

# (Biased) Overview of A.I. Topics

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# High-Level Categorization of AI Topics

1. Artificial Intelligence (other than topics below)
2. Machine Learning (& Deep Learning)
3. Computer Vision
4. Natural Language Processing

# 1. Artificial Intelligence (Based on [AAAI topic list](#))

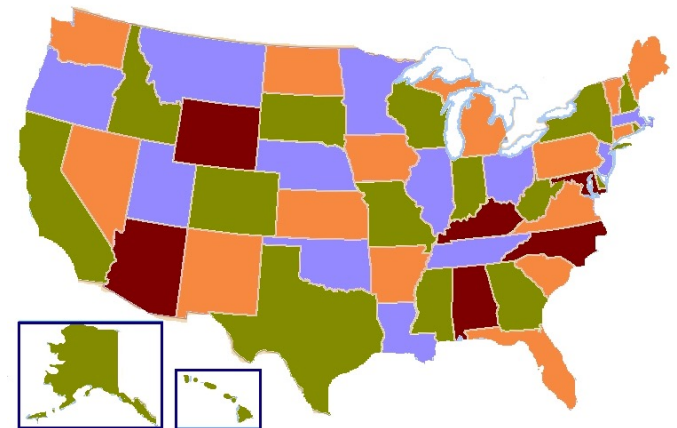
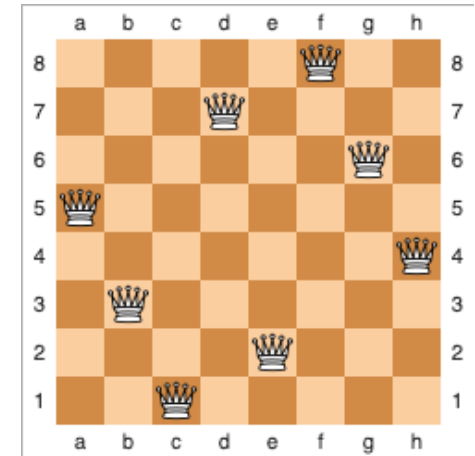
- ▶ Cognitive modeling and systems
- ▶ Constraint Satisfaction/ Optimization
- ▶ Game theory
- ▶ Human + AI
- ▶ Knowledge representation and reasoning
- ▶ Robotics

# AI: Cognitive Modeling

- ▶ Models of human/animal cognition
- ▶ Based on psychological theory and experiments
- ▶ 2 Goals
  - ▶ AI -> Cognitive Science: Understand/test underlying cognitive mechanisms by computational modeling
  - ▶ Cognitive Science -> AI: Improve computational methods via insights from cognitive science

# AI: Constraint Satisfaction / Heuristic Optimization

- ▶ Eight queens puzzle
- ▶ Map coloring problem
- ▶ Real-world
  - ▶ Resource allocation
  - ▶ Scheduling



# AI: Game Theory

## ▶ Prisoner's dilemma

**THE PRISONER'S DILEMMA**

	<b>B stays silent (cooperates)</b>	<b>B betrays A (defects)</b>
<b>A stays silent (cooperates)</b>	Both serve 1 year	A serves 3 years, B goes free
<b>A betrays B (defects)</b>	A goes free, B serves 3 years	Both serve 2 years

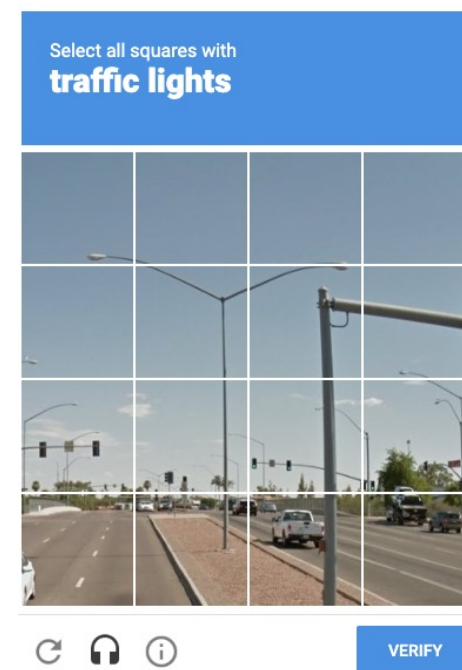
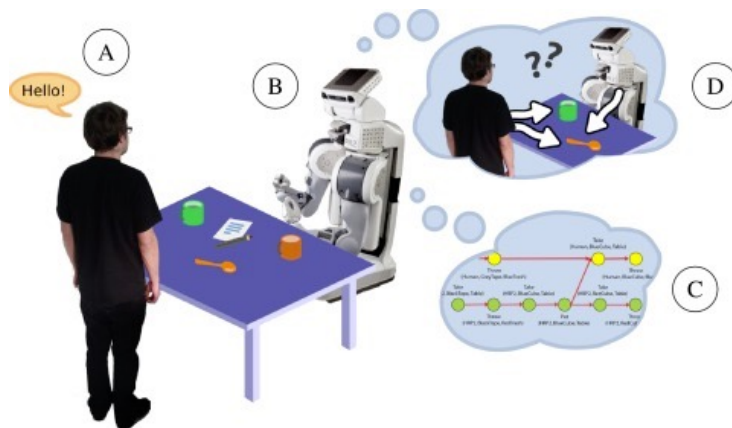
## ▶ Real-world

- ▶ Google Ads bidding
- ▶ Connections to “Generative Adversarial Networks”

# AI: Human + AI

- ▶ Crowdsourcing
  - ▶ “Stop spam, read books”

