Teaching Computers to Understand Human Languages

(Natural Language Processing)

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Q: [Chris] = [Mr. Robin] ?

Christopher Robin is alive and well. **He** is the same person that you read about in the book, **Winnie the Pooh.** As **a boy**, **Chris** lived in a pretty home called **Cotchfield Farm**. When **Chris** was three years old, **his father** wrote a poem about **him**. The poem was printed in a magazine for others to read. **Mr. Robin** then wrote a book

Slide modified from Dan Roth

Complex Decision Structure

Christopher Robin is alive and well. **He** is the same person that you read about in the book, **Winnie the Pooh.** As **a boy**, **Chris** lived in a pretty home called **Cotchfield Farm**. When **Chris** was three years old, **his father** wrote a poem about **him**. The poem was printed in a magazine for others to read. **Mr. Robin** then wrote a book

Q: Who wrote Winnie the Pooh?

Christopher Robin is alive and well. He is the same person that you read about in the book, Winnie the Pooh. As a boy, Chris lived in a pretty home called Cotchfield Farm. When Chris was three years old, his father wrote a poem about him. The poem was printed in a magazine for others to read. Mr. Robin then wrote a book

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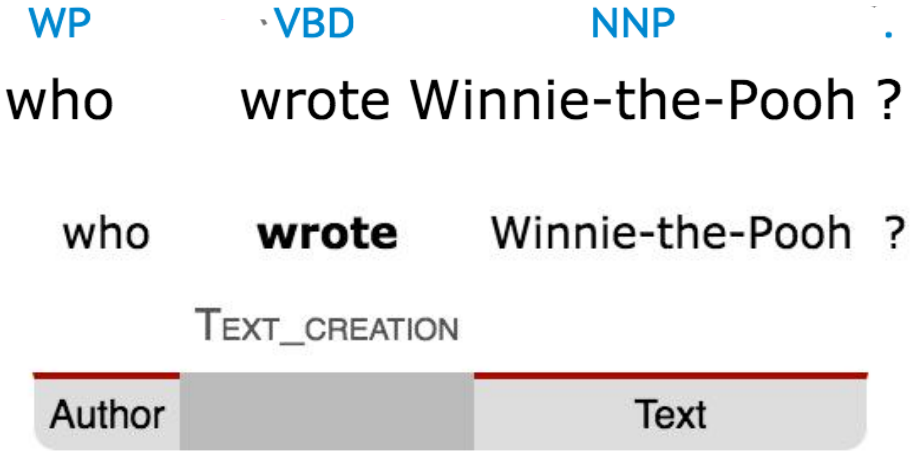
Co-reference Resolution

Christopher Robin is alive and well. **He** is the same person that you read about in the book, **Winnie the Pooh**. As a **boy**, **Chris** lived in a pretty home called **Cotchfield Farm**. When **Chris** was three years old, **his father** wrote a poem about **him**. The poem was printed in a magazine for others to read. **Mr. Robin** then wrote a book

Q: Who wrote Winnie-the-Pooh?

- How to understand the sentence:
  Who wrote Winnie-the-Pooh



- Convert the question to a logic form
  "Winnie-the-Pooh/Creator"

Algebra Word Problems

Problem: Maria is now four times as old as Kate. Four years ago, Maria was six times as old as Kate. Find their ages now.

Equations: $m = 4 \times n$ and $m - 4 = 6 \times (n - 4)$

Solution: $m = 40, n = 10$

Information Extraction

- Unstructured text to database entries

New York Times Co. named Russell T. Lewis, 45, president and general manager of its flagship New York Times newspaper, responsible for all business-side activities. He was executive vice president and deputy general manager. He succeeds Lance R. Primis, who in September was named president and chief operating officer of the parent.

Person	Company	Post	State
Russell T. Lewis	New York Times newspaper	president and general manager	start
Russell T. Lewis	New York Times newspaper	executive vice president	end
Lance R. Primis	New York Times Co.	president and CEO	start

