

# INTRODUCTION TO ARTIFICIAL INTELLIGENCE

ECE 57000, Fall 2020

Section CRNs: 34846 (002, in-person), 26476 (003, online),  
25916 (EPE, online), 25917 (OXE, online)

Instructor: David I. Inouye

Website: <https://www.davidinouye.com/course/ece57000-fall-2020/>

# WHAT IS ARTIFICIAL INTELLIGENCE?

- Merriam-Webster Dictionary
  - “a branch of computer science dealing with the **simulation of intelligent behavior** in computers”
- Oxford Dictionary
  - “the theory and development of computer systems able to perform tasks that **normally require human intelligence**, such as visual perception, speech recognition, decision-making, and translation between languages.”

# POSSIBLY A.I. IS A MOVING TARGET

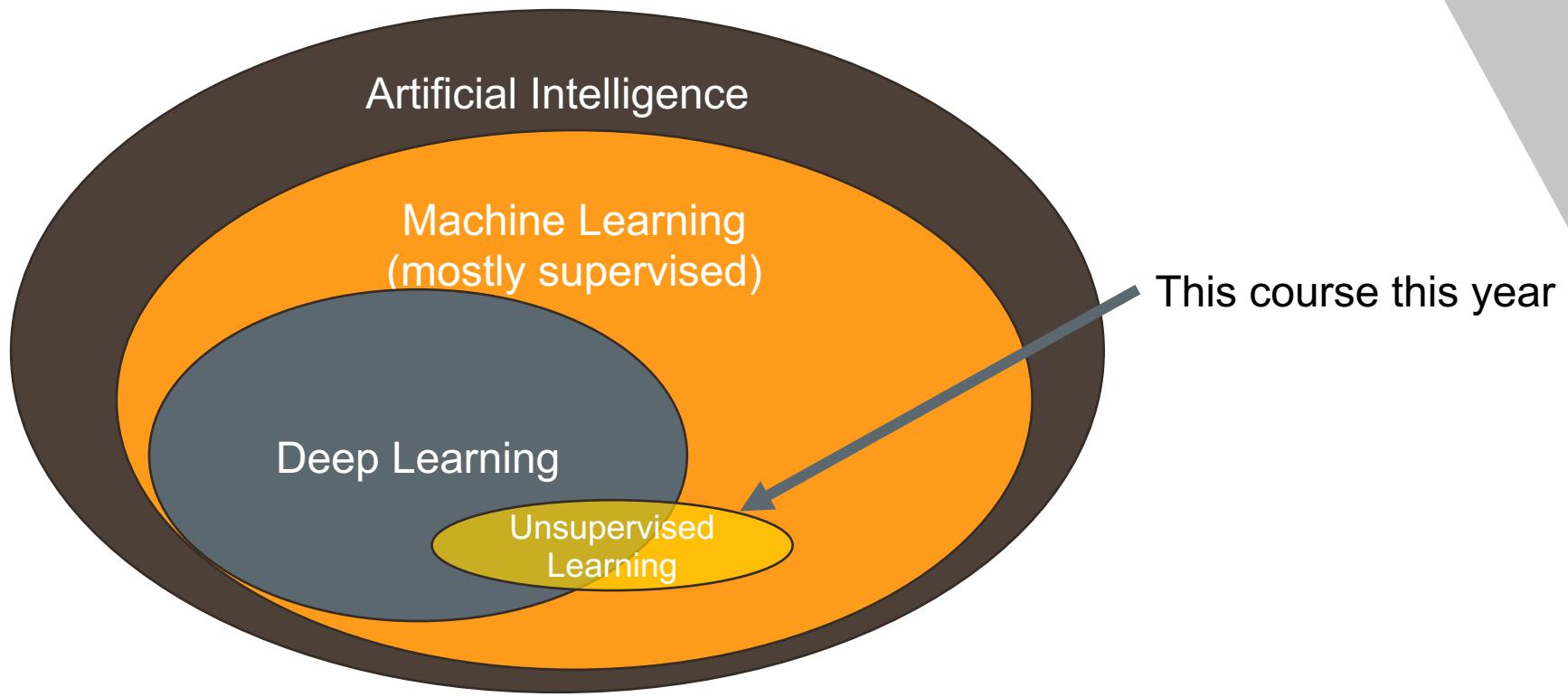
- Are these A.I.?
  - Chess solvers
  - TurboTax
  - Chatbot
- What about these?
  - Speech recognition
  - Face recognition
  - Personalized recommendations
  - Self-driving cars
- “AI is anything that humans can do that computers cannot yet do.”

