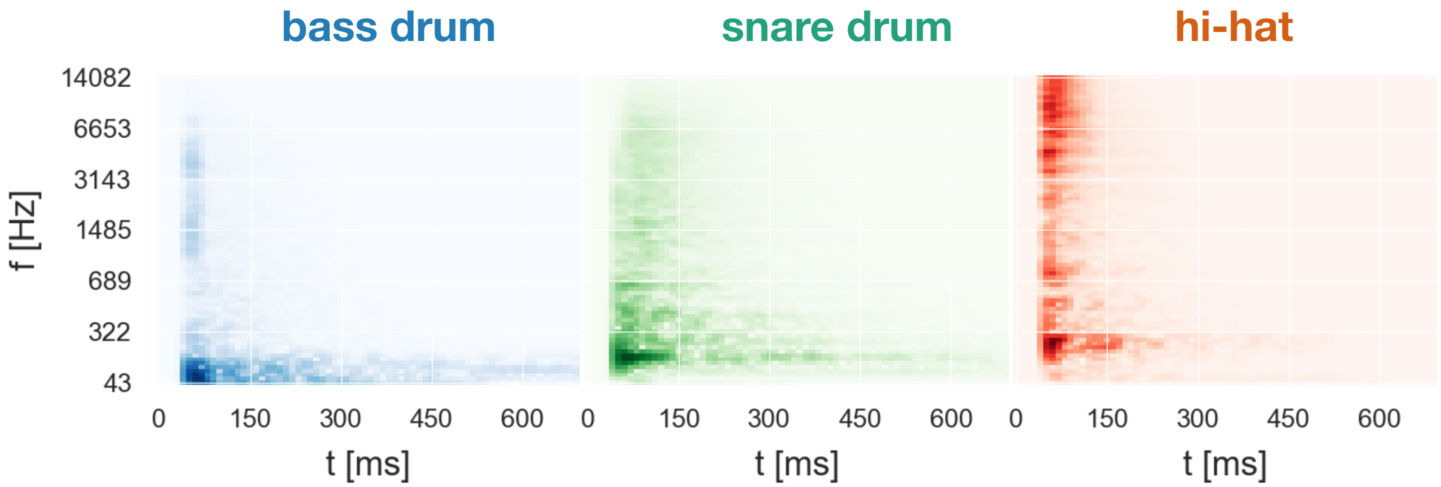

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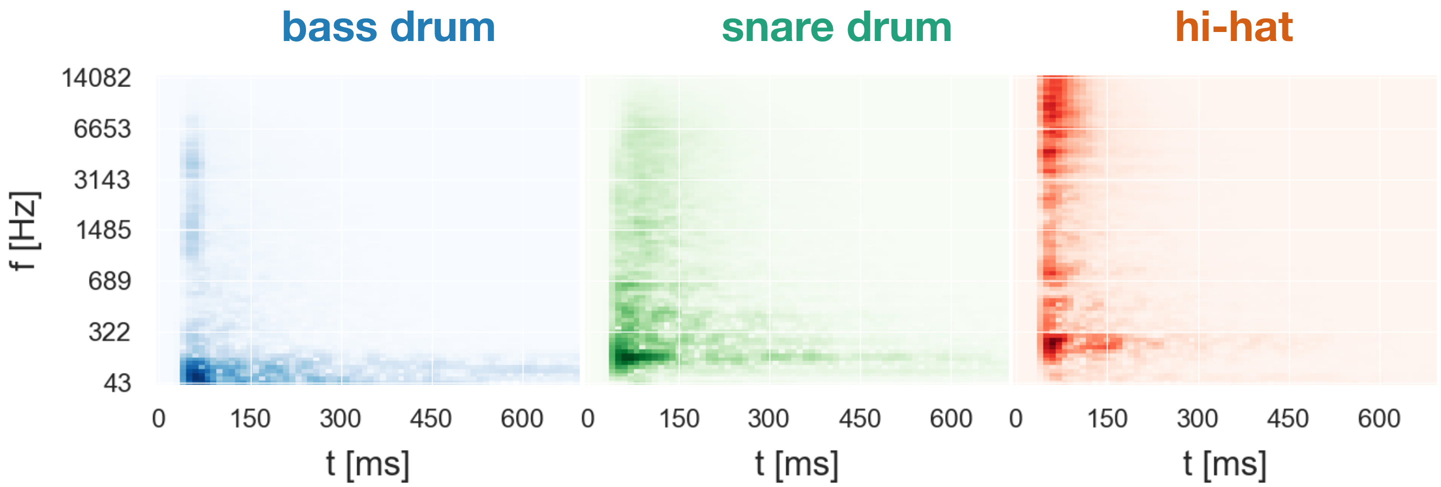

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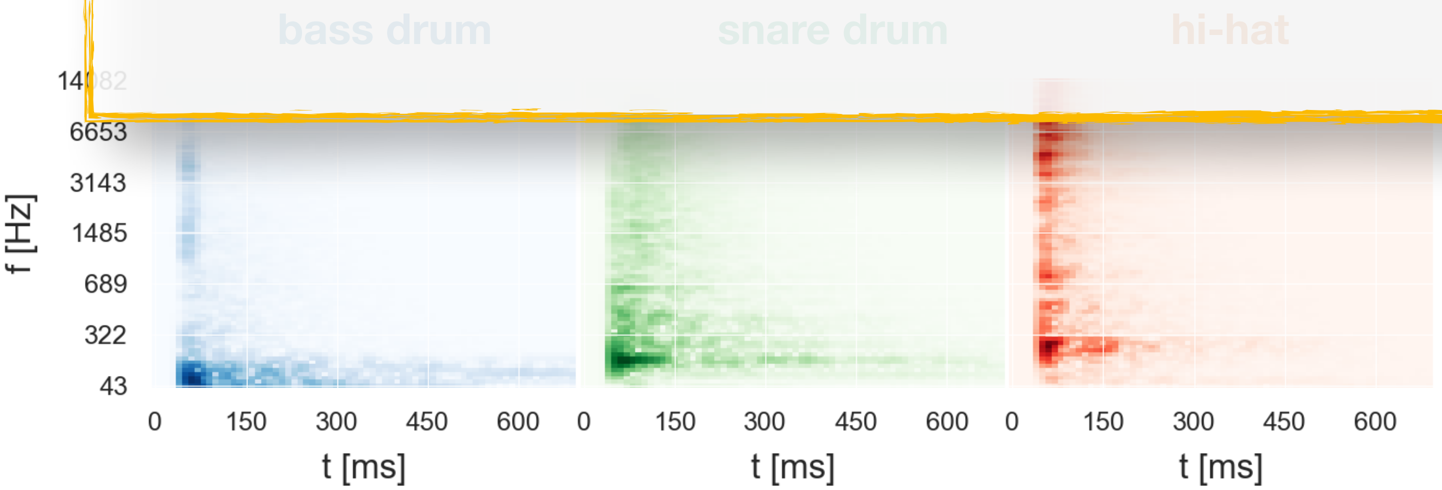
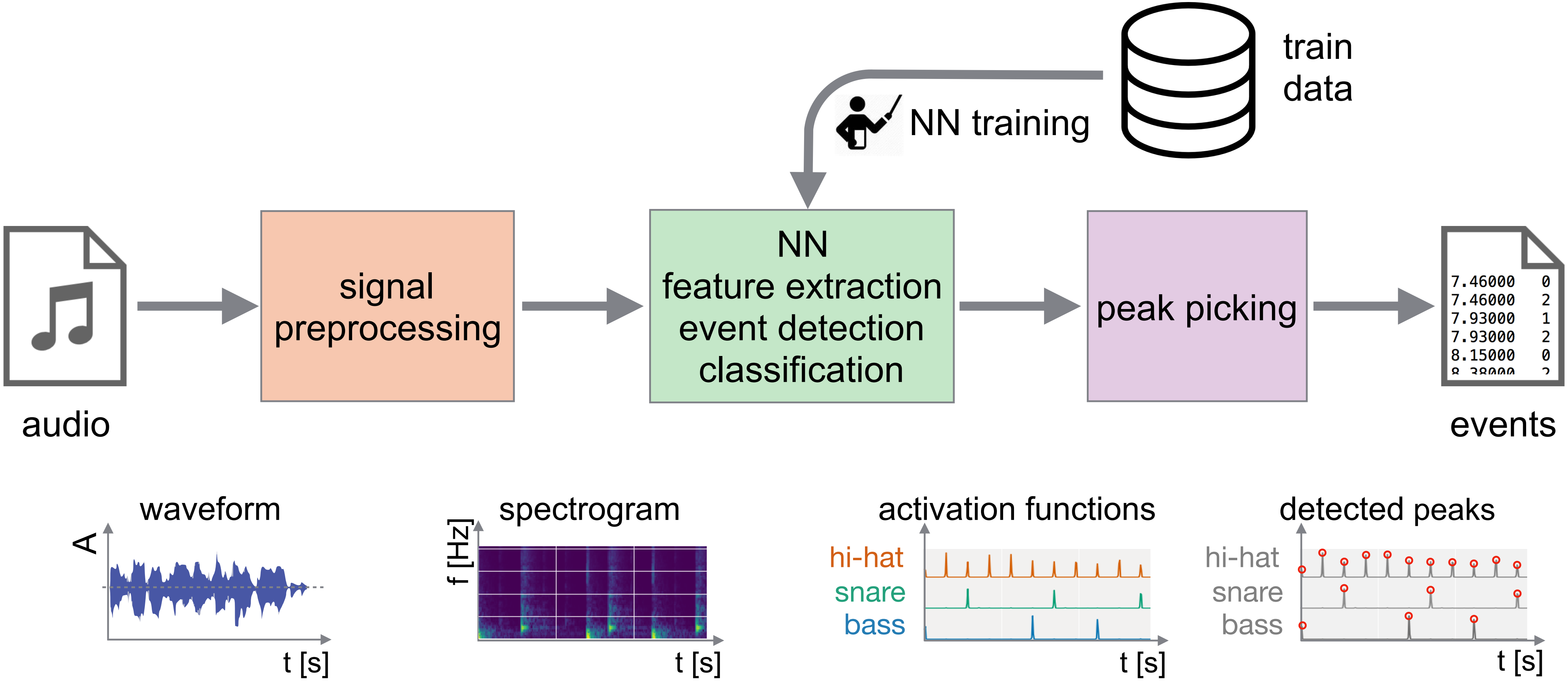
Other instruments are important!

