

Making Music

Eric Wolf (钟伟绅)

Recurrent Neural Network

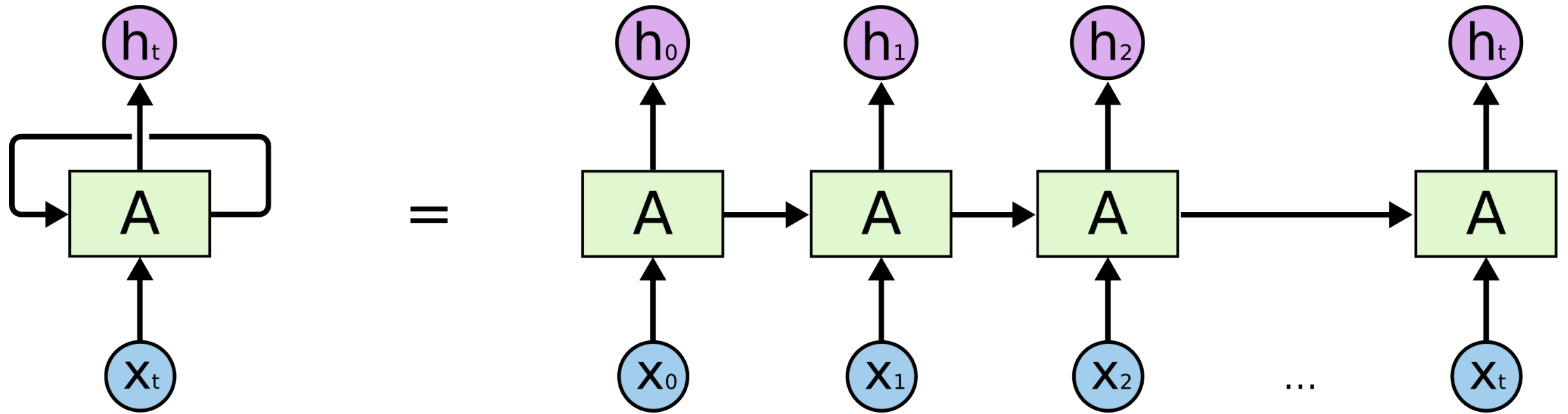
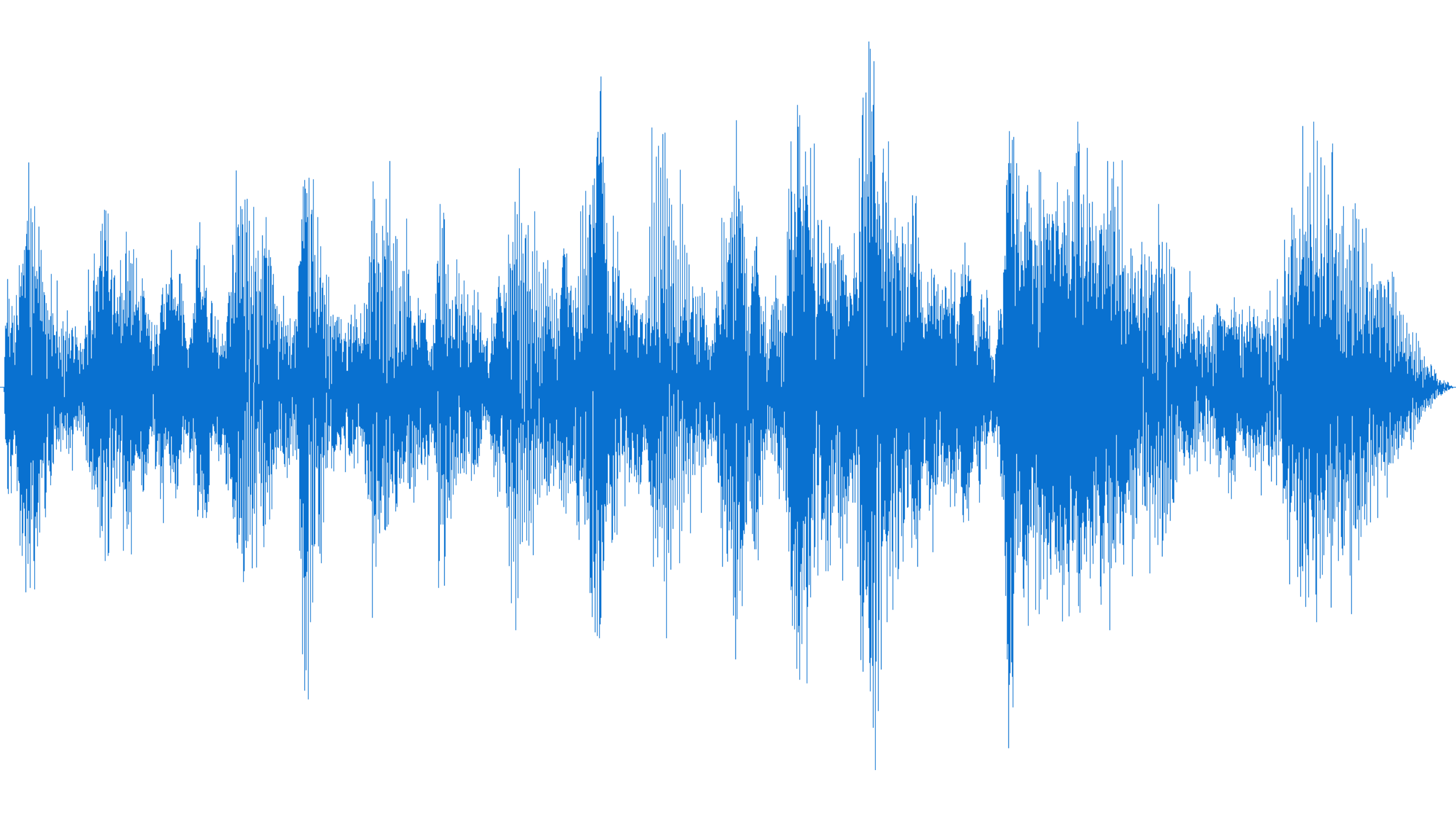