# A MORE PRAGMATIC DEFINITION

“AI is that which appears in academic conferences on AI” \*

\* From slides by Prof. Zico Kolter at CMU:  
<http://www.cs.cmu.edu/~15780/slides/intro.pdf>

# A.I. IS A VERY BROAD FIELD



# OTHER RELATED CLASSES

- Other section of this class (004) by Prof. Wang
- ECE 695: Deep Learning (spring semester) by Prof. Kak and Prof. Bouman
- ECE 595: Introduction to Deep Learning by Prof. Aly El Gamal
- Deep Learning for Computer Vision by Prof. Jeffrey Siskind
- Machine Learning I (spring semester) by Prof. Stanley Chan

# AGENDA

1. Announcements
  - **Room change: LILY 1105**
  - Other section (004) taught by Prof. Wang
  - Emergency preparedness
2. Syllabus
3. Logistics
4. (time-permitting) Defining AI

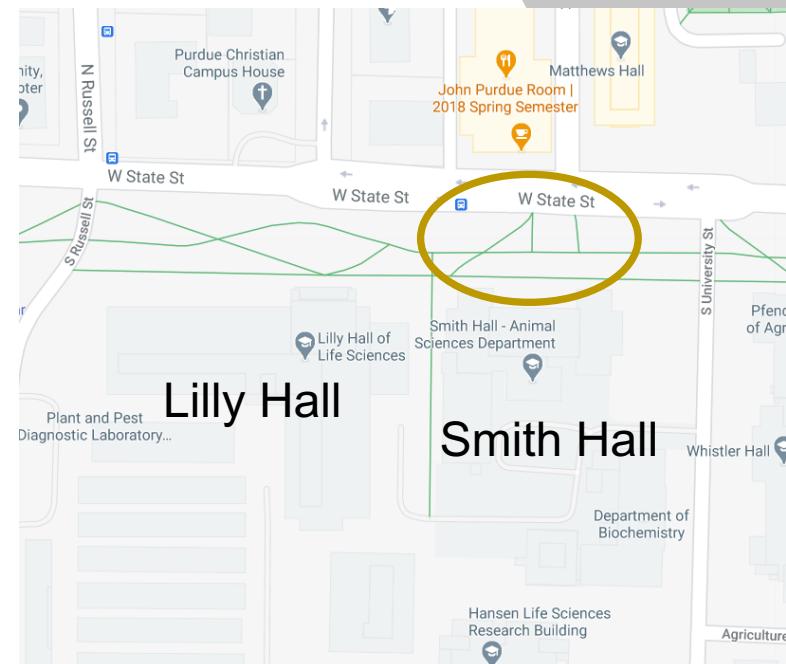
# EMERGENCY PREPAREDNESS

As we begin this semester, I want to take a few minutes and discuss emergency preparedness. While COVID-19 is currently a major focus of our campus health and safety preparations, we must also take time to be prepared for other possible emergencies as we would in any semester. Purdue University is a very safe campus and there is a low probability that a serious incident will occur here at Purdue. However, just as we receive a “safety briefing” each time we get on an aircraft, we want to emphasize our emergency procedures for evacuation and shelter-in-place incidents. Our preparedness will be critical IF an unexpected event occurs!

