Illustration: Tom Gauld

BBM406
Fundamentals of Machine Learning

Lecture 1:
Course outline and logistics, An overview of Machine Learning

HACETTEPE UNIVERSITY COMPUTER VISION LAB

Erkut Erdem // Hacettepe University // Spring 2021

Today's Schedule

- Course outline and logistics
- An overview of Machine Learning

Course outline and logistics

Logistics

- **Instructor:**

Erkut ERDEM
erkut@cs.hacettepe.edu.tr

- **Teaching Assistant:**

Necva Bolucu
necva@cs.hacettepe.edu.tr

- **Lectures:** Mon 16:00 - 16:50_Zoom
  Wed 09:00 - 10:50_Zoom
- **Tutorials:** Fri 16:00 - 18:00_Zoom

About this course

- This is a undergraduate-level introductory course in machine learning (ML)
  - A broad overview of many concepts and algorithms in ML.
- **Requirements**
  - Basic algorithms, data structures.
  - Basic probability and statistics.
  - Basic linear algebra and calculus
  - Good programming skills

common distributions, Bayes rule, mean/median/model

vector/matrix manipulations, partial derivatives

- **BBM 409 Machine Learning Laboratory**
  - Students will gain skills to apply the concepts to real world problems.

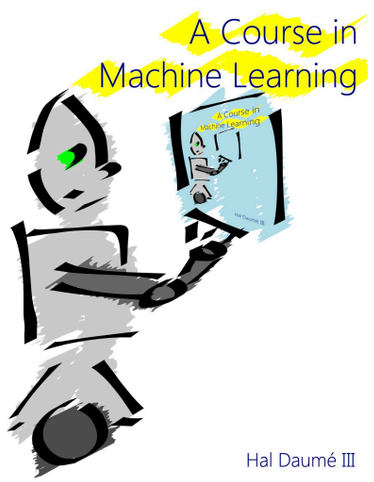
Communication

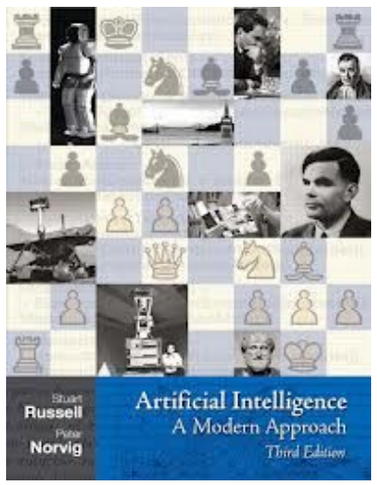
- **Course webpage:** https://web.cs.hacettepe.edu.tr/~erkut/bbm406.s21/
  - The course webpage will be updated regularly throughout the semester with lecture notes, programming and reading assignments and important deadlines.

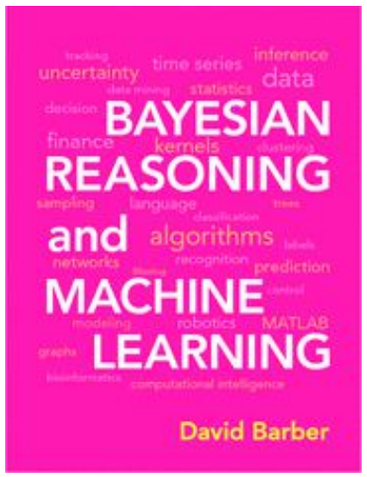
- We will be using Piazza for course related discussions and announcements. Please enroll the class on Piazza by following the link https://piazza.com/hacettepe.edu.tr/spring2021/bbm406

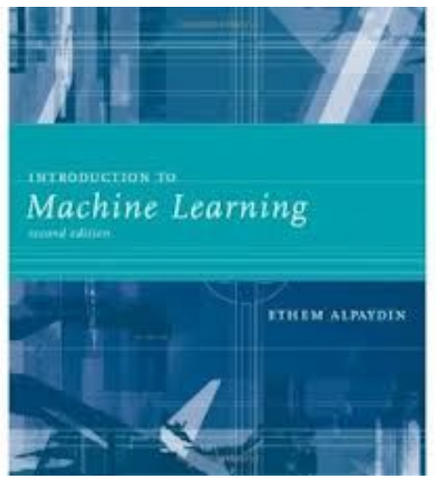
Reference Books

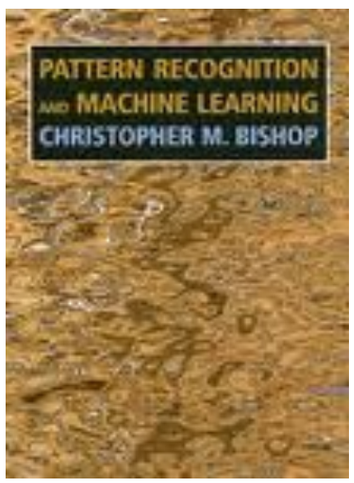
- A Course in Machine Learning, Hal Daumé III, 2017 (**available online**)
- Artificial Intelligence: A Modern Approach (3rd Edition), Russell and Norvig. Prentice Hall, 2009
- Bayesian Reasoning and Machine Learning, Barber, Cambridge University Press, 2012 (**available online**)
- Introduction to Machine Learning (2nd Edition), Alpaydin, MIT Press, 2010
- Pattern Recognition and Machine Learning, Bishop, Springer, 2006 (**available online**)
- Machine Learning: A Probabilistic Perspective, Murphy, MIT Press, 2012

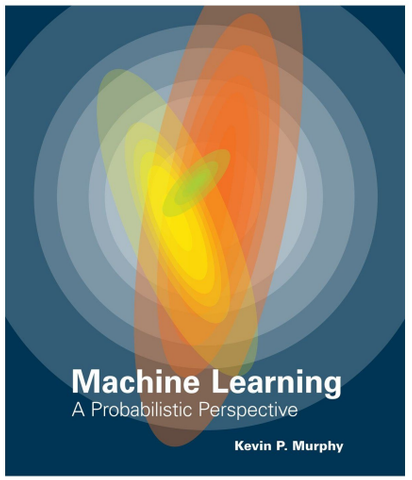












Grading Policy

- Grading for BBM 406 will be based on
  - course project (**done in groups of 3 students**) (35%),
  - midterm exam (30%), and
  - final exam (35%)

- In BBM 409, the grading will be based on
  - a set of quizzes (20%), and
  - 3 assignments (80%)(**done individually**)

Assignments

- 3 assignments
  - First one worths 20%, last two worth 30% each

- **Theoretical**: Pencil-and-paper derivations
- **Programming**: Implementing Python code to solve a given real-world problem

- A quick Python tutorial in this week's tutorial session.

KEEP CALM AND DO YOUR HOMEWORKS

Course Project

- Done in groups of 3 students.
- Choose your own topic (but focused on a specific theme) and explore ways to solve the problem

- **Proposal**: 1 page (Mar 31) (2%)
- **Project Blogs:** Regular blog posts (4%)
- **GitHub commits and meetings with TA:** (5%)
- **Progress Report**: 3-4 pages (May 5) (6%)
- **Project Presentation**: Classroom presentation and video presentation (8%) (May 26)
- **Final Report**: 6-8 pages (May 30) (10%)

Sample projects from 2016

BBM 406 Class Project - Final Report

Cem Güngör, Fatih Baltacı
Department of Computer Engineering
Hacettepe University
Ankara - TURKEY, Fall 2016
{b21328031, b21327689}@cs.hacettepe.edu.tr

Abstract

This paper is a final report of our project "What Am I Eating?" for BBM406 Introduction to Machine Learning lesson. "What Am I Eating?" is an image recognition project which predicts food labels from given images. Developments in the field of Machine Learning and increase of datasets in recent years encourage us to make an image recognition project. We are using deep learning. We performed transfer learning(from Inception v3 model [Szegedy et al. 2015]) and data augmentation. Our dataset is a combination of different datasets which has 113 classes. Each class has 1000 images.

Keywords: deep learning, image recognition, fine tuning

1 Introduction

In recent years there have been major developments in the field of machine learning. The datasets have grown up because of the increase in internet usage. Hardwares become stronger than before. Graphic cards become cheaper. Because of these conditions, researches have increased and new approaches such as deep learning has appeared. Open source libraries were developed.

Deep Learning is a new and very popular area of Machine Learning research. We decided to develop a project using deep learning to improve ourselves in this field. Deep learning is used in many areas such as image recognition, speech recognition, natural language processing and so on. We used deep learning for image recognition. So, What am I Eating? is a deep learning project that recognizes foods from images.

We saw that no dataset has any Turkish foods. We wanted our project to recognize Turkish foods too. Also we have some future thoughts about our project.

Figure 1: ***pizza (score = 0.84349)****, waffle (score = 0.04952), bruschetta (score = 0.02402), omelette (score = 0.01936), ...*

2 Related Work

There are three researches which are closely related to our research topic. All of them are new and made in 2016. One of them is [Liu et al. 2016]. The purpose of this research is to improve the accuracy of current measurements of dietary intake by analyzing the food images captured by mobile

Predicting Restaurant Ratings from Review Texts

Melis Mutlu & Raisha Abdillah
Department of Computer Engineering
Hacettepe University
Beytepe, Ankara 06800, Turkey
{b36160843,b21304258}@cs.hacettepe.edu.tr

Abstract

Nowadays, with the growth of crowd-sourced review website, the quality of business is determined by its ratings and reviews. The costumer and the business owner will be able to see the trends, making decision, and getting recommendations based on their preferences just by looking at the reviews and ratings themselves. In this project, our goal is to predict the ratings which is given to a restaurant by looking at it its review text. We use Yelp Dataset for our training and testing. By applying machine learning and text mining principle, we analyzed the review text from the Yelp Dataset. We were researching for the best algorithm which would give us the best result. The algorithms which we used at this projects are Bayesian Ridge Regression, Support Vector Regression, and Random Forest Regression.

1 Introduction

The development of technology makes it easier for people to make the right decisions. In this matter, technology influences the field of business by delivering a more convenient way for people to evaluate their business. For example, nowadays costumer may look at the reviews and ratings which has been given and getting influenced by it, before deciding to go to a certain restaurant.

The goal of our project is to choose a supervised machine learning algorithm which will give us the best performance in predicting the restaurant ratings by looking at its review text that has been given in Yelp Dataset. Firstly we have to choose the most appropriate dataset to our problem. After that, in order to work with Machine Learning algorithm, we transform our raw data into vector or matrices form.

For our project we use Yelp Dataset, since it already provides the review and rating in an easily accessible format. Then, we did feature extraction from our dataset. We combined several feature extracting process in order to get the better result. For this, we use Bag of Words and Word2Vec model. We have tested these model and it gave us a satisfying result. For the better result, we also removed words which we considered unimportant. After we made our model, we use machine learning algorithm to test our model. We then choose the algorithm which gave us the best performance after we tested it. We treated this problem as regression problem, therefore we used regression algorithm. We made use of Yelp Dataset as our training set and testing set.

In this report, firstly, we will present you the dataset. Secondly, we will tell you about out feature extraction method (Bag of Words, Word2Vec). The next part is that we will explain about the algorithm which we use for this projects, which consists of Bayesian Ridge Regression, Support Vector Regression and Random Forest Regression. Then, by using Explained Variance Score (R^2 score) and Mean Square Error we calculate the accuracy of our model. We will share the result and the conclusion of our project by the last part of this report.

Finding The Ingredients of Pizza Using Deep Learning

Mümin Can Yılmaz
can.yilmaz12@hacettepe.edu.tr
Alim Giray Aytar
giray.aytar12@hacettepe.edu.tr
Hayati İbiş
hayati.ibis12@hacettepe.edu.tr

Abstract

Extracting ingredients from a dish can be a powerful tool for combatting obesity and making food inspection processes easier. For this purpose, we tried to create a program which extracts ingredients from a pizza, using convolutional neural networks. We also created a dataset which has 7405 images and 20 different labels as ingredients. Our experiments show us our model can predict small numbers of ingredients successfully (80 percent for one label), however as the number of ingredients increased, accuracy rate drops significantly (22 percent for 2 labels).

1. Introduction

Our aim is to create a model which can identify ingredients in the pizza. Our program should output a list of ingredients as output when feed with an image of a pizza.

First of all, we started with creating a new dataset from the scratch, because we couldn't find any ready-to-use dataset. To do this, we collected about twenty five thousand images from web and labeled all of them by hand with a little software we created for this purpose.

Secondly, we decided to use a Convolutional Neural Network, because they show much better performance in image recognition problems compared to other approaches. Also when using Convolutional Neural Networks, we don't need to extract any features because CNN's operates directly on images. There is also some downsides of using Convolutional Neural Networks as they need more data and require more computing power than other solutions.

Finally, we evaluated our project with the result that we get after the process of training our classifier model which we present in the results section.

Hardest part of this problem is, because food shapes are deformed after cooking, it might not be possible to predict them correctly for our model. Color information also isn't very helpful, because some different ingredients exactly have the same colour or same ingredients might have different colours.

