

PAT 498/598 (Winter 2025)

Music & AI

Lecture 3: AI & Music

Instructor: Hao-Wen Dong



SCHOOL OF MUSIC, THEATRE & DANCE
PERFORMING ARTS TECHNOLOGY
UNIVERSITY OF MICHIGAN

Communications

- **Course website:** Syllabus, schedule, readings, recordings, etc.
- **Email:** Announcements
- **Google Chat:** Q&A



[hermandong.com/teaching/
pat498_598_winter2025](https://hermandong.com/teaching/pat498_598_winter2025)

Homework 1: Real of Fake!?



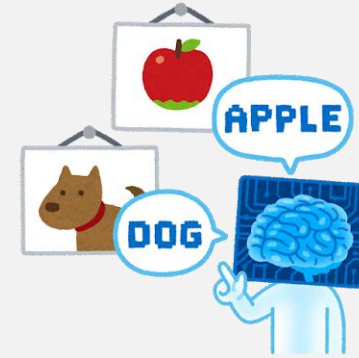
Homework 1: Real of Fake!?

- **Don't worry! You'll be graded by completion (instead of correctness)!**
- Instructions will be sent by **emails** and released on the **course website**
- Please submit your work to **Gradescope**
- Due at **11:59pm ET** on **January 22**
- Late submissions: **1 point deducted per day**

(Recap) What is Artificial Intelligence?



Systems that **think like humans**

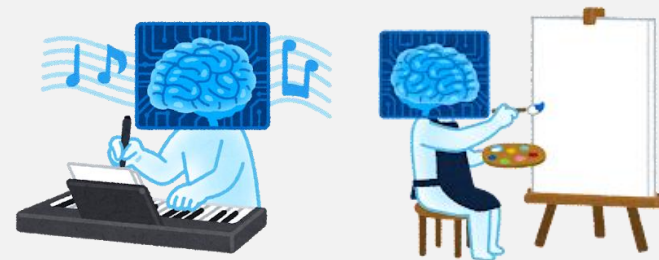


Systems that **think rationally**

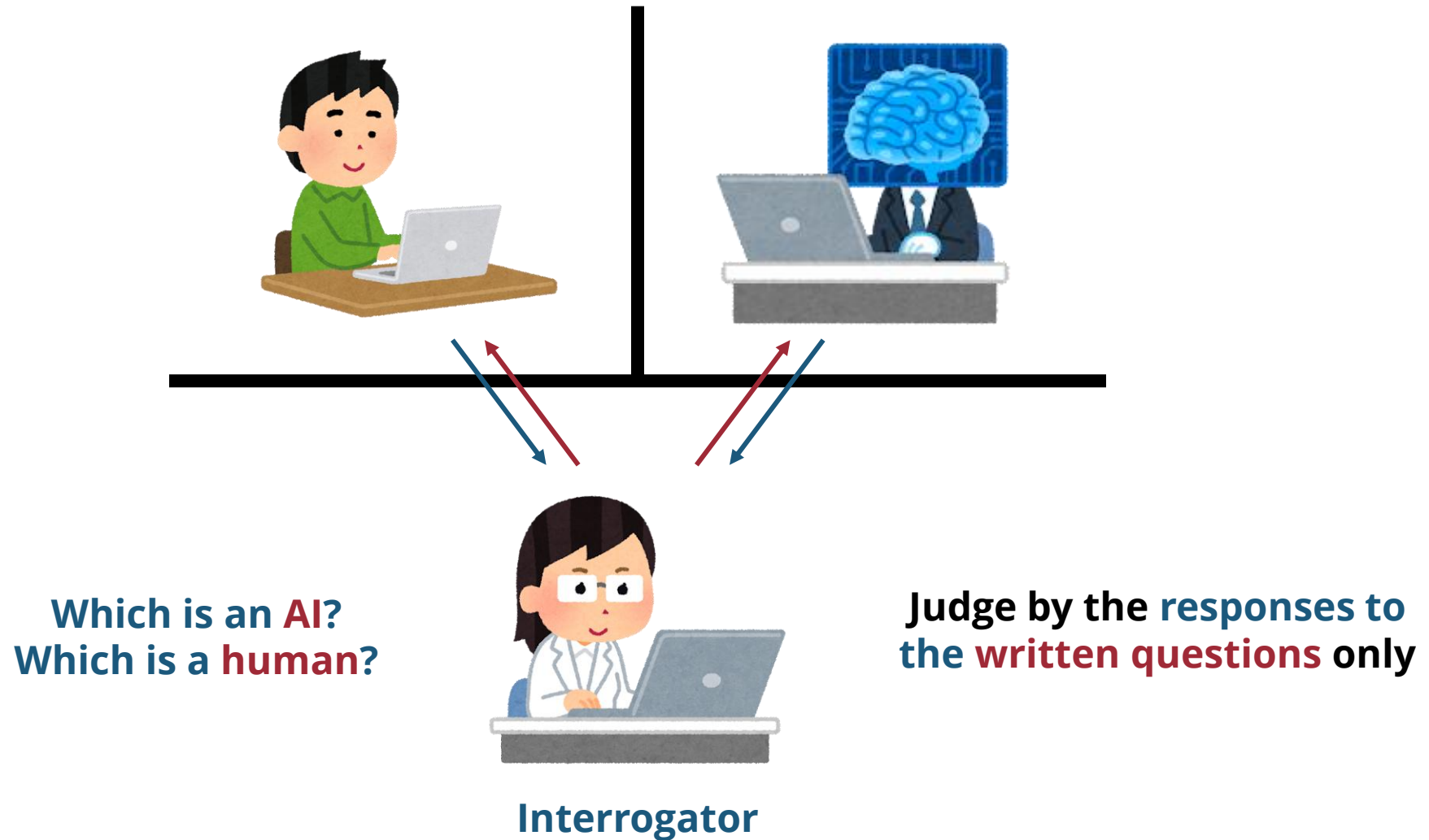
Systems that **act like humans**



Systems that **act rationally**




(Recap) Thinking vs Acting: Turing Test (1950)




(Recap) Can you? (I, Robot, 2004)



Can a robot write a Symphony?



Can a robot take a blank canvas
and turn it into a masterpiece?



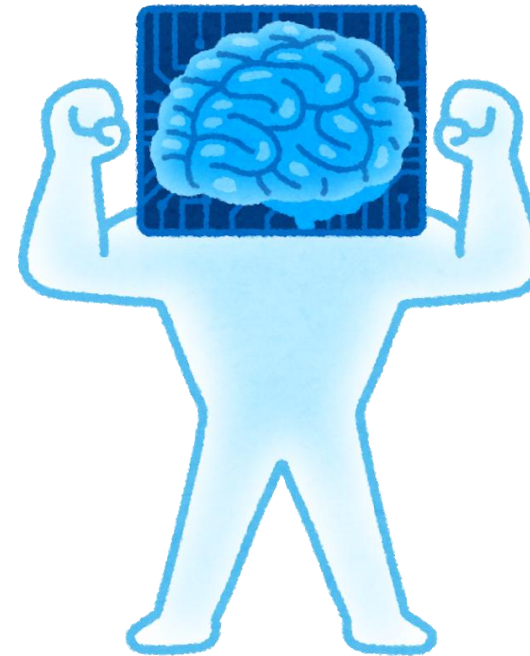
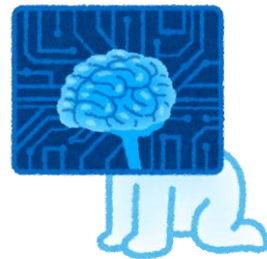
Can you?

(Recap) Human vs AI: Weak AI vs Strong AI

Artificial General Intelligence (AGI)

Reaches human-level intelligence
Have a self-aware consciousness
Solve multiple tasks
Can learn and plan

Performs a single task
Cannot learn from experience
Cannot reason



(Recap) What is Artificial Intelligence?

AI is the study of how to make computers **do things at which, at the moment, people are better.**

– Elaine Rich and Kevin Knight, 1991

1997



(Source: Britannica)

2016



(Source: The Guardian)

20??



