BachDuet : A Deep Learning System for Human-Machine Counterpoint Improvisation

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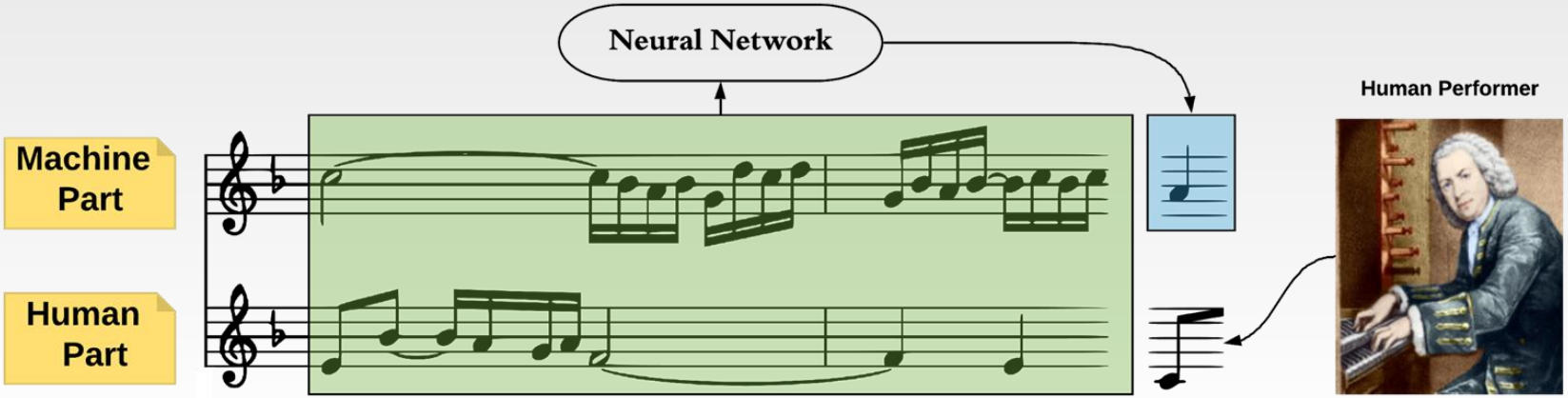
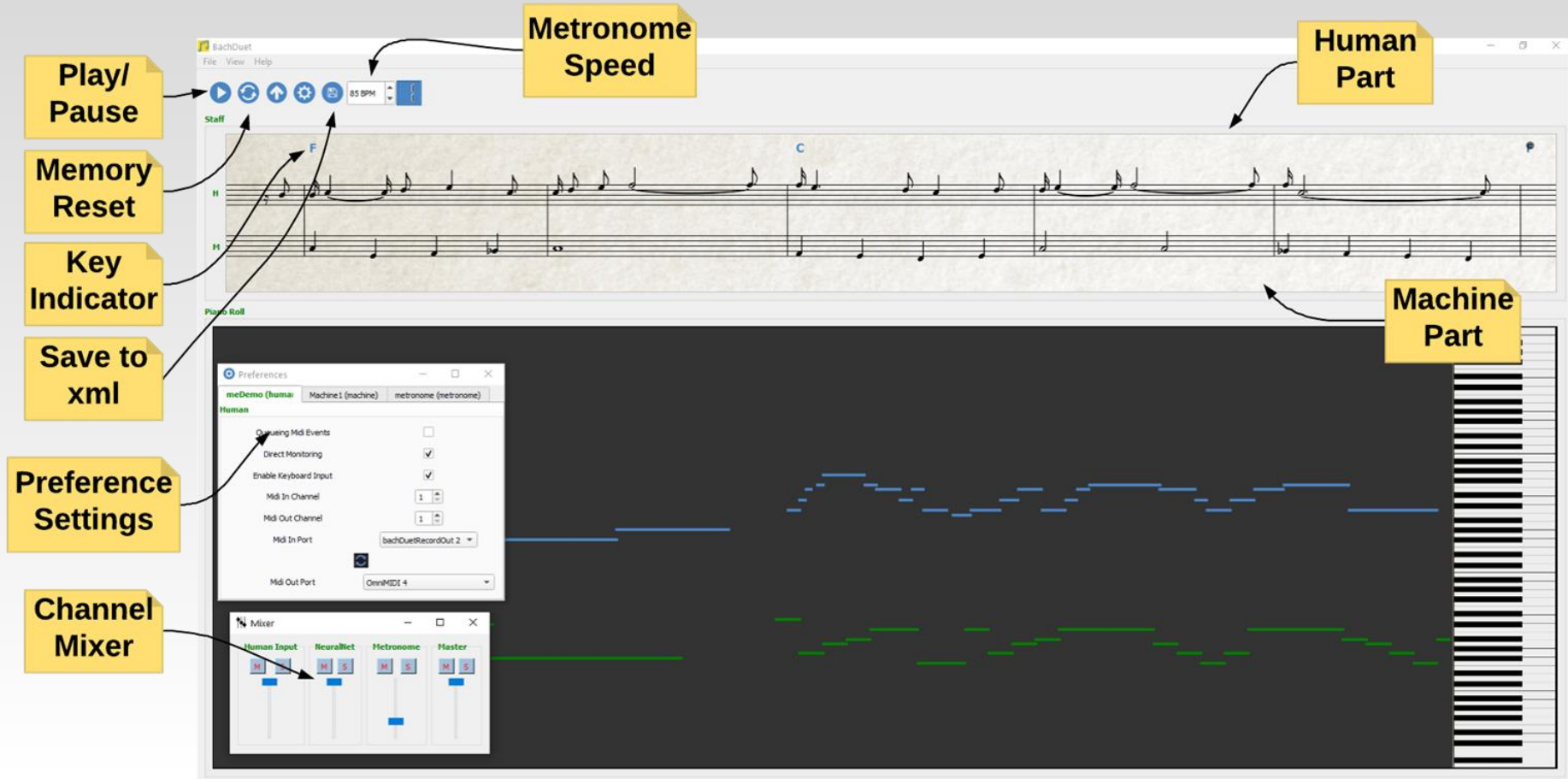
Proposed System