# EMERGENCY PREPAREDNESS

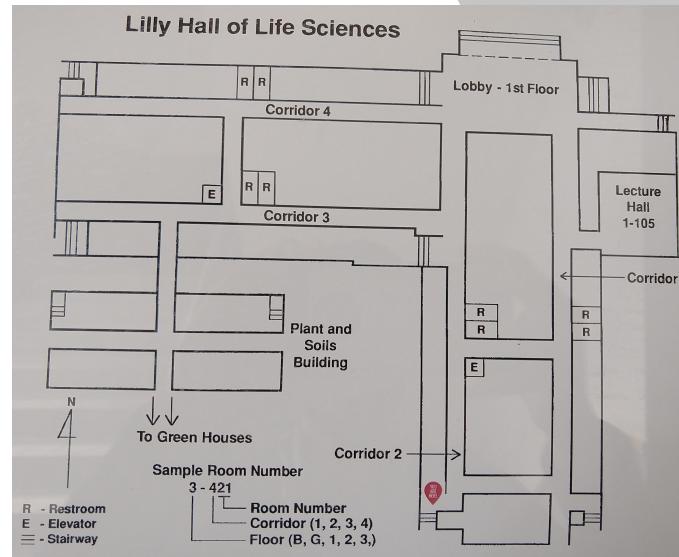
Emergency preparedness is your personal responsibility. Purdue University is actively preparing for natural disasters or human-caused incidents with the ultimate goal of maintaining a safe and secure campus. Let's review the following procedure

- For any emergency text or call 911.
- There are more than 300 Emergency Telephones (aka blue lights) throughout campus that connect directly to the Purdue Police Department (PUPD). If you feel threatened or need help, push the button and you will be connected right away.
- If we hear a fire alarm, we will immediately evacuate the building and proceed to the grassy area in front of **Smith Hall**. Do not use the elevator.



# EMERGENCY PREPAREDNESS

- If we are notified of a Shelter in Place requirement for a tornado warning we will stop classroom or research activities and shelter in the lowest level of this building away from windows and doors. Our preferred location is the **basement corridors of Lilly Hall**.
- If we are notified of a Shelter in Place requirement for a hazardous materials release, we will shelter in **our classroom** shutting any open doors and windows.
- If we are notified of a Shelter in Place requirement for an active threat such as a shooting, we will shelter in **a room that is securable** preferably without windows.



# SYLLABUS!

All significant updates to the syllabus or course schedule will be posted on Piazza:

<https://piazza.com/purdue/fall2020/ece57000inouyeall>

See course website for syllabus:

<https://www.davidinouye.com/course/ece57000-fall-2020/>

# LOGISTICS

- Brightspace
  - **First time: Click on links in Brightspace to connect Purdue account (demo)**
  - Video content (both live and recorded) will be on Brightspace for privacy reasons.
- The course website will have all other necessary links and content

**NOW BACK TO AI...**

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# NOT “MOVIE” A.I.



