MUSIC GENERATION USING DEEP LEARNING

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Agenda

- Deep learning and its improvements
- Automatic music generation
- Music representation for machine learning models
- Background knowledge
- Training
- Generating music
- Conclusions
- References

Making sense of sound

Music is an Art and a Universal language.


On the Edge
Aiva Technologies

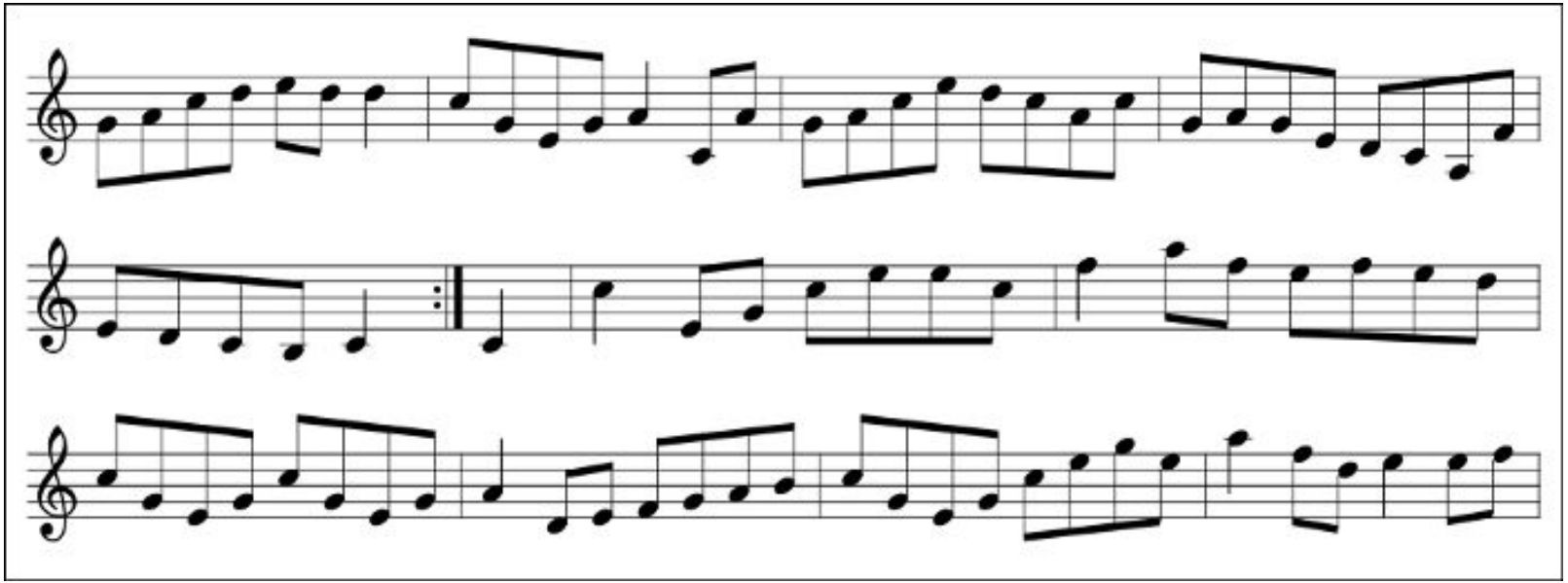