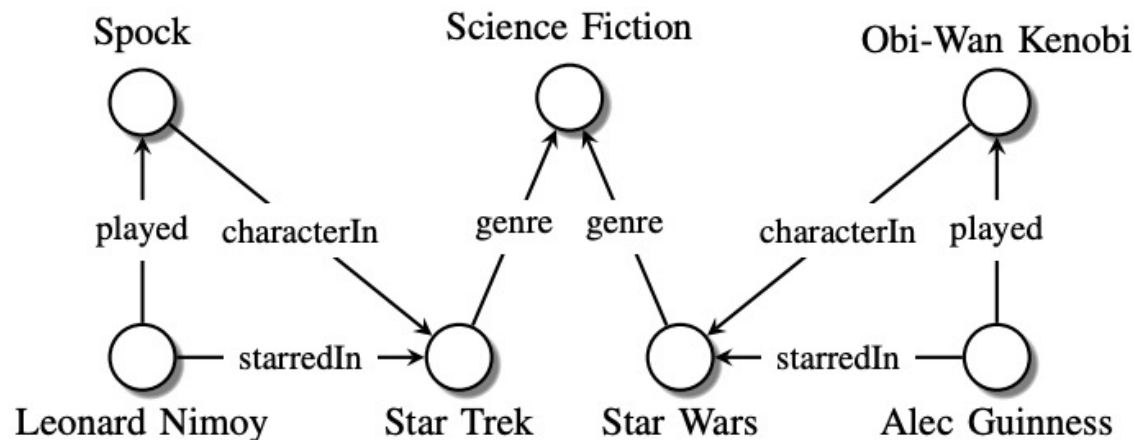
- ▶ Human-robot interactions



<https://www.sciencedirect.com/science/article/pii/S0004370216300790>

# AI: Knowledge representation and reasoning

## ► Knowledge graphs



<https://arxiv.org/pdf/1503.00759.pdf>

## ► Inferences in knowledge graphs

- Did Alec Guinness ever play a Science Fiction character?

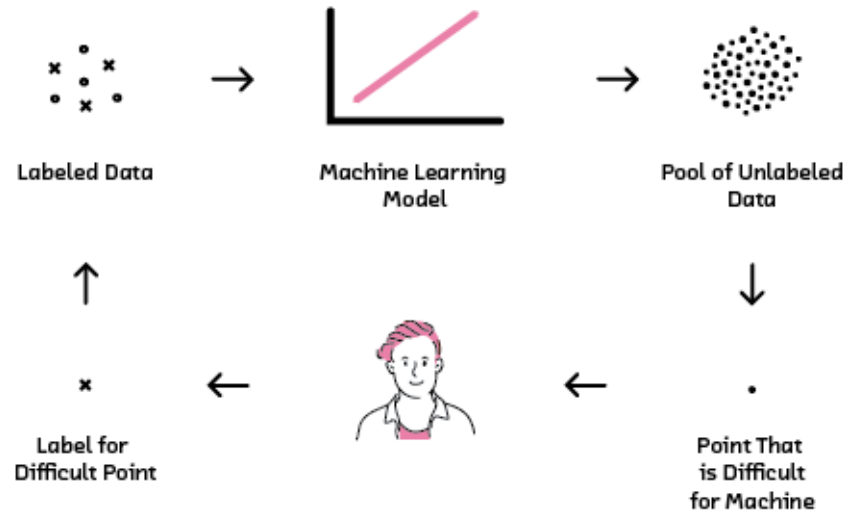


## 2. Machine Learning (based on [NeurIPS Topics](#))

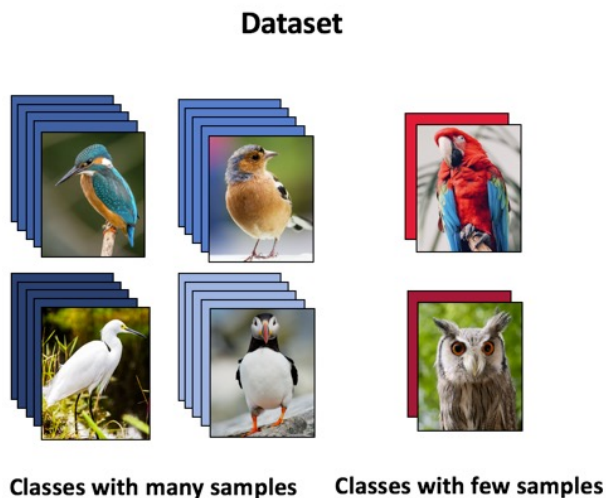
- ▶ Learning with limited labels
- ▶ AutoML / Meta-learning
- ▶ Generative / probabilistic models
- ▶ Reinforcement learning
- ▶ Explainable AI
- ▶ Domain Generalization