Illustration courtesy of Crish Olah.



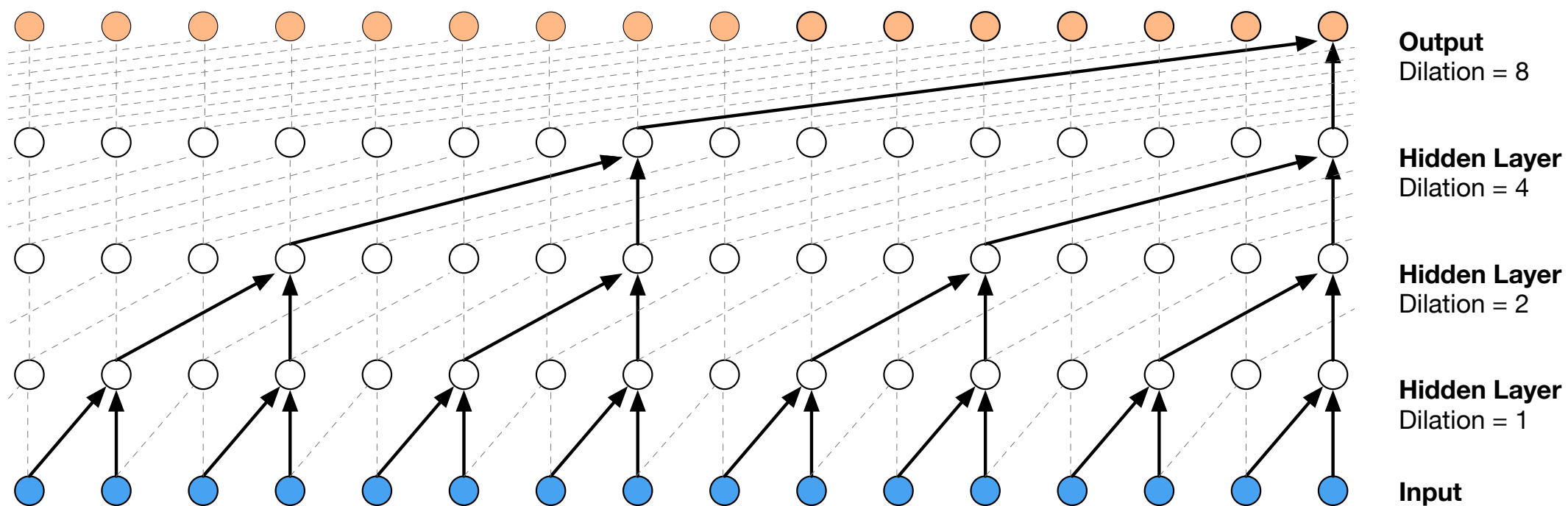


Figure 3: Visualization of a stack of *dilated* causal convolutional layers.

Aäron van den Oord, Sander Dieleman et al. "WaveNet: A Generative Model for Raw Audio." 2016.