→ Increase number of instruments for drum transcription



SYSTEM OVERVIEW



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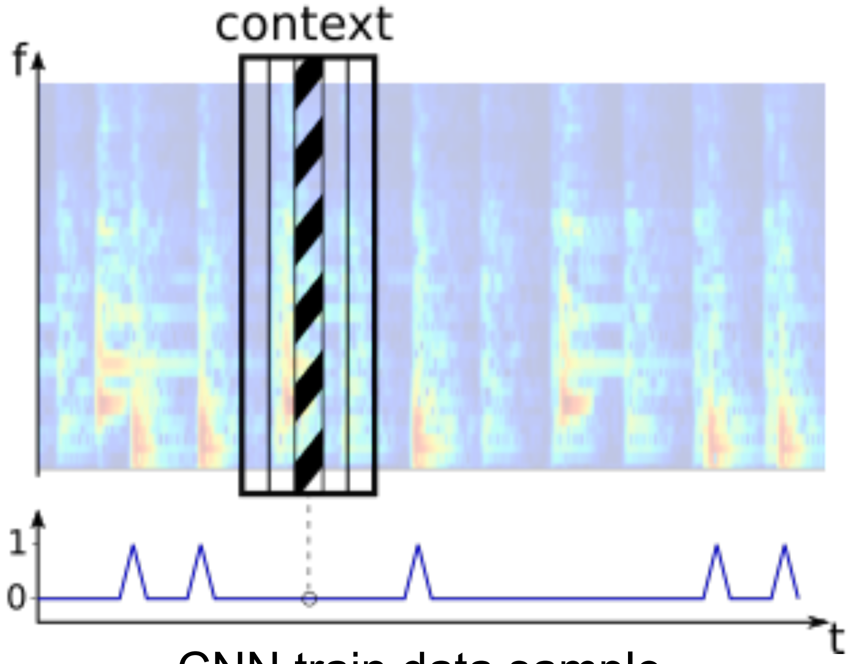
- Convolutional NN (**CNN**)
  - Convolutions capture **local correlations**
  - **Acoustic modeling** of drum sounds



CNN train data sample

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- Convolutional NN (**CNN**)
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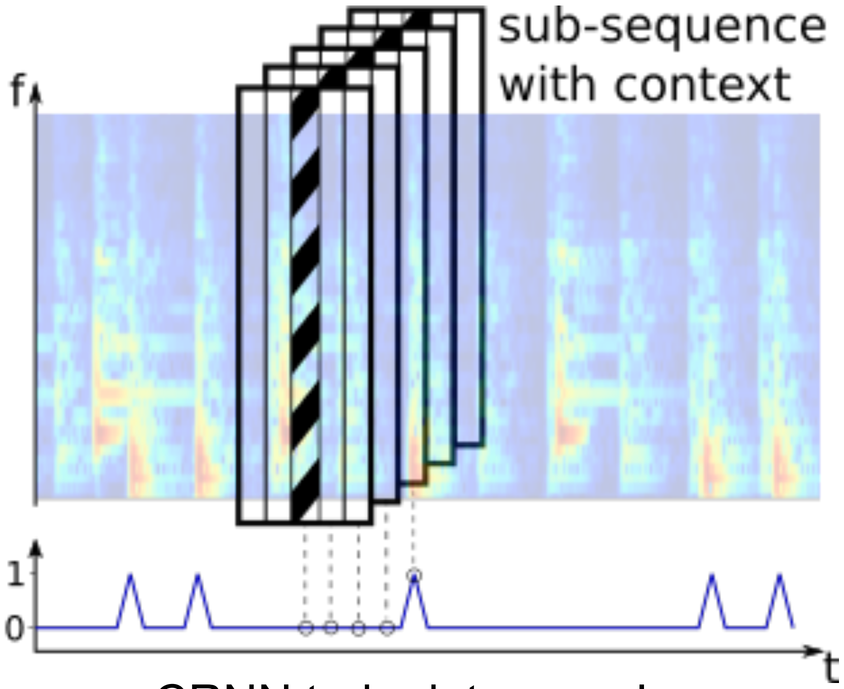
  - **Acoustic modeling** of drum sounds

- Convolutional RNN (**CRNN**)
  - **”best of both worlds”**
  - Low-level CNN for **acoustic modeling**
  - Higher-level RNN for **repetitive pattern modeling**



CRNN train data sample

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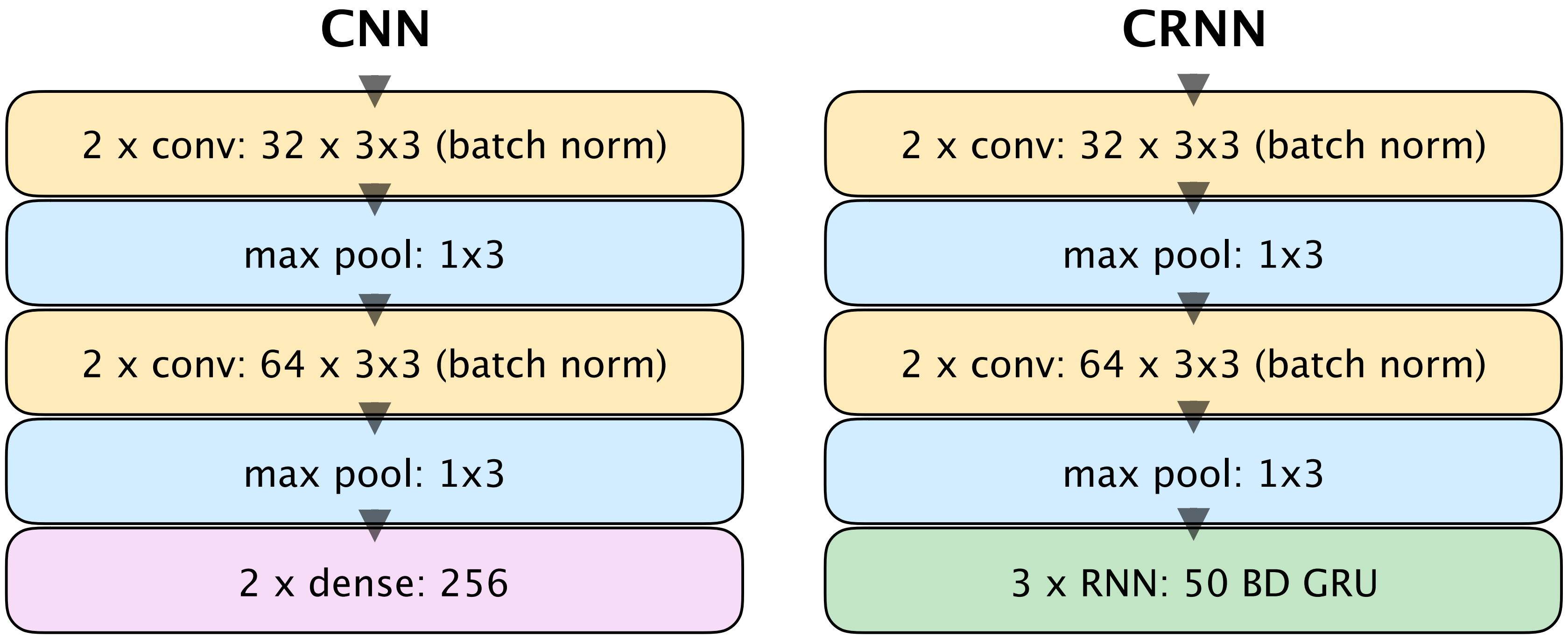

CNN

2 x conv: 32 x 3x3 (batch norm)

max pool: 1x3

2 x conv: 64 x 3x3 (batch norm)

max pool: 1x3

2 x dense: 256

CRNN

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max pool: 1x3

2 x conv: 64 x 3x3 (batch norm)

max pool: 1x3

3 x RNN: 50 BD GRU

- Early stopping
- Batch normalization
- L2 norm
- Dropout (30%)
- ADAM optimizer

	frames	context	conv. layers	rec. layers	dense layers
CNN	—	25	see figure	—	2x256
CRNN	400	13		3 x 50 BD GRU	—

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  - Recordings, three drummers / drum kits
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  - Music from 2013 Red Bull Music Academy, different styles
  - 27 tracks, total duration: **1h 43m**

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number of classes			
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		SS	side stick
		CLP	hand clap
	TT	HT	hight tom
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		LT	low tom
HH	HH	CHH	closed hi-hat
		PHH	pedal hi-hat
		OHH	open hi-hat
		TB	tambourine
	RD	RD	ride cymbal
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		CB	cowbell
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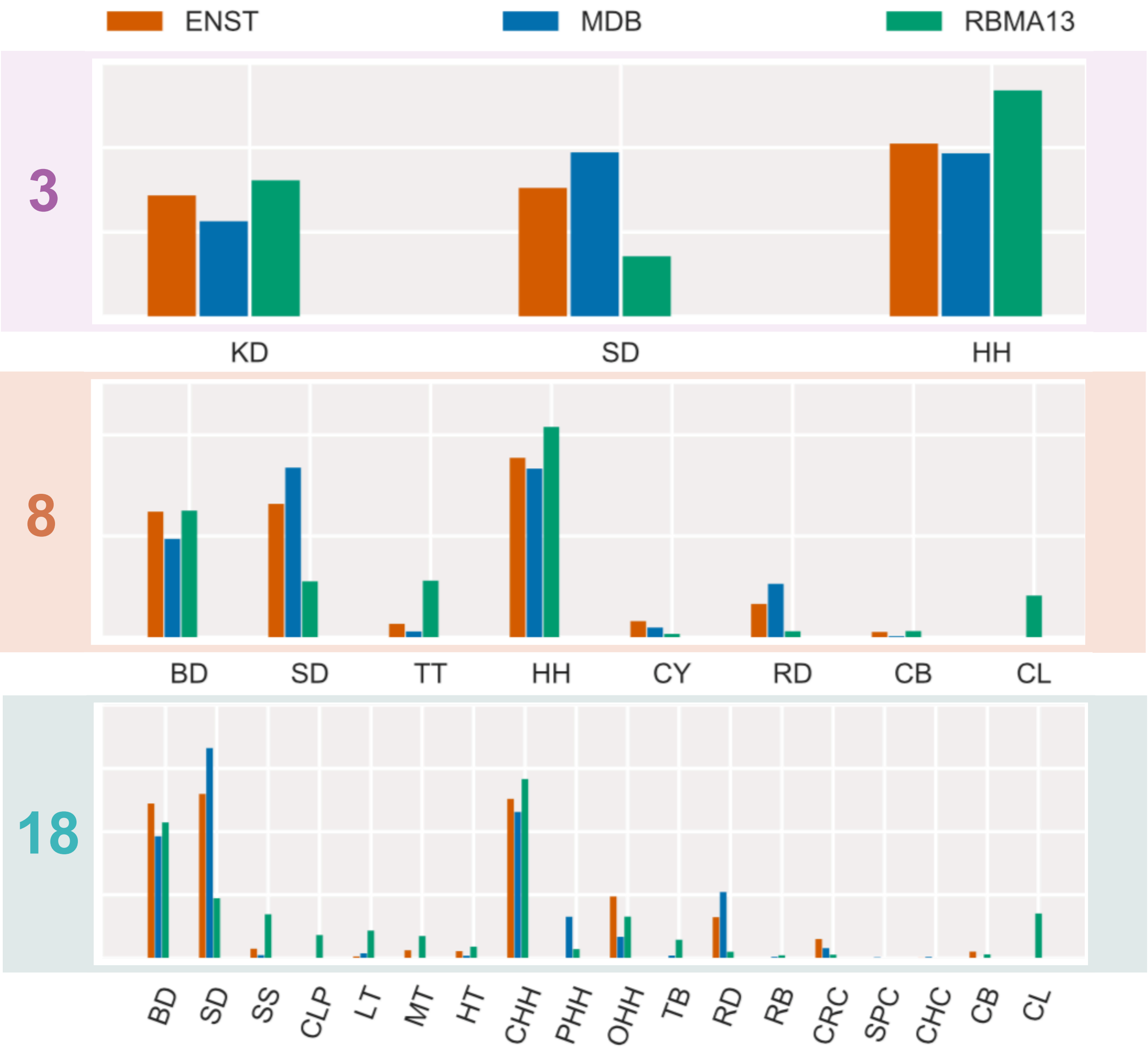
relative frequency of instrument onsets