hamsi: 0.58653
baklava: 0.30801
carrot cake: 0.05741
humus: 0.01253

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 'latitude': latitude,
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 'review_count': review count,
 'categories': [(localized category names)]
 'open': True / False (corresponds to permanently closed, not business hours),
}
```

Green Pepper
Olive
Onion
Salami
Corn
Chicken
....

Sample projects from 2017

Predicting the Location of a Photograph

Ali Yunus Emre ÖZKÖSE
Hacettepe University
ANKARA, TURKEY
aliozkose@hacettepe.edu.tr

Tarık Ayberk YILIKOĞLU
Hacettepe University
ANKARA, TURKEY
tarikyilikoglu@hacettepe.edu.tr

Abstract

In this paper, we addressed to prediction of an image location problem. It is still a hard problem because of several kinds of other problems. We use convolutional neural networks (CNNs) to tackle this problem. We collect data from Flickr[13], create a dataset which we call Turkey15 and test with basic algorithms. After testing the dataset, we train AlexNet and ResNet-18 with Turkey15 from scratch. Since Turkey15 is very small, we use transfer learning to improve results. We use feature extracting and fine-tuning[14]. We also freeze some layers to get better accuracy.

(a) Ankara (b) İstanbul (c) Bursa

Figure 1: Images from Turkey15

1. Introduction

Although there are a lot of works on this issue and it is very popular research topic in recent years, predicting the location of an image is still a hard problem. There are various problems such that constructing features [3], viewpoint problem[4], illumination and structural modification[12] etc.. It can be used for many areas such as estimation people's perception [5]. But how can we predict the location of given image? In this work, We focus on exactly the problem of city classification.

With the development of technology and the increase of applications, people are taking photos and upload to internet much more than ever. The significant point of sharing is that a huge data has existed and it can be used for creating artificial machines as an experience. At this point, we collected images from Flickr where are taken in Turkey, created a dataset which we called Turkey15 and predict image locations where is limited to Turkey.

Figure 2: Images from Turkey15

First of all, we tested our dataset with hand-crafted features which are Tiny images, GIST features, and Hog features, because we should know that our dataset is convenient enough to use as a dataset or not. Details in this process are explained in section 3.1.

After testing the dataset, we trained existed models which are AlexNet and ResNet-18 models with our dataset. We trained from scratch in this step and get some results and compare with training with hand-crafted features. Details and result are written in section 4.1.

Thirdly, we used transfer learning, in particular, fine-tuning and feature extracting. We trained pre-trained models which are trained with places365 and imageNet datasets. Models are AlexNet and ResNet-18 again. Details are written in section 4.2.

Finally, we froze some layers of models and trained AlexNet and ResNet-18 again. Details are written in section 4.3.

2. Related Work

Because of the popularity of this challenge, there are many kinds of proposed methods and works for predicting location. Li et al. propose to represent features with SIFT and match query image features to database image features mutually[11], but matching is only among the prioritized features. They keep informative points. In this way, they reduce computational cost. We also used hand-crafted features for testing dataset, but we use convolutional neural networks for training.

Sound of The City

Buğrahan Akbulut
Department of CS Hacettepe University
akbulutbugrahan@gmail.com

Mustafa Çağdaş Çaylı
Department of CS Hacettepe University
cagdas_cayli@hotmail.com

Abstract

In this paper we will introduce our project that is detects and classify leading sounds on urban sounds. We focused on audio because it was more attractive then working on image or some numerical data and also because sound is a very important tool for understanding the world.Also another reason is working with sound is very challenging because it is hard to find only one pure sound on outside world there are lots of sound sources and we generally hear the mixture of these sounds,so our data sets that we used in this project have real field records - has lots of mixed sounds-.We worked on UrbanSound8K and UrbanSound data sets containing 27 hours of audio with 18.5 hours of annotated sound event occurrences across 10 sound classes(air conditioner,car horn, children playing, dog bark, drilling, engine idling, gun shot, jackhammer, siren, and street music).Our goal was extract leading sounds with a correct shape by using Shogun and classify them correctly.

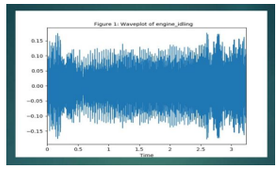
1. Introduction

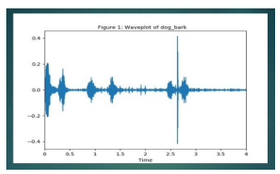
Since new audio technologies developed rapidly recently, audio processing and classification are growing research fields and it contains many challenges. Especially separating audio into its components is a very tough problem.However working on an analysis of urban sounds instead of working on the analysis of speech, music, bioacoustics is relatively easy and relaxing. Furthermore we worked on extraction of the leading sounds with correct shape.

One of the main challenges in this project was lack of labeled mixed sounds.Previous work focused on classification of single labeled audio data. We needed lots of audio data to get our final results correct. With this purpose we created our own multi-labeled audios by using shogun.Actually we first wanted to separate a given any kind of mixed sound into its components by using ICA (independent component analysis) but we could not find any working library or implementation of this algorithm and due to the restricted time we could not achieve this goal.But we wanted to make it so we have done some more researches and find a new library named shogun which provide some tools for mixing and separating sounds not like ICA but it works for us to get some results by making tests on mixed sounds.

