

Working toward computer-generated music traditions

Bob L. Sturm (Queen Mary University of London)

With contributions from my (non-machine) collaborators

Oded Ben-Tal (Kingston University)

João Felipe Santos (INRS-EMT, Montreal Canada)

Iryna Korshunova (ELIS, Ghent University)

Deep learning for music transcription modelling and generation

- Sturm, Santos, Ben-Tal, & Korshunova, “Music transcription modelling and composition using deep learning,” in *Proc. 1st Conference on Computer Simulation of Musical Creativity*, 2016.
- Sturm and Ben-Tal, “Taking the Models back to Music Practice: Evaluating Generative Transcription Models built using Deep Learning”, *Journal of Creative*

76 commits 1 branch 0 releases 3 contributors MIT

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 boblsturm committed on GitHub Update README.md Latest commit 52a7d37 22 hours ago

	configurations	bugfix	a year ago
	data	change to readme	a year ago
	metadata	Updated metadata with newer trained models	a year ago
	samples	add metadata and samples	2 years ago
	soundexamples	Update README.md	a year ago
	.gitignore	clean before checkout	2 years ago
	LICENSE	license	2 years ago
	README.md	Update README.md	22 hours ago
	data_iter.py	added 1hot option	2 years ago
	logger.py	bugfix	a year ago
	sample_rnn.py	added terminal output, fixed initialisation	10 months ago
	train_rnn.py	bugfix	a year ago
	README.md		

Folk music style modelling using LSTMs

A bunch of text data

The screenshot shows the homepage of thesession.org. The page has a dark header with a light gray bar above it. The title "A bunch of text data" is displayed in large white font. Below the header is a navigation bar with various links and social media icons. The main content area has a yellow header bar with the site's logo "S THE SESSION". The main title "Fáilte" is centered above a search bar. The search bar contains the text "Search The Session for" and a yellow "SEARCH" button. Below the search bar, there is a section titled "Recent activity" with a timestamp "2 minutes ago". It shows a single activity: "Cami Francesa Carre added Lost In The Loop to their tunebook.". Further down, another activity is listed: "emmdee left a comment on the discussion FS: 2004 Eamonn Cotter 4 keyed flute." with a timestamp "10 minutes ago". To the right of the activity feed, a large text block states "26,636 transcriptions in total (after extensive cleaning)".

Fáilte

Search The Session for SEARCH

Recent activity

Cami Francesa Carre added [Lost In The Loop](#) to their tunebook.
2 minutes ago

emmdee left a comment on the discussion [FS: 2004 Eamonn Cotter 4 keyed flute.](#)
10 minutes ago

26,636 transcriptions in total
(after extensive cleaning)

Example transcription

3038,3038,"A Cup Of Tea","reel","4/4","Amixolydian","|:eA (3AAA g2 fg |
eA (3AAA BGGf|eA (3AAA g2 fg|1afge d2 gf:|2afge d2 cd||
|:eaag efgf|eaag edBd|eaag efgf|afge dgfg:| ","2003-08-28 21:31:44","dafydd"

Notated

The musical notation is presented in two staves. The top staff is in 4/4 time, Amixolydian mode, with a treble clef. It contains four measures, divided into two groups of two measures each. The first group (measures 1-2) is in 3/4 time, indicated by a '3' above each measure. The second group (measures 3-4) is in 2/4 time, indicated by a '2' above each measure. The bottom staff is also in 4/4 time, Amixolydian mode, with a treble clef. It contains four measures, divided into two groups of two measures each. The first group (measures 1-2) is in 3/4 time, indicated by a '3' above each measure. The second group (measures 3-4) is in 2/4 time, indicated by a '2' above each measure. Measures 1 and 2 of both staves begin with eighth-note patterns. Measures 3 and 4 of both staves begin with sixteenth-note patterns.

Train system to reproduce sequences (or model joint distributions)

3038,3038,"A Cup Of Tea","reel","4/4","Amixolydian","|:eA (3AAA g2 fg |
eA (3AAA BGGf|eA (3AAA g2 fg|1afge d2 gf:|2afge d2 cd||
|:eaag efgf|eaag edBd|eaag efgf|afge dgfg:|","2003-08-28 21:31:44","dafydd"

T: A Cup Df Tea

M: 4/4

L: 1/8

K: Amix

|:eA (3AAA g2 fg|eA (3AAA BGGf|eA (3AAA g2 fg|1afge d2 gf:|2afge d2 cd||
|:eaag efgf|eaag edBd|eaag efgf|afge dgfg:|



Character-based model (char-rnn)

Token-based model (folk-rnn)

<s> M:4/4 K:Cmix |: g c (3 c c c b 2 a b | g c (3 c c c d B B a | g c (3
c c c b 2 a b |1 c' a b g f 2 b a :| |2 c' a b g f 2 e f |: g c' c' b g
a b a | g c' c' b g f d f | g c' c' b g a b g | c' a b g f b a b :| <\s>

