



# artificial intelligence and music

an overview

alexander lerch

## ■ education

- Electrical Engineering (Technical University Berlin)
- Tonmeister (music production, University of Arts Berlin)

## ■ professional

- Associate Dean for Research & Creative Practice and Associate Professor at the **School of Music, Georgia Institute of Technology**
- 2000-2013: CEO at **zplane.development**

## ■ background

- music information retrieval (20+ years)
- audio algorithm design (20+ years)
- commercial music software development (10+ years)
- entrepreneurship (10+ years)



# introduction

## artificial intelligence

### ■ artificial intelligence

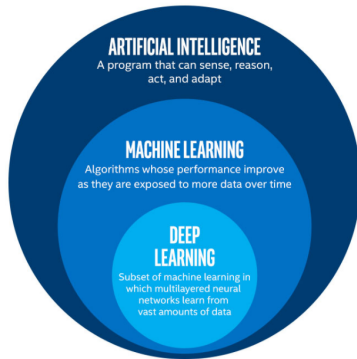
- unclear definition: everything that is perceived to act intelligently
- changes over time

### ■ machine learning

- data-driven: algorithm is more agnostic to task and is parametrized through training with data

### ■ deep learning

- deep neural networks are 'the algorithm'



# machine learning

## importance of data



**machine learning:** generic algorithm mapping an input to an output

- mapping function is learned from patterns and characteristics **from data**
- ⇒ model **success largely depends on training data**

### ■ technical challenges concerning data

- *imbalance & bias* (data distribution is skewed, biased)
- *diversity & representativeness* (data does not reflect target distribution)
- *subjectivity* of annotations
- *noisiness* (bad quality, bad annotations, unrelated data points, ...)



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# introduction

## machine learning categorization based on output types

- **classification:**

input data is categorized into pre-determined output categories (e.g., music genres)

- **clustering:**

input data is grouped into prevalent clusters (no pre-determined categories)

- **regression:**

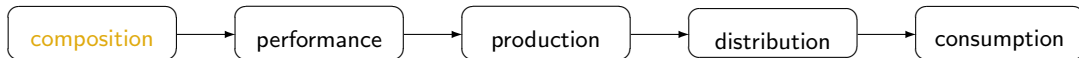
predict a numerical value based on an input (e.g., estimate how danceable a piece of music is)

- **generation:**

input is control data, output is target data (e.g., a composition)

# introduction

## chain of musical communication



### ■ creation of musical ideas (“score”)

- defines style and idea

### ■ realization of musical ideas into acoustical rendition

- interpretation, modification, addition, and dismissal of score information
- unique acoustic representation of score

### ■ recording, mixing, and editing (in case of record media)

- editing and splicing of recorded data; timbre, equalization choices
- not separable from performance in a recording

### ■ distribution & listening

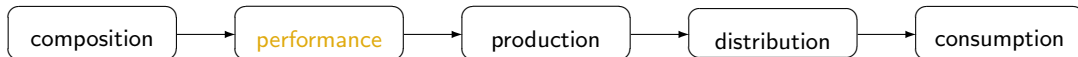
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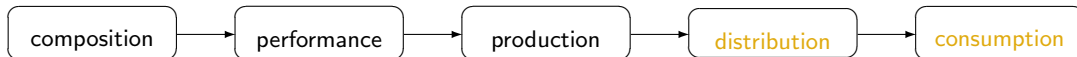
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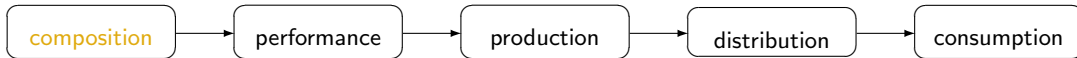
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# introduction

## musical communication and AI



### ■ composition

- intelligent assistance, e.g., ideas, auto-arrangements
- automatic composition

### ■ performance

- interactive music education systems
- generation of 'human' performance

### ■ production

- auto-edit and auto-mix

### ■ distribution

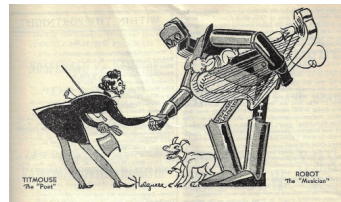
- match music style and consumer

### ■ consumption

- intelligent music discovery & adaptable music

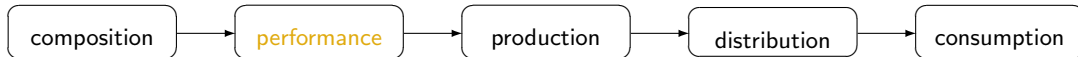
### ■ example:

DeepBach



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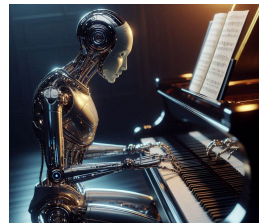
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### ■ example:

Hatsune Miku   
Shimon 



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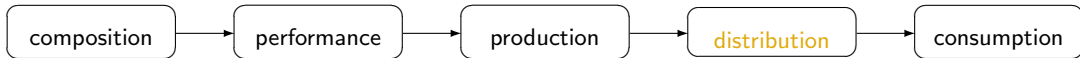
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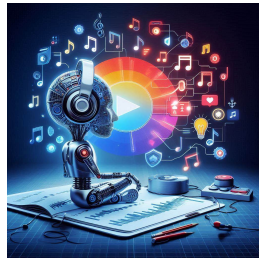
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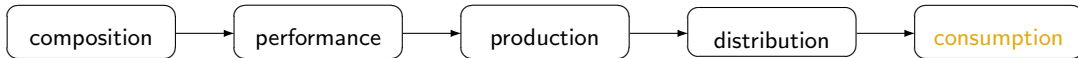
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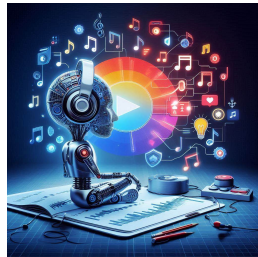
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# challenges

## challenges in (music) ai 1/2

### ■ ethical considerations

- training data (copyright, privacy)
- responsible system usage
- addressing bias

### ■ economic impact

- understanding the implications for music professionals
- adapting to new business models and revenue streams

### ■ quality and authenticity

- plagiarism
- balancing novelty and predictability/homogeneity
- hallucination



# challenges

## challenges in (music) ai 2/2

### ■ sustainability

- energy consumption

### ■ ownership and copyright

- protecting rights of content creators while democratizing the creative process
- navigating complex copyright laws
- accountability & liability

### ■ regulatory framework

- fair use terms
- transparency and interpretability
- labeling of ai-created content
- public perception



# thank you!

## links

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music informatics group: [musicinformatics.gatech.edu](http://musicinformatics.gatech.edu)