Yoav Artzi: Natural language processing

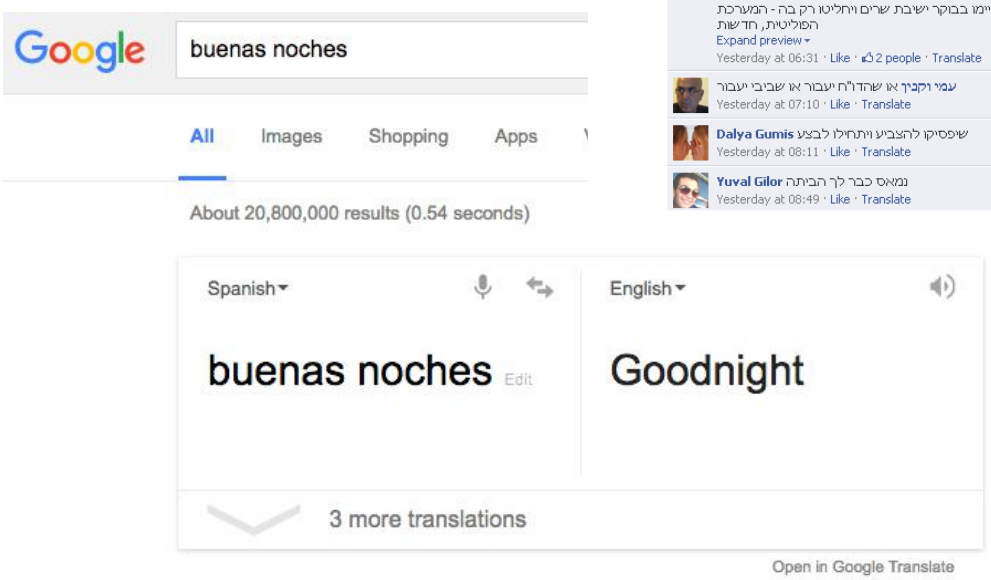
IE

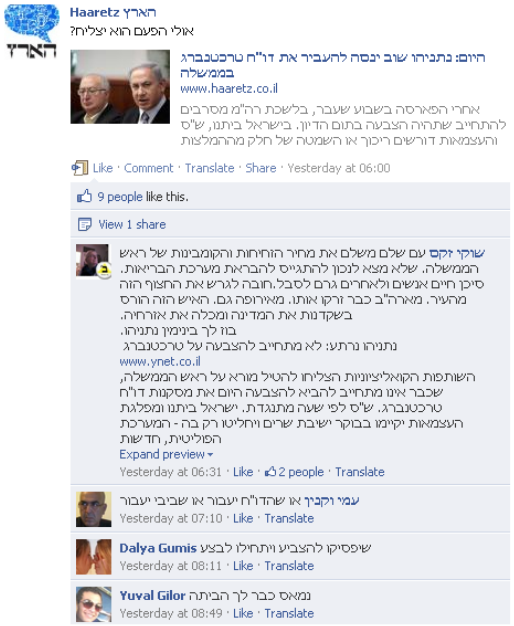
Structured Knowledge			
Entity	Entity	Entity	Relation
T790M	EGFR	gefitinib	Resist
Obama	U.S.		President_of
…	…		…

IE IE IE IE

Structured Knowledge			
Entity	Entity	Entity	Relation
T790M	EGFR	gefitinib	Resist
Obama	U.S.		President_of
Philadelphia	PA.		Locate_in
…	…		…

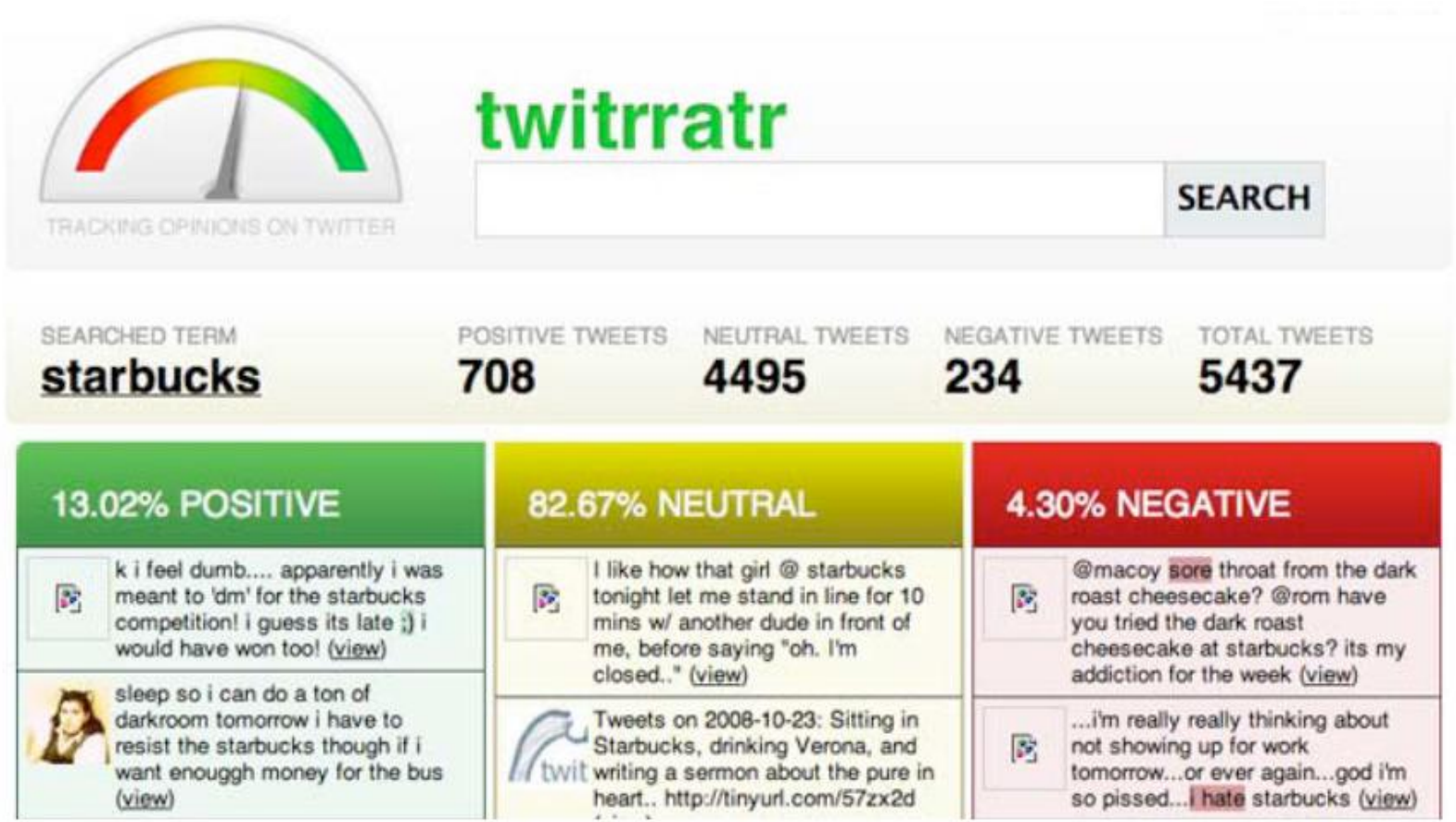
Machine translation





Facebook translation, image credit: Meedan.org

Sentiment/Opinion Analysis



Brainstorming

- List 3 NLP applications.