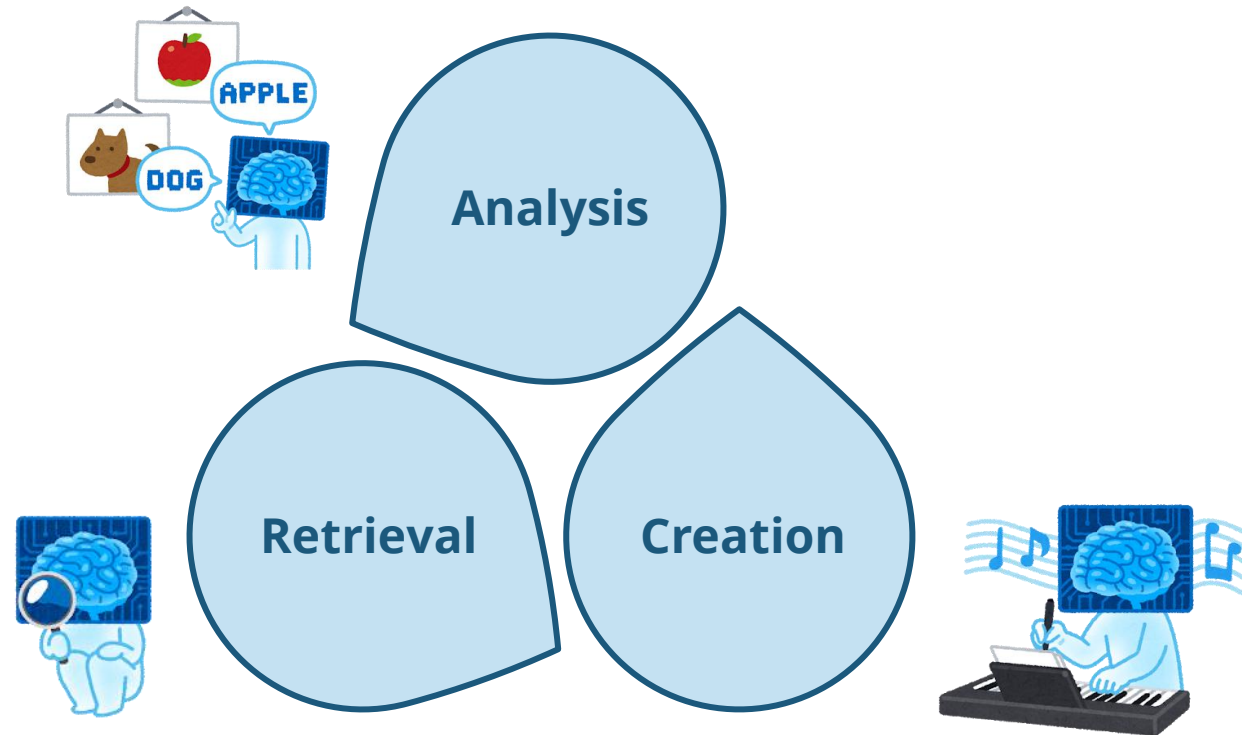
(Source: SC2HL)

Elaine Rich and Kevin Knight, *Artificial Intelligence*. United Kingdom: McGraw-Hill, 1991.
britannica.com/topic/Deep-Blue
theguardian.com/technology/2016/mar/15/alphago-what-does-google-advanced-software-go-next
youtube.com/watch?v=PFMRDm_H9Sg

Music Information Research (MIR)

Music Information Research (MIR)

- “Intelligent ways to analyze, retrieve and create music” (Yang 2018)



Music Information Research (MIR)

Electrical Engineering



a female cat engineer making an electric chip in a classroom

Music



a cat playing heavy metal

Computer Science



a cat engineer debugging on laptop

Made in September 2023!

Music Information Research (MIR)

Electrical Engineering



a cat engineer making an electric chip in a classroom

Music



a cat playing heavy metal

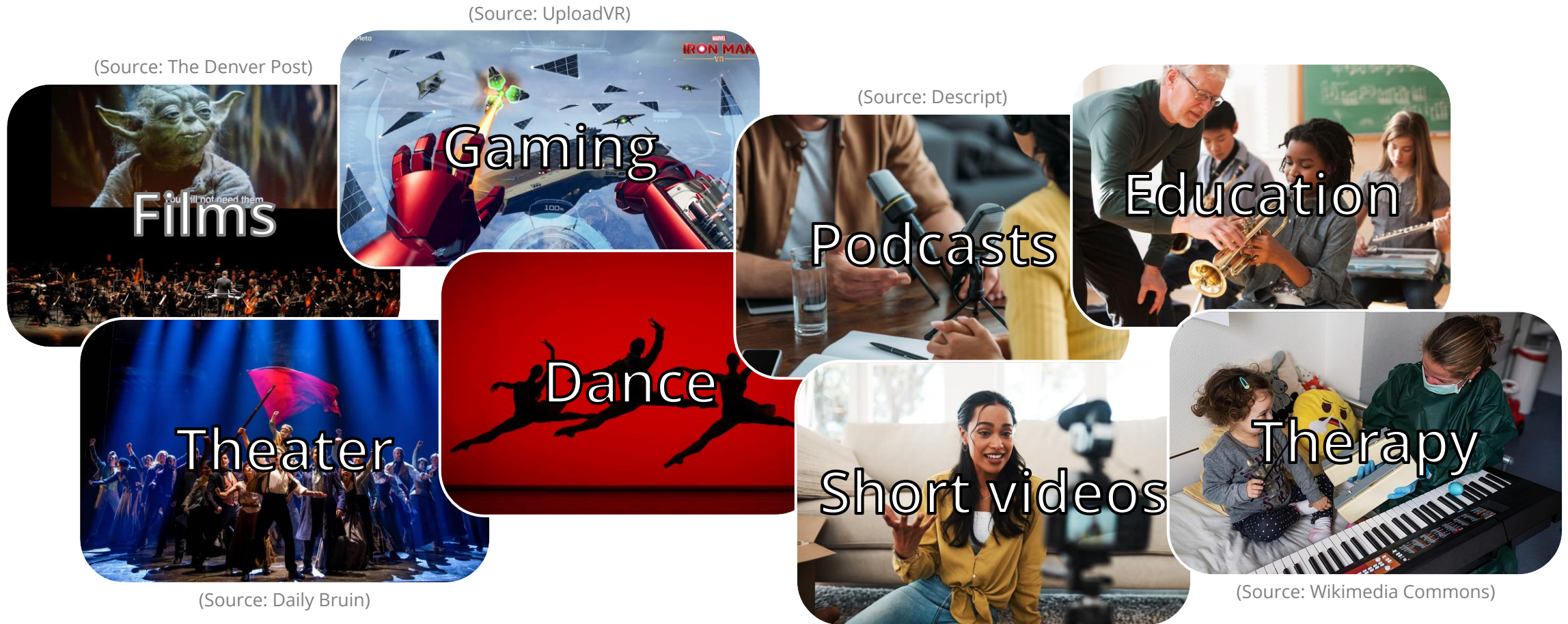
Computer Science



a cat engineer debugging Python programs on a laptop

January 2025
Made in ~~September 2023!~~

Use Cases of AI for Music & Audio



Universitaetsmedizin, [CC BY-SA 4.0](https://commons.wikimedia.org/wiki/File:Universitaetsmedizin), via Wikimedia Commons
uploadvr.com/iron-man-vr-breaks-free-from-cords-load-screens-on-quest-2/
descript.com/blog/article/what-is-the-best-audio-interface-for-recording-a-podcast
denverpost.com/2019/08/02/colorado-symphony-movie-scores-harry-potter-star-wars/
dailybruin.com/2023/08/04/theater-review-the-musical-les-misrables-offers-stellar-displays-and-impassioned-vocals

AI Music in the Early Days

The Early Days

Musical Dice Game (1792)



(Source: gbrachetta)

gbrachetta.github.io/Musical-Dice/

ILLIAC Suite (1957)



(Source: Illinois Distributed Museum)

Emily Howell (2003)



(Source: The Guardian)

Musical Dice Game (1792)


Table des Chiffres pour le Walzer.
Zahlentafel für den Walzer.

