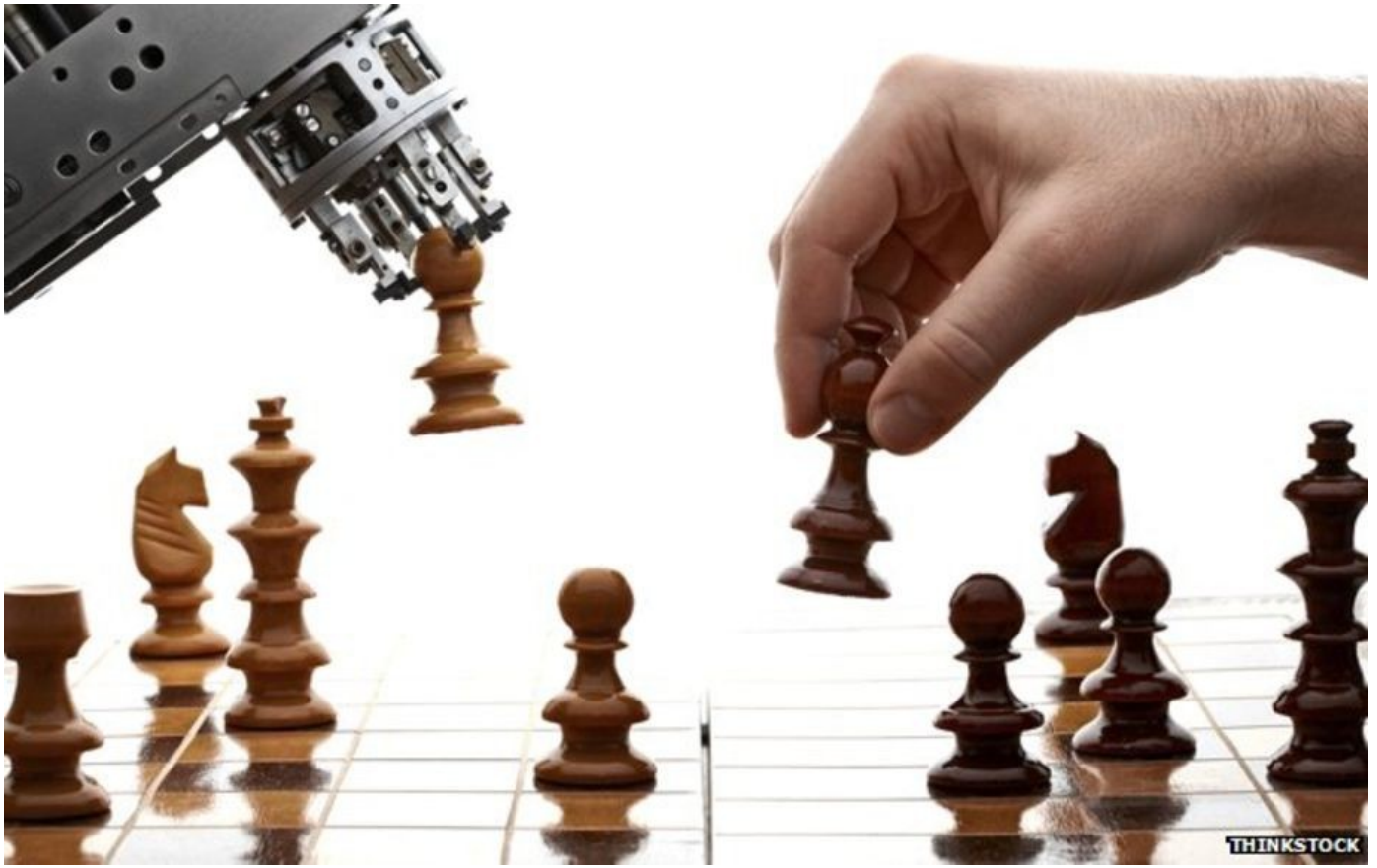


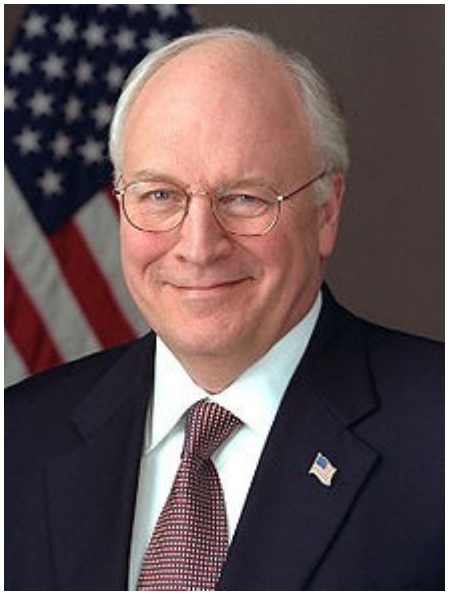
Introduction to Artificial Intelligence

COSC 4550 / COSC 5550

Professor Nick Cheney

8/30/17

Dr. Nick ✗



Mr. Cheney ✗

Professor Cheney ✓

Why study artificial intelligence?

Why study artificial intelligence?

why are you here?

Introductions

What are your experiences with AI?

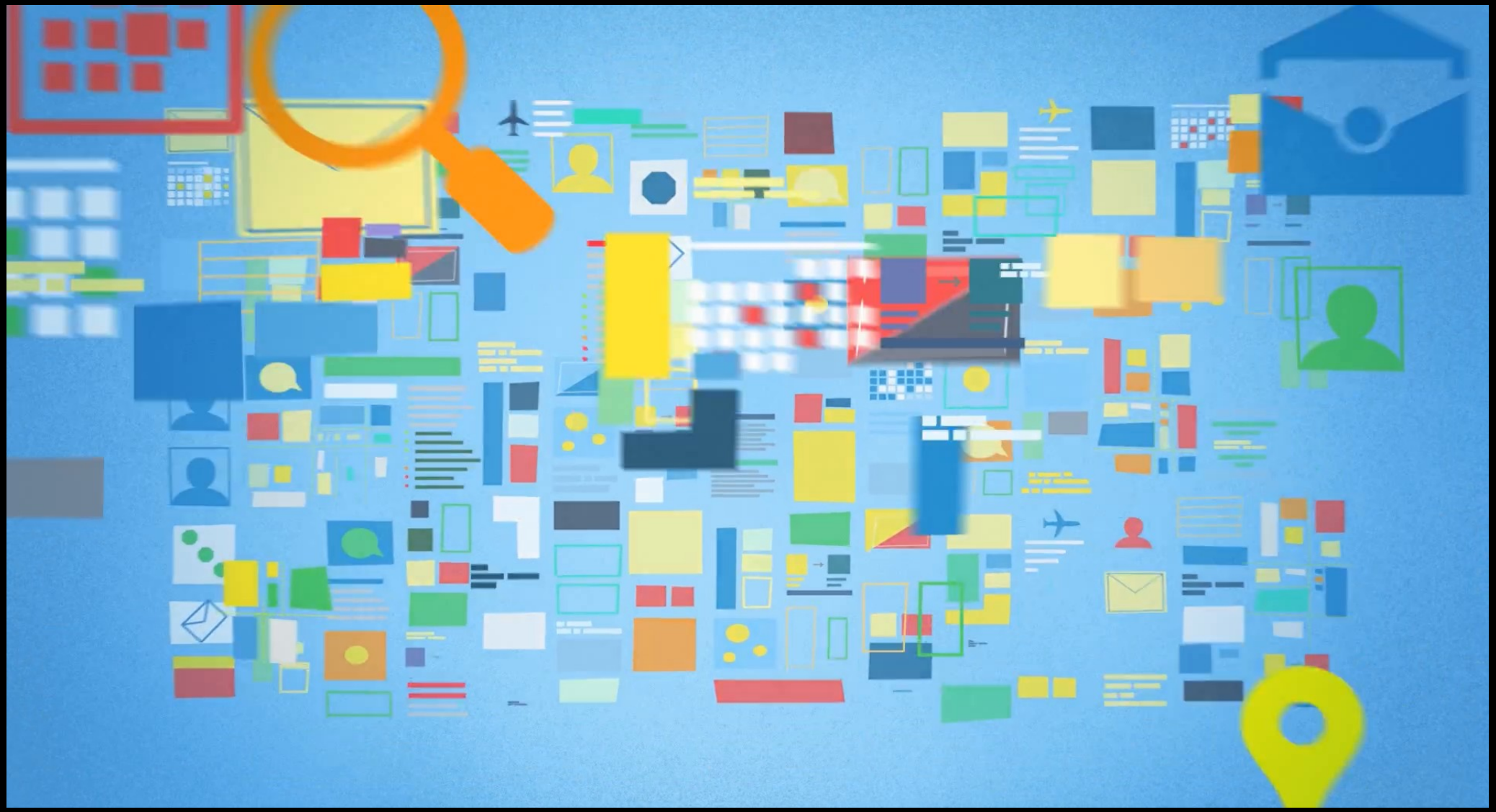
Why are you interested in AI?

One interesting fun-fact

Why study artificial intelligence?

applications...

