Music Generation

skid

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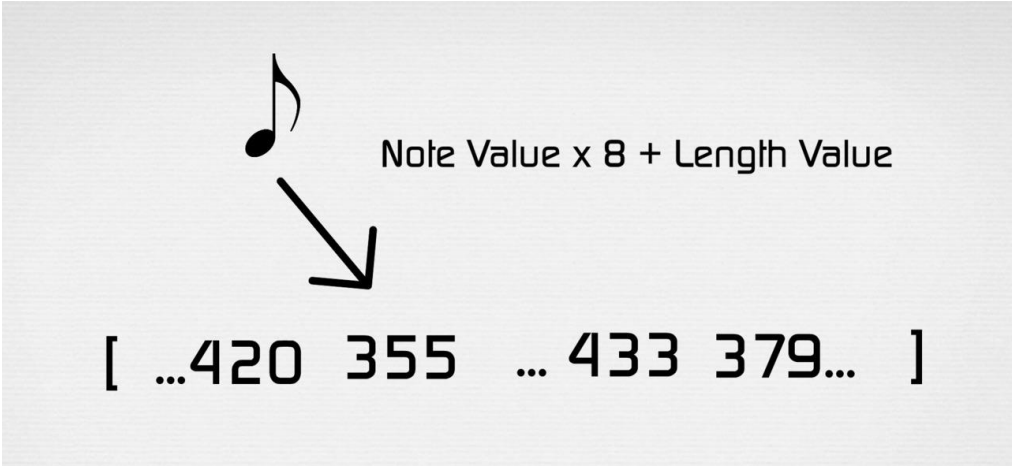
Music generation with RNN

http://davinnovation.github.io/midi_generate_rnn.html



inspired by aikorea.org/blog

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$$P(w_1, \ldots, w_m) = \prod_{i=1}^{m} P(w_i \mid w_1, \ldots, w_{i-1}) \approx \prod_{i=1}^{m} P(w_i \mid w_{i-(n-1)}, \ldots, w_{i-1})$$

< n-gram model >

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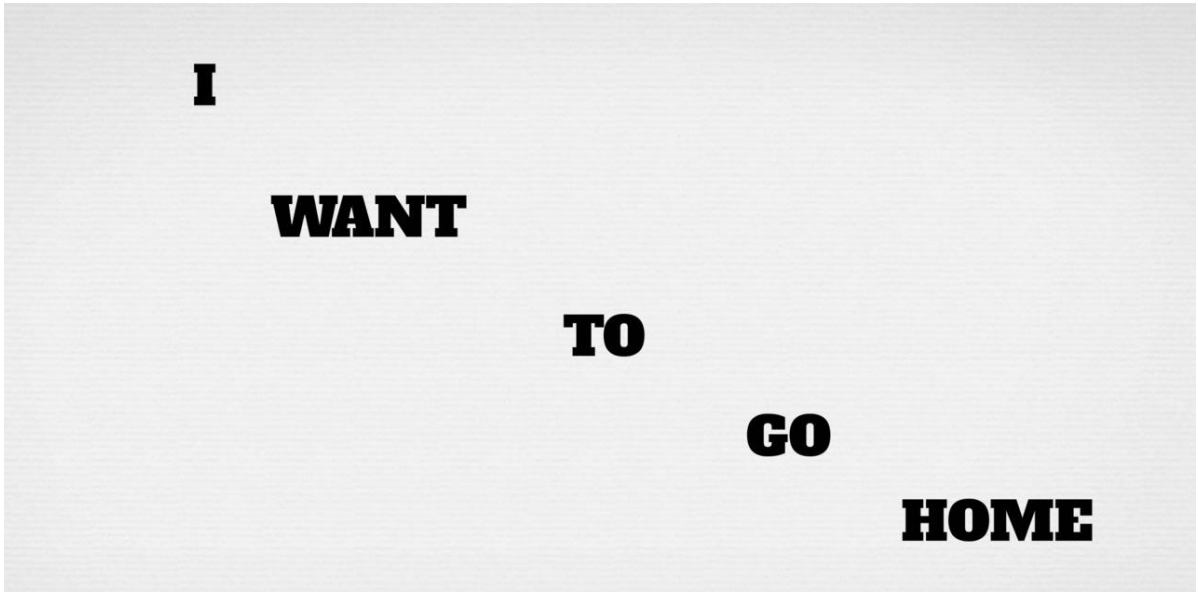