One example generation: X:488

Verbatim output:

```
<s> M:6/8 K:Cmix | G2CC2A | GFDB2G | FDDB2D | D2CCDF | /  
G2CC2A | GFDB2c | dBGFDG | C3C3:| /  
GccGcc | dcducBG | FDDBD | FGABAB | /  
GccGcc | dcBGFG | ABAGFD | C3C3:| </s>
```

One example generation: X:488

folk-rnn

1 2 3 4

5 6 7 8

9 10 11 12

13 14 15 16

<https://youtu.be/eoySGZ5iJ00>
<https://youtu.be/TLzBcMvI15M>

Some other generations

T: Chicken
M: 9/8
L: 1/8
K: Amix

```
|: {cd}A2 e {a}c2 e {g}B2 {G}d | {gdd}B2 {g}d {g}c2 e {gdd}B2 A | {gef}e2 g {d}e2 {g}c {g}AGa | {a}gB{A}B {g}BG{d}B {e}B2 :| |
|: d | {d}c2 c {g}e2 d cBA | {g}A2 e {g}e2 {f}c e2 {B}c | {g}cBc e2 A {a}dBd | ded {c}dcB {g}c2 c :|  
|: d{g}e{a}d e2 g fdc | {g}Bd{d}d d2 A {e}d2 c | {g}ded {g}c2 d {e}e2 d | {g}c{d}c{e}c {g}cde {g}c2 d |  
~e3 {g}ddc {g}Bd{d}B | {g}cde {g}edc {g}Bd{g}A | {g}B{d}A{d}A {g}e3 {g}edc | {a}dBc {g}d2 d {g}e2 :|  
g | {g}f{g}d{G}e {g}fed {g}BG{A}G | {g}Bd{a}d {g}ea{g}a ged | {a}B {c}A2 {g}gdB {g}ed{d}c | {g}Bdd {g}dBG {eB}BAG |  
|: {g}cBA {g}Aga {g}e2 d | {G}de{f}e {g}dBG eA{B}d | {g}fe{G}f g{g}e{g}f ga{a}g | {g}fGA ABC {g}B2 d :|  
|: A{g}f{g}f {g}d{g}e{f}e {g}e2 d | {g}Bc{A}d {g}edc {g}B{d}d{e}B | {g}A{d}A{e}A {f}gfe {d}e2 g | {g}ed{G}B {g}B{c}B{G}A {G}B2 d :|  
|: ddd gdB {g}gdB | d{d}d{e}d {g}ecA {g}efe | {g}cGe {g}ed{A}d gd f | {g}eG{G}G {G}AAB g (3GGG :|  
|: {e}ABe {g}edB {g}edB | {g}AB{B}c {e}dBG ~B2 e | {g}B{d}B{e}B {gf}g2 d {a}dBG | {g}A{A}B{G}A {g}ABd {g}e2 d |  
{g}ce{g}e {G}ef{g}e d2 d | {g}edB {d}AB{G}A {G}c2 A | {g}B{c}B{e}B {g}BG{G}B {g}dBf | {g}cBA {g}AGA ||  
: A{d}A{e}A {G}B2 G | {g}Ade {g}ege | {g}c{d}c{e}c {g}BGB | {g}Bd{G}d {g}edB |
```



T: Drunken Pint, The

M: 2/4

L: 1/8

K: Gmaj

<https://youtu.be/omHhyVD3PD8>

```
| : G |B/c/d =c>B | AB/G/G B/A/ | G/A/G/F/ ED | Be/d/ dB/A/ |  
G>D Bd | c2 B2 | A/B/A/G/ F/G/A/c/ | BG G :|  
| : A/B/ |c2 E/F/G | ed- de | c>B AG | G>^F GA |  
BG E>D | EG FE | D/^c/d/^c/ d^c | d3- :|
```

The Endless Traditional Music Session

Music generated and titled by a [recurrent neural network](#), trained on over 23,000 tunes from ABC code posted on [Session](#).

This set is performed by *The First Me Schoast* (playlist updated every 5 minutes).

<http://www.eecs.qmul.ac.uk/~sturm/research/RNNIrishTrad/index.html>

Now with 741 tunes!

