

# Neural Networks and Deep Learning

**Danna Gurari**

University of Colorado Boulder

Fall 2022



<https://home.cs.colorado.edu/~DrG/Courses/NeuralNetworksAndDeepLearning/AboutCourse.html>

# Today's Topics

- Applications
- History of neural networks and deep learning
- How does a machine learn?
- Course logistics

# Today's Topics

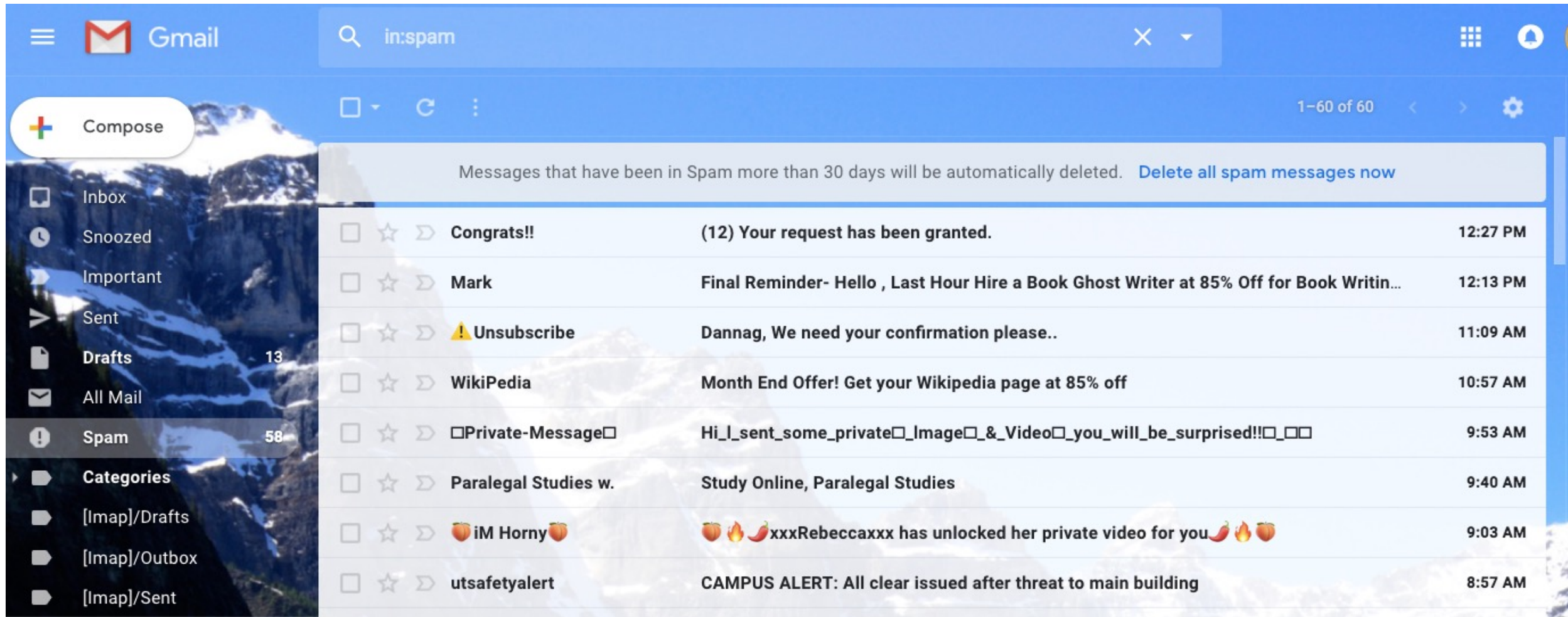
- Applications
- History of neural networks and deep learning
- How does a machine learn?
- Course logistics

# Key Motivation

Systems that support humans by either  
*improving upon existing human capabilities*  
or *providing new capabilities*



# Solutions – Spam Detection



The screenshot shows the Gmail interface with the search bar set to "in:spam". The left sidebar lists folders: Inbox, Snoozed, Important, Sent, Drafts (13), All Mail, Spam (58), and Categories. The main area displays a list of 60 spam messages. A notification at the top of the message list states: "Messages that have been in Spam more than 30 days will be automatically deleted. [Delete all spam messages now](#)".

Message Icon	Sender	Subject	Time
<input type="checkbox"/> ☆ ▷	Congrats!!	(12) Your request has been granted.	12:27 PM
<input type="checkbox"/> ☆ ▷	Mark	Final Reminder- Hello , Last Hour Hire a Book Ghost Writer at 85% Off for Book Writin...	12:13 PM
<input type="checkbox"/> ☆ ▷	! Unsubscribe	Dannag, We need your confirmation please..	11:09 AM
<input type="checkbox"/> ☆ ▷	WikiPedia	Month End Offer! Get your Wikipedia page at 85% off	10:57 AM
<input type="checkbox"/> ☆ ▷	Private-Message	Hi_I_sent_some_private_Image_&_Video_you_will_be_surprised!!	9:53 AM
<input type="checkbox"/> ☆ ▷	Paralegal Studies w.	Study Online, Paralegal Studies	9:40 AM
<input type="checkbox"/> ☆ ▷	iM Horny	xxxRebeccaxxx has unlocked her private video for you	9:03 AM
<input type="checkbox"/> ☆ ▷	utsafetyalert	CAMPUS ALERT: All clear issued after threat to main building	8:57 AM

# Solutions – Information Retrieval

**Baidu 新闻** machine learning 百度一下

网页 新闻 贴吧 知道 音乐 图片 视频 地图 文库 更多»

找到相关新闻92篇 ☒ 新闻全文 ☐ 新闻标题 | 按焦点排序 ▾

**...GWAS summary statistics for data mining and machine learning**  
中国矿业大学 2017年12月26日 16:58  
报告题目:Using GWAS summary statistics for data mining and machine learning 时间:12月29日上午9:00 地点:文昌校区逸夫楼邵206 主办单位:中国矿业大学信息与... 百度快照


**[Machine Learning] 深度学习中消失的梯度**  
深圳热线 2017年12月07日 09:46  
原标题:[Machine Learning] 深度学习中消失的梯度 好久没有更新blog了,最近抽时间看了Nielsen的《Neural Net 百度快照

**Machine learning can help enhance drug trials: study**  
新华网 2017年11月16日 01:40  
15 (Xinhua) -- A team of researchers have demonstrated that machine learning could be an effective tool in determining whether a new drug works in the... 百度快照

**Google** machine learning

All News Videos **Images** Books More

artificial intelligence big data iot distributed robotic cyber s



Machine learning ⊆ artificial intelligence

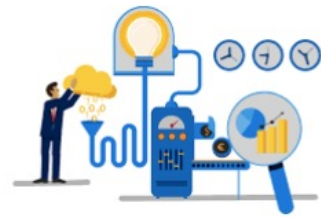
**ARTIFICIAL INTELLIGENCE**  
Design an intelligent agent that perceives its environment and makes decisions to maximize chances of achieving its goal.  
Subfields: vision, robotics, machine learning, natural language processing, planning, ...


**MACHINE LEARNING**  
Oliver "computes the ability to learn without being explicitly programmed" (Arthur Samuel, 1959)

**SUPERVISED LEARNING**  
Classification, regression

**UNSUPERVISED LEARNING**  
Clustering, dimensionality reduction, recommendation

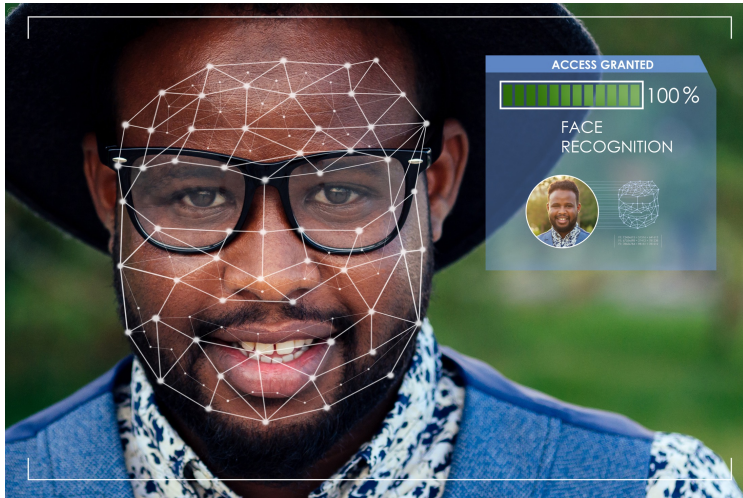
**REINFORCEMENT LEARNING**  
Reward maximization







# Solutions – Recognition



(Face)



(Speech)



(Fraud)

# Solutions – Robotics



(Self-driving Vehicles)



(Medical Surgery)



(Manufacturing)

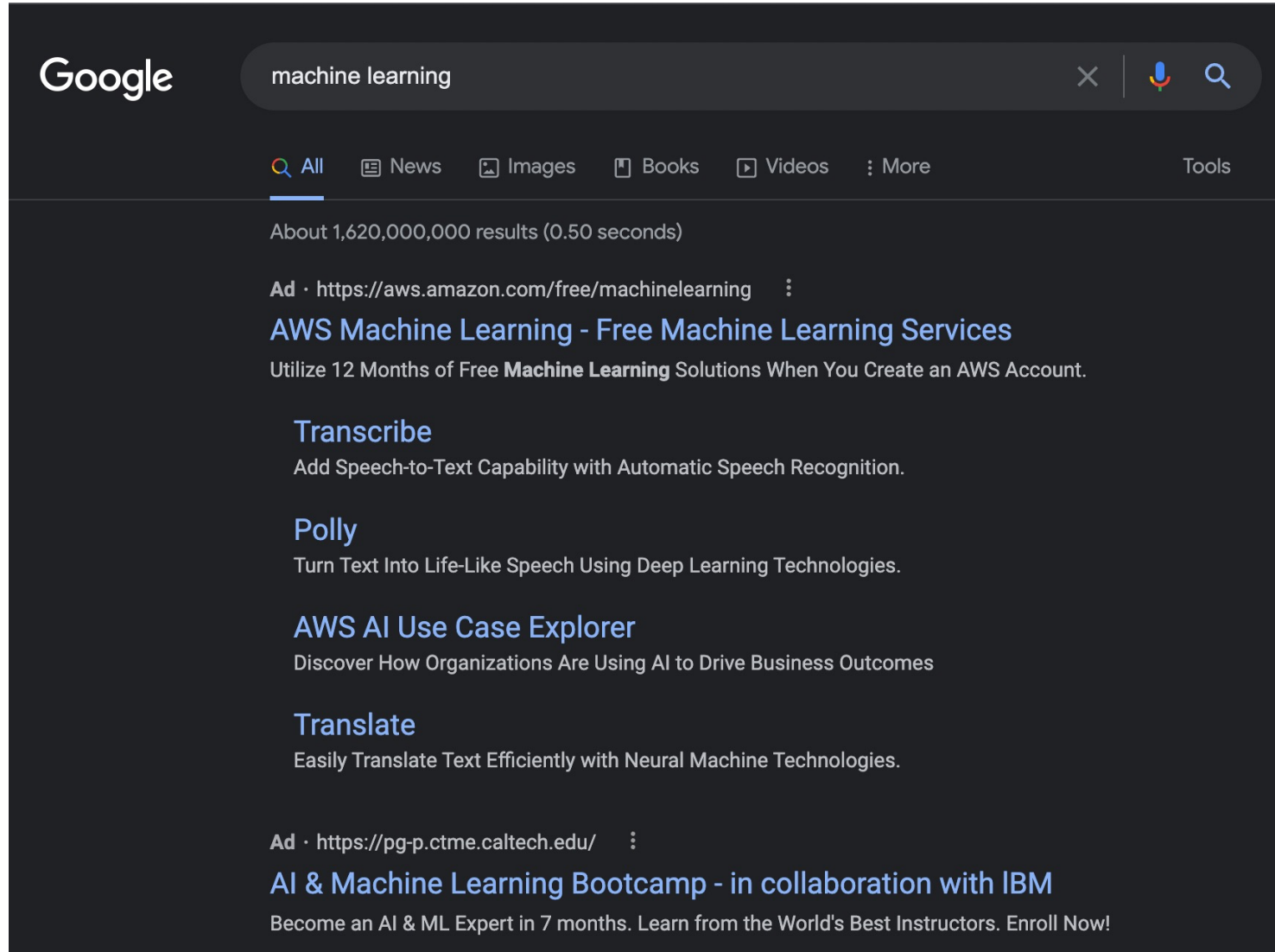


# Solutions – Recommendation Systems

The image displays four overlapping screenshots of digital interfaces that utilize recommendation systems:

- Netflix Movies:** Shows a 'Movies' section with a featured image of a couple and a list of 'Critically-acclaimed' titles.
- Amazon Prime:** Shows a 'Departments' dropdown menu with 'Books' selected. It displays '1-12 of 14,024 results for Books' and a list of categories including 'Computers & Technology', 'AI & Machine Learning', 'Intelligence & Semantics', 'Data Processing', 'Machine Theory', 'Data Mining', 'Neural Networks', 'Probability & Statistics', 'Computer Vision & Pattern Recognition', and 'Data Modeling & Design'. A 'See more' link is also present.
- Facebook Groups:** Shows a 'Groups' section with a 'Recommended' list of groups, including 'CNCUT CraftLife' and 'AE 319'.
- The New York Times Recommendations:** Shows a 'Recommendations' section for the 'U.S. Edition'. It features a grid of book covers from Packt Publishing, including titles like 'Python Machine Learning', 'Computer Vision with Python 3', 'Python Machine Learning By Example', 'Deep Learning with TensorFlow', 'Python Machine Learning Projects', 'Statistics for Machine Learning', 'Implementing AppFog', 'Expert Pythce Programming', 'Predictive Analytics with TensorFlow', 'Mastering Blockchain', and 'Pandas Cookbook'. A large green banner at the bottom reads: 'Get personalized recommendations, based on what you enjoy reading on NYTimes.com'. Below the banner are buttons for 'Log In', 'Register Now', and 'Log In With Facebook'.

