Demystifying AI
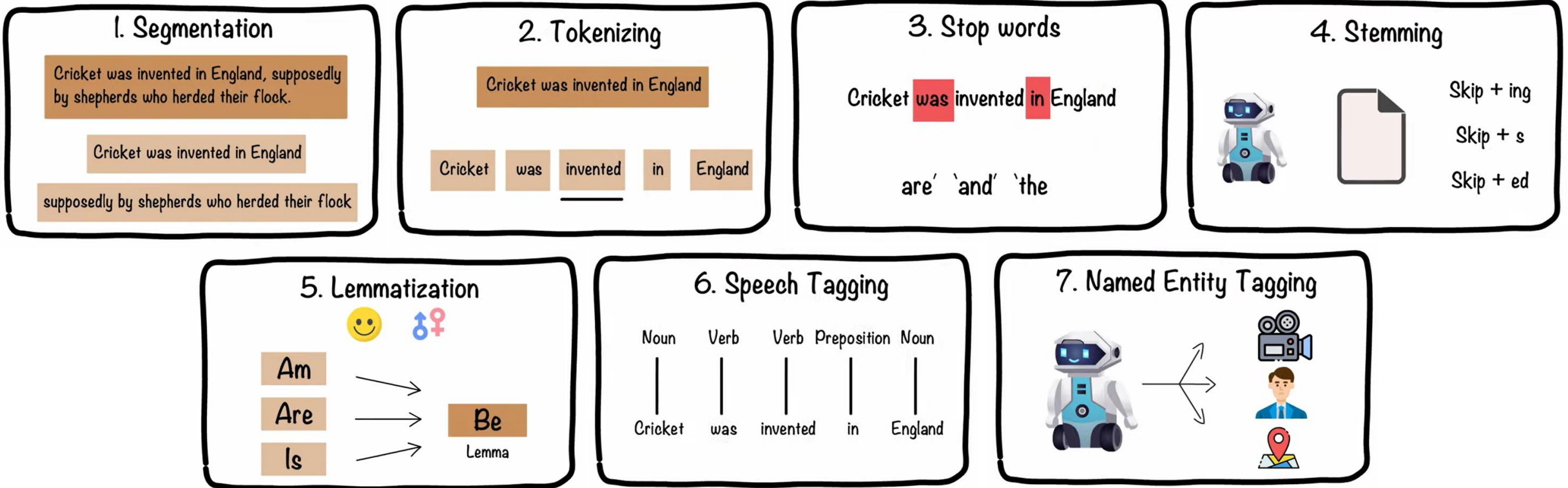
Natural Language Processing

Instructor: Pat Virtue

NLP Sub-tasks

Many different operations to help process language
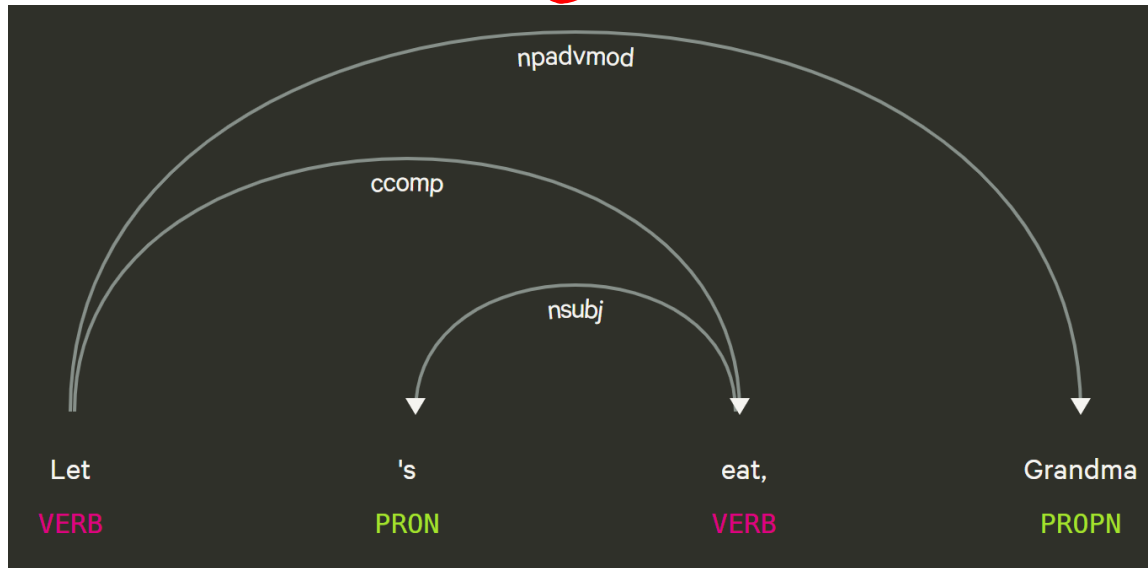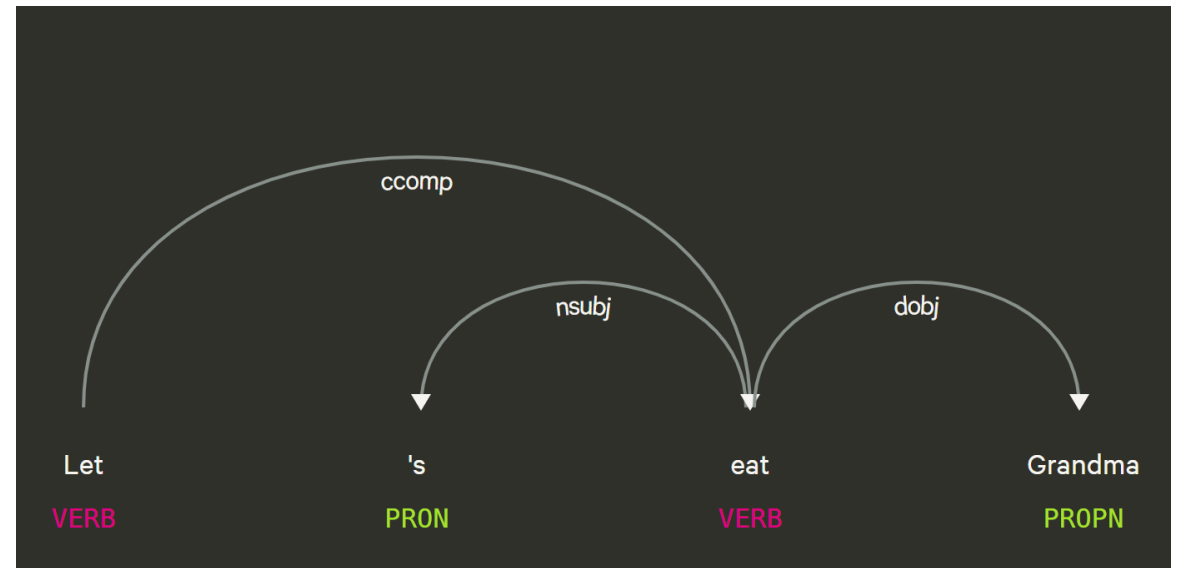

1. Segmentation

Cricket was invented in England, supposedly by shepherds who herded their flock.