After all these things we also want to improve our results getting from tests, we decided to combine two different machine learning approach to get higher results and it was another challenge for us to increase our results by using neural networks and support vector machines combination.The aproach we use to combine these two algorithms will be explained in more detail at "The Approach" section.

Here you can see wave-plot form of single and mixed sound sources we worked on :





Prediction Of Life Quality

Tark Ramazan BASOGLU
Department of Computer Engineering
Hacettepe University, Ankara, TURKEY
tarik.basoglu@hacettepe.edu.tr

Emre DOGAN
Department of Computer Engineering
Hacettepe University, Ankara, TURKEY
emre.dogan@hacettepe.edu.tr

Abstract

In this study, we mention about the usage of using a machine learning approach to specify life qualities of cities instead of public research. We create an assorted dataset that contains statistical and physical features. To do that, we utilize from MAPZEN. We expect to predict the scores on MOVEHUB with high accuracy.

1. Introduction

Nowadays, we can easily see that cities differ considerably from each other in terms of their physical and social characteristics and that difference is highly influential in human life. We are making great efforts to determine the effects of these differences on human life and to make cities more livable and to change this imbalance positively.

In this situation, we are faced with a notion named quality of life.

"Quality of life (QOL) is the general well-being of individuals and societies, outlining negative and positive features of life. It observes life satisfaction, including everything from physical health, family, education, employment, wealth, religious beliefs, finance and the environment."[2]

By this definition, there are various social and physical criteria that influence the quality of life. The number of researchs and studies carried out in this area is increasing day by day. While life quality information for large cities is easily accessible, it is not possible to find reliable results for cities that are not big enough.

In this project, we purpose to achieve higher efficiency in shorter time and reduce the burden on a human in such researches. Rather the laborious and time-consuming processes of public researches we also aim to provide a new, flexible and developable method by making use of machine learning experiences. Thus, we get a chance to detect the life qualities for any cities in the world. At the same time, we are expecting to be able to observe which physical factors effects the life quality with which rates.

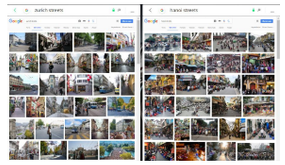


Figure 1. The reflection of the crowd difference between the Hanoi and Zrich on the street photos

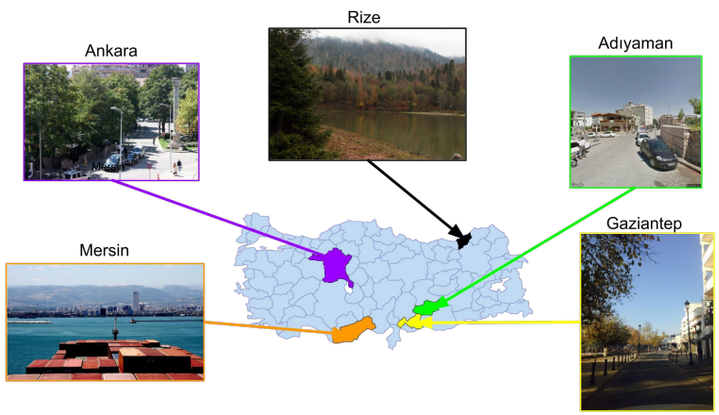
MoVEHUB
There is a platform named MOVEHUB that helps you make informed decisions about where to move to around the world. And it has a city ranking list consists of over 200 cities. We utilized this list as the main target in the estimation results.

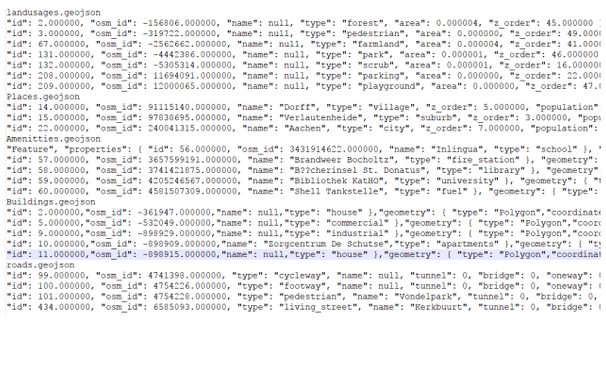
MAPZEN
Mapzen is an open and accessible mapping platform that is focused on the core components of geo platforms, including search, rendering, navigation, and data.

2. Related Work

There are numberless researchs done to measure life quality in cities every year. In this researches generally, lots of criteria are considered to obtain correct results. Such researches have been carried out in the form of public opinion polls up to now.

MOVEHUB: MOVEHUB is similar research that includes





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Sample projects from 2018

Wi-Fi Based Indoor Positioning Systems

Burak Emre Ozer
Hacettepe University
Ankara, Turkey
burak.ozer@hacettepe.edu.tr

Furkan Caglar Gulmez
Hacettepe University
Ankara, Turkey
furkancaglargulmez@gmail.com

Huzeyfe Kocabas
Hacettepe University
Ankara, Turkey
kocabashuzeyfe@gmail.com

Figure 1: Source [12] Left: map of UJI campus and Tx buildings. Middle: red indicates ESTCE - Tx building. Right: example of a reference point.

Abstract

Wi-Fi Fingerprint-based positioning approach that detects the position of user or device is widely used in the indoor positioning systems instead of Global Positioning System (GPS). In this approach, Received Signal Strength (RSS) values that are known as Wi-Fi fingerprints used. Received Signal Strength values are the measurement of the power present in a received radio signals. We use UJIIndoorLoc dataset with 19937 training records and 1111 test records. This dataset of RSS values are collected by using previously placed wireless access points (WPAs) in Tx Buildings of University of Jaume I campus. We aim to predict location points with respect to floor IDs, building IDs, longitude and latitude values with supervised machine learning algorithms such as K-Nearest Neighbor Algorithm, Random Forest Algorithm, Support Vector Machine and Decision Tree Algorithm. Then we use the model with the highest accuracy in the rest of the progress. Classification techniques are used for building and floor classification and regression techniques are used for detection of location points.

Keywords— indoor positioning, received signal strength indication (RSSI), machine learning algorithms, classification, random forest

1. Introduction

Global Positioning System (GPS), which uses satellites,is the most popular outdoor positioning system, however its signals can be easily blocked by various structures and factors then it becomes useless for indoor environment because of signal loss. Unlike the GPS, Indoor Positioning Systems aims to detect the position of user or device by using Access Points signal also called Wi-Fi ngerprint. With the advancing technology and spread of wireless networks, Indoor Positioning Systems become even more important place in the fields of augmented reality, social networking, personal tracking, guiding blind people, tracking small children or elderly individuals and location-based advertising etc.

Wi-Fi-based fingerprint methods have some problems when positioning phase in indoor. These problems can be caused by the fact that the devices in which the radio signals are collected during the training stage and the devices in the test phase are different.

Another reason is that the number of access points in the environment varies greatly. Inevitably, these problems negatively affect positioning success. However, we will try to determine the position with regression algorithms using the real latitude and longitude values of the collected locations.