# Solutions – Advertising



The image is a screenshot of a Google search results page for the query "machine learning". The search bar at the top shows the Google logo, the search term "machine learning", and icons for voice search and image search. Below the search bar, navigation tabs for "All", "News", "Images", "Books", "Videos", and "More" are visible, with "All" being the selected tab. The results indicate "About 1,620,000,000 results (0.50 seconds)".

The first advertisement is from AWS, with the URL "https://aws.amazon.com/free/machinelearning". The headline is "AWS Machine Learning - Free Machine Learning Services" in blue. The description reads: "Utilize 12 Months of Free **Machine Learning** Solutions When You Create an AWS Account." Below this, there are three sub-sections, each with a blue heading and a description:

- Transcribe**: Add Speech-to-Text Capability with Automatic Speech Recognition.
- Polly**: Turn Text Into Life-Like Speech Using Deep Learning Technologies.
- AWS AI Use Case Explorer**: Discover How Organizations Are Using AI to Drive Business Outcomes

The second advertisement is from Caltech, with the URL "https://pg-p.ctme.caltech.edu/". The headline is "AI & Machine Learning Bootcamp - in collaboration with IBM" in blue. The description reads: "Become an AI & ML Expert in 7 months. Learn from the World's Best Instructors. Enroll Now!"

# Solutions – Home Virtual Assistants



e.g., Amazon's Echo with Alexa



e.g., Google Home

# Today's Topics

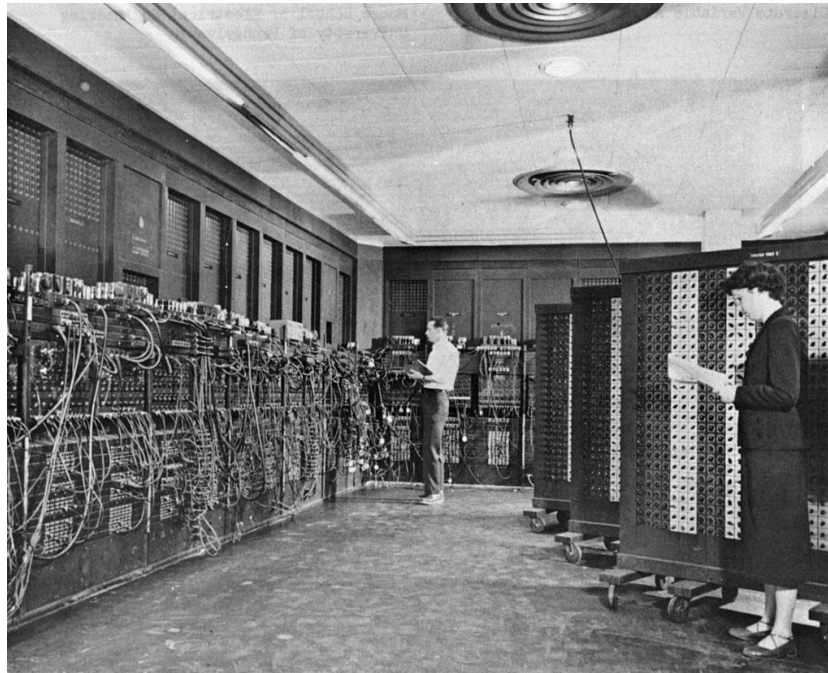
- Applications
- History of neural networks and deep learning
- How does a machine learn?
- Course logistics



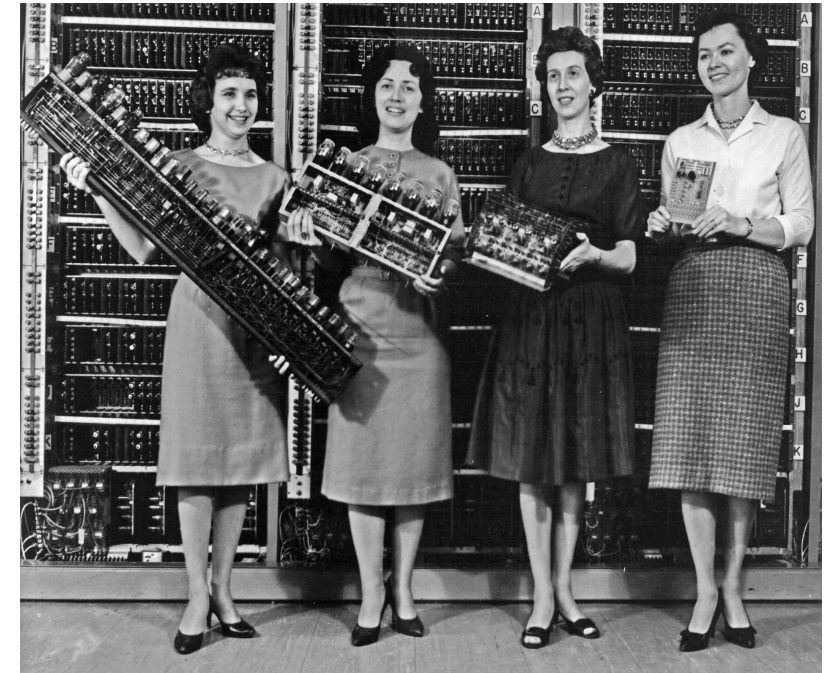
# Origins: Computers

1945

First programmable  
machine



ENIAC (Electronic Numerical Integrator and Computer) created during World War II  
(could compute 5,000 additions in one second)



First programmers

# Origins: Conceptual Framework

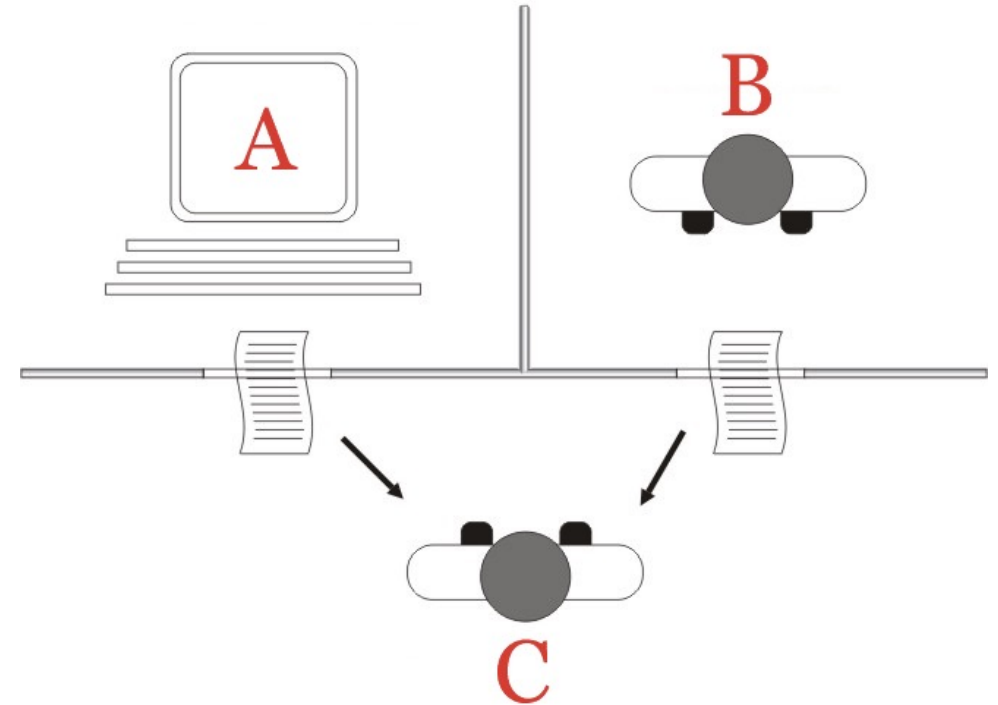
1945      1950

First programmable  
machine

Turing test

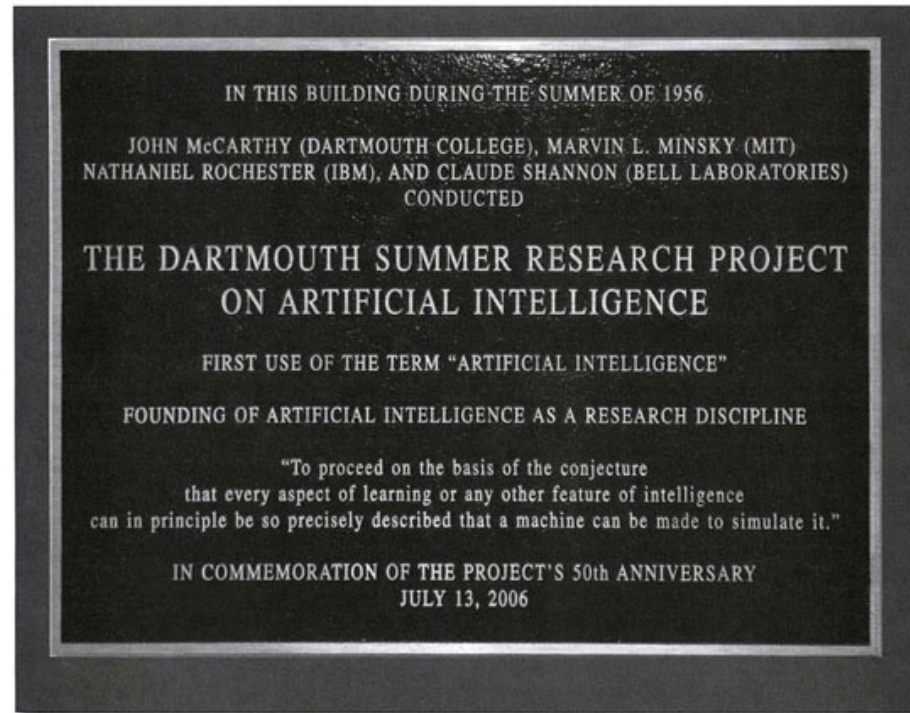


Alan Turing  
(1912-1954)



Turing Test: can "C" decide whether text responses come from a machine or human

# Origins: Conceptual Framework



“Artificial intelligence” established as a field at a workshop

# Origins: Conceptual Framework

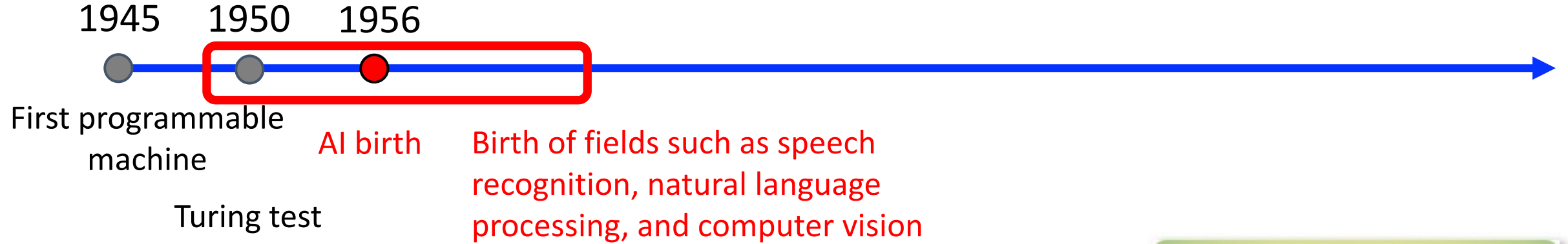


IN THIS BUILDING DURING THE SUMMER OF 1956

**Workshop Proposal:** "... 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..."

"Artificial intelligence" established as a field at a workshop

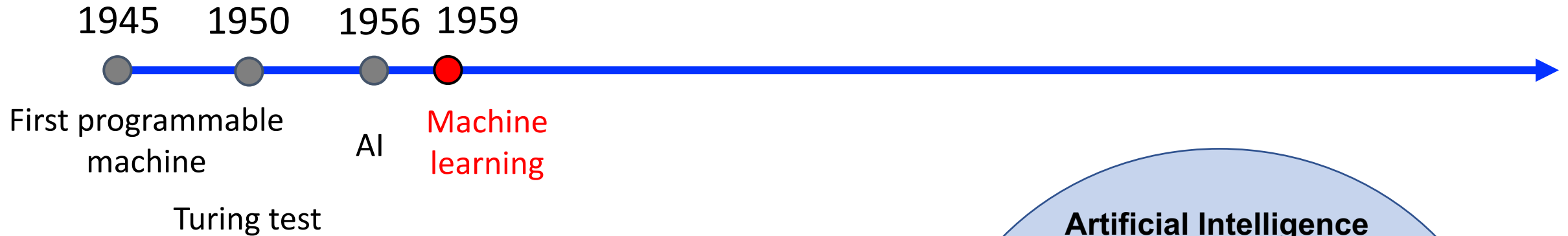
# Origins: Conceptual Framework



What human intelligence  
might computers imitate?