Cricket was invented in England

supposedly by shepherds who herded their flock

2. Tokenizing

Cricket was invented in England

Cricket | was | invented | in | England

3. Stop words

Cricket was invented in England

are' 'and' 'the

4. Stemming

Skip + ing
Skip + s
Skip + ed

5. Lemmatization

Am →
Are → Be
Is →
Lemma

6. Speech Tagging

Noun | Verb | Verb | Preposition | Noun
Cricket | was | invented | in | England

7. Named Entity Tagging

NLP Grammar

Text to parts of speech and parse tree

https://explosion.ai/demos/displacy

Let's eat, Grandma

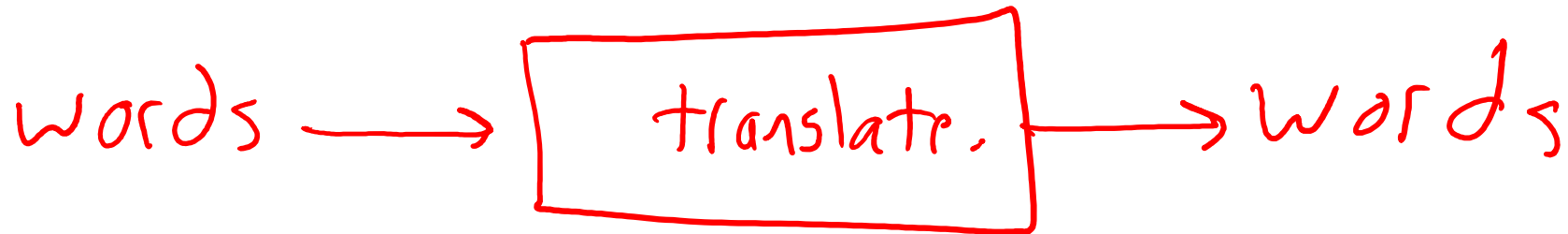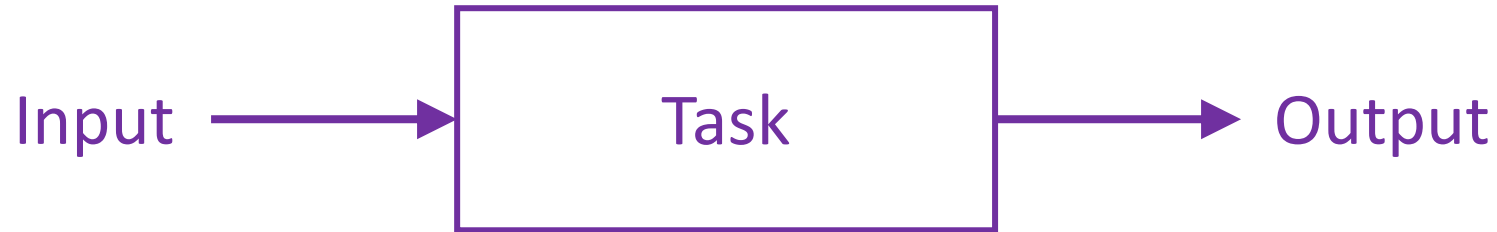Let's eat Grandma

Commas save lives ☺

Language is Hard

Emphasis can drastically change meaning

I didn't eat your dog

Exercise: NLP Tasks

How many different NLP Input/Output agents can you think of?

