Machine Learning, Advanced Topics, 6th Seminar

Application of Modern Machine Learning in Music

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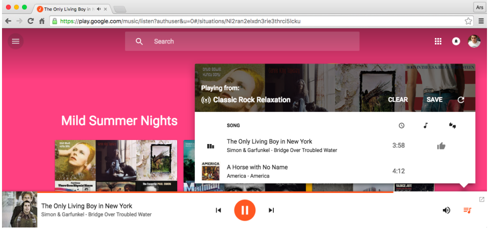
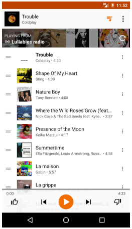
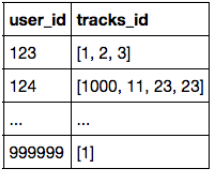
How to apply ML for Music Data to get Money?

- You are working in a big music service as a data scientist

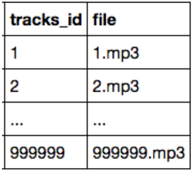

The Only Living Boy in N
https://play.google.com/music/listen?authuser&u=0#/situations/NI2ran2elxdn3rie3thrci5lcku
Search
Mild Summer Nights
Playing from:
Classic Rock Relaxation
CLEAR
SAVE
SONG
The Only Living Boy in New York
Simon & Garfunkel - Bridge Over Troubled Water
3:58
A Horse with No Name
America - America
4:12
The Only Living Boy in New York
Simon & Garfunkel - Bridge Over Troubled Water



- In this service there's a lot of music data – mp3 files



user_id	tracks_id
123	[1, 2, 3]
124	[1000, 11, 23, 23]
...	...
999999	[1]

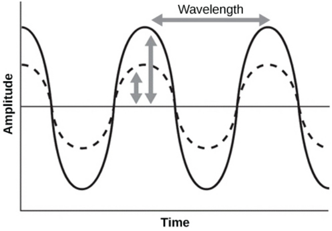


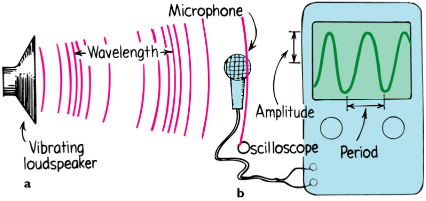
tracks_id	file
1	1.mp3
2	2.mp3
...	...
999999	999999.mp3

- You were given the task – make money using this data

What is the sound?

- Waves and Recording





- How to store sound? Store as huge array with samples.

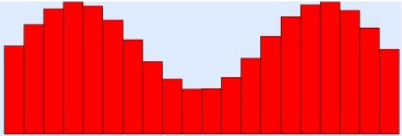


Fig 4: 100 Samples per Second (100 Hz)

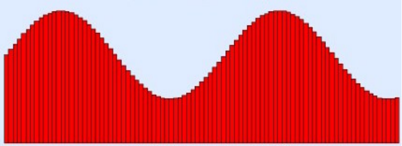


Fig 6: 400 Samples per Second (400 Hz)

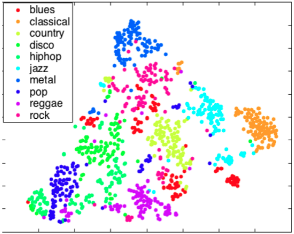
- $[1, 2, 3, 5, 3, 2, 1, 1, 1, 1, 2, 3, 5, 3, 2]$, Usually 16 000 float per second

Finding similar tracks

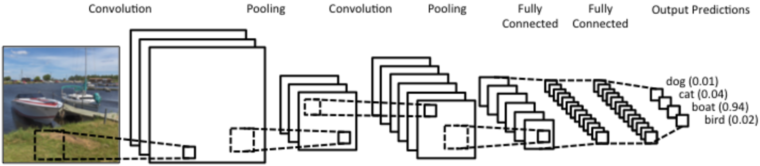
- How to find similar tracks using ML methods?