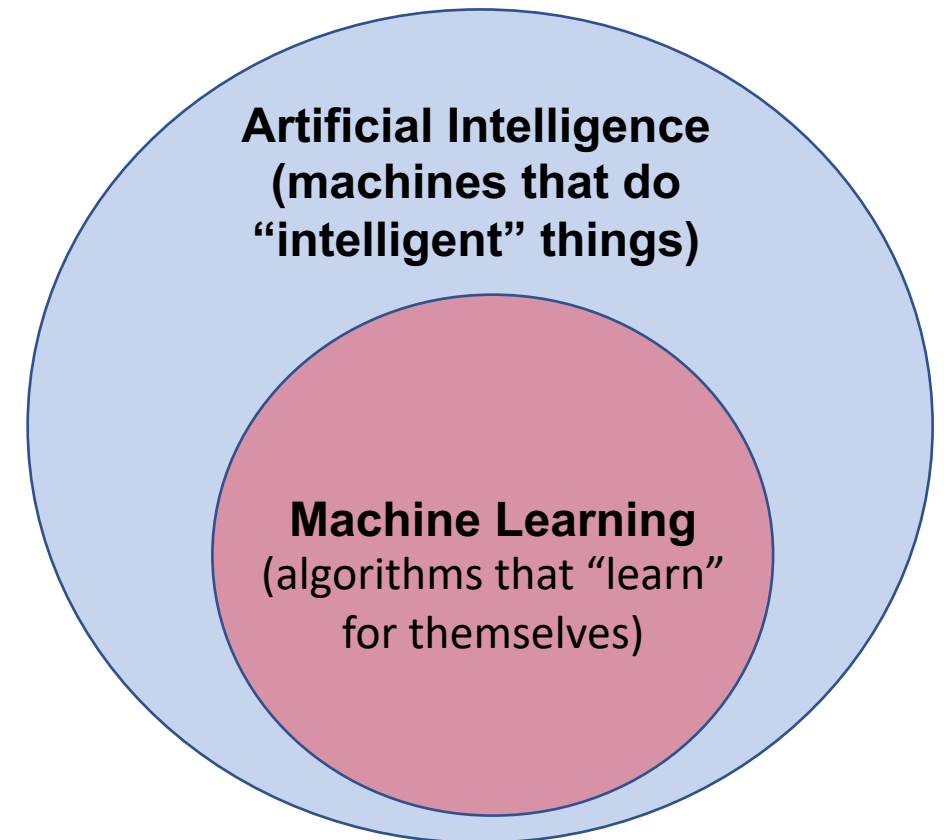


# Origins: Conceptual Framework



AI researcher Arthur Samuel coins the term “machine learning” as:

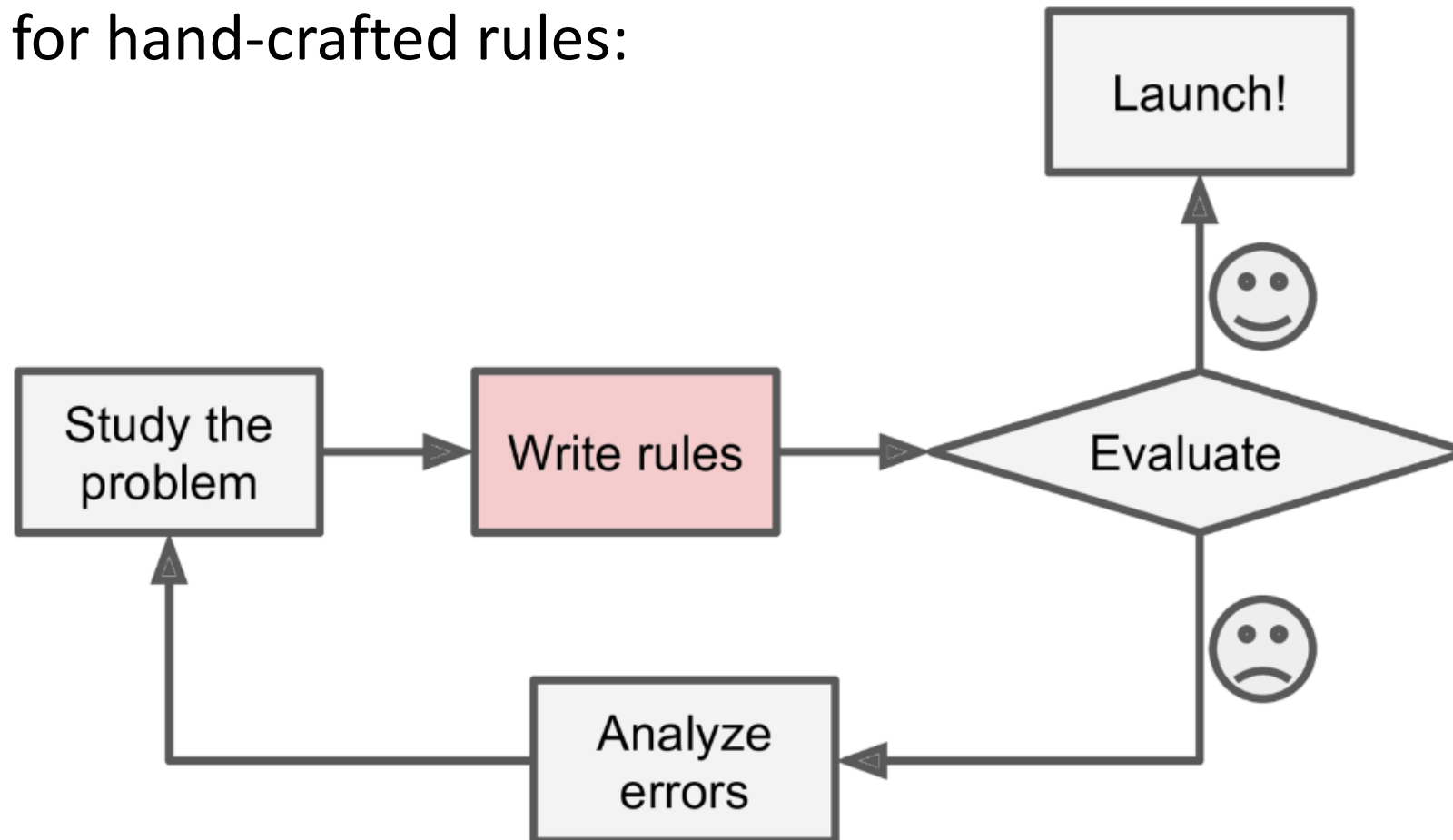
“Field of study that gives computers **the ability to learn without being explicitly programmed.**”





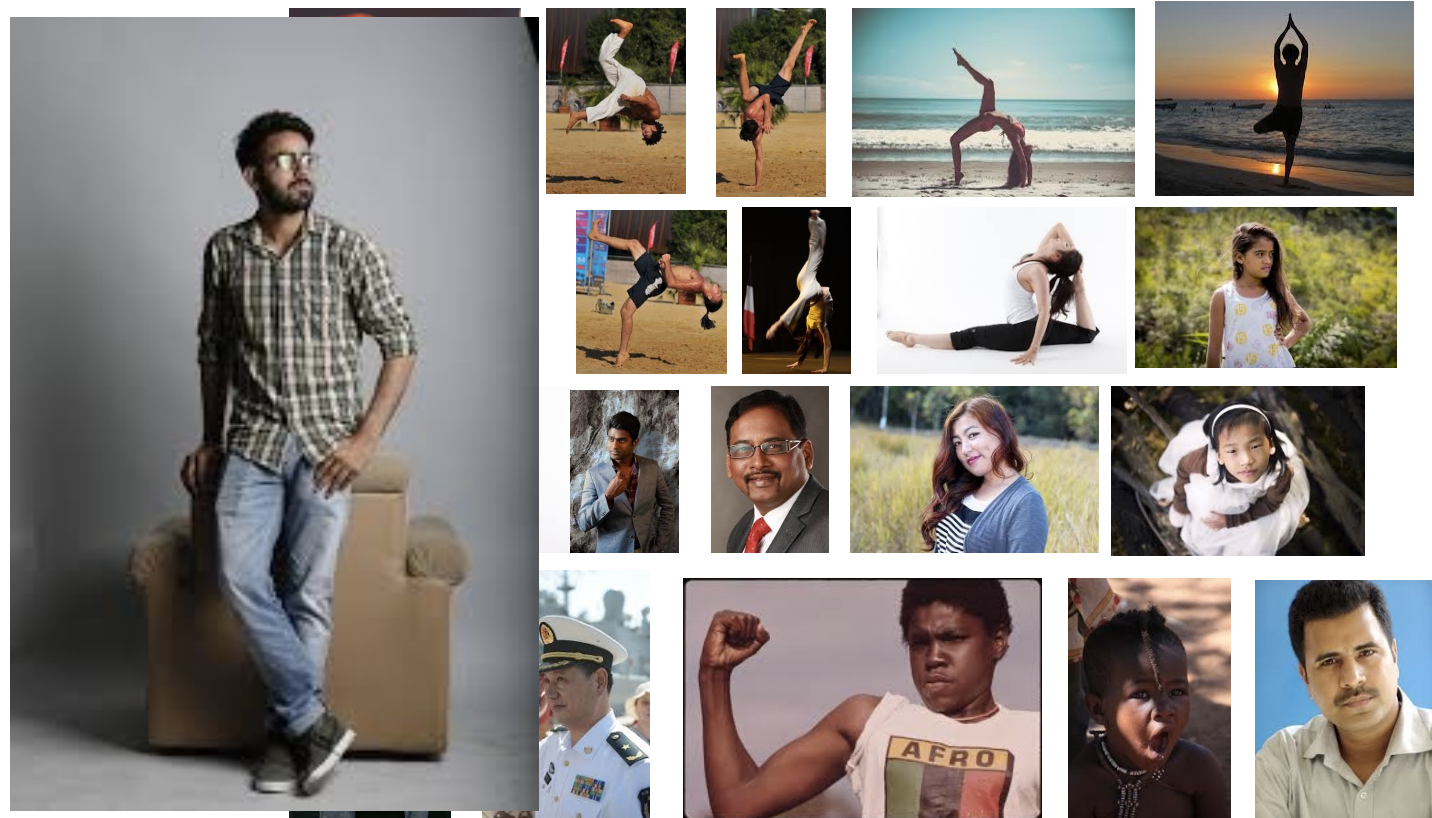
# Motivation for Machines that “Learn”

- Process for hand-crafted rules:



# Motivation for Machines that “Learn”: Class Task

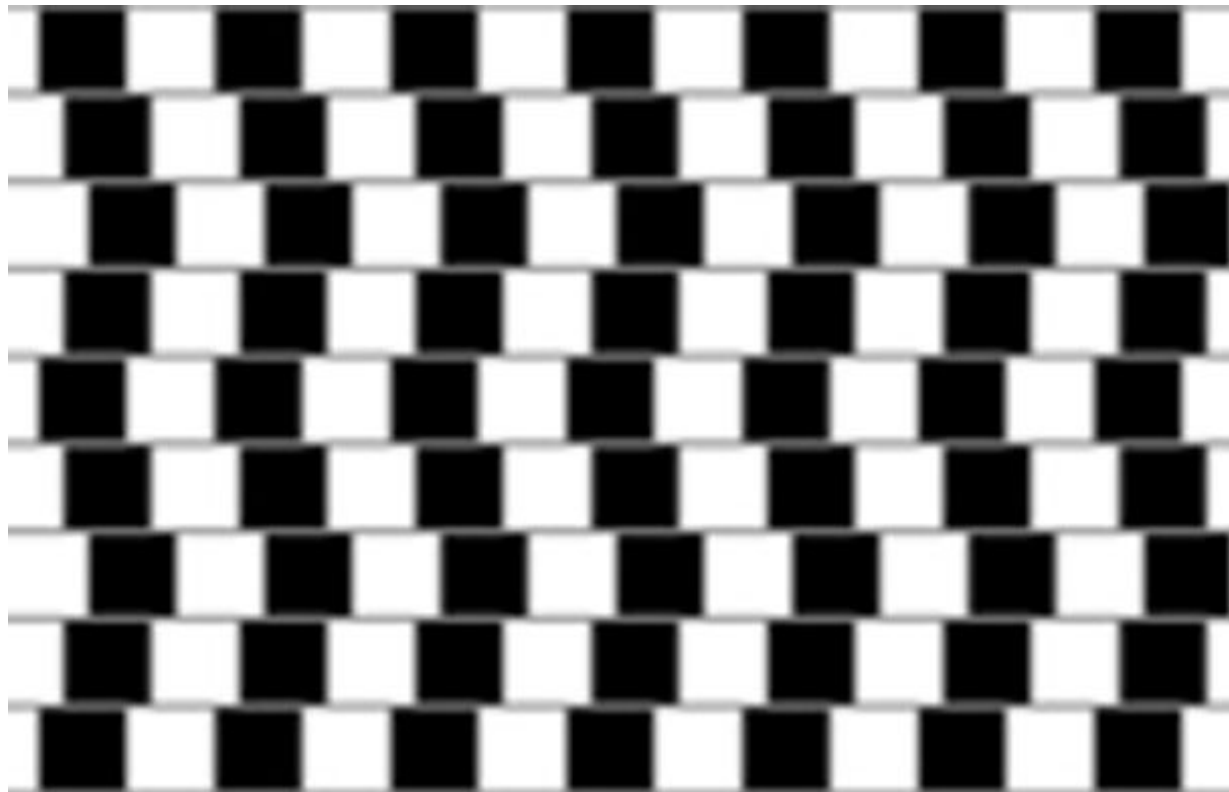
e.g., What rules would you use to answer: “Is a person in the image?”