- What NLP applications you hope to see in the future?

Always working?!

Expectation

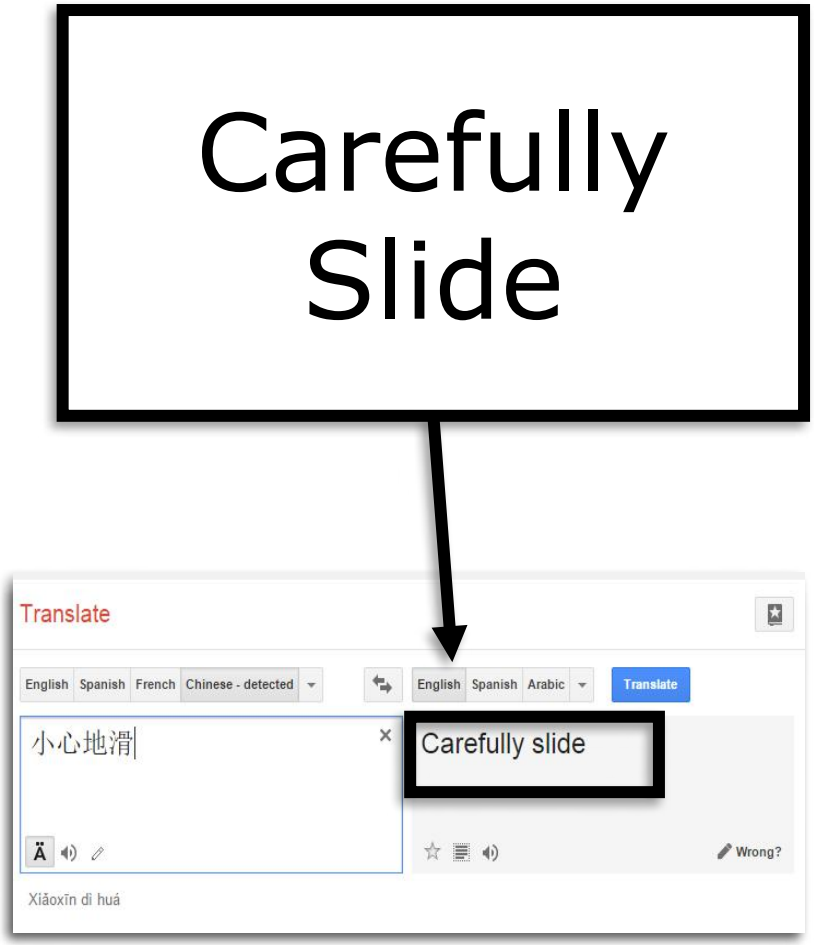
Reality

http://viralscape.com/travel-expectations-vs-reality/

Credit: http://stuffsirisaid.com

Carefully Slide

Challenges--language is compositional



Challenges--language is compositional

小心:
Carefully
Careful
Take
Care
Caution

地滑:
Slide
Landslip
Wet Floor
Smooth

Why is NLP hard

Ambiguity

I saw her duck

Challenges in Language

I saw her duck

Challenges in Language

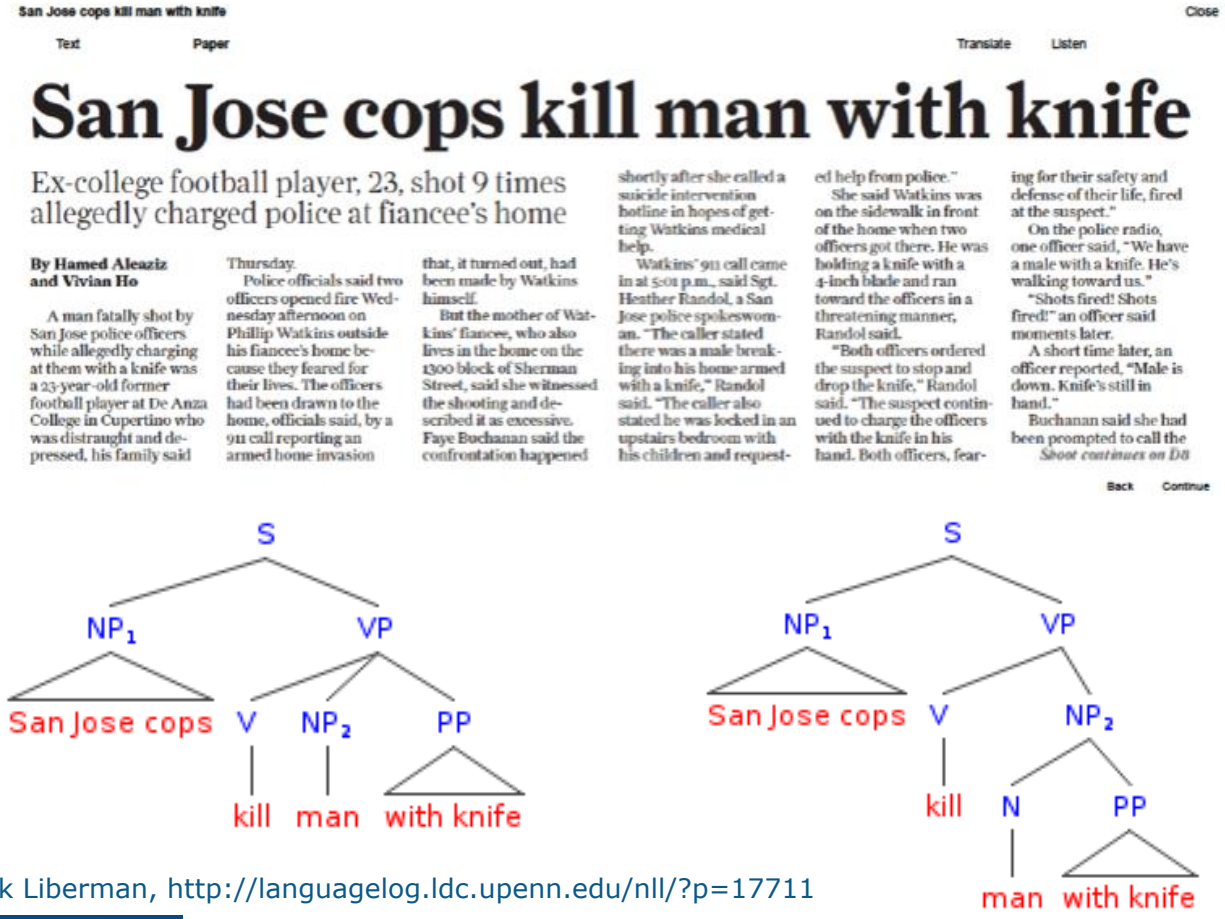
I saw her duck

Challenges in Language

I saw her duck with a telescope

Challenges – ambiguity

- PP attachment ambiguity



San Jose cops kill man with knife

Text Paper Translate Listen Close

San Jose cops kill man with knife

Ex-college football player, 23, shot 9 times allegedly charged police at fiancee's home

By Hamed Aleaziz and Vivian Ho

A man fatally shot by San Jose police officers while allegedly charging at them with a knife was a 23-year-old former football player at De Anza College in Cupertino who was distraught and depressed, his family said Thursday.

Police officials said two officers opened fire Wednesday afternoon on Phillip Watkins outside his fiancee's home because they feared for their lives. The officers had been drawn to the home, officials said, by a 911 call reporting an armed home invasion that, it turned out, had been made by Watkins himself.

