

DEEP LEARNING FOR MUSIC GENERATION

This file presents the State of the Art of Music Generation.

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Table of Contents

1. [Algorithmic Composition](#)
 - [1992](#)
 - [Books](#)
2. [Neural Network Architectures](#)
3. [Deep Learning Models for Music Generation](#)
 - [2021](#)
 - [2020](#)
 - [2019](#)
 - [2018](#)
 - [2017](#)
 - [2016](#)
 - [2015](#)
 - [2002](#)
 - [Books and Reviews](#)
 - [Books](#)
 - [Reviews](#)
4. [Datasets](#)
5. [Journals and Conferences](#)
6. [Authors](#)
7. [Research Groups and Labs](#)
8. [Apps for Music Generation with AI](#)
9. [Other Resources](#)

Author

2. Algorithmic Composition

1992

HARMONET

Hild, H., Feulner, J., & Menzel, W. (1992). HARMONET: A neural net for harmonizing chorales in the style of JS Bach. In Advances in

Paper

Books

- Westergaard, P. (1959). Experimental Music. Composition with an Electronic Computer.
- Cope, D. (2000). The algorithmic composer (Vol. 16). AR Editions, Inc..
- Nierhaus, G. (2009). Algorithmic composition: paradigms of automated music generation. Springer Science & Business Media.
- Müller, M. (2015). Fundamentals of music processing: Audio, analysis, algorithms, applications. Springer.
- McLean, A., & Dean, R. T. (Eds.). (2018). The Oxford handbook of algorithmic music. Oxford University Press.

2. Neural Network Architectures

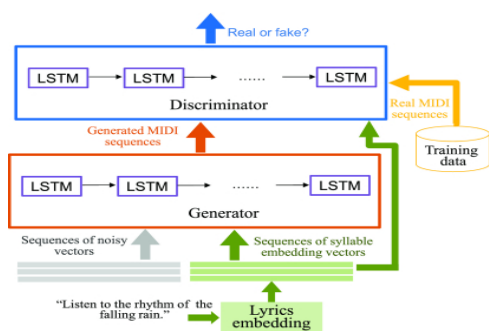
NN Architecture	Year	Authors	Link to original paper	Slides
Long Short-Term Memory (LSTM)	1997	Sepp Hochreiter, Jürgen Schmidhuber	http://www.bioinf.jku.at/publications/older/2604.pdf	LSTM.pdf
Convolutional Neural Network (CNN)	1998	Yann LeCun, Léon Bottou, Yoshua Bengio, Patrick Haffner	http://vision.stanford.edu/cs598_spring07/papers/Lecun98.pdf	
Variational Auto Encoder (VAE)	2013	Diederik P. Kingma, Max Welling	https://arxiv.org/pdf/1312.6114.pdf	
Generative Adversarial Networks (GAN)	2014	Ian J. Goodfellow, Jean Pouget-Abadie, Mehdi Mirza, Bing Xu, David Warde-Farley, Sherjil Ozair, Aaron Courville, Yoshua Bengio	https://arxiv.org/pdf/1406.2661.pdf	
Transformer	2017	Ashish Vaswani, Noam Shazeer, Niki Parmar, Jakob Uszkoreit, Llion Jones, Aidan N. Gomez, Łukasz Kaiser, Illia Polosukhin	https://arxiv.org/pdf/1706.03762.pdf	

3. Deep Learning Models for Music Generation

2021

Melody Generation from Lyrics

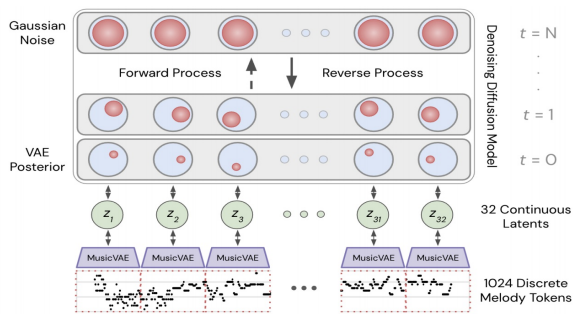
Yu, Y., Srivastava, A., & Canales, S. (2021). Conditional lstm-gan for melody generation from lyrics. ACM Transactions on Multimedia Computing and Communications.