BachDuet enables a human performer to improvise a counterpoint duet with a computer agent in real time.

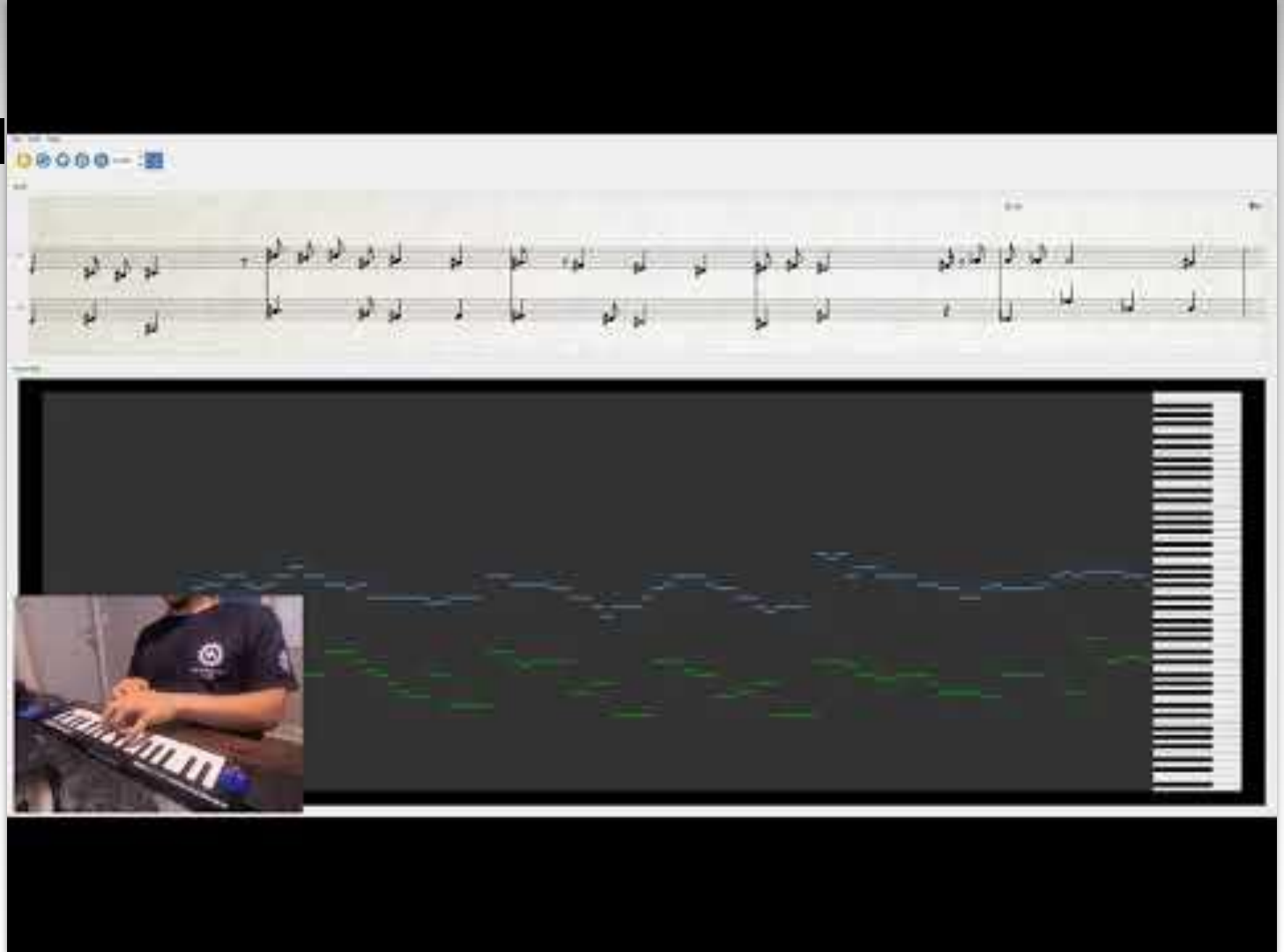
- Input: Human musician's monophonic performance on a MIDI keyboard
- Output: The machine's monophonic performance in real time generated by an RNN.