Premiere Partie.
Erster Theil.

	A	B	C	D	E	F	G	H
2	96	22	141	41	105	122	11	30
3	32	6	128	63	146	46	134	81
4	69	95	158	13	153	55	110	24
5	40	17	113	85	161	2	159	100
6	48	74	163	45	80	97	36	107
7	24	157	27	167	154	68	118	91
8	2	60	171	53	99	133	21	127
9	9	84	114	50	140	86	169	94
10	98	142	42	156	75	129	62	123
11	3	87	165	61	135	47	147	33
12	9	9	9	93	28	37	106	5

Seconde Partie.
Zweiter Theil.

	A	B	C	D	E	F	G	H
2	70	121	26	9	112	49	109	14
3	117	39	126	56	174	18	116	83
4	66	139	15	132	73	58	145	79
5	90	176	7	34	67	160	52	170
6	25	143	64	125	76	136	1	93
7	138	71	150	29	101	162	23	151
8	16	155	57	175	43	168	89	172
9	120	88	48	166	51	115	72	111
10	65	77	19	82	137	38	149	8
11	102	4	31	164	144	59	173	78
12	35	20	108	92	12	124	44	131



(Source: gbrachetta)

gbrachetta.github.io/Musical-Dice/



Lejaren Hiller – ILLIAC Suite for String Quartet (1957)

ILLIAC SUITE FOR STRING QUARTET

3

I. EXPERIMENT NO. 1

L.A. HILLER, JR. AND L.M. ISAACSON

PRESTO

VIOLIN I

VIOLIN II

VIOLA

CELLO

10

20

30

(A)



(Source: Illinois Distributed Museum)

youtu.be/n0njBFLQSk8 &
music.arts.uci.edu/abauer/3.1/scores/Hiller_Illiac_Suite.pdf



Emily Howell (by David Cope) – Prelude (2007)



Reading: David Cope on Emily Howell

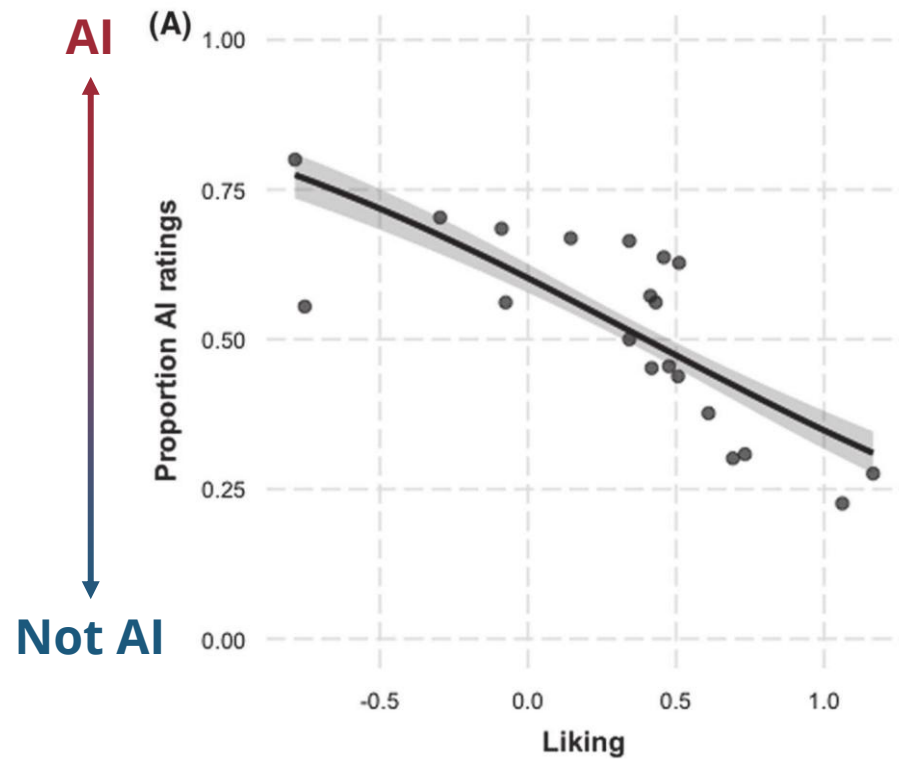
- David Cope: 'You pushed the button and out came hundreds and thousands of sonatas'
 - Interview by Tim Adams published on *The Observer*, *The Guardians*, July 10, 2010

"People tell me they don't hear soul in the music," he says. "When they do that, I pull out a page of notes and ask them to show me where the soul is. We like to think that what we hear is soul, but I think audience members put themselves down a lot in that respect. **The feelings that we get from listening to music are something we produce, it's not there in the notes. It comes from emotional insight in each of us, the music is just the trigger.**"

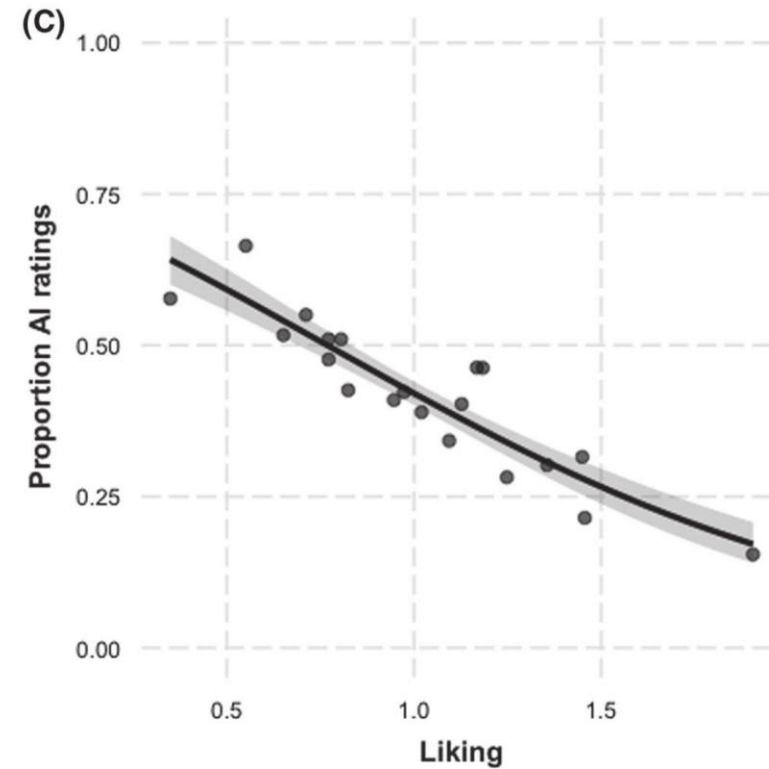


AI Composer Bias (Shank et al., 2023)

Electronic music



Classical music



How should we interpret these two figures?

Correlation \neq Causality

What about ChatGPT?

Large Language Models (LLMs)

- The models behind ChatGPT!