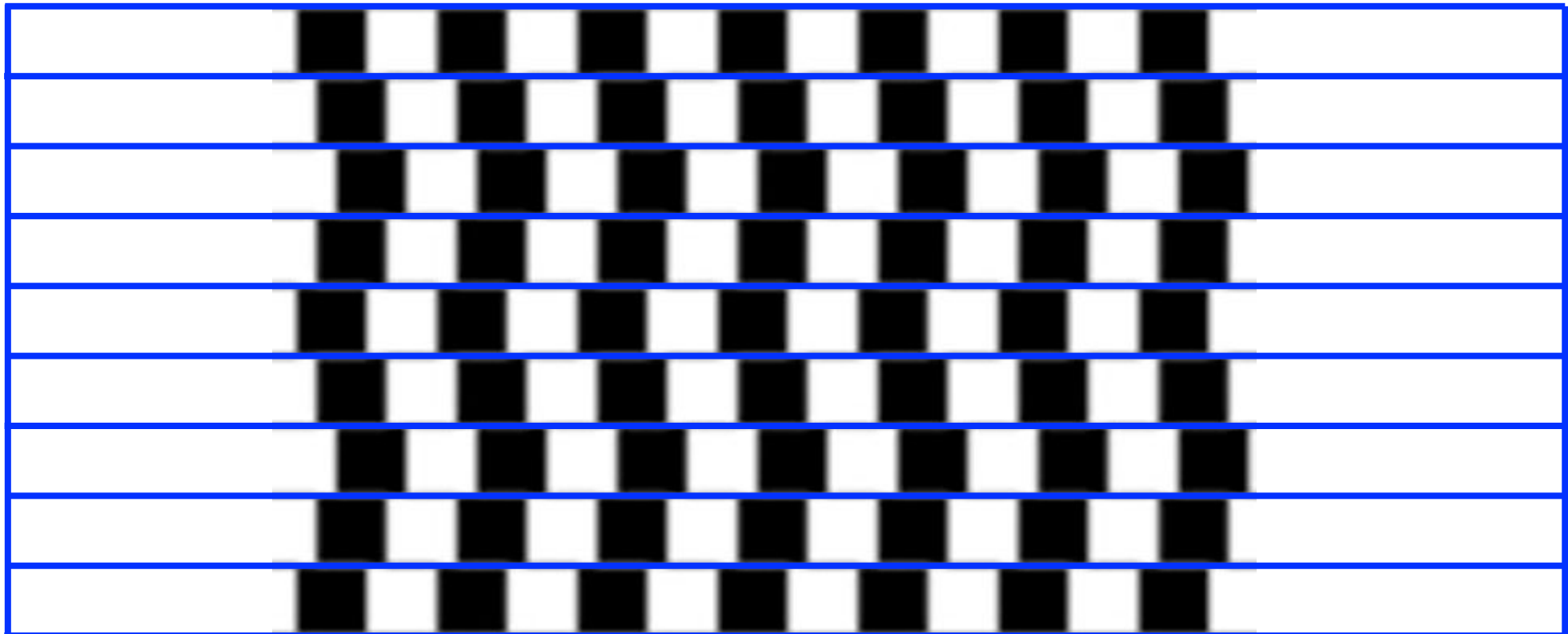
# Motivation for Machines that “Learn”

e.g., are these lines parallel?



# Motivation for Machines that “Learn”

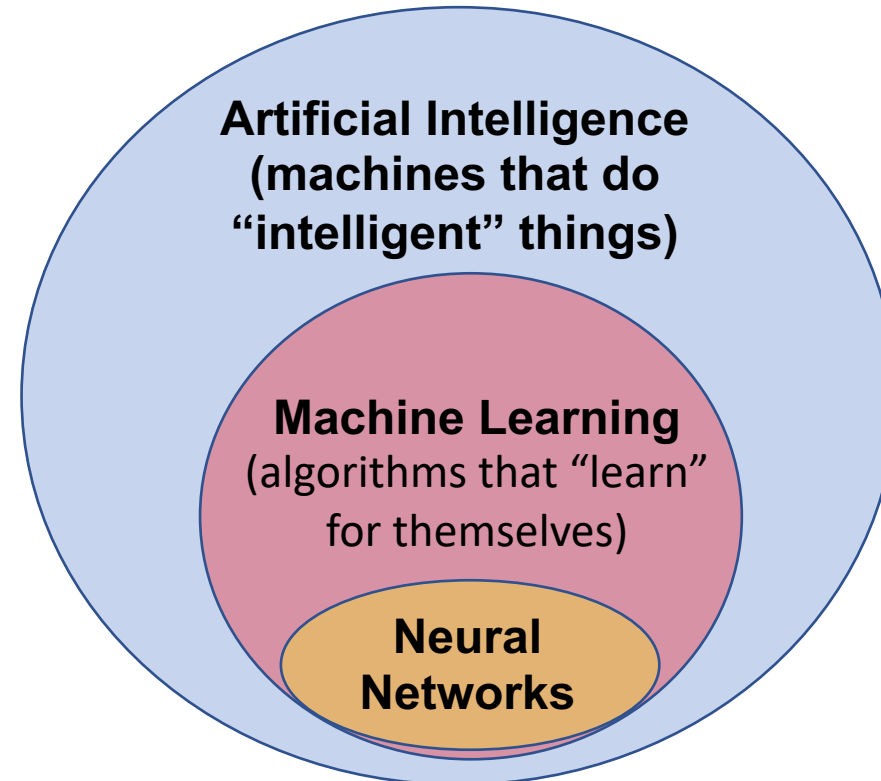
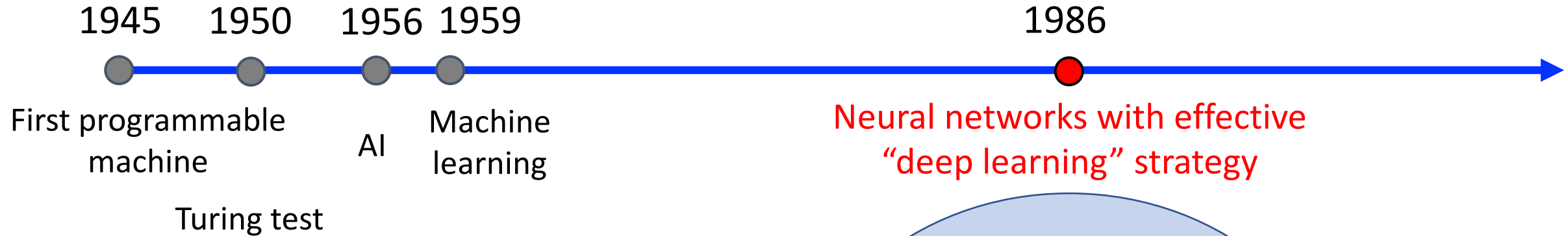
e.g., are these lines parallel?



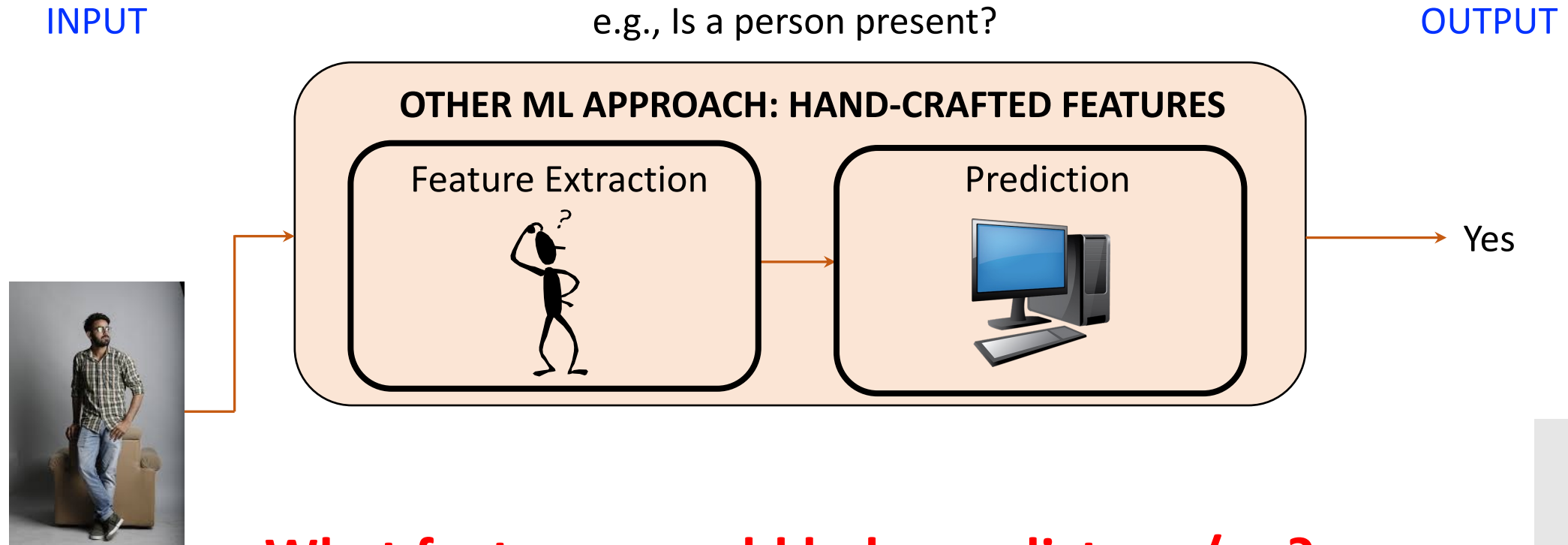
# Motivation for Machines that “Learn”

1. It is hard to hand-craft a complete set of rules
2. We, as humans, may not devise the best rules for a machine since our brains (unconsciously) pre-process the data we sense