[Paper](#)

Music Generation with Diffusion Models

Mittal, G., Engel, J., Hawthorne, C., & Simon, I. (2021). Symbolic music generation with diffusion models. arXiv preprint arXiv:2105.00800.

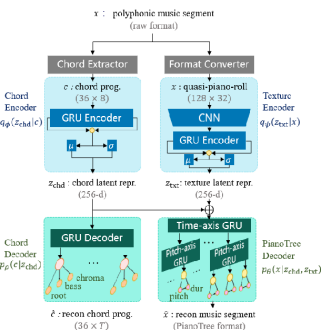


[Paper](#)

2020

Controllable Polyphonic Music Generation

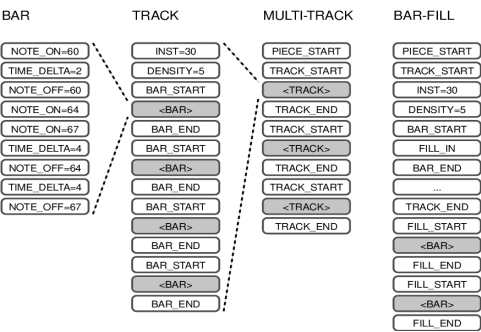
Wang, Z., Wang, D., Zhang, Y., & Xia, G. (2020). Learning interpretable representation for controllable polyphonic music generation.



[Paper](#) [Web](#) [Video](#)

MMM: Multitrack Music Generation

Ens, J., & Pasquier, P. (2020). Mmm: Exploring conditional multi-track music generation with the transformer. arXiv preprint arXiv:2009.07834.



[Paper](#) [Web](#) [Colab](#) [Github](#) (AI Guru)

Transformer-XL

Wu, X., Wang, C., & Lei, Q. (2020). Transformer-XL Based Music Generation with Multiple Sequences of Time-valued Notes. arXiv preprint arXiv:2009.07834.

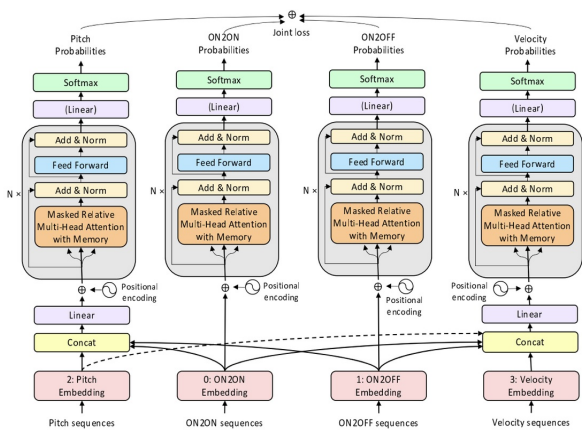
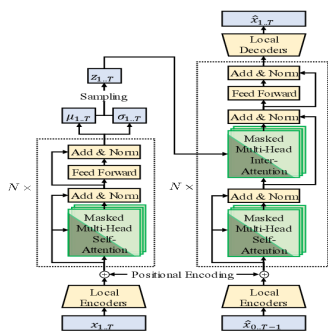


Figure 2: Our proposed framework with four transformer-xl networks.

Paper

Transformer VAE

Jiang, J., Xia, G. G., Carlton, D. B., Anderson, C. N., & Miyakawa, R. H. (2020, May). Transformer vae: A hierarchical model for str

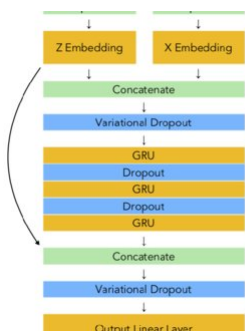


Paper

2019

TonicNet

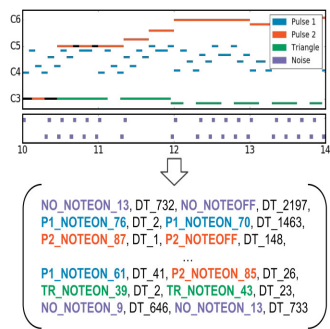
Peracha, O. (2019). Improving polyphonic music models with feature-rich encoding. arXiv preprint arXiv:1911.11775.