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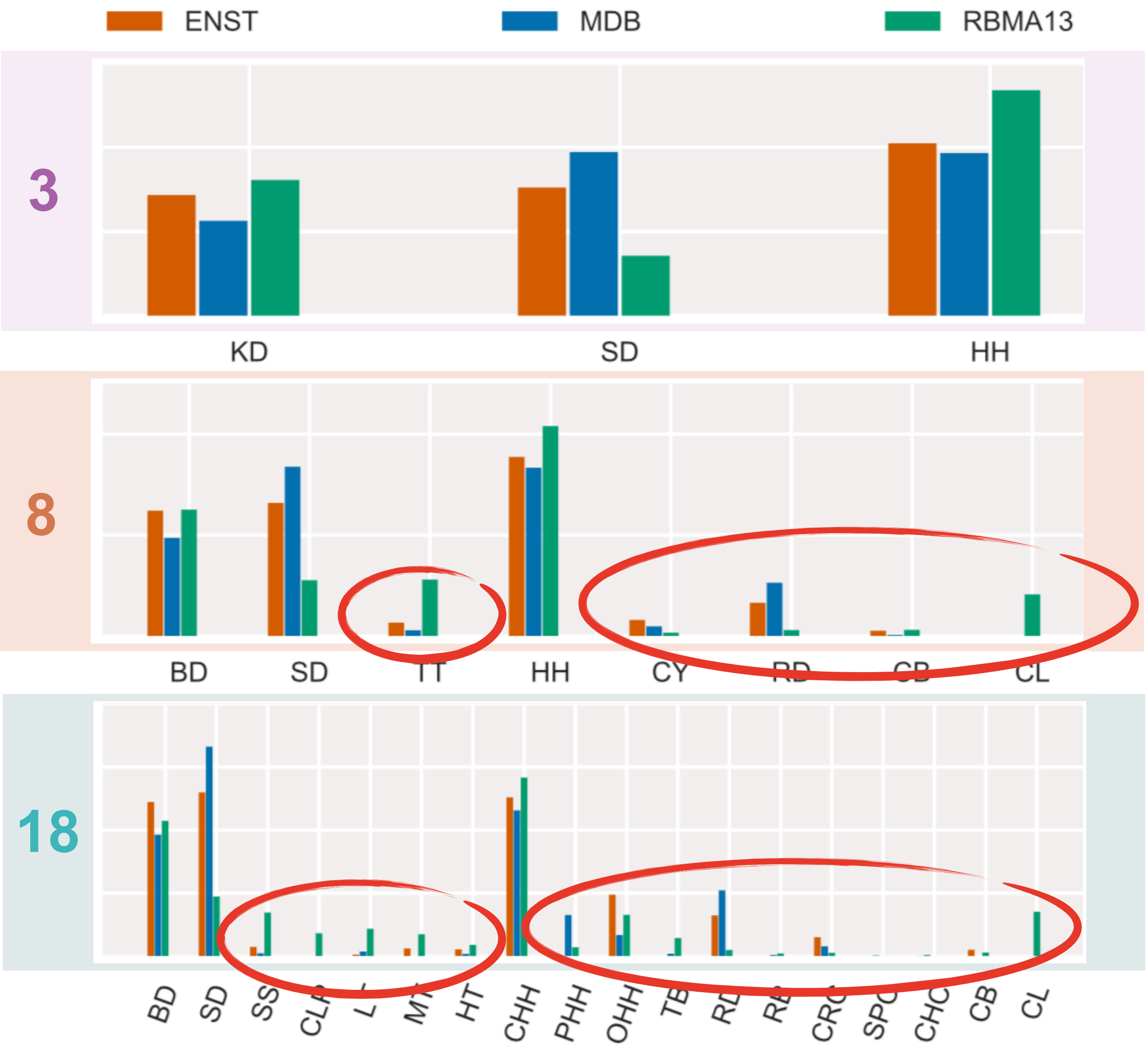

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Synthetic dataset from **MIDI** songs

- Mix of different genres, **full songs**

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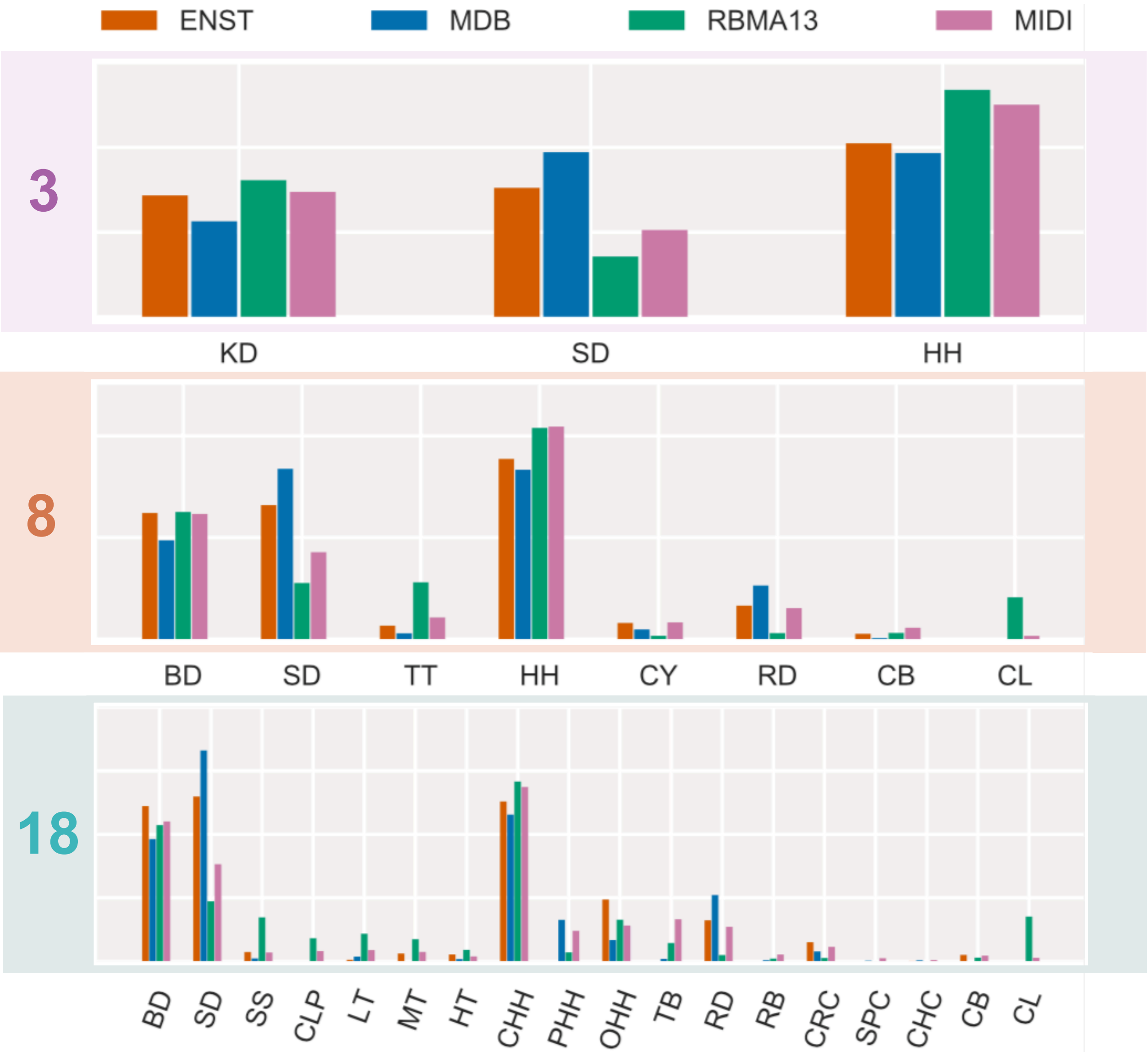
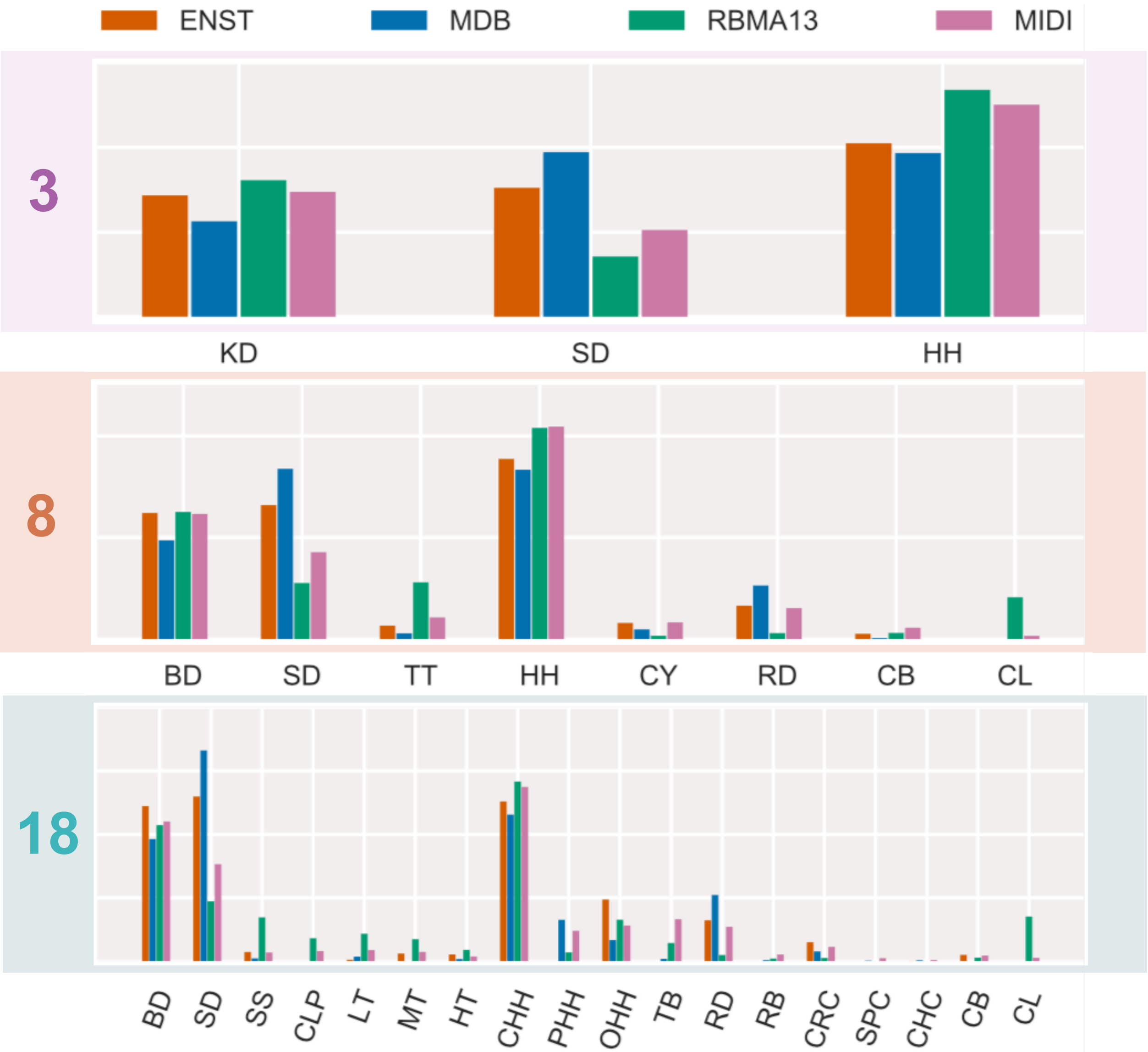


