

# (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

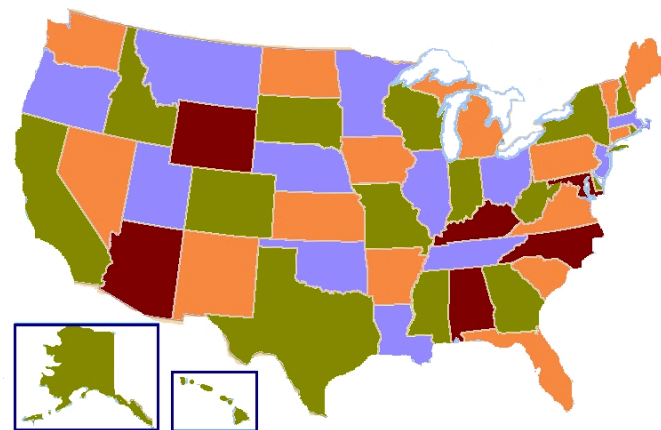
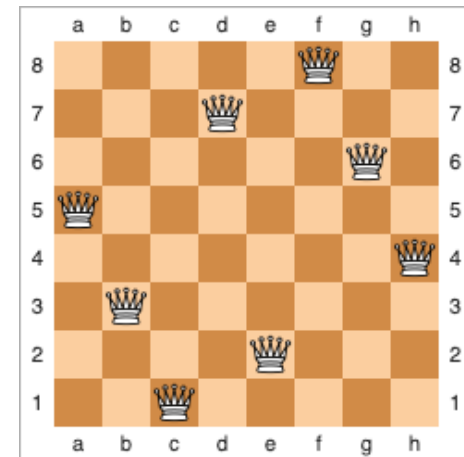
# AI: Cognitive Modeling

- ▶ 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

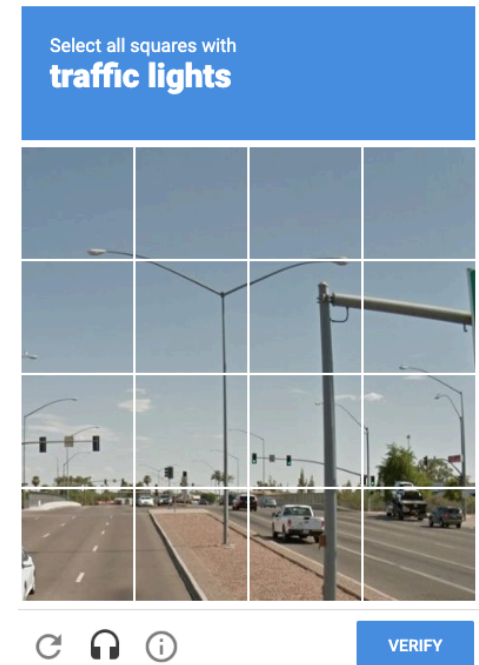
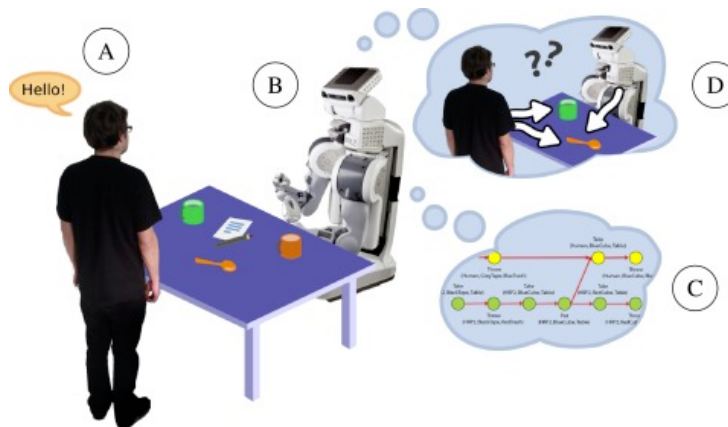
	<b>B stays silent (cooperates)</b>	<b>B betrays A (defects)</b>
<b>A stays silent (cooperates)</b>	<b>Both</b> serve 1 year	<b>A</b> serves 3 years, <b>B</b> goes free
<b>A betrays B (defects)</b>	<b>A</b> goes free, <b>B</b> serves 3 years	<b>Both</b> serve 2 years