Paper

LakhNES

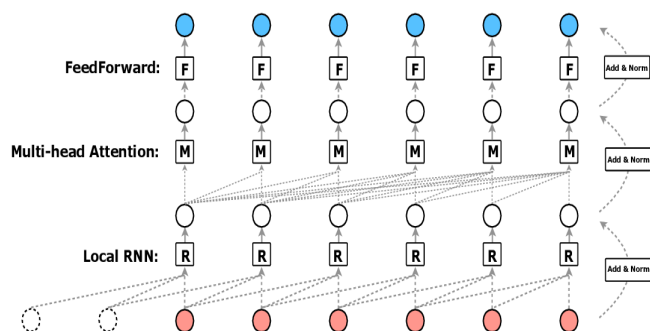
Donahue, C., Mao, H. H., Li, Y. E., Cottrell, G. W., & McAuley, J. (2019). LakhNES: Improving multi-instrumental music generation wi



[Paper](#)

R-Transformer

Wang, Z., Ma, Y., Liu, Z., & Tang, J. (2019). R-transformer: Recurrent neural network enhanced transformer. arXiv preprint arXiv:1906.08932v2 [cs.LG].

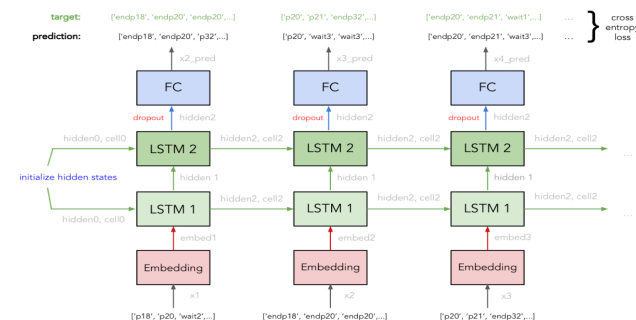


[Paper](#)

MuseNet - OpenAI

[Web](#)

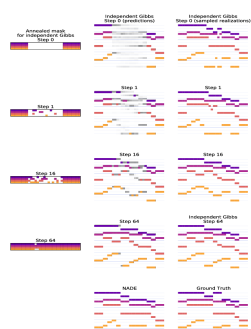
Maia Music Generator



[Web](#)

Coconet: Counterpoint by Convolution

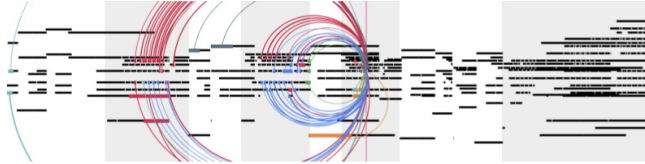
Huang, C. Z. A., Cooijmans, T., Roberts, A., Courville, A., & Eck, D. (2019). Counterpoint by convolution. arXiv preprint arXiv:1906.08932v2 [cs.LG].



2018

Music Transformer - Google Magenta

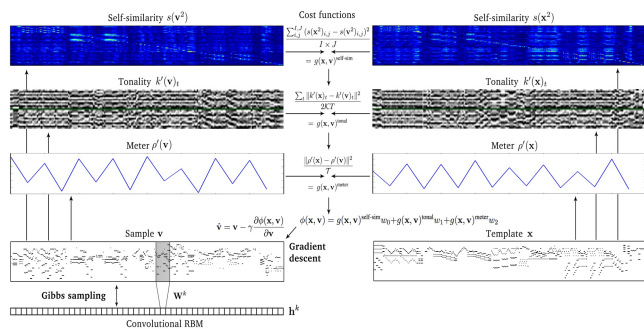
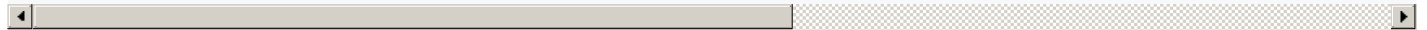
Huang, C. Z. A., Vaswani, A., Uszkoreit, J., Shazeer, N., Simon, I., Hawthorne, et al. (2018). Music transformer. arXiv preprint arXiv:1808.08769