SYNTHETIC DATASET

- Follows the **same relative instrument distribution**

relative frequency of instrument onsets



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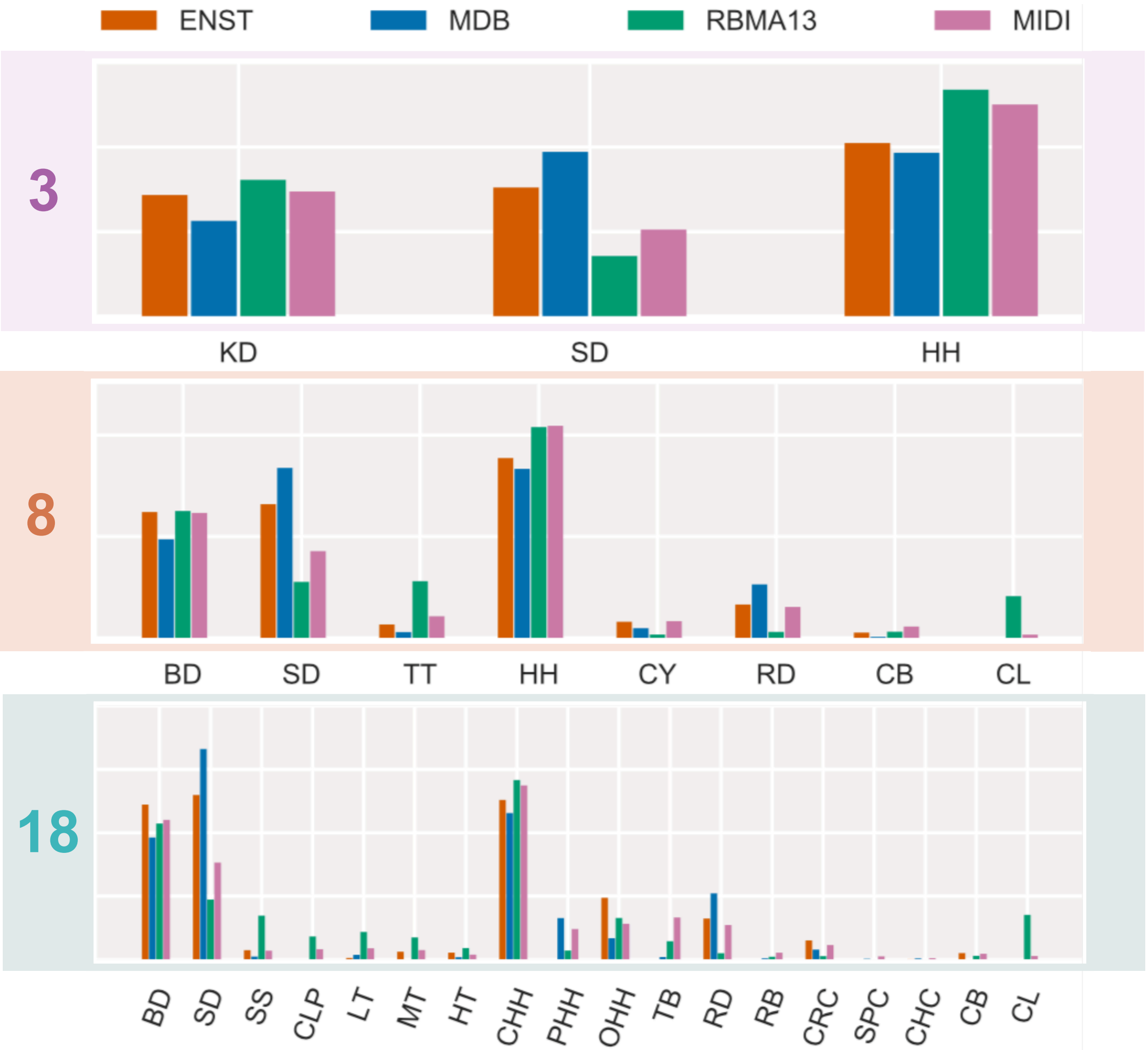
    same problems during training

relative frequency of instrument onsets



SYNTHETIC DATASET

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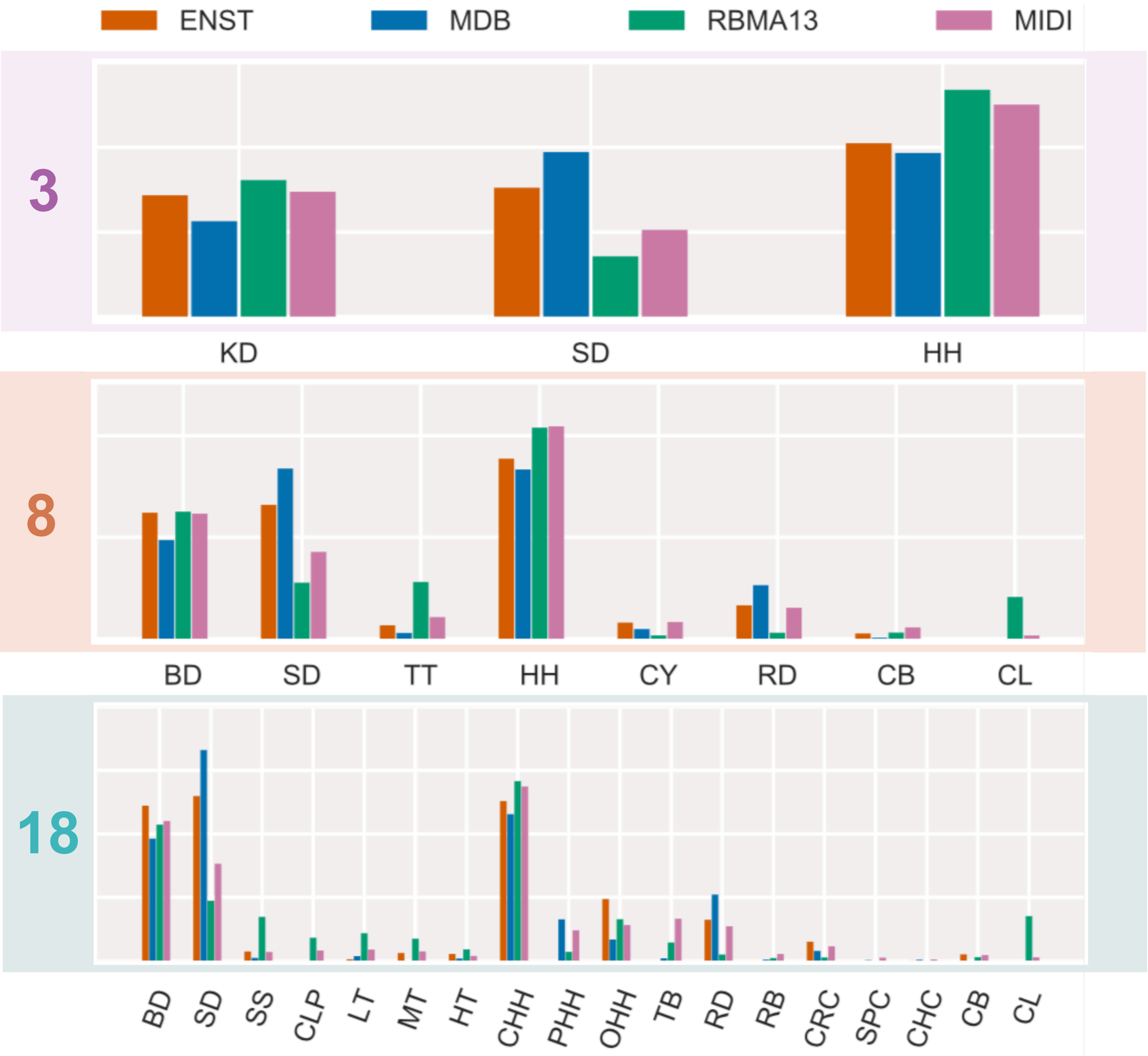
    same problems during training
  - + datasets are **representative samples**