Then we will turn our problem into classification problem by using the building and floor features in the data set. In the test section, we will try to estimate which building is located or which floor of the building.

Different machine learning algorithms will be tried and we will decide the most suitable algorithm for indoor positioning.

We will use the UJIIndoorLoc database throughout the entire project. Classification and regression problems will be solved using the RSS values from 520 wireless access points (WAPs). In the classification part, since the data set contains 3 buildings, we will divide the data into three and try to estimate which floor is located.

The rest of the paper is organized as follows: Presentation of related studies, explanation of the data set used in the experiment, explanation of solution approaches, experimental results

Country Classification Using House Photos

Meltem TOKGOZ
Hacettepe University
21527381
meltemtokgoz@hacettepe.edu.tr

Enes Furkan CIGDEM
Hacettepe University
21526877
enescigdem@hacettepe.edu.tr

Asma AIOUEZ
Hacettepe University
21504074
asma.aiouvez@hacettepe.edu.tr

Abstract

Home designs vary from country to country and when we talk about housing, we should refer to both modern and traditional styles. You can come across a picture of a house taken by someone anywhere in the world and you may wonder where it has been taken from. In this project, we tried to find out which country the photo of a house was taken from. In short, we worked on the problem of classification according to where the photographs were taken.

We used our own World dataset for this project. This dataset contains over 4000 pictures for 15 different countries. In our project, we collected our data from the Flickr [1] , Pinterest [3], and Google Photos [2]. We first tested our data with a single layer neural network and then with convolutional neural networks (CNN). We used ResNet18 and AlexNet models when implementing CNN in our project. In accordance with the results, we applied some methods to increase the accuracy and we got the best accuracy with ResNet18.

1. Introduction

Recognizing home photos and classifying them by country is a quite difficult problem. Because the houses in many countries in the modern world are similar to each other. Beside that, there are some features to distinguish these houses. For example, each country's climate, people's lifestyle and culture are different. This gives us some hints on the architecture of the houses in that country. From this point of view, especially the design of traditionally styled houses begins to change from a country to another. The main problem here is that the houses in the same continent are very similar to each other. For example as shown in *Figure 1*, in the Asian continent, traditionally styled houses of some countries such as South Korea, Japan, Indonesia and Malaysia are very similar. This factor complicates the solution of the problem. In addition, many factors such as the shooting angle, light, shadow and seasonal differences affect the solution of this problem.

Figure 1. Example of similar data

Since this is an image classification problem, there are many algorithms and methods used in its solution. K-nearest neighbors, logistic regression, support vector machine and convolutional neural networks are some of these solutions. Especially in recent years, CNN is a successful algorithm preferred to solving problems in this area.

Figure 2. Example of similar data

In our study, we deal with the problem of classification according to the country where the house pictures were

Rock or Not?

Defne Tuncer [1] **Kutay Barcin** [1]

Abstract

In the era of technology, millions of songs are brought to people everyday. The dramatic increase in the size of music collections has made the music genre recognition (MGR) an important task on machine learning. The goal of this paper is to give machines a chance to predict music genres given input features from music tracks. To do that, we applied various techniques based on machine learning on the dataset called Free Music Archive (FMA), and we have reached an accuracy score of 67.80% as our highest.

1. Introduction

When there is people, there is music. As people, living in today's world, music is always at our reach through technology. The ease of it has brought the demand of automatically generated playlists and customized music recommendations. The task in both those challenges is to be able to group songs in semantic categories. In this work, we aim to model and classify music genres with the assumption of different music genres are also different at the bit level.

In this paper, we will put forward the efforts we made concerning the classification models that allow us to recognize the genre of a given song from its audio features. As for the beginning, we introduced studies on the subject music genre recognition. Then we made a brief introduction to the dataset we bring into use, and explained how we handled our data. Thereafter, we implemented various baseline classification models, and discussed towards advancing the models to solve the problem of music genre recognition. These methods include: 4.1.1 Nearest Neighbor Classifier with/without dimensionality reduction through Principal Component Analysis (PCA) and weighting hyperparameter. 4.1.2 Logistic Regression through one-vs-one scheme, multinomial approach and one-vs-rest scheme with variety of solvers and regularization. 4.1.3 Support Vector Machines with linear and radial basis function (RBF) kernels. 4.1.4 Deep Learning method Neural Network also known as Multi-Layer Perceptron through various optimizers. To represent the audio tracks in building our baseline models we planned to use the combination of all the features, which have been shown to be effective in the task of predicting genres. We improved our methods with model and feature selection by using k-fold cross validation afterwards. Based on the results obtained from the algorithms, we performed experimental analysis. Finally, ended our work with a detailed conclusion, and proposed our feature work.

2. Related Work