Total number of tunes generated now: 35809

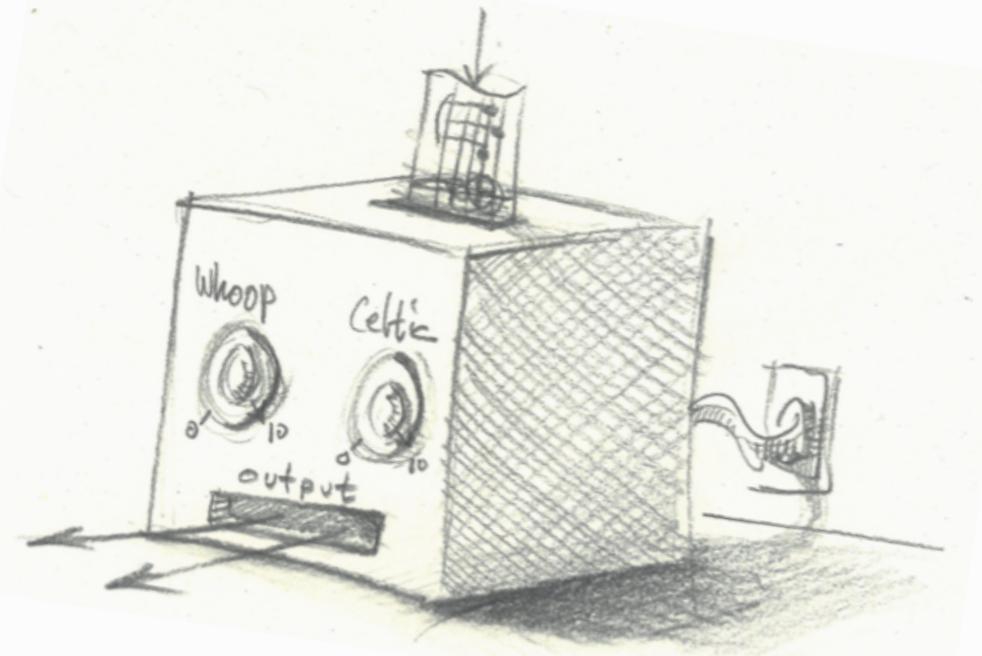
Created by: [Bob L. Sturm](#) and [João Felipe Santos](#). ([More info.](#))

Vols. 1 - 10

30,000 transcriptions in staff notation, ABC, and with hyperlinks to sound files generated by the second version of the model

The folk-rnn Session Book
Volume 1 of 10*

September 12, 2016



<https://highnoongmt.wordpress.com/2017/08/10/folk-rnn-session-books-volumes-1-10-and-v3-volumes-1-4/>

Vols. 1 - 4

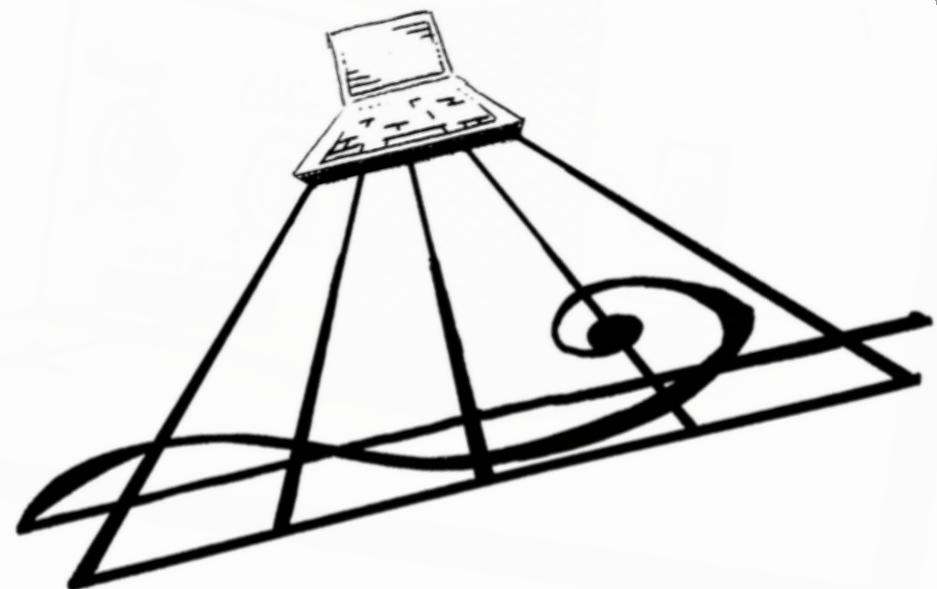
10,000 transcriptions
in staff notation and ABC
generated by the third
version of the model