# ML: Learning with limited labels

## ▶ Active learning



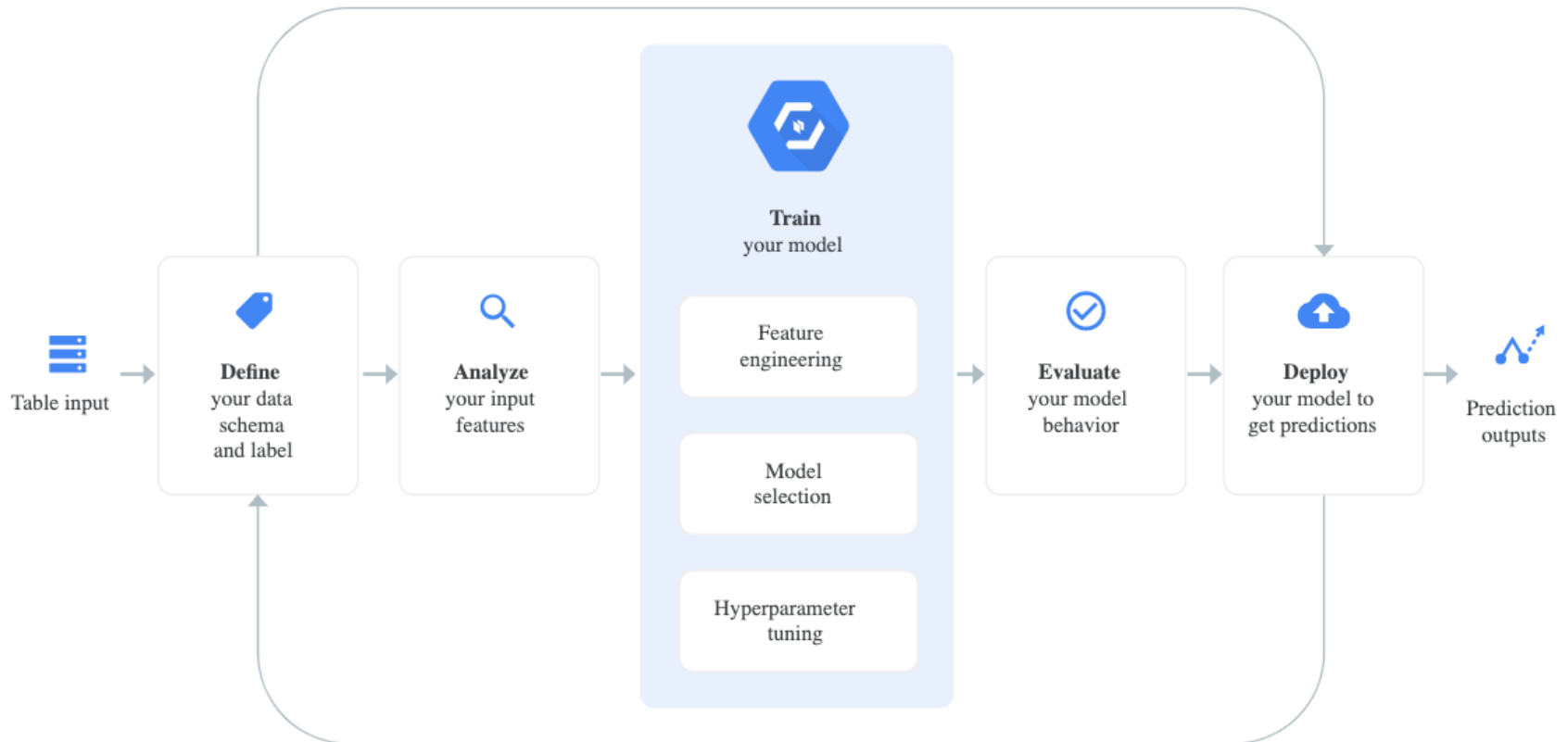
## ▶ Few-Shot Learning



<https://blog.cloudera.com/a-guide-to-learning-with-limited-labeled-data/>

<https://medium.com/sap-machine-learning-research/deep-few-shot-learning-a1caa289f18>

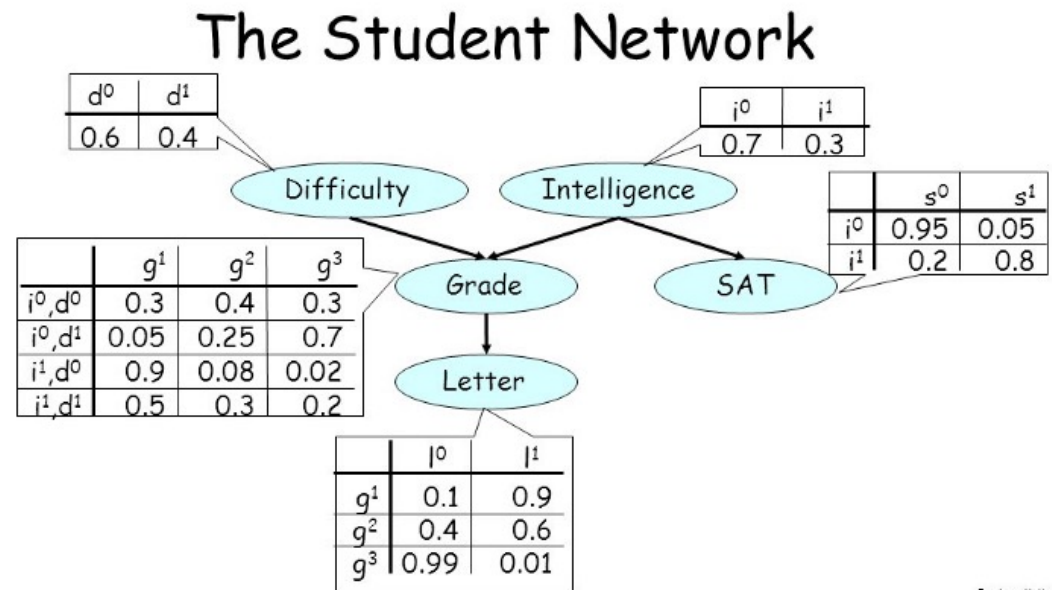
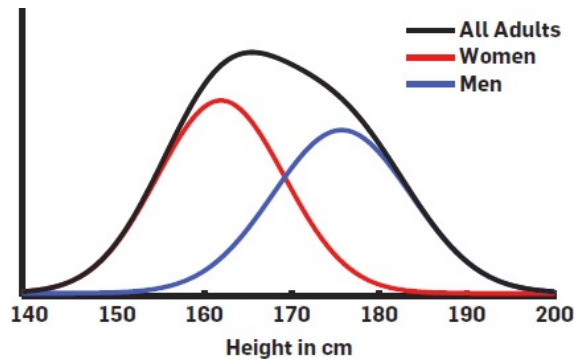
# ML: AutoML / Meta-learning