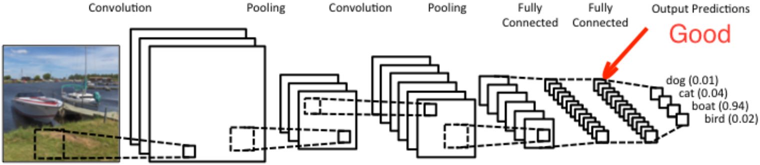
  Data: 30 sec * 16000 features, 10^7 items

  Task: define function of $similarity(track_i, track_j)$
- Why ordinary methods are so bad?
  - shift and noise tolerance, over-fitting
- Metric approach is still good idea, if we have a high level description
- Good representation of music track
  - Human – guitar, rock, Queen, 1997, UK, 3 min., ...
  - Computer – good small vector of numbers



Get good representation using Convolutional Neural Nets



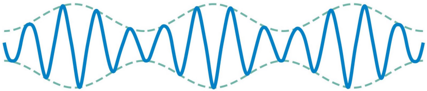


Issue

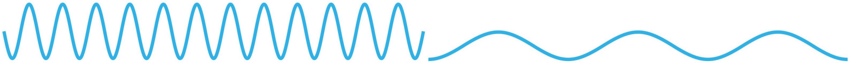
We need to get picture!

What is the sound? (2)

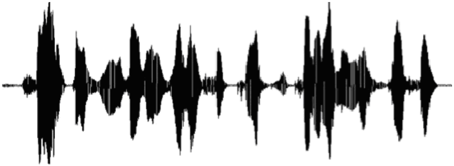
We have some wave



lets represent this wave as a sum of two waves

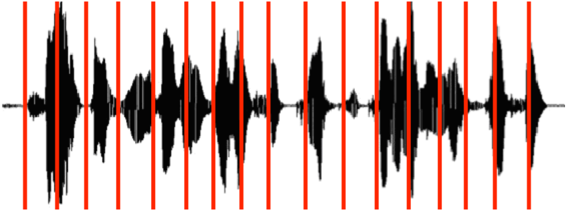


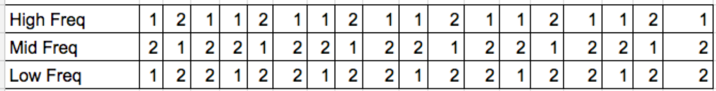
sound is a combination of big waves range



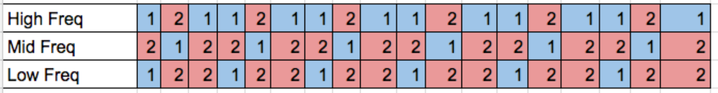
What have we lost in our representation?

Getting the Frequency

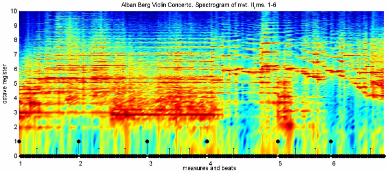




High Freq	1	2	1	1	2	1	1	2	1	1	2	1	1	2	1	1	2	1
Mid Freq	2	1	2	2	1	2	2	1	2	2	1	2	2	1	2	2	1	2
Low Freq	1	2	2	1	2	2	1	2	2	1	2	2	1	2	2	1	2	2

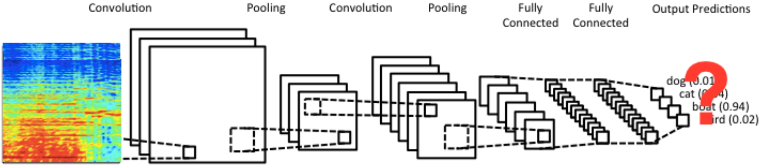


High Freq	1	2	1	1	2	1	1	2	1	1	2	1	1	2	1	1	2	1
Mid Freq	2	1	2	2	1	2	2	1	2	2	1	2	2	1	2	2	1	2
Low Freq	1	2	2	1	2	2	1	2	2	1	2	2	1	2	2	1	2	2



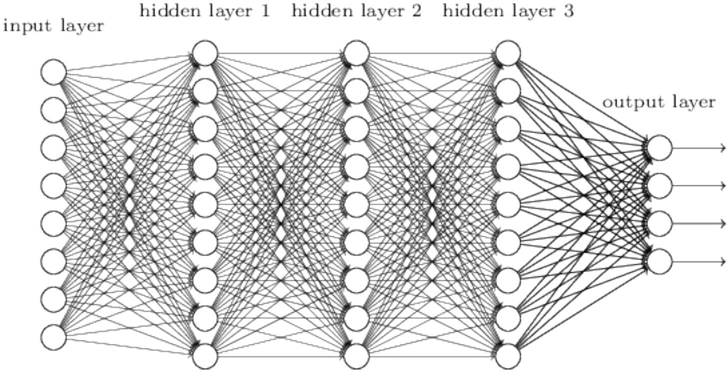
We need to train Neural Nets, but how can we do that?!