SA

You

What's so cool about **AI for music**? Give me a brief answer



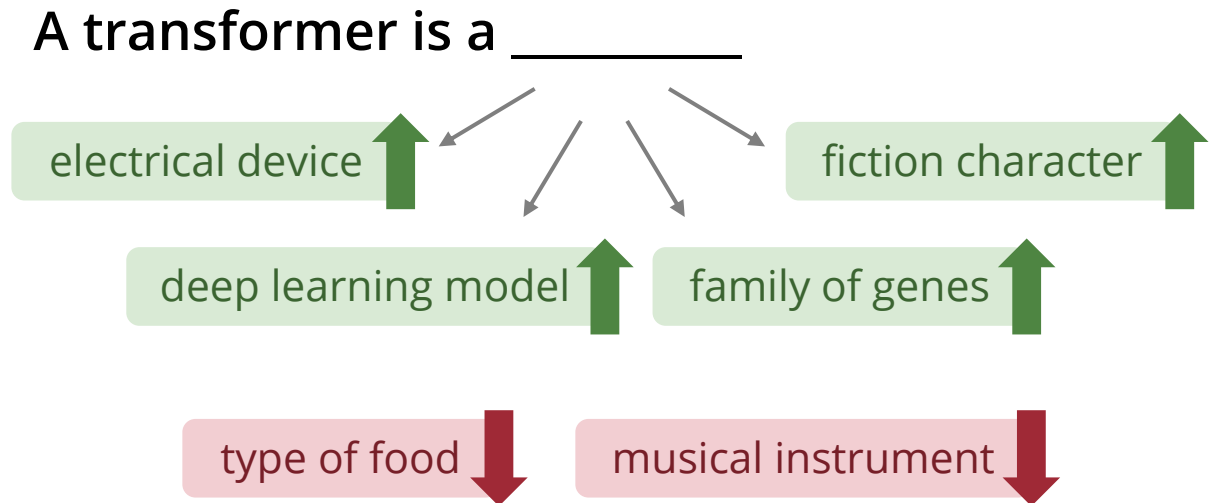
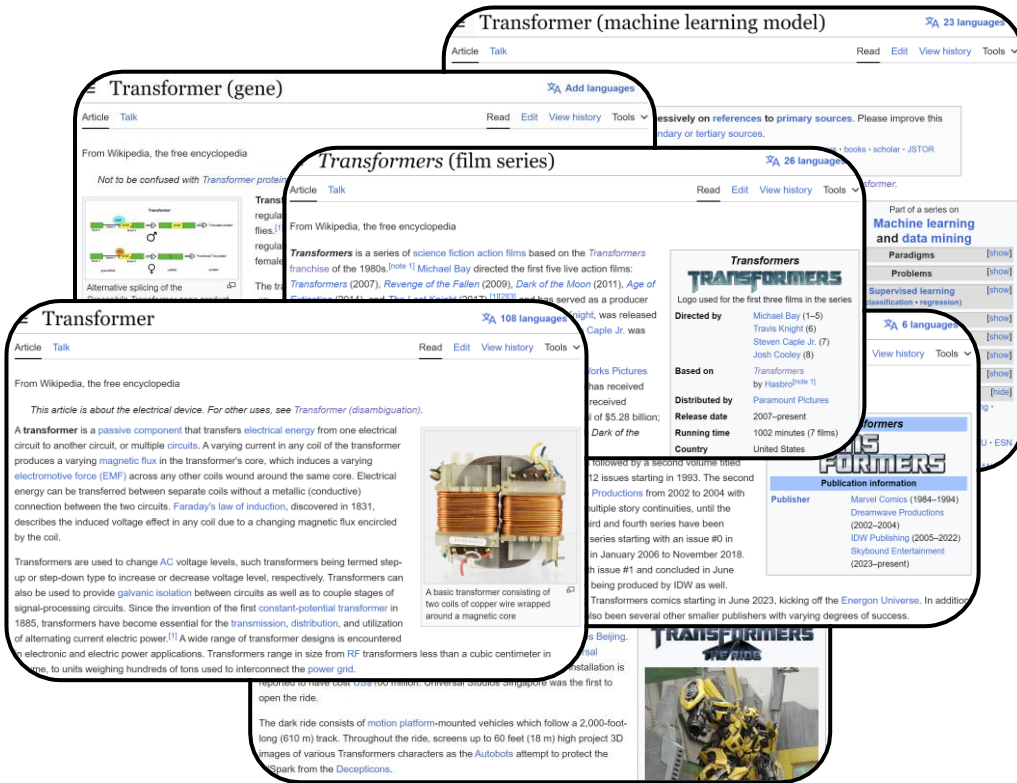
ChatGPT

Word-by-word generation

AI in music is cool because it can compose original pieces, provide personalized recommendations, automate music production tasks, enhance creativity for artists, enable interactive performances, analyze music trends, and even create virtual artists or bands, expanding the possibilities in music creation and enjoyment.

Language Models

- Predicting the next word given the past sequence of words



Language Models (Mathematically)

- A class of machine learning models that **learn** the next word probability

$$P(x_i \mid x_1, x_2, \dots, x_{i-1})$$

Next word Previous words

$P(\text{electrical} \mid \text{A transformer is a})$	↑
$P(\text{character} \mid \text{A transformer is a})$	↑
$P(\text{gene} \mid \text{A transformer is a})$	↑
$P(\text{model} \mid \text{A transformer is a})$	↑
$P(\text{food} \mid \text{A transformer is a})$	↓
$P(\text{musical} \mid \text{A transformer is a})$	↓

Language Models – Generation

- How do we **generate** a new sentence using a trained language model?

A transformer is a

→ Model → deep

A transformer is a deep

→ Model → learning

A transformer is a deep learning

→ Model → model

A transformer is a deep learning model

→ Model → introduced

A transformer is a deep learning model introduced

→ Model → in

A transformer is a deep learning model introduced in

→ Model → 2017

Designing a Machine-readable Music Language

- How can we “represent” music in a way that machines understand?



What is this song in ABC notation?

```
CCGG | AAG2 | FFEE | DDC2 : |  
| : GGFF | EED2 | GGFF | EED2 |  
CCGG | AAG2 | FFEE | DDC2 : |
```

Twinkle, twinkle, little star!

An Example of ABC Notation

Ah! vous dirai-je, maman
(Twinkle, twinkle, little star)

anon. (France)

♩ = 120

Metadata

```
X:571
T:Ah! vous dirai-je, maman
T:(Twinkle, twinkle, little star)
C:anon.
O:France
R:Nursery song
M:C Meter
L:1/4 Unit note length (temporal resolution)
Q:120 Tempo
K:C Key
CCGG|AAG2|FFEE|DDC2:|
|:GGFF|EED2|GGFF|EED2|
CCGG|AAG2|FFEE|DDC2:|
```

ChatGPT can Compose Songs in ABC Notation!

You
Write a cheerful folk song using ABC notation

ChatGPT
Certainly! Here's a cheerful folk song in ABC notation:

```
vbnet Copy code  
X:1  
T:Sunshine on the Meadow  
M:4/4  
K:C  
G2 G2 E2 E2 | F2 F2 D4 | E2 E2 G2 G2 | A4 G4 |  
G2 G2 E2 E2 | F2 F2 D4 | E2 E2 G2 G2 | C4 E4 |  
G2 G2 E2 E2 | F2 F2 D4 | E2 E2 G2 G2 | A4 G4 |  
G2 G2 E2 E2 | F2 F2 D4 | G4 F4 | E4 D4 | C4 z4 |  
G2 G2 E2 E2 | F2 F2 D4 | E2 E2 G2 G2 | A4 G4 |  
G2 G2 E2 E2 | F2 F2 D4 | E2 E2 G2 G2 | C4 E4 |  
G2 G2 E2 E2 | F2 F2 D4 | E2 E2 G2 G2 | A4 G4 |  
G2 G2 E2 E2 | F2 F2 D4 | G4 F4 | E4 D4 | C4 z4 |
```

Feel free to play around with the tempo and instrumentation to give it your own unique style!