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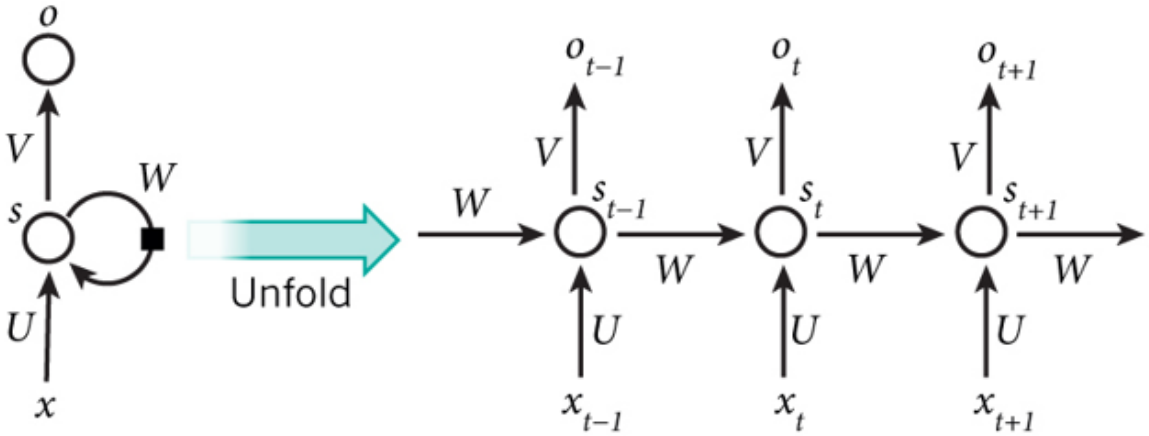

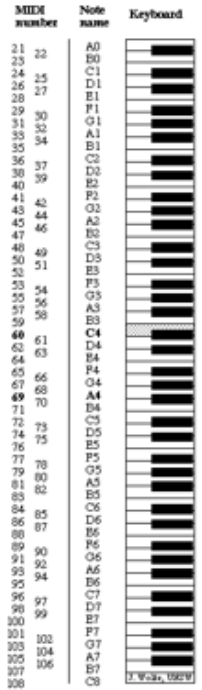

$X_t \in R^{88+2}$: Midi Pitch의 범위는 21 ~ 108 + START_TOKEN + END_TOKEN

$O_t \in R^{88+2}$: x의 output

$S_t \in R^{50}$: Hidden Layer의 개수 (default 50이나 실험 결과에 따라 유동적으로 변화)

$U \in R^{50*90}$ / $V \in R^{90*50}$ / $W \in R^{50*50}$

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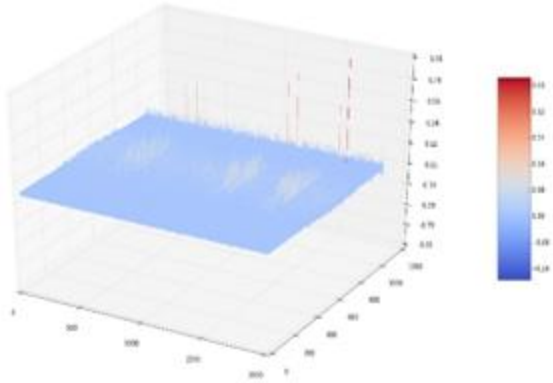

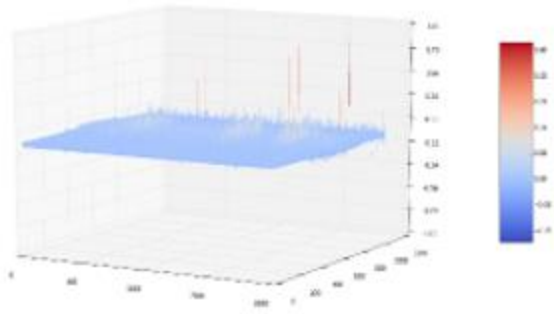

Loss function $L(y, o) = -\frac{1}{N}\sum_{n \in N} y_n \log o_n$

U = U - learning rate * $\frac{\partial L}{\partial U}$

V = V - learning rate * $\frac{\partial L}{\partial V}$

W = W - learning rate * $\frac{\partial L}{\partial W}$

Epoch 0 loss: 6.93361 (expected $log 1026$)