## ► Real-world

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

# AI: Human + AI

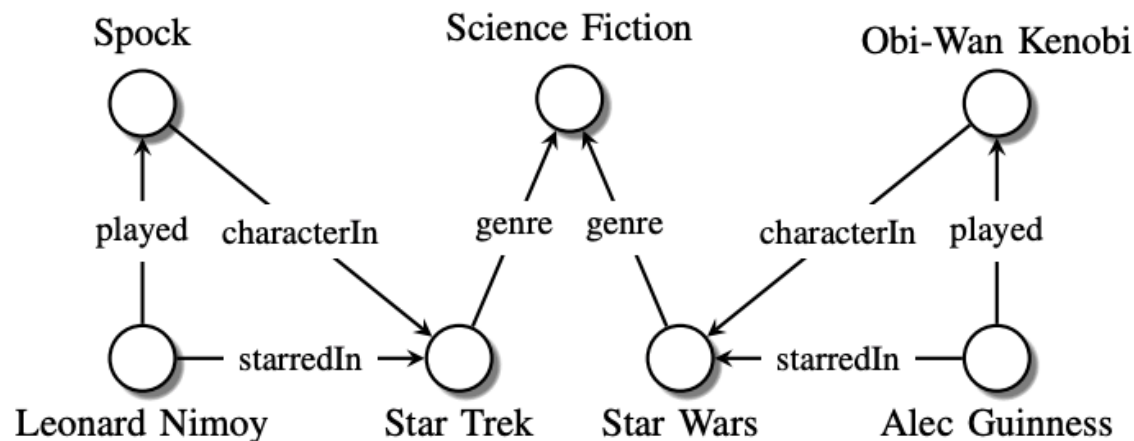
- ▶ Crowdsourcing
  - ▶ “Stop spam, read books”
- ▶ Human-robot interactions



<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

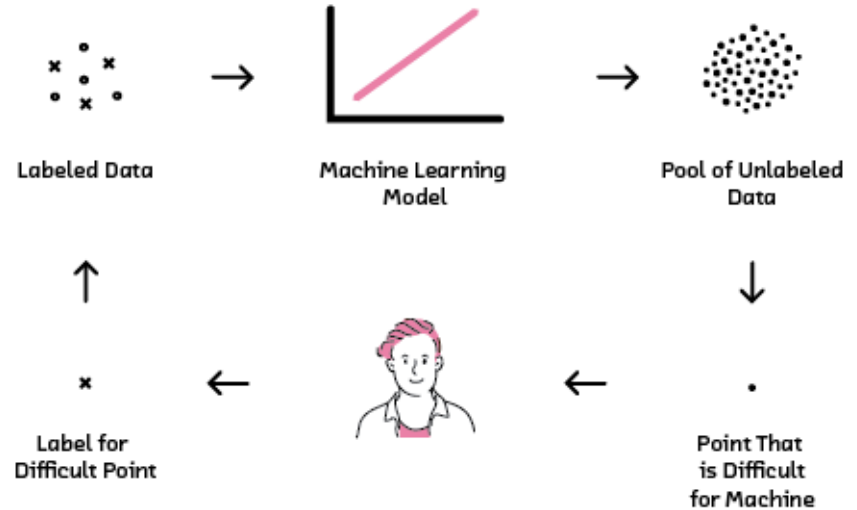
- Did Alec Guinness ever play a Science Fiction character?

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

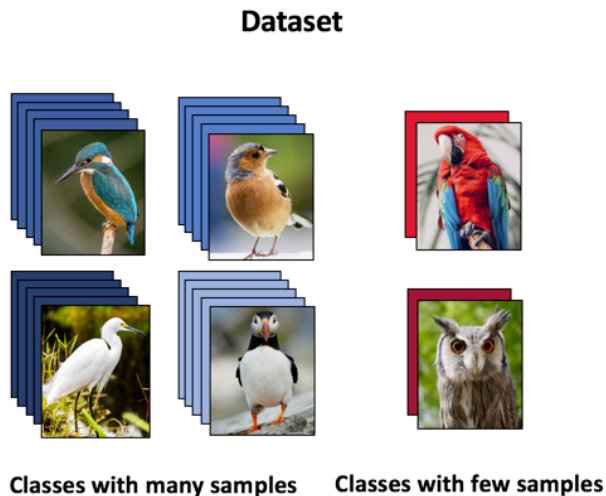
- ▶ Learning with limited labels
- ▶ Generative / probabilistic models
- ▶ Reinforcement learning
- ▶ Explainable AI