# Origins: Neural Networks with Deep Learning

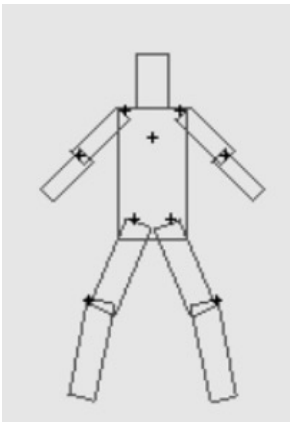


# Motivation for Neural Networks (NNs) Over Other Machine Learning (ML) Approaches

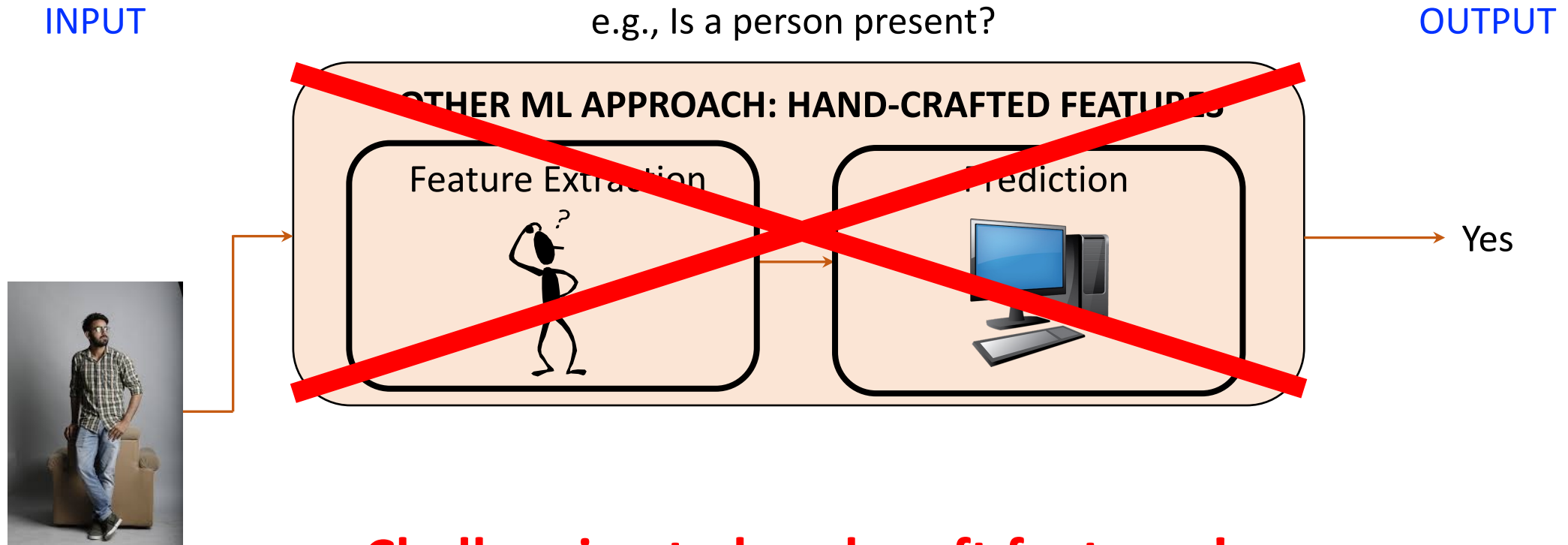


**What features would help predict yes/no?**

**e.g., corners, lines, and model of expected body parts as connected shapes**

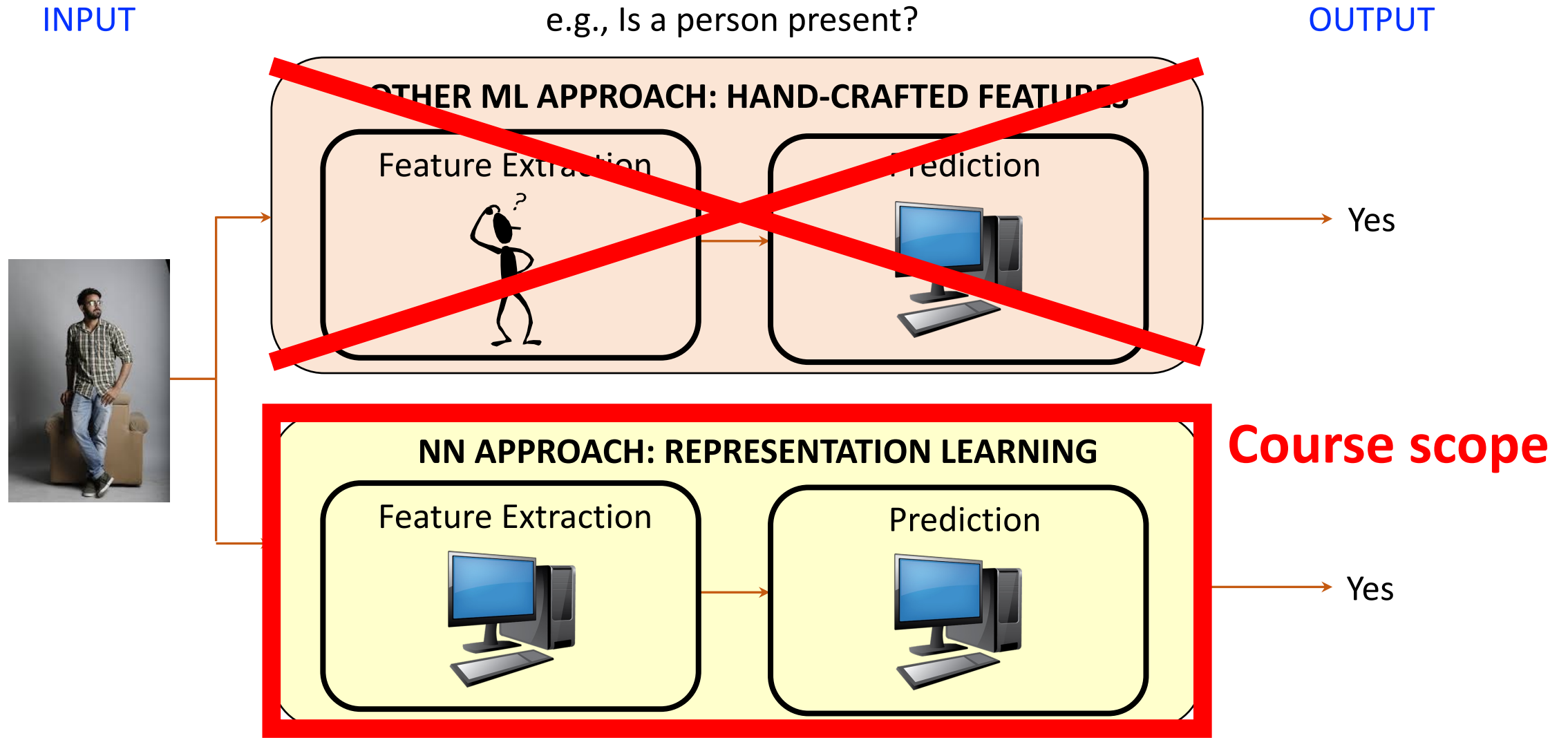


# Motivation for Neural Networks (NNs) Over Other Machine Learning (ML) Approaches

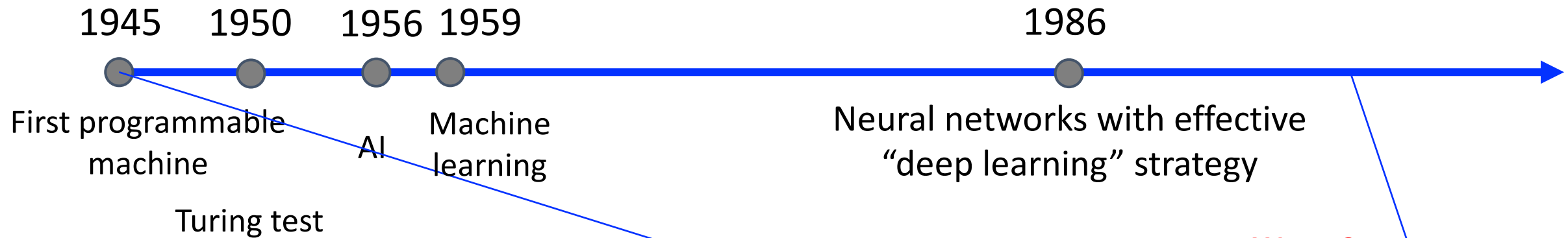


**Challenging to hand-craft features!**

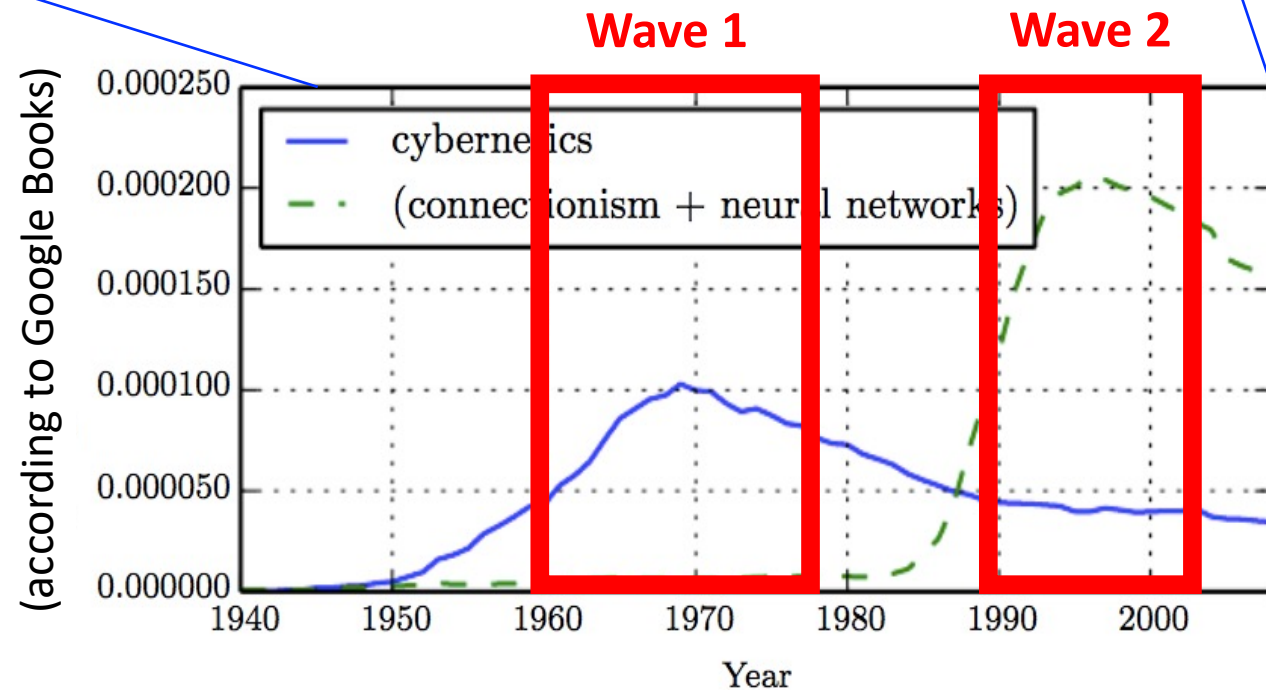
# Motivation for Neural Networks (NNs) Over Other Machine Learning (ML) Approaches



# Origins: Rises/Falls of Neural Network Popularity

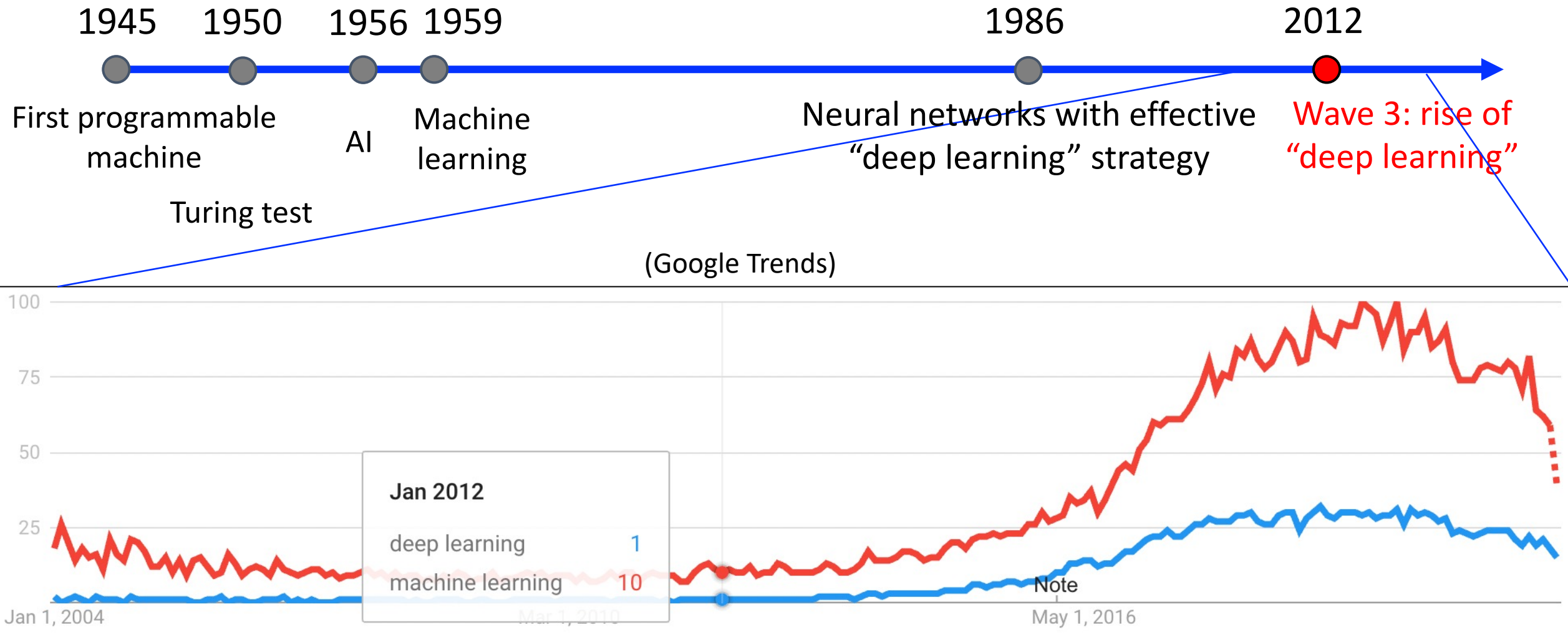


Neural networks are not new and have been called many names:





# Origins: Rises/Falls of Neural Network Popularity



**Machine learning popularity has paralleled rise of deep learning popularity**

# Today's Topics

- Applications
- History of neural networks and deep learning
- How does a machine learn?
- Course logistics

# General Idea

An **algorithm** learns from **data**  
patterns that will be used to  
make a prediction

# General Idea

An **algorithm** learns from data patterns that will be used to make a prediction

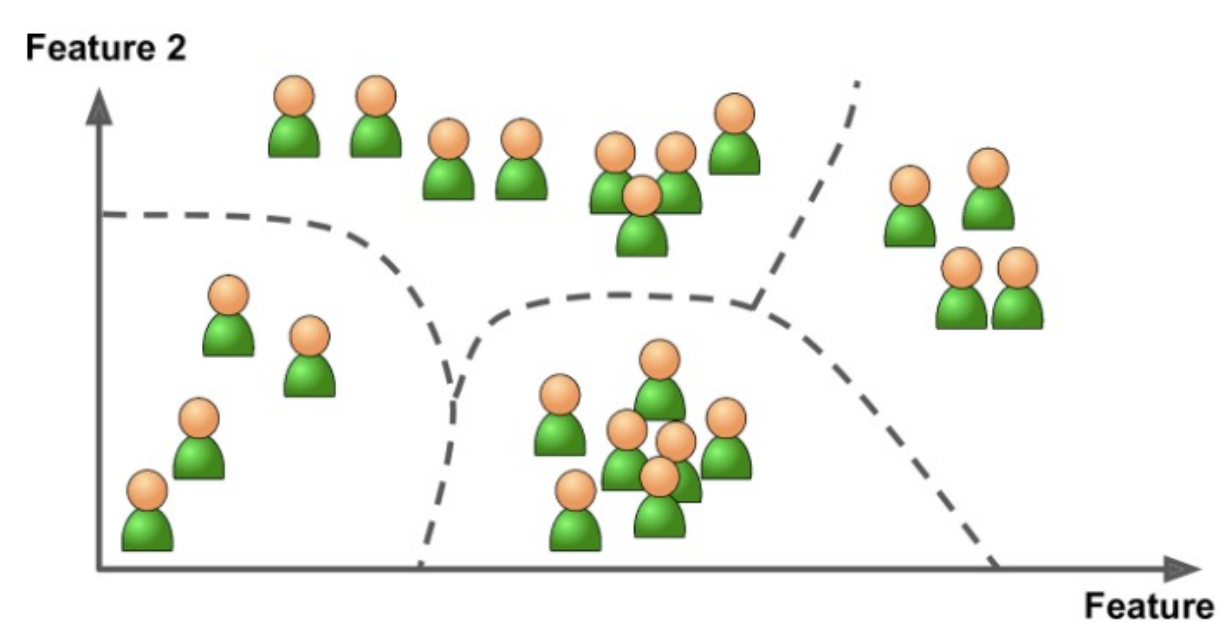
# Typical Algorithm Design

- Unsupervised Learning
  - Identify patterns by observing *unstructured* data
- Supervised Learning
  - Identify patterns by studying *structured* data with labels of expected outputs



# Types of “Unsupervised” Learning Tasks

Clustering

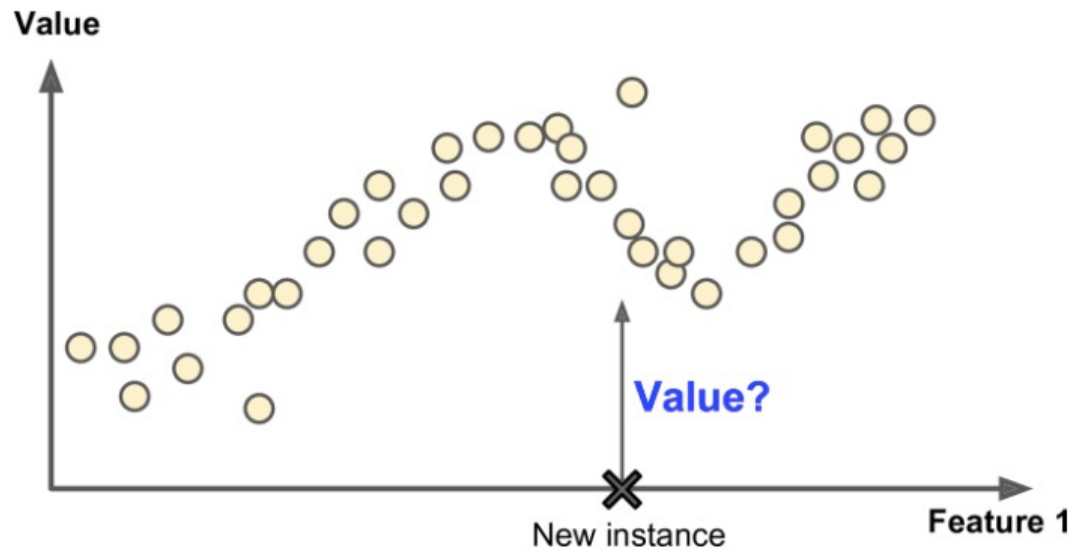


Anomaly Detection

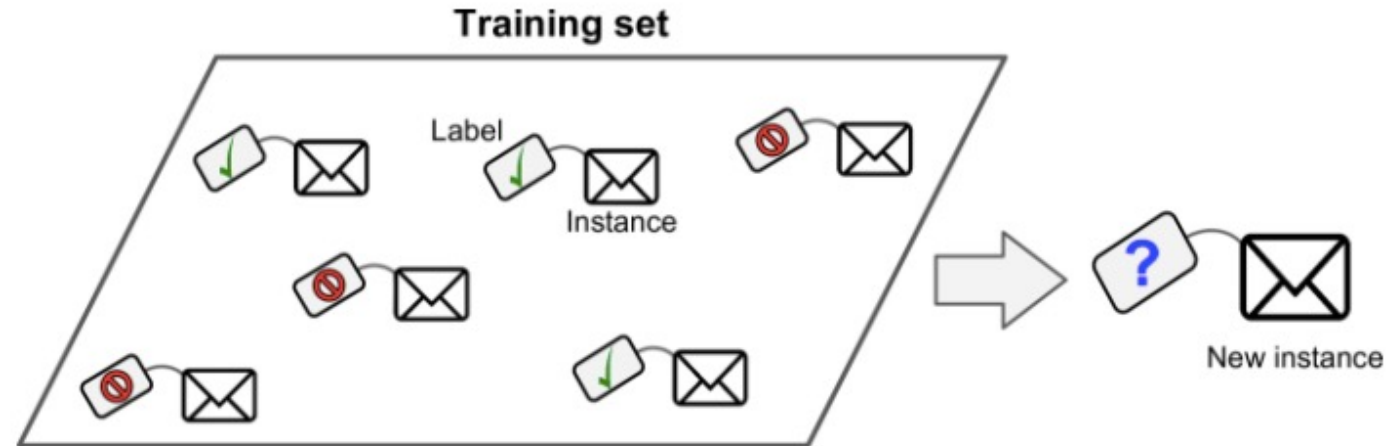


# Types of “Supervised” Learning Tasks

Regression  
(predict **continuous** value)

