Neural Nets for Music

Workshop Day 1

David Goedicke and Prof. Wendy Ju

What will we do this week?

- Set-up and run Audio Detection networks.
- How to train your network and manage data.
- How to implementing interactivity with your neural net.
- We will present a run-down on uses of neural networks used with audio.

Provisional Workshop Schedule

Time	Monday	Tuesday	Wednesday	Thursday	Friday
9am	Introductions	Review/Q&A	Review/Q&A	Review/Q&A	Review/Q&A
10-noon	Neural Nets	Collecting & Analyzing Sounds	Designing Interaction	Applications of AI for Sound	Project time
noon-1:30	Lunch	Lunch	Lunch	Lunch	Lunch
1:30-3:30	Lab Setup	Home Sounds Dataset Activity	Wizard Lab	Final Project	Project Time/ Show and Tell
3:30-5pm	Cats & Dogs Lab	Home Sounds Dataset Activity	Plotting Final Project	Final Project	Happy Hour

Scandalously short introduction to machine learning

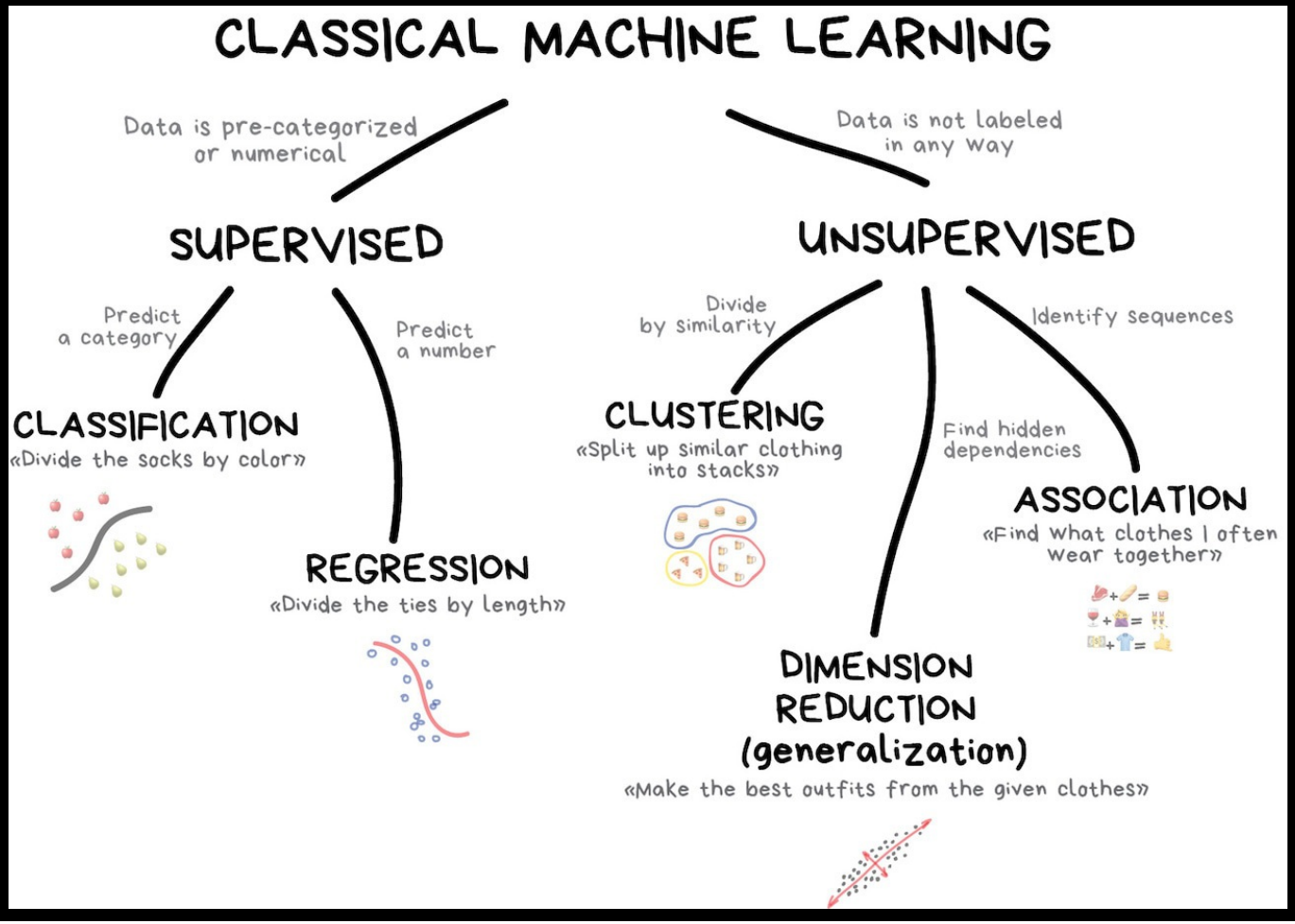
Using cartoons by Vasily Zubarev
(thanks Vas3k!)

David Goedicke and Wendy Ju

Vocabulary

- Data: images, sound, information
- Features: parameters or variables about the data
- Algorithms: Processes or sets of rules to be followed

Classical Machine Learning



Traditional ML for Audio

- Involves looking for/labelling/devising algorithms to identify key features which can, say, separate cat from dog sounds.
- The problem with this is that it isn't easy to take the solution you've made to classify dogs and cats and apply it to, say, ducks and chickens, or planes vs. cars.

The biggest lesson that can be read from 70 years of AI research is that general methods that leverage computation are ultimately the most effective,
and by a large margin.

-Rich Sutton, Bitter Lesson

Moore's Law, predicted

Cramming More Components onto Integrated Circuits

GORDON E. MOORE, LIFE FELLOW, IEEE

With unit cost falling as the number of components per circuit rises, by 1975 economics may dictate squeezing as many as 65 000 components on a single silicon chip.

The future of integrated electronics is the future of electronics itself. The advantages of integration will bring about a proliferation of electronics, pushing this science into many new areas.

Integrated circuits will lead to such wonders as home computers—or at least terminals connected to a central computer—automatic controls for automobiles, and personal portable communications equipment. The electronic wristwatch needs only a display to be feasible today.

But the biggest potential lies in the production of large systems. In telephone communications, integrated circuits in digital filters will separate channels on multiplex equipment. Integrated circuits will also switch telephone circuits and perform data processing.

Computers will be more powerful, and will be organized in completely different ways. For example, memories built of integrated electronics may be distributed throughout the machine instead of being concentrated in a central unit. In addition, the improved reliability made possible by integrated circuits will allow the construction of larger processing units. Machines similar to those in existence today will be built at lower costs and with faster turnaround.