Input → **Task** → Output

words → translate. → words

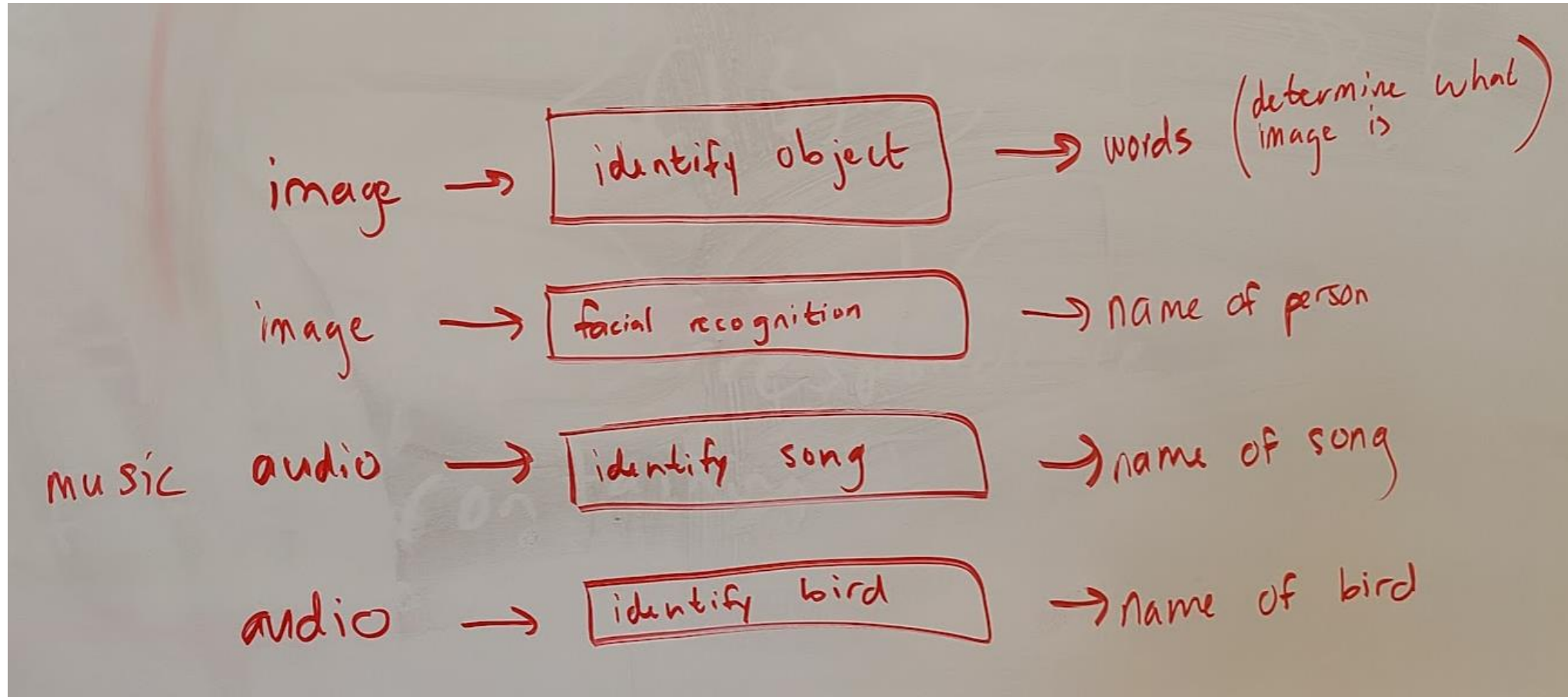audio → Siri/Alexa add event → action (add calendar event)
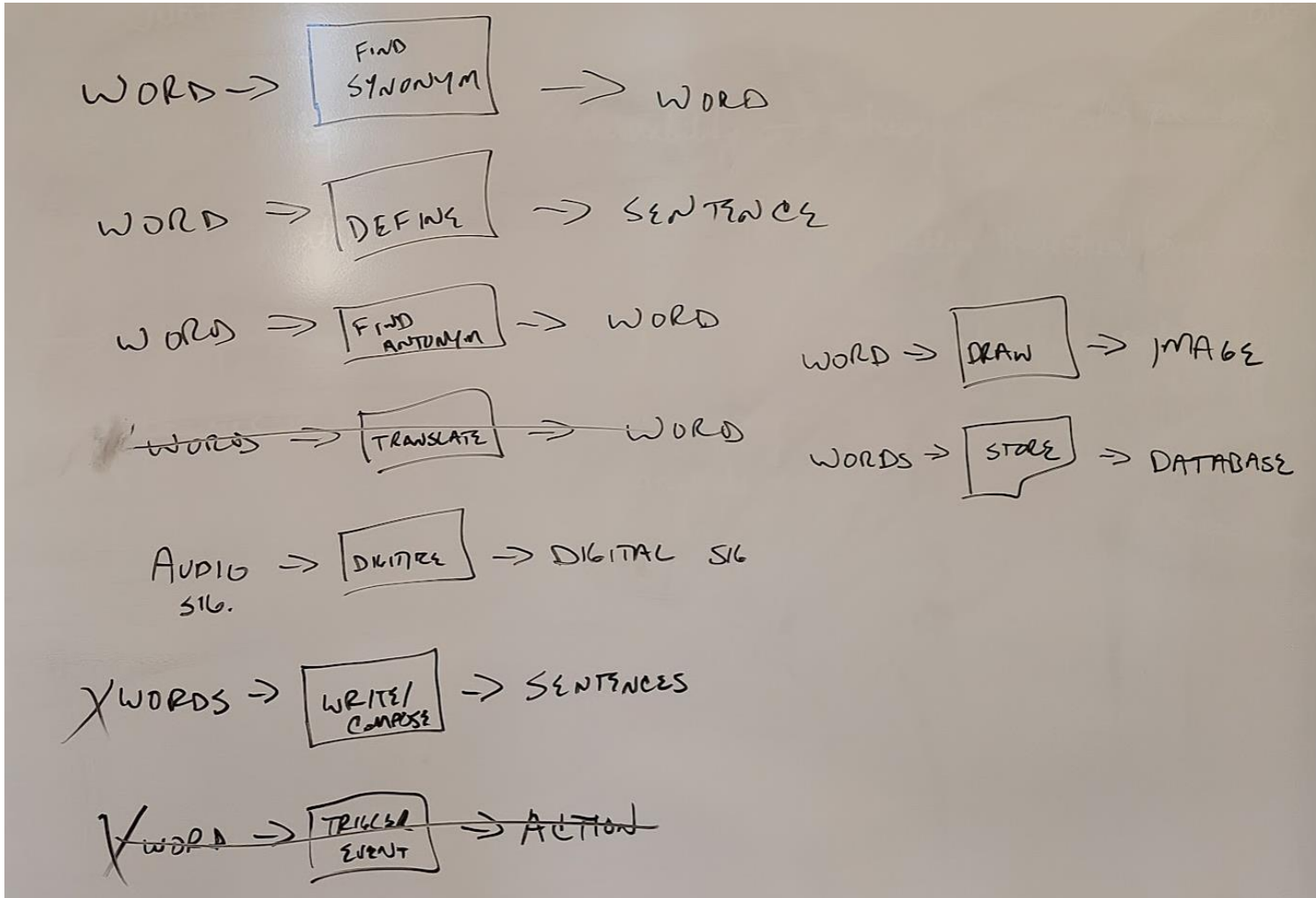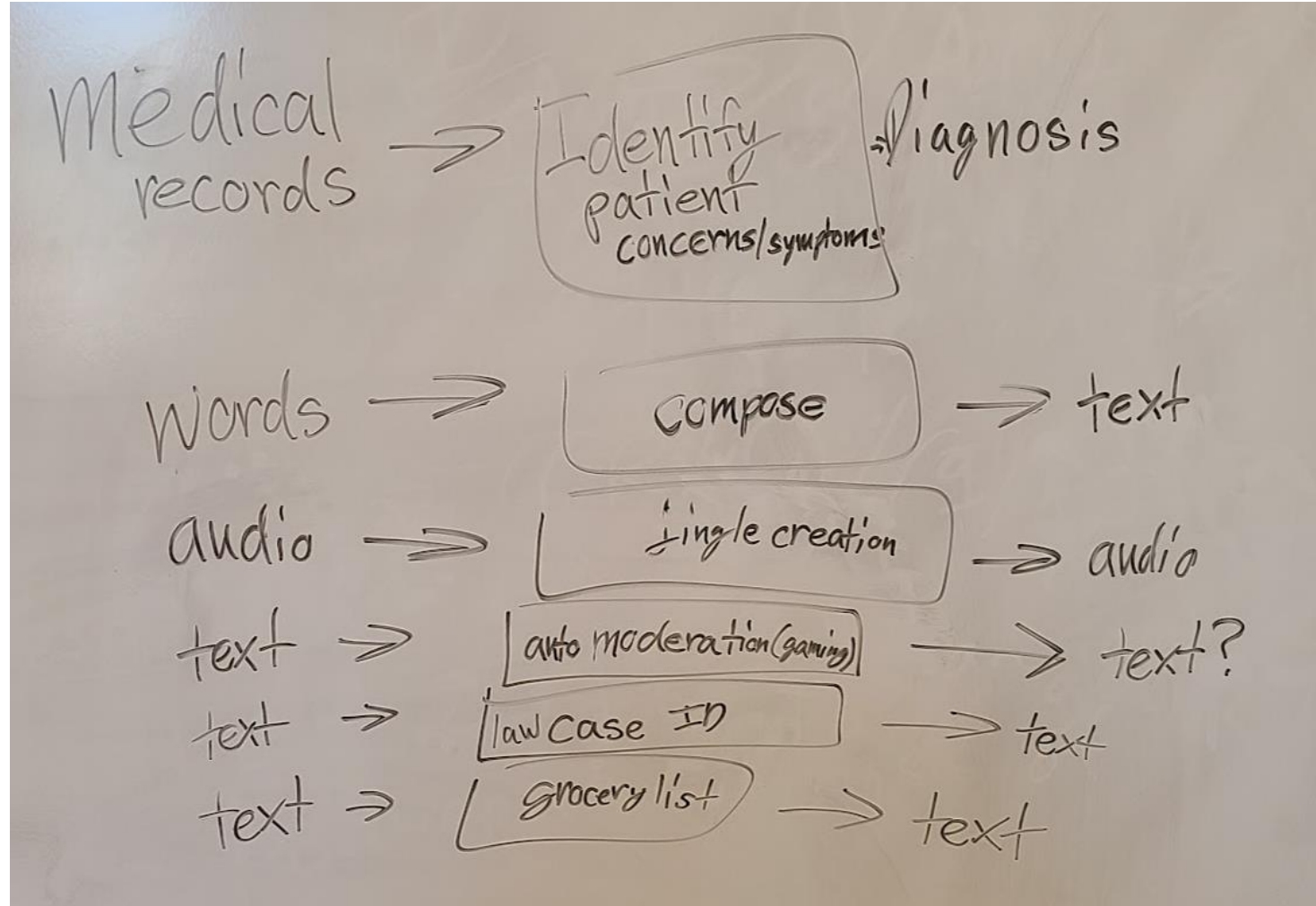
Exercise: NLP Tasks