*C-3PO and R2D2 in Star Wars.*



*The rogue A.I. HAL9000 from the movie 2001: A Space Odyssey.*



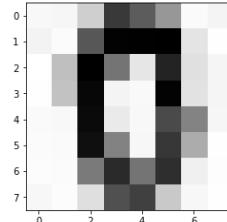
*Skynet from Terminator.*

# COMPUTERS DON'T "THINK" LIKE WE DO

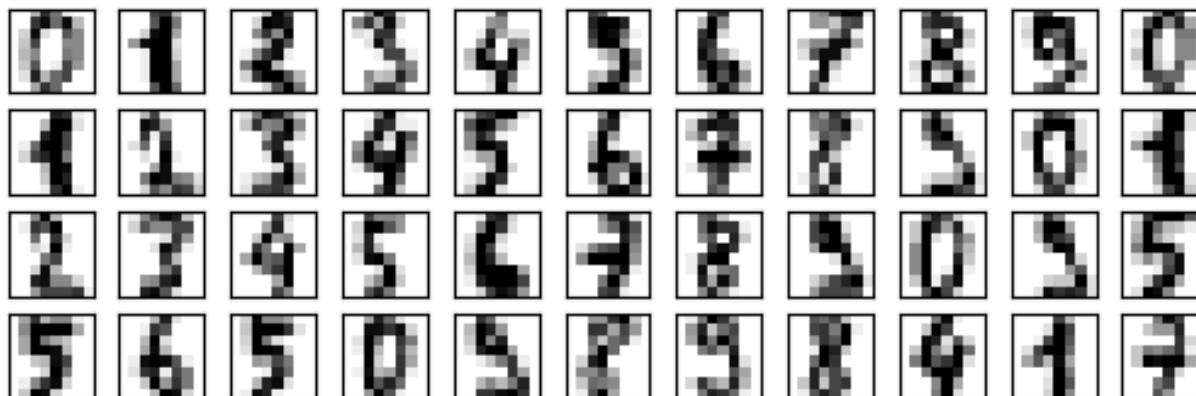
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[2.02e-05 3.83e-03 1.58e-02 2.87e-03 9.79e-04 1.18e-02 8.46e-03 7.81e-04]
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[3.15e-04 2.36e-03 1.46e-02 5.44e-03 1.10e-02 1.21e-02 2.09e-04 1.61e-04]
[6.53e-04 2.53e-04 6.47e-03 1.32e-02 1.02e-02 1.10e-04 6.56e-04 1.38e-04]]
```

A matrix of numbers as the computer "sees".  
Do you know what this matrix represents?

# COMPUTERS DON'T "THINK" LIKE WE DO



The same matrix of numbers displayed as an image.



Other examples from this dataset.  
Do you know what the numbers represent now?

# COMPUTERS DON'T "THINK" LIKE WE DO



$x$   
“panda”  
57.7% confidence

$+ .007 \times$



$\text{sign}(\nabla_x J(\theta, x, y))$   
“nematode”  
8.2% confidence

=



$x +$   
 $\epsilon \text{sign}(\nabla_x J(\theta, x, y))$   
“gibbon”  
99.3 % confidence



Real gibbon...

\* From [Explaining and Harnessing Adversarial Examples](#) by Goodfellow et al.

# NOR IS HUMAN IMITATION NECESSARILY THE GOAL

- Consider flight

Imitation



Understanding  
+ Engineering  
(Underlying  
principles)



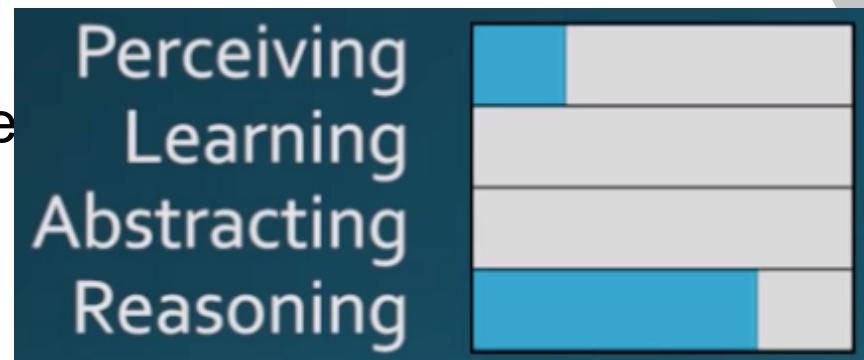