# ML: Learning with limited labels

## ► Active learning



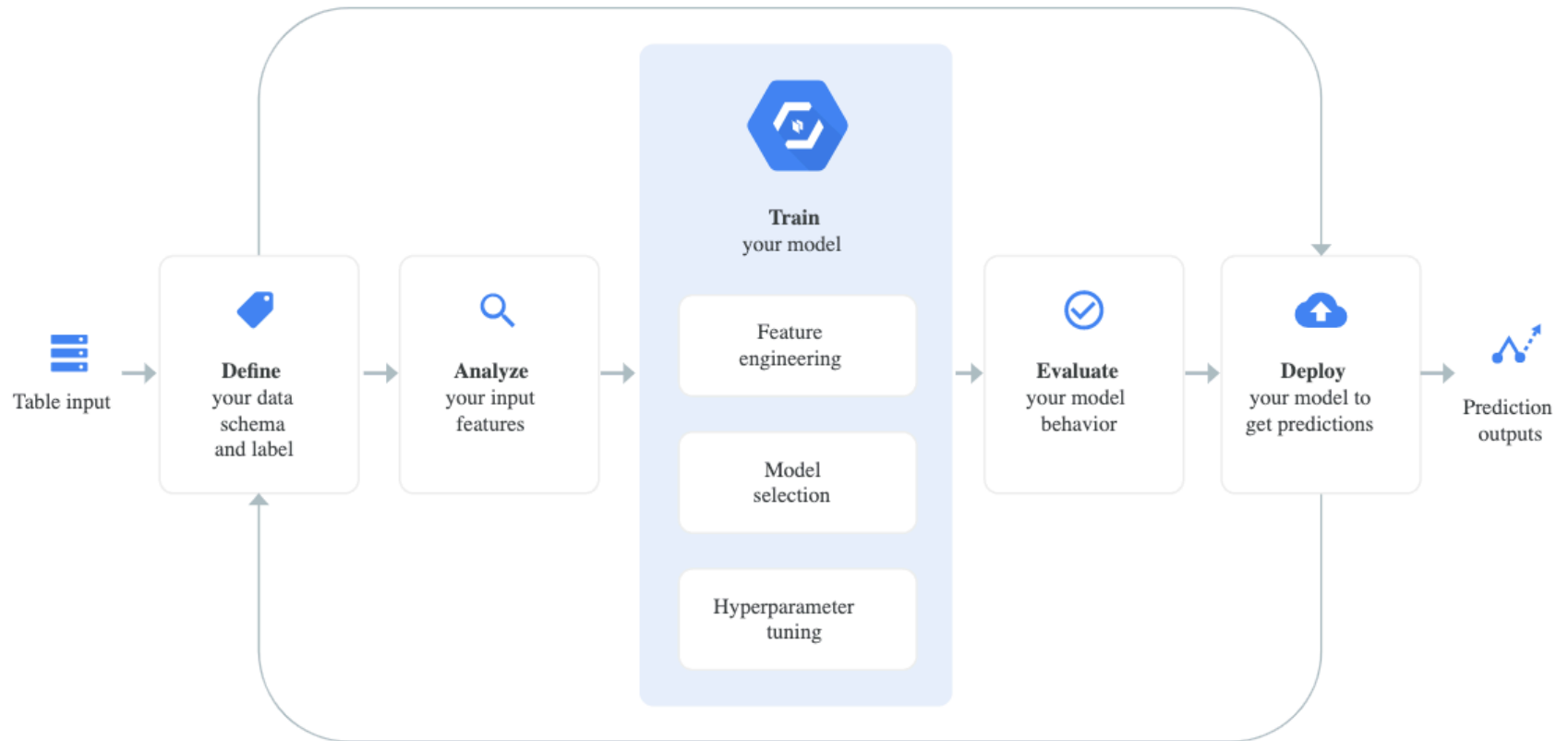
## ► Few-Shot Learning



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

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

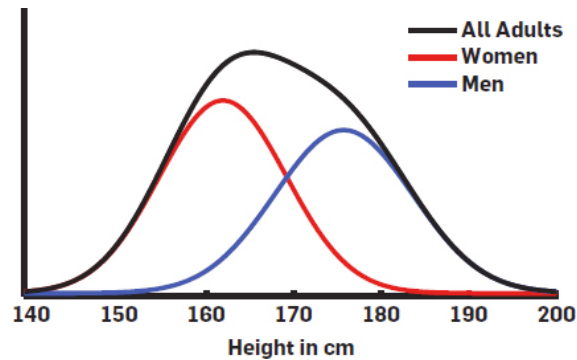
# ML: AutoML / Meta-learning



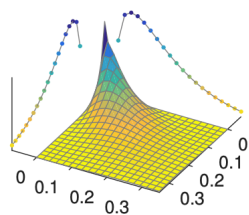
<https://cloud.google.com/automl-tables/?hl=vi>

# ML: Generative/Probabilistic Models

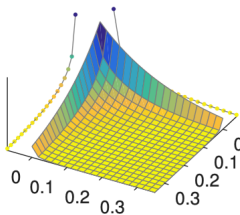
## ► Density estimation / Graphical Models