<https://cloud.google.com/automl-tables/?hl=vi>

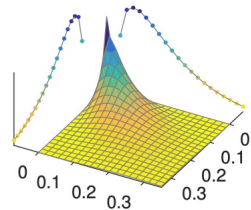
# ML: Generative/Probabilistic Models

## ► Density estimation / Graphical Models

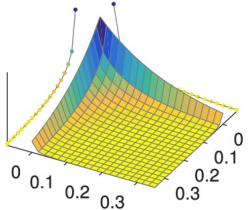


Dezhne Koller

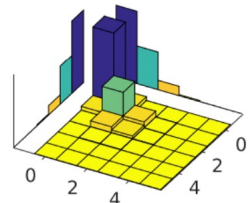
Positive Exp. SQR



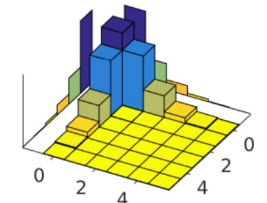
Negative Exp. SQR



Positive Poisson SQR

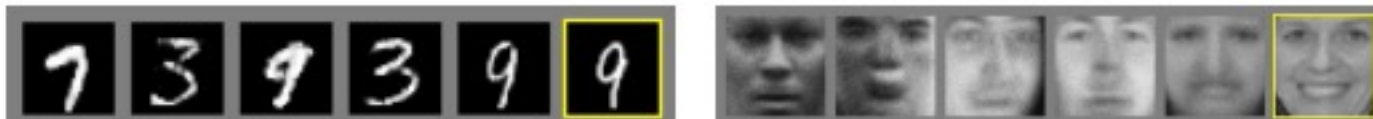


Negative Poisson SQR



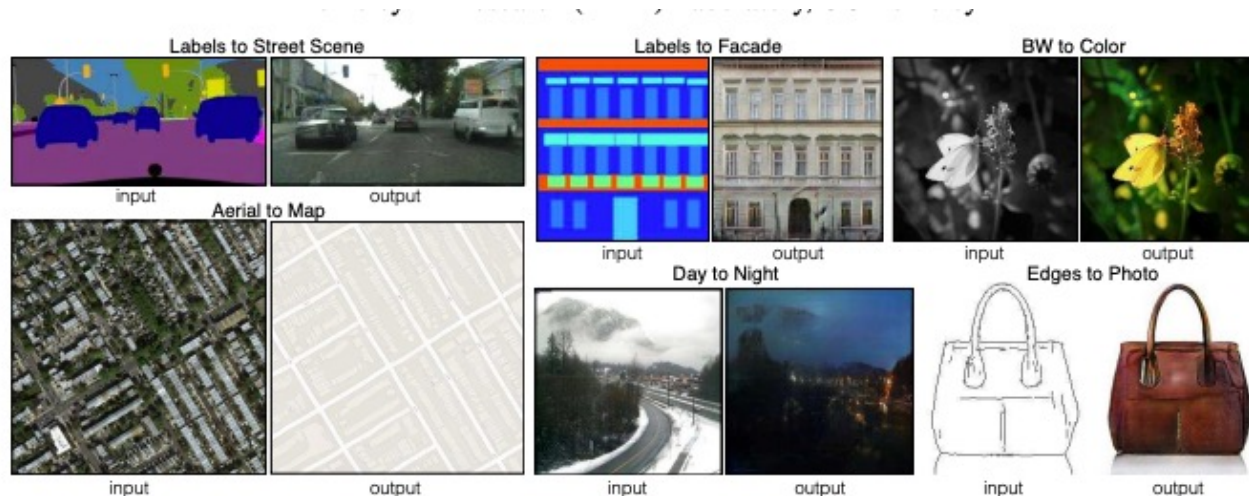
# ML: Generative Adversarial Networks (GAN)

## ► Generative Adversarial Networks (GAN)



<http://papers.nips.cc/paper/5423-generative-adversarial-nets.pdf>

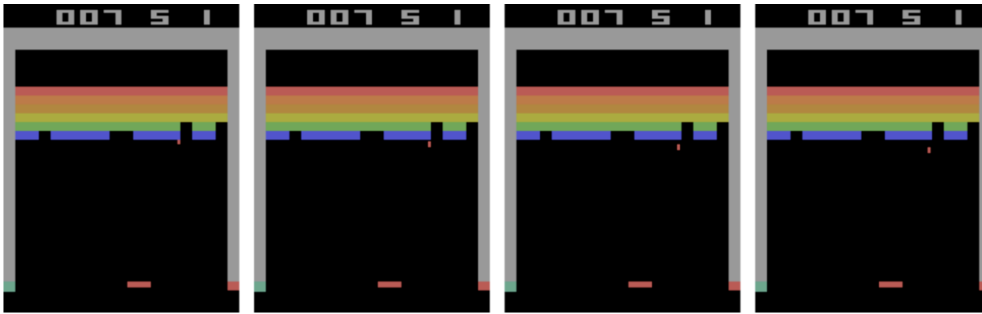
## ► Image to image translation via GANs



[http://openaccess.thecvf.com/content\\_cvpr\\_2017/papers/Isola\\_Image-To-Image\\_Translation\\_With\\_CVPR\\_2017\\_paper.pdf](http://openaccess.thecvf.com/content_cvpr_2017/papers/Isola_Image-To-Image_Translation_With_CVPR_2017_paper.pdf)

# ML: Reinforcement Learning

- ▶ Game playing



- ▶ Bandit algorithms (simpler form of RL)
  - ▶ Which Google search result should I show?

# ML: Explainable AI

Why model explanations?  
Accuracy is insufficient for many applications



Loan approval: “Could the model make a catastrophic mistake?”



Self-driving cars: “Does the model obey common sense intuitions?”



Bail decisions: “Is the model biased because of historical discrimination?”