1B1
2B1
3B1
4B1
1A1
2A1
3A1
4A1
KIVA Systems
2178
KIVA Systems
1348
1377
1375



AUTOMORO

AUTODESK

facebook
yelp
Google
NETFLIX
pandora
ebay
amazon
tinder

PHILIPS

NanoTech T5 Reflector

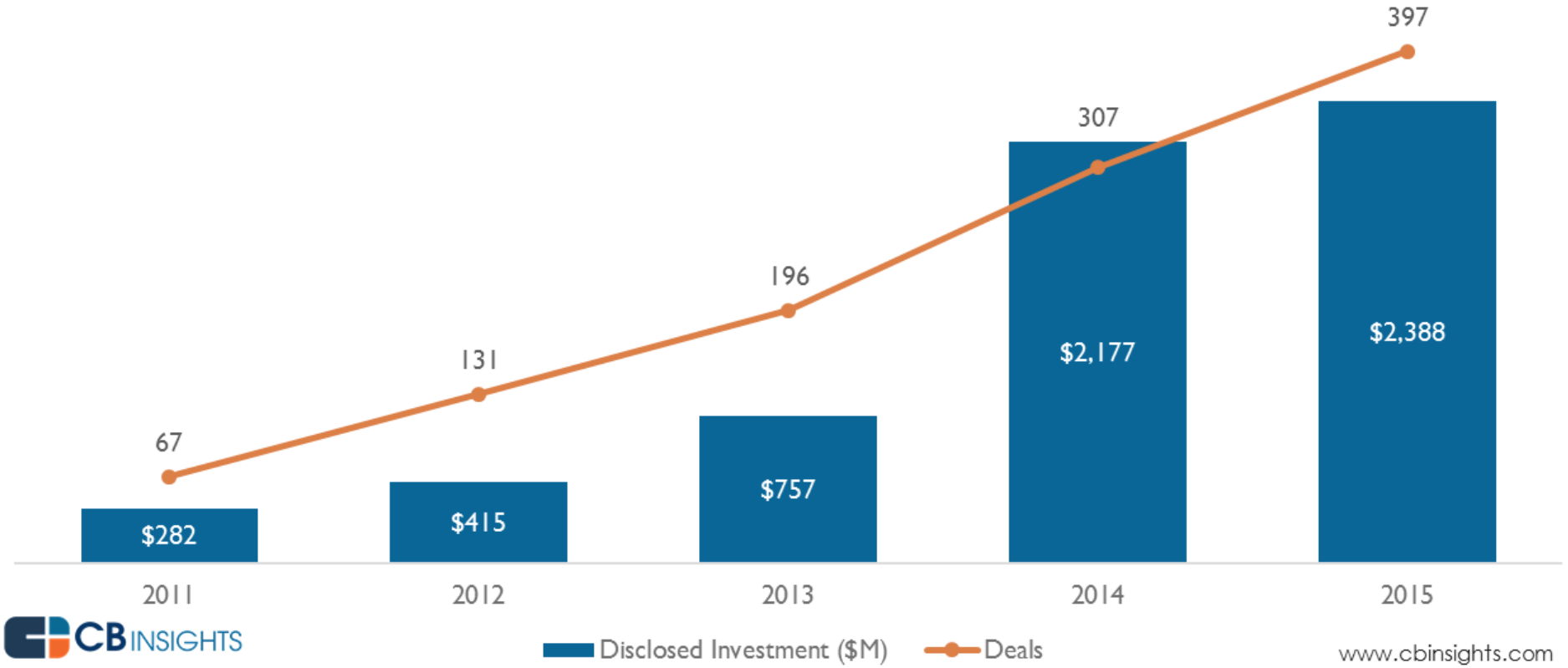
and more… ?

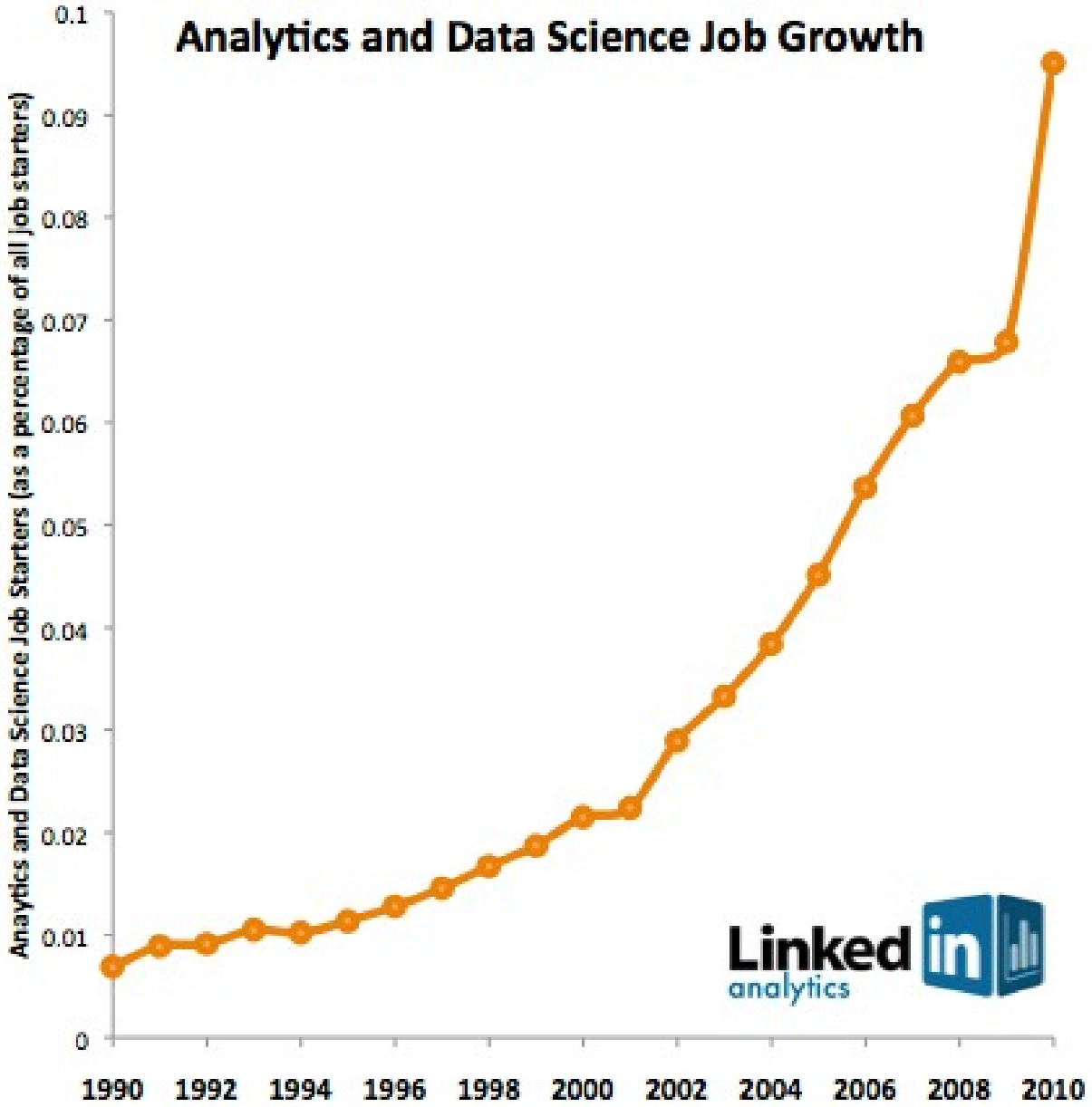
Why study artificial intelligence?

jobs...

AI Landscape: Global Yearly Financing History

2011-2015




Analytics and Data Science Job Growth
Anaytics and Data Science Job Starters (as a percentage of all job starters)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Linked in analytics

indeed
Home
View Job Trends Navigation Menu
"Data Scientist" Job Trends
"Data Scientist"
+ Add Term
Find Trends
Scale: Absolute | Relative
Job Postings
% of Matching Jobs
0.10
0.08
0.06
0.04
0.02
0.00
2012
2013
2014
2015
2016

Machine Learning Scientist Salaries

glassdoor

21 Salaries

Updated Jul 18, 2017

National Avg

$122,194

Min $95k

Max $135k

Machine Learning Scientist
Amazon
14 salaries

$131,115 per year

$102k — $170k

Machine Learning Scientist
Google
1 employee salary or estimate

About **$135k - $144k**

$135k — $144k

Machine Learning Scientist
Theranos
2 salaries

About **$93k - $135k**

$93k — $135k

Machine Learning Scientist
GE
1 employee salary or estimate

About **$128k - $138k**

$128k — $138k

Machine Learning Scientist
Edmunds.com
1 employee salary or estimate

About **$133k - $141k**

$133k — $141k

Machine Learning Scientist Salaries

glassdoor

21 Salaries

Updated Jul 18, 2017

National Avg

$122,194

Min $95k

Max $135k

Data Scientist Salaries

2,223 Salaries

Updated Aug 15, 2017

National Avg

$113,436

Min $76k

Max $146k

Programmer Salaries

35,289 Salaries

Updated Aug 2, 2017

National Avg

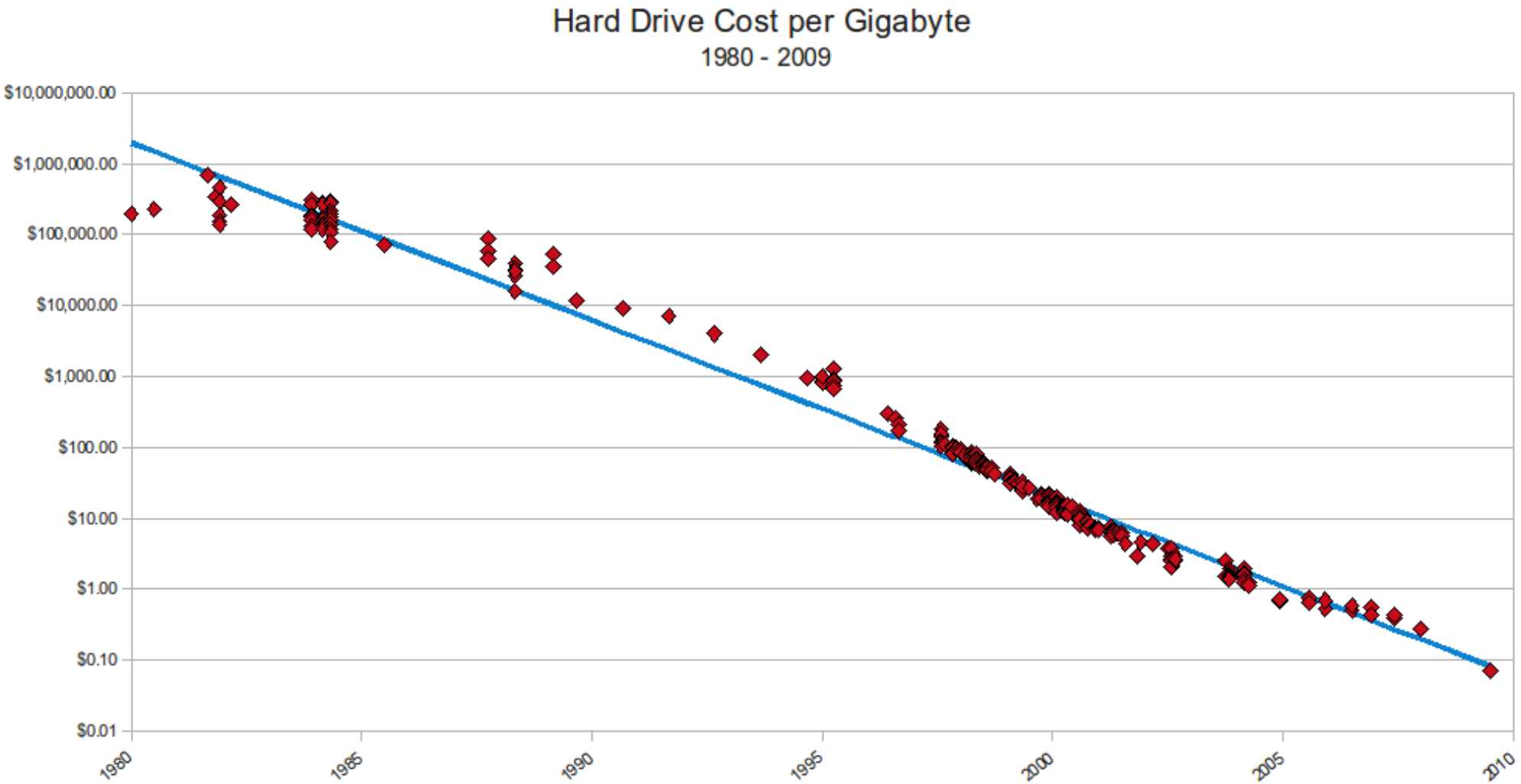
$65,806

Min $52k

Max $84k

Why study artificial intelligence?

why now?