I. Present and Future

By integrated electronics, I mean all the various technologies which are referred to as microelectronics today as well as any additional ones that result in electronics functions supplied to the user as irreducible units. These technologies were first investigated in the late 1950's. The object was to miniaturize electronics equipment to include

Each approach evolved rapidly and converged so that each borrowed techniques from another. Many researchers believe the way of the future to be a combination of the various approaches.

The advocates of semiconductor integrated circuitry are already using the improved characteristics of thin-film resistors by applying such films directly to an active semiconductor substrate. Those advocating a technology based upon films are developing sophisticated techniques for the attachment of active semiconductor devices to the passive film arrays.

Both approaches have worked well and are being used in equipment today.

II. The Establishment

Integrated electronics is established today. Its techniques are almost mandatory for new military systems, since the reliability, size, and weight required by some of them is achievable only with integration. Such programs as Apollo, for manned moon flight, have demonstrated the reliability of integrated electronics by showing that complete circuit functions are as free from failure as the best individual transistors.

Most companies in the commercial computer field have machines in design or in early production employing integrated electronics. These machines cost less and perform better than those which use "conventional" electronics.

Instruments of various sorts, especially the rapidly increasing numbers employing digital techniques, are starting to use integration because it cuts costs of both manufacture and design.

The use of linear integrated circuitry is still restricted primarily to the military. Such integrated functions are expensive and not available in the variety required to satisfy a major fraction of linear electronics. But the first applications

Fig. 2.

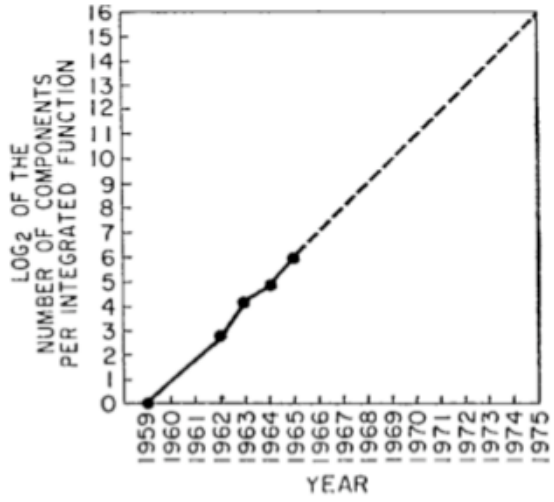
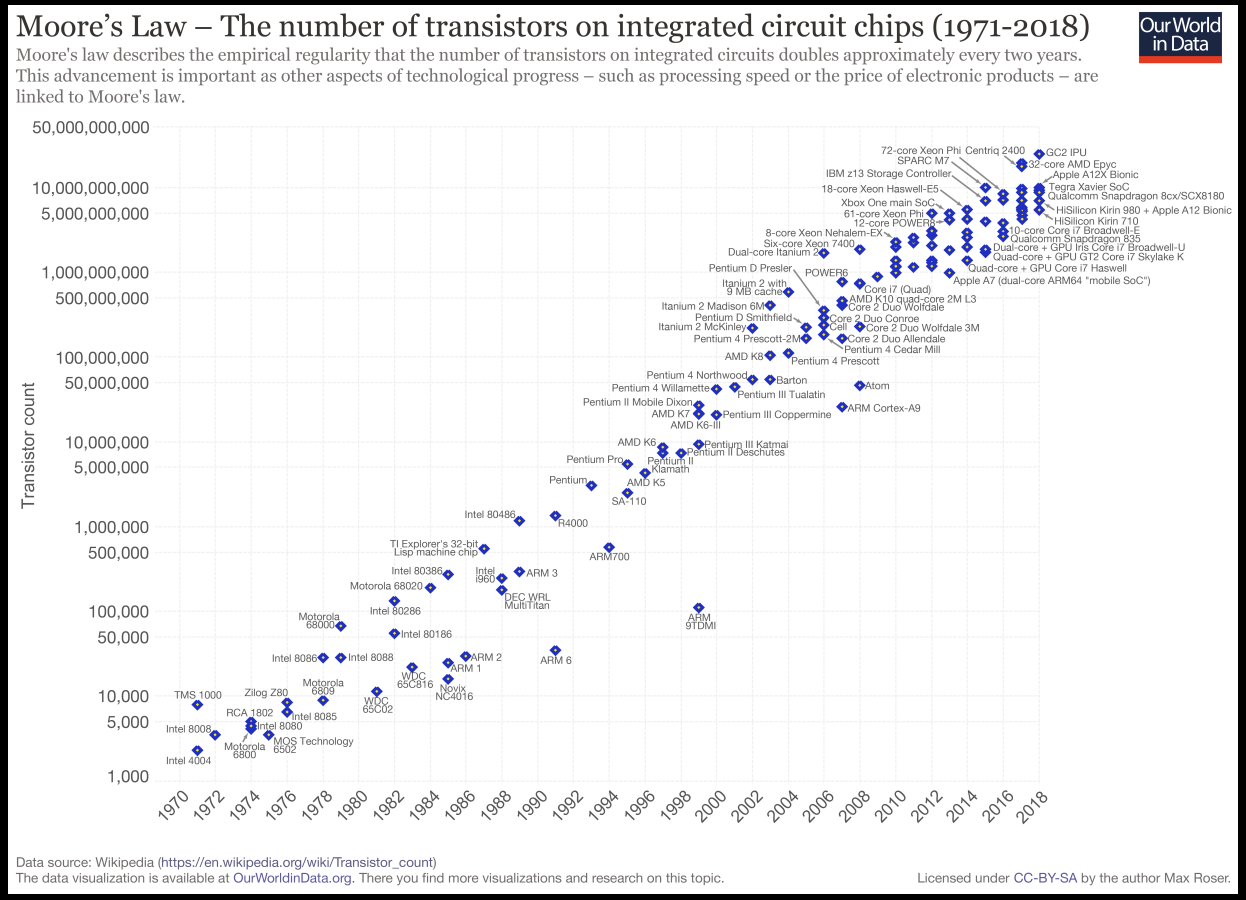


Fig. 3.

Moore, Gordon E. (1965). "Cramming more components onto integrated circuits" (PDF). Electronics Magazine. p. 4. Retrieved 2006-11-11.