But the mother of Watkins' fiancee, who also lives in the home on the 1300 block of Sherman Street, said she witnessed the shooting and described it as excessive. Faye Buchanan said the confrontation happened shortly after she called a suicide intervention hotline in hopes of getting Watkins medical help.

Watkins' 911 call came in at 5:01 p.m., said Sgt. Heather Randol, a San Jose police spokeswoman. "The caller stated there was a male breaking into his home armed with a knife," Randol said. "The caller also stated he was locked in an upstairs bedroom with his children and requested help from police."

She said Watkins was on the sidewalk in front of the home when two officers got there. He was holding a knife with a 4-inch blade and ran toward the officers in a threatening manner, Randol said.

"Both officers ordered the suspect to stop and drop the knife," Randol said. "The suspect continued to charge the officers with the knife in his hand. Both officers, fearing for their safety and defense of their life, fired at the suspect."

On the police radio, one officer said, "We have a male with a knife. He's walking toward us."

"Shots fired! Shots fired!" an officer said moments later.

A short time later, an officer reported, "Male is down. Knife's still in hand."

Buchanan said she had been prompted to call the

Shoot continues on D8

Back Continue

Credit: Mark Liberman, http://languagelog.ldc.upenn.edu/nll/?p=17711

Challenges -- ambiguity

- Ambiguous headlines:
  - Include your children when baking cookies
  - Local High School Dropouts Cut in Half
  - Hospitals are Sued by 7 Foot Doctors
  - Iraqi Head Seeks Arms