Web Poster Paper

Imposing Higher-level Structure in Polyphonic Music

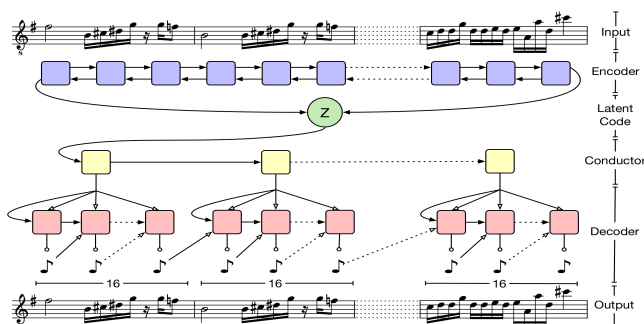
Lattner, S., Grachten, M., & Widmer, G. (2018). Imposing higher-level structure in polyphonic music generation using convolutional recurrent neural networks. arXiv preprint arXiv:1808.08769



Paper

MusicVAE - Google Magenta

Roberts, A., Engel, J., Raffel, C., Hawthorne, C., & Eck, D. (2018, July). A hierarchical latent vector model for learning long-term dependencies in music. arXiv preprint arXiv:1808.08769

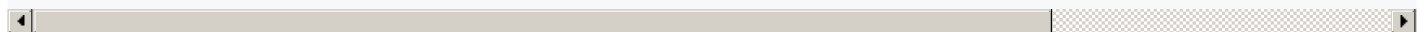


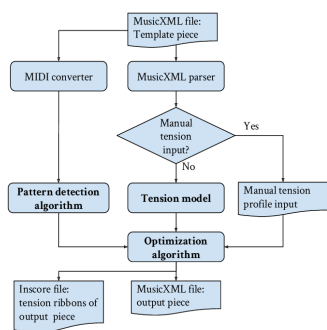
Web Paper Code Google Colab Explanation

2017

Morpheus

Herremans, D., & Chew, E. (2017). Morpheus: generating structured music with constrained patterns and tension. IEEE Transactions on Audio, Speech, and Language Processing, 25(12), 4488-4500.

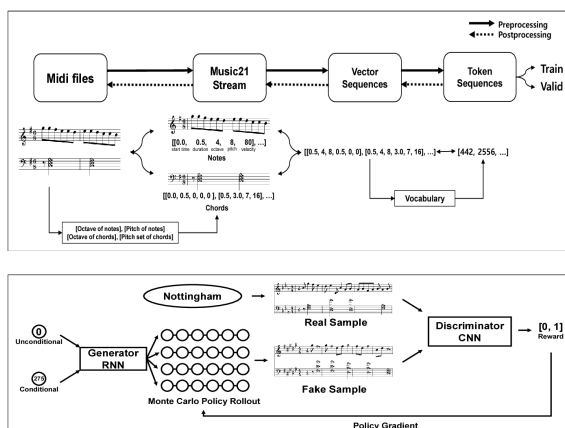




Paper

Polyphonic GAN

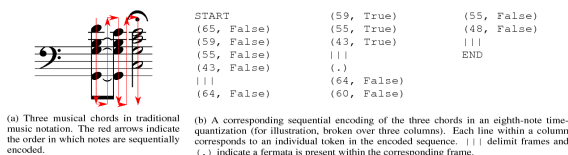
Lee, S. G., Hwang, U., Min, S., & Yoon, S. (2017). Polyphonic music generation with sequence generative adversarial networks. arXiv