Moore’s Law, Actualized



Data source: Wikipedia (https://en.wikipedia.org/wiki/Transistor_count)
The data visualization is available at OurWorldinData.org. There you find more visualizations and research on this topic.

https://en.wikipedia.org/wiki/Moore%27s_law

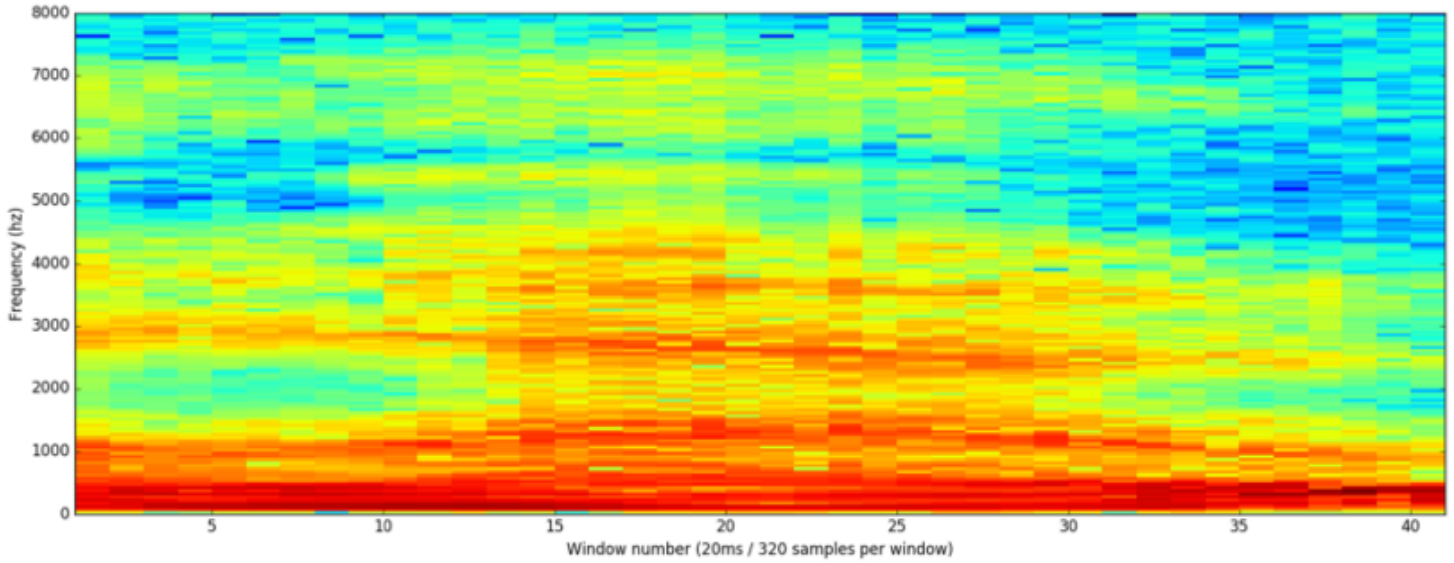
Computer Chess

https://rarehistoricalphotos.com/kasparov-deep-blue-1997/

Alpha Go

https://www.netflix.com/title/80190844

Speech Recognition



The full spectrogram of the "hello" sound clip

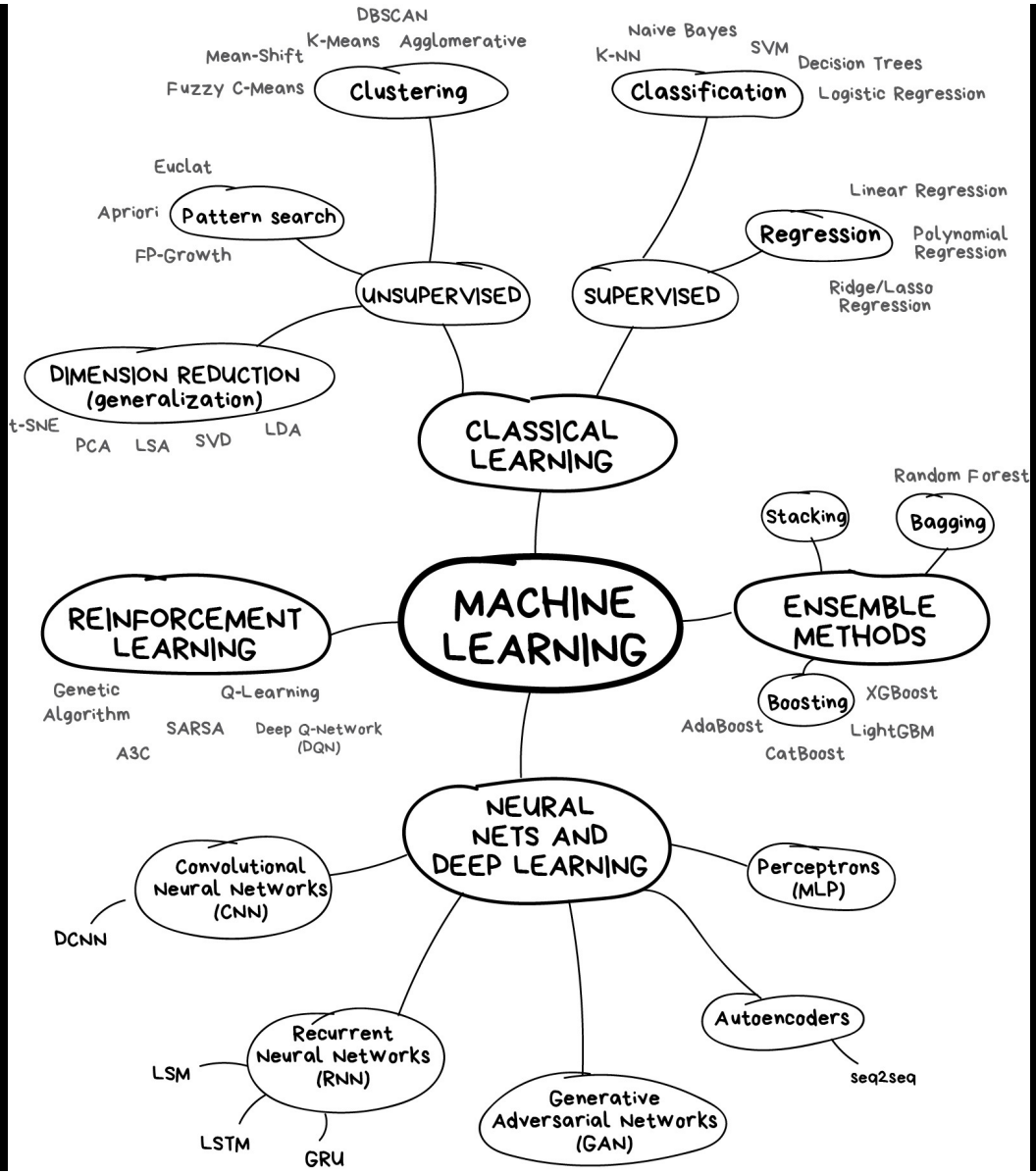
https://medium.com/@ageitgey/machine-learning-is-fun-part-6-how-to-do-speech-recognition-with-deep-learning-28293c162f7a