Epoch 80 loss: 4.97166

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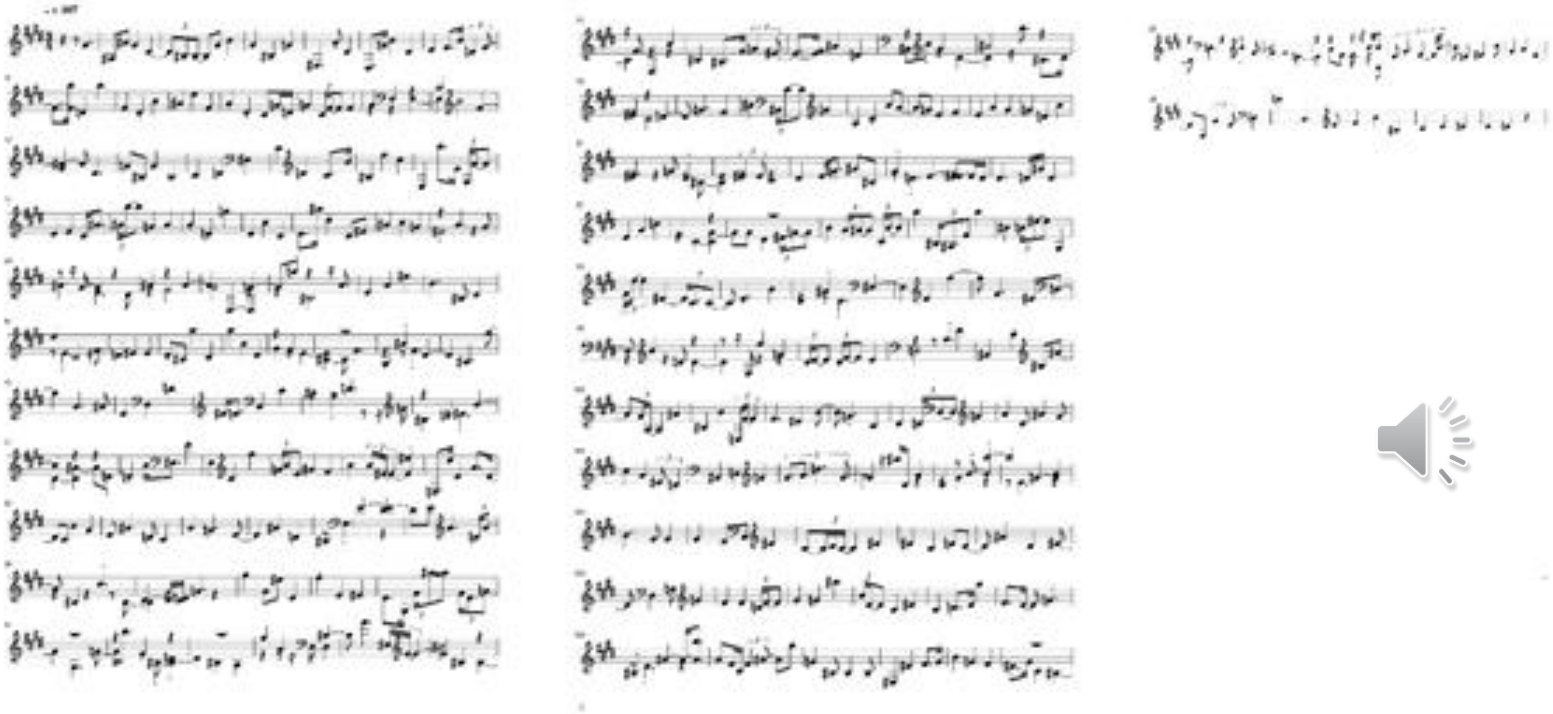

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magenta

ML for art & music

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What is Magenta?

Use Machine learning to create art and music (June. 2016)

by Google Brain Team (Jeff Dean etc)