The Decisive Battle

Final Fantasy VI

Arranged by Ian Stocker

Nobuo Uematsu

Presto

Am F/A Amin6 F/A Am



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magenta

Make Music and Art Using Machine Learning

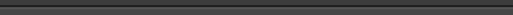
GET STARTED

Modelling Sheet Music – Challenges

- How do we encode a note?

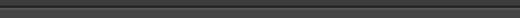
Steinway Grand Piano | Ch1

A digital piano interface for a Steinway Grand Piano. It features a small 3D model of the piano on the left, the text "Steinway Grand Piano | Ch1" in the center, and a volume knob on the right. Below the text are icons for a metronome and headphones, and a horizontal volume slider.



Fingerstyle Bass | Ch1

Bebop Organ | Ch1



Epic Cloud Formation | Ch1

[illegible][illegible][illegible]

MIDI Region	Number of Countries	Number of Languages
Central Asia	5	12
East Asia	10	25
East Europe	10	15
North America	23	35
South America	12	18
South Asia	9	22
Sub-Saharan Africa	30	45
Western Europe	15	20
Western North Africa	10	15
Western South Asia	5	10

[illegible]

MIDI Region		Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7	Region 8	Region 9	Region 10	Region 11	Region 12	Region 13	Region 14	Region 15	Region 16	Region 17	Region 18	Region 19	Region 20	Region 21	Region 22	Region 23	Region 24	Region 25	Region 26	Region 27	Region 28	Region 29	Region 30	Region 31	Region 32	Region 33	Region 34	Region 35	Region 36	Region 37	Region 38	Region 39	Region 40	Region 41	Region 42	Region 43	Region 44	Region 45	Region 46	Region 47	Region 48	Region 49	Region 50	Region 51	Region 52	Region 53	Region 54	Region 55	Region 56	Region 57	Region 58	Region 59	Region 60	Region 61	Region 62	Region 63	Region 64	Region 65	Region 66	Region 67	Region 68	Region 69	Region 70	Region 71	Region 72	Region 73	Region 74	Region 75	Region 76	Region 77	Region 78	Region 79	Region 80	Region 81	Region 82	Region 83	Region 84	Region 85	Region 86	Region 87	Region 88	Region 89	Region 90	Region 91	Region 92	Region 93	Region 94	Region 95	Region 96	Region 97	Region 98	Region 99	Region 100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100		

[illegible][illegible]

Modelling Sheet Music – Challenges

- Starting/holding notes

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Presto

Am F/A Amin6 F/A Am

f

For example, using the default quantizing resolution of 4 steps per quarter note, a sequence containing only a C Major chord with a duration of one quarter note would look like this:

```
START
NEW_NOTE, 67
NEW_NOTE, 64
NEW_NOTE, 60
STEP_END
CONTINUED_NOTE, 67
CONTINUED_NOTE, 64
CONTINUED_NOTE, 60
STEP_END
CONTINUED_NOTE, 67
CONTINUED_NOTE, 64
CONTINUED_NOTE, 60
STEP_END
CONTINUED_NOTE, 67
CONTINUED_NOTE, 64
CONTINUED_NOTE, 60
STEP_END
END
```

From Project Magenta's documentation of their polyphonic RNN model

Modelling Sheet Music – Challenges

- Starting/holding notes
- Polyphony: playing multiple notes at once

Fantasy For Orchestra

© 2000 Paul R. Heckerl

♩=144; Movement 1

Piccolo
 Flute
 Oboe
 English Horn
 B♭ Clarinet
 Bass Clarinet
 Bassoon
 Contr. Bassoon
 French Horn 1
 French Horn 2
 B♭ Trumpet 1
 B♭ Trumpet 2
 Trombone
 Bass Trombone
 Tuba
 Timpani
 Percussion 1
 Percussion 2
 Percussion 3
 Percussion 4
 Percussion 5
 Harp
 Piano
 Violin 1
 Violin 2
 Viola
 Cello
 Bass

large bass drum
 large tom tom
 tambourine shake
 tap
 tambourine shake
 harp
 piano