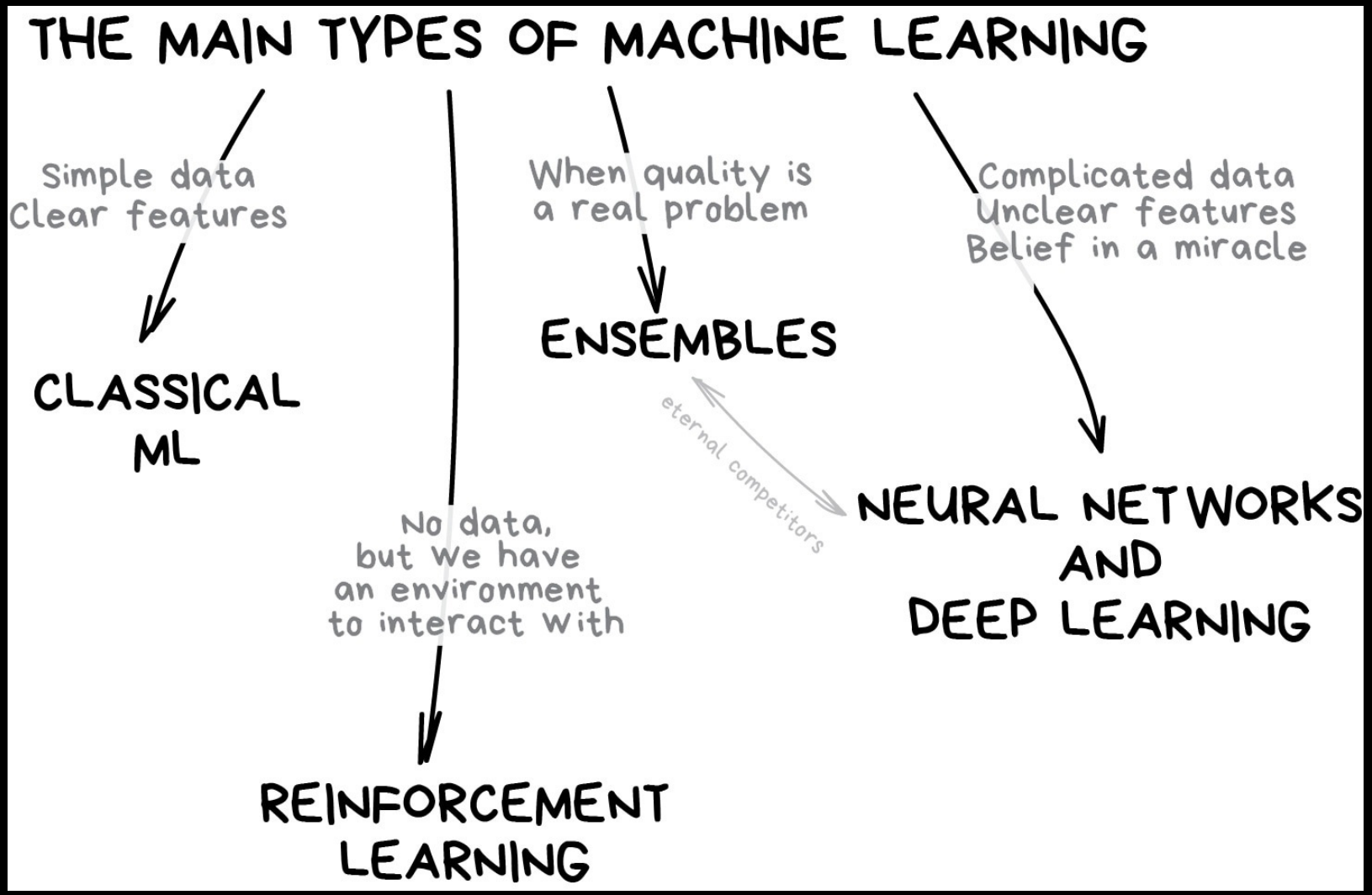
Computer Vision

https://towardsdatascience.com/image-classifier-cats-vs-dogs-with-convolutional-neural-networks-cnns-and-google-colabs-4e9af21ae7a8

The bitter lesson is that:

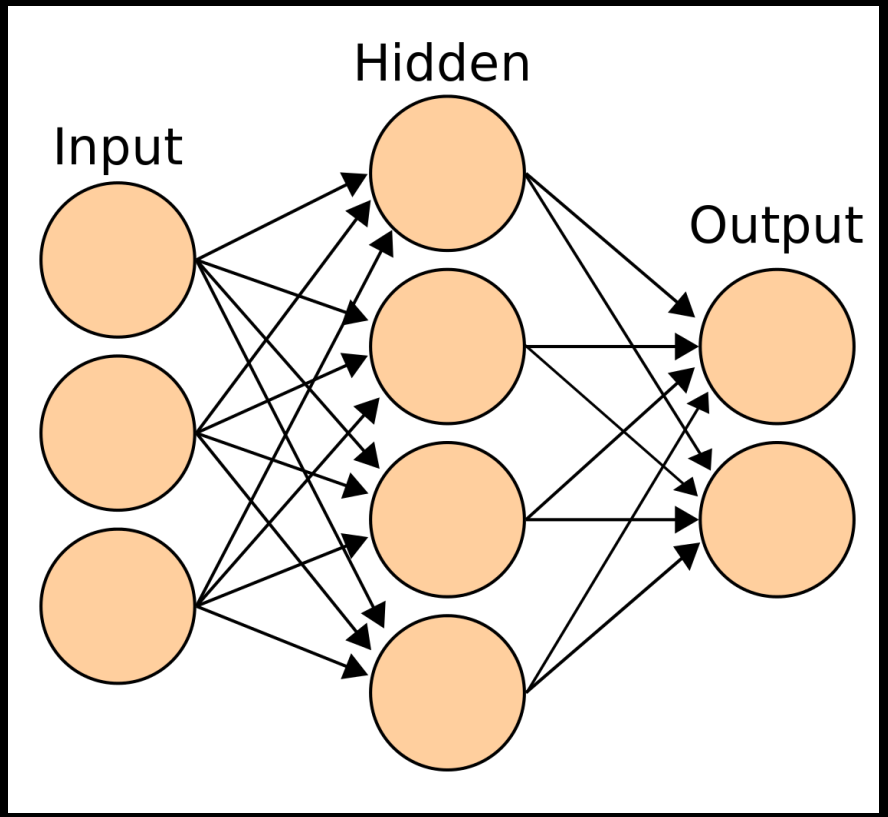
1. AI researchers have often tried to build knowledge into their agents,
2. this always helps in the short term, and is personally satisfying to the researcher, but
3. in the long run it plateaus and even inhibits further progress, and
4. breakthrough progress eventually arrives by an opposing approach based on scaling computation by search and learning.