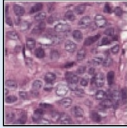
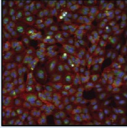
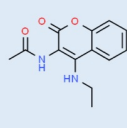
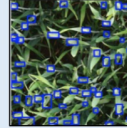



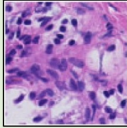
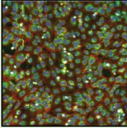
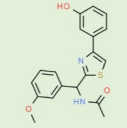
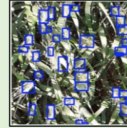


Healthcare: “Does the model agree with doctor’s knowledge?”



Military strategy: “How will the model perform in adversarial settings?”

# ML: Domain Generalization

## ► Distribution shifts in the real-world

	Domain generalization					Subpopulation shift	Domain generalization + subpopulation shift			
Dataset	iWildCam	Camelyon17	RxRx1	OGB-MolPCBA	GlobalWheat	CivilComments	FMoW	PovertyMap	Amazon	Py150
Input (x)	camera trap photo	tissue slide	cell image	molecular graph	wheat image	online comment	satellite image	satellite image	product review	code
Prediction (y)	animal species	tumor	perturbed gene	bioassays	wheat head bbox	toxicity	land use	asset wealth	sentiment	autocomplete
Domain (d)	camera	hospital	batch	scaffold	location, time	demographic	time, region	country, rural-urban	user	git repository
# domains	323	5	51	120,084	47	16	16 x 5	23 x 2	2,586	8,421
# examples	203,029	455,954	125,510	437,929	6,515	448,000	523,846	19,669	539,502	150,000
Train example						What do Black and LGBT people have to do with bicycle licensing?			Overall a solid package that has a good quality of construction for the price.	<pre>import numpy as np ... norm=np.____</pre>
Test example						As a Christian, I will not be patronizing any of those businesses.			I "loved" my French press, it's so perfect and came with all this fun stuff!	<pre>import subprocess as sp p=sp.Popen() stdout=p.____</pre>
Adapted from	Beery et al. 2020	Bandi et al. 2018	Taylor et al. 2019	Hu et al. 2020	David et al. 2021	Borkan et al. 2019	Christie et al. 2018	Yeh et al. 2020	Ni et al. 2019	Raychev et al. 2016

## ► How can you train models so that they work in new unseen test domains?

Koh, P. W., Sagawa, S., Xie, S. M., Zhang, M., Balsubramani, A., Hu, W., ... & Liang, P. (2021, July). Wilds: A benchmark of in-the-wild distribution shifts. In *International Conference on Machine Learning* (pp. 5637-5664). PMLR. <https://wilds.stanford.edu/datasets/>

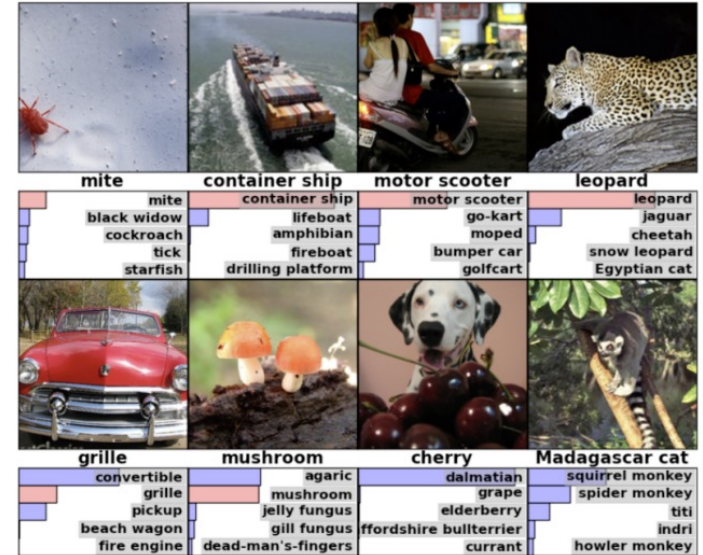


### 3. Computer Vision (Based on CVPR sessions)

- ▶ Classic tasks
- ▶ 3D Multiview / Depth estimation
- ▶ Synthesis

# CV: Classic Tasks

## ► Recognition



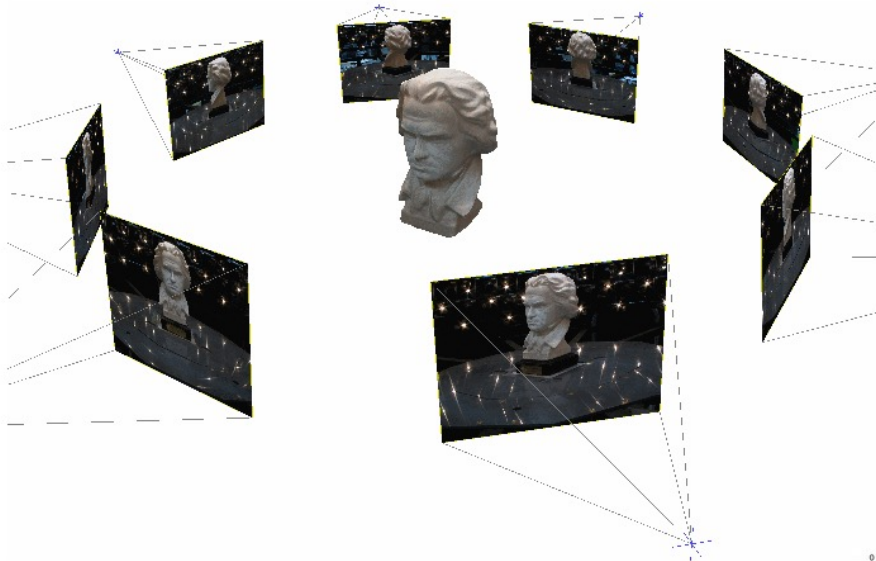
<http://www.cs.toronto.edu/~fritz/absps/imagenet.pdf>