Graphical User Interface



Vi



Motivation - Goals

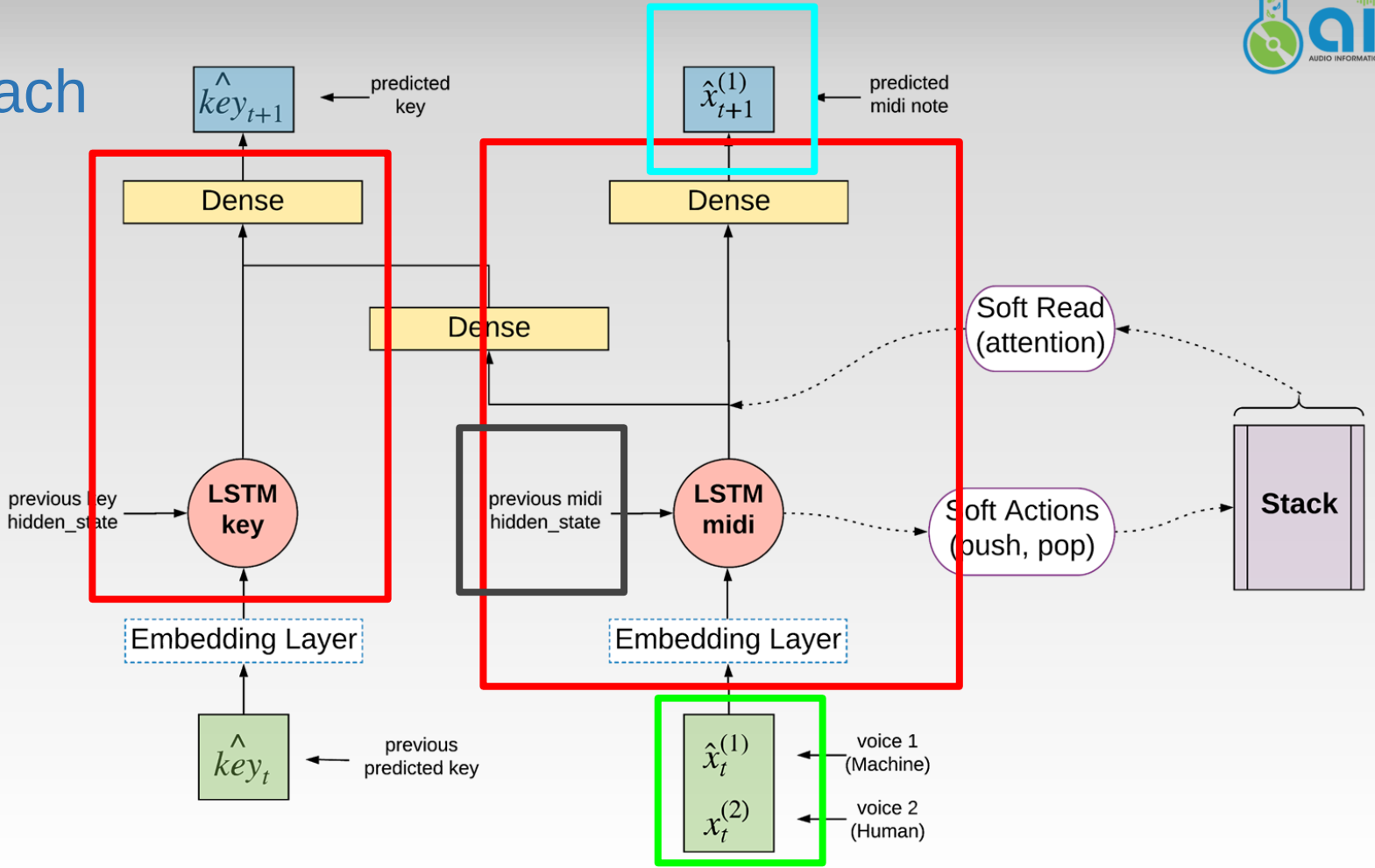
- Lack of improvisation culture in classical music
- Classical musicians either are not trained to improvise, or cannot find other people to improvise with
- Hopefully, BachDuet can be used both for education and entertainment purposes