The folk-rnn Session Book
Volume 1 of 10*

September

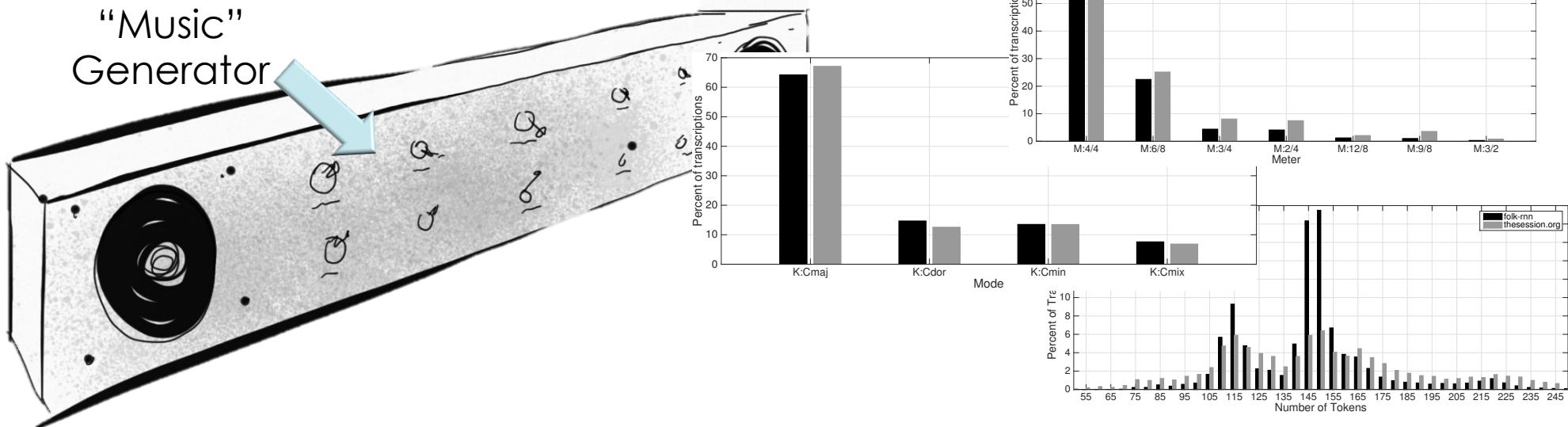
The folk-rnn v3 Session Book
Volume 1 of 4*

August 4, 2017



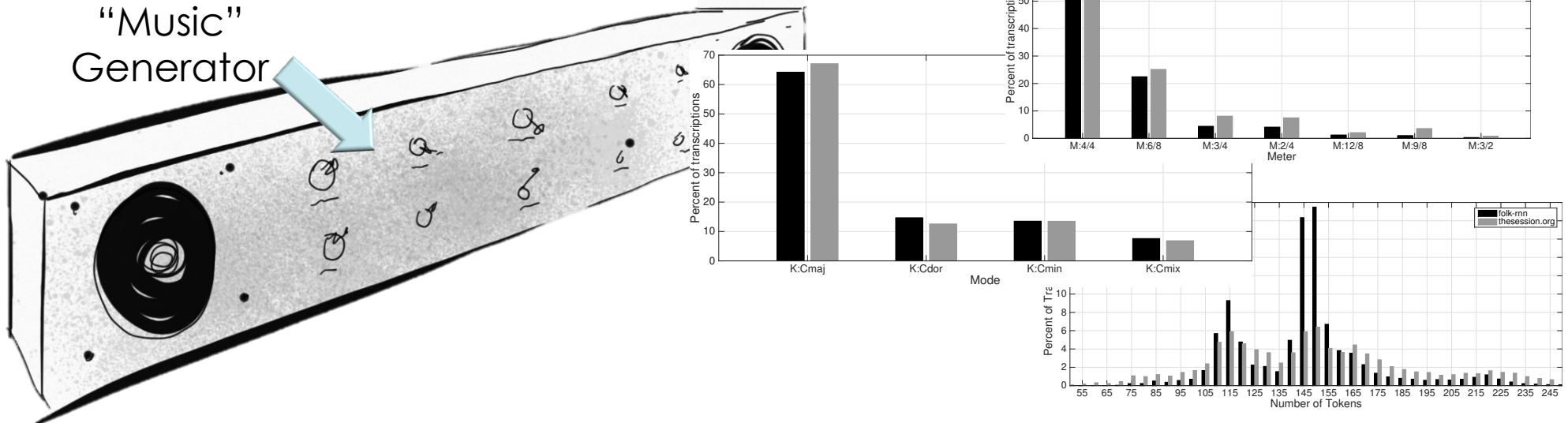
<https://highnoongmt.wordpress.com/2017/08/10/folk-rnn-session-books-volumes-1-10-and-v3-volumes-1-4/>

Computer modelling



- The system seems to embody some of the “grammars” of this kind of music (admittedly limited and abstract)
- Wait: ***what has it actually learned to do?***
- ***Count? Repeat and vary? Cadences?***

Computer modelling



- ❑ The system has a **very fragile** understanding of counting and variation (which is actually no surprise)
- ❑ Is it still useful?
 - ❑ e.g., as a compositional assistant, or a material generator, or a model that can be adapted to other styles?

folk music modelling w

76 commits

Branch: master New

boblstorm committed

configurations

data

metadata

samples

soundexamples

.gitignore

LICENSE

README.md

data_iter.py

logger.py

sample_rnn.py

train_rnn.py

README.md

Folk mu

This code was also used to create the following music compositions:

1. "Bastard Tunes" by Oded Ben-Tal + folk-rnn (2017) <https://www.youtube.com/playlist?list=PLdTpPwVfxuXpQ03F398HH463SAE0vR2X8>
2. "Safe Houses" by Una Monaghan + folk-rnn (for concertina and tape, 2017)
3. "The Fortootuise Pollo" by Bob L. Sturm + folk-rnn (2017) <https://soundcloud.com/sturmen-1/the-fortootuise-pollo-1>
4. "Chicken Bits and Bits and Bobs" by Bob L. Sturm + folk-rnn (2017) <https://youtu.be/n-avS-ozrQU>
5. "March to the Mainframe" by Bob L. Sturm + folk-rnn (2017) <https://youtu.be/TLzBcMvl15M?list=PLdTpPwVfxuXrdOyjtwfokrpzfplnJc5o>
6. "Interlude" by Bob L. Sturm + folk-rnn (2017) <https://youtu.be/NZ08dDdYh3U?list=PLdTpPwVfxuXrdOyjtwfokrpzfplnJc5o> (synthesized version: <https://soundcloud.com/sturmen-1/interlude-synthesised>)
7. "The Humours of Time Pigeon" by Bob L. Sturm + folk-rnn (2017) <https://youtu.be/1xBisQK8-3E?list=PLdTpPwVfxuXrdOyjtwfokrpzfplnJc5o> (synthesized version: <https://soundcloud.com/sturmen-1/the-humours-time-pigeon-synthesised>)
8. "The Glas Herry Comment" by folk-rnn + DeepBach (2017) <https://youtu.be/y9xJl-IjOuA>
9. X:7153 by folk-rnn + DeepBach (2017) <https://youtu.be/tdKCzAyynu4>
10. X:633 by folk-rnn + DeepBach (2017) <https://youtu.be/BUIrbZS5eXc>
11. "It came out from a pretrained net" by Bob L. Sturm + folk-rnn (2016) <https://highnoongmt.wordpress.com/2015/12/16/tis-the-season-for-some-deep-carols/>
12. The folk-rnn Session Book Volume 1, transcriptions 1469, 1470 & 1472 by folk-rnn + Torbjorn Hultmark (2016) <https://youtu.be/4kLxvJ-rXD>
13. "The Ranston Cassock" by Bob L. Sturm + folk-rnn (2016) <https://youtu.be/JZ-47lavYAU> (Version for viola and tape: <https://highnoongmt.wordpress.com/2017/06/18/the-ranston-cassock-take-2/>)
14. "The Millennial Whoop Reel" by Bob L. Sturm + folk-rnn (2016) <https://highnoongmt.wordpress.com/2016/08/29/millennial-whoop-with-derp-learning-a-reel/>
15. "The Millennial Whoop Jig" by Bob L. Sturm + folk-rnn (2016) <https://highnoongmt.wordpress.com/2016/08/28/millennial-whoop-with-derp-learning/>
16. "Eight Short Outputs ..." by folk-rnn + Bob L. Sturm (2015) <https://youtu.be/RaO4HpM07hE>
17. "The Drunken Pint" by folk-rnn (2015) <https://youtu.be/omHhyVD3PD8>
18. "The Glas Herry Comment" by folk-rnn (2015) <https://youtu.be/QZh0WSjFFDs>
19. "We three layers o' hidd'n units are" by Bob L. Sturm + folk-rnn (2015) <https://highnoongmt.wordpress.com/2015/12/16/tis-the-season-for-some-deep-carols/>
20. "The March of Deep Learning" by Bob L. Sturm + folk-rnn (2015) <https://highnoongmt.wordpress.com/2015/08/15/deep-learning-for-assisting-the-process-of-music-composition-part-4/>
21. "The Mal's Copperim" by folk-rnn (2015) <https://youtu.be/YMbWwU2JdLg>
22. "The Castle Star" by folk-rnn + Bob L. Sturm (2015) <https://highnoongmt.wordpress.com/2015/08/12/deep-learning-for-assisting-the-process-of-music-composition-part-2/>
23. "The Doutlace" by folk-rnn + Bob L. Sturm (2015) <https://highnoongmt.wordpress.com/2015/08/11/deep-learning-for-assisting-the-process-of-music-composition-part-1/>