- But how can we train the nets on music?
- Let's invent a fake machine learning task



  - genre classification
  - artist classification
  - rating prediction
  - .....

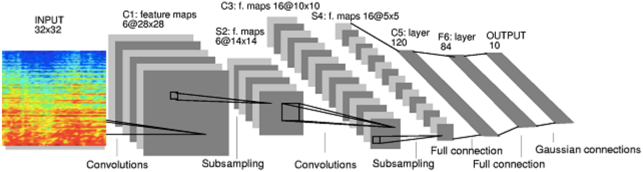
Fully connected NN



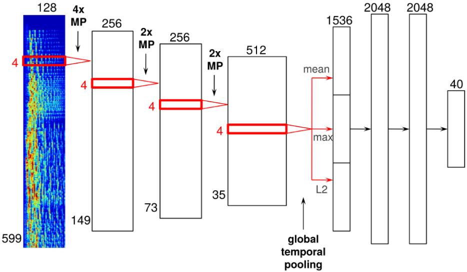
- too many parameters – number of weights $= 16^4 * neurons + ...$
- It doesn't work =(

Convolution NN

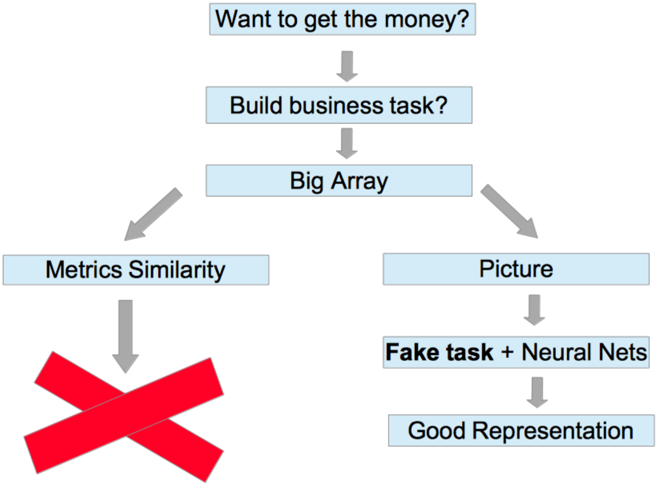
Let's invent some convolution architecture



important detail – pooling of time axis [Spotify Deep Learning]



General scheme, what did we do?



How to measure quality of good representation?

What do we have?

- We have had represented each track as a vector
- But maybe our solution is too bad, how can we understand that?
- How to test "good representation"?

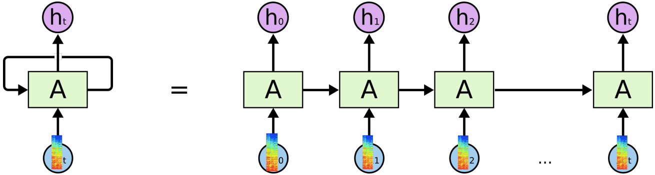
Let's invent the metrics:

- using assessors
- recommendation quality
- using vectors to classify another labels

Let's adapt to Different length and Additional information

How to use any length?:

1. Average prediction for many patches
2. Recurrent neural net on many patches



3. Whatever?

How to take account?:

1. Lyrics

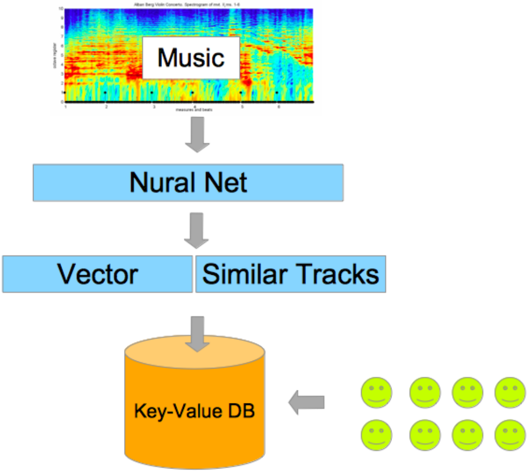
$$\text{Concat(TextRNN, Conv)} \rightarrow \text{FC} \rightarrow \text{Cost}$$

2. Genre, Artist, Year – embedding too, multi-cost task
3. ....

Technical details

How to build fast system for million users?

1. pre-compute vectors and tracks simulation
2. fast key-value storage



End

Current Status of your Field!

Thanks for your attention!