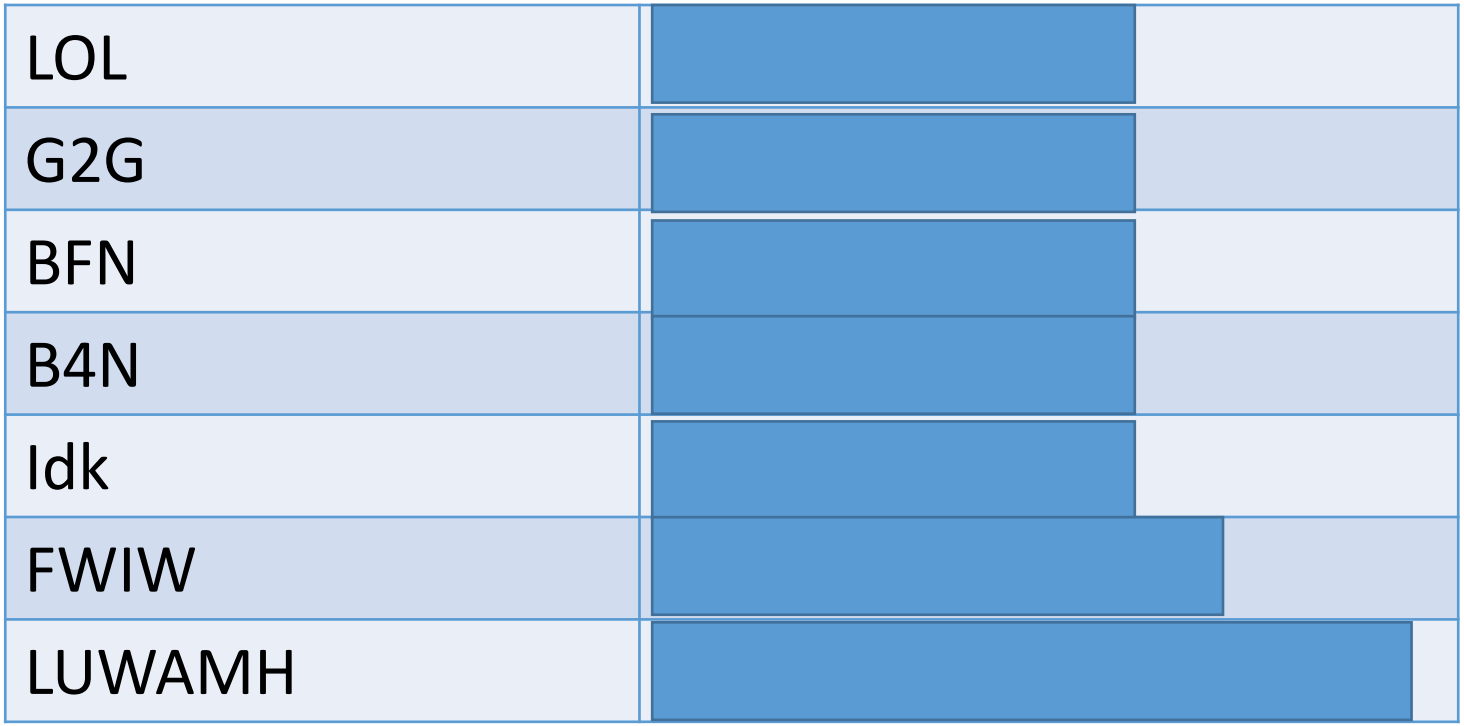
  - Safety Experts Say School Bus Passengers Should Be Belted
  - Teacher Strikes Idle Kids

Challenges – ambiguity

- Word sense ambiguity

Challenges – language is not static

- Language grows and changes
  - e.g., cyber lingo



Challenges – ambiguity

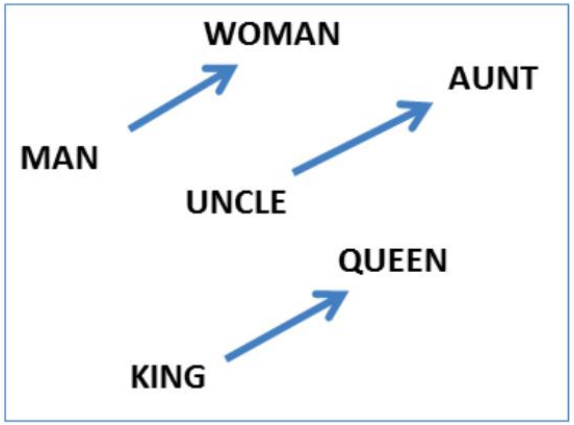
- Pronoun reference ambiguity

Dr. Macklin often brings his dog Champion to visit with the patients. He just loves to give big, wet, sloppy kisses!

Credit: http://www.printwand.com/blog/8-catastrophic-examples-of-word-choice-mistakes

Word Embeddings can be Dreadfully Sexist [nips16, **reported by NPR, MIT tech review**]

- $v_{man} - v_{woman} + v_{uncle} \sim v_{aunt}$



he: ___	she: __
uncle	aunt
lion	
surgeon	
architect	
beer	
professor	

We use Google w2v embedding trained from the news

Human Bias in Structured Prediction Models

[EMNLP 17] w/ Jieyu Zhao, Tianlu Wang, Mark Yatskar, Vicente Ordonez

What's the agent for this image?

Cooking	
Role	Object
agent	?
food	vegetable
container	bowl
tool	knife
place	kitchen