[Komorowski 2009]

Backblaze Average Cost per Drive Size

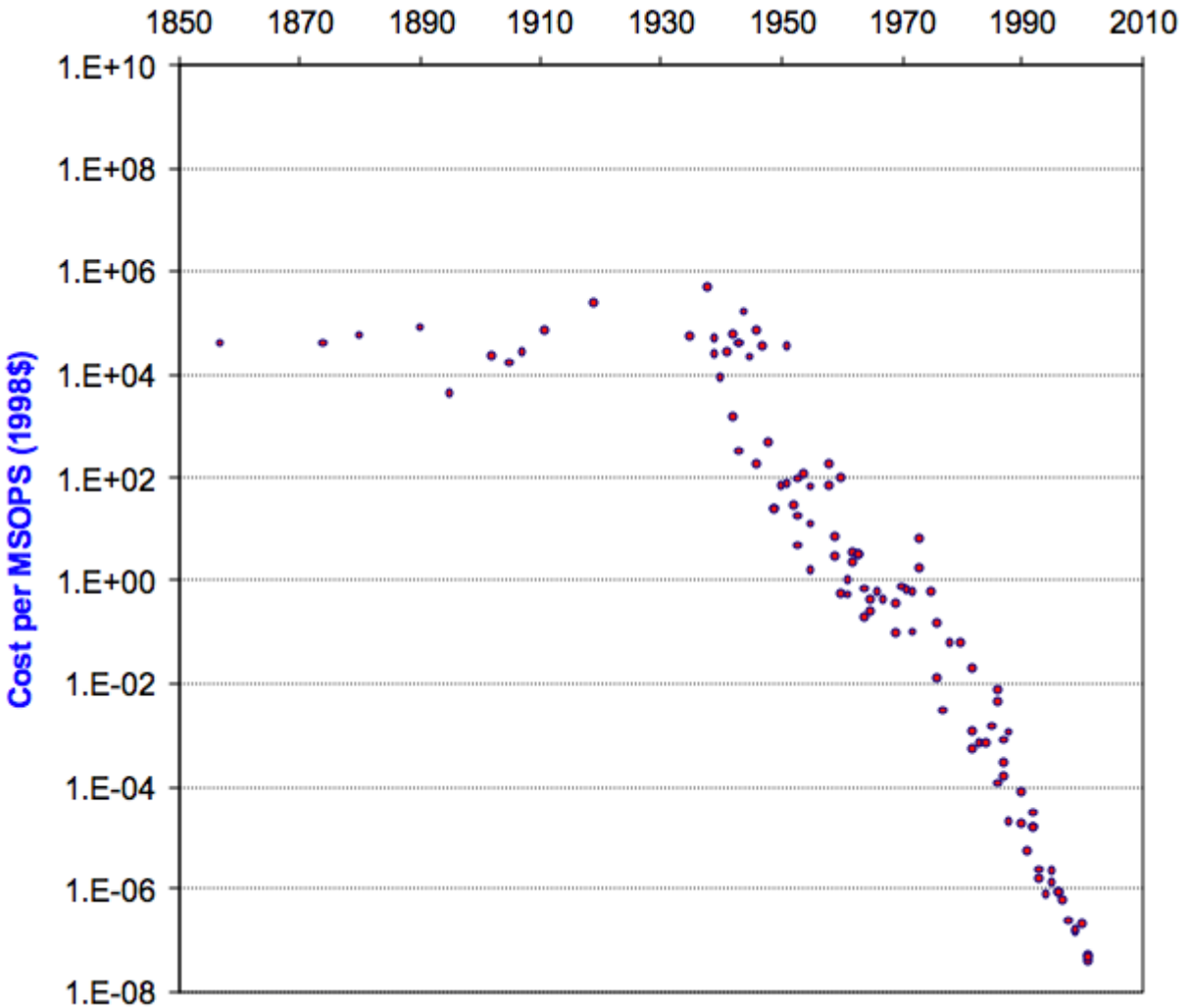
By Quarter: Q1 2009 - Q2 2017

BACKBLAZE

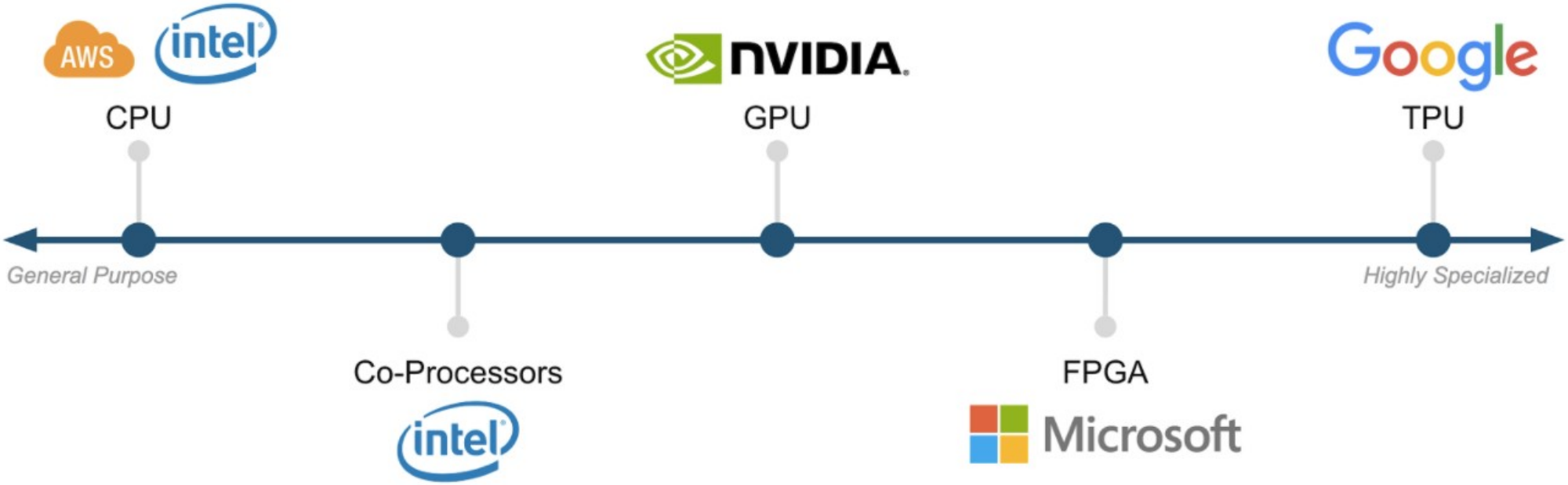
SAMSUNG
htc
ASUS

BIG
DATA
USE
ONE
SINCE
SOFTWARE
REQUIRING
UBIQUITOUS
RADIO-FREQUENCY
COMPLEXITY
SOLID
WIRELESS
BUSINESS
MOVING
ANALYTICS
SAN
TOLERABLE
PARALLEL
SIZE
NEEDED
QUALITIES
PETABYTES
INTERNET
TECHNOLOGIES
PROCESSING
BURIED
LOGS
ORGANIZATIONS
USING
TYPES
WORKING
GARTNER
MASSIVELY
BIOLOGICAL
RELATED
ALSO
PERFORMANCE
HUNDREDS
CREATED
DISK
DESKTOP
RELATIONAL
ZETTABYTES
GENOMICS
COMPUTING
TOOLS
SET
SHARED
TIME
COMBAT
SIGNIFICANT
WITHIN
PROCESS
INCLUDE
SYSTEMS
DEFINITION
NETWORKS
BIOGEOCHEMICAL
SEARCH
RECONSIDER
OPPORTUNITIES
INFORMATION
CONNECTOMICS
RECORDS
CURRENTLY
FC
TENS
CAPACITY
FORMS
PRESENTATIONS
WORLD'S
PRACTITIONERS
NOW
USED
DISTRIBUTED
CAPTURE
MAY
MANAGEMENT
MANAGE
GROW
SOCIAL
LARGE
STORE
DEFINING
COST
CONTINUES
TERABYTES
MPP
RESEARCH
STORAGE
EVERY
CASE
CITATION
COMPLEX
DATABASES
LARGER
INDEXING
DIFFICULTY
TARGET
ABILITY
SETS
EXAMPLES
ELAPSED
CURRENT
THOUGHT
APPLIED
SENSOR
ARCHIVES
AMOUNT
DESCRIBING