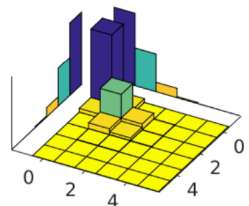
Positive Exp. SQR



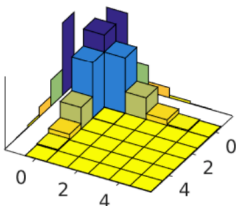
Negative Exp. SQR



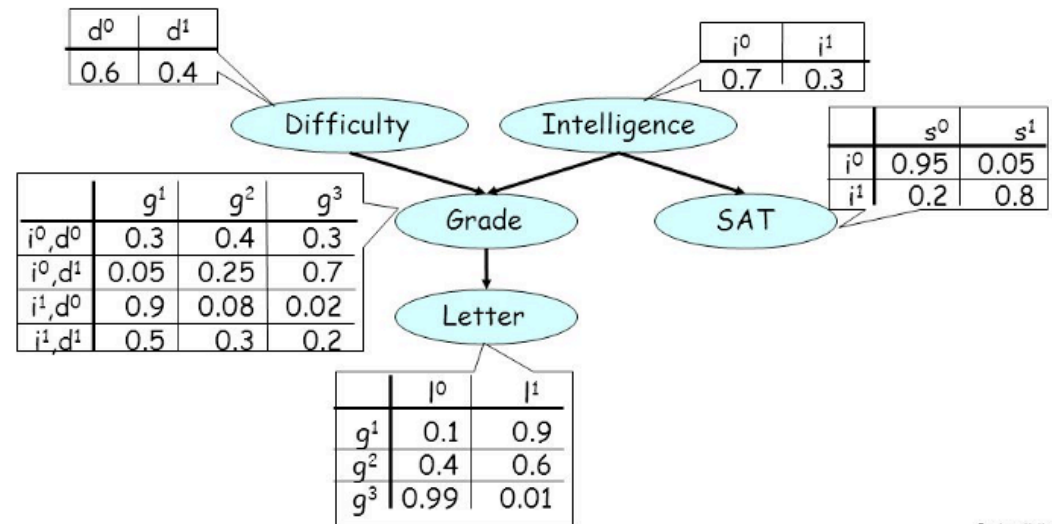
Positive Poisson SQR



Negative Poisson SQR



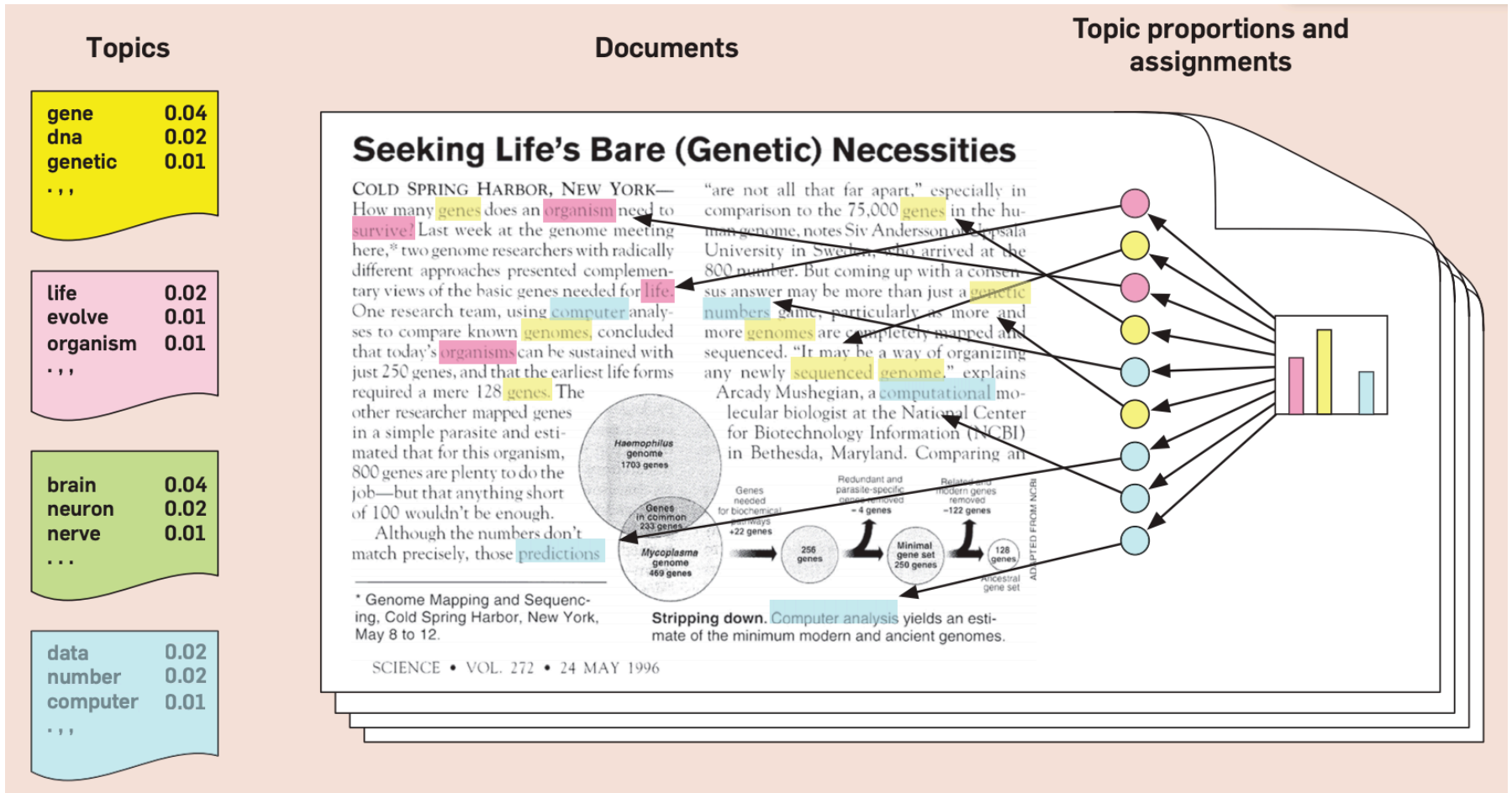
## The Student Network



Daphne Koller



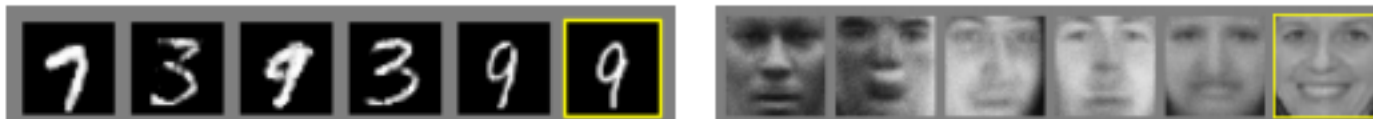