relative frequency of instrument onsets



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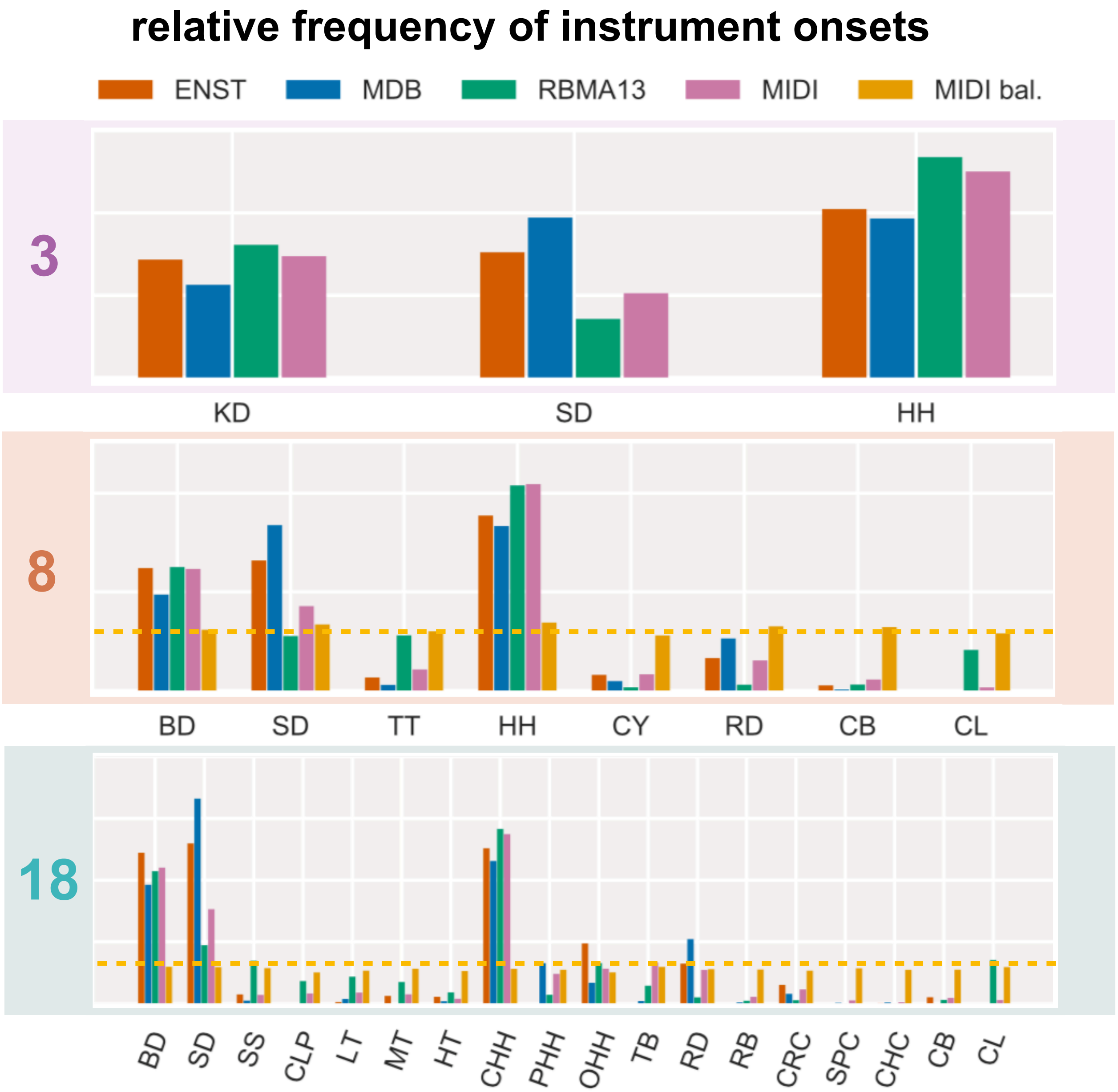

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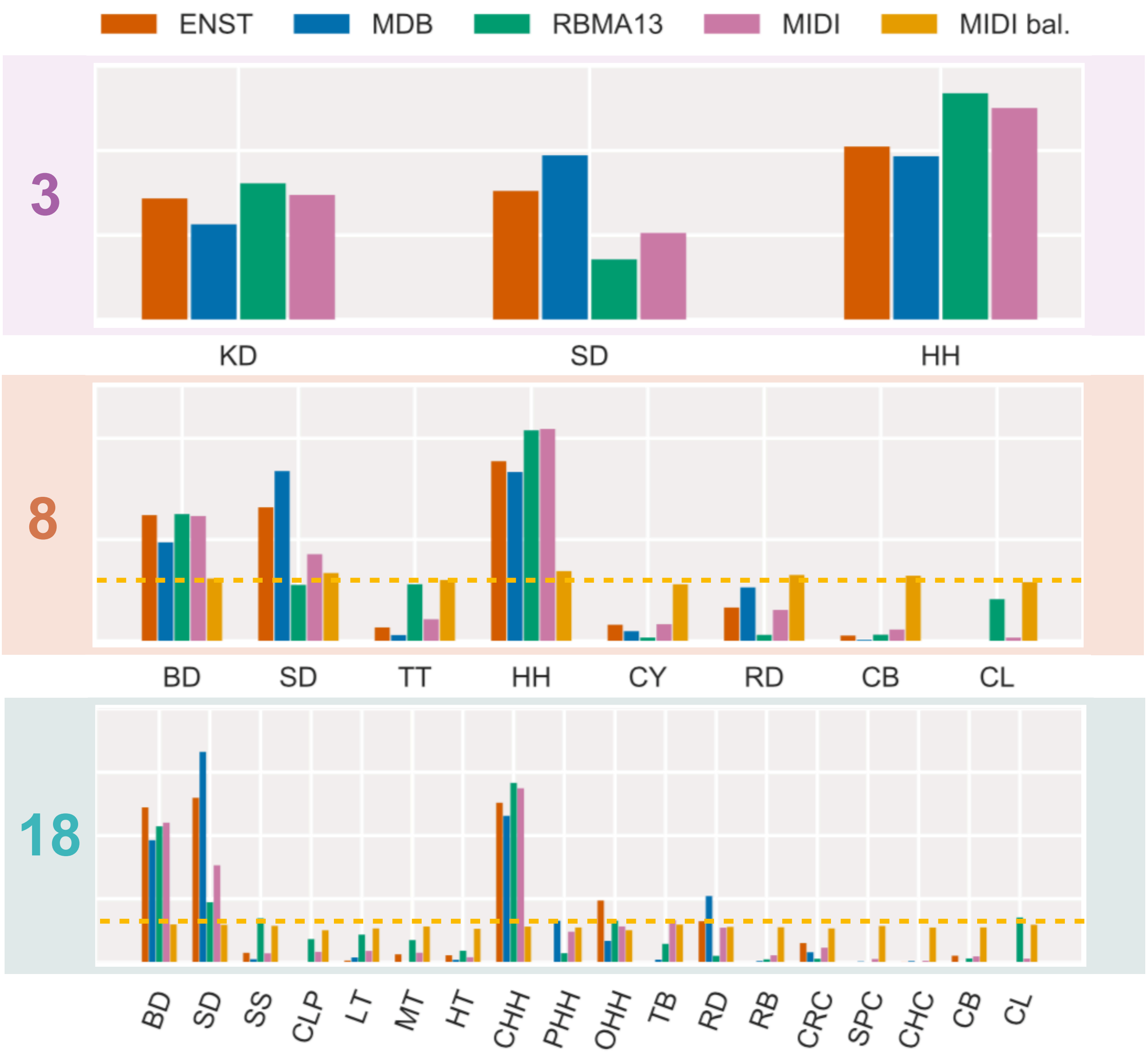
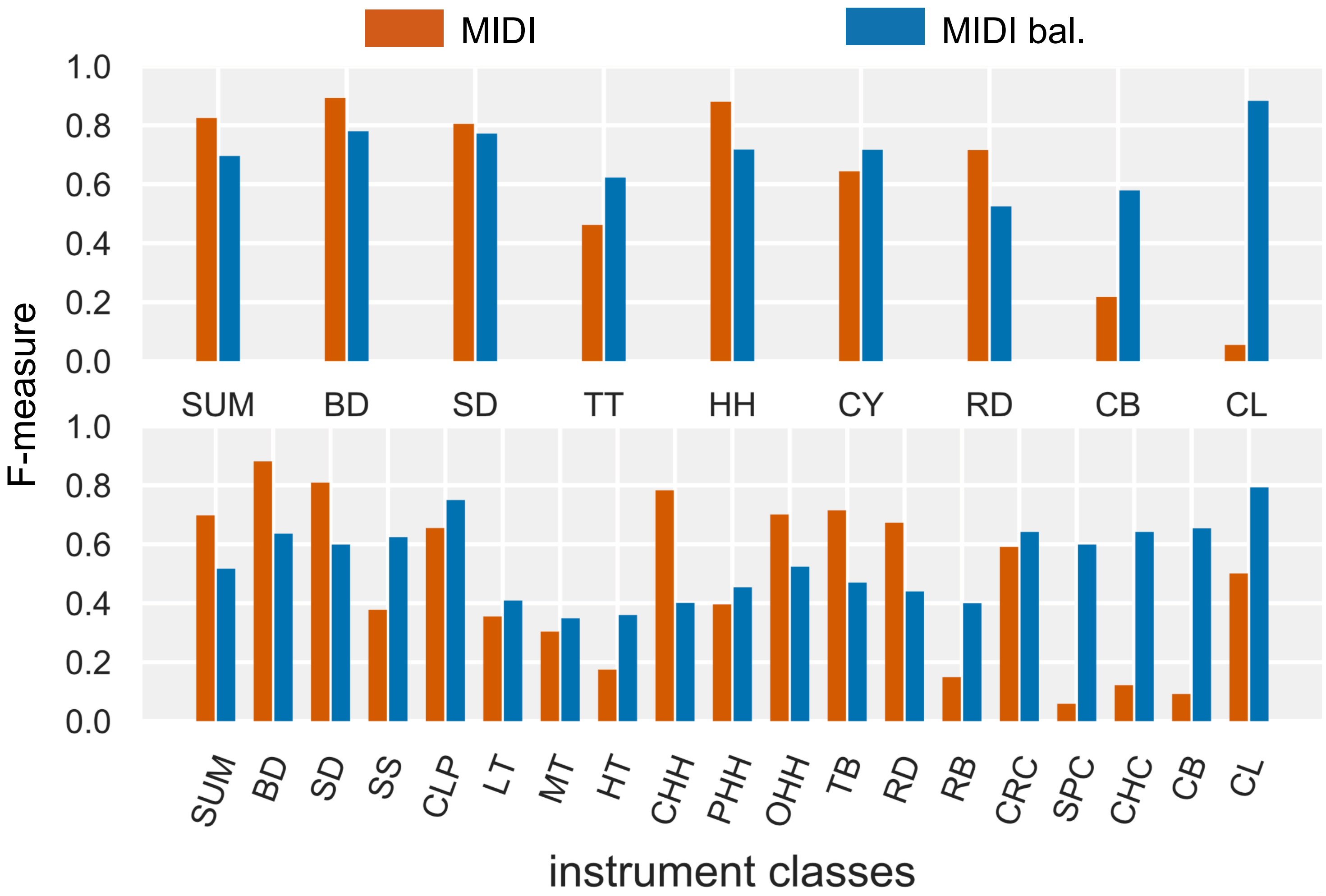