The Cost of Computation



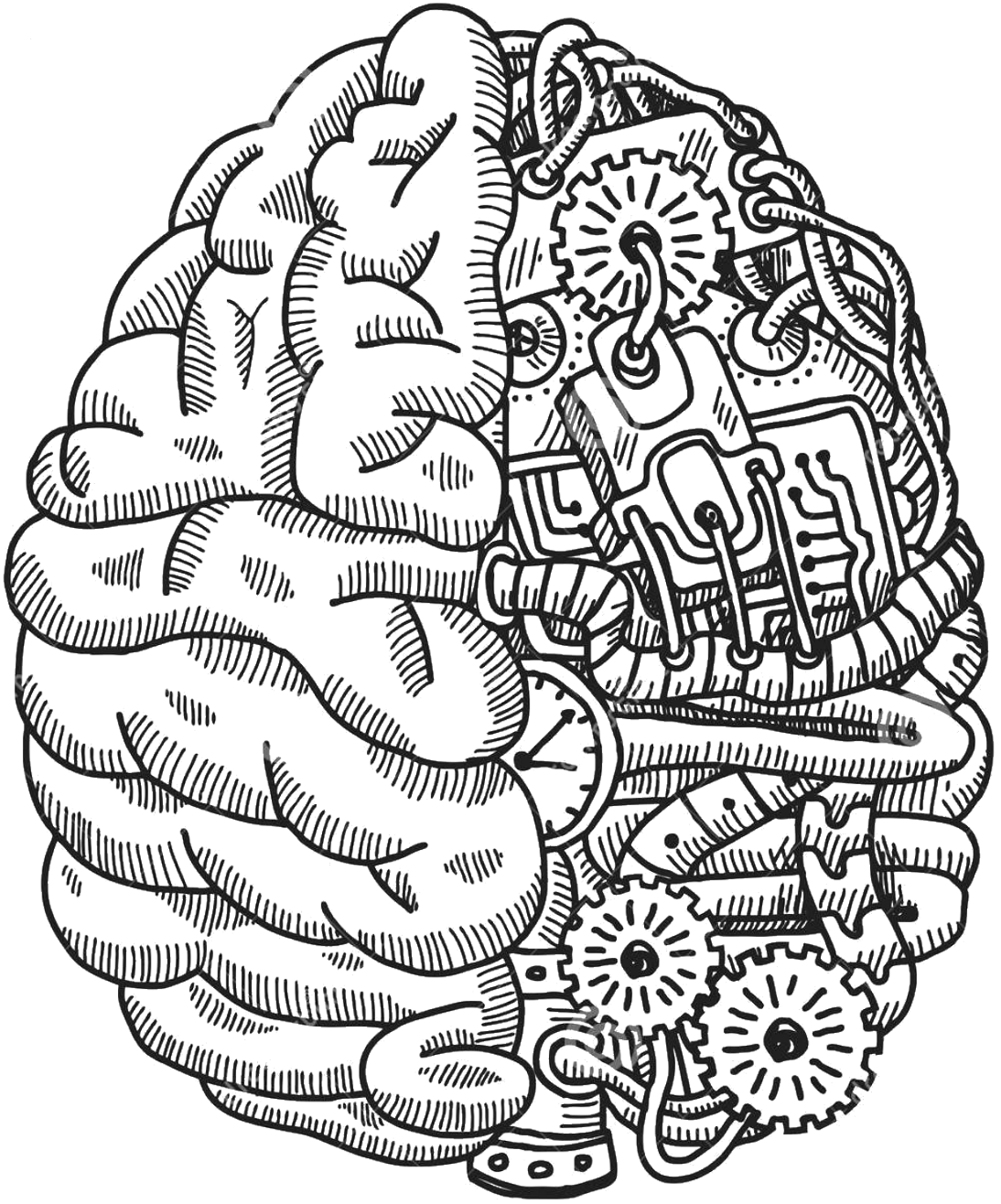
[Nordhaus 2001]

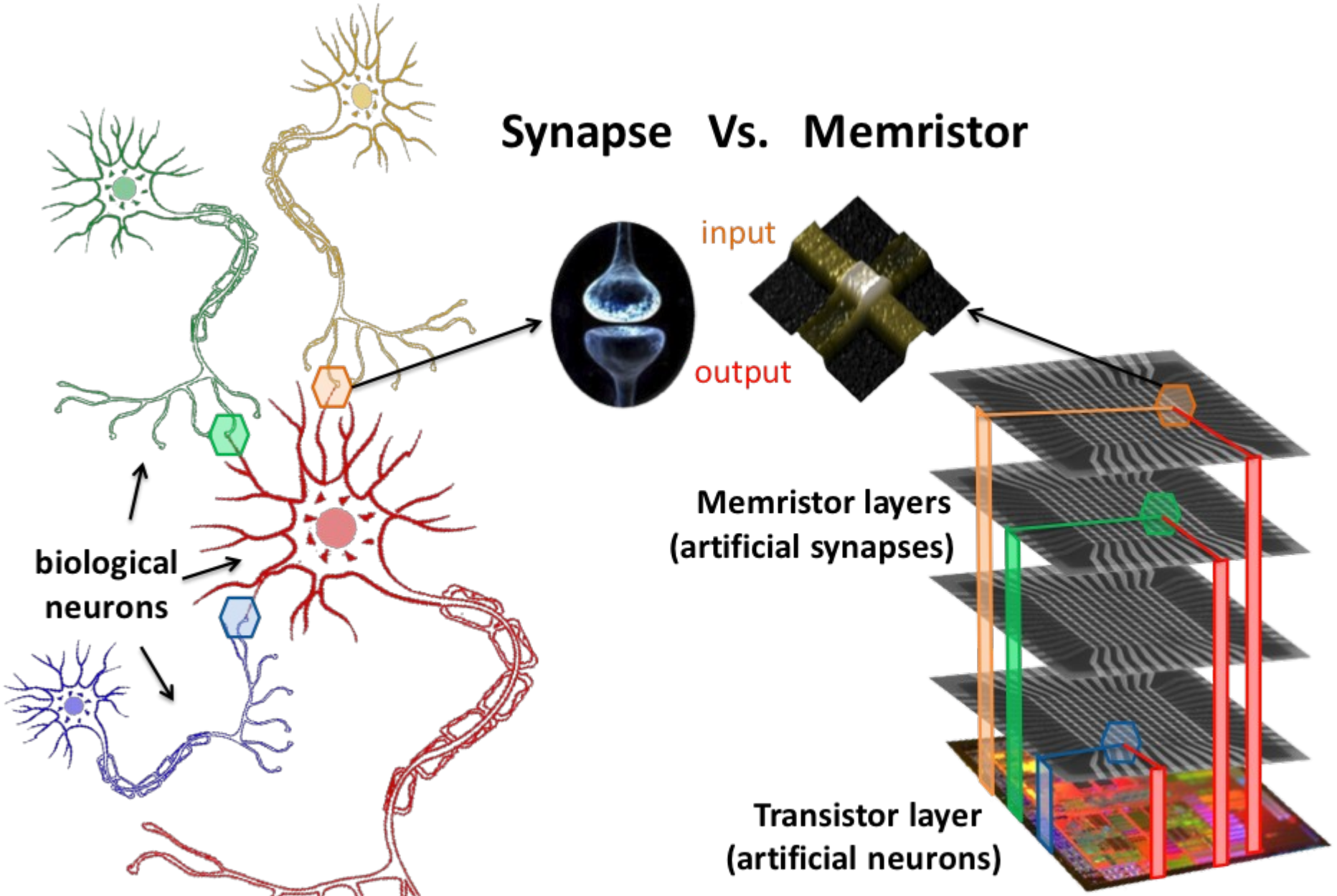

AWS
intel
CPU
NVIDIA
GPU
Google
TPU
General Purpose
Co-Processors
intel
FPGA
Microsoft
Highly Specialized