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Exercise: NLP Tasks

How many different NLP Input/Output agents can you think of?
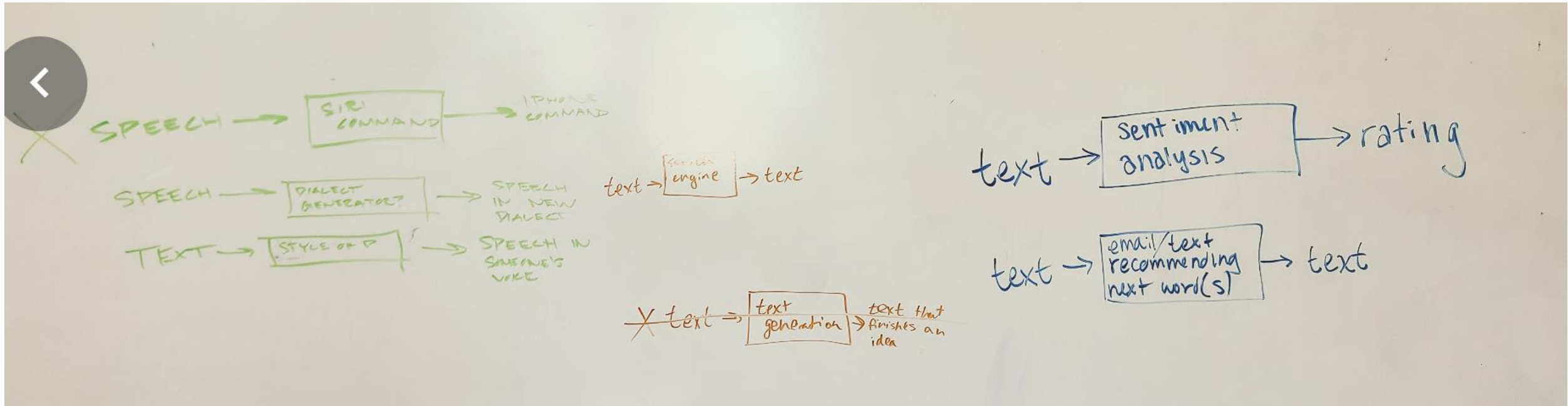
Exercise: NLP Tasks

How many different NLP Input/Output agents can you think of?

Exercise: NLP Tasks

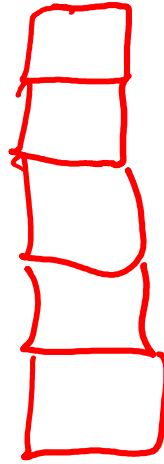How many different NLP Input/Output agents can you think of?

Sentiment Analysis

Sentiment analysis demo

https://text2data.com/Demo

"I recommend that you find something better to do with your time"