# DARPA'S PERSPECTIVE ON AI

- First wave – Handcrafted Knowledge
- Second wave – Statistical Learning
- Third wave (future) – Contextual Adaptation

Excellent DARPA video (16 min) on AI (content above based on this):  
<https://www.youtube.com/watch?v=-O01G3tSYpU>

# 1<sup>ST</sup> WAVE: HANDCRAFTED KNOWLEDGE

- Examples
  - Auto-scheduling systems
  - Chess
  - TurboTax
  - Simple medical diagnosis
- Good at
  - Logical reasoning from rules
- Bad at
  - Perceiving
  - Learning



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# ONE KEY PROBLEM: **(FORMALLY) STATING WHY IS HARD BUT LABELING IS EASY**

- What is this a photo of?



<https://unsplash.com/search/photos/cute-cat>

- Why is this an image of a cat?
- Can you state a rule for all cats?

# 2<sup>ND</sup> WAVE: STATISTICAL LEARNING

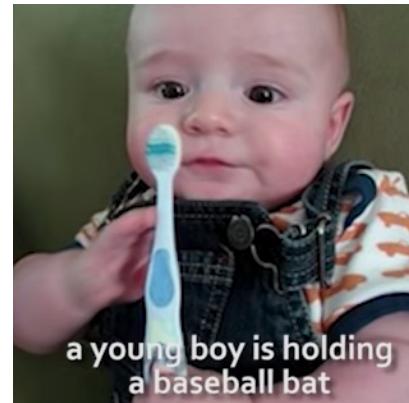
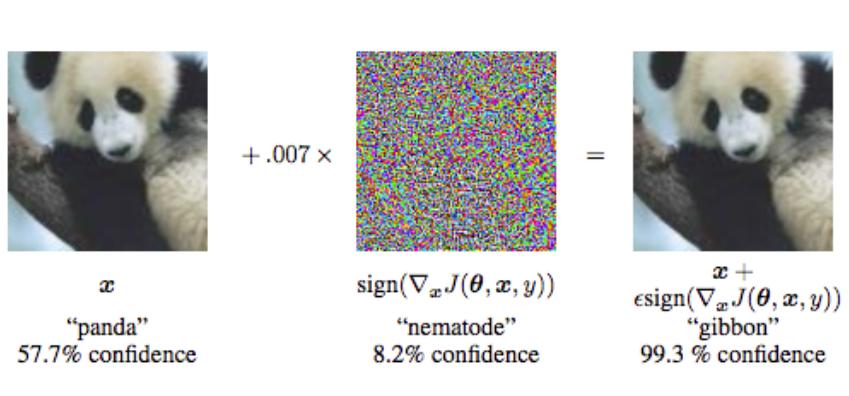
- Examples
  - Voice/face recognition
  - Personalized recommendations
- Good at
  - Perceiving
  - Learning
- Bad at
  - Logical reasoning
  - Robustness



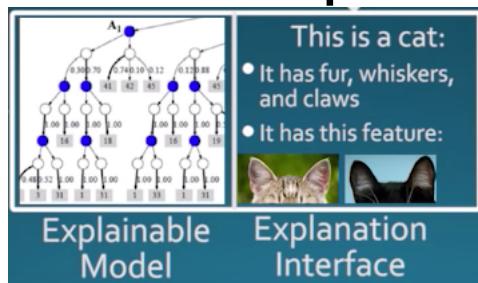
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# KEY PROBLEMS WITH 2<sup>ND</sup> WAVE

- Lack of robustness / fragile systems



- Lack of explanations



I understand why  
 I understand why not  
 I know when you'll succeed  
 I know when you'll fail  
 I know when to trust you