Constituent Elements of Music

- Note
- Chord
- Octave

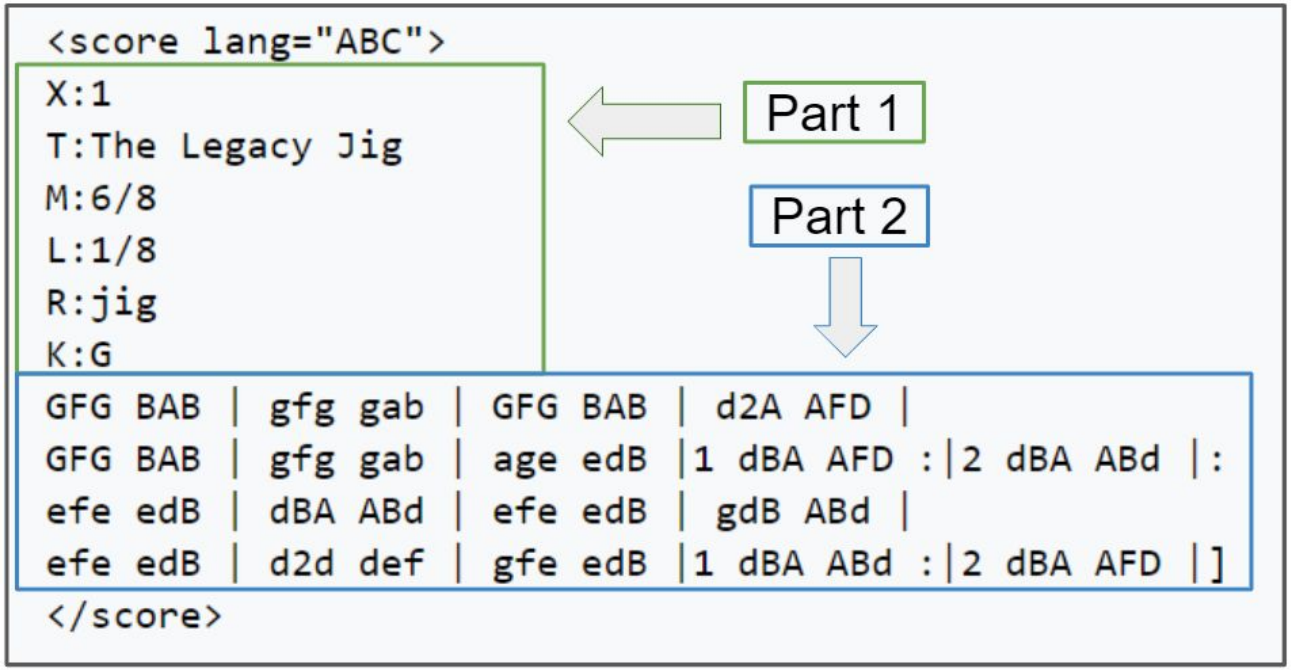
Music Representation

1. Sheet-music
2. ABC-notation: it has a sequence of characters which is very simple for Neural Network train. https://en.wikipedia.org/wiki/ABC_notation
3. MIDI: https://towardsdatascience.com/how-to-generate-music-using-a-lstm-neural-network-in-keras-68786834d4c5
4. mp3- store only audio file.