chat.openai.com

Sunshine on the Meadow



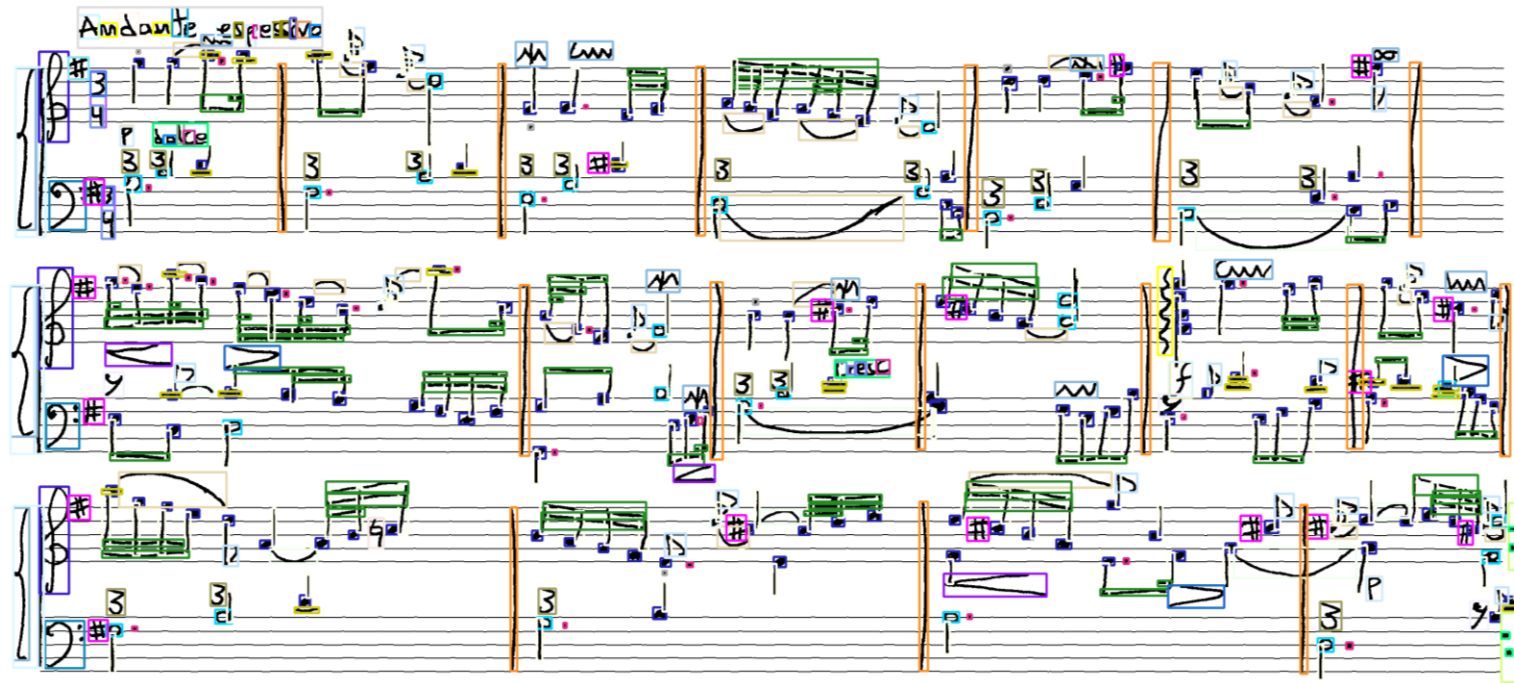
A.I. Duet (Mann et al, 2016)



youtu.be/0ZE1bfPtvZo
experiments.withgoogle.com/ai/ai-duet/view

Why not using sheet music “scans” directly?

- Machines still have a hard time reading scanned sheet music
- A task known as **optical music recognition (OMR)**



(Source: Pacha et al.)

More Examples

Piano Genie (Donahue et al., 2018)

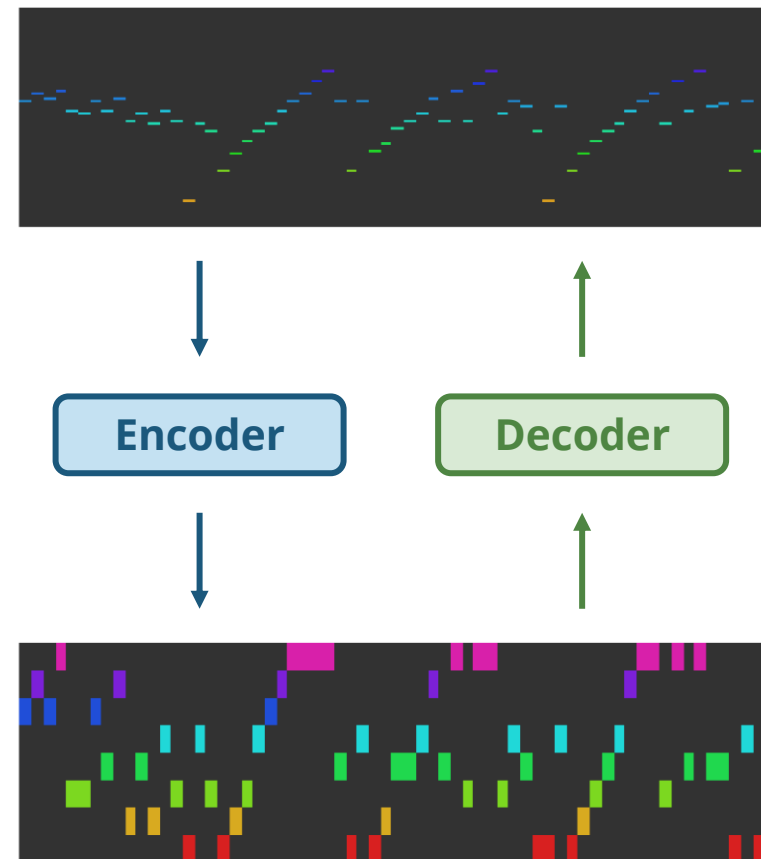
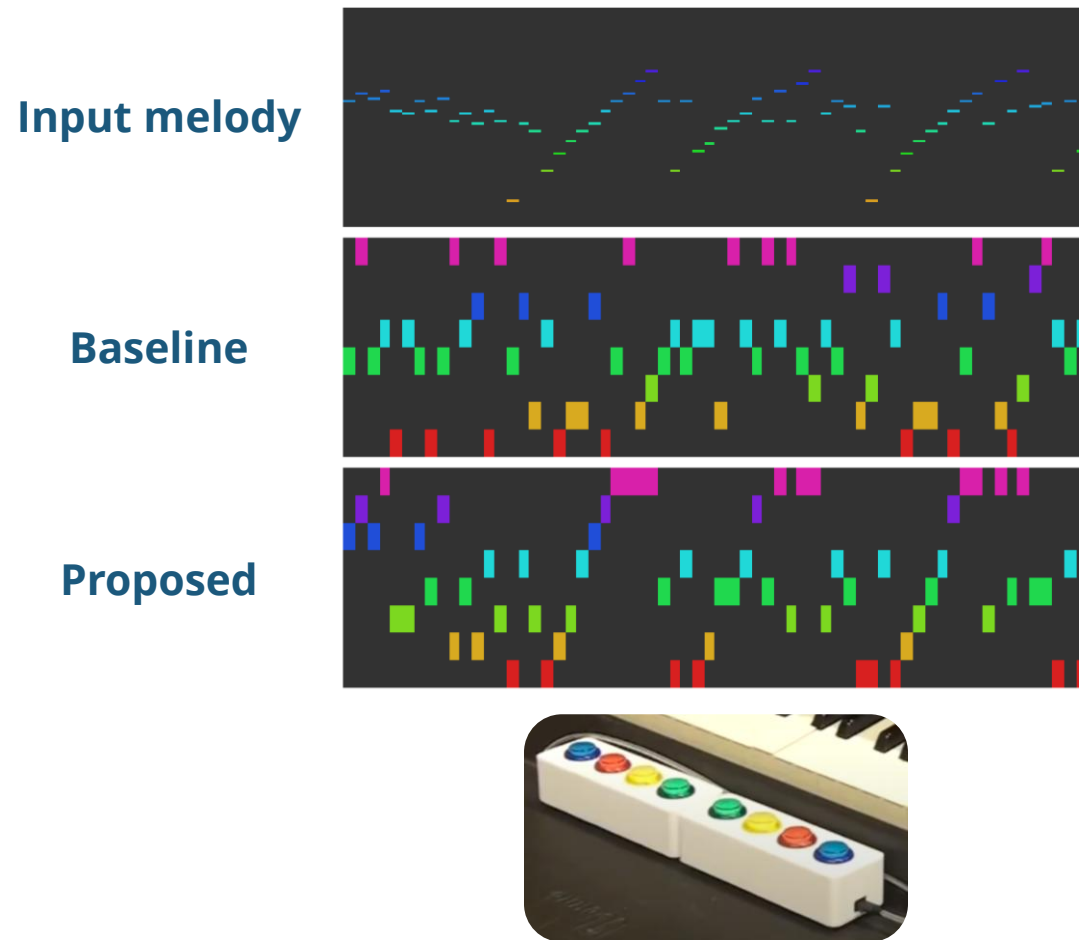