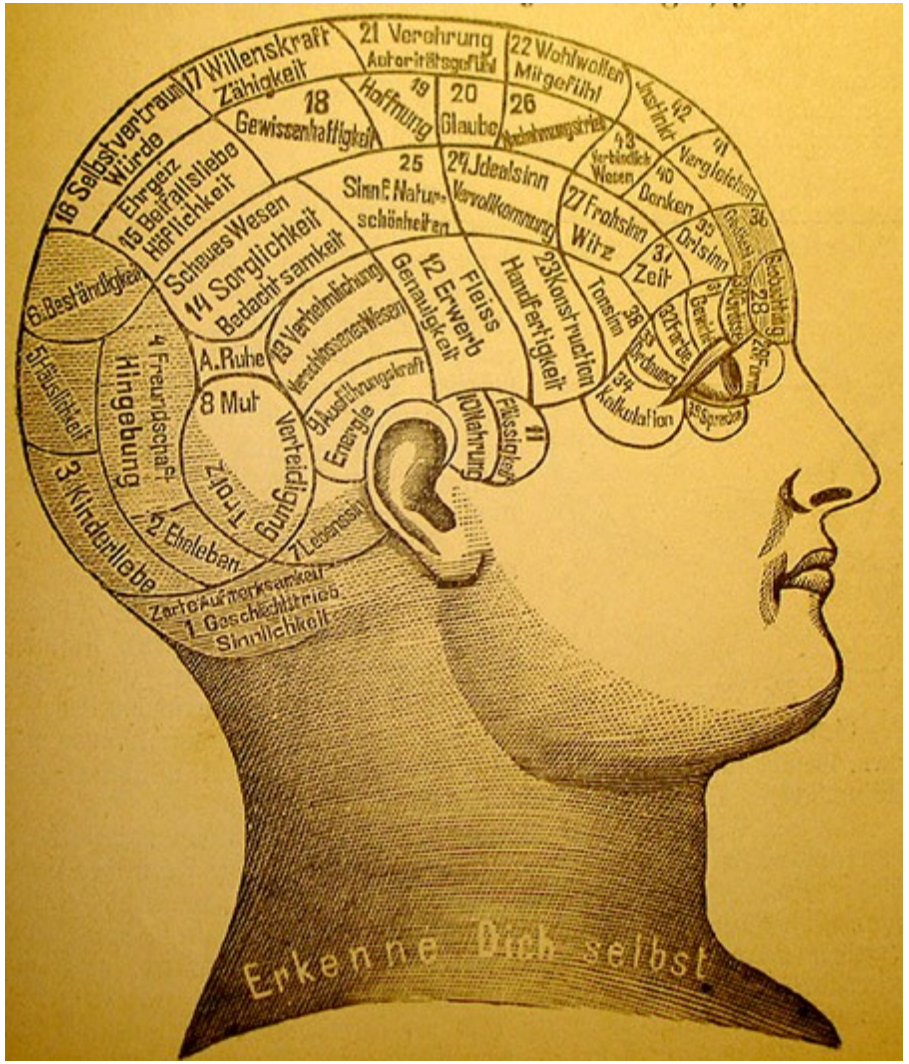
CLOUD 3.0
The Rise of Big Compute

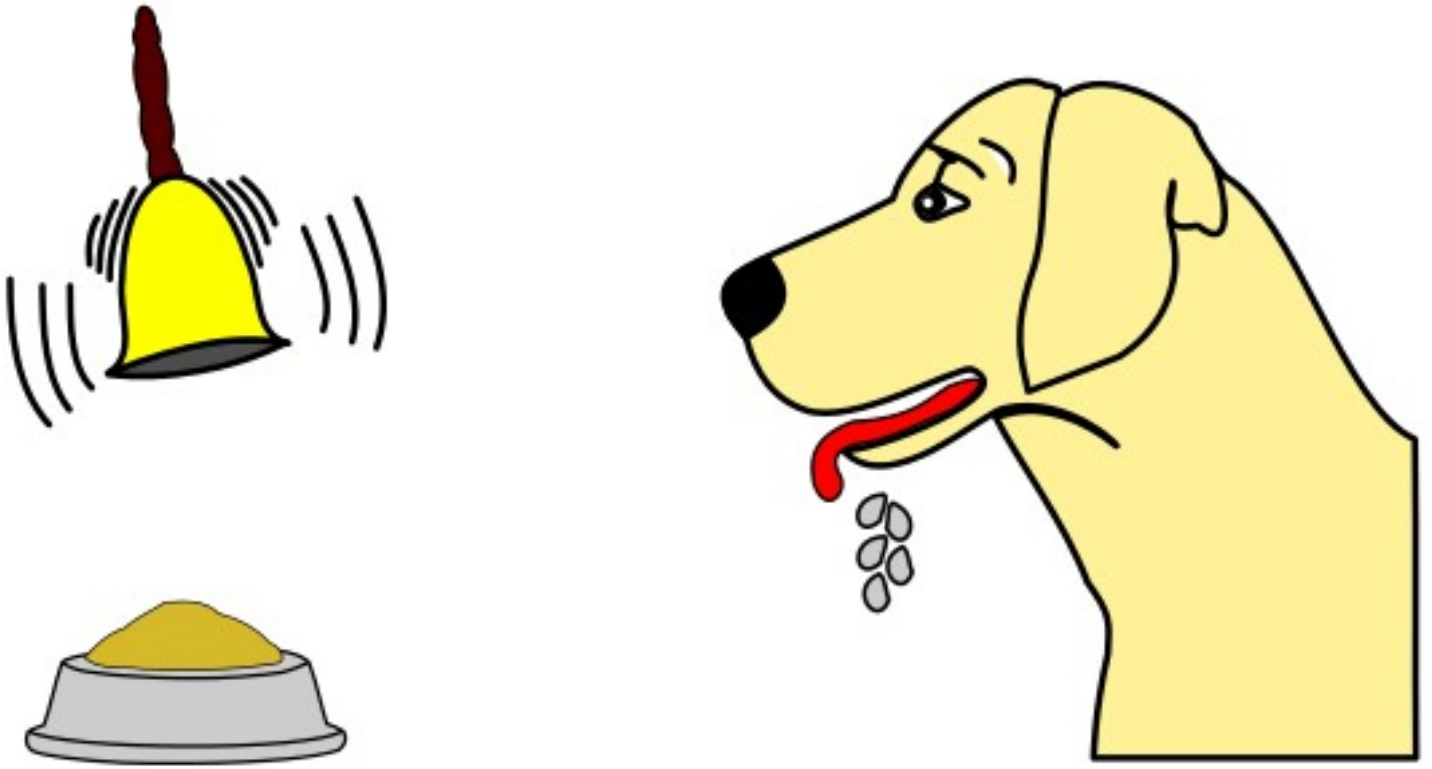
Why study artificial intelligence?

for understanding… science!

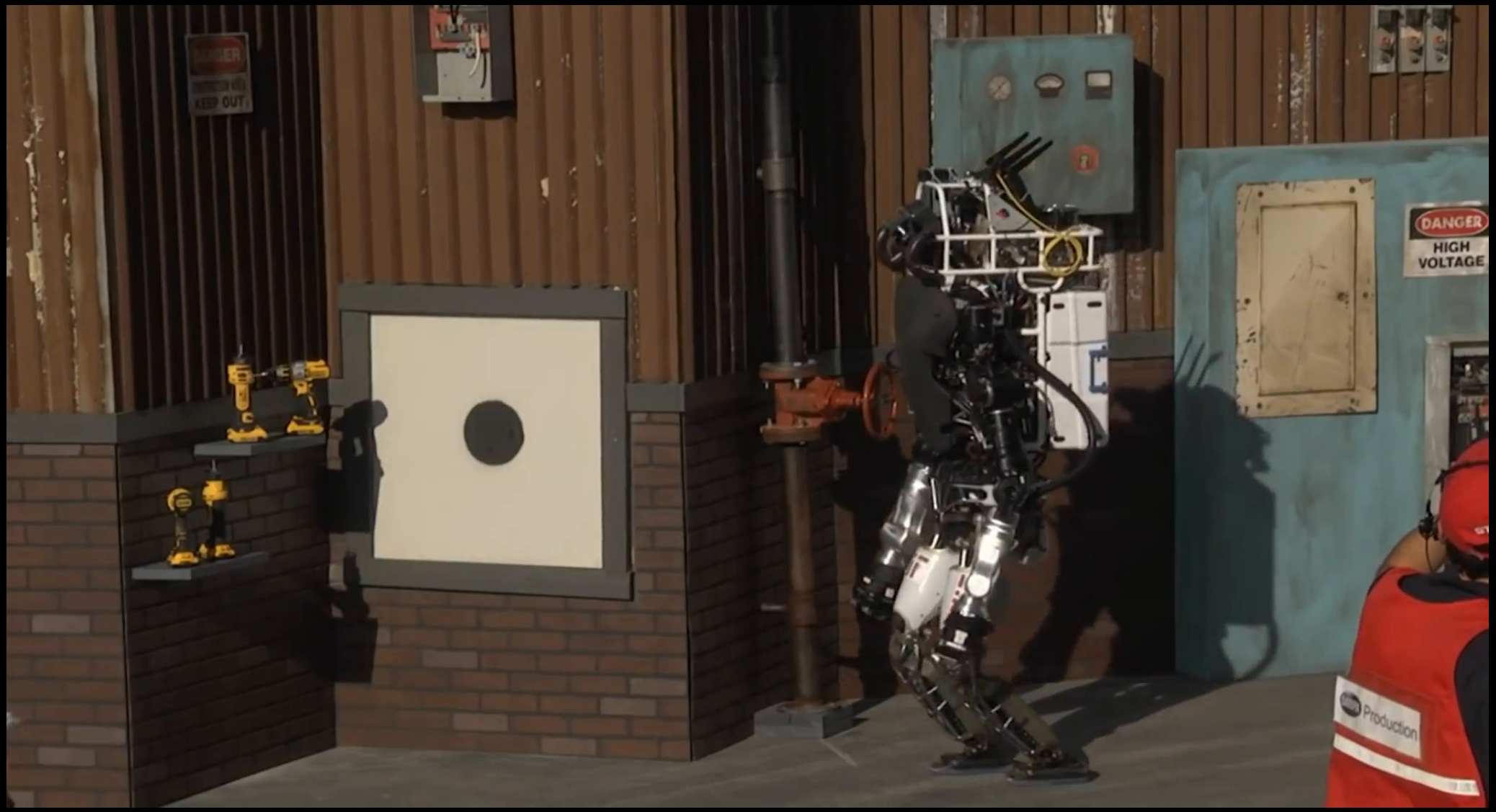



Synapse Vs. Memristor
input
output
biological neurons
Memristor layers (artificial synapses)
Transistor layer (artificial neurons)


16 Selbstvertrauen Würde
17 Willenskraft Zähigkeit
18 Gewissenhaftigkeit
19 Hoffnung
20 Glaube
21 Verehrung Autoritätsgefühl
22 Wohlwollen Mitgefühl
26
Ehrgeiz
15 Beifallsliebe Höflichkeit
Scheues Wesen
14 Sorglichkeit Bedachtsamkeit
25 Sinn f. Naturschönheiten
24 Idealsinn Vervollkommnung
27 Frohsinn Witz
Denken
Vergleichen
Zeit
Ortsinn
Gedächtnis
Gedächtnis
Gedächtnis



focus on intelligent agents

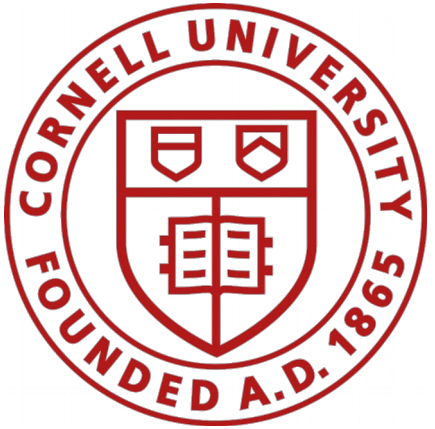

KEEP OUT
DANGER
HIGH
VOLTAGE
Production

FAIRPLEX
FAIRPLEX
6:16:36 05/06/2015

Brief intro to me

Burlington, VT
BEN & JERRY'S
Cookie Dough
ICE CREAM
Vanilla Ice Cream with Chunks of Chocolate Chip Cookie Dough
NEWPORT
ST. ALBANS
MT. MANSFIELD 4393 FT.
BURLINGTON
STOWE
CHRISTMAS TREES
ST.JOHNSBURY
WATERBURY
MONTPELIER
GREEN MT. NATIONAL FOREST
BARRE
SUGARBUSH VALLEY SKI AREA
MIDDLEBURY
WOODSTOCK
RUTLAND
KILLINGTON SKI RESORT
MANCHESTER
MT. SNOW SKI RESORT
BRATTLEBORO
BENNINGTON
State of Vermont
PURE
MAPLE
SYRUP
REGISTERED
1 pint 2 fl. oz 533 ml