# ML: Topic Models



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

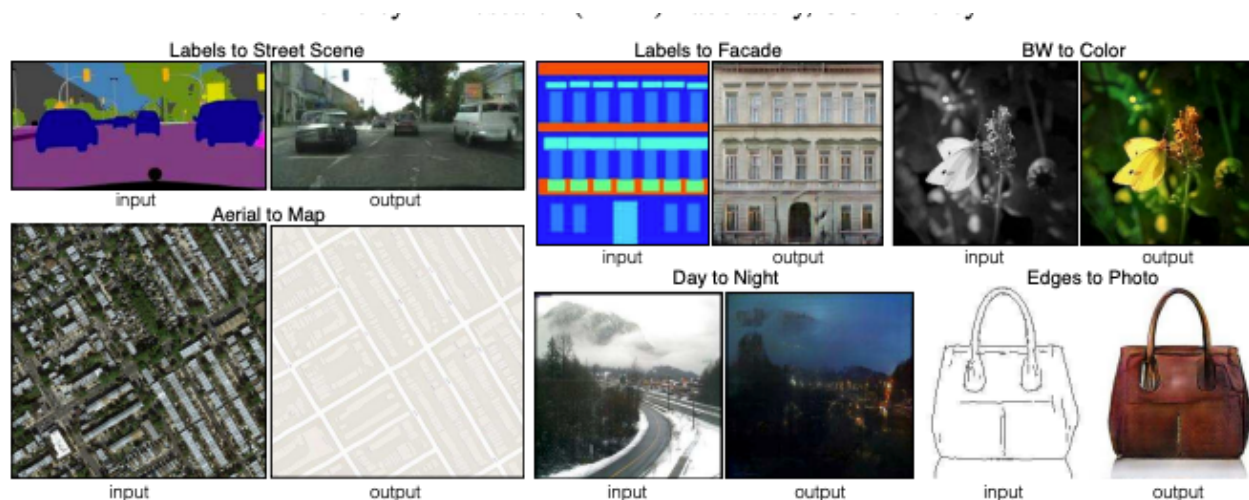
# ML: Generative Adversarial Networks (GAN)

## ► 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)

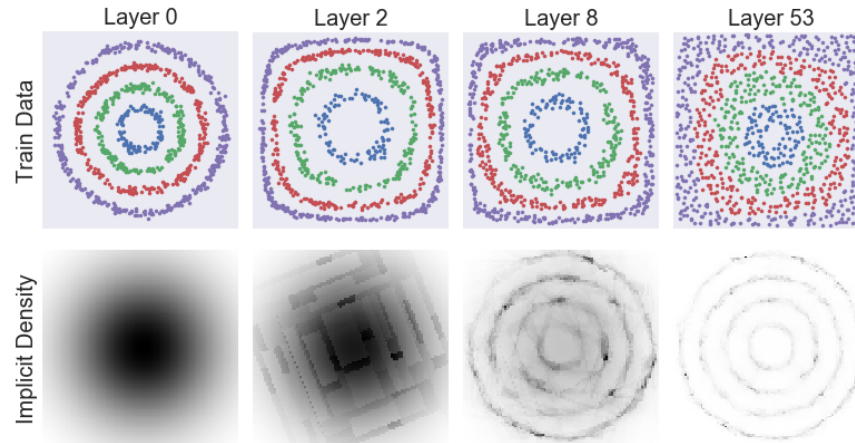
# ML: Invertible networks

## ► Invertible Flows



<https://papers.nips.cc/paper/8224-glow-generative-flow-with-invertible-1x1-convolutions.pdf>