Sheet music



ABC Notation

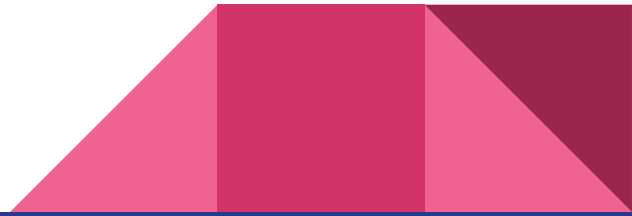


MIDI

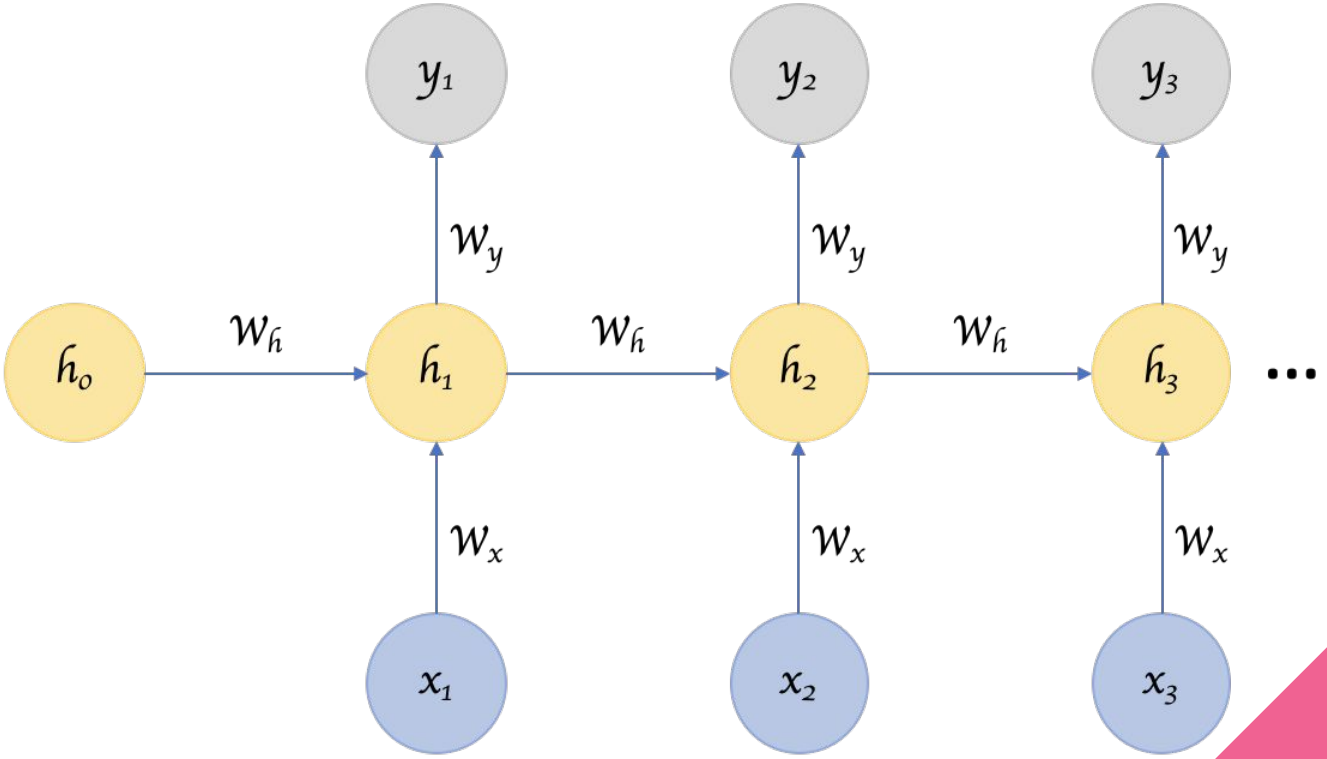
```
...
<music21.note.Note F>
<music21.chord.Chord A2 E3>
<music21.chord.Chord A2 E3>
<music21.note.Note E>
<music21.chord.Chord B-2 F3>
<music21.note.Note F>
<music21.note.Note G>
<music21.note.Note D>
<music21.chord.Chord B-2 F3>
<music21.note.Note F>
<music21.chord.Chord B-2 F3>
<music21.note.Note E>
<music21.chord.Chord B-2 F3>
<music21.note.Note D>
<music21.chord.Chord B-2 F3>
<music21.note.Note E>
<music21.chord.Chord A2 E3>
...
```

Background Concepts

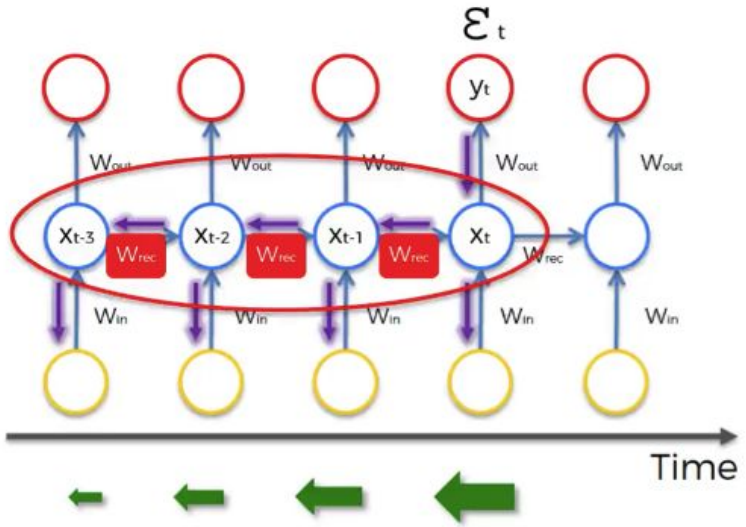
- Recurrent Neural Networks (RNN)
- Long Short term memory
- Music21
- Keras