MACHINE LEARNING
CLASSICAL LEARNING
UNSUPERVISED
SUPERVISED
Clustering
DBSCAN
K-Means
Agglomerative
Mean-Shift
Fuzzy C-Means
Classification
Naive Bayes
K-NN
SVM
Decision Trees
Logistic Regression
Pattern search
Euclat
Apriori
FP-Growth
Regression
Linear Regression
Polynomial Regression
Ridge/Lasso Regression
DIMENSION REDUCTION (generalization)
t-SNE
PCA
LSA
SVD
LDA
REINFORCEMENT LEARNING
Genetic Algorithm
Q-Learning
SARSA
Deep Q-Network (DQN)
A3C
ENSEMBLE METHODS
Stacking
Bagging
Random Forest
Boosting
XGBoost
AdaBoost
LightGBM
CatBoost
NEURAL NETS AND DEEP LEARNING
Convolutional Neural Networks (CNN)
DCNN
Perceptrons (MLP)
Recurrent Neural Networks (RNN)
LSM
LSTM
GRU
Generative Adversarial Networks (GAN)
Autoencoders
seq2seq


THE MAIN TYPES OF MACHINE LEARNING
Simple data
Clear features
CLASSICAL ML
No data,
but we have
an environment
to interact with
REINFORCEMENT LEARNING
When quality is
a real problem
ENSEMBLES
eternal competitors
Complicated data
Unclear features
Belief in a miracle
NEURAL NETWORKS AND DEEP LEARNING

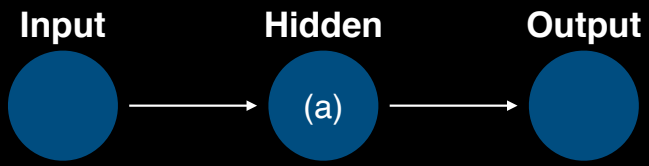
What is a neural net?

A network of connected “neurons” that perform “simple” input on a number input.



How does it learn?

Network:



Data:

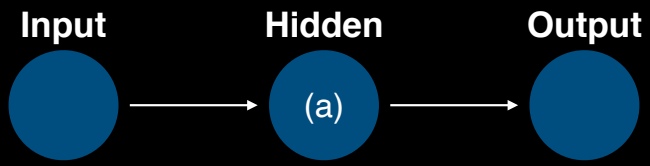
Input	Output
1	0.5
2	1
3	1.5
4	2

How does it learn?

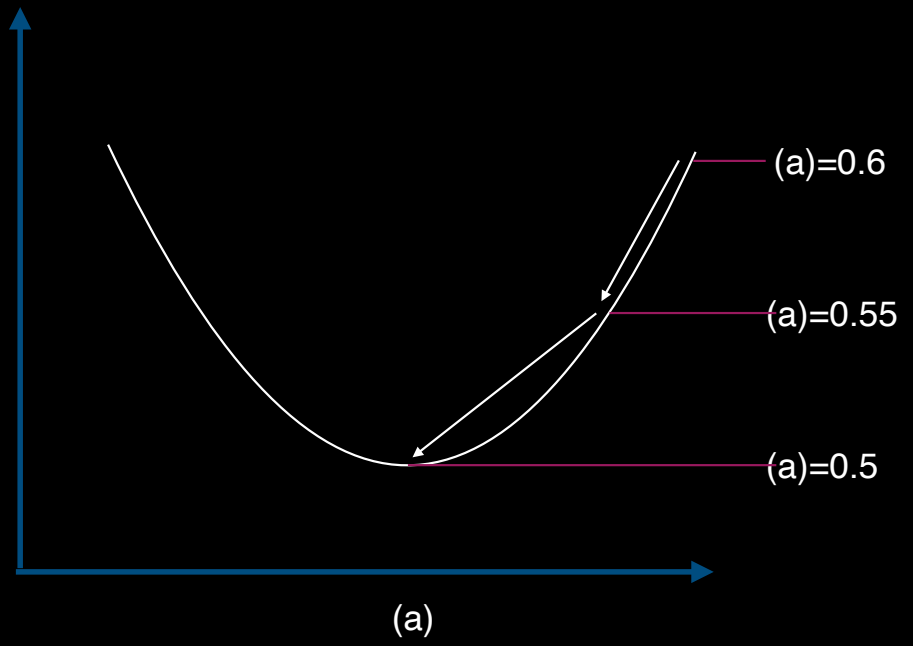
Input	Output	(a)	*Est.Out*	*Error*
1	0.5	0.6	0.6	0.1
2	1	0.6	1.2	0.2
3	1.5	0.6	1.8	0.3
4	2	0.6	2.4	0.4
			Loss:	0.25

How does it learn?