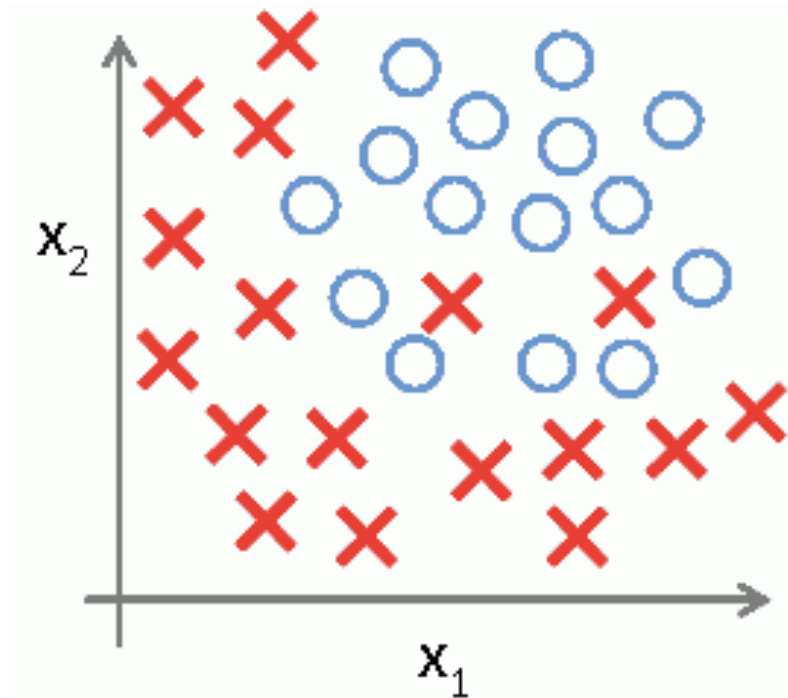


Classification  
(predict **discrete** value)



# Typical Supervised Learning Algorithm Design

- Model-based classification approach
  - e.g., create model to separate x from o



Class volunteer:

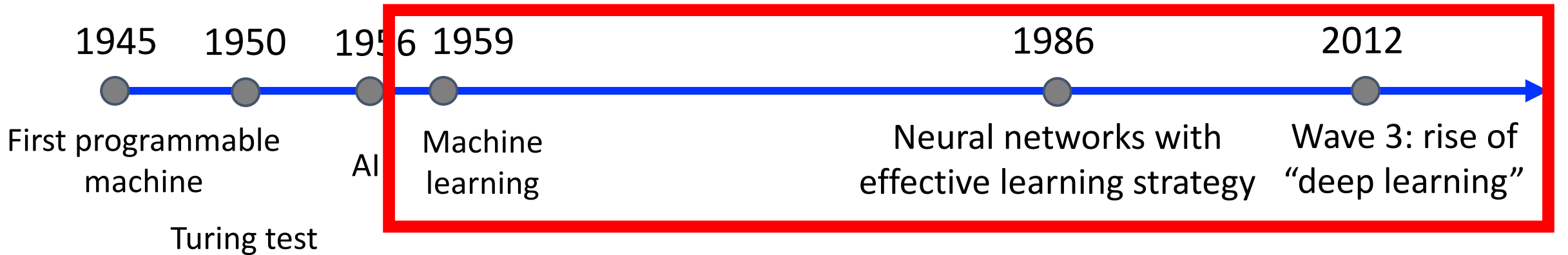
- 1) Draw a straight line (linear equation)
- 2) Draw a parabola (quadratic equation)
- 3) Draw any curve



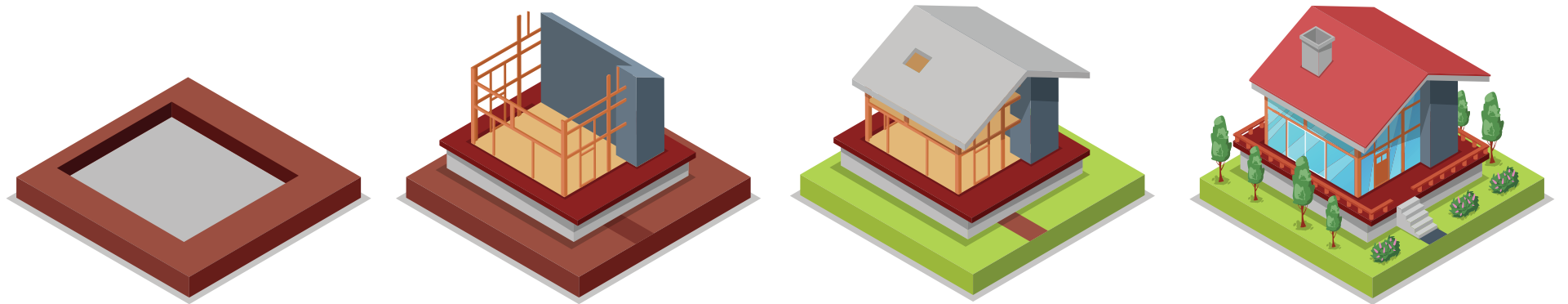
Models with increasing  
representational capacity



# Algorithm Scope for Course: Last 65 Years

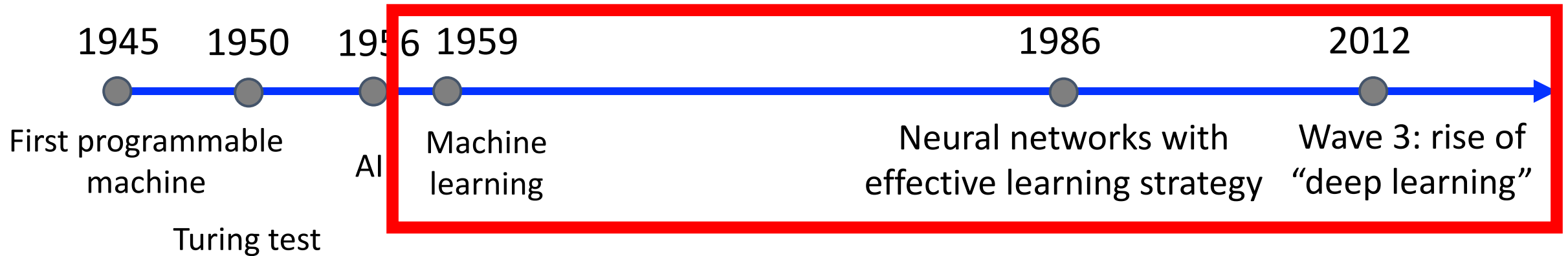


Analogous to understanding how houses we live-in work:



**We study older algorithms because modern deep learning algorithms rely on techniques developed over the past 65 years.**

# Algorithm Scope for Course: Last 65 Years



Week	Topic(s)
1	Introduction, Artificial neurons
2	Feedforward neural networks (NN), NN training
3	NN training
4	Convolutional neural networks (CNN), Introduction to CV
5	Training CNN algorithms
6	Regularization, Pretrained CNN features, Fine-tuning
7	Object detection, Semantic segmentation, Recurrent neural networks
8	Introduction to natural language processing, Neural word embeddings, Attention

Week	Topic(s)
9	Transformers
10	Multimodal NN (vision + language)
11	Multimodal NN, Self-supervised learning, GANs
12	Few/zero-shot learning, Responsible/ethical learning
13	Deep learning in industry (guest speakers)
14	Model compression, Efficient learning
15	NNs for speech processing & reinforcement learning
16	NN for information retrieval & course summary

# General Idea

An algorithm learns from **data**  
patterns that will be used to  
make a prediction

# Data Types: What a Machine Learns From?

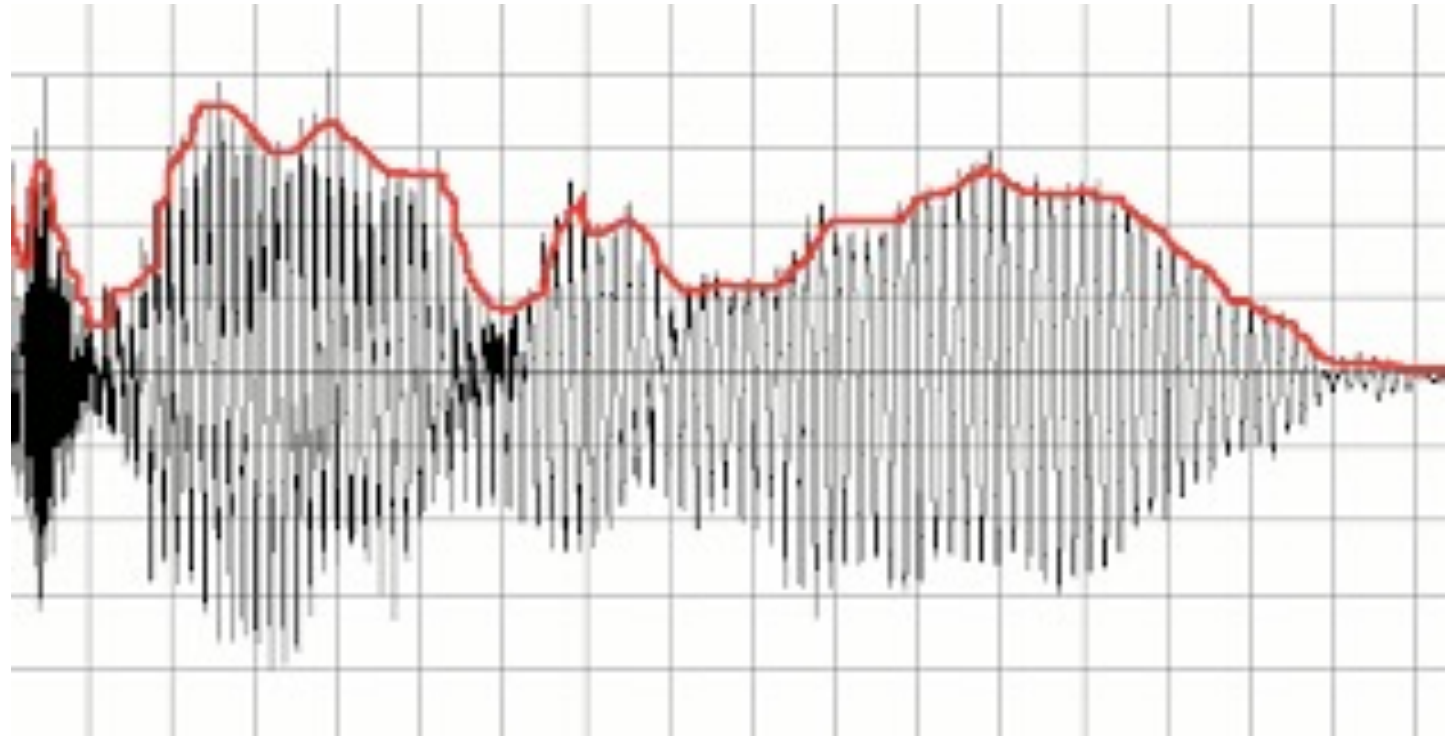


- Audio

- Input?



e.g.,

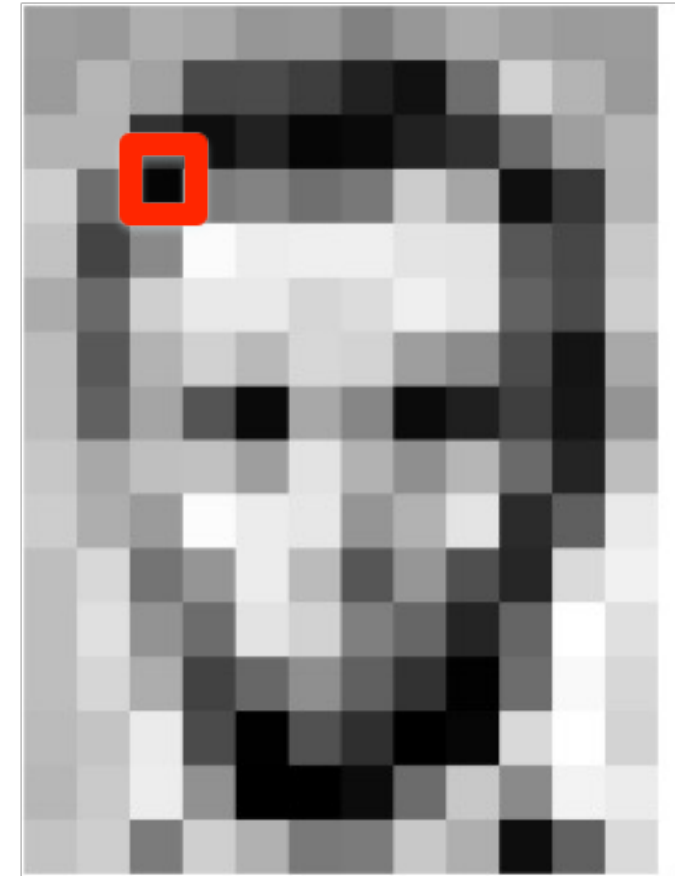


# Data Types: What a Machine Learns From?



- Audio
  - Input?
- Images
  - Input?