Recurrent Neural Networks



Vanishing and Exploding Gradient Problems



$$\frac{\partial \mathcal{E}}{\partial \theta} = \sum_{1 \le t \le T} \frac{\partial \mathcal{E}_t}{\partial \theta} \quad (3)$$

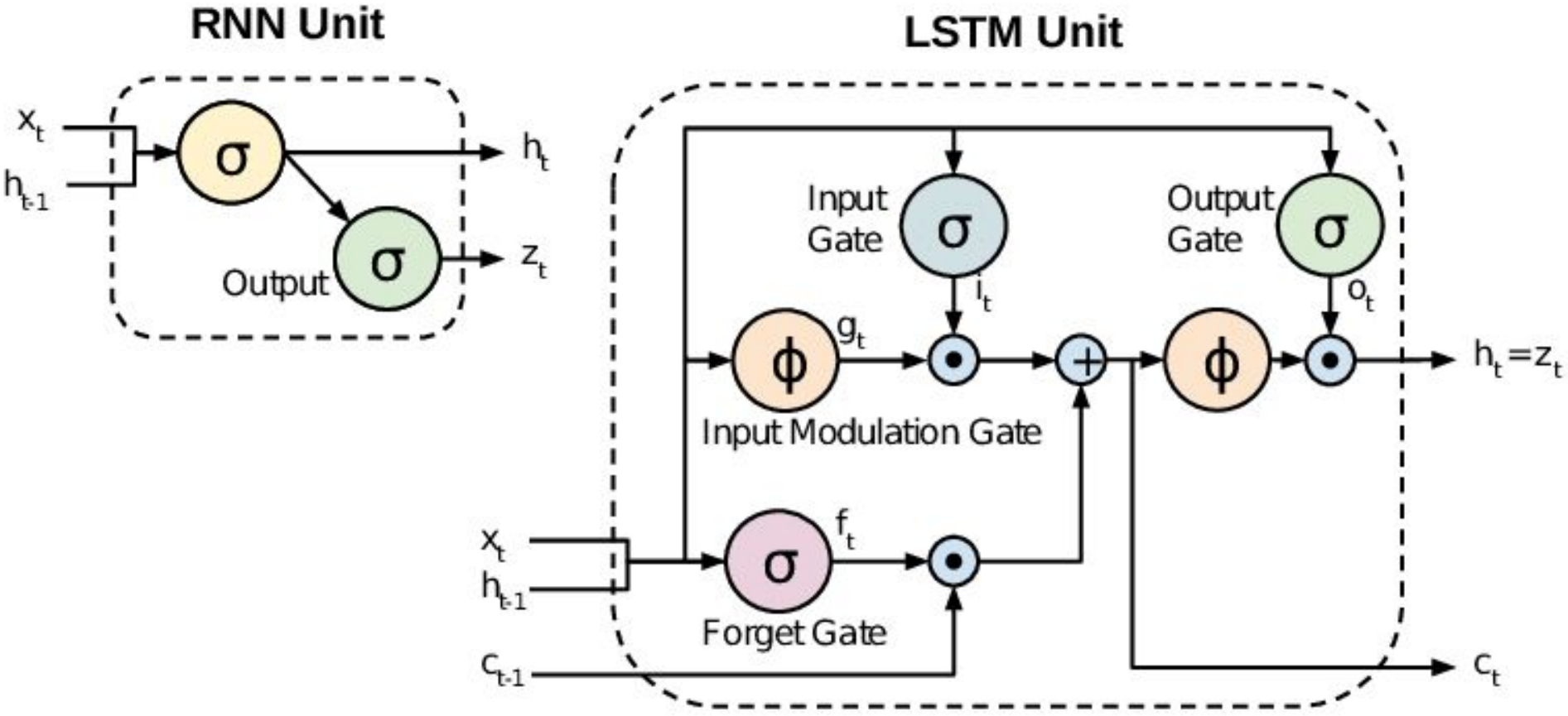
$$\frac{\partial \mathcal{E}_t}{\partial \theta} = \sum_{1 \le k \le t} \left(\frac{\partial \mathcal{E}_t}{\partial \mathbf{x}_t} \frac{\partial \mathbf{x}_t}{\partial \mathbf{x}_k} \frac{\partial^+ \mathbf{x}_k}{\partial \theta} \right) \quad (4)$$

$$\frac{\partial \mathbf{x}_t}{\partial \mathbf{x}_k} = \prod_{t \ge i > k} \frac{\partial \mathbf{x}_i}{\partial \mathbf{x}_{i-1}} = \prod_{t \ge i > k} \mathbf{W}_{rec}^T diag(\sigma'(\mathbf{x}_{i-1})) \quad (5)$$