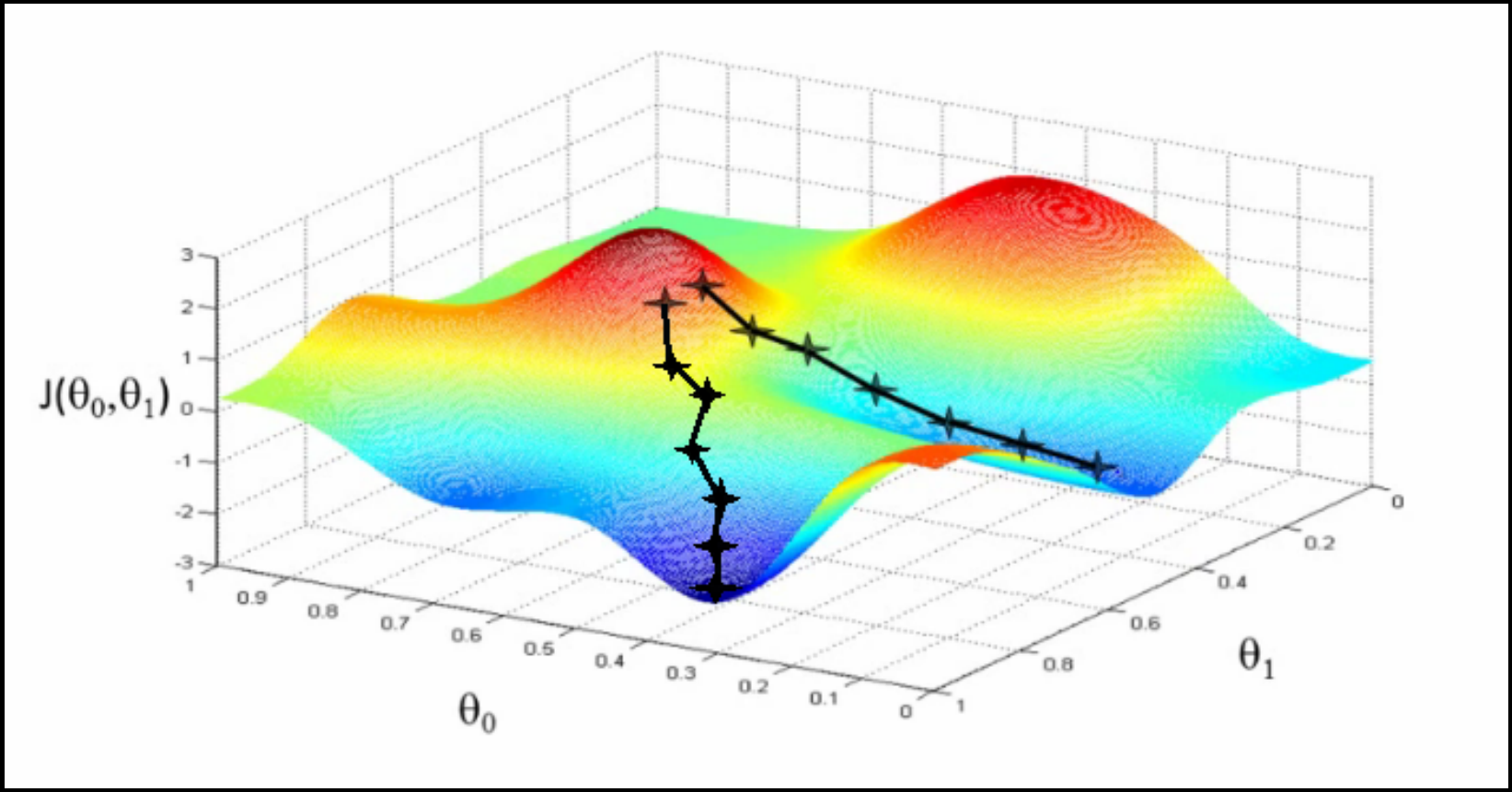
Network:

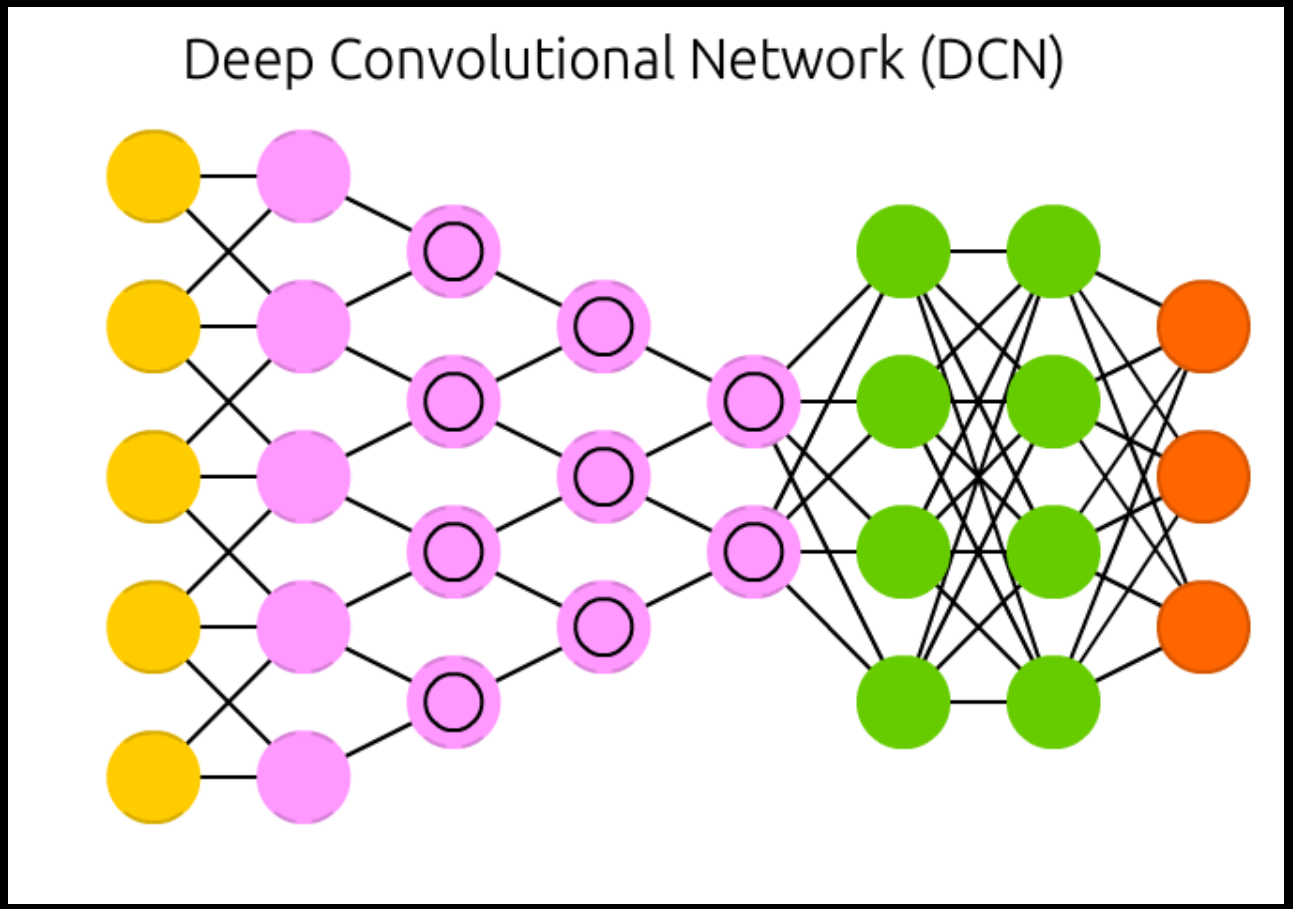


Loss:

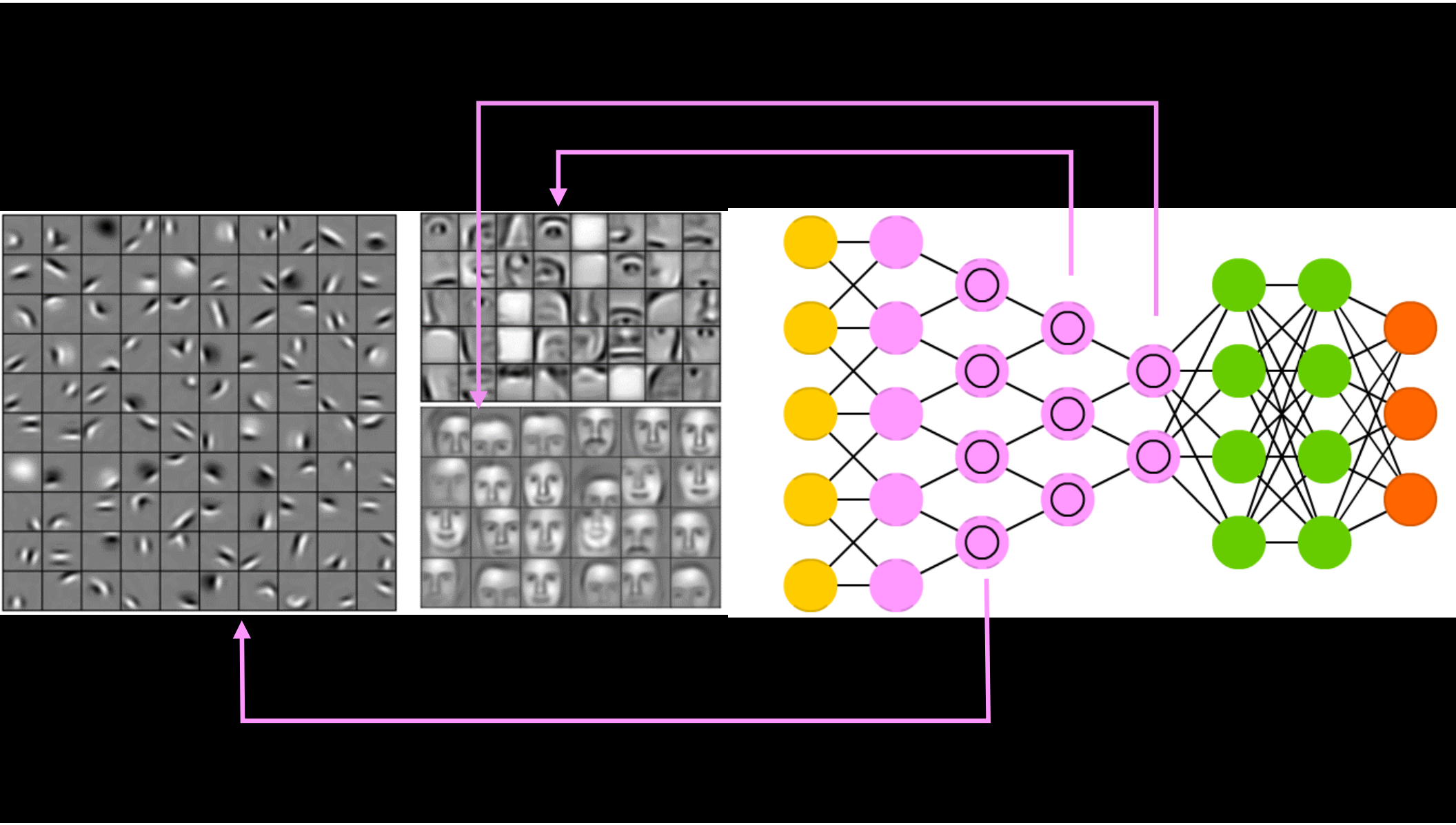


How does it learn?





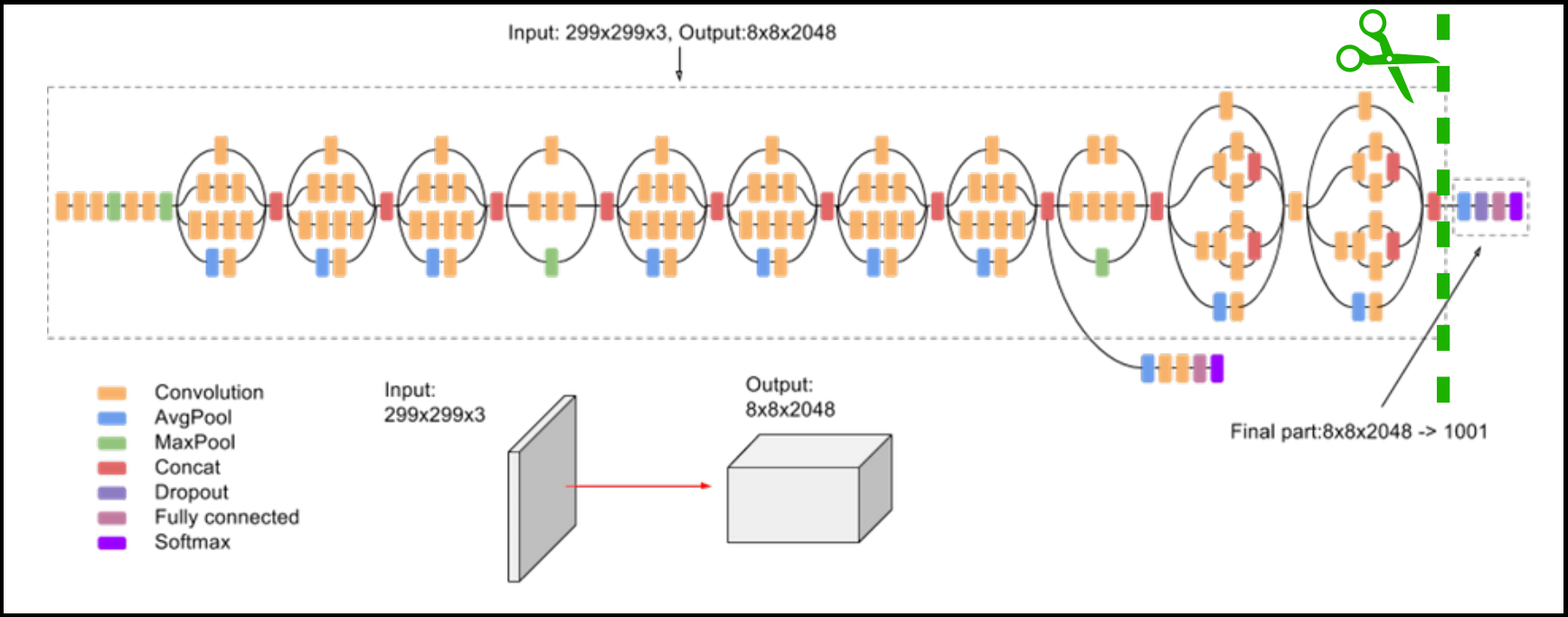
http://www.asimovinstitute.org/neural-network-zoo/



How long does it take?