lk-rnn

MIT

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it 52a7d37 22 hours ago

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a year ago

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2 years ago

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22 hours ago

2 years ago

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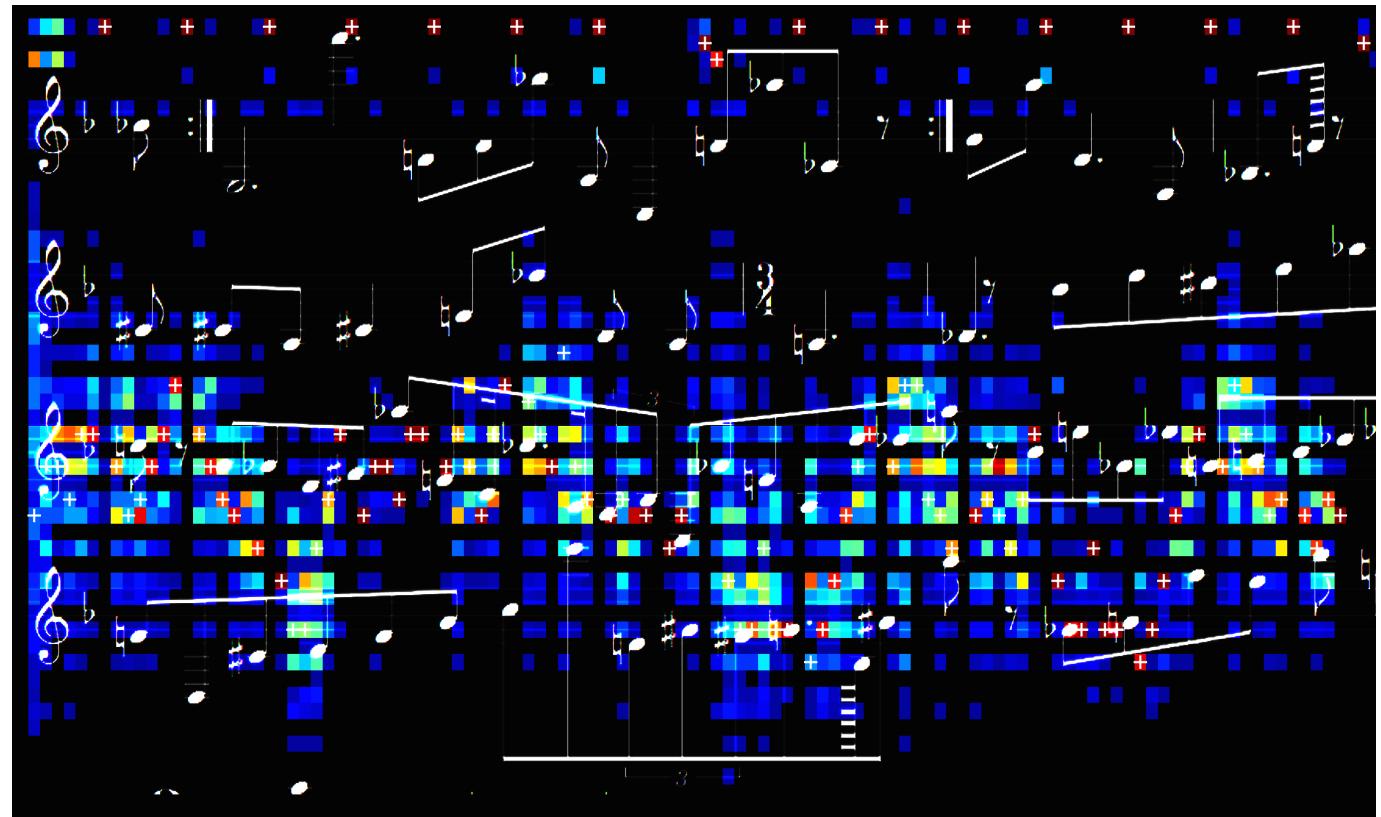
10 months ago

a year ago

Concert May 23 2017 QMUL

Featuring music
co-composed with
our system and other
machine intelligences

Ensemble x.y
Daren Banarsë
and musicians
Úna Monaghan
Elaine Chew
Richard Salmon



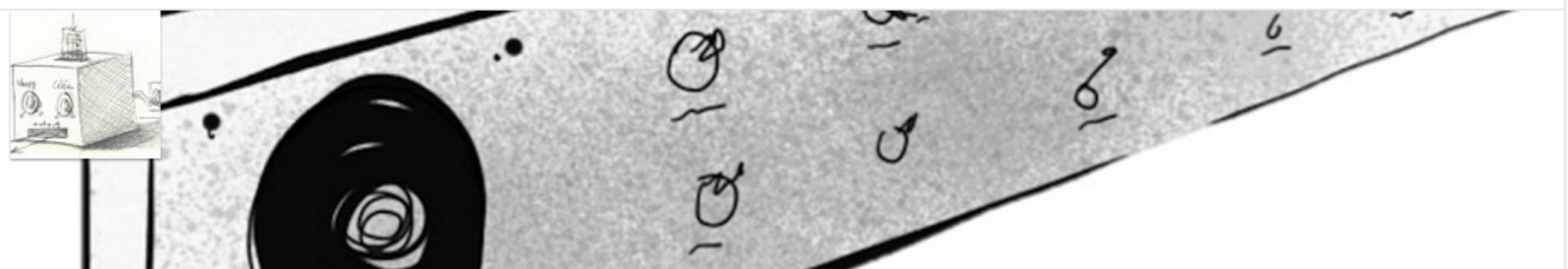
<https://www.youtube.com/playlist?list=PLdTpPwVfxuXpASK9pZdKHxqu1z9wTs6wi>