Paper

BachBot - Microsoft

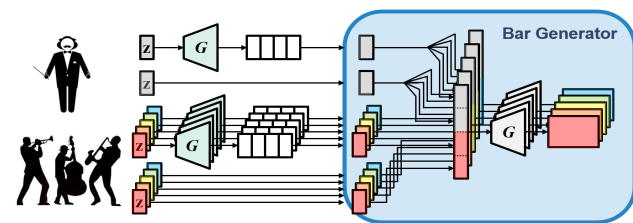
Liang, F. T., Gotham, M., Johnson, M., & Shotton, J. (2017, October). Automatic Stylistic Composition of Bach Chorales with Deep LSTM



Paper Liang Master Thesis 2016

MuseGAN

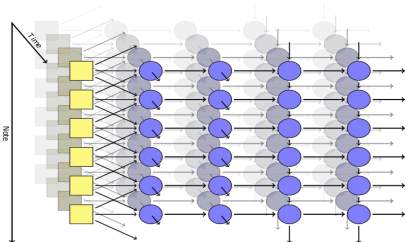
Dong, H. W., Hsiao, W. Y., Yang, L. C., & Yang, Y. H. (2018, April). Musegan: Multi-track sequential generative adversarial networks



[Web Paper Poster GitHub](#)

Composing Music with LSTM

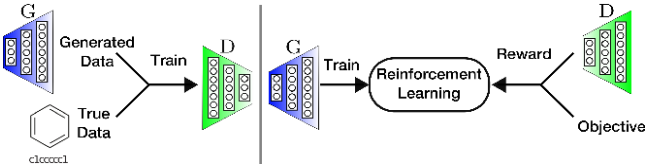
Johnson, D. D. (2017, April). Generating polyphonic music using tied parallel networks. In International conference on evolutionary



[Paper Web GitHub Blog](#)

ORGAN

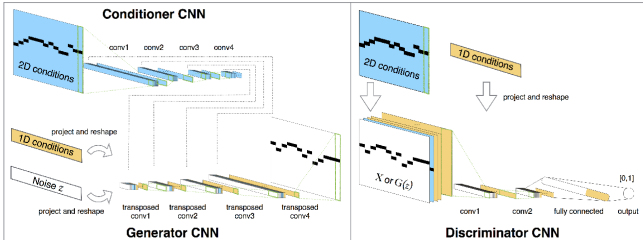
Guimaraes, G. L., Sanchez-Lengeling, B., Outeiral, C., Farias, P. L. C., & Aspuru-Guzik, A. (2017). Objective-reinforced generative



[Paper](#)

MidiNet

Yang, L. C., Chou, S. Y., & Yang, Y. H. (2017). MidiNet: A convolutional generative adversarial network for symbolic-domain music ge

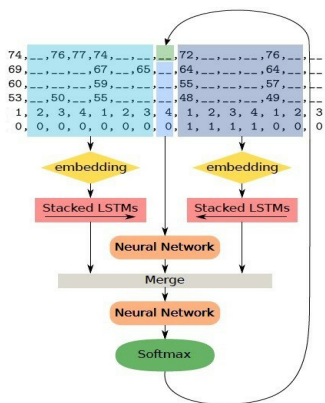


[Paper](#)

2016

DeepBach

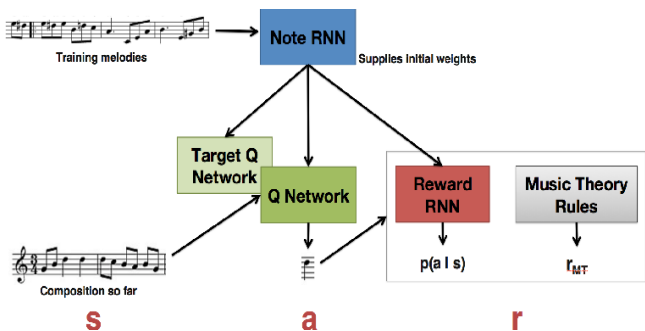
Hadjeres, G., Pachet, F., & Nielsen, F. (2017, July). Deepbach: a steerable model for bach chorales generation. In International Cor



[Web Paper Code](#)

Fine-Tuning with RL

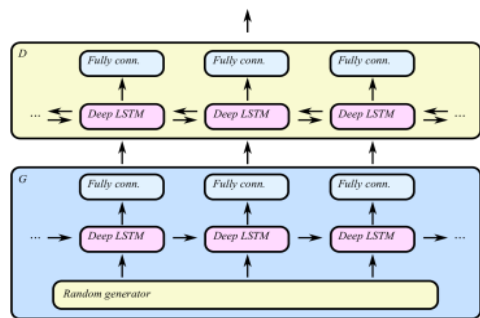
Jaques, N., Gu, S., Turner, R. E., & Eck, D. (2016). Generating music by fine-tuning recurrent neural networks with reinforcement learning. *arXiv preprint arXiv:1609.03250*.