NLP Features

Hand-crafted features

email

ALL CAPS
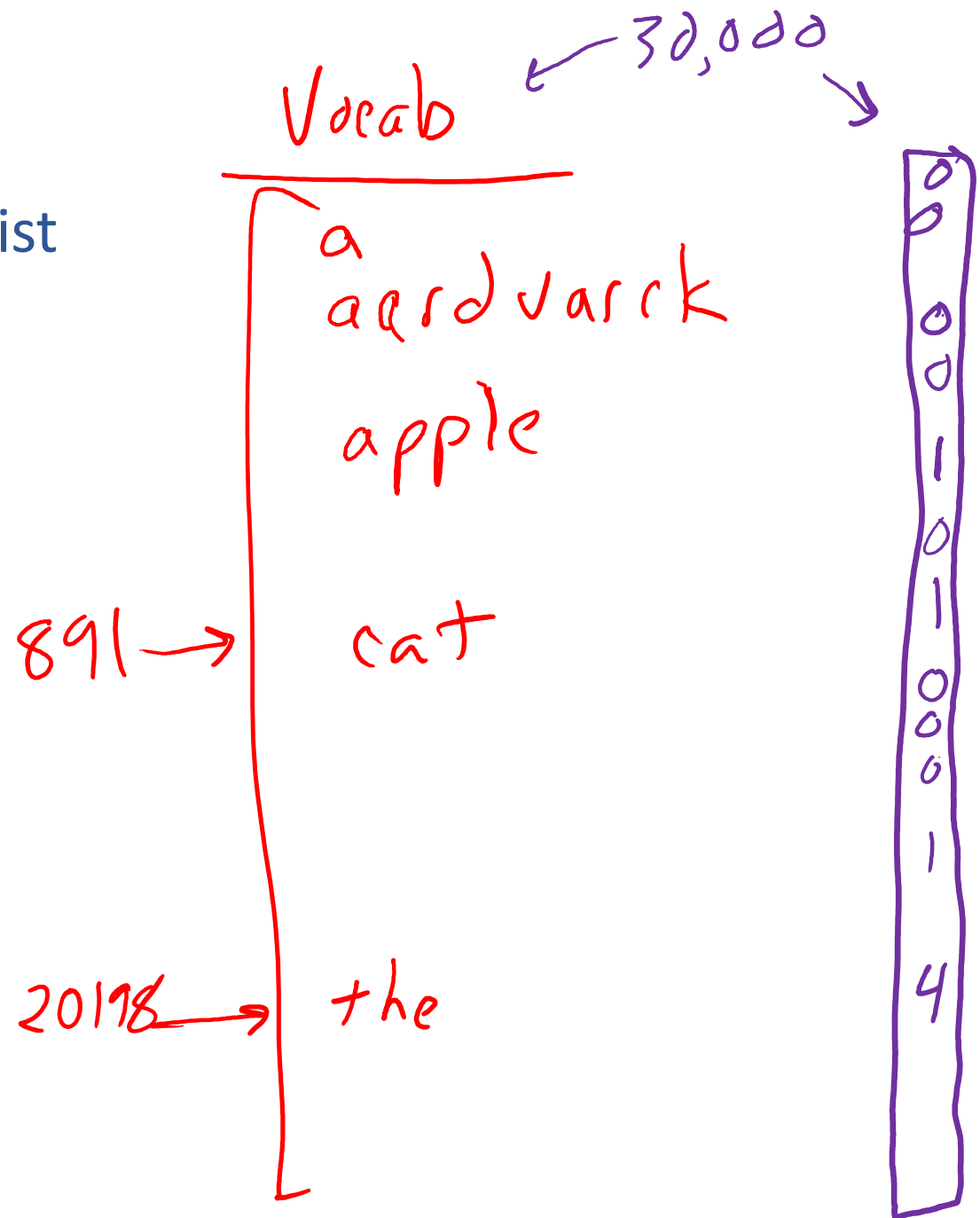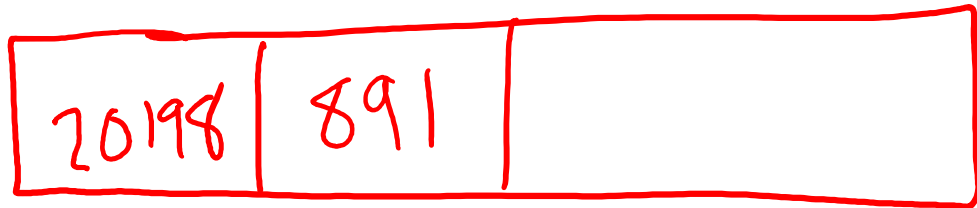0/1 contain "morey"
0/1 contain my name

NLP Features

Word → integer index in vocabulary list

"the | cat | ran | fast"

20198	891	

Vocab ← 30,000 →

a
aardvarck
apple
891 → cat
20198 → the

0
0
0
0
1
0
0
0
1
4

NLP Features

Word embeddings
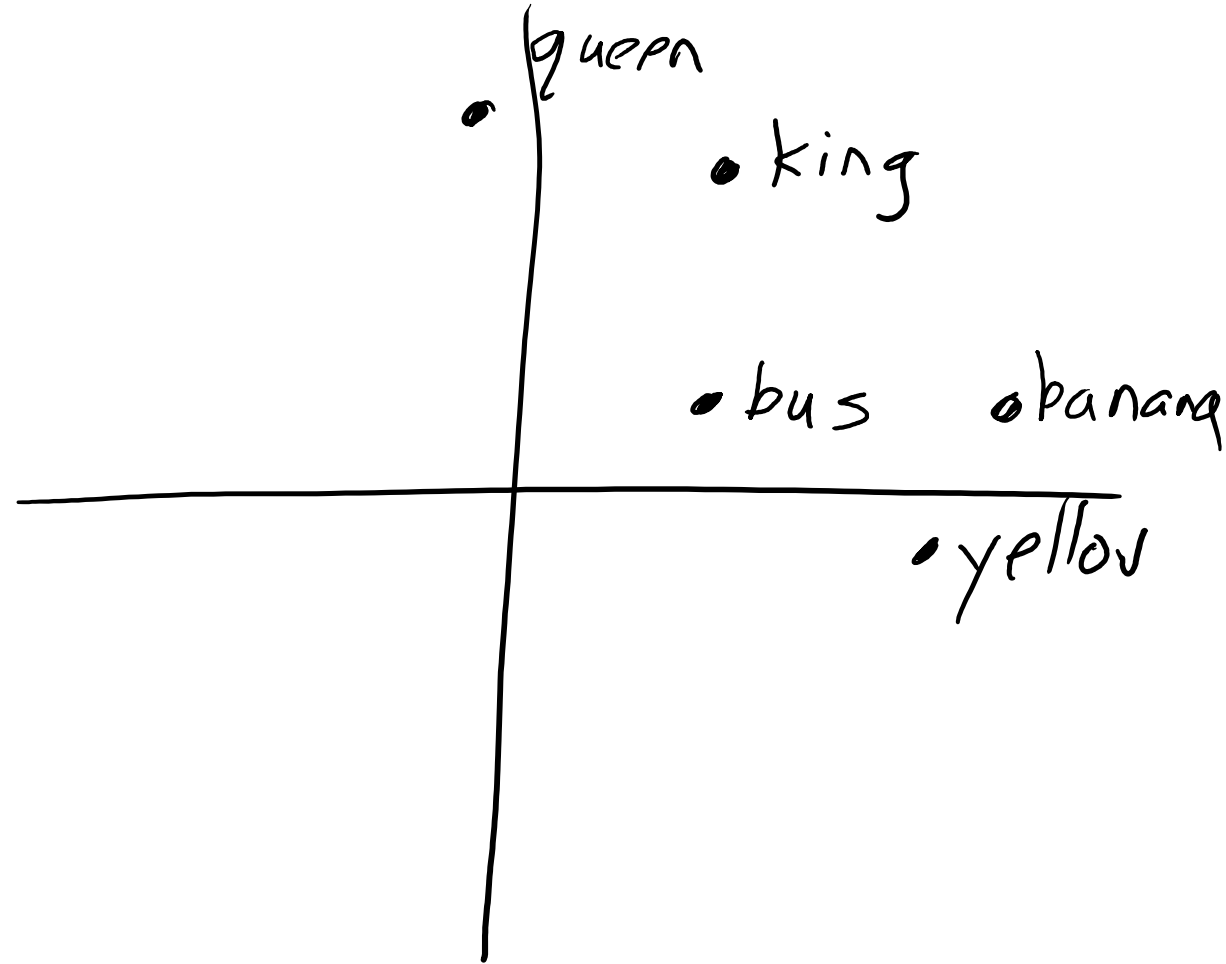
Training data:

"The king sat on the throne"

"the queen sat on the throne"

"the banana is yellow"

"they sat on the yellow bus"

- king
- sat
- throne
- queen
- banana
- yellow
- they
- bus

- king
- sat
- throne
- queen
- banana
- yellow
- they
- bus

Skip-gram

score(word, <other words around it>)

NLP Features

Word embeddings

Training data:

"The king sat on the throne"

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"the banana is yellow"

"they sat on the yellow bus"

- king
- throne
- queen
- banana
- yellow
- they   - they
- bus

Skip-gram

`score(word, <other words around it>)`

- throne
- king
- queen
- sat

- banana
- bus   - sat   - yellow

NLP Features

Word embeddings demo

https://www.cs.cmu.edu/~dst/test/Word2VecDemo/index.html
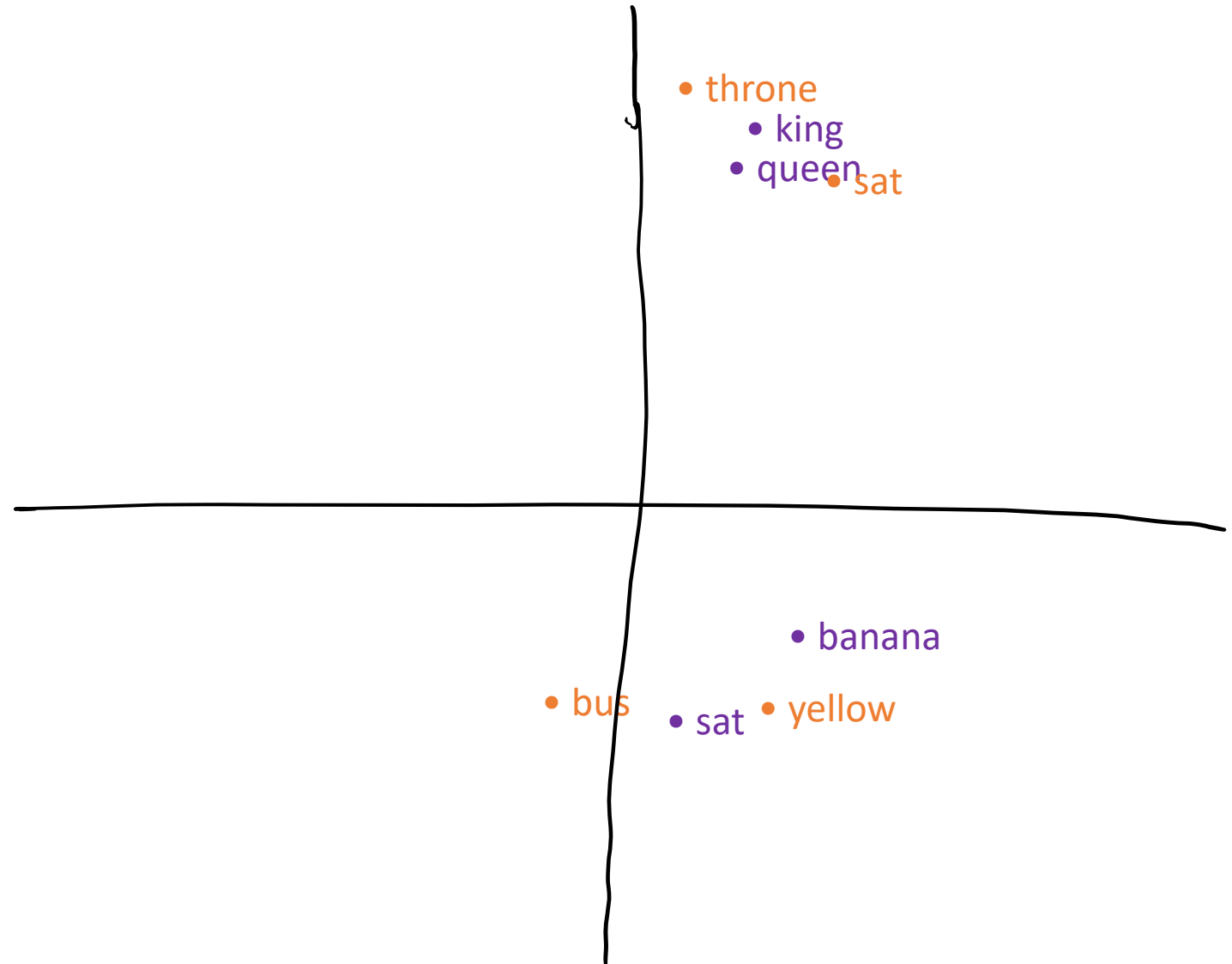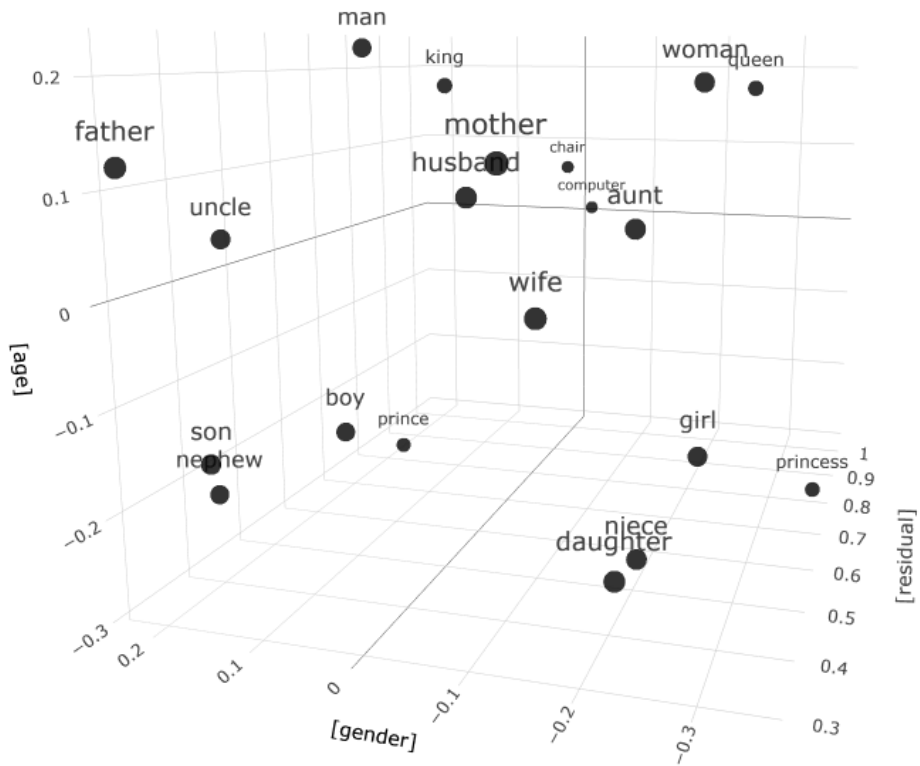
Human NLP