The University of Vermont

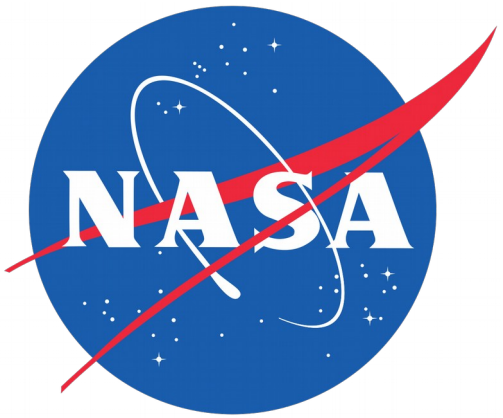

CORNELL UNIVERSITY
FOUNDED A.D. 1865

COLUMBIA UNIVERSITY

VERMONT
COMPLEX SYSTEMS CENTER

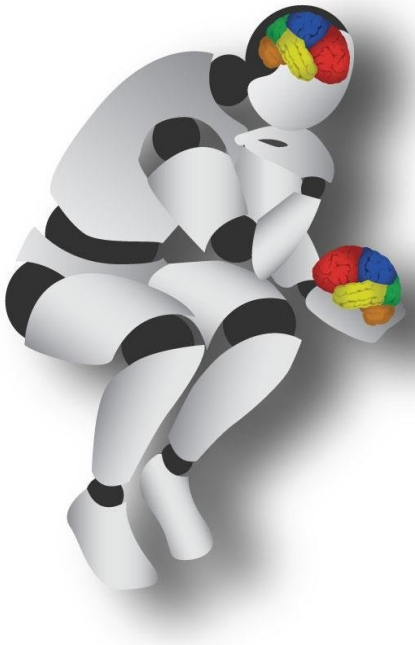
UNIVERSITY OF WYOMING

SANTA FE INSTITUTE


NASA

DARPA

SCIENCE TO SHAPE THE FUTURE OF THE ARMY
ARMY RESEARCH OFFICE
1951



EVOLVING ARTIFICIAL INTELLIGENCE LABORATORY

UNIVERSITY OF WYOMING

Build robots
that rival animals

CREATIVE MACHINES LAB
COLUMBIA UNIVERSITY

Build robots that
create and are creative

Ever wonder what it would be like
to see evolution happening
right before your eyes?

INSIGHT
Machine intelligence

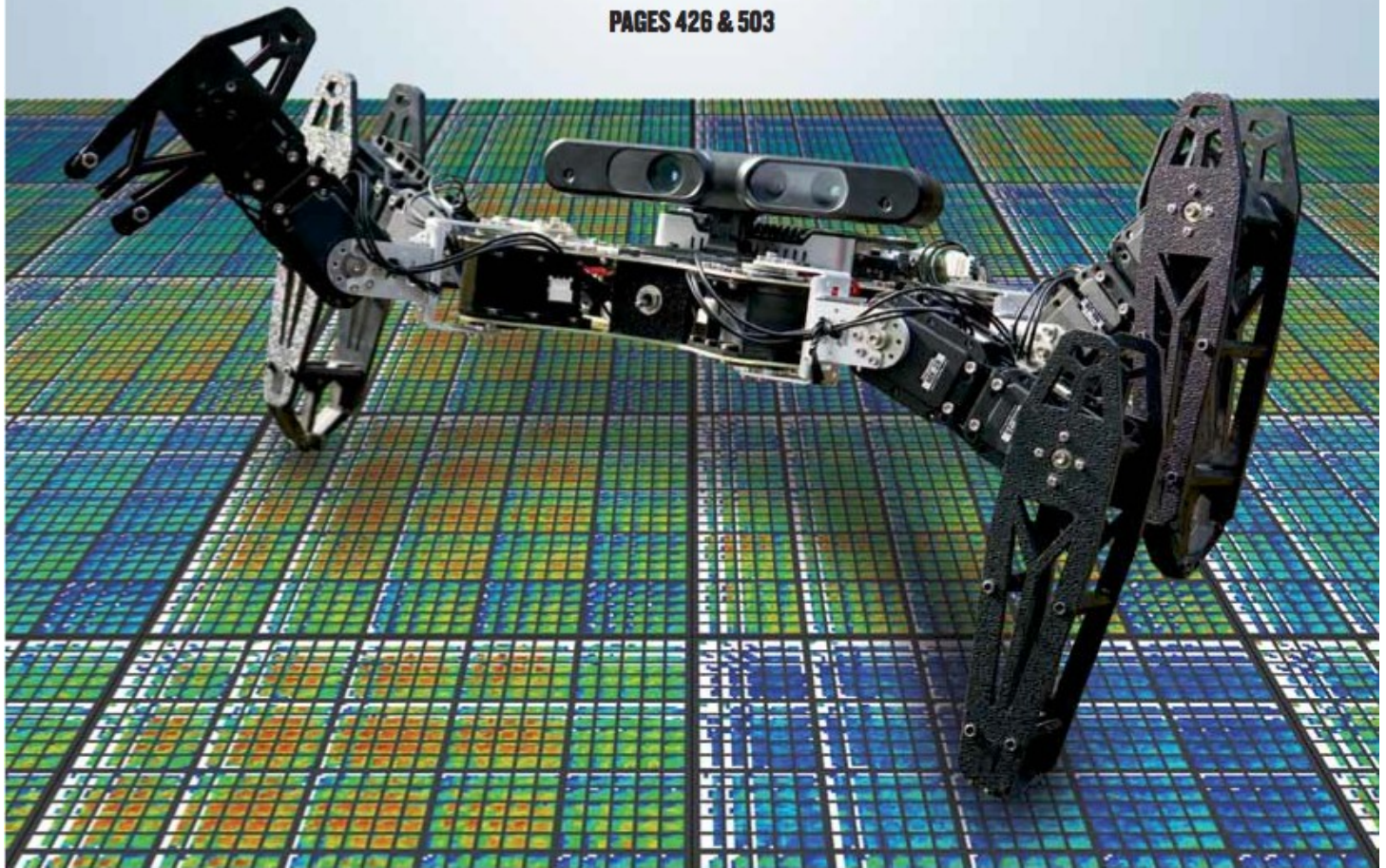
nature

THE INTERNATIONAL WEEKLY JOURNAL OF SCIENCE

Back on its feet

Using an intelligent trial-and-error learning algorithm this robot adapts to injury in minutes

PAGES 426 & 503



fetch
robotics
fetch
fetch robotics

USLacrosse®

High School All-Americans

Course Logistics

We’re going to take a journey through AI-land together!

Our goal is to help you understand the AI technology that surrounds you
(and figure out which parts of it you may want to work on)

We'll focus on understanding intelligent agents
(robots, animals, humans, ...)

We'll learn about many sub-fields

But not all (the field is way too big!)

Visiting all would mean too shallow an understanding

I'll try to balance depth vs. breadth

Course Contents

Part I: Artificial Intelligence
- Introduction
- Intelligent Agents

Part II: Problem Solving
- Search
- Optimization
- Games

~~**Part III: Knowledge, Reasoning, & Planning**~~

Part IV: Uncertainty and Reasoning
- Probability
- Bayesian Statistics
- Markov Models

Part V: Learning ← take COCS 4010/5010 Machine Learning!
- Unsupervised Learning
- Supervised Learning
- Reinforcement Learning

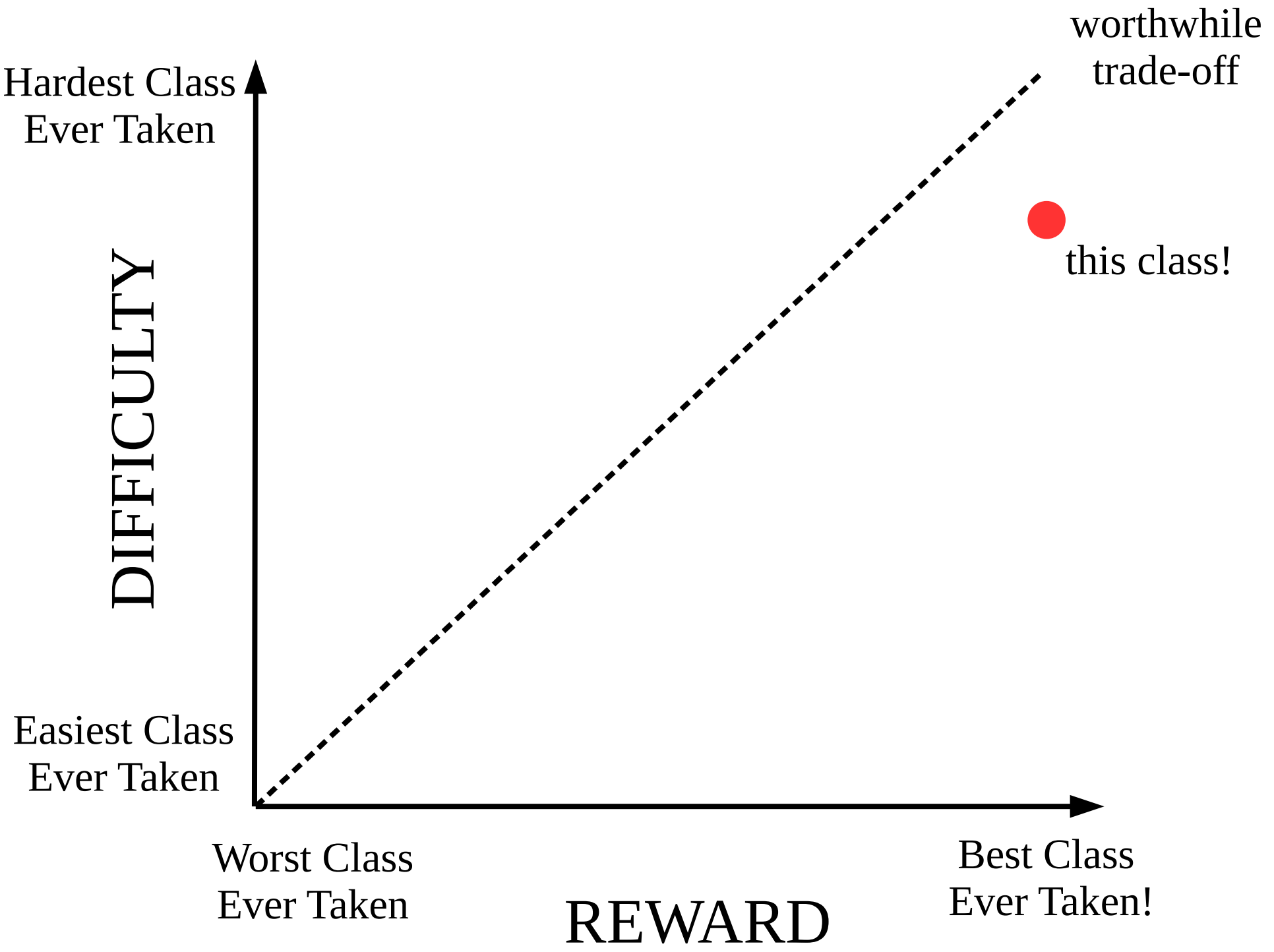
Part VI: Communicating, Perceiving, & Acting ← take COCS 4560/5560 Modern Robotics!
- Natural Language Processing
- Object Recognition ← take COCS 5540 Computer Vision!
- Robotics

There is a lot to cover!