RESULTS ON SYNTHETIC DATA



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- **Overall performance** for MIDI bal. **is worse**
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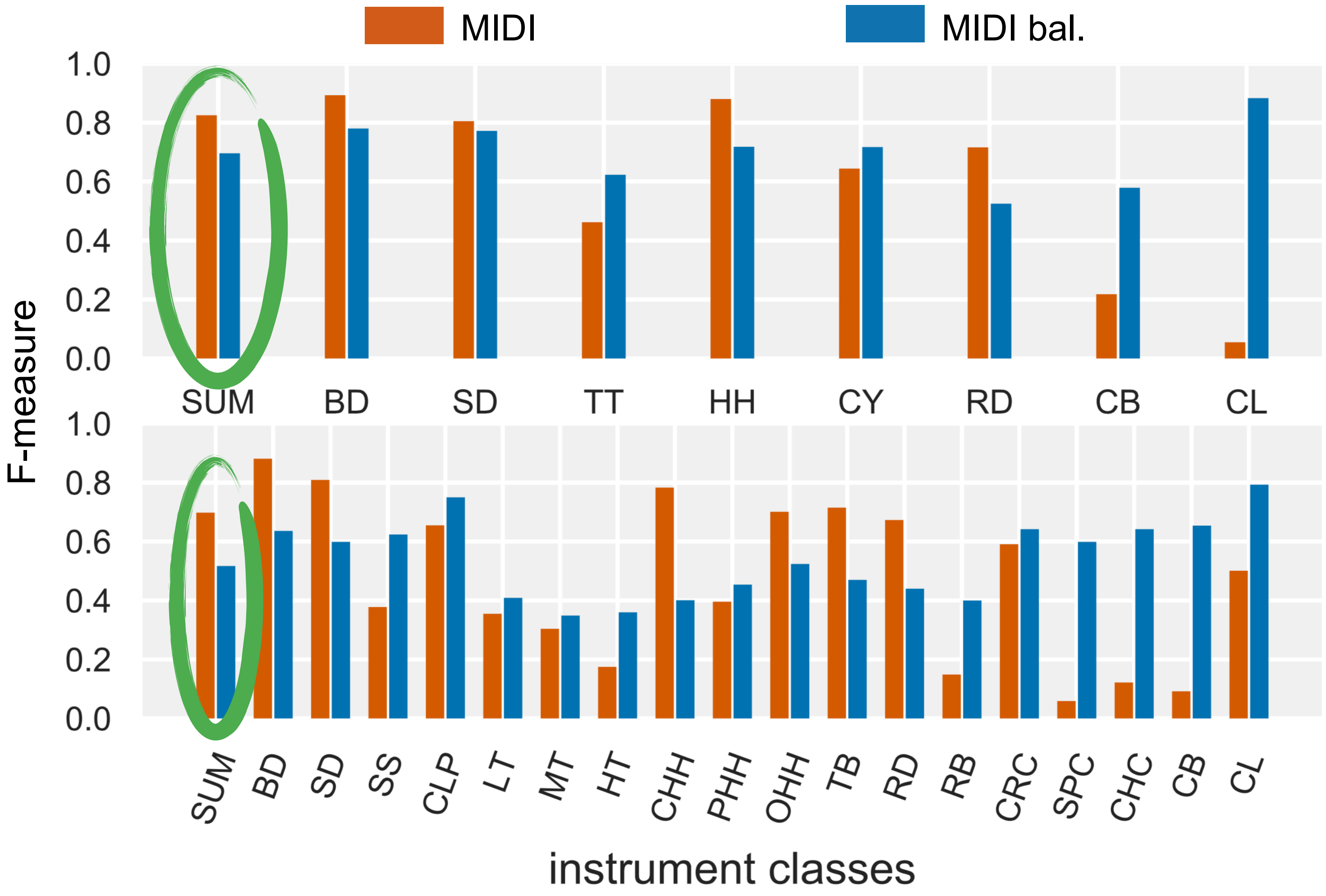
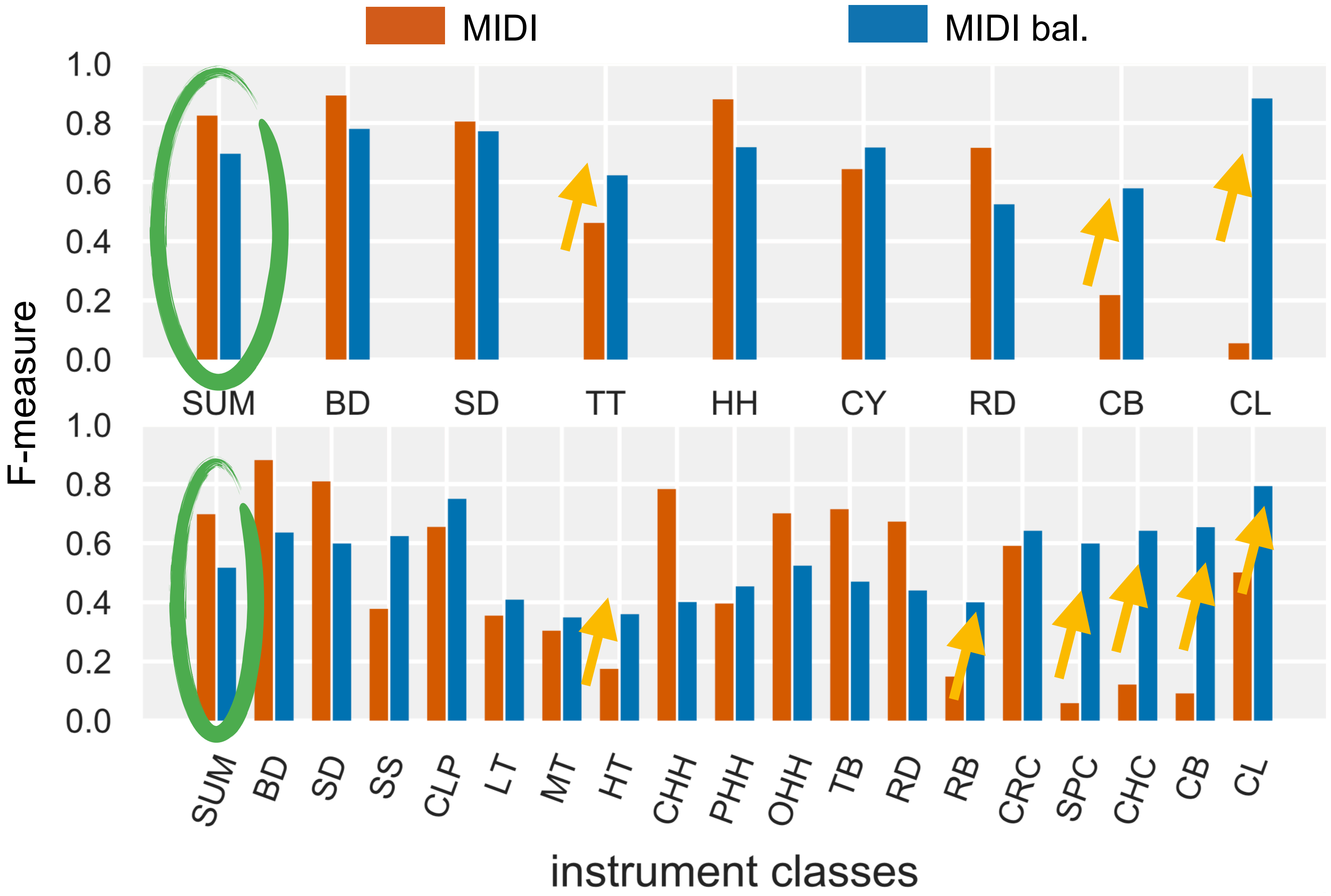