<i>Pieces for organ: The Glas Herry Comment & X:7153</i> by folk-rnn + Deep Bach (2017)	Richard Salmon organ
Traditional Irish Sets (with <i>folk-rnn</i> tunes in <i>italics</i>) <ul style="list-style-type: none"> • Jigs (The Cuil Aodha, The Dusty Windowsill, <i>The Glas Herry Comment</i>) • Slow Reels (Maghera Mountain, X:2897) • Fast Reels (The Rookery, X:1068, Toss The Feathers II) 	Daren Banarsë and Musicians
March to the Mainframe, Interlude, The Humours of Time Pigeon by Bob L. Sturm + <i>folk-rnn</i> (2017)	Ensemble x.y
Ed SheerAI vs XenAkls vs Aldele by Nick Collins (2017)	Ensemble x.y
3 morphed pieces from “A Little Notebook for Anna Magdalena” by J. S. Bach (1722) + MorpheuS (2017) 3 morphed pieces from “30 and 24 Pieces for Children” by Kabalevsky (1937) + MorpheuS (2017)	Elaine Chew piano
Safe Houses by Úna Monaghan + <i>folk-rnn</i> (2017)	Úna Monaghan
The Choice by Úna Monaghan (2015)	<i>Irish harp, concertina, electronics</i>
The Chinwag by Úna Monaghan (2015)	
<i>Pieces for organ: X:633 & The Drunken Pint</i> by folk-rnn + Deep Bach (2017)	Richard Salmon organ
Chicken Bits and Bits and Bobs by Bob L. Sturm + <i>folk-rnn</i> (2017)	Ensemble x.y
Bastard Tunes by Oded Ben-Tal + <i>folk-rnn</i> (2017)	Ensemble x.y

32 subscribers

6,520 views

Video Manager

https://www.youtube.com/channel/UC7wzmG64y2lbTUeWji_qKhA

The Bottomless Tune Box



Subscribe

32

The music on this channel arises from creative partnerships between musicians and a deep learning system that models music transcription ... Show more

Uploads Public

[Set #3 \(fast reels\)](#)

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[Set #1 \(jigs\)](#)

69 views • 3 weeks ago

["Chicken Bits and Bits and Bobs" by Bob L. Sturm + folk-rnn](#)

68 views • 3 weeks ago

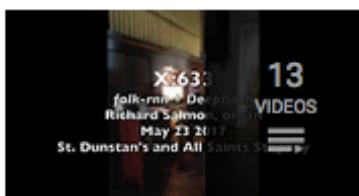
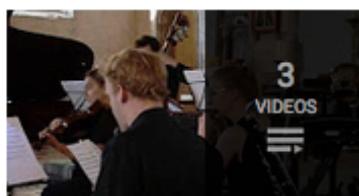
["Interlude" by Bob L. Sturm + folk-rnn](#)

26 views • 3 weeks ago

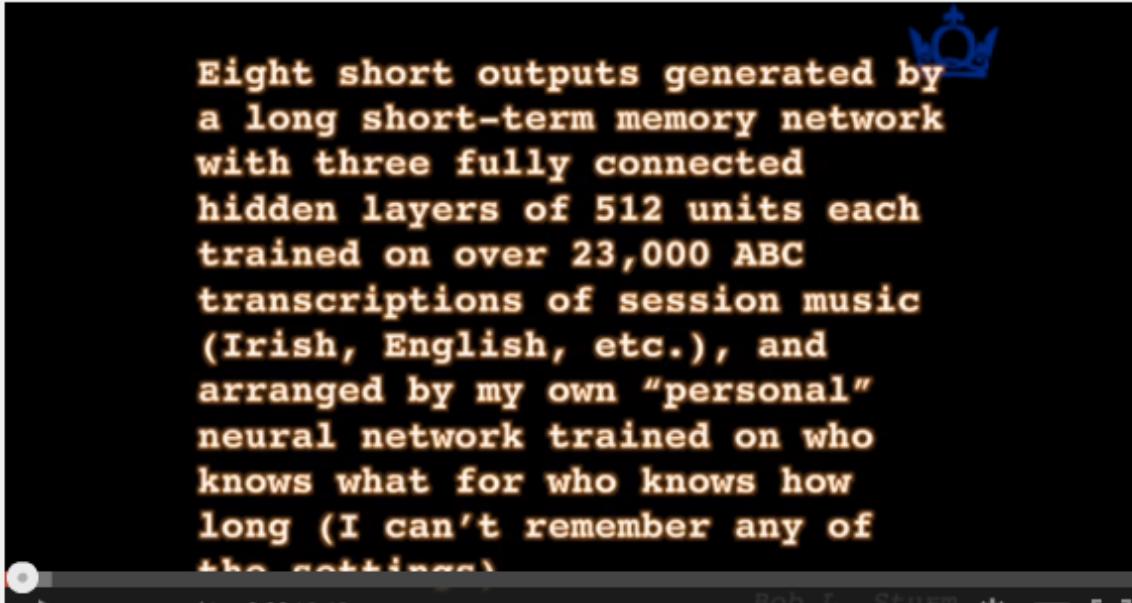
["The Humours of Time Pigeon" by Bob L. Sturm + folk-rnn](#)

41 views • 3 weeks ago

Created playlists Public

[C4DM concert \(QMUL Nov. 18 2016\)](#)[Partnerships concert \(May 23 2017\)](#)[Two short pieces and an Interlude in Concert](#)[Bastard Tunes in Concert](#)[C4DM concert \(QMUL Nov 23 2015\)](#)

“Failure” can be useful!