An example from a vSRL (visual Semantic Role Labeling) system

Dataset Gender Bias

33%

Male

66%

Female

Model Bias After Training

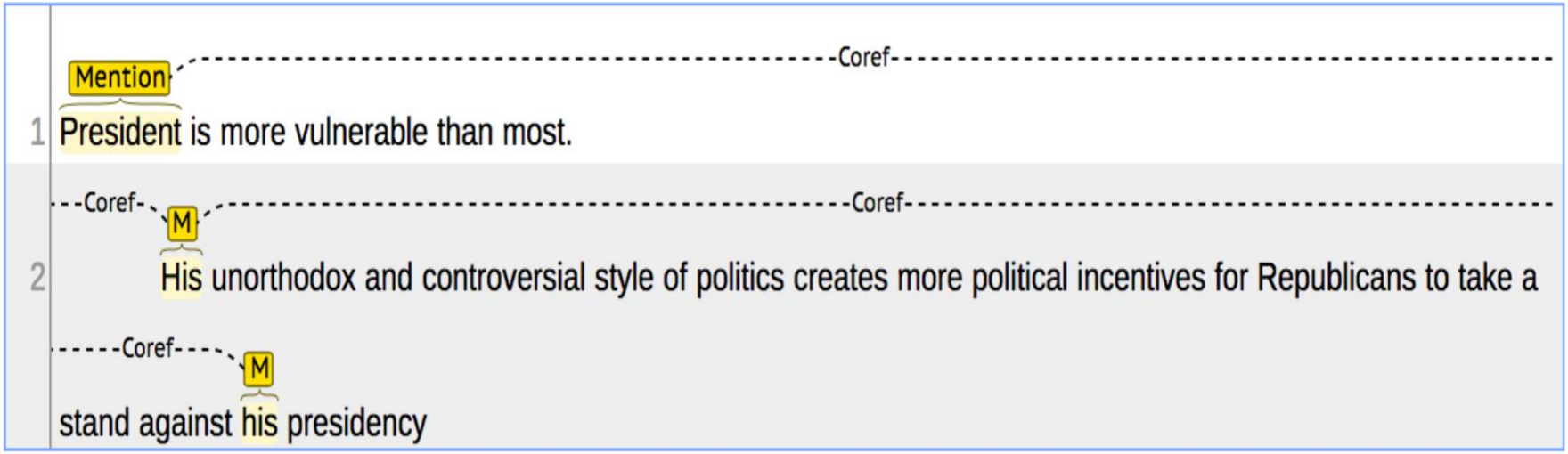
16%

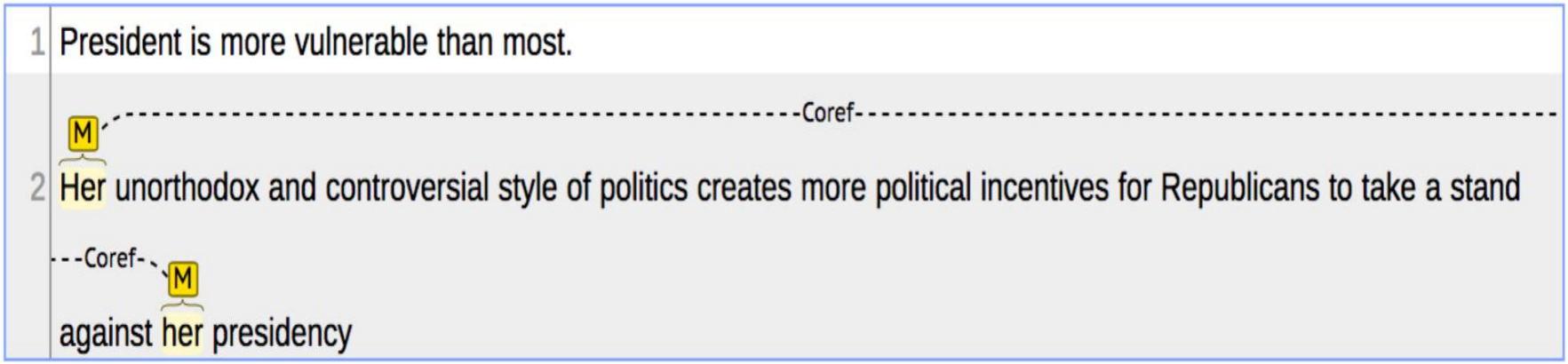
84%

Male

Female

Gender Bias in Coref [NAACL 2018]





Concurrent work (Rudinger et al., 2018) @NAACL18 also studied gender bias in Coref.

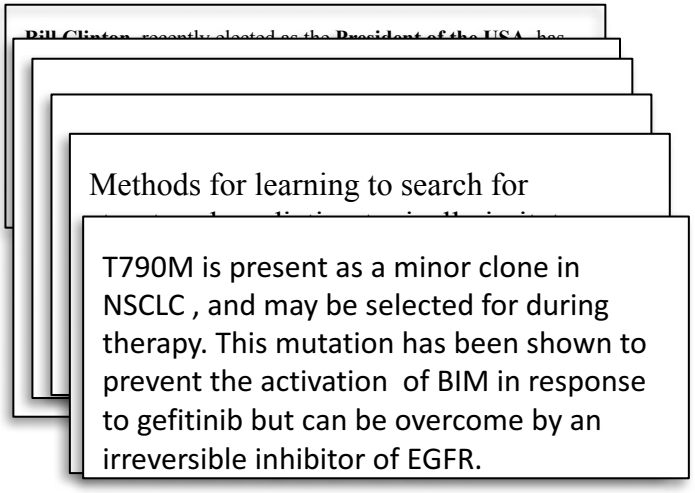
NLP Models are Brittle

Original Text Prediction: **Entailment** (Confidence = 86%)
Premise: *A runner wearing purple strives for the finish line.* **Hypothesis:** *A **runner** wants to head for the finish line.*
Adversarial Text Prediction: **Contradiction** (Confidence = 43%)
Premise: *A runner wearing purple strives for the finish line.* **Hypothesis:** *A **racer** wants to head for the finish line.*

Table 2: Example of attack results for the textual entailment task. Modified words are highlighted in green and red for the original and adversarial texts, respectively.