For the music genre recognition task, the most common datasets are GTZAN (Tzanetakis & Cook, 2002), Million Song Dataset (MSD) (Bertin-mahieux et al., 2011) and FMA: A Dataset For Music Analysis (Defferrard et al., 2017). While FMA, which consists of 161 sub-genres among 106,574 tracks and published in 2017, is the most up-to-date dataset, and is especially suited for MGR as it features fine genre information. A challenge took place as one of challenges of Web Conference (WWW2018) by the publishers of FMA Dataset on the subject predicting genres of the music (Defferrard et al., 2018). The winner succeeded by examining through artist-related information and scored an accuracy of 66.29% on predicting 16 genres (Kim et al., 2018).

In Music Information Retrieval (MIR), there have been various number of studies on building effective models to predict genre of music using audio features. Mel-Frequency Cepstral Coefficients (MFCCs), one of the audio features, are generally used in music genre classification as the perceptual scale of pitches of a human hearing are represented by the Mel-scale. A Hidden Markov model with MFCCs is used to classify pop, country, jazz and classical genres in (Shao et al., 2004). On the other hand, another study focuses on a new feature called Renyi Entropy Cepstral Coefficients (RECCs) (Tsai & Bao, 2010). The highest achieved accuracy scores reported on the datasets ISMIR2004 which is from the contest (Cano et al., 2006) and GTZAN are accomplished by representing the auditory human perception with a proposed spectrogram (Panagakis et al., 2009). Most of their studies are done through researching the timbre texture,

[1]Department of Computer Engineering, Hacettepe University, Ankara, Turkey. Correspondence to: Defne Tuncer <defnetuncer@hacettepe.edu.tr>, Kutay Barcin <kutaybarcin@hacettepe.edu.tr>.

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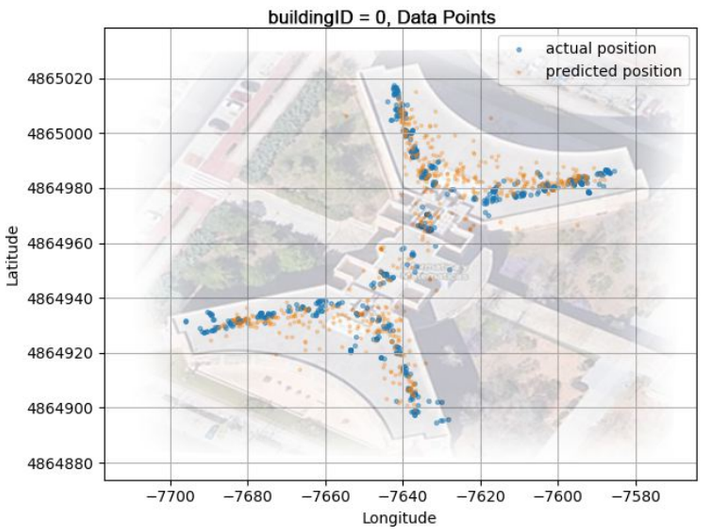
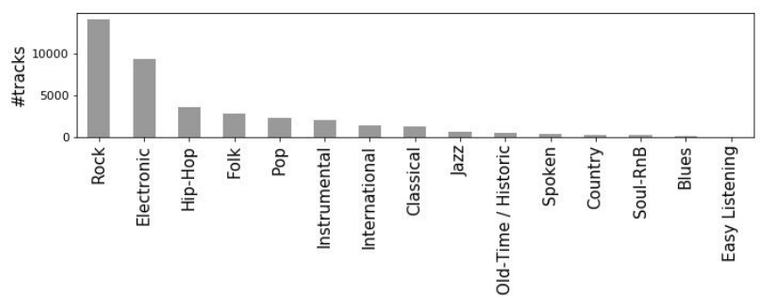


Predict Class : Indonesia

Correct Class : Malaysia



Sample projects from 2019

ClearSky: Satellite Imagery Based Deep Learning Model to Predict Wildfire Spread

Ahmet Ş. Yener Deniz Zağlı

Abstract

As wildfires rage across the entire continent of Australia, the lack of resources are more apparent than ever. When there are limited resources the lack of forecasts make the distribution of resources inefficient. This inefficiency has a wide range of effects, from human and animal life loses to monetary damage. Current in use forecast systems require expert knowledge to run and are case to case basis so the data available is not leveraged to the extent it should. We've developed a system that alleviates these problems combining GIS (Geographic Information Systems) and Deep Learning models that are used in meaning extraction from visual data. We've expanded and showed the agnosticism of the model to spatial,temporal data and underlying code frameworks. We propose future work that will increase efficiency and automate the system, making it distributable to the authorities around the globe.

1. Introduction

The current climate change effects create much more suitable conditions for wildfire outbreaks and spread (Clarke, Hamish, et al. (2019)). Wildfires across the globe are expected to rise in amount and intensity (Running, Steven W.,James, Sagil, et al. "Smart Drone Technology for Wildfire Prediction and Prevention." (2019)., (Chung, M., M. Jung, and Y. Kim. et al. (2019).) While detection is possible, forecast on the spread of the wildfire is a critical information for minimizing the damage caused.

Data we are using is widely spread and do not exist in an analyzable form in any single place. This obscurity by diffusion limits the amount of work done on such a critical area. Data in it's provided form needs heavy processing and geo-referencing to be able to analyzed by the Deep Learning models. These obstacles can be automated with collaboration by the data providers. The upside is that the datasets used are all publicly available.

We use Satellite generated imagery combined with GIS applications to generate input and create ground-truth for the supervised Deep Learning model. The prediction ability of the Deep Learning model combined with GIS applications to provide spatial characteristics such as elevation, health and the density of vegetation at that area proves to be able to forecast the highly chaotic event which are wildfires.

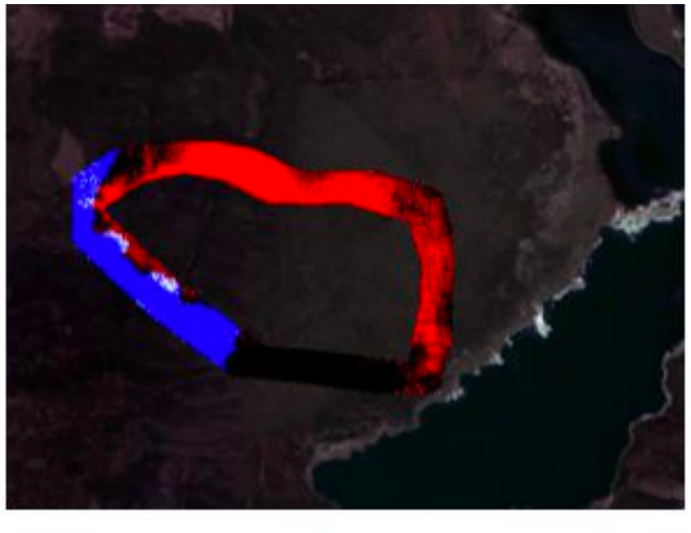
Entire system after processing can be run on mid level machines, and operating systems supporting the libraries used. The prediction is of highly interpretable form without prior training on the legend, combined with low computational and memory costs make the model appropriate for field use. We hope the system in use can reduce all types of damages to human, animal life and will provide a livable future for the children of humanity. We contribute in this paper proof of agnosticism to the spatial and temporal characteristics of the wildfire to the system proposed in the FireCast paper (Radke, David, Anna Hessler, and Dan Ellsworth. "Firecast: leveraging deep learning to predict wildfire spread." Proceedings of the 28th International Joint Conference on Artificial Intelligence . AAAI Press, 2019.) and some further data and model complexity reduction.

2. Related Work

The first of it's kind the Deep Learning Model proposed by the above cited paper has been a major inspiration for this paper. Their model presented in the paper is implemented with PyTorch and the dataset providers proposed by them are used in our own compiled dataset.

Their work was done on the Rocky Mountain range with limited availability of consecutively mapped perimeter for the day, We have gathered our data from the entire area of the state of California. The wildfire outbreak of 2018 provides a great amount of data, combined with 2017 data to prove robustness against changing conditions of the outbreak locations and time.

Since the data is unique in its relation to the fire only rotation is suitable as an augmentation. This means the current methods in use that provide expansion of the dataset to the model are not suitable for this task, so the amount of original data is highly valuable for the prediction capability of the model.



Heart Disease Detection

Oğuzhan Eroğlu [1] Harun Alperen Toktaş [1]

Abstract