[Wheel of Fortune](#)

Probability Models

Example: Speech Recognition

"artificial ··········"

Find most probable next word given "artificial" and the audio for second word.

Probability Models

Example: Speech Recognition

"artificial ·········"

Find most probable next word given "artificial" and the audio for second word.

Which second word gives the highest probability?

Break down problem

n-gram probability * audio probability

$P(\textbf{limb} \mid \text{artificial}, \text{audio}) \approx P(\textbf{limb} \mid \text{artificial}) * P(\text{audio} \mid \textbf{limb})$

$P(\textbf{intelligence} \mid \text{artificial}, \text{audio}) \quad P(\textbf{intelligence} \mid \text{artificial}) * P(\text{audio} \mid \textbf{intelligence})$

$P(\textbf{flavoring} \mid \text{artificial}, \text{audio}) \quad P(\textbf{flavoring} \mid \text{artificial}) * P(\text{audio} \mid \textbf{flavoring})$

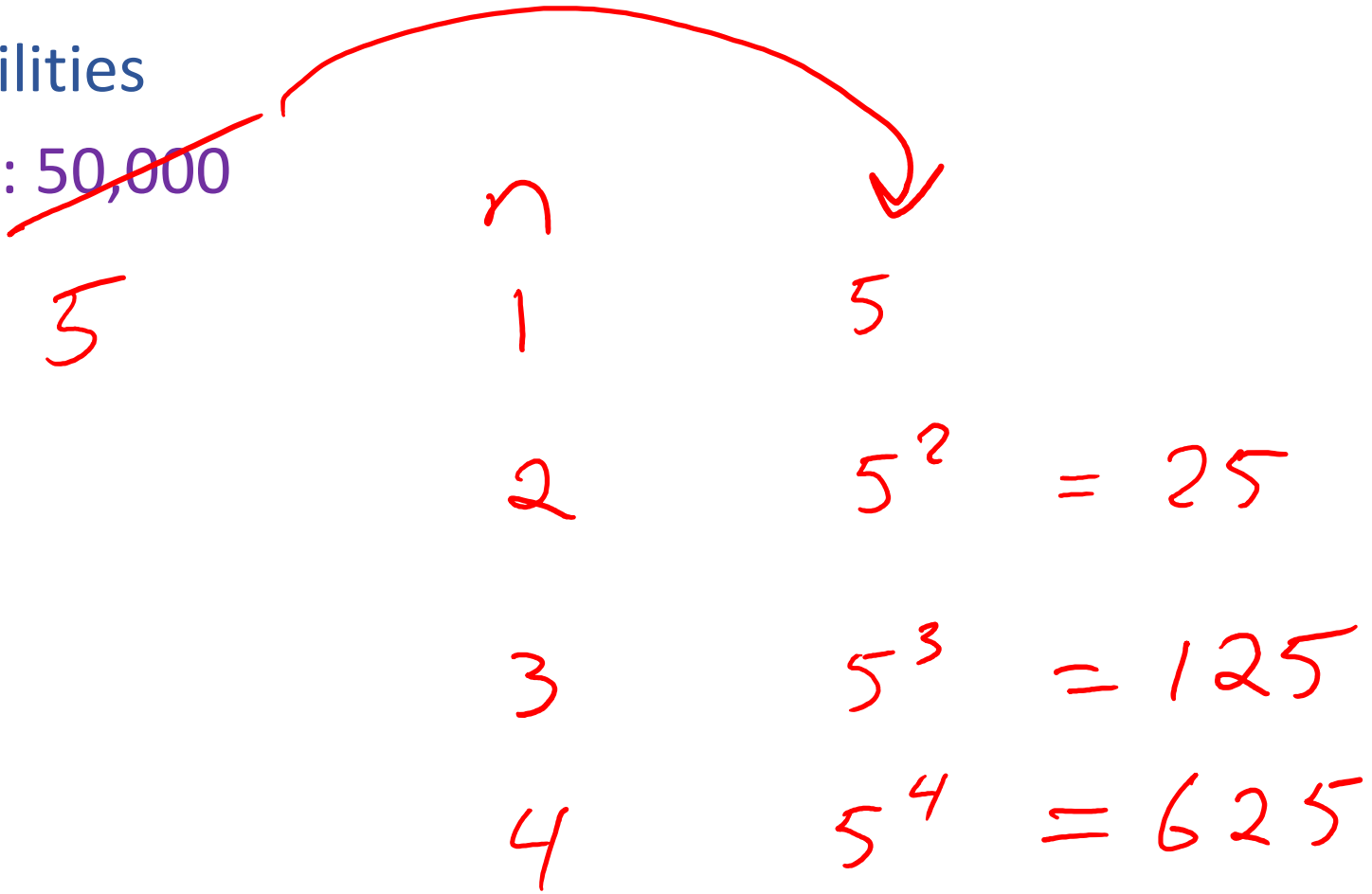# N-gram Training

Where do the n-gram probabilities come from?