## ► Segmentation

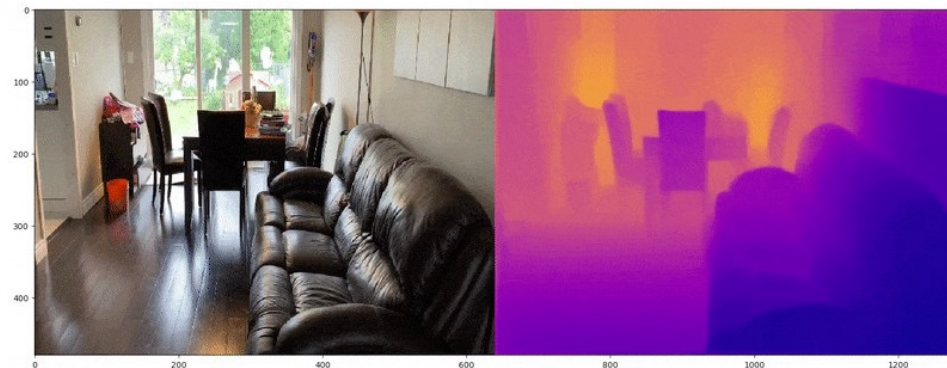


<http://vladlen.info/publications/feature-space-optimization-for-semantic-video-segmentation/>

# CV: 3D Multiview / Depth estimation



[https://vision.in.tum.de/research/image-based\\_3d\\_reconstruction/multiviewreconstruction](https://vision.in.tum.de/research/image-based_3d_reconstruction/multiviewreconstruction)



<https://towardsdatascience.com/depth-estimation-on-camera-images-using-densenets-ac454caa893>

# CV: Image / Video Generation (Synthesis)

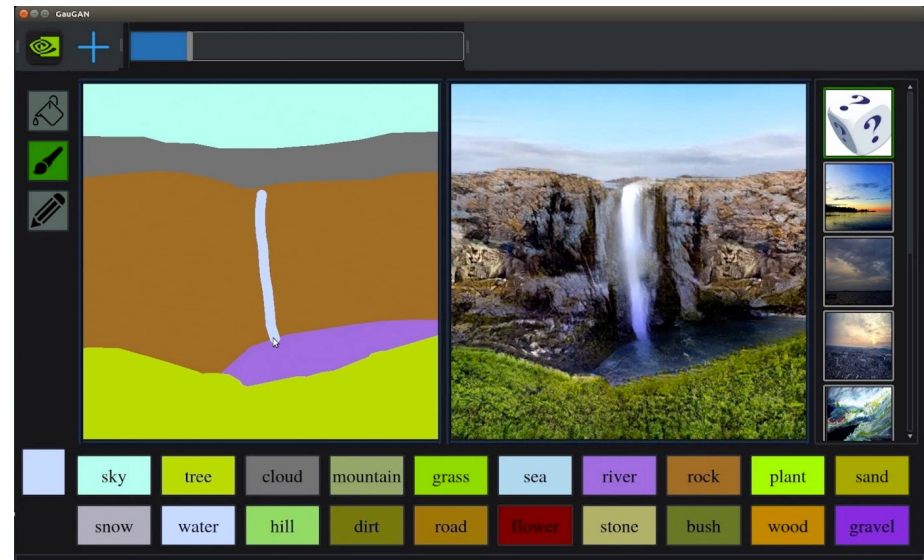
## ► Style transfer

[https://www.cv-foundation.org/openaccess/content\\_cvpr\\_2016/paper\\_s/Gatys\\_Image\\_Style\\_Transfer\\_CVPR\\_2016\\_paper.pdf](https://www.cv-foundation.org/openaccess/content_cvpr_2016/paper_s/Gatys_Image_Style_Transfer_CVPR_2016_paper.pdf)



## ► Sketch to draw

<https://techcrunch.com/2019/03/18/nvidia-ai-turns-sketches-into-photorealistic-landscapes-in-seconds/>



## 4. Natural Language Processing (based on [ACL 2019 Call for Papers \(CFP\)](#))

- ▶ Tagging and Parsing
- ▶ Information Extraction and Text Mining
- ▶ Dialogue Systems / Question Answering
- ▶ Applications
  - ▶ Summarization
  - ▶ Sentiment Analysis
  - ▶ Machine Translation

# NLP: Ambiguity is huge challenge in NLP

## Lexical Ambiguity

The presence of two or more possible meanings within a single word.



"I saw her duck."

## Syntactic Ambiguity

The presence of two or more possible meanings within a single sentence or sequence of words.