The image shows a YouTube video player interface. The main content area displays a block of text in white on a black background. The text discusses a neural network's output, mentioning "Eight short outputs generated by a long short-term memory network with three fully connected hidden layers of 512 units each trained on over 23,000 ABC transcriptions of session music (Irish, English, etc.), and arranged by my own “personal” neural network trained on who knows what for who knows how long (I can’t remember any of the settings)". Below the video player, there is a navigation bar with icons for play, volume, and other controls, and a progress bar indicating 0:00 / 9:46. At the bottom, there are video management options like Analytics and Video Manager.

Eight Short Outputs ...

[https://www.youtube.com/
watch?v=RaO4HpM07hE](https://www.youtube.com/watch?v=RaO4HpM07hE)



“The Humours of Time Pigeon”



“A Fhsoilah Kilnie”

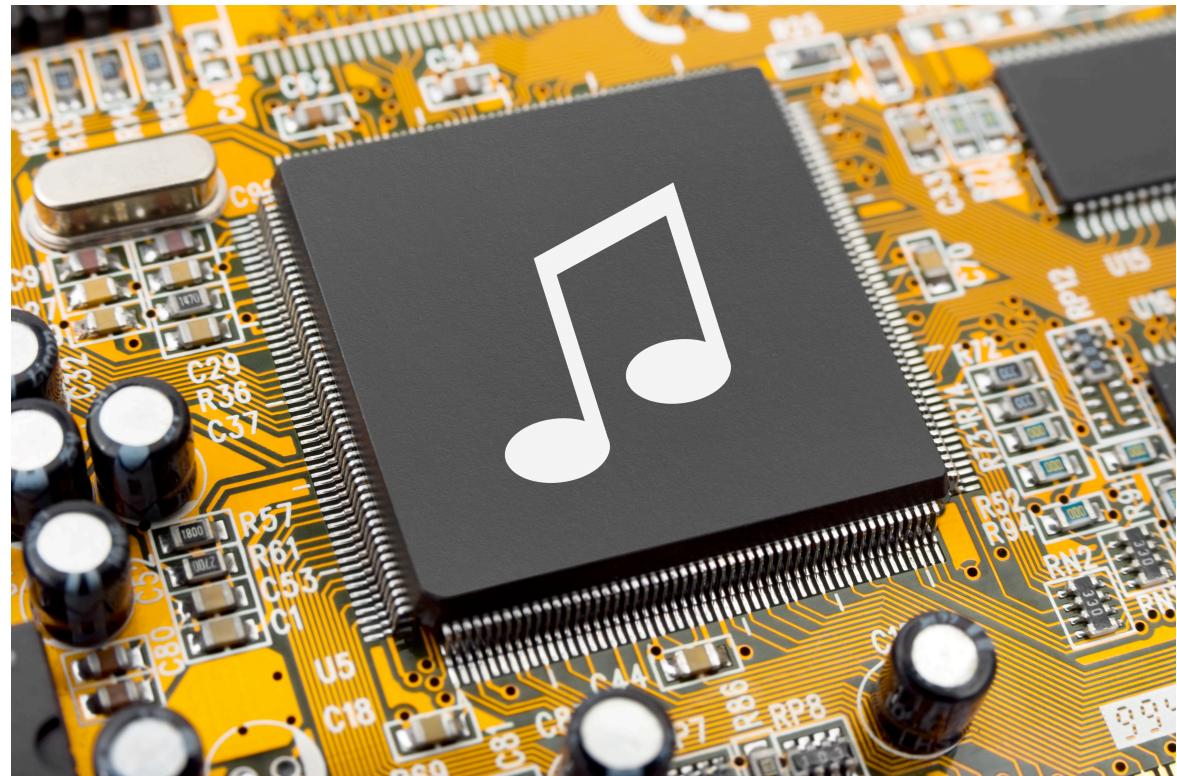
Listen to much more!!

- YouTube: <https://www.youtube.com/user/boblsturm/videos>
- soundcloud: <https://soundcloud.com/sturmen-1>
- web log: <https://highnoongmt.wordpress.com>
- The Endless Traditional Music Session:
<http://www.eecs.qmul.ac.uk/~sturm/research/RNNIrishTrad/index.html>

Concert Nov 20 2017

*Music in the Age of
Artificial Creation*

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[http://eshop.qmul.ac.uk/product-catalogue/tickets/tickets/
concert-music-in-the-age-of-artificial-creation-part-of-the-2017-being-human-festival](http://eshop.qmul.ac.uk/product-catalogue/tickets/tickets/concert-music-in-the-age-of-artificial-creation-part-of-the-2017-being-human-festival)