DIY Training NN

Cutting the head off a pre-trained model and retrain the output layer



DIY Training NN

1. Introduction
2. Setup
3. Download the training images
4. (Re)training the network
5. Training And TensorBoard (Optional)
6. Using the Retrained Model
7. Trying Other Hyperparameters (Optional)
8. Training on Your Own Categories (Optional)
9. Next steps

Did you find a mistake? Please file a bug.

TensorFlow For Poets

21 min remaining

1. Introduction

TensorFlow is an open source library for numerical computation, specializing in machine learning applications.

What you will build

In this codelab, you will learn how to run TensorFlow on a single machine, and will train a simple classifier to classify images of flowers.

Image CC-BY by Retinafunk

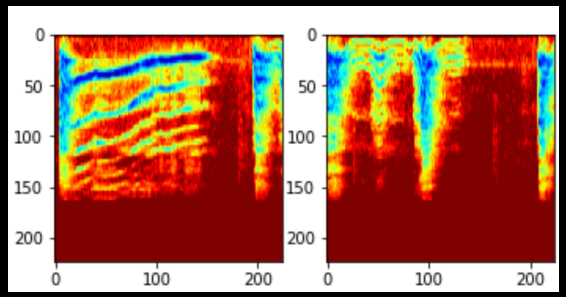
```
daisy (score = 0.99071)
sunflowers (score = 0.00595)
dandelion (score = 0.00252)
```

Next

```
1 x,sr=librosa.load(MainFile,mono=True)
2 print(x[:10])
```

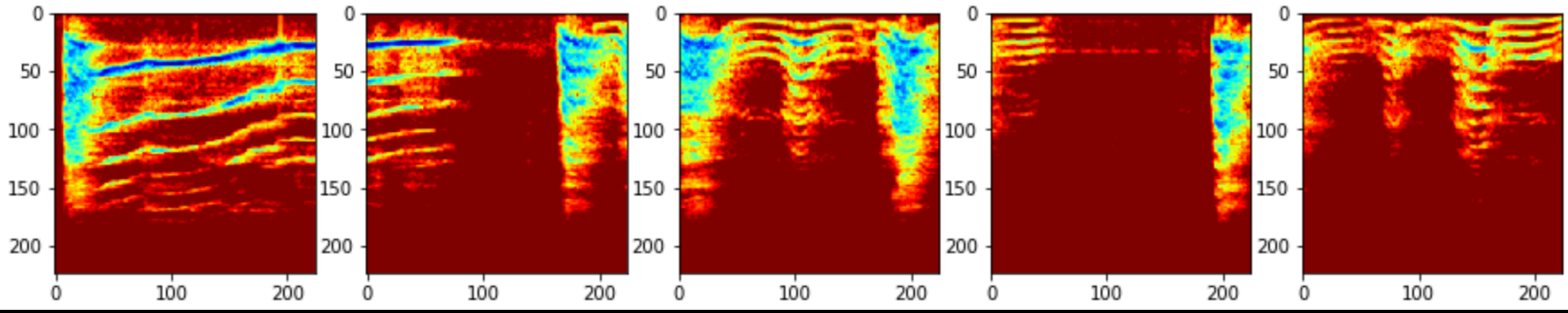
```
[7.2846080e-07 4.4798618e-04 4.2338486e-04 5.1860156e-04 5.2436633e-04
 6.2011537e-04 7.4167160e-04 7.3620537e-04 8.4487378e-04 6.9093634e-04]
```

!=

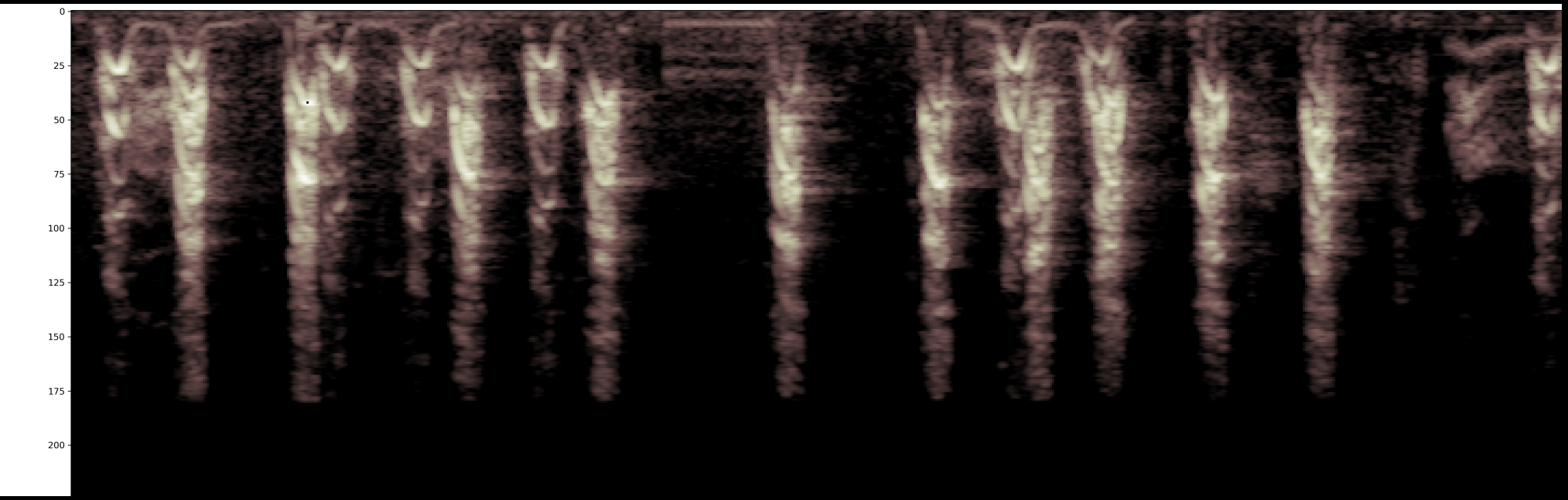


$\approx\!\!\neq$

Spectrogram generation




```
MainFile="../AudioData/audio-cats-and-dogs/cats_dogs/train/dog/dog_barking_20.wav"
```


0
25
50
75
100
125
150
175
200

What is done currently with audio detection

Used for finding existing music:

- Shazam (Apple Music, Google Assistant, Alexa)

Contextual information in robotics

Today!

Getting set-up and running the basic example.

ToDos

Join Discord https://discord.gg/qEHeFn

Follow along on https://github.com/FAR-Lab/RealtimeAudioClassification