In this paper we introduce methods for heart disease detection and data sets analysis, We experiment with three different data sets. The first data set includes 303 records and 13 features + binary target. The second data set includes over 4000 records and 14 features + binary target. The third data set includes 70.000 records of patients data, 11 features + binary target. We aim to compare different machine learning algorithms on this data sets and their results. We are going to determine which algorithm is more suitable for the data sets we use for heart disease detection problem. We are going to also compare the results we have found for all algorithms with previous studies.

1. Keywords

Heart Disease Detection, Early Diagnosis, Prediction, Classification, AI For Good.

2. Introduction

We will introduce you to the project of the machine learning course that we are taking this semester. The theme of the projects of this semester is machine learning for good. So we decided to do Heart Disease Detection. The motivation behind choosing this project is to show people that machine learning techniques can be life-saving.

We miss a lot of things while dealing with the daily hustle and bustle. The most important of these is our health. Health is better than wealth. Millions of people die every year because of sudden heart diseases. These sudden cardiac disorders may result in sudden deaths, as well as life-long disturbances. Can we take precautions without letting such disturbances reduce our quality of life?

Early diagnosis is very important in the prevention of heart diseases. But most people are unaware that they have any problems, so they don't realize that they need to see a doctor for early diagnosis. By integrating machine learning techniques into real life, we can warn people for early detection and force them to take action. Thanks to our algorithm analysis for the Heart Disease Detection problem, people can receive early warning of heart disease using their smart watches, using their personal medical data in real time. At the same time, with a mobile application, people can get information about their health condition by entering their own medical data.

In this study, by using three different data sets, we tried to determine the risk of heart disease through the factors that cause. In line with our analyzes, we tried to find the algorithm that would give the most accurate results for these data sets and to determine what kind of changes the algorithms could show on different data sets. In addition, through these analyzes, we tried to make it easier for people to learn the risk of heart disease by entering their personal health information into the correct algorithms.At the same time, it may be possible for doctors to use their resources better.So we can help more people with the health budgets we have.

3. Related Work

As we said before, we have analyzed three different data sets. We have found a study [1] using the Machine Learning concept for the first data set only. The most important thing that distinguishes this study from others is its feature selection. The feature selection process and clear the noisy data process was done with a software tool called rapid miner. In this way, data preprocessing was also more successful. In addition, in another study [2] using the same software tool, they also used the cross-validation technique. What distinguishes this work from theirs is that they use 10-fold instead of 5-fold. Thus, the diversity required to make more generalization is provided. At the same time, they tripled the data set by creating a random sample of the using maximum and minimum values for each feature. In this way, they have increased the number of samples that are less to generalize in order to give better results.

4. The Approach

We have tried approaches that are known to work well on these data sets or similar data sets and have been proven in

*Equal contribution [1]Hacettepe University, Department of Computer Engineering. Correspondence to: <>.

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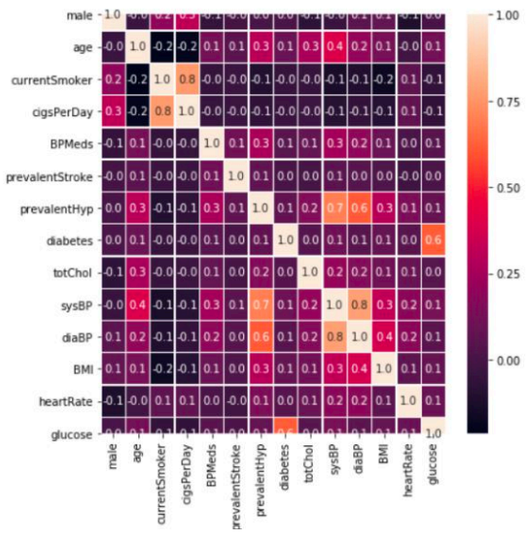

Histopathological Cancer Detection by Using Convolutional Neural Network

Bahar Bender [1] Ezgi Türkokuloğlu [1] Furkan Kaya [1]

Abstract

According to research, the risk of people getting cancer increases with each passing year. In this case, machine learning algorithms are required to step into the health sector to provide early diagnosis and speed up the work of pathologists. This paper aims to detect malignant tumors by using histopathological data and to reveal the presence of cancer. For this purpose, an algorithm has been developed to predict the presence of metastatic cancer in small image patches (96x96px) from high-resolution pathology scans. Our data set will be a modified data set obtained by subtracting duplicates from the PatchCamelyon (PCam) benchmark dataset (Veeling et al., 2018). By supporting various parameters and improvements, we applied the Convolutional Neural Network and reached the highest AUC value of 97.56% as the measurement metric.

1. Introduction

"Cancer develops when normal cells in a particular part of the body begin to grow out of control. Cancer is the second leading cause of death in the world after cardiovascular diseases. Today, millions of cancer people extend their life due to early identification and treatment." (Sudhakar, 2009)

According to research, 14 million people are diagnosed with cancer every year in the world and more than 32 million people live with cancer. In our country, approximately 150 thousand cancer is diagnosed every year. Besides, cancer in almost every country is showing an increase of 1–2 percent per year. Due to advances in early diagnosis and treatment, cancer is now among the curable diseases. Therefore, the biggest motivation in the project is to be able to diagnose cancer much faster and hope for the lives of many more people.

Histopathology is a branch of pathology specializing in

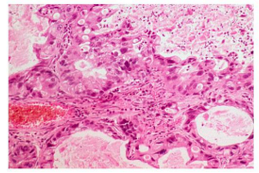

Figure 1. Example of histopathological image

histological examination of diseased tissue. Histopathology, which is an important tool for anatomic pathology, is also used for accurate and definitive diagnosis of cancer and other diseases and is of great importance in this respect (Vik). For this reason, histopathology will be used for cancer detection in our project.