# 3<sup>RD</sup> WAVE (FUTURE): CONTEXTUAL ADAPTATION

- Combination of previous two waves
- System will construct **explanatory models**
  - Causation
  - Some abstraction
  - Explainable
- Examples
  - Incorporate handwriting knowledge for recognizing new characters
  - ? - (Maybe you can work on this)
- Good at
  - Perceiving
  - Learning
  - Reasoning
- Slightly better at
  - Abstracting



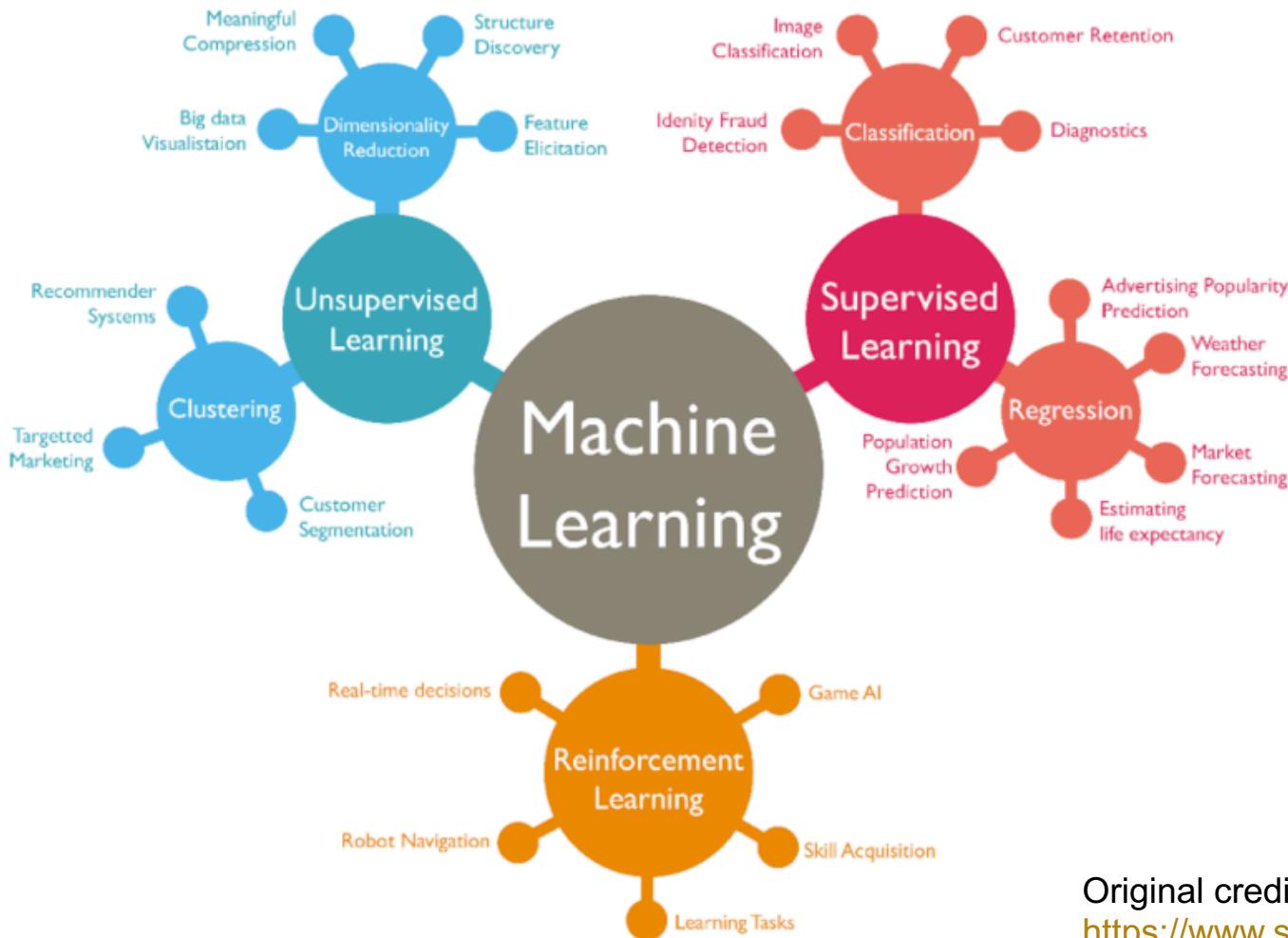
Perceiving  
Learning  
Abstracting  
Reasoning

Excellent DARPA video (16 min) on AI (content above based on this):  
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# MACHINE LEARNING IN AI

- ML itself
  - Models
  - Algorithms
  - Theory
- Or as tool for other AI applications
  - Natural language processing
  - Computer vision
  - Robotics

# INCOMPLETE TAXONOMY OF ML



Original credit unknown, retrieved from  
<https://www.sharper.ai/taxonomy-ai/>

# WHY UNSUPERVISED LEARNING?

- Labeling data is expensive  
(Supervised)
- Gathering raw data is cheap  
(Unsupervised)
- Best will probably be a combination

# WHY UNSUPERVISED LEARNING? POSSIBLY FOR “COMMON SENSE”

- *“AI systems today do not possess “common sense”, which humans and animals acquire by observing the world, acting in it, and understanding the physical constraints of it. Some of us see unsupervised learning as the key towards machines with common sense.”*

*- Yann LeCun, Head of Facebook AI, 2016.*

# QUESTIONS?