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Install Magenta

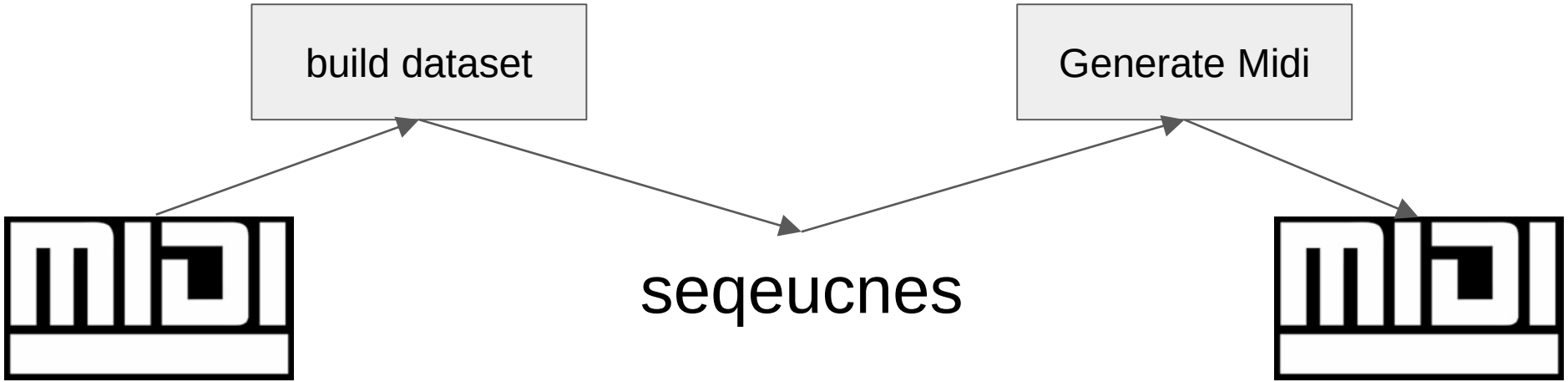
0. Only On Unbuntu 14.04 LTS

1. Bazel > 0.2.3. && Tensorflow > 0.9

2. [git clone https://github.com/tensorflow/magenta.git]

3. [bazel test //magenta/…]

Magenta Learning & Generating



Magenta - Build Dataset

conevert_midi_dir_to_note_sequences.py

> Seqeunces

Time Signatures ...about (4/4, 4/2 ~)

Key Signatures ...about key (Minor ~ Major , C0 ~ B0)

Tempo … about (note..?)

Instrument events

http://frontjang.info/entry/MIDI-%ED%8C%8C%EC%9D%BC-%EB%B6%84%EC%84%9D%ED%95%98%EA%B8%B0-2-Meta-events

http://www.deluge.co/?q=midi-tempo-bpm

Magenta - Generate Midi

Seqeunces -> Melody [note 48 to 84] //

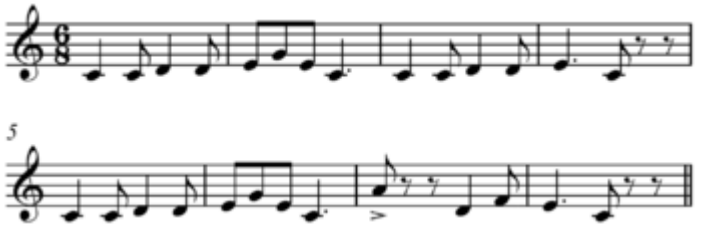
Basic RNN (shared) : LSTM cell

Lookback RNN : shared +

Attention RNN : +attention option

Basic RNN - Learn

Input : MonoPhonic Data
[note off, no event, note-on] for every pitch

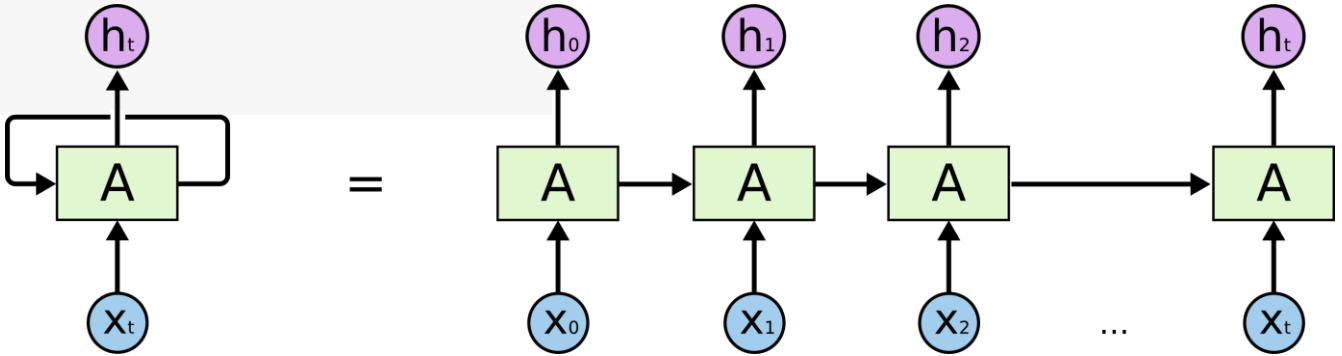


extract a melody line if it is at least **7 measures long**, and at least **5 unique pitches** (with octave equivalence). If multiple notes play at the same time, one note is kept.