In this work, we aim to identify metastatic cancer in small image patches taken from larger digital pathology scans. Areas with a high proportion of tumor tissue will be detected and regions with benign tissues will be eliminated. In this way, pathologists will be able to focus on more difficult and suspicious cases to diagnose. This saves time for pathologists and increases the chance of early detection. In this project, we aim to implement a binary classification algorithm to solve our problem. In order to implement this algorithm, we plan to use convolutional neural networks.

2. Related Work

The process of detecting cancerous tissues on histopathological images has been studied on many individuals and different classification methods and architectures have been used. According to Bastiaan S. Veeling (Xiao et al., 2017), the identification and classification of metastatic breast cancer was performed on digital full-slide images of sentinel lymph node biopsies using ResNeXt, a 101-layer network

*Equal contribution [1]Hacettepe University, Department of Computer Engineering. Correspondence to: <>.

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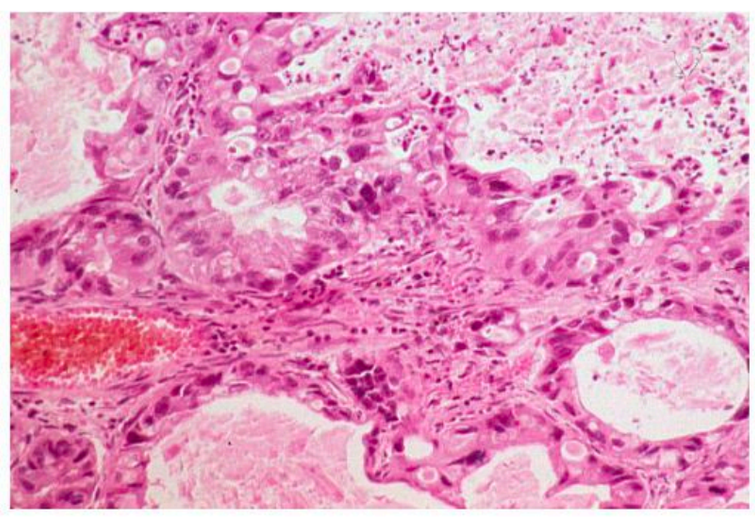


Collaboration Policy

- All work on assignments have to be done **individually**. The course project, however, can be done **in groups of 2-3**.

- You are encouraged to discuss with your classmates about the given assignments, but these discussions should be carried out in an abstract way.

- **In short, turning in someone else's work, in whole or in part, as your own will be considered as a violation of academic integrity.**

- Please note that the former condition also holds for the material found on the web as everything on the web has been written by someone else.

http://www.plagiarism.org/plagiarism-101/prevention/

Course Outline

- **Week1** Overview of Machine Learning, Nearest Neighbor Classifier
- **Week2** Linear Regression, Least Squares

Assg1 out

- **Week3** Machine Learning Methodology
- **Week4** Statistical Estimation: MLE, MAP, Naïve Bayes Classifier

Assg1 due

- **Week5** Linear Classification Models: Logistic Regression, Linear Discriminant Functions, Perceptron

Assg2 out

- **Week6** Neural Networks

Course project proposal due

- **Week7** Deep Learning

Assg2 due

Course Outline (cont'd.)

- **Week8** Support Vector Machines (SVMs)

Assg3 out

- **Week9** *Midterm Exam*

- **Week10** Multi-class SVM, Kernels, Support Vector Regression

Assg3 due

- **Week11** Decision Tree Learning, Ensemble Methods: Bagging, Random Forests, Boosting

Project progress report due

- **Week12** Clustering: K-Means Clustering,

- **Week13** Clustering: Spectral Clustering, Agglomerative Clustering

- **Week14** Dimensionality Reduction: PCA, SVD, ICA, Autoencoders
  Course Wrap-up, Project Presentations

Final project report due

Machine Learning:

An Overview

Quotes

- *"If you were a current computer science student what area would you start studying heavily?*
  - *–Answer: Machine Learning.*
  - *–"The ultimate is computers that learn"*

–Bill Gates, Reddit AMA

- *"Machine learning is today's discontinuity"*

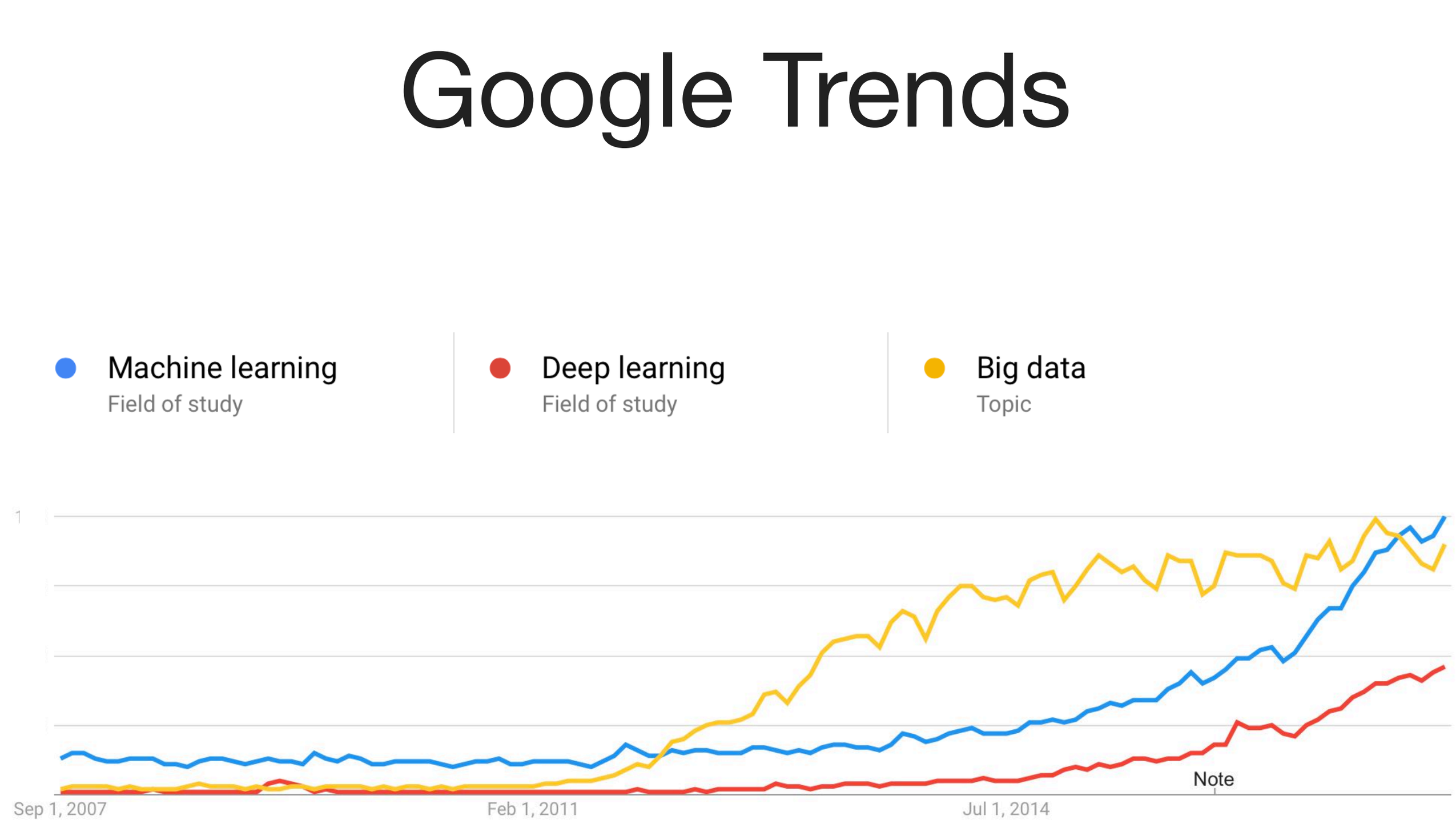
–Jerry Yang,
Co-founder, Yahoo

- *"AI is the new electricity! Electricity transformed countless industries; AI will now do the same."*

–Andrew Ng

slide by David Sontag

Google Trends



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MACHINE INTELLIGENCE 3.0

2017 Edition

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Two definitions of learning

(1) Learning is the acquisition of knowledge about the world.

Kupfermann (1985)

(2) Learning is an adaptive change in behavior caused by experience.

Shepherd (1988)

Empirical Inference

- Drawing conclusions from empirical data (observations, measurements)

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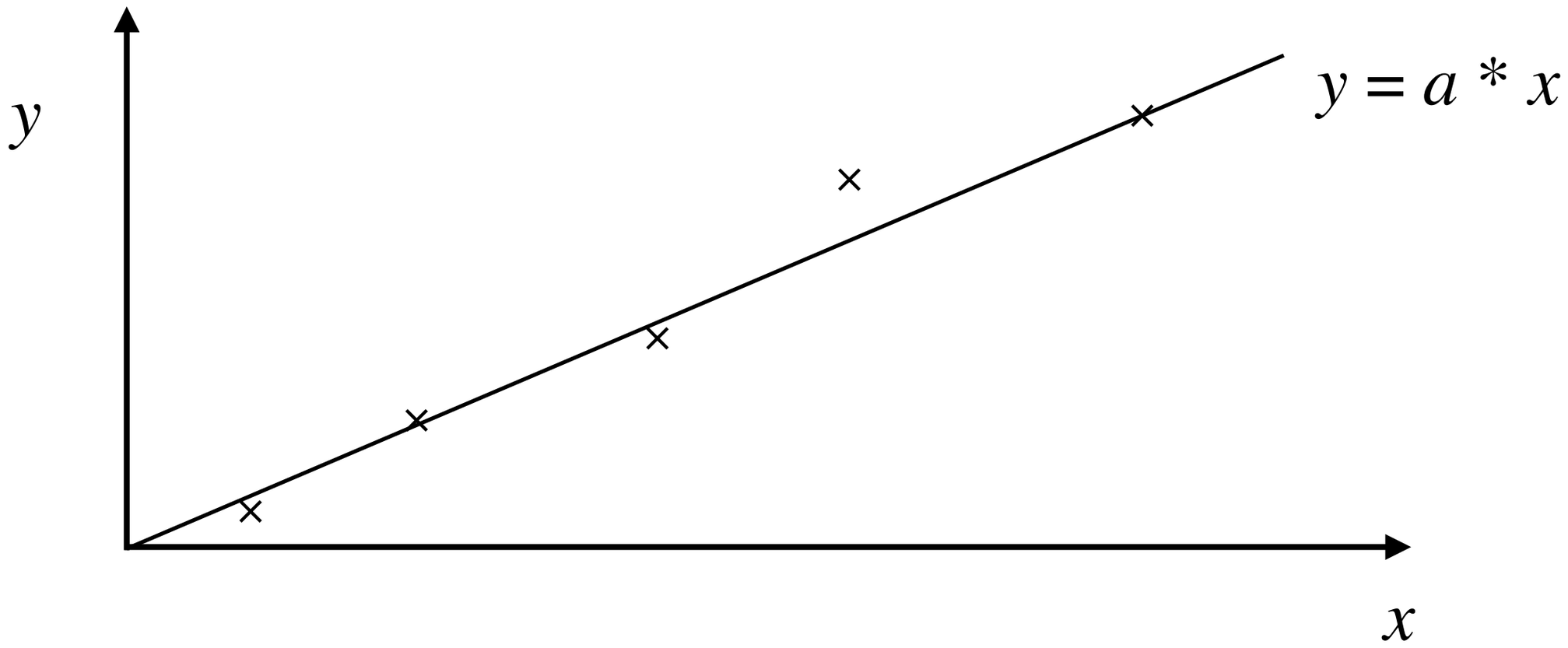
- Example 1: scientific inference

slide by Bernhard Schölkopf

Empirical Inference

- Drawing conclusions from empirical data (observations, measurements)
- Example 1: scientific inference



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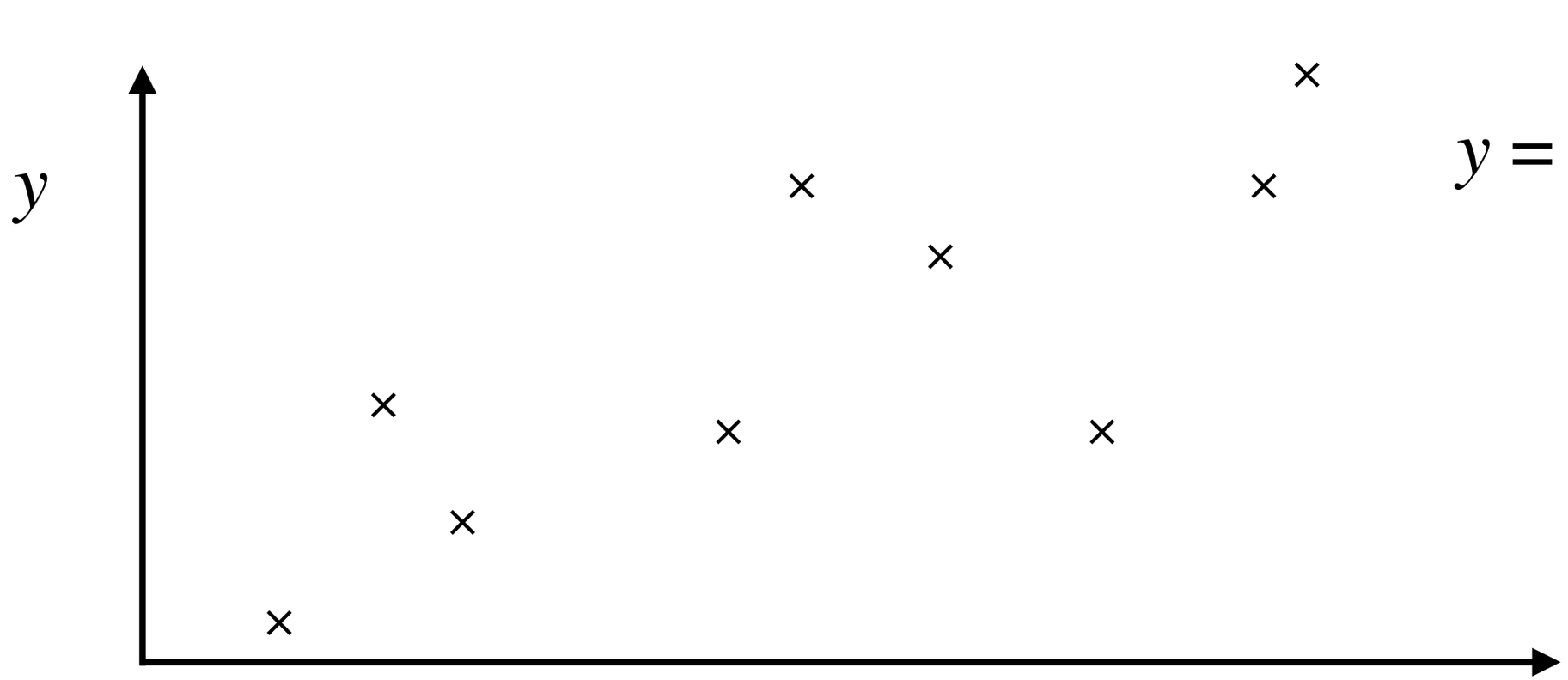
Empirical Inference

- Drawing conclusions from empirical data (observations, measurements)
- Example 1: scientific inference

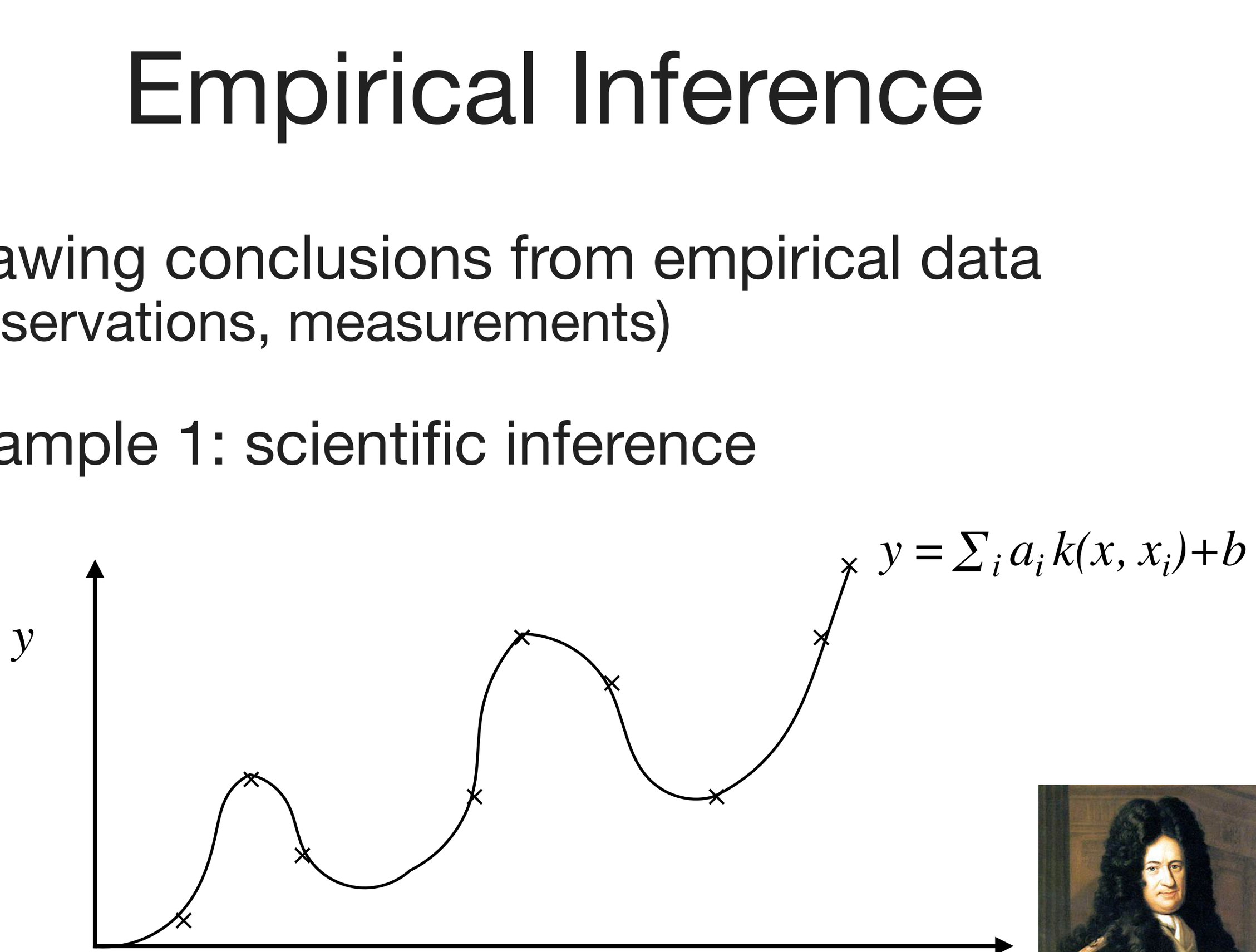


Leibniz, Weyl, Chaitin

slide by Bernhard Schölkopf

Empirical Inference

- Drawing conclusions from empirical data (observations, measurements)
- Example 1: scientific inference



Leibniz, Weyl, Chaitin

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Empirical Inference

- Example 2: perception

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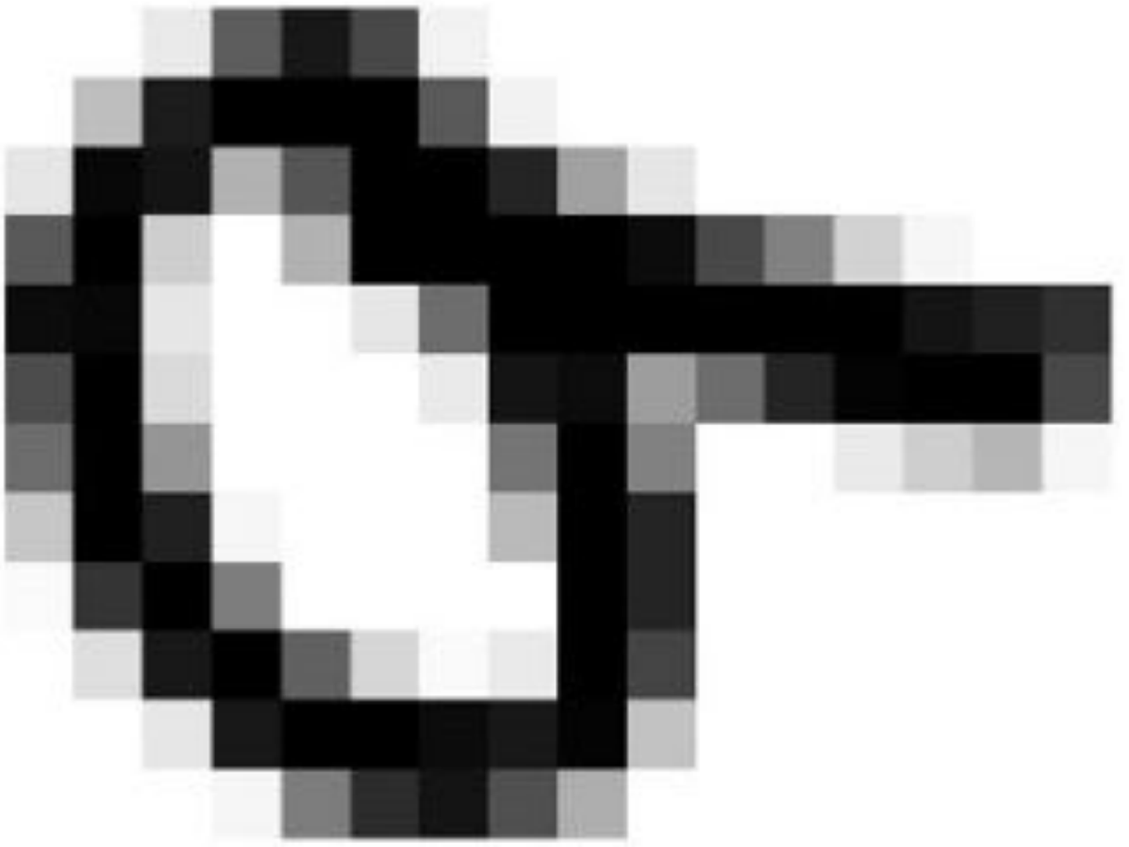

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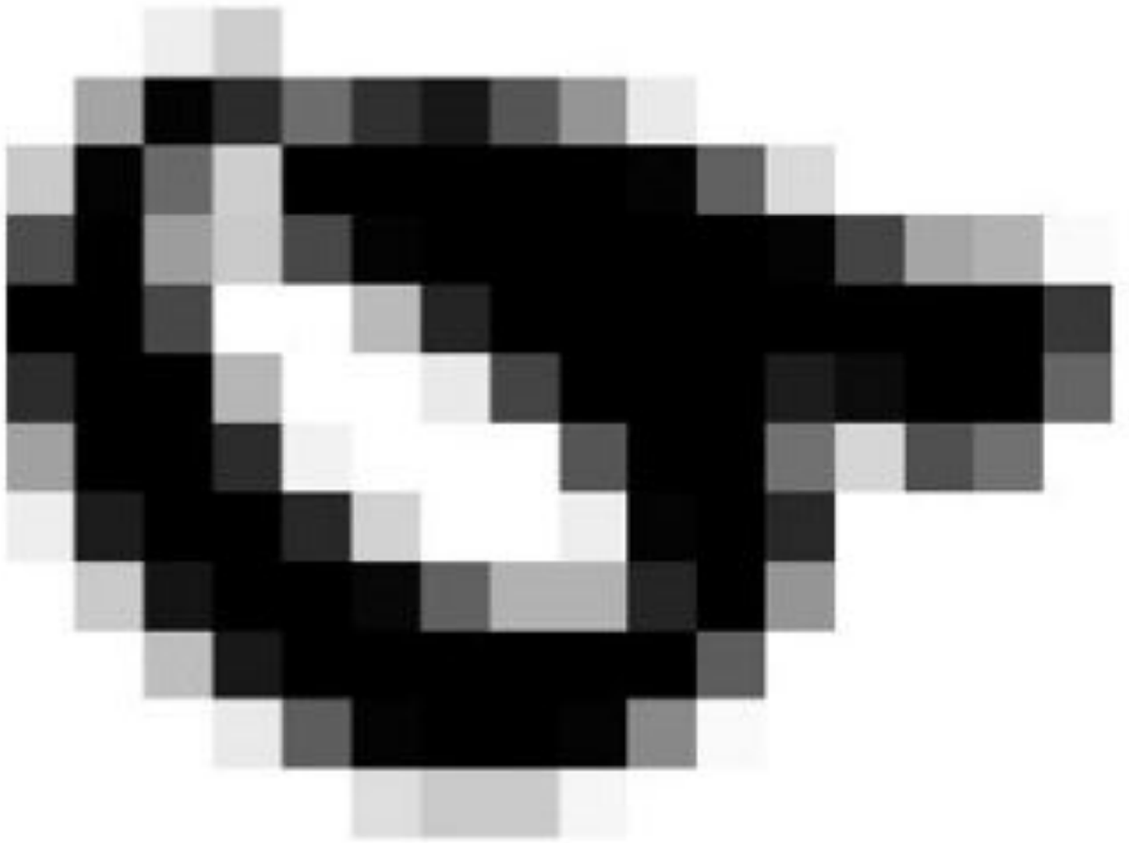

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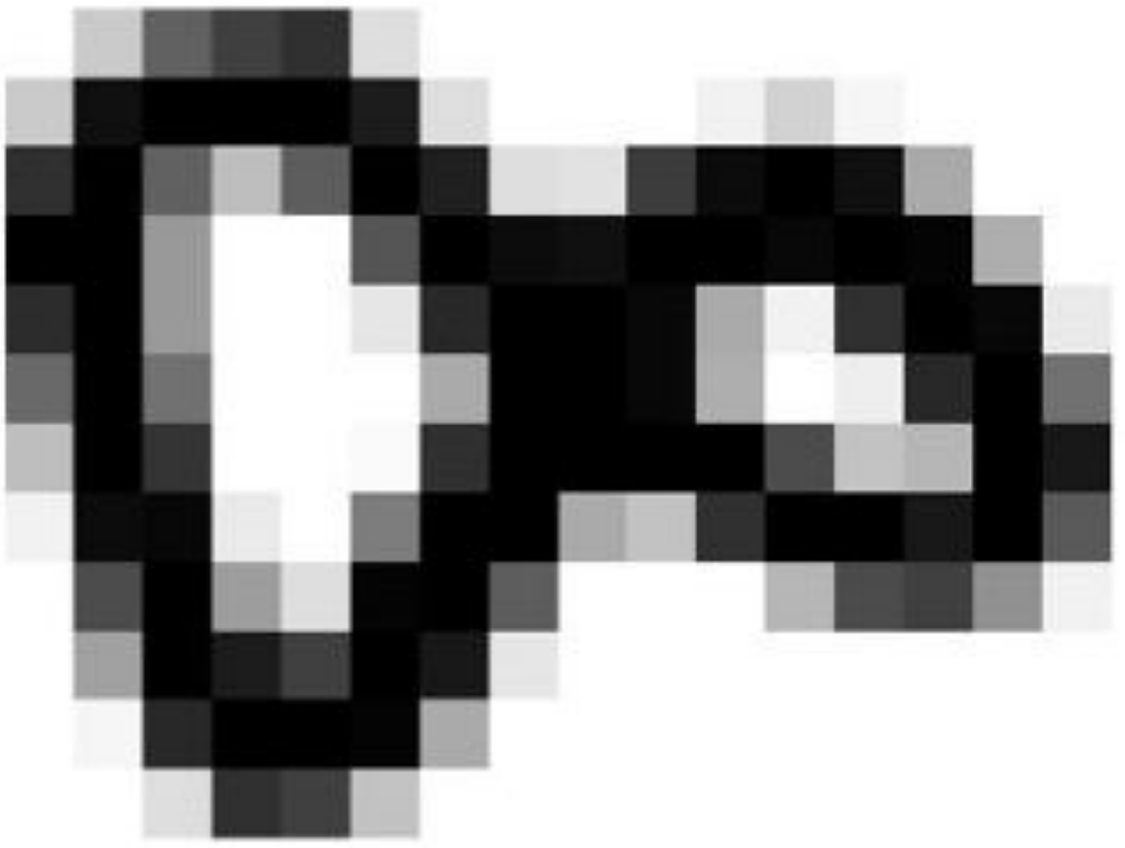

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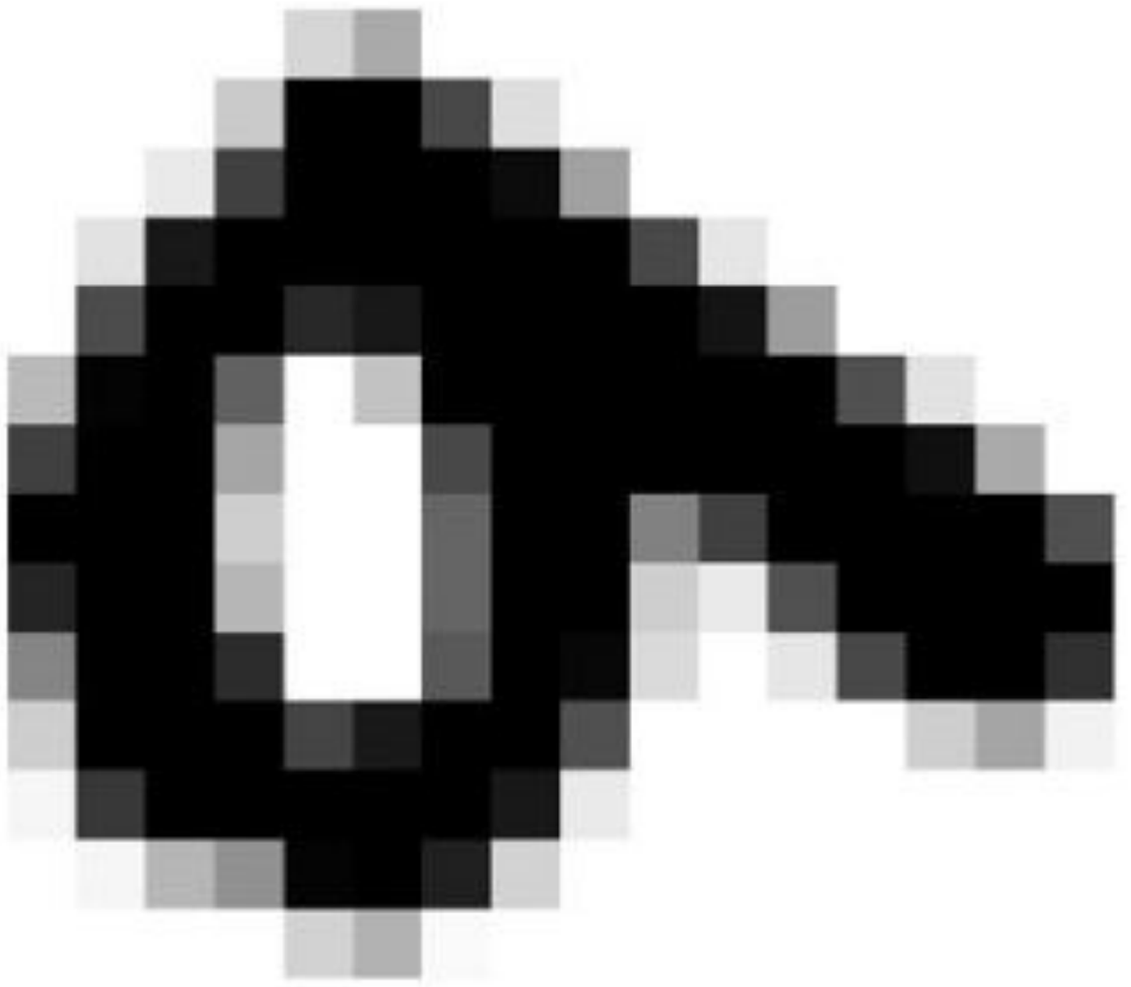

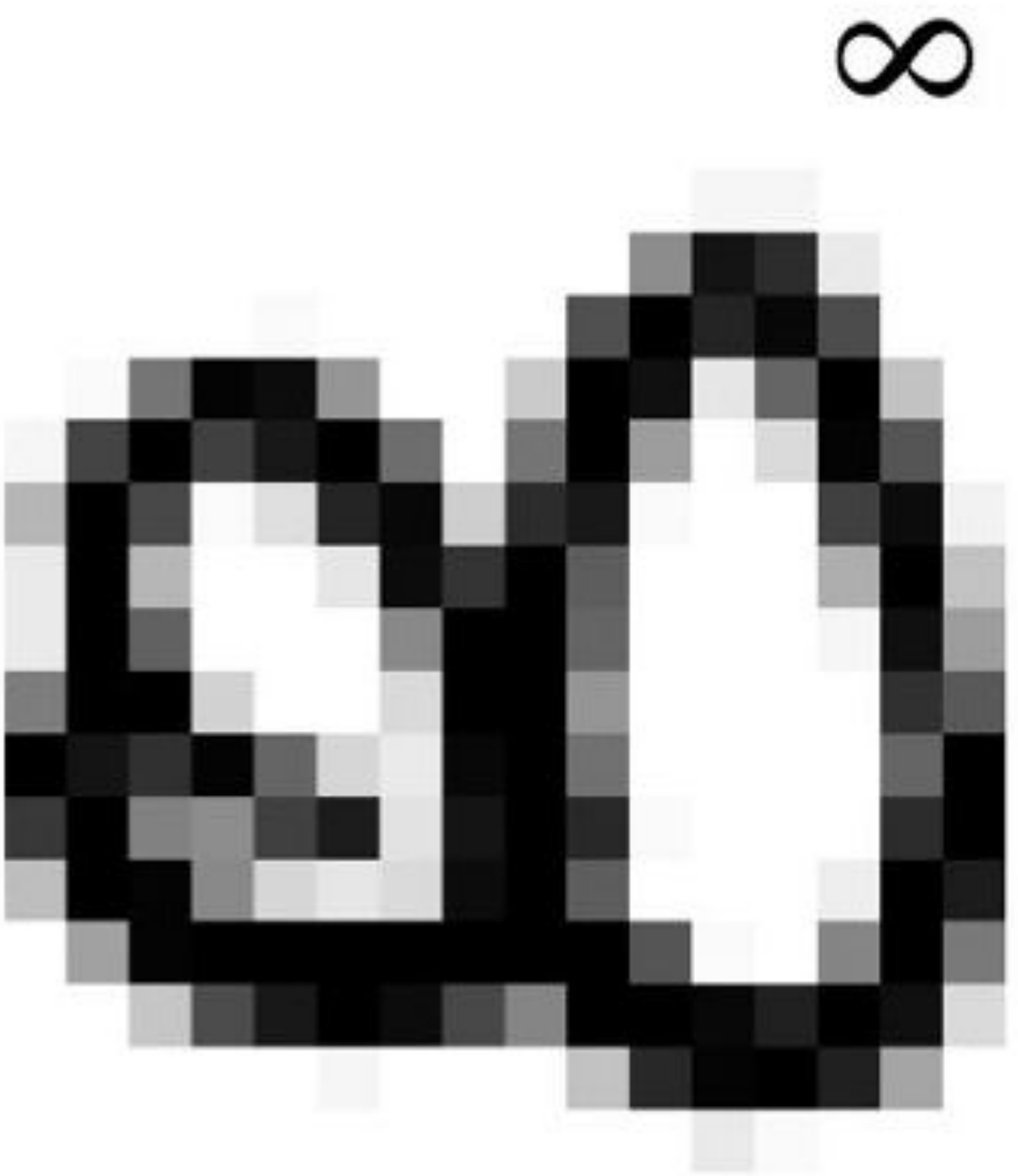

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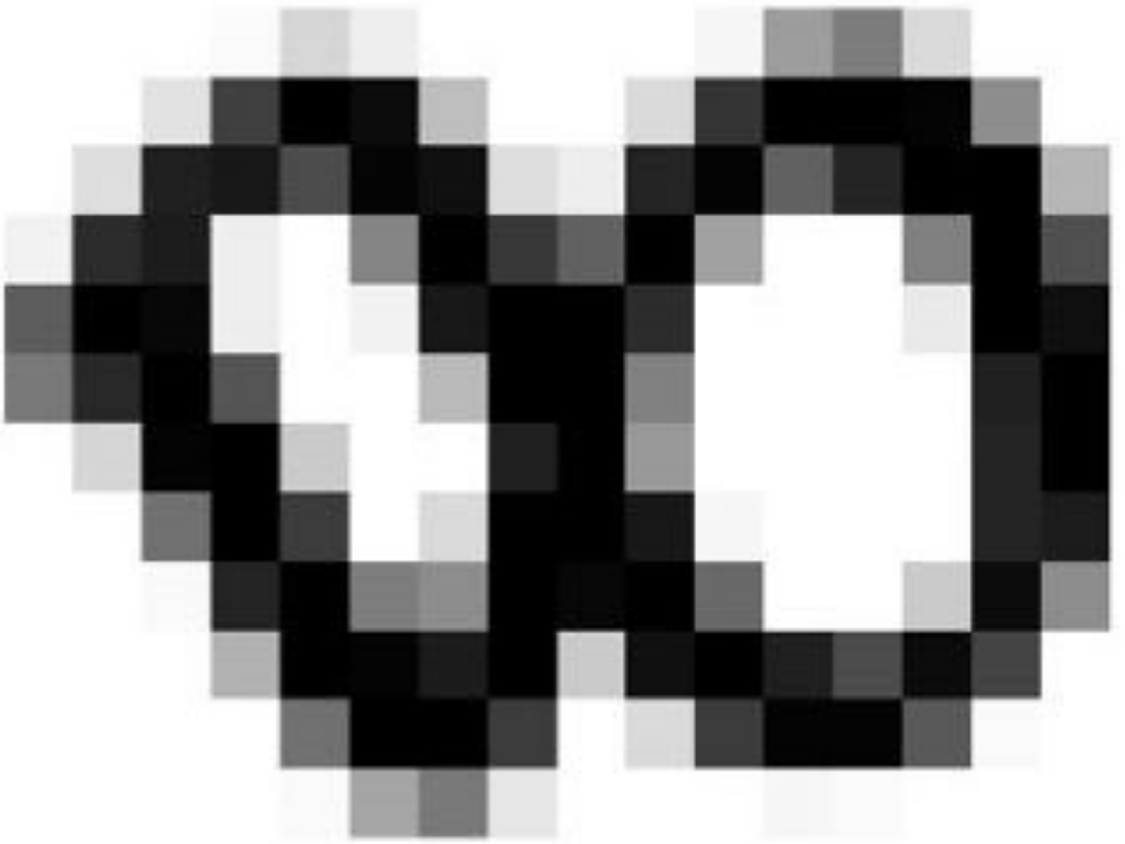

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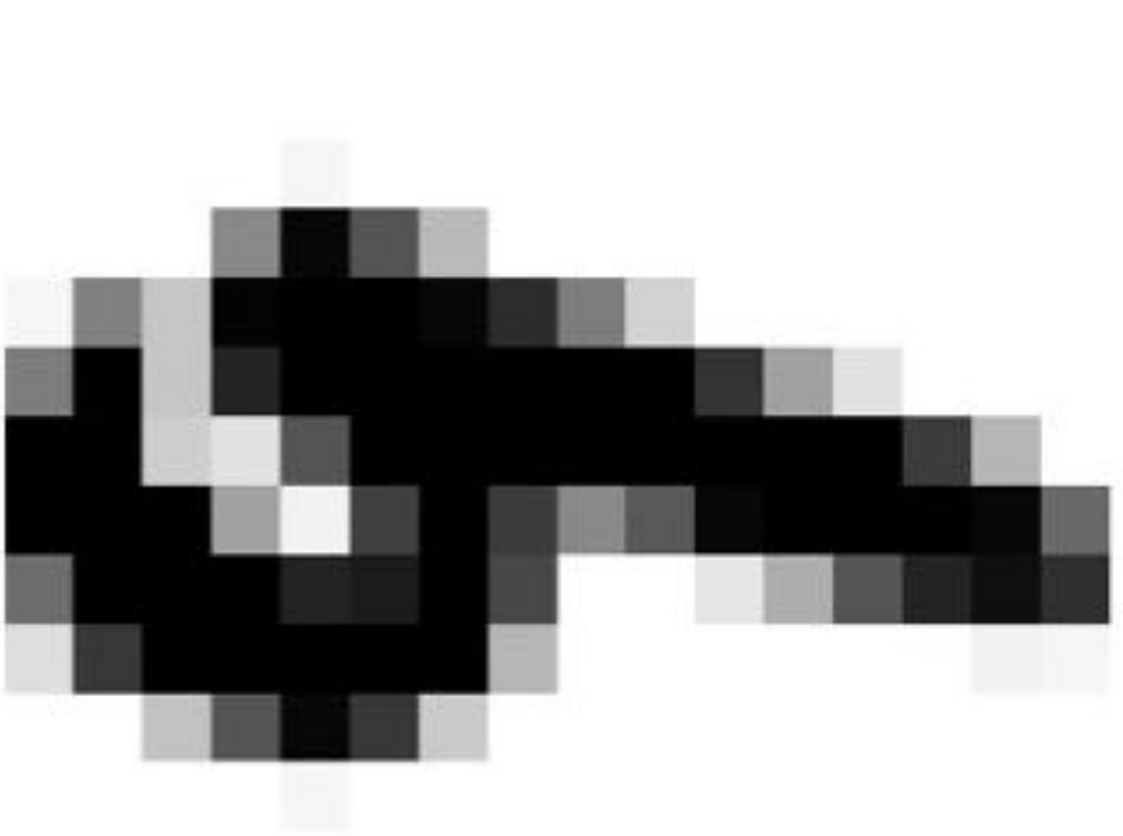

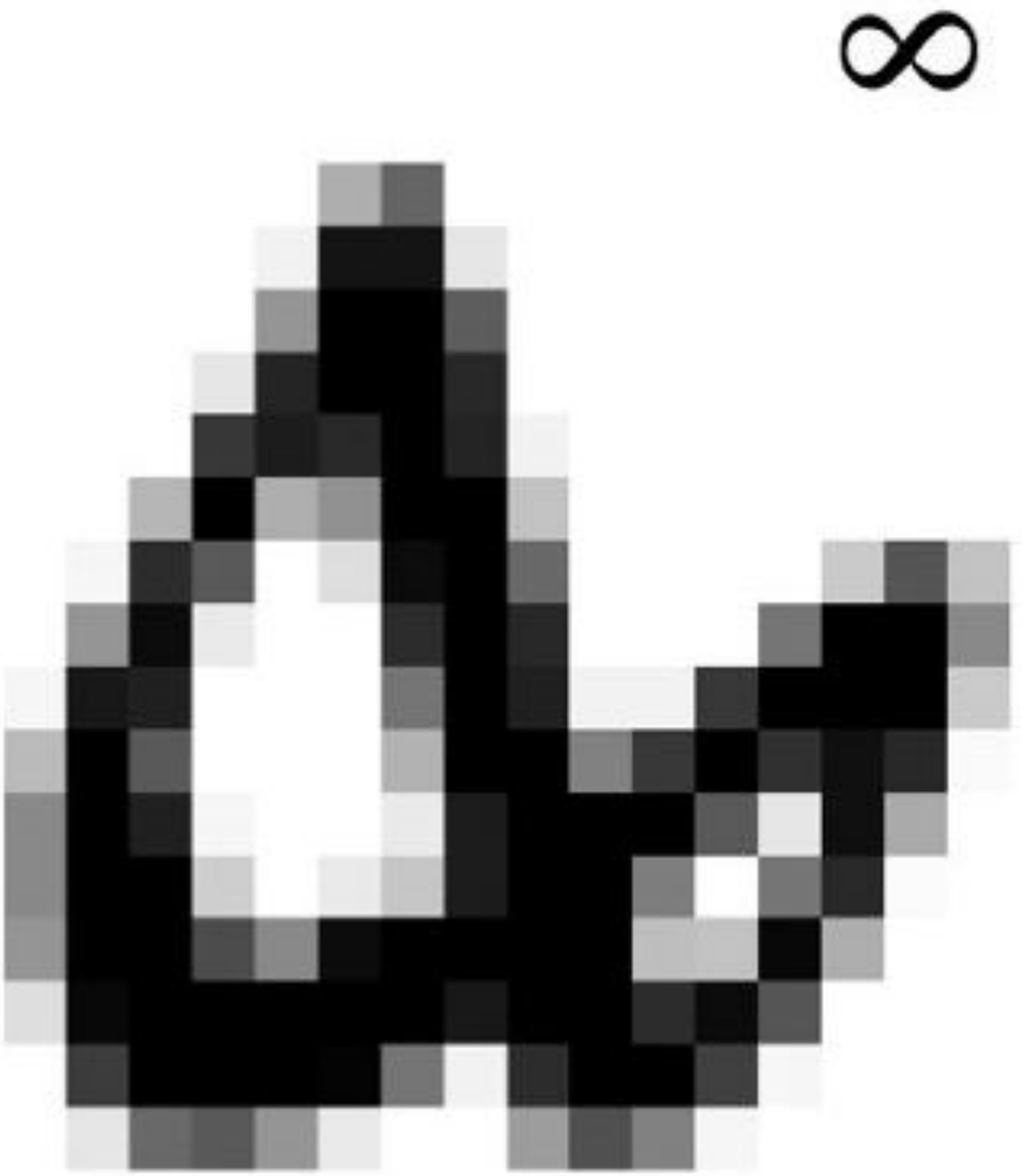

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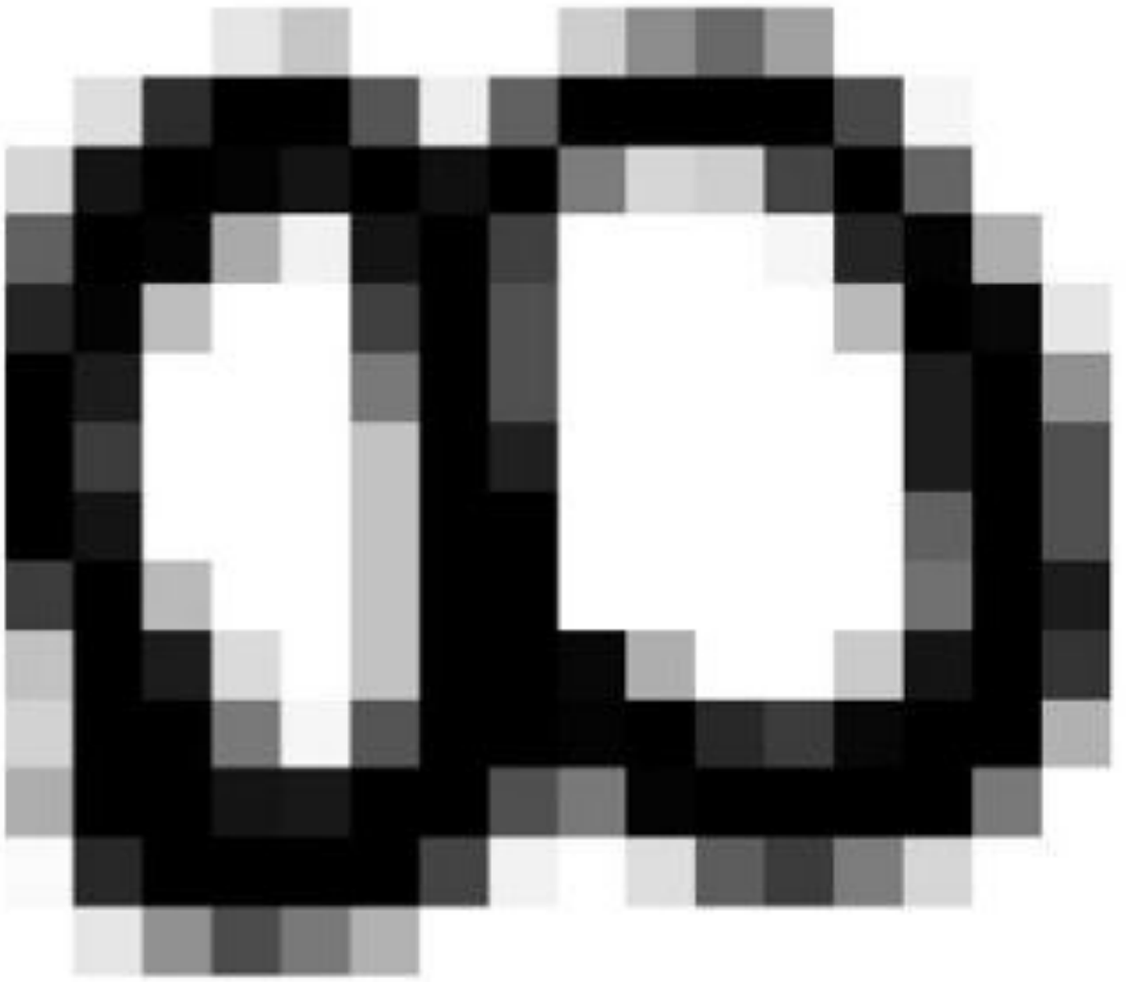

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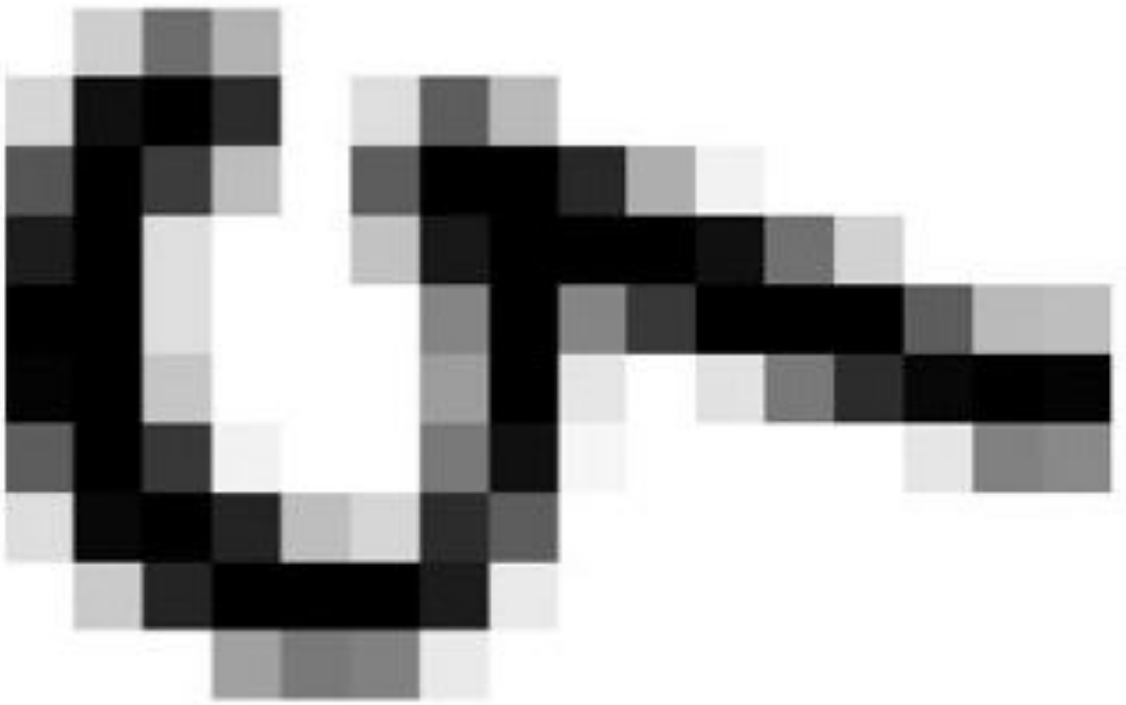

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Empirical Inference

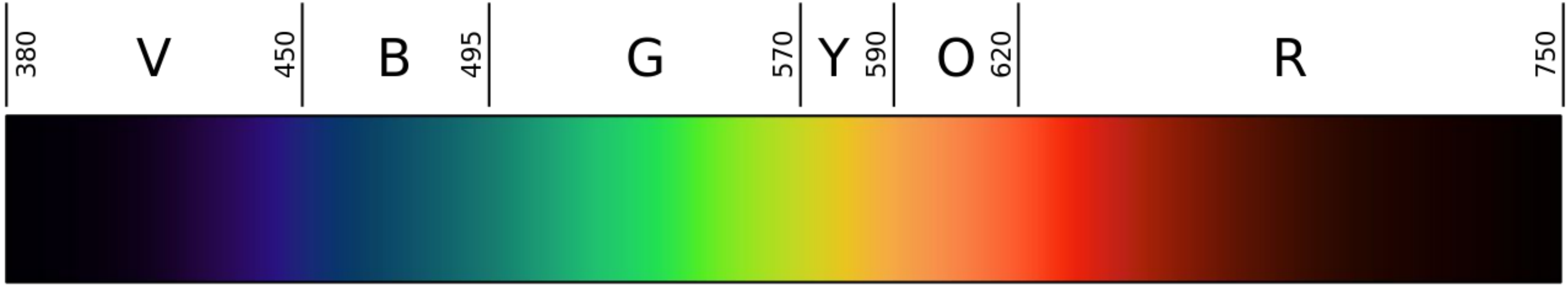
- Example2: perception

"The brain is nothing but a statistical decision organ"

H. Barlow

slide by Bernhard Schölkopf

Color Perception



X

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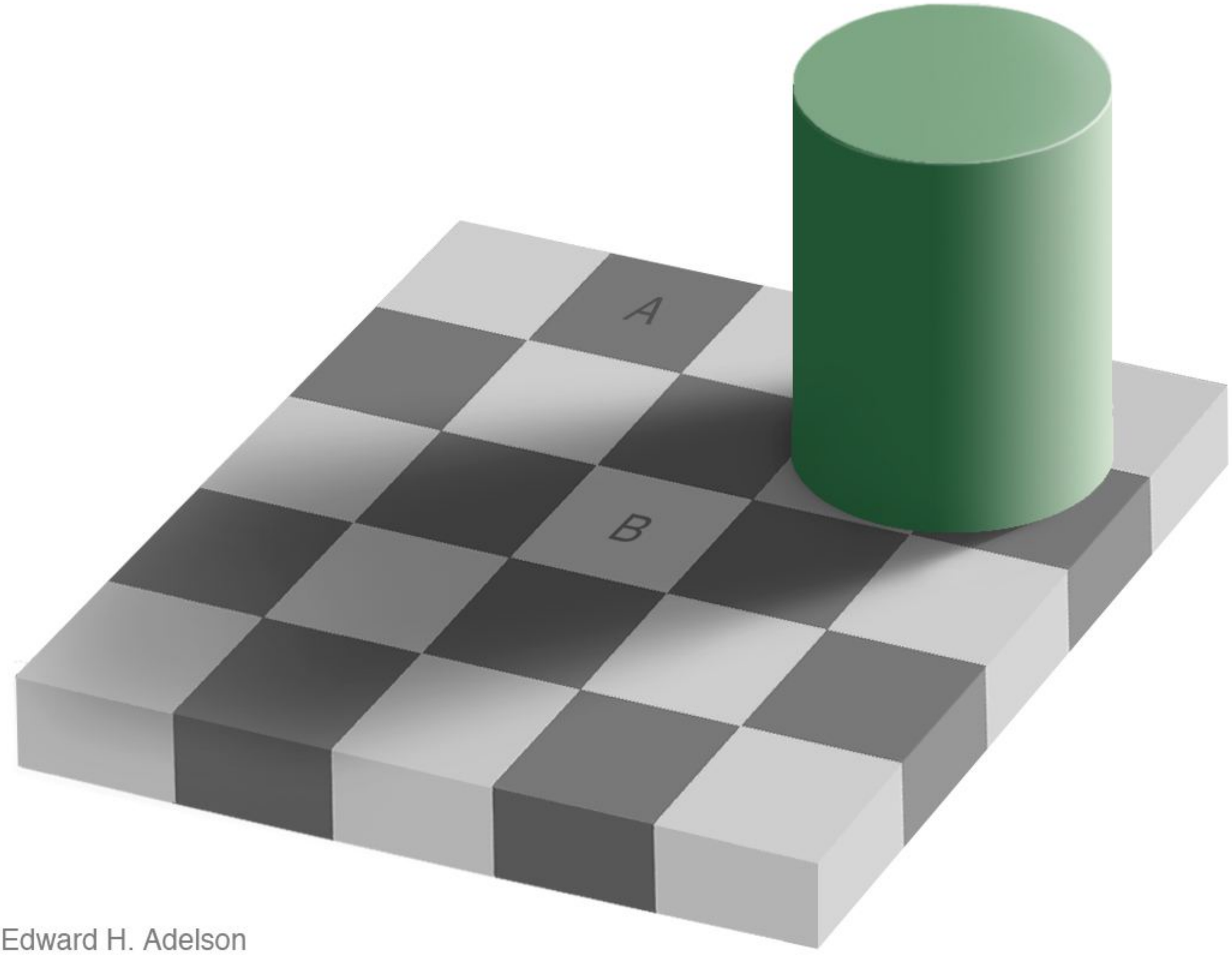
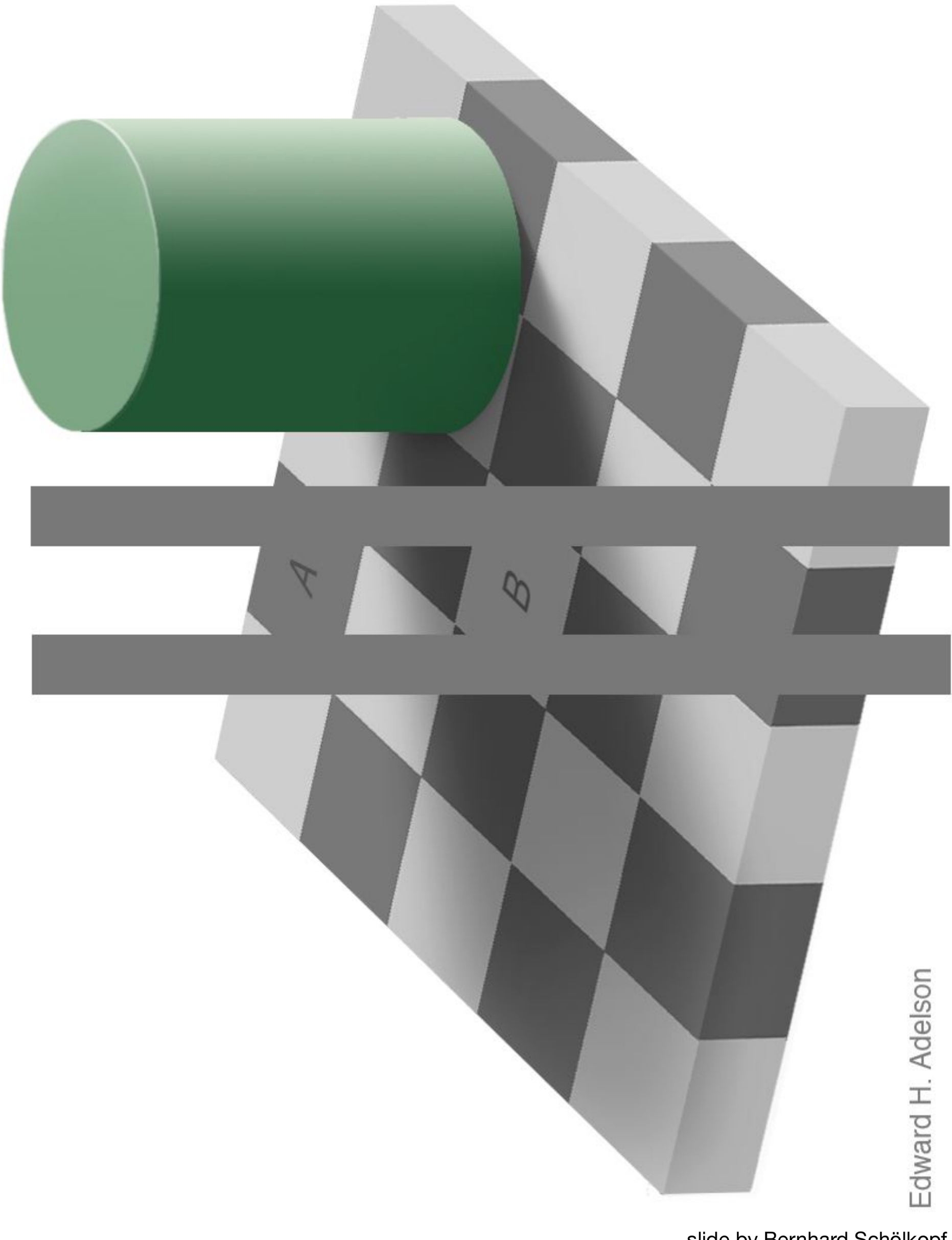


Edward H. Adelson



slide by Bernhard Schölkopf

*reflected light = illumination * reflectance*

slide by Bernhard Schölkopf

Hard Inference Problems

- High dimensionality — consider many factors simultaneously to find regularity
- Complex regularities — nonlinear; nonstationary, etc.
- Little prior knowledge — e.g. no mechanistic models for the data
- Need large data sets — processing requires computers and automatic inference methods

slide by Bernhard Schölkopf

What is machine learning?

Example: Netflix Challenge

- Goal: Predict how a viewer will rate a movie
- 10% improvement = 1 million dollars

slide by Yaser Abu-Mostapha