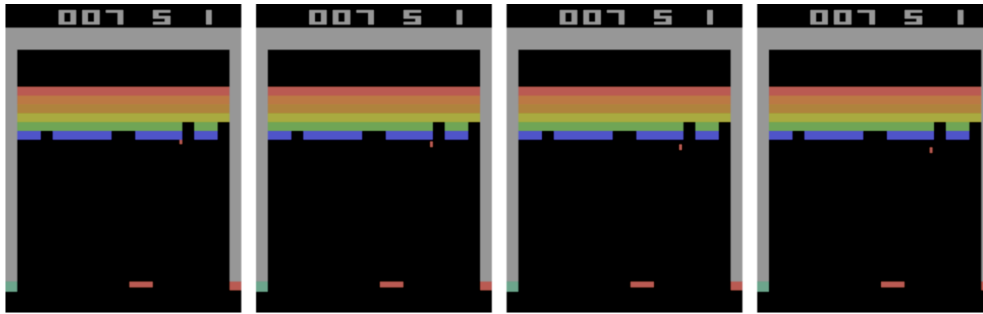
## ► Deep Density Destructors



<https://www.davidinouye.com/publication/inouye-2018-deep/inouye-2018-deep.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?”

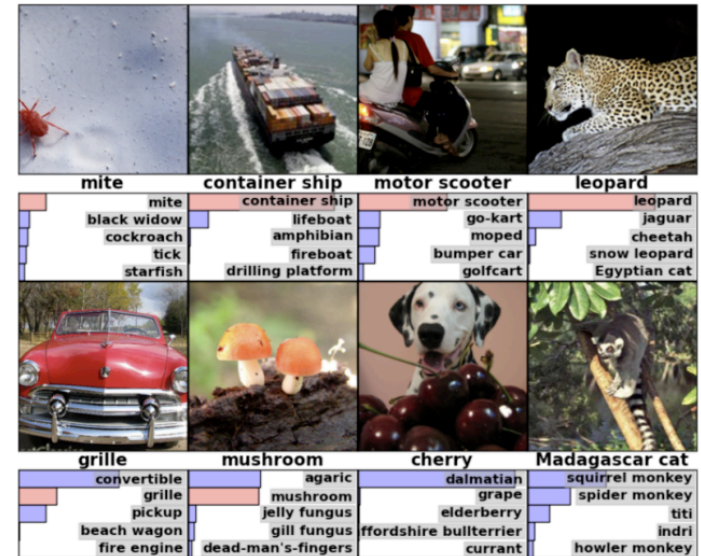
### 3. Computer Vision (Based on CVPR sessions)

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



# CV: Classic Tasks

## ► Recognition



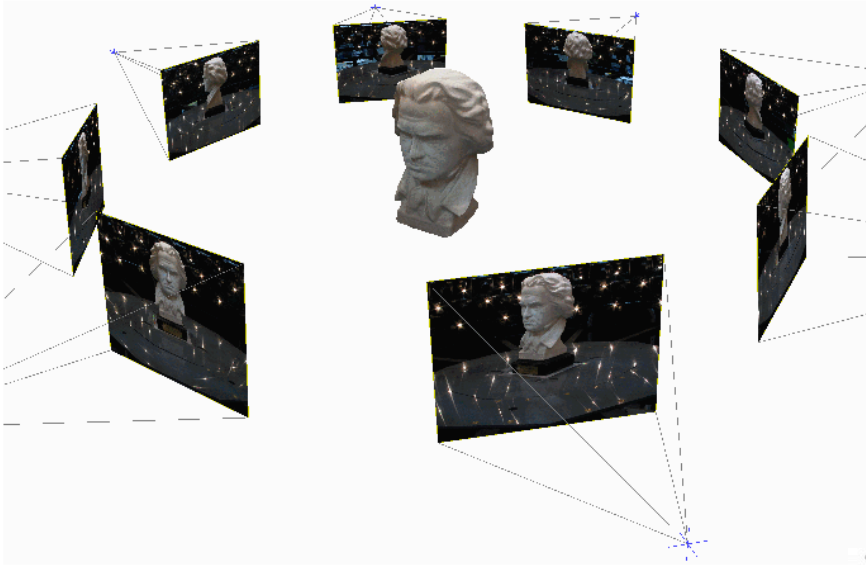
<http://www.cs.toronto.edu/~fritz/absps/imagenet.pdf>