[Paper](#)

C-RNN-GAN

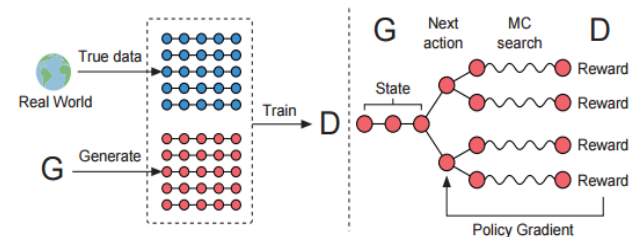
Mogren, O. (2016). C-RNN-GAN: Continuous recurrent neural networks with adversarial training. *arXiv preprint arXiv:1611.09904*.



[Paper](#)

SeqGAN

Yu, L., Zhang, W., Wang, J., & Yu, Y. (2017, February). Seqgan: Sequence generative adversarial nets with policy gradient. In *Proceedings of the 31st AAAI conference on artificial intelligence* (pp. 27-34).



2002

Temporal Structure in Music

Eck, D., & Schmidhuber, J. (2002, September). Finding temporal structure in music: Blues improvisation with LSTM recurrent networks.

Books and Reviews

Books

- Briot, J. P., Hadjeres, G., & Pachet, F. (2020). Deep learning techniques for music generation (pp. 1-249). Springer.

Reviews

- Ji, S., Luo, J., & Yang, X. (2020). A Comprehensive Survey on Deep Music Generation: Multi-level Representations, Algorithms, Evaluations, and Future Directions. arXiv preprint arXiv:2011.06801. [Paper](#)
- Briot, J. P., Hadjeres, G., & Pachet, F. D. (2017). Deep learning techniques for music generation—a survey. arXiv preprint arXiv:1709.01620. [Paper](#)

4. Datasets

- The Lakh MIDI Dataset v0.1 [Web](#) [Tutorial](#) [IPython](#)

5. Journals and Conferences

- International Society for Music Information Retrieval (ISMIR) [Web](#)
- IEEE Signal Processing (ICASSP) [Web](#)
- ELSEVIER Signal Processing Journal [Web](#)
- Association for the Advancement of Artificial Intelligence (AAAI) [Web](#)
- Journal of Artificial Intelligence Research (JAIR) [Web](#)
- International Joint Conferences on Artificial Intelligence (IJCAI) [Web](#)
- International Conference on Learning Representations (ICLR) [Web](#)
- IET Signal Processing Journal [Web](#)
- Journal of New Music Research (JNMR) [Web](#)
- Audio Engineering Society - Conference on Semantic Audio (AES) [Web](#)
- International Conference on Digital Audio Effects (DAFx) [Web](#)

6. Authors

- David Cope [Web](#)
- Colin Raffel [Web](#)
- Jesse Engel [Web](#)
- Douglas Eck [Web](#)
- François Pachet [Web](#)

7. Research Groups and Labs

- Audiolabs Erlangen [Web](#)
- Music Informatics Group [Web](#)

- Music and Artificial Intelligence Lab [Web](#)

8. Apps for Music Generation with AI

- AIVA (paid) [Web](#)
- Amper Music (paid) [Web](#)
- Ecrett Music (paid) [Web](#)
- Humtap (free, iOS) [Web](#)
- Amadeus Code (free/paid, iOS) [Web](#)
- Computoser (free) [Web](#)
- Brain.fm (paid) [Web](#)

9. Other Resources

- Bustena (web in spanish to learn harmony theory) [Web](#)

Author

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