Example: Netflix Challenge

- Goal: Predict how a viewer will rate a movie
- 10% improvement = 1 million dollars
- Essence of Machine Learning:
  - A pattern exists
  - We cannot pin it down mathematically
  - We have data on it

slide by Yaser Abu-Mostapha

AlphaGo vs Lee Sedol

NVIDIA BB8 AI Car

End to End Learning for Self-Driving Cars

Mariusz Bojarski
NVIDIA Corporation
Holmdel, NJ 07735

Davide Del Testa
NVIDIA Corporation
Holmdel, NJ 07735

Daniel Dworakowski
NVIDIA Corporation
Holmdel, NJ 07735

Bernhard Firner
NVIDIA Corporation
Holmdel, NJ 07735

Beat Flepp
NVIDIA Corporation
Holmdel, NJ 07735

Prasoon Goyal
NVIDIA Corporation
Holmdel, NJ 07735

Lawrence D. Jackel
NVIDIA Corporation
Holmdel, NJ 07735

Mathew Monfort
NVIDIA Corporation
Holmdel, NJ 07735

Urs Muller
NVIDIA Corporation
Holmdel, NJ 07735

Jiakai Zhang
NVIDIA Corporation
Holmdel, NJ 07735

Xin Zhang
NVIDIA Corporation
Holmdel, NJ 07735

Jake Zhao
NVIDIA Corporation
Holmdel, NJ 07735

Karol Zieba
NVIDIA Corporation
Holmdel, NJ 07735

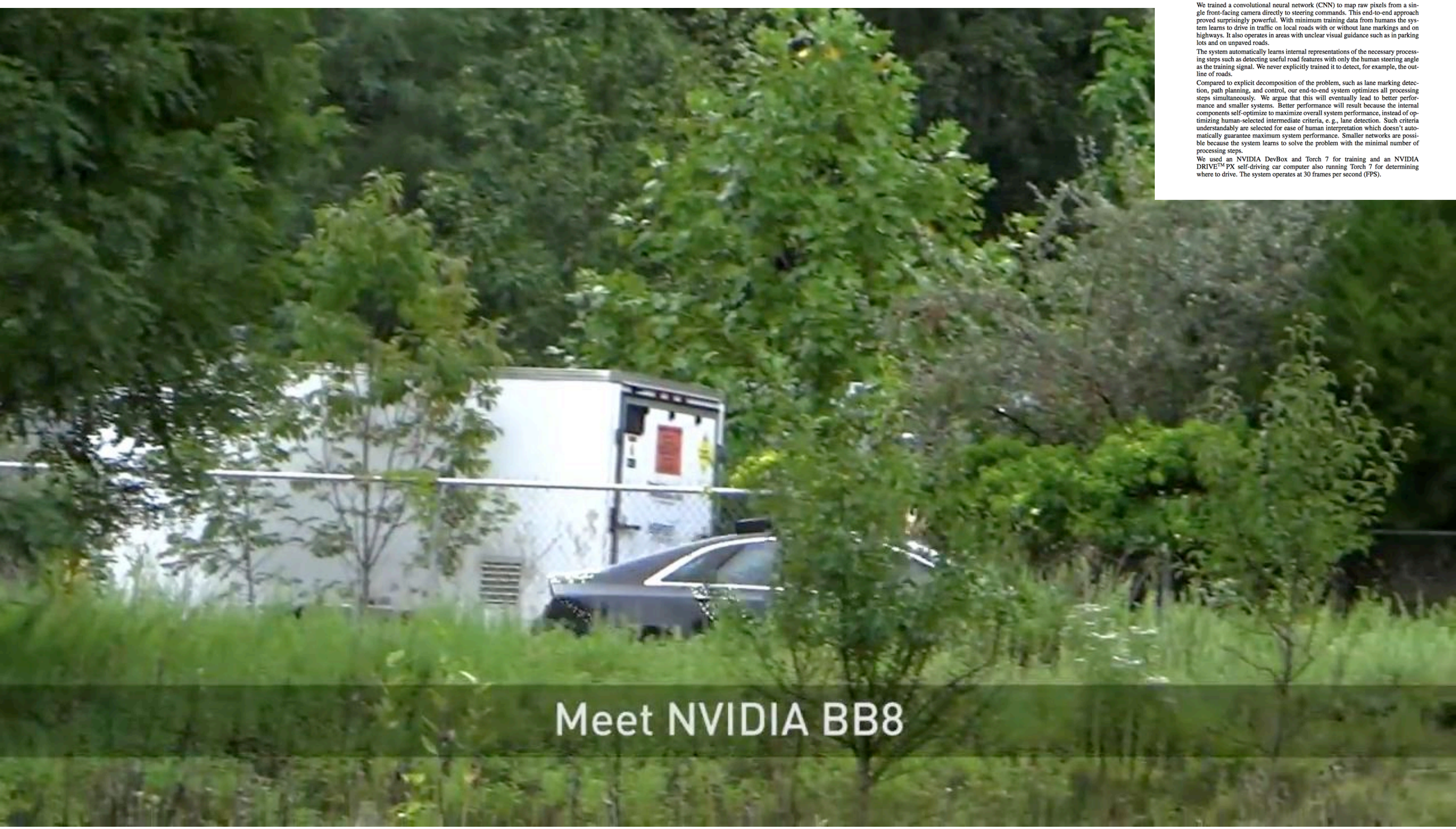
Abstract

We trained a convolutional neural network (CNN) to map raw pixels from a single front-facing camera directly to steering commands. This end-to-end approach proved surprisingly powerful. With minimum training data from humans the system learns to drive in traffic on local roads with or without lane markings and on highways. It also operates in areas with unclear visual guidance such as in parking lots and on unpaved roads.

The system automatically learns internal representations of the necessary processing steps such as detecting useful road features with only the human steering angle as the training signal. We never explicitly trained it to detect, for example, the outline of roads.

Compared to explicit decomposition of the problem, such as lane marking detection, path planning, and control, our end-to-end system optimizes all processing steps simultaneously. We argue that this will eventually lead to better performance and smaller systems. Better performance will result because the internal components self-optimize to maximize overall system performance, instead of optimizing human-selected intermediate criteria, e. g., lane detection. Such criteria understandably are selected for ease of human interpretation which doesn't automatically guarantee maximum system performance. Smaller networks are possible because the system learns to solve the problem with the minimal number of processing steps.

We used an NVIDIA DevBox and Torch 7 for training and an NVIDIA DRIVE™ PX self-driving car computer also running Torch 7 for determining where to drive. The system operates at 30 frames per second (FPS).



What is Machine Learning?

- [Arthur Samuel, 1959]
  - Field of study that gives computers
  - the ability to learn without being explicitly programmed

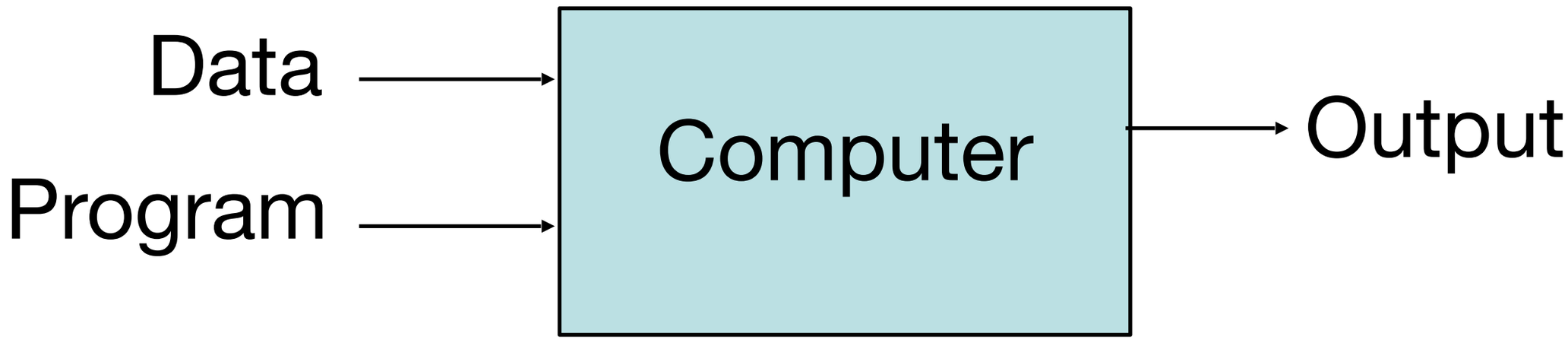
- [Kevin Murphy] algorithms that
  - automatically detect patterns in data
  - use the uncovered patterns to predict future data or other outcomes of interest

- [Tom Mitchell] algorithms that
  - improve their performance (P)
  - at some task (T)
  - with experience (E)

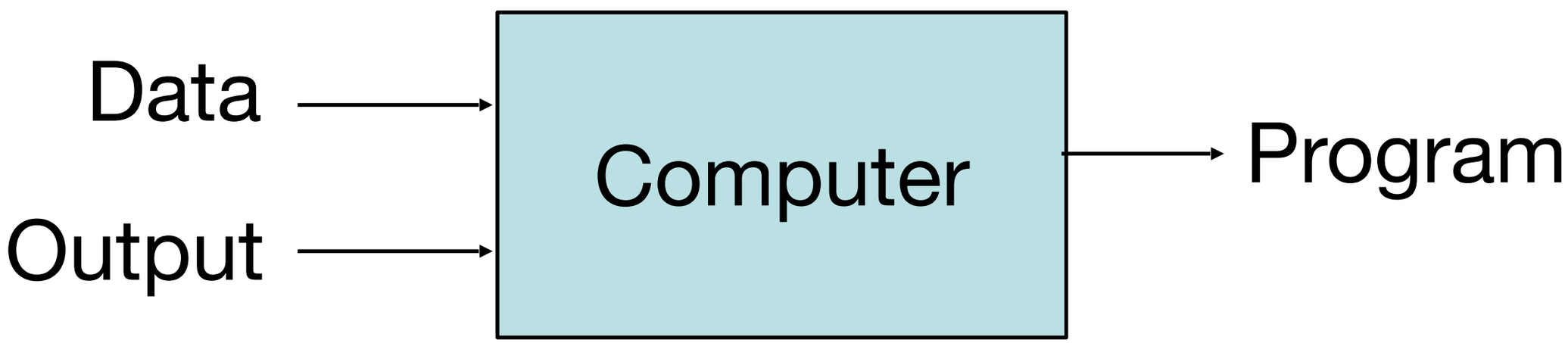
slide by Dhruv Batra

Comparison

- **Traditional Programming**



- **Machine Learning**



Slide by Pedro Domingos, Tom Mitchel, Tom Dietterich

Comparison

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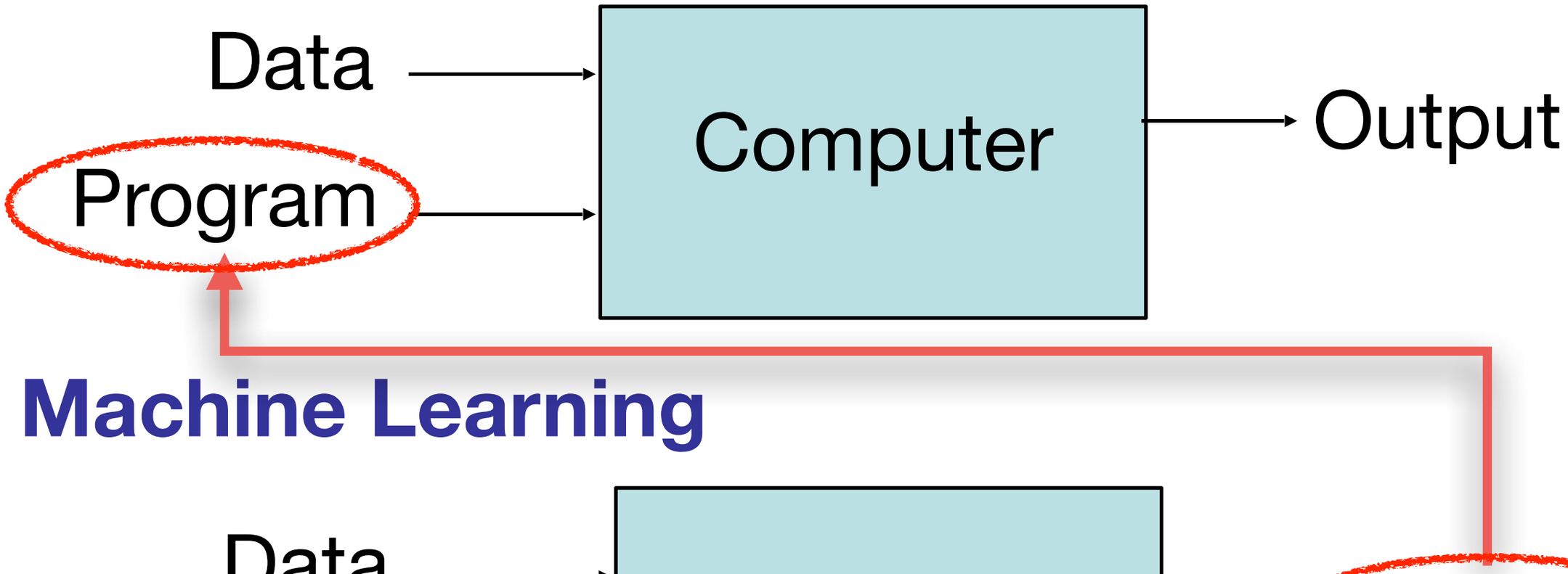
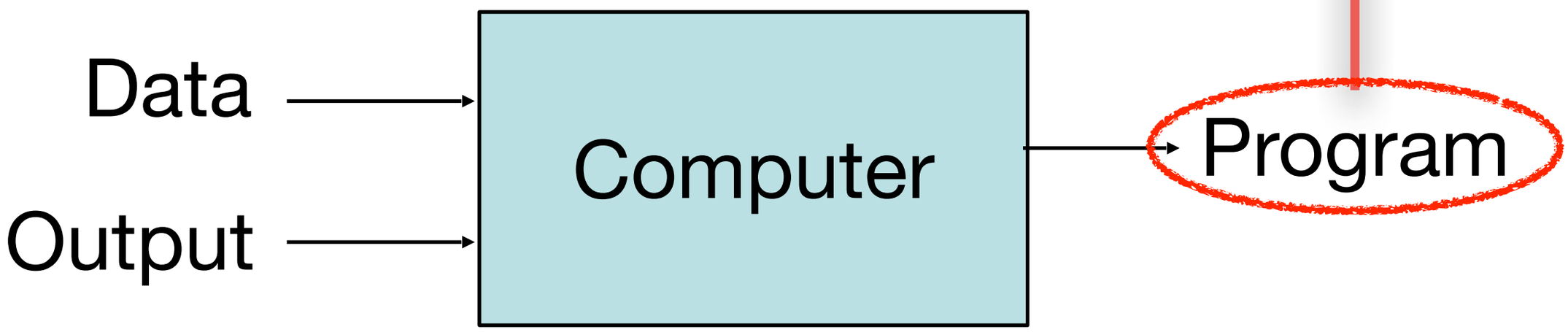


- **Machine Learning**



What is Machine Learning?

- If you are a Scientist

- If you are an Engineer / Entrepreneur
  - Get lots of data
  - Machine Learning
  - ???
  - Profit!

slide by Dhruv Batra

Why Study Machine Learning?

Engineering Better Computing Systems

- Develop systems
  - too difficult/expensive to construct manually
  - because they require specific detailed skills/knowledge
  - ***knowledge engineering bottleneck***

- Develop systems
  - that adapt and customize themselves to individual users.
  - Personalized news or mail filter
  - Personalized tutoring

- Discover new knowledge from large databases
  - Medical text mining (e.g. migraines to calcium channel blockers to magnesium)
  - ***data mining***

slide by Dhruv Batra

Why Study Machine Learning?

Cognitive Science

- Computational studies of learning may help us understand learning in humans
  - and other biological organisms.

  - Hebbian neural learning
    - “Neurons that fire together, wire together.”

slide by Dhruv Batra

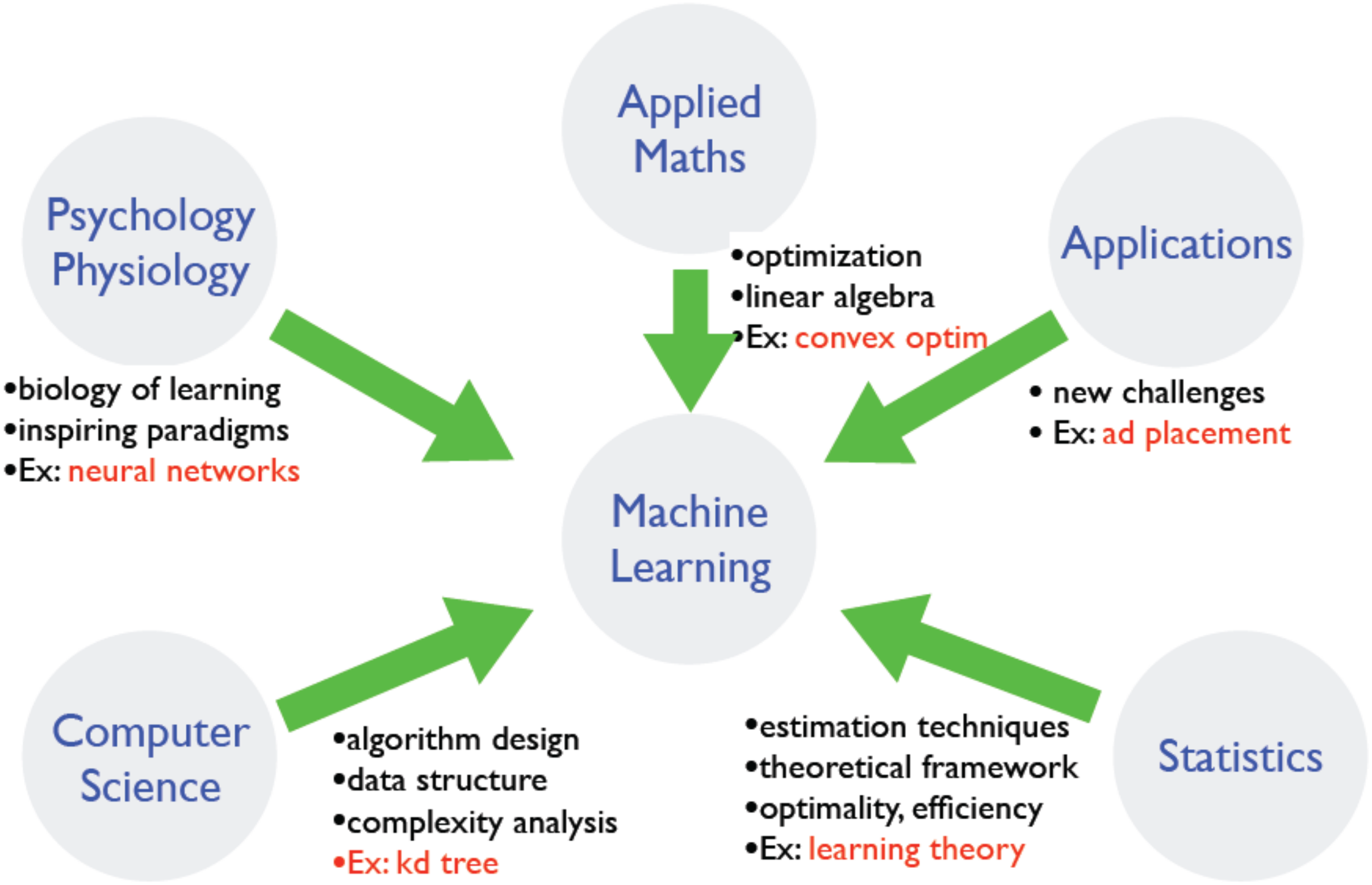
Why Study Machine Learning?

The Time is Ripe

- Algorithms
  - Many basic effective and efficient algorithms available.
- Data
  - Large amounts of on-line data available.
- Computing
  - Large amounts of computational resources available.

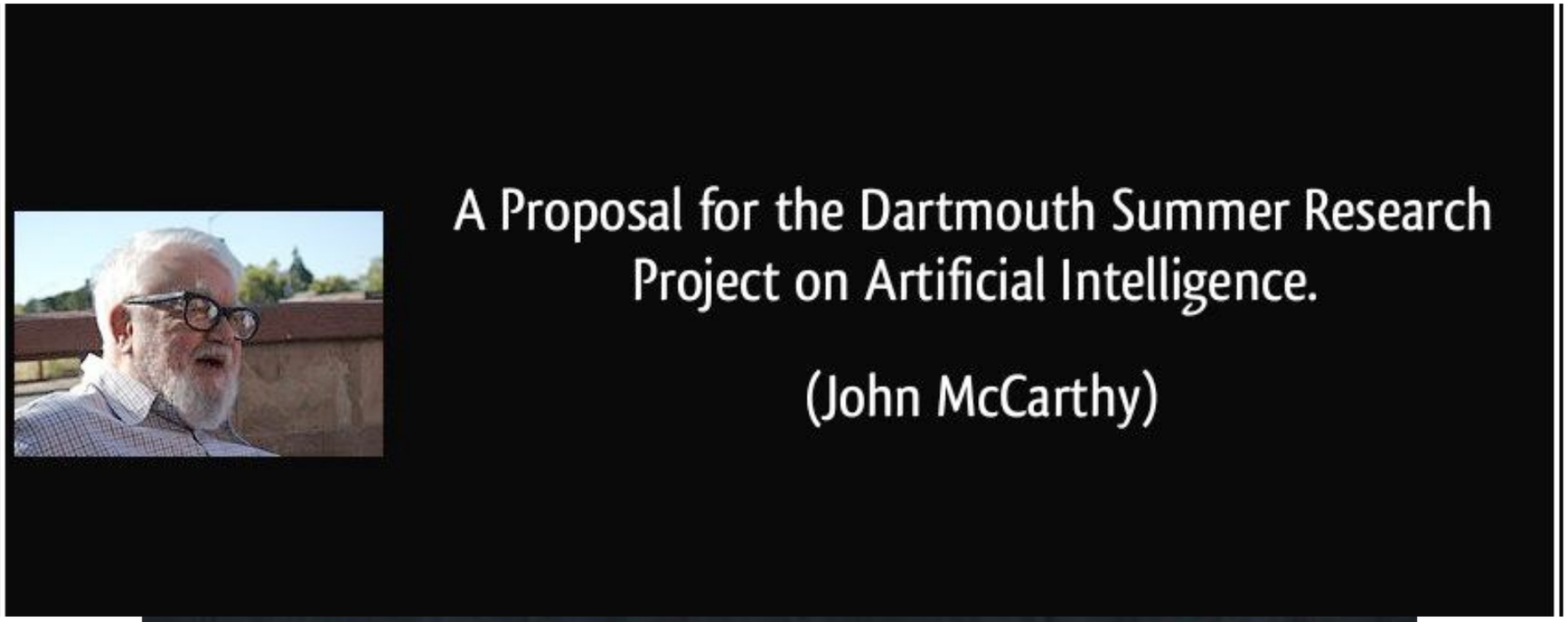
slide by Ray Mooney

Where does ML fit in?



slide by Fei Sha

A Brief History of AI



1956

slide by Dhruv Batra

A Proposal for the

DARTMOUTH SUMMER RESEARCH PROJECT ON ARTIFICIAL INTELLIGENCE

June 17 - Aug. 16

We propose that a 2 month, 10 man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer.

The following are some aspects of the artificial intelligence problem:

1) Automatic Computers

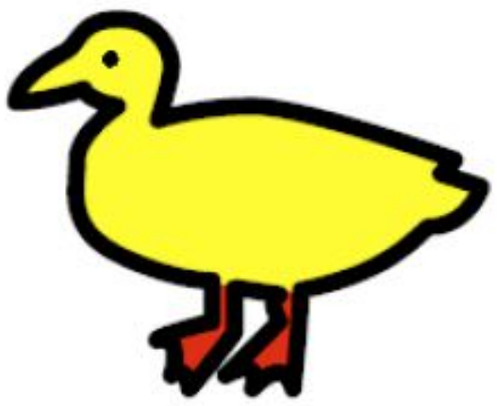
If a machine can do a job, then an automatic calculator can be programmed to simulate the machine. The speeds and memory capacities of present computers may be insufficient to simulate many of the higher functions of the human brain, but the major obstacle is not lack of machine capacity, but our inability to write programs taking full advantage of what we have.

2) How Can a Computer be Programmed to Use a Language

It may be speculated that a large part of human thought consists of manipulating words according to rules of reasoning

Why is AI hard?

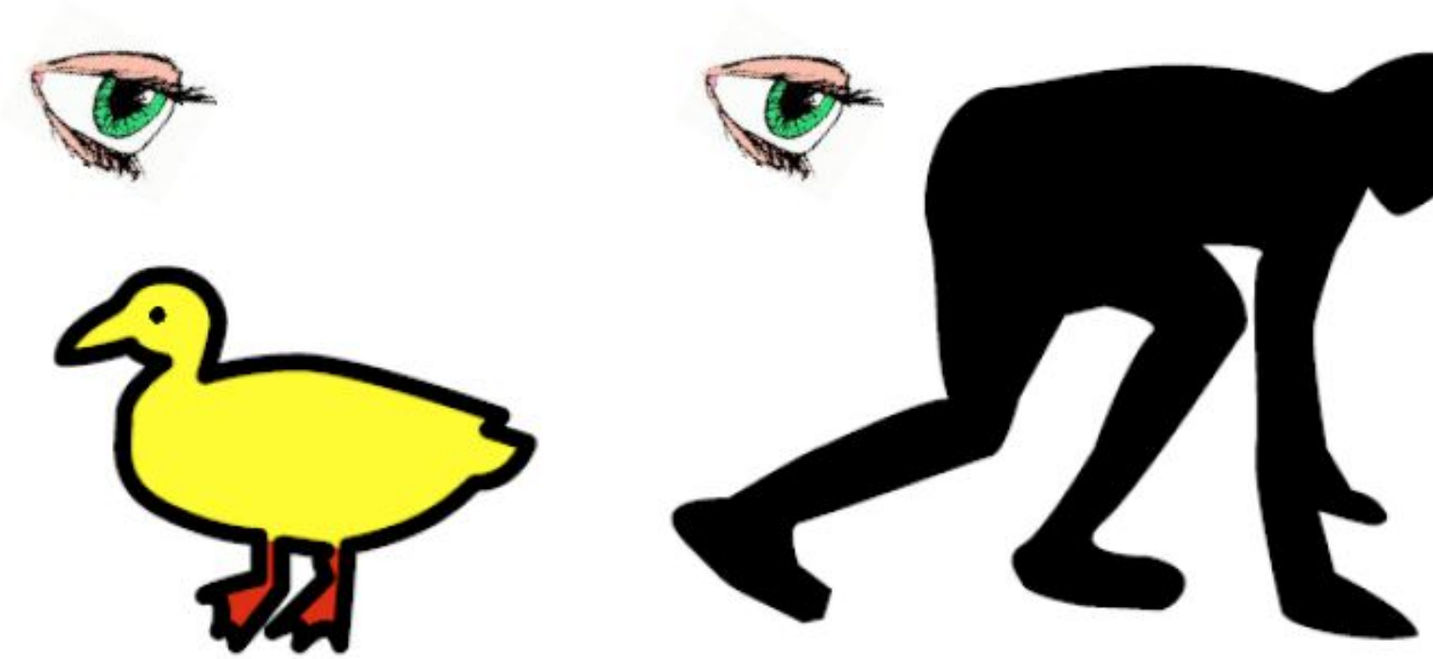
“I saw her duck”



slide by Liang Huang

Image Credit: Liang Huang

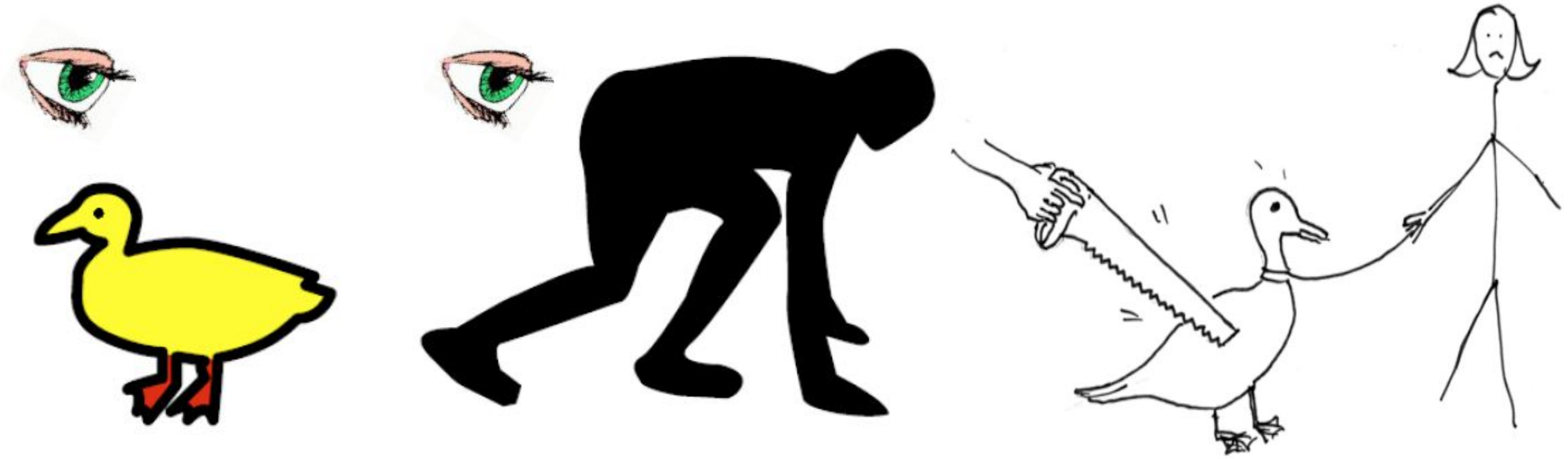
“I saw her duck”



slide by Liang Huang

Image Credit: Liang Huang

“I saw her duck”



slide by Liang Huang

Image Credit: Liang Huang

Why are things working today?

- More compute power
- More data
- Better algorithms/ models

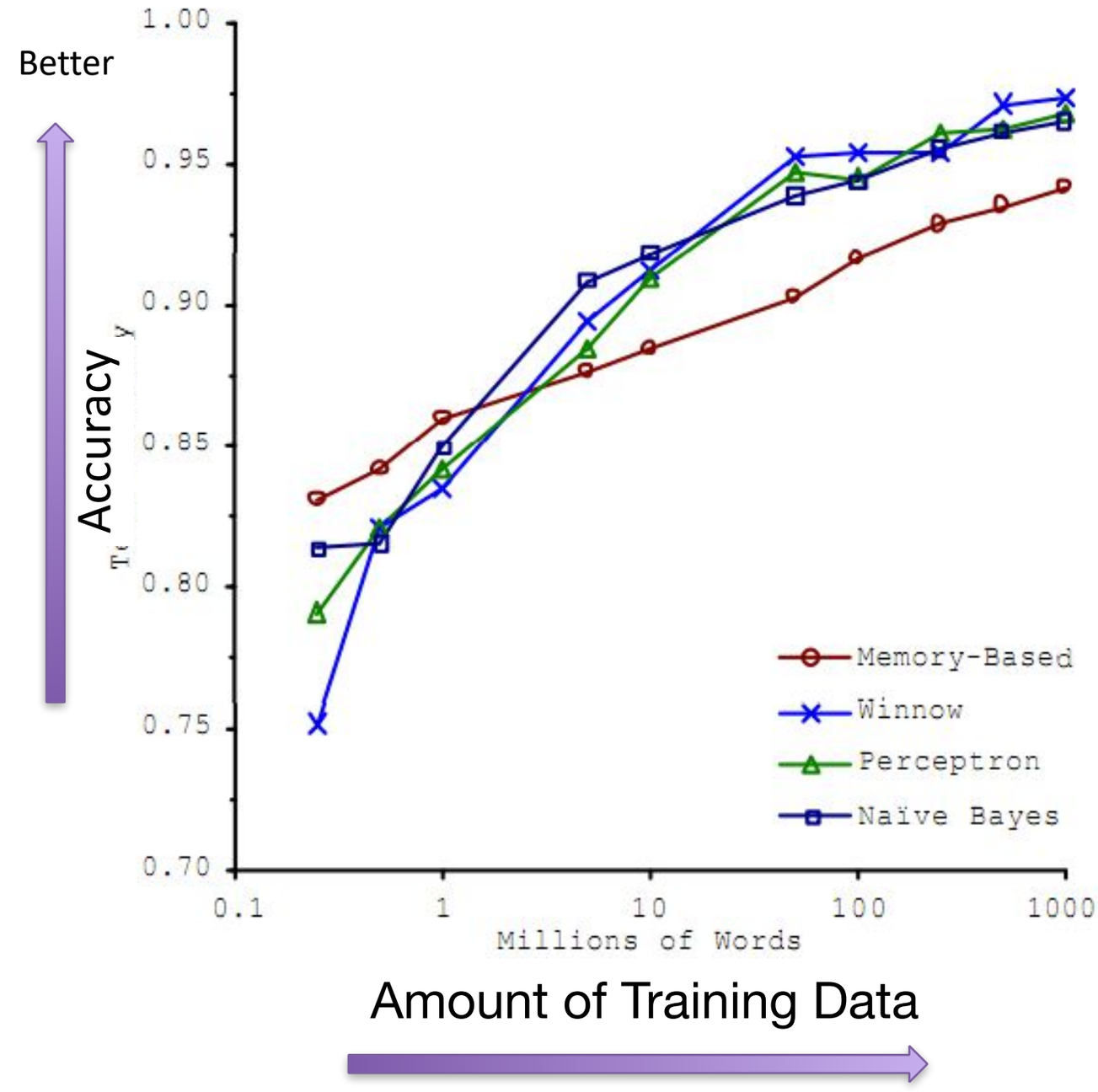


Figure Credit: Banko & Brill, 2011

slide by Dhruv Batra

Next Class:

Machine Learning by Examples,
Nearest Neighbor Classifier