Modelling Sheet Music – Challenges

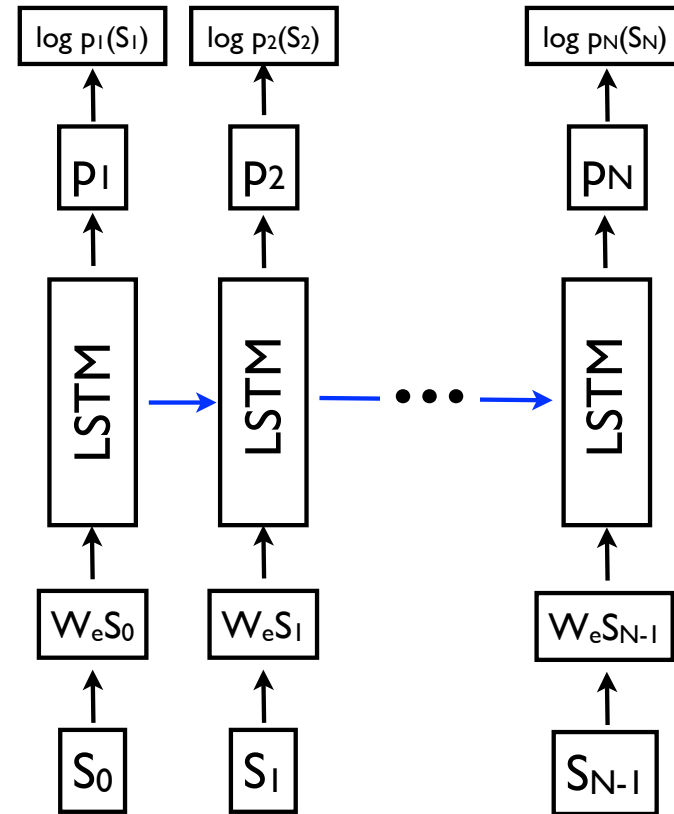
- Starting/holding notes
- Polyphony: playing multiple notes at once
- Multiple instruments

VERSE	CHORUS	VERSE	CHORUS	BRIDGE	CHORUS
A	B	A	B	C	B

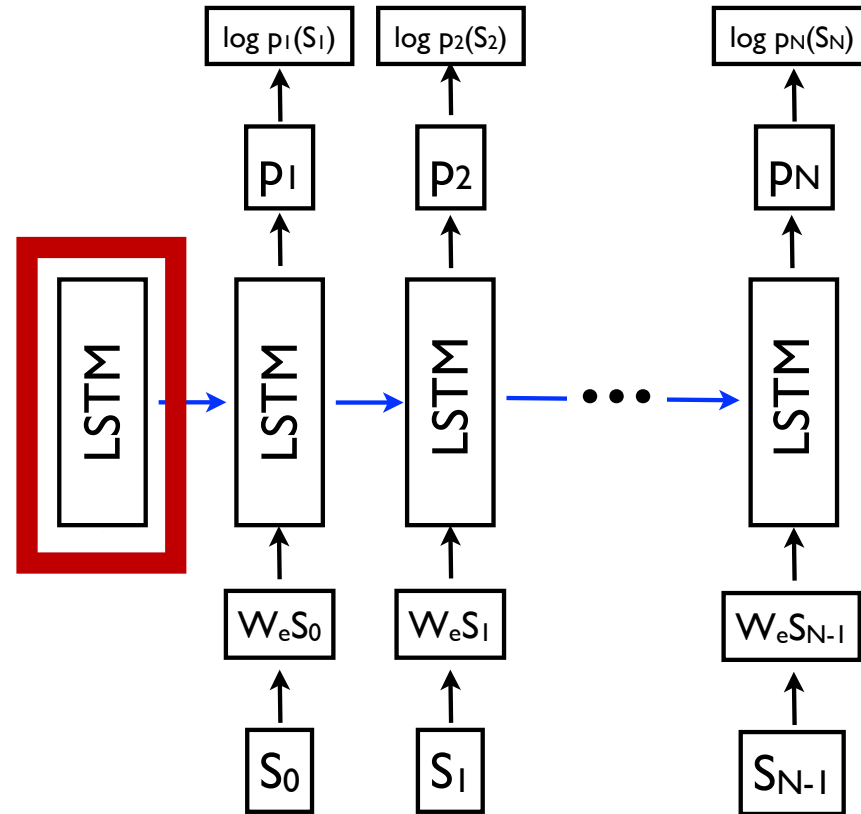
Modelling Sheet Music – Challenges

- Starting/holding notes
- Polyphony: playing multiple notes at once
- Multiple instruments
- Learning song structures

A Generative Model



Vinyals, Oriol, et al. "Show and tell: A neural image caption generator." *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*. 2015.



Vinyals, Oriol, et al. "Show and tell: A neural image caption generator." *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*. 2015.

Applications

- Clustering songs
 - Genres (Pop, Rock, Jazz, Classical, ...)
 - Artists
- Varying individual features
- Interpolate between songs: *I want something that sounds similar to these songs/that artist/from that genre*
- Discover similar songs
- Recommender systems

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