Machine Learning

Input space



Statistical model

Label space

present

T790M is present as a minor clone in NSCLC

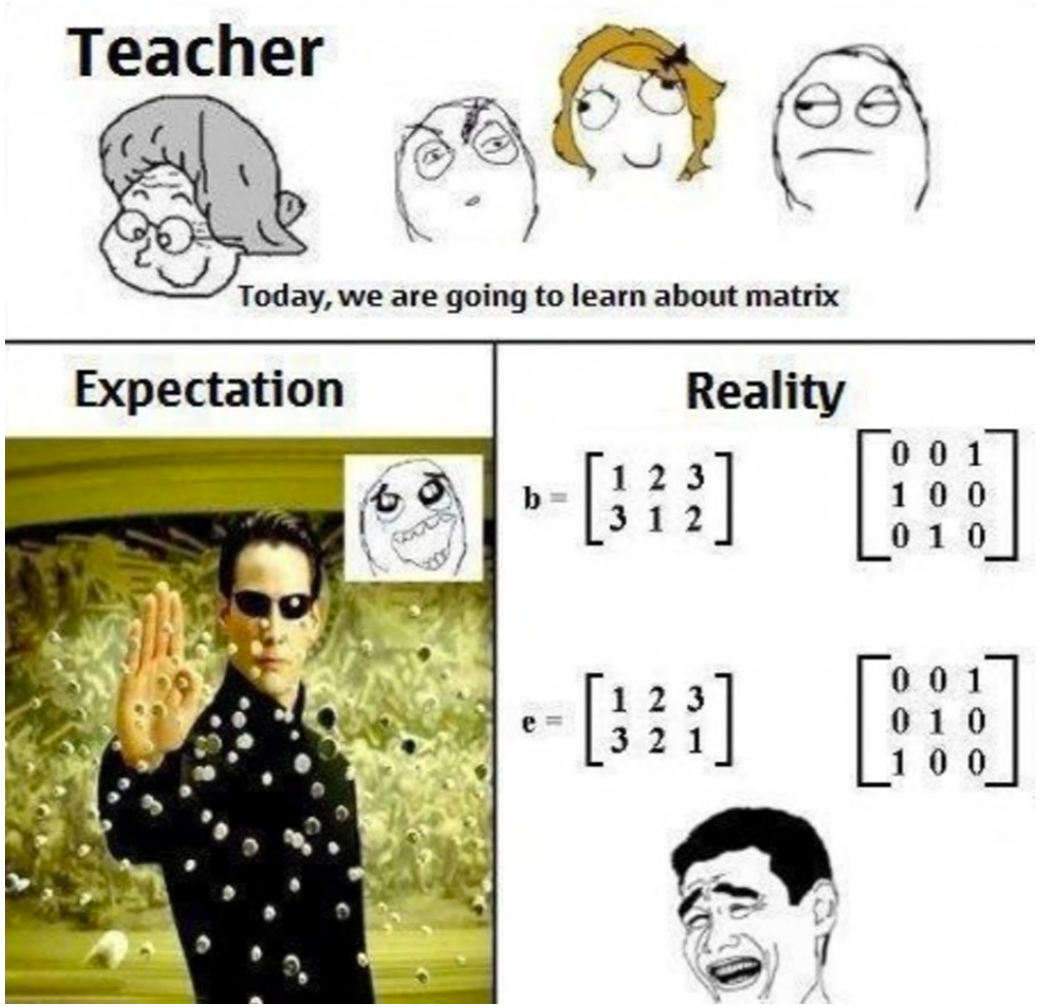
Human Annotation

It’s cool, let's work on it

Cool Cat: Genius by ToValhalla

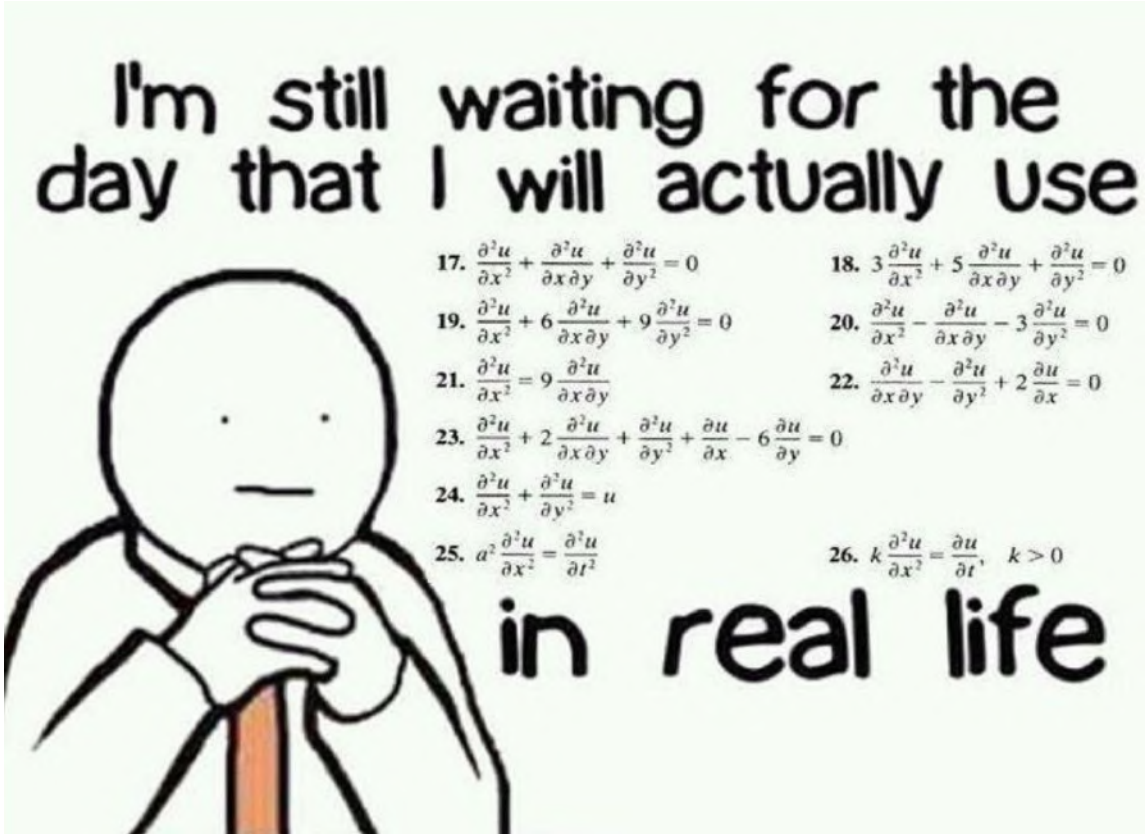
Prerequisites

- Math tools
  - Linear algebra



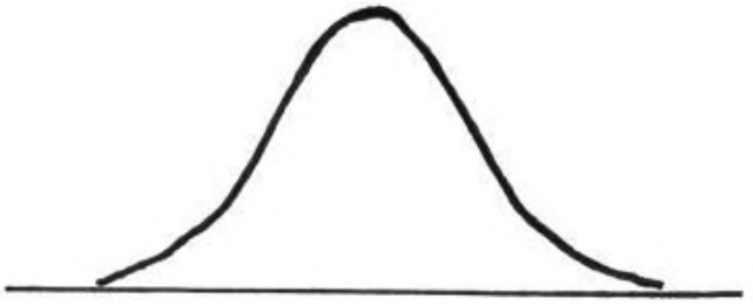
Prerequisites

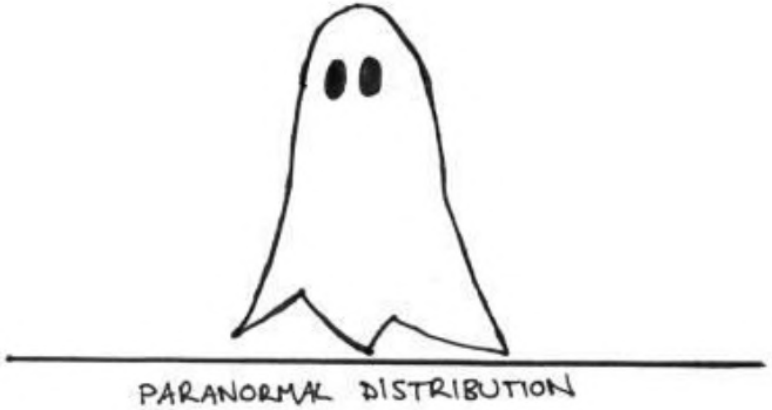