youtu.be/YRb0XAnUplk & magenta.tensorflow.org/pianogenie

piano-genie.glitch.me/

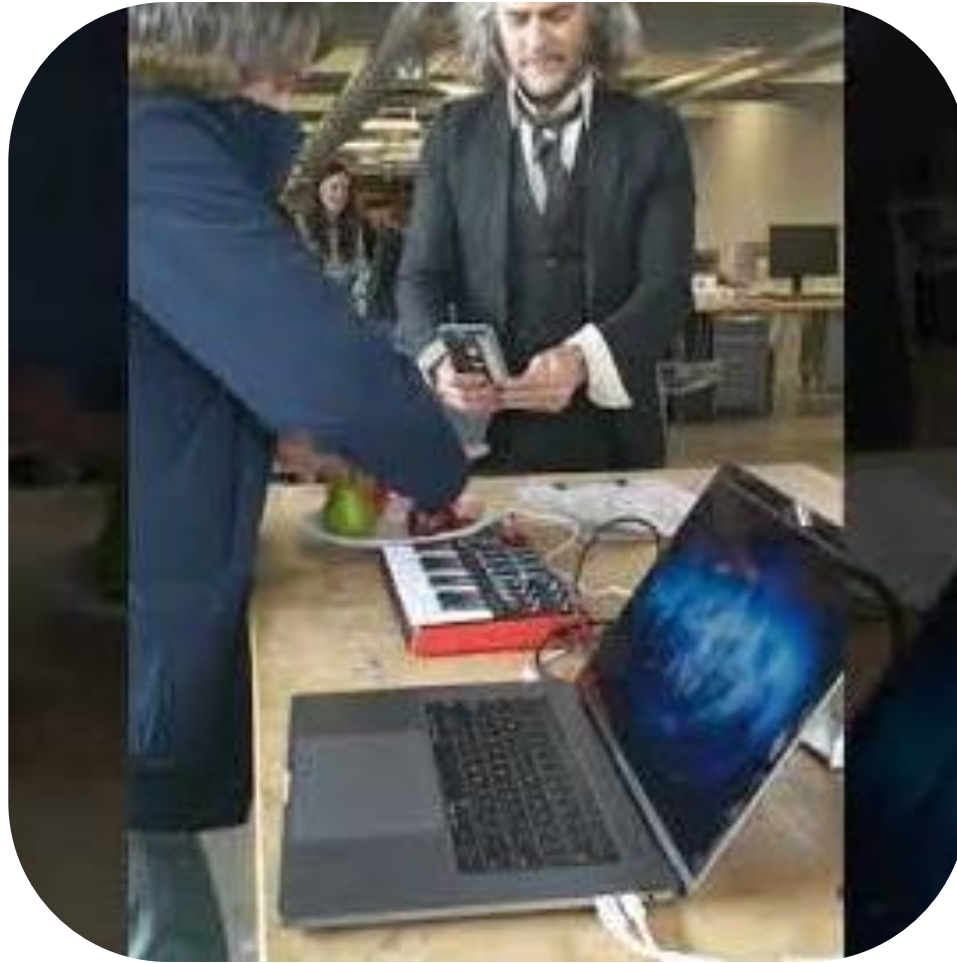


Piano Genie (Donahue et al., 2018)



(Source: Donahue et al., 2019)

Fruit Genie (2019)



youtu.be/HoVs4kC68no

Fruit Genie Live (2019)



youtu.be/L4wvXrPmlkU

JS Bach Doodle (2019)



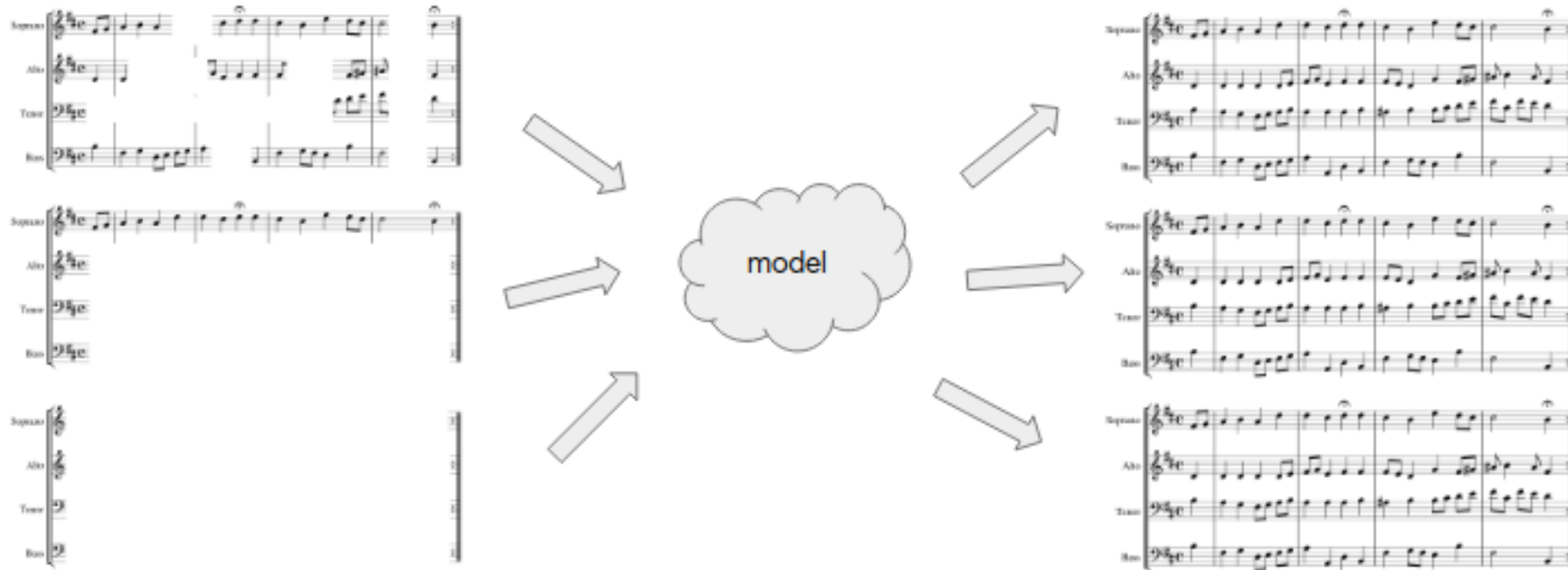
youtu.be/XBfYPp6KF2g & magenta.tensorflow.org/coconet

[doodles.google/doodle/
celebrating-johann-
sebastian-bach/](https://doodles.google/doodle/celebrating-johann-sebastian-bach/)



Coconet (Huang et al., 2017)

- Based on Orderless NADE (Uribe et al., 2014)