157	153	174	168	150	152	129	151	172	161	155	156
155	182	163	74	75	62	33	17	110	210	180	154
180	180	50	14	34	6	10	33	48	106	159	181
206	105	5	14	131	111	120	204	166	15	56	180
194	68	137	251	237	239	239	228	227	87	71	201
172	105	207	233	233	214	220	239	228	98	74	206
188	88	179	209	185	215	211	158	139	75	20	169
189	97	165	84	10	168	134	11	31	62	22	148
199	168	191	193	158	227	178	143	182	106	36	190
205	174	155	252	236	231	149	178	228	43	95	234
190	216	116	149	236	187	86	150	79	38	218	241
190	224	147	108	227	210	127	102	36	101	255	224
190	214	173	66	103	143	96	50	2	109	249	215
187	196	235	75	1	81	47	0	6	217	255	211
183	202	237	145	0	0	12	108	200	138	243	236
195	206	123	207	177	121	123	200	175	13	96	218



# Data Types: What a Machine Learns From?



- Audio
  - Input?
- Images
  - Input?
- Video
  - Input?

157	153	174	168	150	152	129	151	172	161	155	156
155	182	163	74	75	62	33	17	110	210	180	154
180	180	50	14	34	6	10	33	48	106	159	181
206	109	5	124	131	111	120	204	166	15	56	180
194	68	137	251	237	239	239	228	227	87	71	201
172	105	207	233	233	214	220	239	228	98	74	206
188	88	179	209	185	215	211	158	139	75	20	169
189	97	165	84	10	168	134	11	31	62	22	148
199	168	191	193	158	227	178	143	182	106	36	190
205	174	155	252	236	231	149	178	228	43	95	234
190	216	116	149	236	187	86	150	79	38	218	241
190	224	147	108	227	210	127	102	36	101	255	224
190	214	173	66	103	143	96	50	2	109	249	215
187	196	235	75	1	81	47	0	6	217	255	211
183	202	237	145	0	0	12	108	200	138	243	236
195	206	123	207	177	121	123	200	175	13	96	218

Time 1

157	153	174	168	150	152	129	151	172	161	155	156
155	182	163	74	75	62	33	17	110	210	180	154
180	180	50	14	34	6	10	33	48	106	159	181
206	109	5	124	131	111	120	204	166	15	56	180
194	68	137	251	237	239	239	228	227	87	71	201
172	105	207	233	233	214	220	239	228	98	74	206
188	88	179	209	185	215	211	158	139	75	20	169
189	97	165	84	10	168	134	11	31	62	22	148
199	168	191	193	158	227	178	143	182	106	36	190
205	174	155	252	236	231	149	178	228	43	95	234
190	216	116	149	236	187	86	150	79	38	218	241
190	224	147	108	227	210	127	102	36	101	255	224
190	214	173	66	103	143	96	50	2	109	249	215
187	196	235	75	1	81	47	0	6	217	255	211
183	202	237	145	0	0	12	108	200	138	243	236
195	206	123	207	177	121	123	200	175	13	96	218

1 hour

Analogous to:



# Data Types: What a Machine Learns From?



- Audio
  - Input?
- Images
  - Input?
- Video
  - Input?
- Text
  - Input?

e.g.,

Confidential letter sh 



David-Khoza@mmoscacsv.com

to 

.

## 2 Attachments

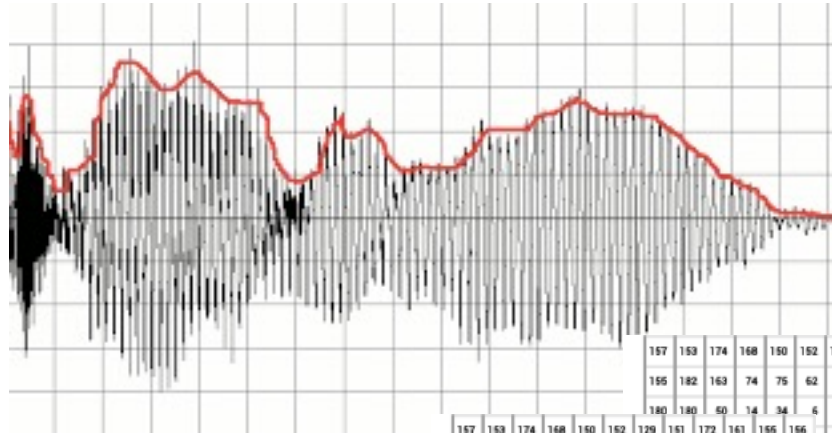




# Data Types: What a Machine Learns From?



- Audio
  - Input?
- Images
  - Input?
- Video
  - Input?
- Text
  - Input?
- Multi-modal
  - Input? - combination of the above



157	153	174	168	150	152	129	151	172	161	155	156
155	182	163	74	75	62	33	17	110	210	180	154
180	180	50	14	34	6	10	33	48	106	159	181
206	109	5	124	131	111	120	204	166	15	56	180
194	68	137	251	237	239	239	228	227	87	71	201
172	105	207	233	233	214	220	239	228	98	74	206
188	88	179	209	185	215	211	158	139	75	20	169
189	97	165	84	10	168	134	11	31	62	22	148
199	168	191	193	158	227	178	143	182	106	36	190
205	174	155	252	236	231	149	178	228	43	95	234
190	216	116	149	236	187	86	150	79	38	218	241
190	224	147	108	227	210	127	102	36	101	255	224
190	214	173	66	103	143	96	50	2	109	249	215
187	196	235	75	1	81	47	0	6	217	255	211
183	202	237	145	0	0	12	108	200	138	243	236
195	206	123	207	177	121	123	200	175	13	96	218

157	153	174	168	150	152	129	151	172	161	155	156
155	182	163	74	75	62	33	17	110	210	180	154
180	180	50	14	34	6	10	33	48	106	159	181
206	109	5	124	131	111	120	204	166	15	56	180
194	68	137	251	237	239	239	228	227	87	71	201
172	105	207	233	233	214	220	239	228	98	74	206
188	88	179	209	185	215	211	158	139	75	20	169
189	97	165	84	10	168	134	11	31	62	22	148
199	168	191	193	158	227	178	143	182	106	36	190
205	174	155	252	236	231	149	178	228	43	95	234
190	216	116	149	236	187	86	150	79	38	218	241
190	224	147	108	227	210	127	102	36	101	255	224
190	214	173	66	103	143	96	50	2	109	249	215
187	196	235	75	1	81	47	0	6	217	255	211
183	202	237	145	0	0	12	108	200	138	243	236
195	206	123	207	177	121	123	200	175	13	96	218

Confidential letter sh

? David-Khoza@mmoscacsv.com  
to

# Data Types: Many Public Datasets Available

- Dataset creation is beyond the scope of this class
- We will benefit from other people's efforts:
  - [Google Dataset Search](#)
  - [Amazon's AWS datasets](#)
  - [Kaggle datasets](#)
  - [Wikipedia's list](#)
  - [UC Irvine Machine Learning Repository](#)
  - Quora.com
  - Reddit
  - Dataportals.org
  - Opendatamonitor.eu
  - Quandl.com

# General Idea

An **algorithm** learns from **data**  
patterns that will be used to  
make a prediction

# Why Are Neural Networks and Deep Learning So Popular? – Its Success in Practice!

It's success was realized with the relatively recent onset of:

1. **Big data:** originally, often from the Internet
2. **Better hardware:** faster hardware and more storage enabled practically fast “deep learning”

# Neural Networks: Key Ingredients for Success

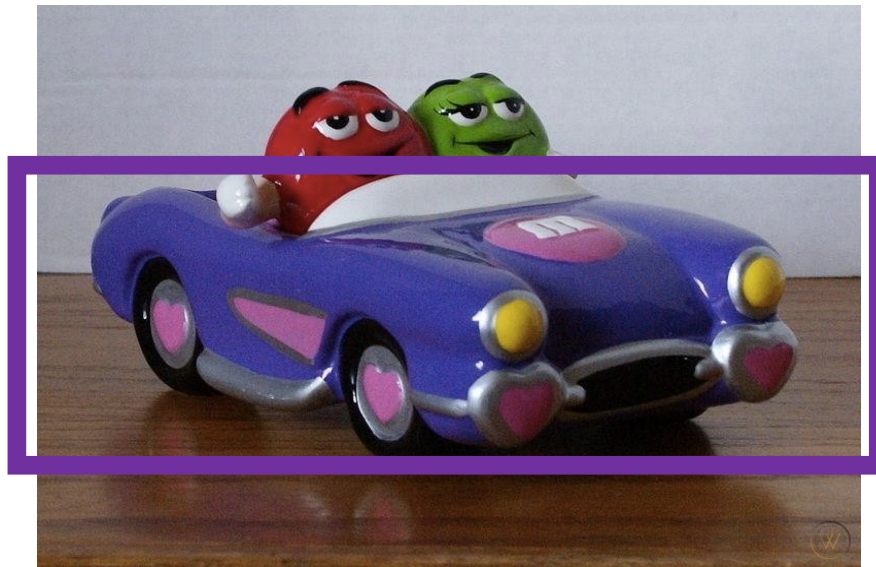
An **algorithm** learns from **data**  
on a **processor** the patterns that  
will be used to make a prediction



Analogous to a Love Story of Partnering Up and Road Tripping Somewhere

# Key Challenge 1: How Long Does Learning Take?

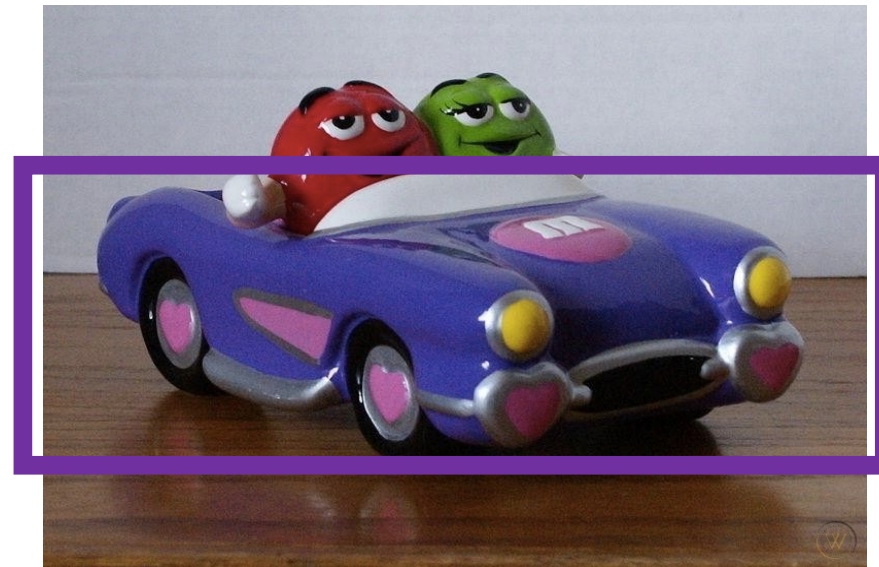
An **algorithm** learns from **data**  
on a **processor** the patterns that  
will be used to make a prediction



Analogous to a Love Story of Partnering Up and Road Tripping Somewhere

# Key Challenge 1: How Long Does Learning Take?

**e.g., Train Algorithms Using  
GPUs (think Porsche) Instead of CPUs (think Golf Cart)**



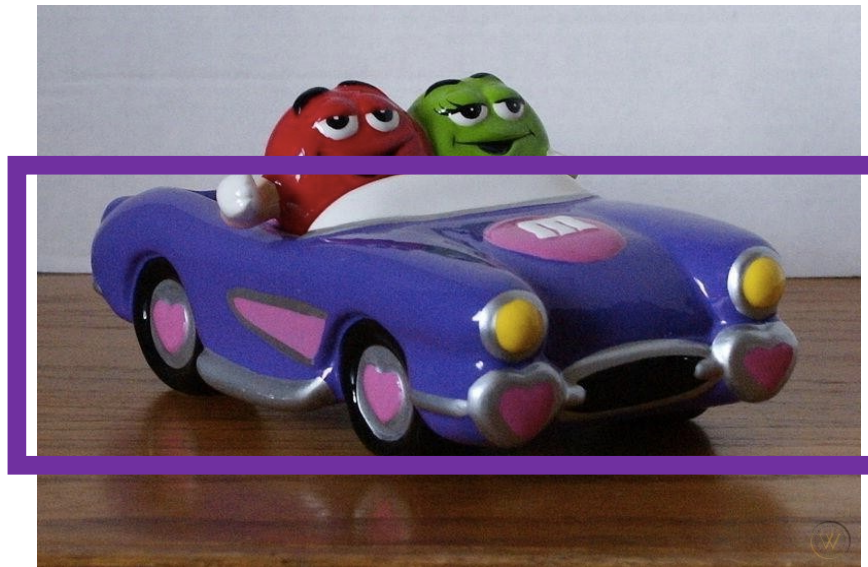


# Key Challenge 2: Where Will You Go?



Using Twitter to call out Google's algorithmic bias

<https://www.theverge.com/2015/7/1/8880363/google-apologizes-photos-app-tags-two-black-people-gorillas>



Two kids bought their mom a camera for Mother's Day... when they took portrait pictures of each other, a message flashed across the screen asking, "Did someone blink?"