This class will be a lot of work – it's going to be hard!

Lots of reading early on, lots of project work later

But it will be totally worth it, and you will learn a lot!


worthwhile
trade-off
Hardest Class
Ever Taken
DIFFICULTY
this class!
Easiest Class
Ever Taken
Worst Class
Ever Taken
REWARD
Best Class
Ever Taken!

This class will be fast paced! (so is the field)

The most fun parts of AI build on the basics

The faster we go, the more hands-on examples, the more advanced/applicable concepts, the more latest developments, and the more employable skills we can cover!

Feedback

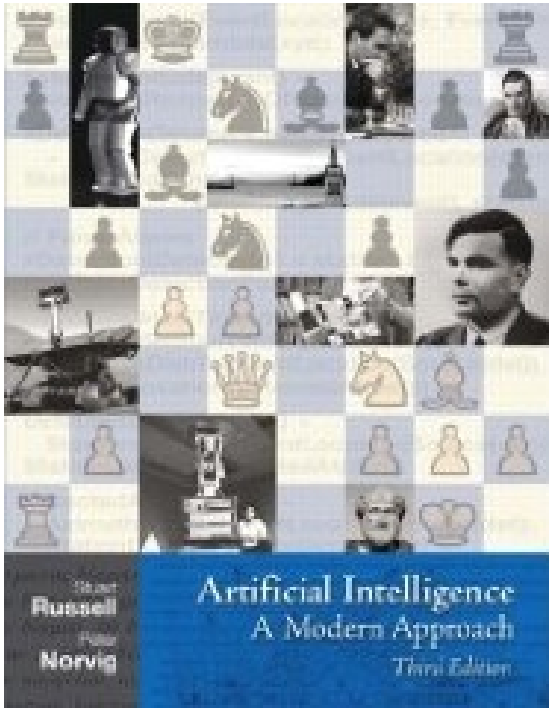
Please let me know how you feel about the class
(e.g. too fast/slow, not enough/too much time
on a given concept, good/bad application examples)

Tell me: after/before/during class
mid-term survey
office hours
email (including anonymous email)

I will strongly consider your feedback
(good chance I will implement it in some way)

Textbook

Russell & Norvig (RN)
Artificial Intelligence: A Modern Approach, 3rd Edition



Make sure it's 3rd edition!
(can be used 3rd Edition)

Reading will be posted on course website:

ncheney.com/teaching/ai

Schedule will be updated regularly
check back often!

Read **before** class!!!

Some of the material will be covered (read it anyways!)

Some will not be covered during the lectures
You are still responsible for the material for exams!!!

Lectures are not a duplication of the readings

Read **before** class!!!

We can't do as many cool examples/applications/topics if you don't come into the class with a basic understanding of that class' material already!

You're smart enough to learn the basics on your own (and smart enough to ask questions when you don't)!

Read **before** class!!!

But actually…. do it!

Lecture Slides

Link to pdfs will be posted on the course website

ncheney.com/teaching/ai

within a day or two after class
(let me know if I'm being slow…)

Grading

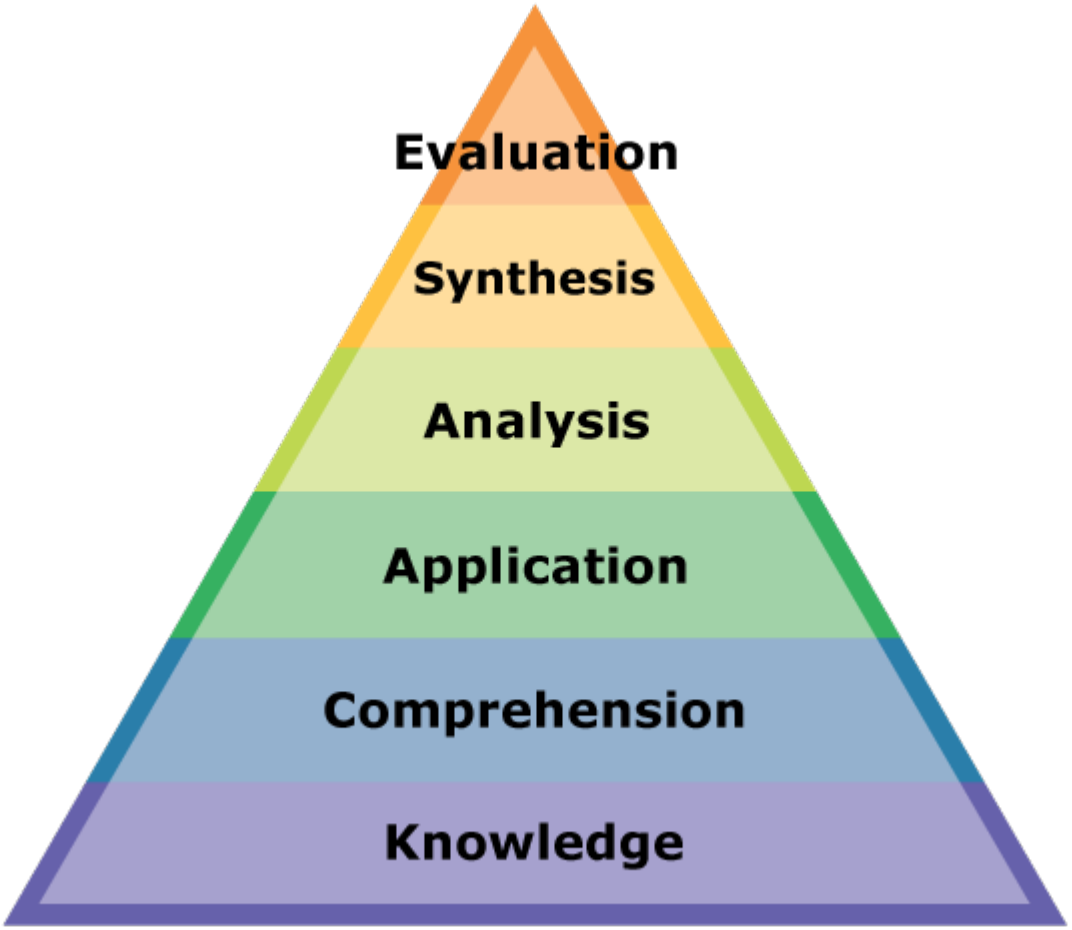
30% – AI Challenges (homework), learn by doing!

30% – Exam (late midterm), covers material from textbook

30% – Course Project (final), hands on AI research project

10% – Participation (involvement in class discussions, office hours, Piazza, etc.)

Bloom's Taxonomy



Participation

Part of being an AI researcher is being involved
in an active community of discussion

Class should be a discussion with lots of feedback
(you and I get rare feedback on learning from exams/grades)

(non-trivial part of your grade)

The Piazza online forum is a great way to earn participation credit outside of class times

Earn credit for both asking and answering questions to/from your classmates

piazza.com/uwyo/fall2017/cocs45505550

This is also a huge part of being an AI researcher!
(e.g. Stack Exchange)

Attendance is also a part of participation grades

Expectation is that you will attend all lectures
(I'll try to make it that you really want to also!)

For exam/project presentations,
only University Excused Absences are excepted
(you can get these from the Dean of Students)

Additional accommodations (including taking exams at the Disability Support Services office) are available for any students with physical/learning/psychological disabilities

Please first contact the DSS office
(again with the Dean of Students)
And they will work with me to arrange
the necessary accommodations

Laptops and smartphones are not allowed in class
(this is also part of your participation grade)

Leads to worse overall learning outcomes[1]
(distracting for you, distracting for others around/behind you, distracting for me

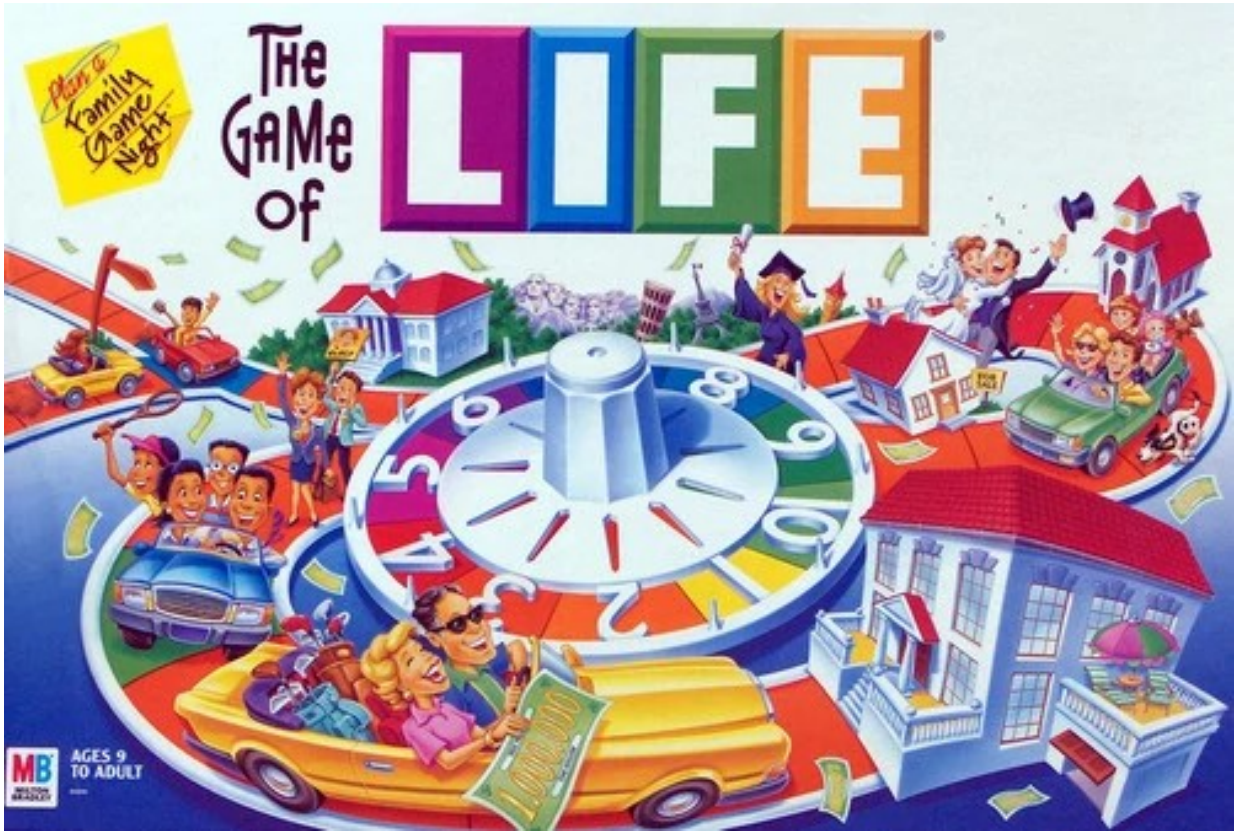
Please bring a pen and paper for in-class exercises
You do not need to bring your textbook

[1] Sana, F., Weston, T., & Cepeda, N. J. (2013). Laptop multitasking hinders classroom learning for both users and nearby peers. Computers & Education, 62, 24-31.