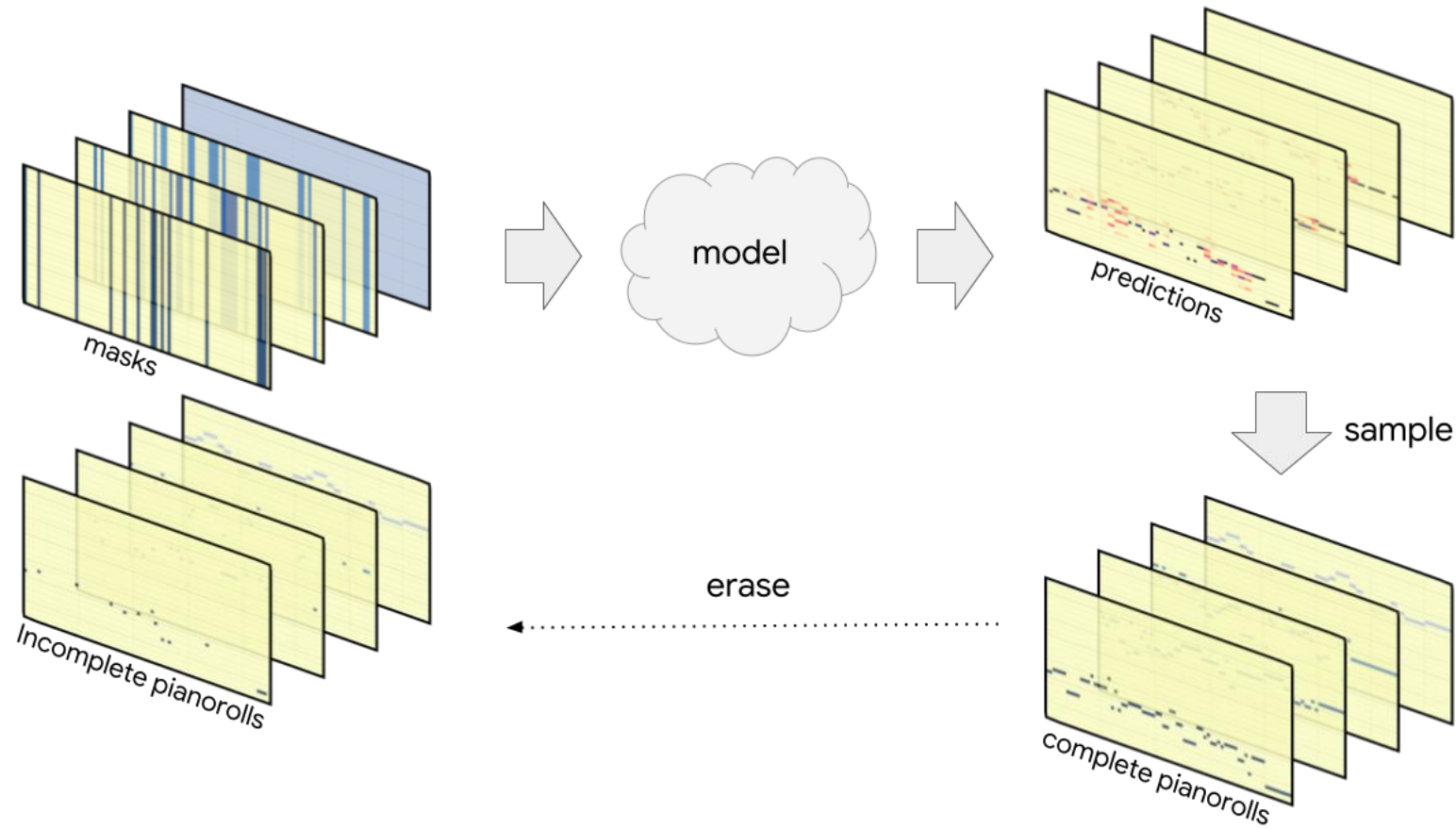
(Source: Huang et al., 2019)

Benigno Uribe, Iain Murray, and Hugo Larochelle, "A Deep and Tractable Density Estimator," *ICML*, 2014.

Cheng-Zhi Anna Huang, Tim Cooijmans, Adam Roberts, Aaron Courville, and Douglas Eck, "Counterpoint by Convolution," *ISMIR*, 2017.

Cheng-Zhi Anna Huang, Tim Cooijmans, Monica Dinulescu, Adam Roberts, and Curtis Hawthorne, "Coconet: the ML model behind today's Bach Doodle," *Magenta Blog*, 2019.

Coconet (Huang et al., 2017)



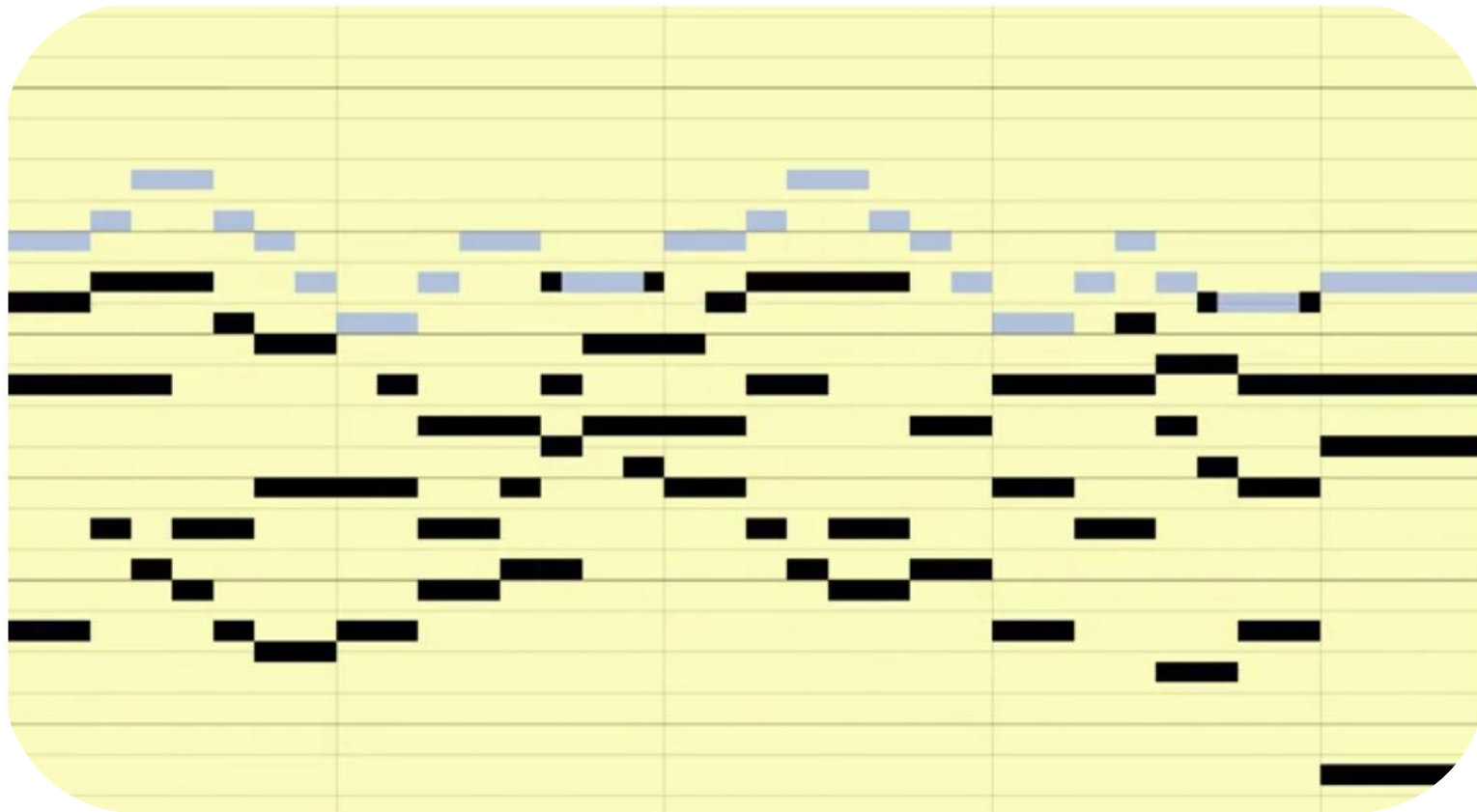
(Source: Huang et al., 2019)

Coconet (Huang et al., 2017)



(Source: Huang et al., 2017)

Coconet (Huang et al., 2017)



(Source: Huang et al., 2017)

RAVE (2022)