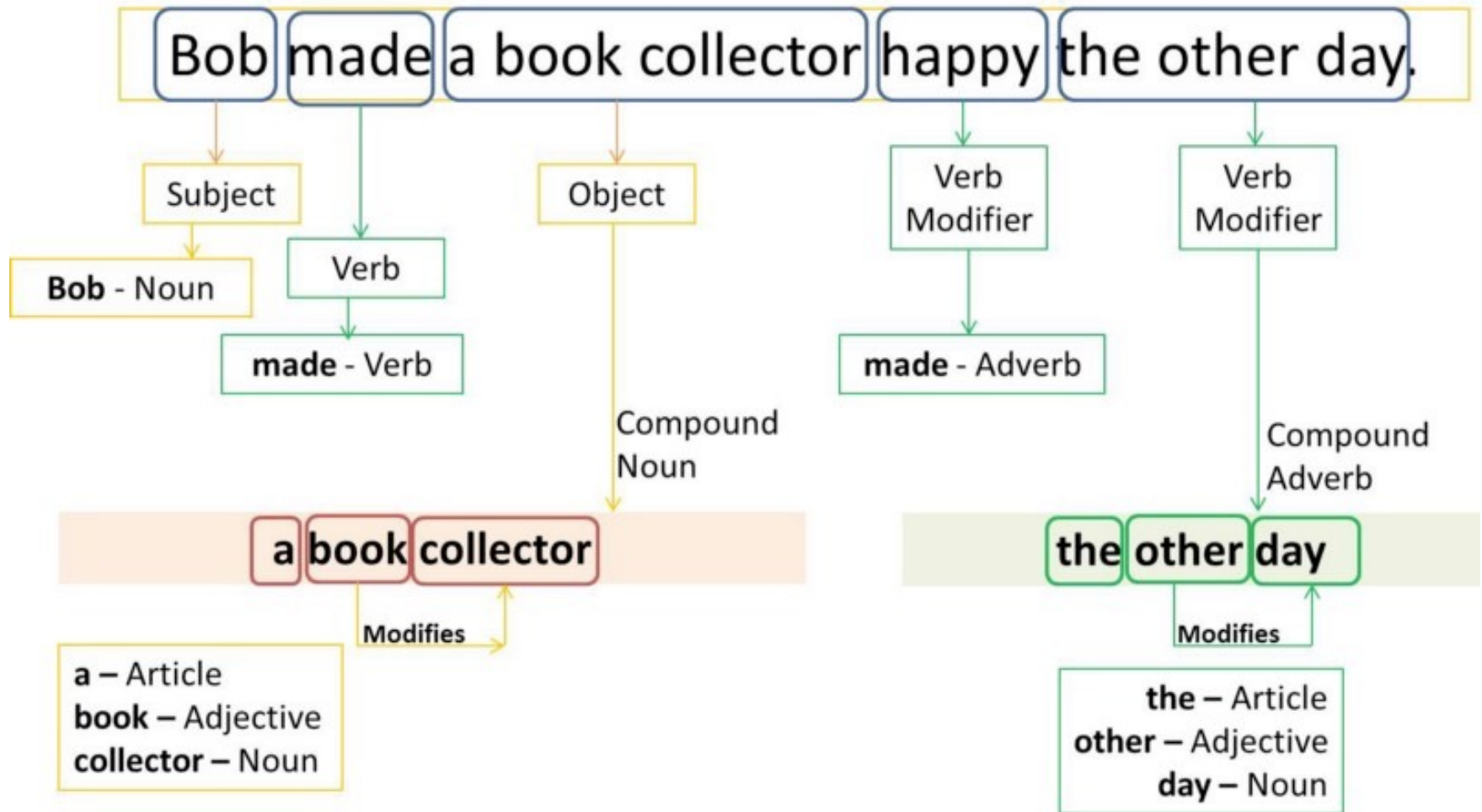


"The chicken is ready to eat."

ThoughtCo.

<https://www.thoughtco.com/ambiguity-language-1692388>

# NLP: Tagging and Parsing



# NLP: Information Extraction and Text Mining

## Text in

**Brazil** ranks number 5 in the list of countries by population.

The term "**Ibu Negara**" (Lady/Mother of the State) is used for **wife** of the President of **Indonesia**.

**Game of Thrones** is an adaptation of A Song of Ice and Fire, George R. R. Martin's series of fantasy novels. It ranks **fourth** among the **IMDB Top Rated TV Shows**

## Data out

### THE COUNTRIES WITH THE LARGEST POPULATION

China	1	1,388,232,693
India	2	1,342,512,706
Unites States	3	326,474,013
Indonesia	4	263,510,146
<b>Brasil</b>	5	174,315,386

### THE COUNTRY'S' FIRST LADIES

Brigitte Macron

- Spouse: Emmanuel Macron, President of France (2017 - )

Melania Trump

- Spouse: Donald J. Trump, U.S. President (2017- )

**Iriana Widodo**

- Spouse: Joko Widodo, **President of Indonesia** (2014 - )

- Also known as: "**Ibu Negara**" (Lady/Mother of the State)

### IMDB TOP RATED TV SHOWS

- 1 Planet Earth II (2016) 9.6.
- 2 Band of Brothers (2001) 9.5.
- 3 Planet Earth (2006) 9.5.
- 4 **Game of Thrones** (2011) 9.4.
- 5 Breaking Bad (2008) 9.4.

<https://www.ontotext.com/knowledgehub/fundamentals/information-extraction/>



# NLP: Topic Models

### Topics

gene	0.04
dna	0.02
genetic	0.01
...	

life	0.02
evolve	0.01
organism	0.01
...	

brain	0.04
neuron	0.02
nerve	0.01
...	

data	0.02
number	0.02
computer	0.01
...	

### Documents

## Seeking Life's Bare (Genetic) Necessities

COLD SPRING HARBOR, NEW YORK— How many genes does an organism need to survive? Last week at the genome meeting here,\* two genome researchers with radically different approaches presented complementary views of the basic genes needed for life. One research team, using computer analyses to compare known genomes, concluded that today's organisms can be sustained with just 250 genes, and that the earliest life forms required a mere 128 genes. The other researcher mapped genes in a simple parasite and estimated that for this organism, 800 genes are plenty to do the job—but that anything short of 100 wouldn't be enough.