<http://content.time.com/time/business/article/0,8599,1954643,00.html>

# Today's Topics

- Applications
- History of neural networks and deep learning
- How does a machine learn?
- Course logistics

# Introductions

**Instructor:** Danna Gurari; aka, Dr. G  
(preferred pronouns: she/her)



**Teaching assistant:** Samreen Anjum  
(preferred pronouns: she/her)



**Teaching assistant:** Lucas Hayne  
(preferred pronouns: he/him)



# Introductions

NameCoach: share your name pronunciation in Canvas

To record your name:

1. Find NameCoach in Canvas courses page
2. Click on record button to start
3. Review recording by clicking on play button

[BigBlueButton](#)

[Collaborations](#)

[Chat](#)

[Attendance](#)

[My Media](#)

[Web Grading Sync](#)

[New Analytics](#)

**NameCoach** 1.

[CU Boulder Libraries](#)

[Studio](#)

[Zoom](#)

[Piazza](#)

[Course Materials](#)

[Files](#)

[Settings](#)



## NameCoach info for CSCI 5922: Neural Nets and Deep Learning

### Your recording for CSCI 5922: Neural Nets and Deep Learning

3. Play



**Danna Gurari**

(danna.gurari@colorado.edu)

2. Record/Update

Update

### Recordings for CSCI 5922: Neural Nets and Deep Learning

Recorded Names

Unrecorded Names

1 person have recorded their name

Show entries per page

10

Name/email Last Name

Name Pronunciation Invited At

Danna Gurari  
(danna.gurari@colorado.edu)

Danna Gurari

Invited At: 08.09.2022  
Recorded At: 01.05.2022

# Course Objectives

- Understand the key concepts for designing deep learning models:
  1. Characterize the process to train and test deep learning algorithms
  2. Identify the challenges for designing modern deep learning algorithms that can harness today's 'big' data
  3. Recognize strengths and weaknesses of different deep learning algorithms
- Apply deep learning models to perform various AI tasks:
  1. Experiment with deep learning libraries, including scikit-learn and Keras
  2. Evaluate deep learning algorithms for tasks in various application domains, including for analyzing text and images

# Course Objectives

- Conduct and communicate a novel project:
  1. Propose a novel project idea (this will be an iterative process)
  2. Design and execute experiments to support the proposed idea
  3. Create a presentation about the project
  4. Write a report about the project



# Course Overview

- Website
  - <https://home.cs.colorado.edu/~DrG/Courses/NeuralNetworksAndDeepLearning/AboutCourse.html>
- Syllabus on website

	% of Final Class Grade	
• Grading :	Problem Sets	25%
	Lab Assignments	35%
	Final Project	40%



# Q&A: “What are the assignments?”

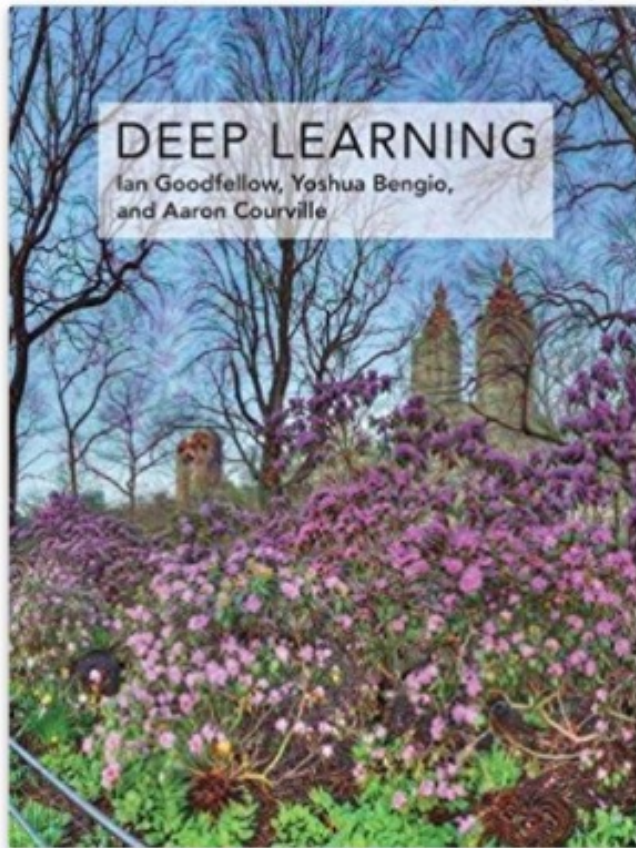
- 3 problem sets (first assignment due next week)
- 4 lab assignments
- Final project
  - Proposal
  - Outline
  - Presentation
  - Final report
- Grading policies:
  - Late policy: Penalized 1% per hour for up to 2 hours and no credit afterwards
  - Regrade requests: Must be submitted within 2 weeks of receiving the grade to the TA, Samreen Anjum. After the allotted time frame, regrade requests will not be considered.
- Grading timeline
  - Due to many students (100+) and 2 graders, expect to receive grades ~1 week after submission

Q&A: “Do I have the appropriate pre-requisites/background?”

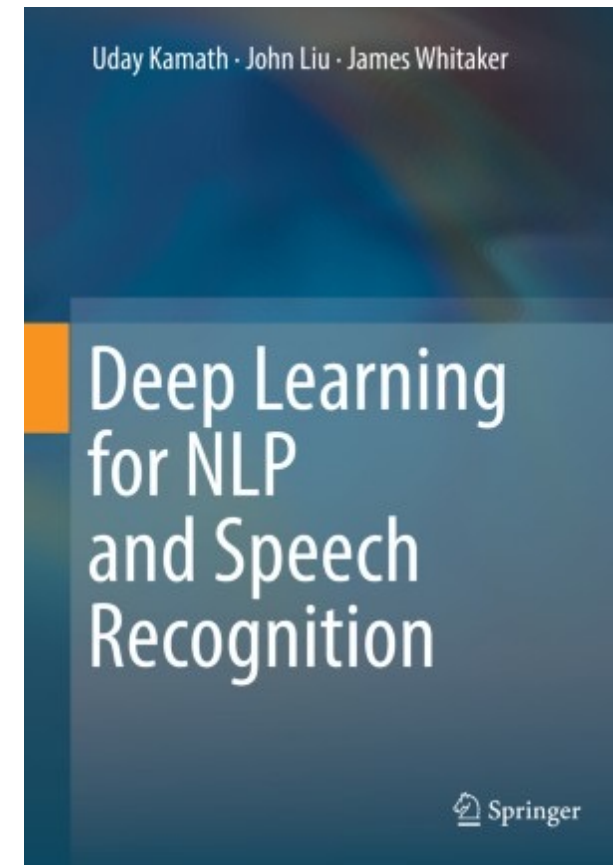
- You are expected to have programming competency as well as experience with probability/statistics and linear algebra.

# Q&A: “What are required textbooks?”

(available online for free)



(available online for free when connected to CU Boulder's network or VPN)



# Q&A: “How Do I Contact You for Questions?”

- **Questions for Instructor:** I will stay after each class lecture to answer questions.
- **Piazza:** We encourage you to first post any questions to Piazza. This can benefit other students, who may have similar questions, to see the answers posted on Piazza and it also allows peers to answer your questions. You can post questions to Piazza from Canvas.
- **Office Hours:** The TAs will host office hours every day from Monday to Friday. To attend, please enter your name on the office hours spreadsheet shared in Canvas and Piazza and then join the video meeting link shared on Canvas.
- **Appointments:** Email the TA to make an appointment or solicit an answer. Please note that at least 24 hours notice will typically be needed before the TA will be able to meet. The TA will involve the instructor for any items she is unable to address.
- **Regrade requests:** All requests must be emailed to the TA, Samreen Anjum, within 2 weeks of receiving the grade to be considered.

# My Experience Related to Deep Learning

2007-2010

2010-2015

2015-2017

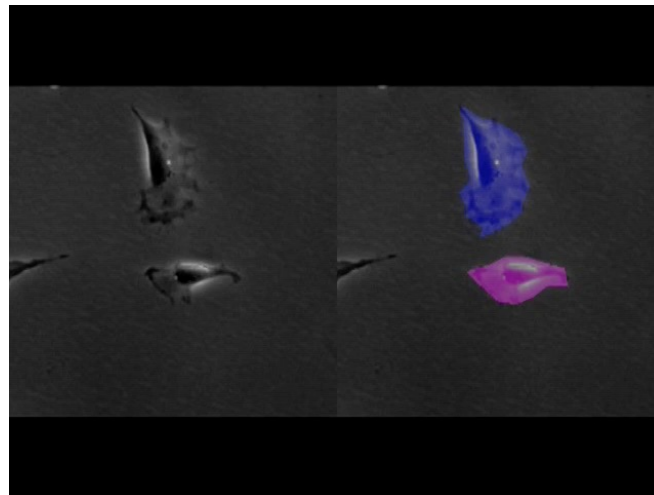
2017-Present

Software developer and project manager helping to record and analyze visible and infrared video



Source: Boulder Imaging

PhD student designing computer vision methods to segment and track cells in images and videos



Postdoctoral fellow conducting research projects related to vision and language problems



Is it edible or poisonous?

Assistant professor overseeing research projects related to many vision and language problems

e.g., image classification, object detection, semantic segmentation, object tracking, image captioning, visual question answering, style transfer, image inpainting, and image search

# My Experience Related to Deep Learning

2007-2010

2010-2015

2015-2017

2017-Present

Software developer and project manager helping to record and analyze visible and infrared video



Source: Boulder Imaging

PhD student designing computer vision methods to segment and track cells in images and videos



Postdoctoral fellow conducting research projects related to vision and language problems



Is it edible or poisonous?

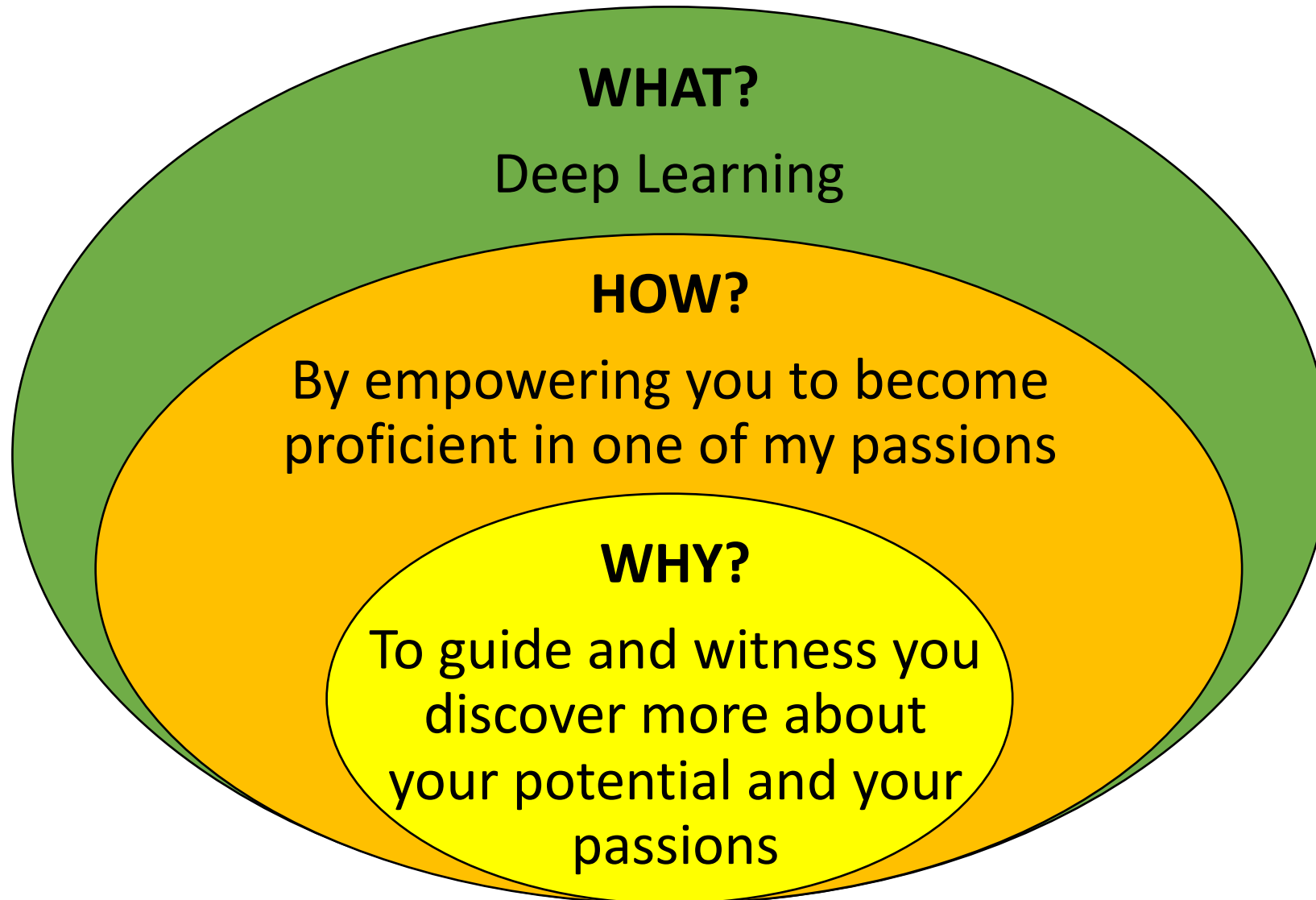
Assistant professor overseeing research projects related to many vision and language problems

e.g., image classification, object detection, semantic

style transfer, image inpainting, and image search

20 publications involving deep learning

# What is My “Why” for Teaching You...





# Today's Topics

- Applications
- History of neural networks and deep learning
- How does a machine learn?
- Course logistics



*The End*