Basic RNN - Generate

```
# Provide a MIDI file to use as a primer for the generation.
# The MIDI should just contain a short monophonic melody.
# primer.mid is provided as an example.
PRIMER_PATH=<absolute path of your primer MIDI file>

bazel run //magenta/models/basic_rnn:basic_rnn_generate -- \
--run_dir=/tmp/basic_rnn/logdir/run1 \
--hparams='{"rnn_layer_sizes":[50]}' \
--output_dir=/tmp/basic_rnn/generated \
--num_outputs=10 \
--num_steps=128 \
--primer_midi=$PRIMER_PATH
```



Lookback RNN - Learn

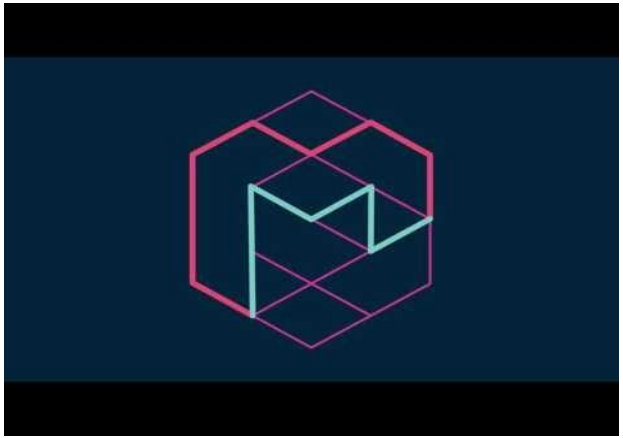
Input : MonoPhonic Data
[note off, no event, note-on] for every pitch

+

1. Input events from 1 and 2 bars ago
2. Input whether the last event was repeating the event from 1 or 2 bars before it
3. Input the current position within the measure

Lookback RNN - Generate

```
bazel run //magenta/models/lookback_rnn:lookback_rnn_generate -- \
--run_dir=/tmp/lookback_rnn/logdir/run1 \
--hparams="{'batch_size':64,'rnn_layer_sizes':[64,64]}" \
--output_dir=/tmp/lookback_rnn/generated \
--num_outputs=10 \
--num_steps=128 \
--primer_melody="[60]"
```



Attention RNN - Learn

Input : MonoPhonic Data
[note off, no event, note-on] for every pitch

\+ (from Grammer as a Foreign Language [http://arxiv.org/abs/1412.7449])

1. look at the outputs from the last n steps when generating the output for the current step

$$u_i^t = v^T \tanh(W_1' h_i + W_2' d_t)$$
$$a_i^t = \text{softmax}(u_i^t)$$
$$d_t' = \sum_{i=1}^{T_A} a_i^t h_i$$

v and matrices W_1', W_2' are learnable parameters of the model.

hi are the RNN outputs from the previous n steps

dt is the current step's RNN cell state

a mask-like vector a_i^t

Attention RNN – Learn [step by step in 1]

Gen Step 1

If we are on the 4th step

Step 1: $[1.0, 0.0, 0.0, 1.0]$
Step 2: $[0.0, 1.0, 0.0, 1.0]$
Step 3: $[0.0, 0.0, 0.5, 0.0]$

$$u_i^t = v^T \tanh(W_1' h_i + W_2' d_t)$$
$$a_i^t = \text{softmax}(u_i^t)$$
$$d_t' = \sum_{i=1}^{T_A} a_i^t h_i$$

Attention RNN – Learn [step by step in 2]

Gen Step 2

If we are on the 4th step

Attention mask

$$a_i^t = [0.7, 0.1, 0.2]$$

```
def _attention(self, state, attn_states):
  with tf.variable_scope('Attention'):
    v = tf.get_variable('V', [self._attn_vec_size])
    attn_states_flat = tf.reshape(attn_states, [-1, self._attn_size])
    attn_states_vec = tf.contrib.layers.linear(
        attn_states_flat, self._attn_vec_size, scope='AttnStatesVec')
    attn_states_vec = tf.reshape(
        attn_states_vec, [-1, self._attn_length, self._attn_vec_size])
    state_vec = tf.contrib.layers.linear(
        state, self._attn_vec_size, scope='StateVec')
    state_vec = tf.expand_dims(state_vec, 1)
    attn = tf.reduce_sum(v * tf.tanh(attn_states_vec + state_vec), 2)
    attn_mask = tf.nn.softmax(attn)
    attn_mask = tf.expand_dims(attn_mask, 2)
    return tf.reduce_sum(attn_states * attn_mask, 1)
```