## ► Segmentation

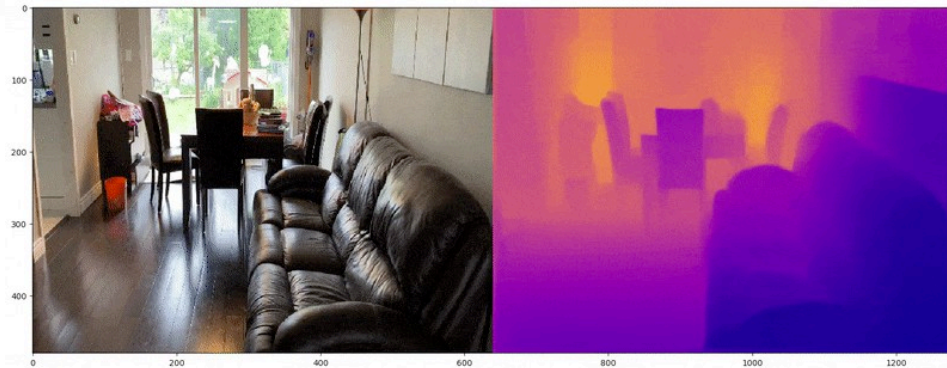


<http://vladlen.info/publications/feature-space-optimization-for-semantic-video-segmentation/>

# CV: 3D Multiview / Depth estimation



<https://vision.in.tum.de/research/image-based-3d-reconstruction/multiviewreconstruction>



<https://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/papers/Gatys\\_Image\\_Style\\_Transfer\\_CVPR\\_2016\\_paper.pdf](https://www.cv-foundation.org/openaccess/content_cvpr_2016/papers/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.