Novelty

- Very few interactive classical music systems
- Most interactive music systems support the "call & response" interaction mode[1,2,3]

[1] J. A. Biles et al. GenJam: A genetic algorithm for generating jazz solos. ICMC (1994)
[2] Y. Mann. AI duet.https://experiments.withgoogle.com/ai/ai-duet, (2016)
[3] F. Pachet. The continuator: Musical interaction with style. JNMR (2003).

Approach


$\hat{key}_{t+1}$
predicted key
$\hat{x}^{(1)}_{t+1}$
predicted midi note
Dense
Dense
Dense
Soft Read (attention)
previous key hidden_state
LSTM key
previous midi hidden_state
LSTM midi
Soft Actions (push, pop)
Stack
Embedding Layer
Embedding Layer
$\hat{key}_t$
previous predicted key
$\hat{x}^{(1)}_t$
voice 1 (Machine)
$x^{(2)}_t$
voice 2 (Human)

Subjective Tests

- **Group 1** (user study)
    - 13 musically trained participants
    - Above average keyboard and improvisation skills
    - Played with BachDuet (HM task) and with another human (HH task)
    - Answered a questionnaire about their experience
- **Group 2** (Turing listening test)
    - 48 musically trained participants
    - Listened to a random selection of duets from Group's 1 HH and HM tasks
    - Predicted which duets were HH and which were HM
    - Rated the quality of duets on a scale from 1 (dislike) to 5 (like)

Results

- **Group 1** (user study)
  - Things they liked
    - The GUI is intuitive and the visualization is very accurate
    - BachDuet's output is consistent with the Chorale style
    - The machine and the human have relatively equal roles in the improvisation
    - Most users think BachDuet can improve their improvisation skills
  - Things the disliked
    - The key prediction can be improved
    - Most users rated higher their interaction with another human(8.6/10), than with BachDuet (8/10)

Results

- **Group 2** (Turing listening test)
    - The HM duets received better (3.64/5 vs 3.54/5) but not statistically significant rating
    - Participants could not easily differentiate between HH and HM duets

true\predicted	HH	HM
HH	45.3%	54.7%
HM	48.1%	51.9%

HH vs HM clips

Human vs Machine
(BachDuet)

Human vs Human

Limitations

1) Fixed tempo
2) Trained on limited data
3) Only MIDI is supported (not Audio)
4) Impersonal type of interaction

Conclusions

1) Duet counterpoint improvisation is a feasible but not easy task for classical musicians
2) Users find BachDuet a good partner for duet improvisation
3) Listeners can’t distinguish between HH and HM duets