Attention RNN – Learn [step by step in 3]

Gen Step 3

If we are on the 4th step

$$a_i^t = [0.7, 0.1, 0.2]$$

Step 1 (70%): $[0.7, 0.0, 0.0, 0.7]$
Step 2 (10%): $[0.0, 0.1, 0.0, 0.1]$
Step 3 (20%): $[0.0, 0.0, 0.1, 0.0]$

$$u_i^t = v^T \tanh(W_1' h_i + W_2' d_t)$$
$$a_i^t = \text{softmax}(u_i^t)$$
$$d_t' = \sum_{i=1}^{T_A} a_i^t h_i$$

Attention RNN – Learn [step by step in 4]

Gen Step 4

If we are on the 4th step

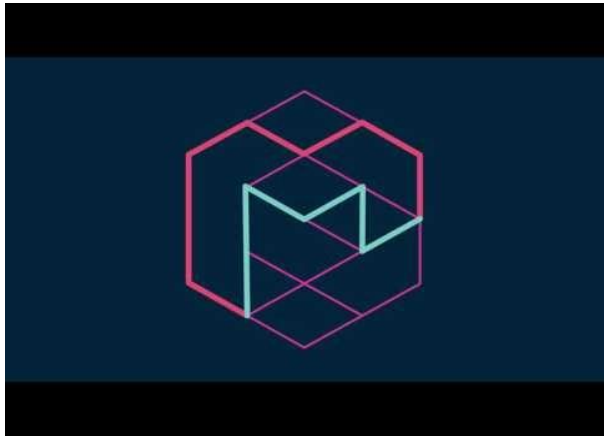
Step 1 (70%): $[0.7, 0.0, 0.0, 0.7]$
Step 2 (10%): $[0.0, 0.1, 0.0, 0.1]$
Step 3 (20%): $[0.0, 0.0, 0.1, 0.0]$

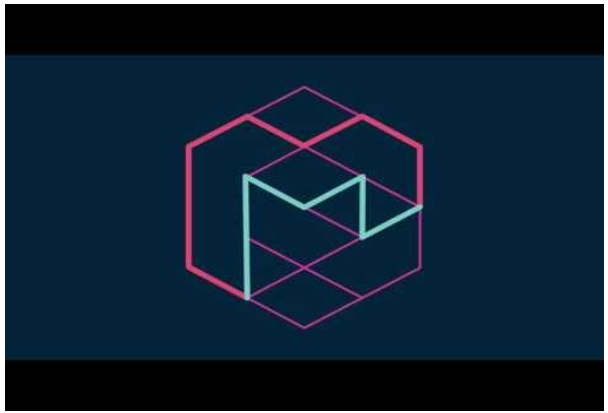
$$u_i^t = v^T \tanh(W_1' h_i + W_2' d_t)$$
$$a_i^t = \text{softmax}(u_i^t)$$
$$d_t' = \sum_{i=1}^{T_A} a_i^t h_i$$

$$d_t' = [0.7, 0.1, 0.1, 0.8]$$

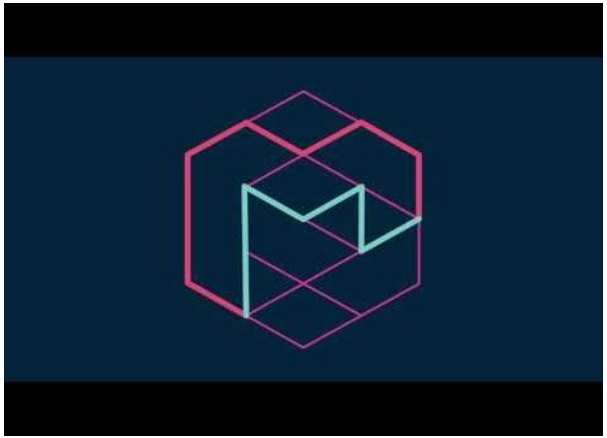
Attention RNN - Generate

```
bazel run //magenta/models/attention_rnn:attention_rnn_generate -- \
--run_dir=/tmp/attention_rnn/logdir/run1 \
--hparams="{'batch_size':64,'rnn_layer_sizes':[64,64]}" \
--output_dir=/tmp/attention_rnn/generated \
--num_outputs=10 \
--num_steps=128 \
--primer_melody="[60]"
```





Google’s First Song



Same Initial

Combine Melody 1 & 2
AABA + drums