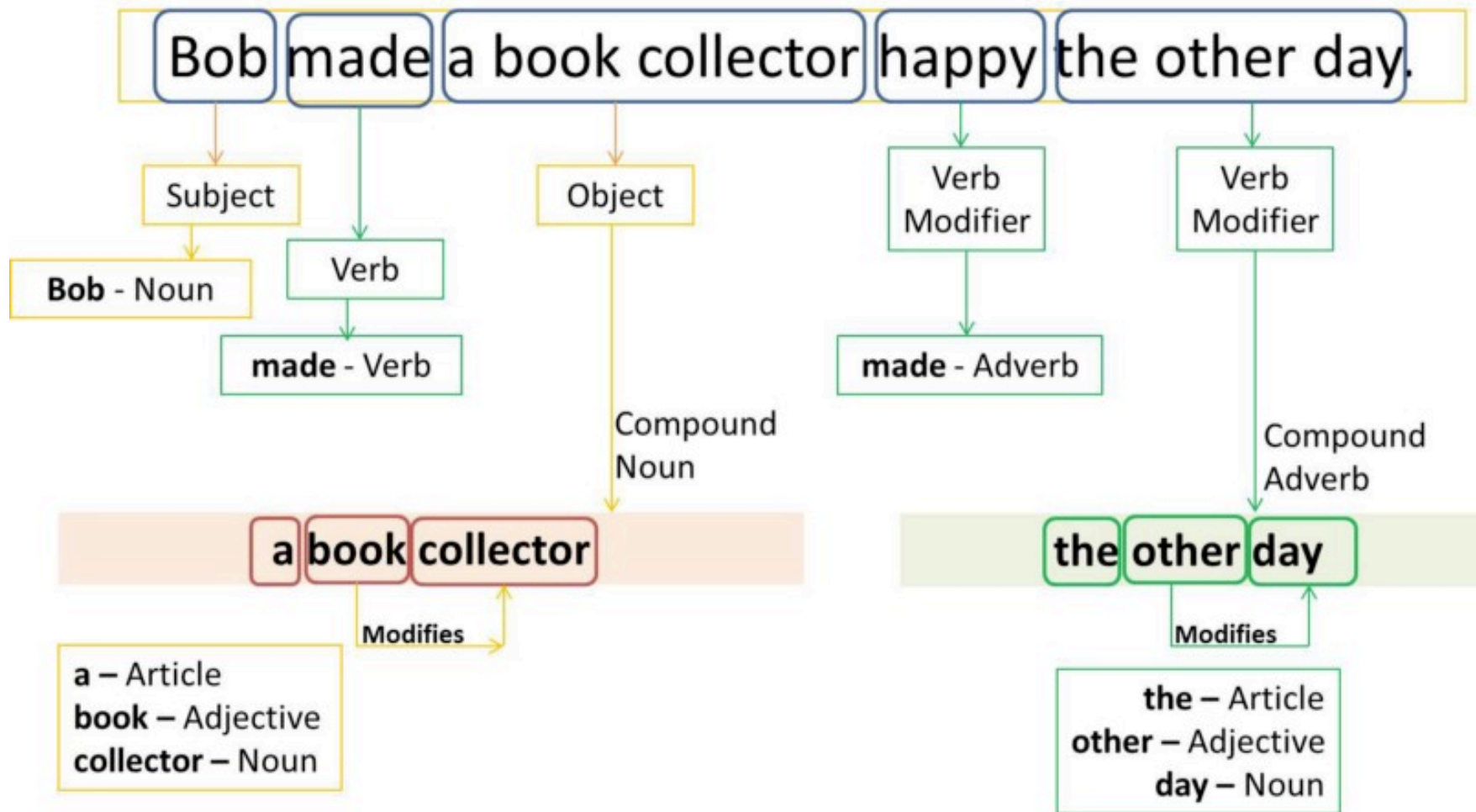


"The chicken is ready to eat."

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 - )

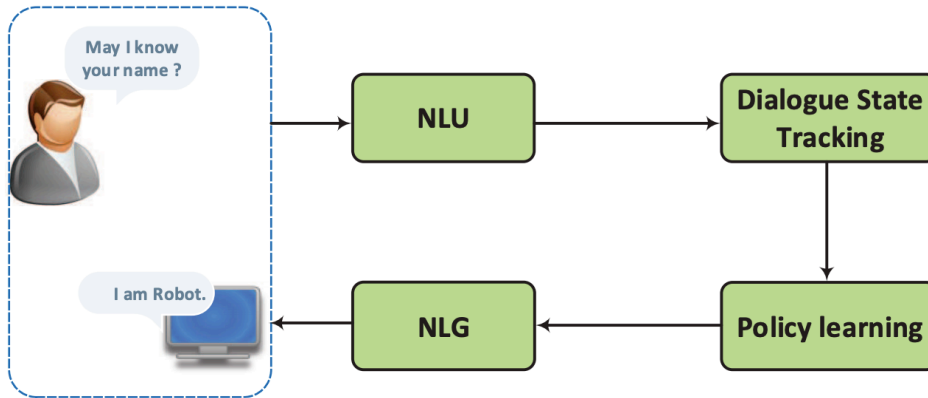
- Also known as: "**Ibu Negara**" (Lady/Mother of the State)

### IMDB TOP RATED TV SHOWS

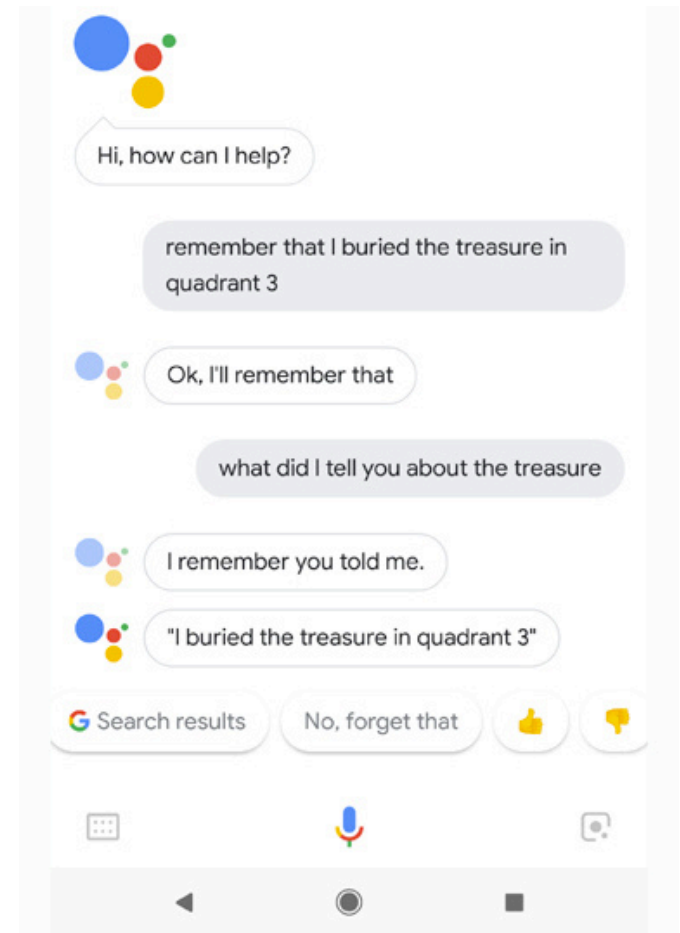
- 1 Planet Earth II (2016) 9.6.
- 2 Band of Brothers (2001) 9.5.
- 3 Planet Earth (2006) 9.5.
- 4 **Game of Thrones** (2011) 9.4.
- 5 Breaking Bad (2008) 9.4.

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

# NLP: Dialogue Systems / Question Answering



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



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