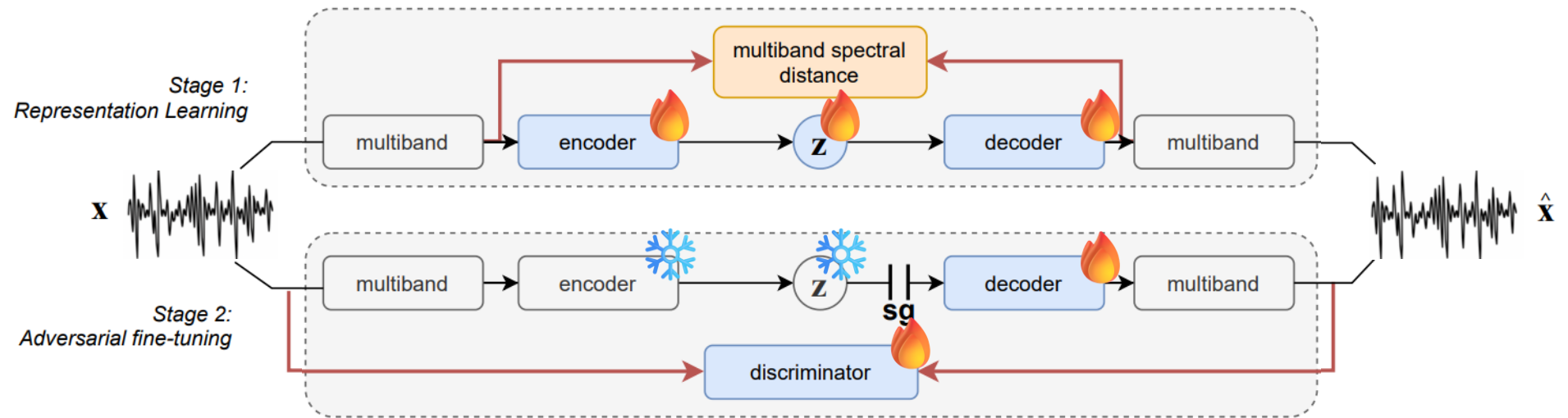


youtu.be/dMZs04TzxUI

github.com/acids-ircam/RAVE



RAVE (2022)



RAVE (2022)



youtu.be/jAIRf4nGgYI

github.com/acids-ircam/RAVE

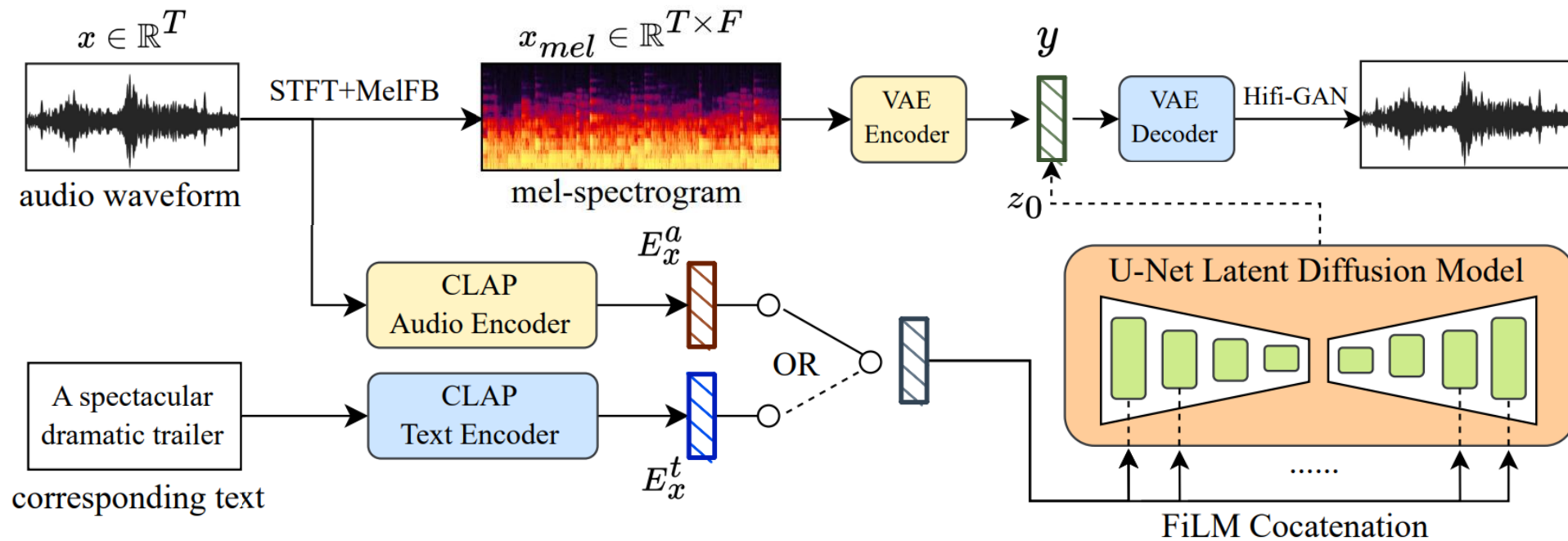


MusicLDM (Chen et al., 2023)



youtu.be/DALv7ea6cv0

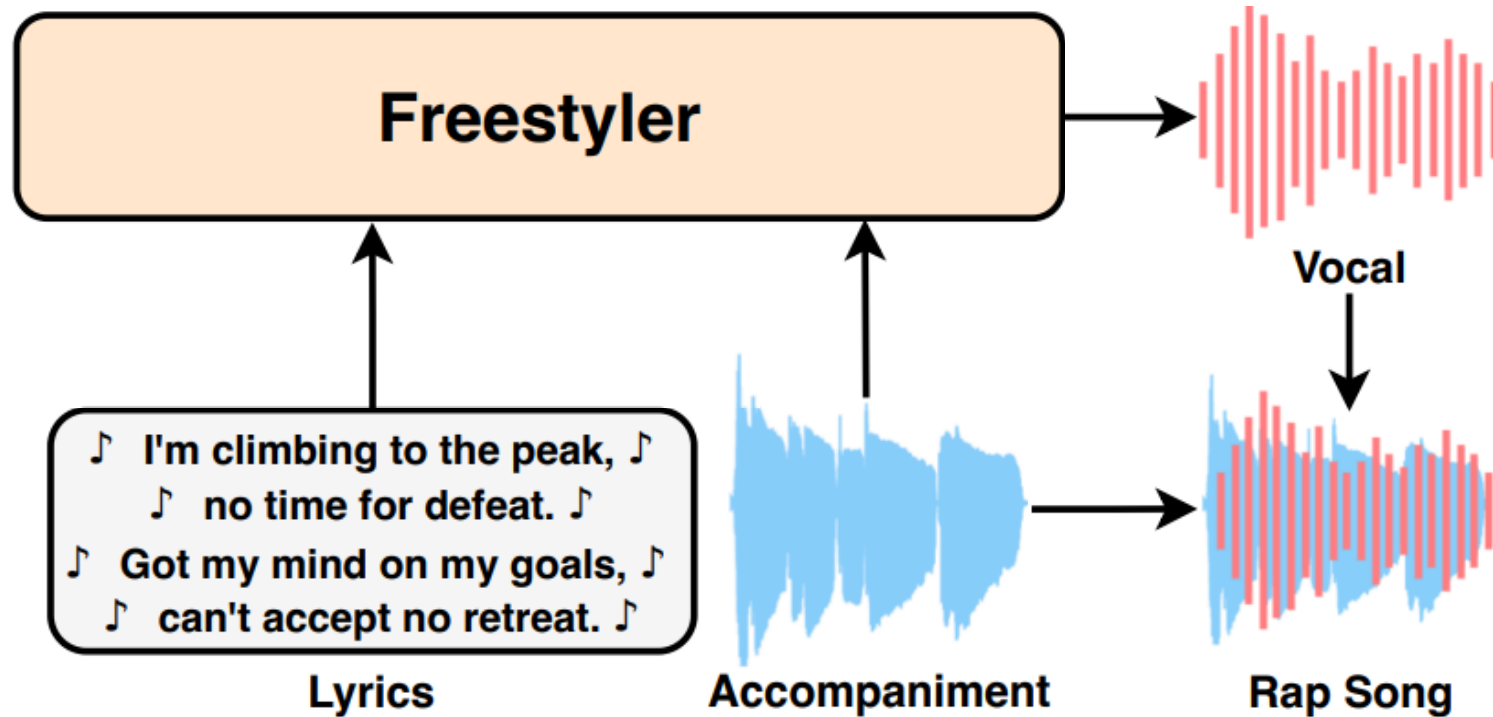
MusicLDM (Chen et al., 2023)



(Source: Ke et al., 2023)

musicldm.github.io

Freestyler (Ning et al., 2025)



nzqian.github.io/Freestyler