Participation Extra Credit (10+):

(+1) come to office hours so I can get to know!

(I can only help you to achieve your goals if I know them)



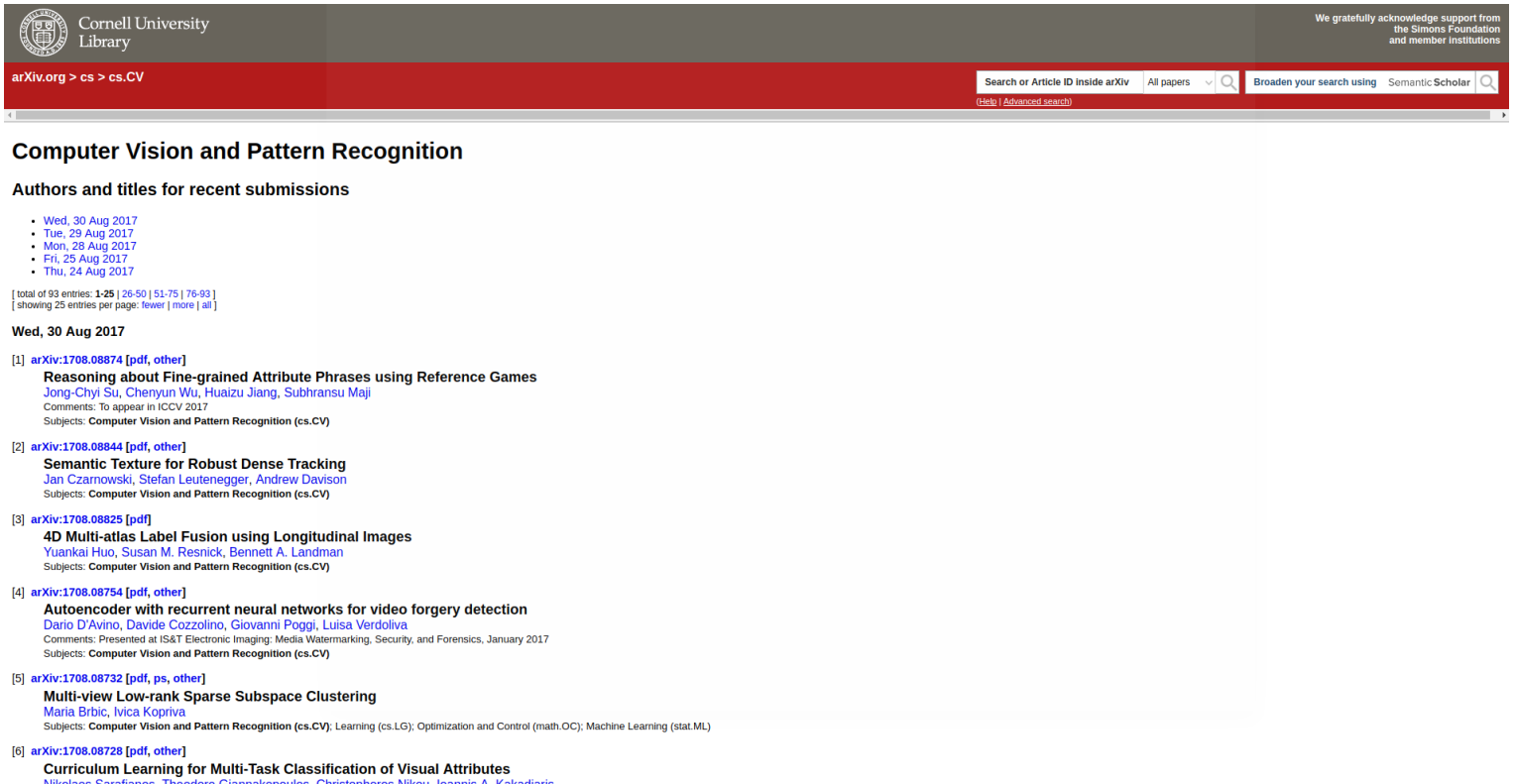
Participation Extra Credit (10+):

(+1) volunteer at the Laramie Robotics Club with us!

(teach middle schoolers about programming and robotics)

Participation Extra Credit (10+):

(+1) be curious and share you findings with the class!
(make a slide or two from something you saw
in class or in the news and did extra research on)



Cornell University Library

We gratefully acknowledge support from the Simons Foundation and member institutions

arXiv.org > cs > cs.CV

Search or Article ID inside arXiv | All papers | Broaden your search using Semantic Scholar

(Help | Advanced search)

Computer Vision and Pattern Recognition

Authors and titles for recent submissions

- Wed, 30 Aug 2017
- Tue, 29 Aug 2017
- Mon, 28 Aug 2017
- Fri, 25 Aug 2017
- Thu, 24 Aug 2017

[total of 93 entries: **1-25** | 26-50 | 51-75 | 76-93]
[showing 25 entries per page: fewer | more | all]

Wed, 30 Aug 2017

[1] arXiv:1708.08874 [pdf, other]
Reasoning about Fine-grained Attribute Phrases using Reference Games
Jong-Chyi Su, Chenyun Wu, Huaizu Jiang, Subhransu Maji
Comments: To appear in ICCV 2017
Subjects: **Computer Vision and Pattern Recognition (cs.CV)**

[2] arXiv:1708.08844 [pdf, other]
Semantic Texture for Robust Dense Tracking
Jan Czarnowski, Stefan Leutenegger, Andrew Davison
Subjects: **Computer Vision and Pattern Recognition (cs.CV)**

[3] arXiv:1708.08825 [pdf]
4D Multi-atlas Label Fusion using Longitudinal Images
Yuankai Huo, Susan M. Resnick, Bennett A. Landman
Subjects: **Computer Vision and Pattern Recognition (cs.CV)**

[4] arXiv:1708.08754 [pdf, other]
Autoencoder with recurrent neural networks for video forgery detection
Dario D'Avino, Davide Cozzolino, Giovanni Poggi, Luisa Verdoliva
Comments: Presented at IS&T Electronic Imaging: Media Watermarking, Security, and Forensics, January 2017
Subjects: **Computer Vision and Pattern Recognition (cs.CV)**

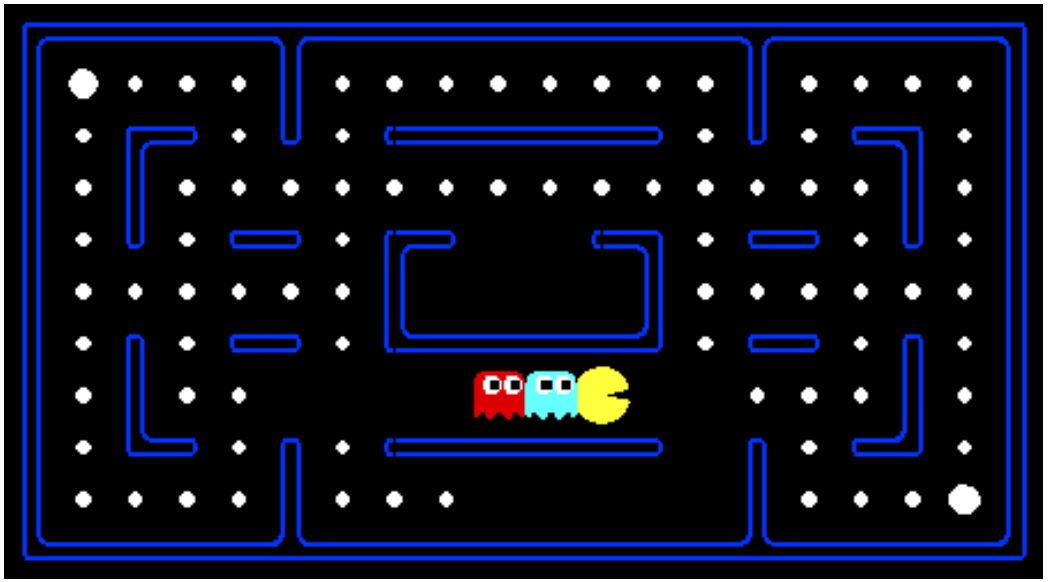
[5] arXiv:1708.08732 [pdf, ps, other]
Multi-view Low-rank Sparse Subspace Clustering
Maria Brbic, Ivica Kopriva
Subjects: **Computer Vision and Pattern Recognition (cs.CV)**; Learning (cs.LG); Optimization and Control (math.OC); Machine Learning (stat.ML)

[6] arXiv:1708.08728 [pdf, other]
Curriculum Learning for Multi-Task Classification of Visual Attributes

AI Challenges! (AIC)

Hands-on Implementation of concepts we learn in class
Learn by doing![1]

Programming assignments in Python
(due every 1-2 weeks)



[1] Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. Proceedings of the National Academy of Sciences, 111(23), 8410-8415.

Posted ahead of time – start early!

Really… start early!

Piazza is a great place to ask clarifying/high-level questions
(not to ask for solutions…)

Joost will be available to help answer questions
(both on Piazza, and during office hours)

Summary

(1) we're going to learn a ton of cool stuff,
but we're going to go fast, and it won't be easy

(2) go to the course website (and check it often):
ncheney.com/teaching/ai

(3) read the textbook **before** class

(4) join Piazza and come to office hours
both for help and just to be a part of the discussion

(5) be thinking of your project topic throughout the course