W_{rec} ~ small ⇨ Vanishing

W_{rec} ~ large ⇨ Exploding

LSTMs


RNN Unit
LSTM Unit
Input Gate
Output Gate
Output
Input Modulation Gate
Forget Gate

Music21

Keras

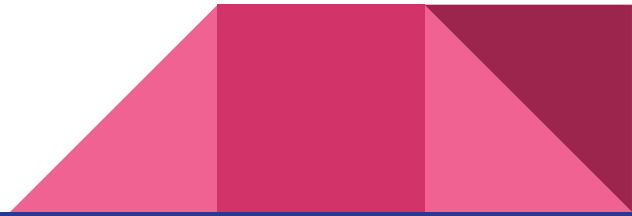
Exploration and Analysis of Training Data

- Single instrument music like Piano (352 different notes and chords)
- Neural network will have to be able to predict which note or chord is next.
- Prediction array will have to contain every note and chord object that we encounter in our training set.

https://github.com/Skuldur/Classical-Piano-Composer

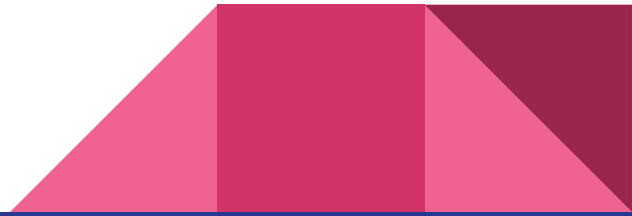
Preparing the Data

- Music21 to parse the music file and generate the stream object
- Using that stream object we get a list of all the notes and chords in the file.
- Encoding and mapping categorical data into numerical data.



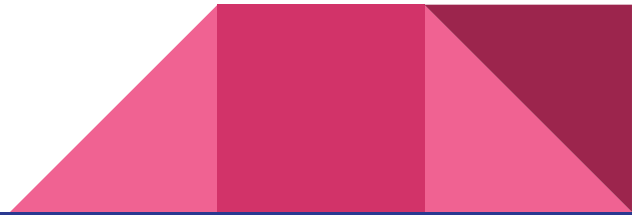
Model

- LSTM layers
- Dropout layers
- Dense layers or fully connected layers
- The Activation layer



Architecture of the Network

- A simple network consisting of three LSTM layers, three Dropout layers, two Dense layers and one activation layer.
- To calculate the loss for each iteration of the training we will be using categorical cross entropy since each of our outputs only belongs to a single class and we have more than two classes to work with.
- RMSprop optimizer as it is usually a very good choice for recurrent neural networks.



Conclusions

- Load the saved weights to the network model.
- A full list of note sequences at our disposal.
- A random index is picked from the list as a starting point, this allows us to rerun the generation code without changing anything and get different results every time.
- Generating music

References

[1] https://deeplearning4j.org/lstm.htm

[2] https://keras.io/

[3] https://colah.github.io/posts/2015-08-UnderstandingLSTMs/

[4] Chun-Chi J. Chen and Risto Miikkulainen. Creating melodies with evolving recurrent neural networks. Proceedings of the 2001 International Joint Conference on Neural Networks, 2001.

[5] Douglas Eck and Jurgen Schmidhuber. A first look at music composition using lstm recurrent neural networks. Technical Report No. IDSIA-07-02, 2002.

[6] Daniel Johnson. Composing music with recurrent neural networks.

[7] K. Choi, G. Fazekas, and M. Sandler, “Text-based LSTM networks for Automatic Music Composition”, 1st Conference on Computer Simulation of Musical Creativity, 2016


Thank
you