- Math tools
  - Linear algebra
  - Calculus



Prerequisites

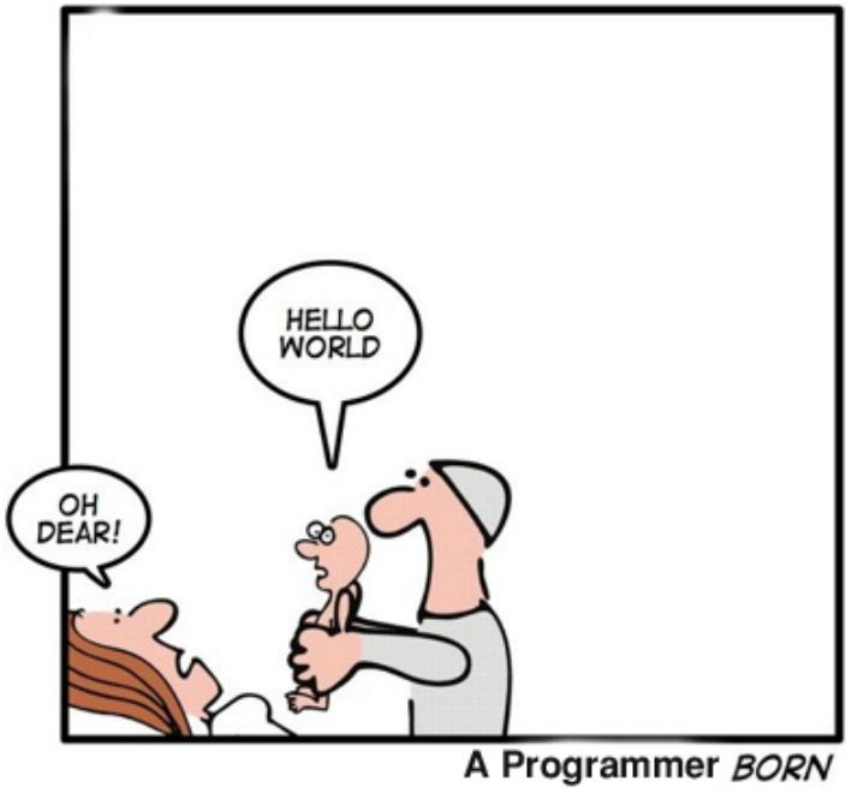
- Math tools
  - Linear algebra
  - Calculus
  - Probability





Prerequisites

- Math tools
  - Linear algebra
  - Calculus
  - Probability
- Programming skills
- Algorithm / Data structure
- CS146 – Intro to ML
- Natural Language Processing



More information

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