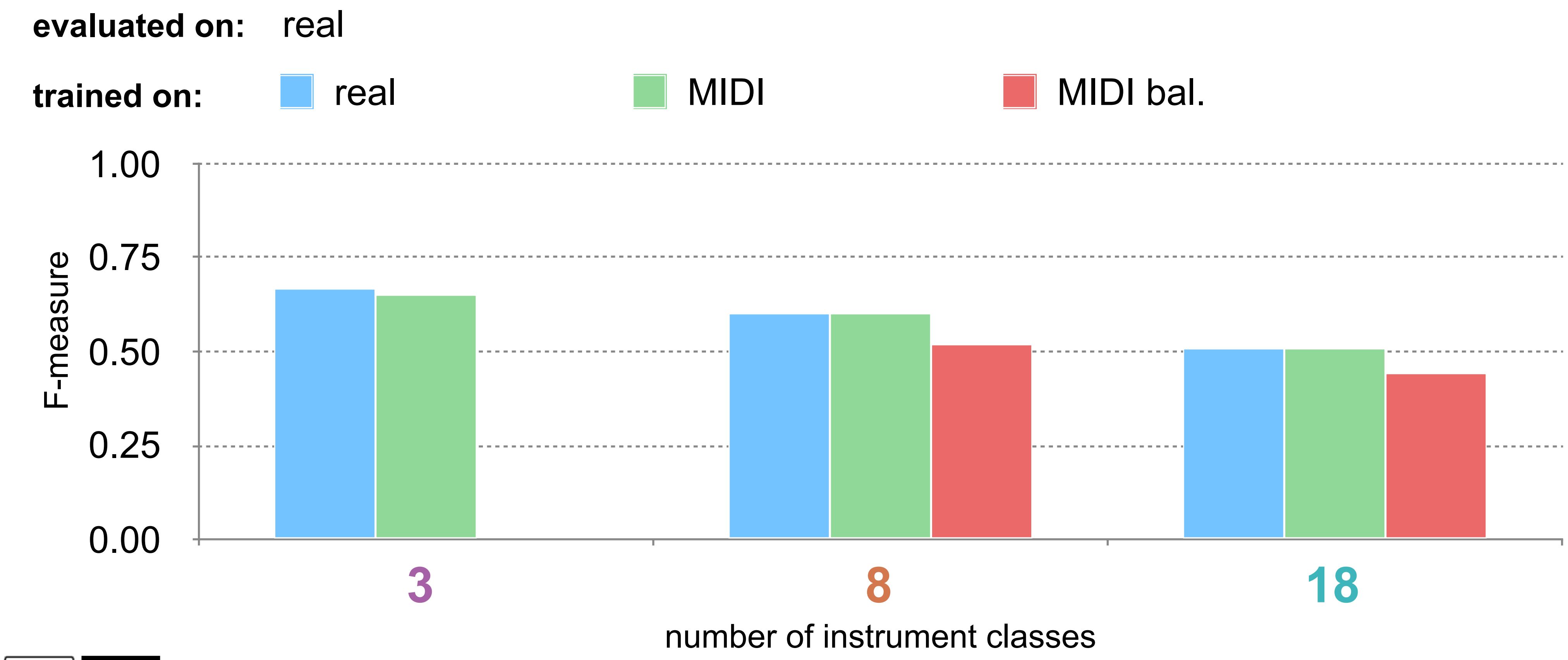
RESULTS ON SYNTHETIC DATA

- **Overall performance** for MIDI bal. **is worse**
  - It is a harder task
- Performance of **underrepresented instruments improves**
  - Providing more samples forces the network to learn formerly sparsely used instruments



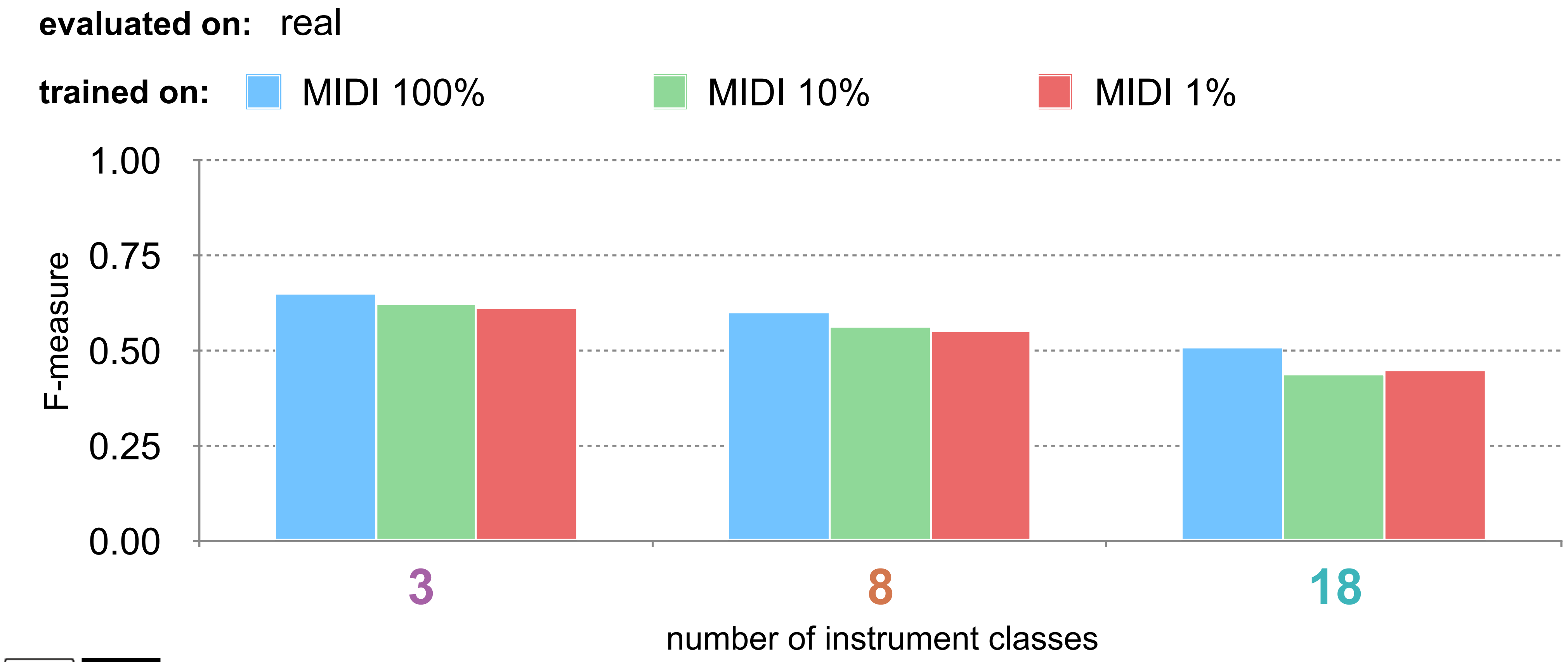
OVERALL PERFORMANCE ON REAL DATA

- Model trained on synthetic data **performs well** on real-world data (ENST + MDB + RBMA)



RESULTS FOR DIFFERENT SIZES

- Performance **decreases**, but **not drastically**



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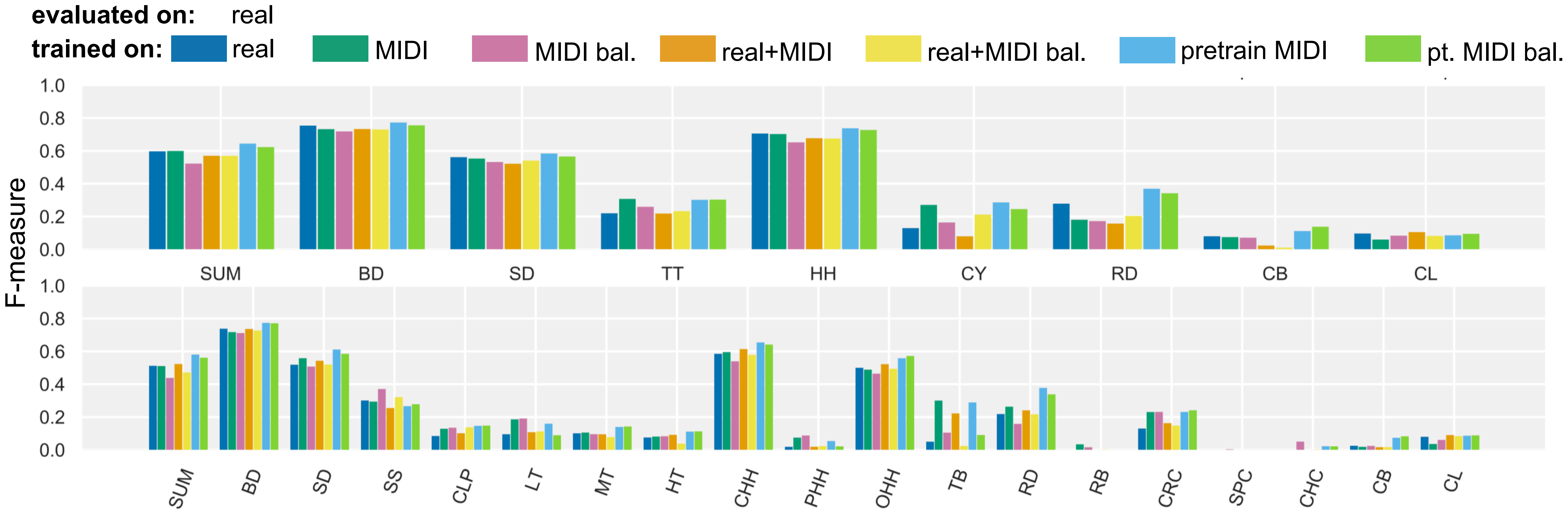

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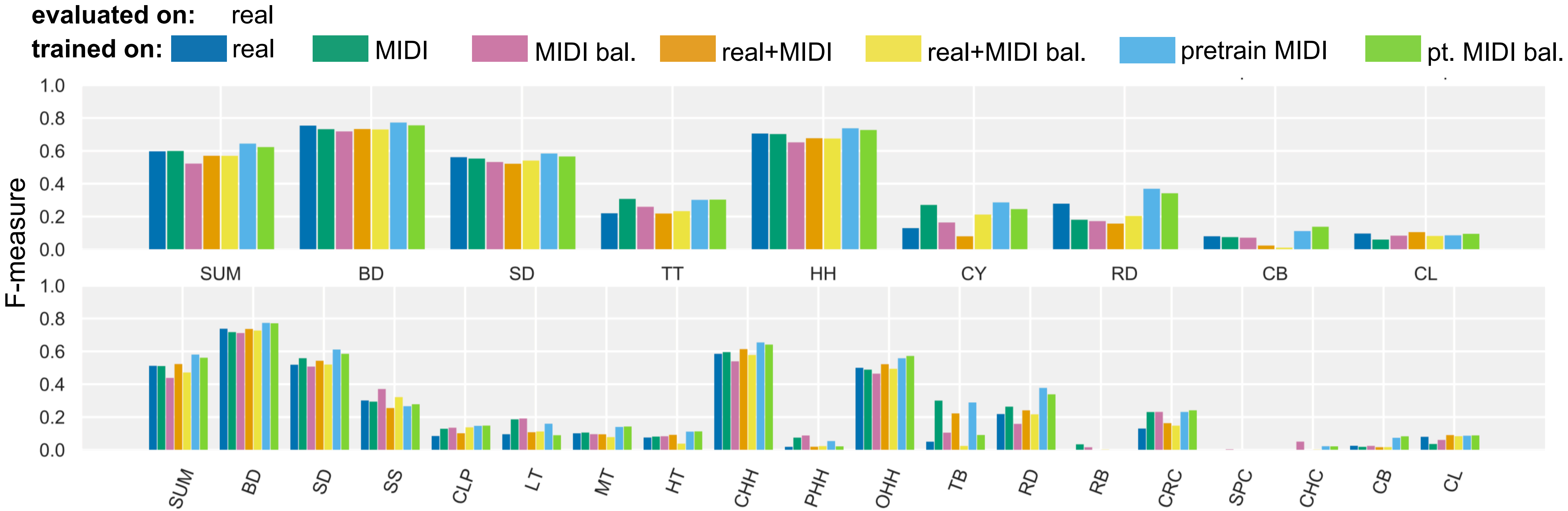