Although the numbers don't match precisely, those predictions

"are not all that far apart," especially in comparison to the 75,000 genes in the human genome, notes Siv Andersson of Uppsala University in Sweden, who arrived at the 800 number. But coming up with a consensus answer may be more than just a genetic numbers game, particularly as more and more genomes are completely mapped and sequenced. "It may be a way of organizing any newly sequenced genome," explains Arcady Mushegian, a computational molecular biologist at the National Center for Biotechnology Information (NCBI) in Bethesda, Maryland. Comparing an

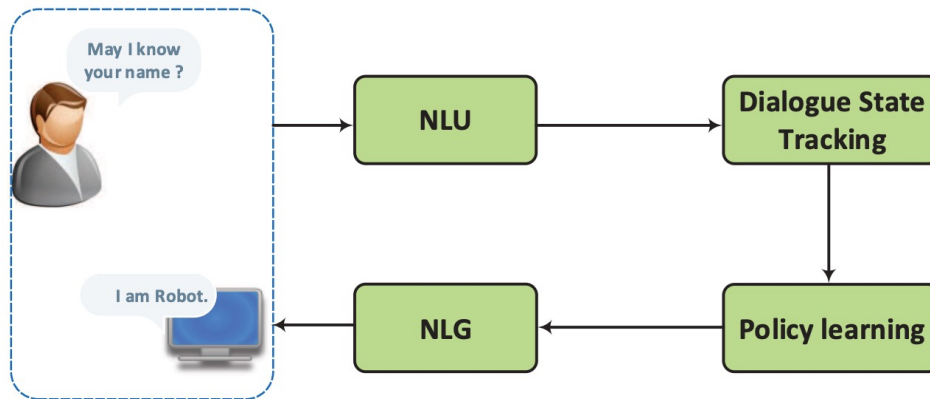
\* Genome Mapping and Sequencing, Cold Spring Harbor, New York, May 8 to 12.

SCIENCE • VOL. 272 • 24 MAY 1996

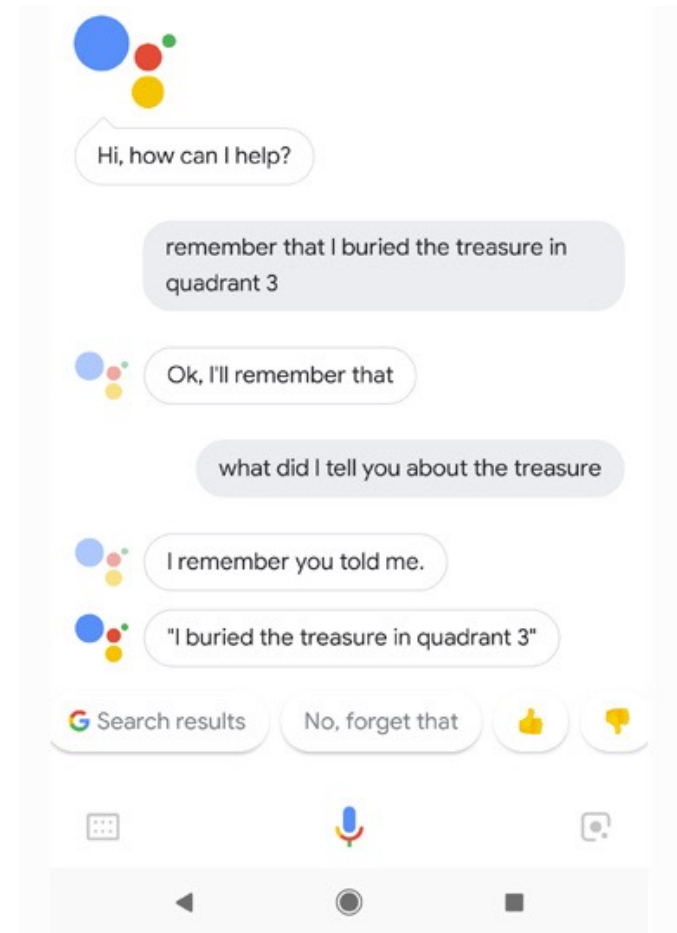
### Topic proportions and assignments

<http://www.cs.columbia.edu/~blei/papers/Blei2012.pdf>

# NLP: Dialogue Systems / Question Answering



<https://arxiv.org/pdf/1711.01731.pdf>



# NLP: Large Language Models (e.g., ChatGPT3)

## ChatGPT is at capacity right now

[Get notified when we're back](#)

### Explain the status of ChatGPT in the style of Shakespeare.

Ah, dear user of ChatGPT, thou art not alone in thy desire to engage with our esteemed AI chatbot. Many have flocked to our website in this hour, and we do our utmost to accommodate each and every one. Yet, alas, our resources are not without limit and we must ask for thy patience and forbearance. In time, we shall be able to provide thee with access to ChatGPT. Until then, we beg thee to return at a future juncture, when we may better serve thy needs. Until then, we bid thee adieu and good fortune.

**C** Can you write me a 4 paragraph academic essay comparing and contrasting the theories of nationalism of Benedict Anderson and Ernest Gellner?



Benedict Anderson and Ernest Gellner both have theories about the origins and nature of nationalism, but their perspectives differ in key ways. Anderson believes that nationalism is a cultural construct, arising from the development of print capitalism and the creation of imagined communities. Gellner, on the other hand, sees nationalism as a product of modernization and industrialization, with nations being formed as a means of organizing society and providing a shared identity.

One key difference between the two theories is the role of culture. For Anderson, culture is central to the creation of nationalism, as the spread of print media allows for the creation of imagined communities that transcend physical boundaries. This allows for the development of a national identity based on shared cultural experiences and practices. In contrast, Gellner downplays the importance of culture in the formation of nationalism, arguing that it is primarily a function of economic and political developments. He sees nations as being formed in response to the need for a shared identity and sense of belonging in an industrialized society.

Another point of contrast is the emphasis on agency. Anderson's theory suggests that people actively participate in the construction of national identity, through their engagement with print media and other cultural practices. In contrast, Gellner's theory emphasizes the role of external factors in shaping national identity, with individuals being passive recipients of the national identity imposed on them by the forces of modernization.

Overall, while both Anderson and Gellner provide valuable insights into the origins of nationalism, their theories offer different perspectives on the role of culture and agency in the formation of national identity. Anderson emphasizes the cultural construction of nationalism, while Gellner sees it as a product of modernization and industrialization. Both theories offer valuable insights into the complex process of national identity formation, and can be useful in understanding the dynamics of nationalism in different historical contexts.

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# High-Level Categorization of AI Topics

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