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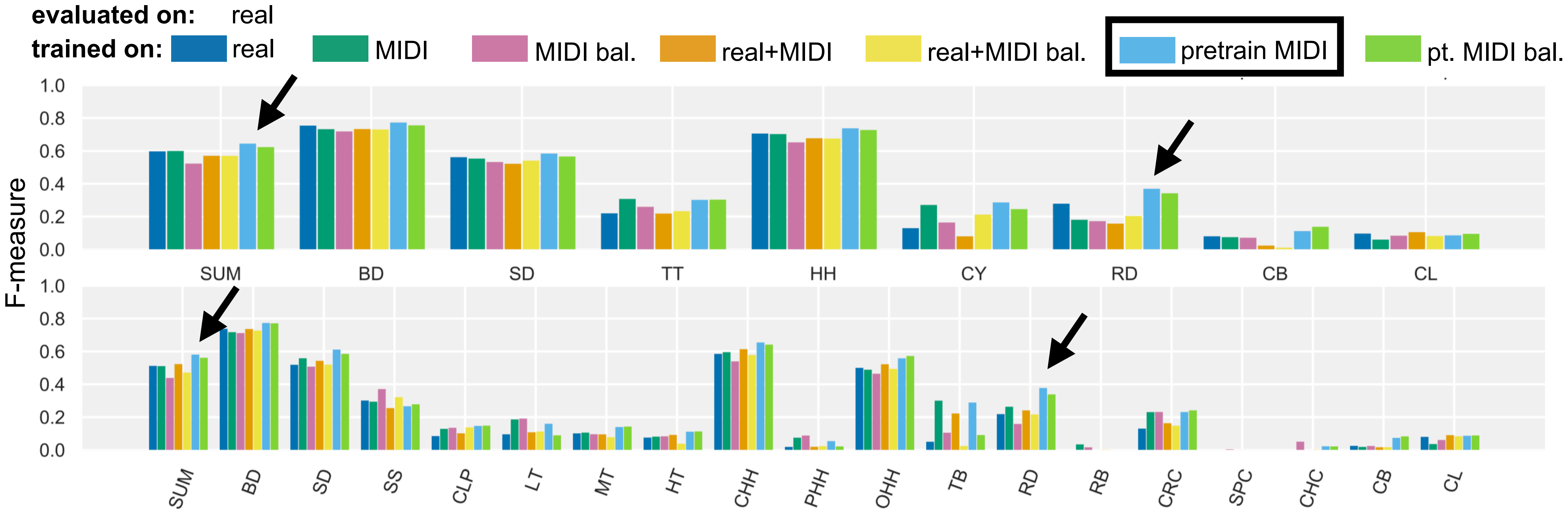
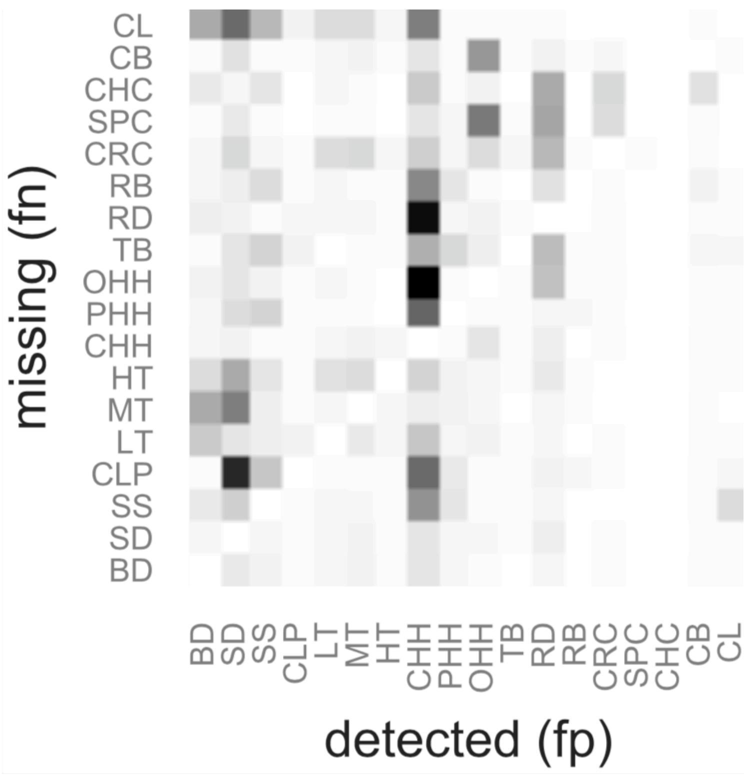
- Small improvements **using pre-training**



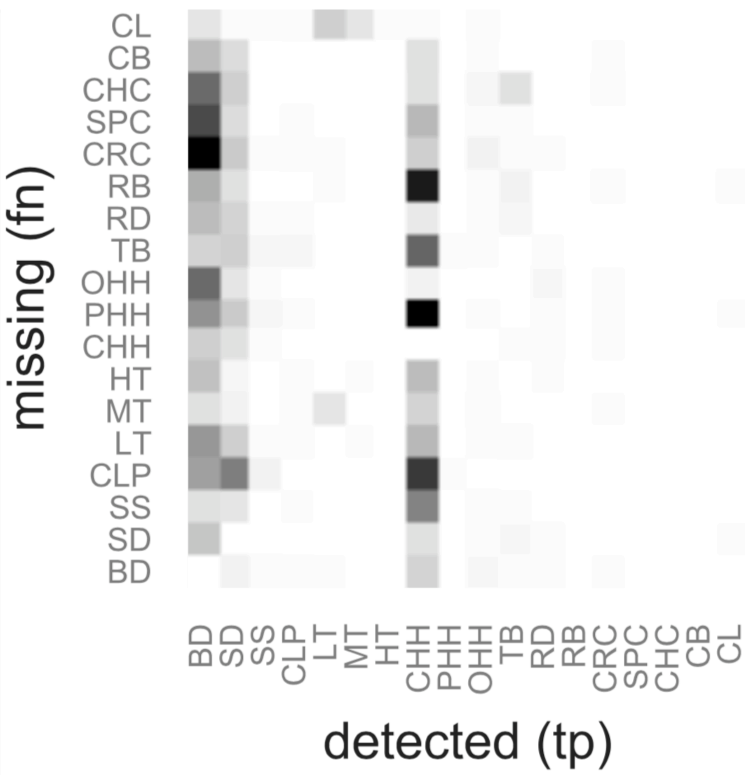
INSTRUMENT CONFUSIONS

trained on: real+MIDI
evaluated on: real+MIDI

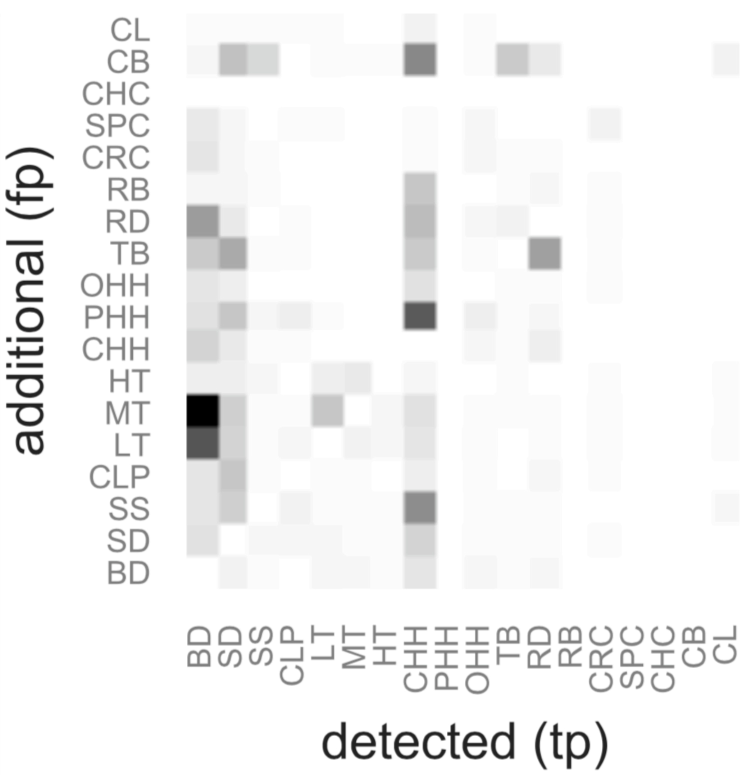
confusions



hidden onsets



additional onsets



CAN YOU HEAR THE DIFFERENCE?

♫ ♫

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3: bass drum

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- Which **cymbal** is it?

hi-hat
splash cymbal
crash cymbal
Chinese cymbal
ride cymbal

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♫ ♫

1: crash
2: ride
3: China

CONCLUSIONS

- Publicly available large scale **synthetic dataset** `http://ifs.tuwien.ac.at/~vogl/dafx2018/`
  - Optional with **balanced instruments**
  - **Generalizes** well to real data
- Dataset size important but not that critical
- Balancing **did not improve** performance on real-world data
  - Recurrent layers learn **untypical patters**
- **Pre-training** with synthetic data provides small improvement
- **Mistakes** are *understandable*
  - Focus more on context