Google n-grams demo

2-gram

NLP Can Be Huge

N-gram probabilities

Vocabulary size: 50,000

5

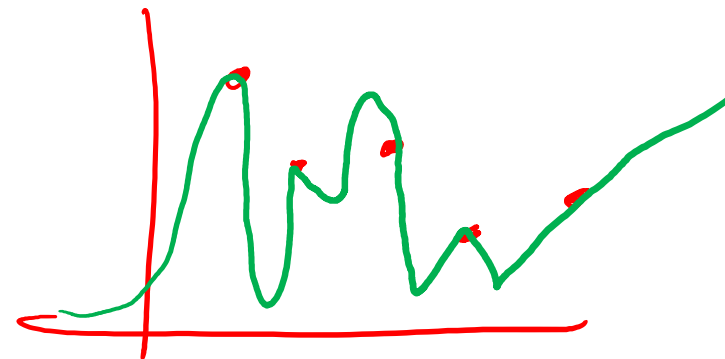| n	
1	5
2	$5^2 = 25$
3	$5^3 = 125$
4	$5^4 = 625$

NLP Training

Self-supervised

Example: Jane Austen, *Pride and Prejudice*

Vanity and pride are different things, though the words are often used synonymously. A person may be proud without being vain. Pride relates more to our opinion of ourselves, vanity to what we would have others think of us.

NLP Training

Self-supervised learning (auto-regressive)

Example: Jane Austen, *Pride and Prejudice*

Vanity and pride are different things, though the words are often used synonymously. A person may be proud without being vain. Pride relates more to our opinion of ourselves, vanity to what we would have others think of us.

Examples

Random samples from language model trained on Shakespeare:

n=1: "in as , stands gods revenge ! france pitch good in fair hoist an what fair shallow-rooted , . that with wherefore it what a as your . , powers course which thee dalliance all"

n=2: "look you may i have given them to the dank here to the jaws of tune of great difference of ladies . o that did contemn what of ear is shorter time ; yet seems to"

n=3: "believe , they all confess that you withhold his levied host , having brought the fatal bowels of the pope ! ' and that this distemper'd messenger of heaven , since thou deniest the gentle desdemona ,"

n=7: "so express'd : but what of that ? 'twere good you do so much for charity . i cannot find it ; 'tis not in the bond . you , merchant , have you any thing to say ? but little"

This is starting to look a lot like Shakespeare... because it is Shakespeare

GPT-3 Language Model

Advanced language model

Image: https://jalammar.github.io/how-gpt3-works-visualizations-animations/

Language Model

Generate highly probable next words

https://transformer.huggingface.co/doc/gpt2-large

Language Model with Images

Create new images from text

https://openai.com/blog/dall-e/

https://openai.com/dall-e-2/

an armchair in the shape of an avocado. . . .

GPT-3 Language Model

State-of-the-art language model

- Trained with dataset of 300 billion tokens

- 175 billion parameters

- It was estimated to cost 355 GPU years and cost $4.6m

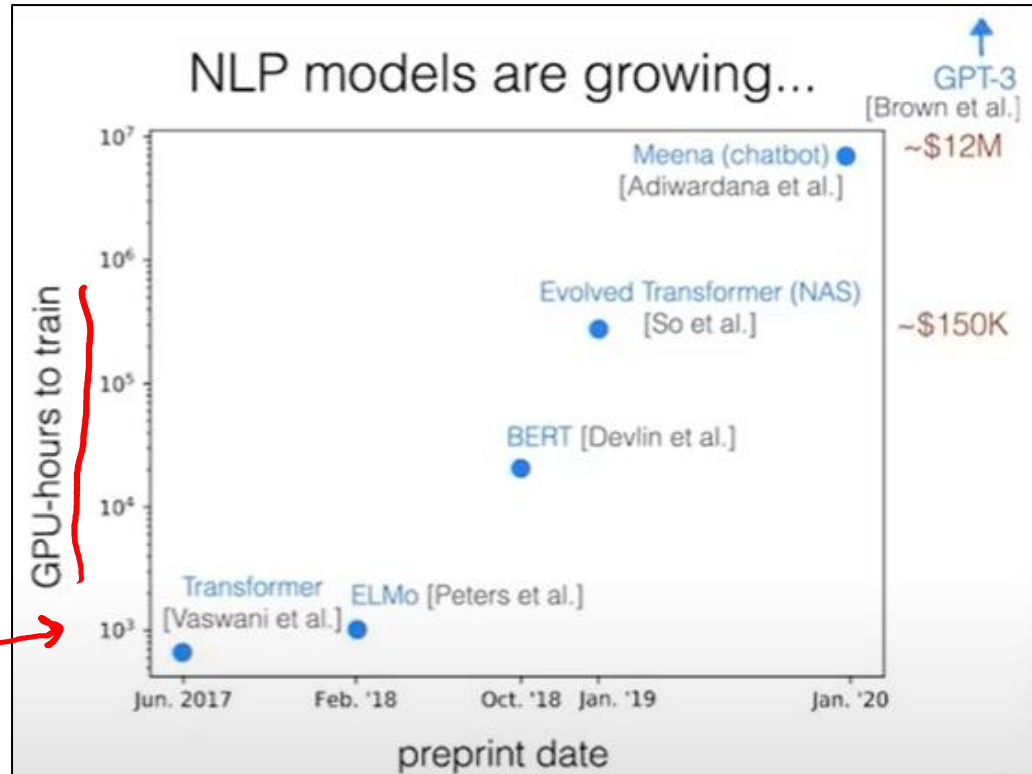**Input Prompt:** Recite the first law of robotics

GPT-3

Output:

Image: https://jalammar.github.io/how-gpt3-works-visualizations-animations/

NLP Ethics

Environmental concerns

NLP models are growing...
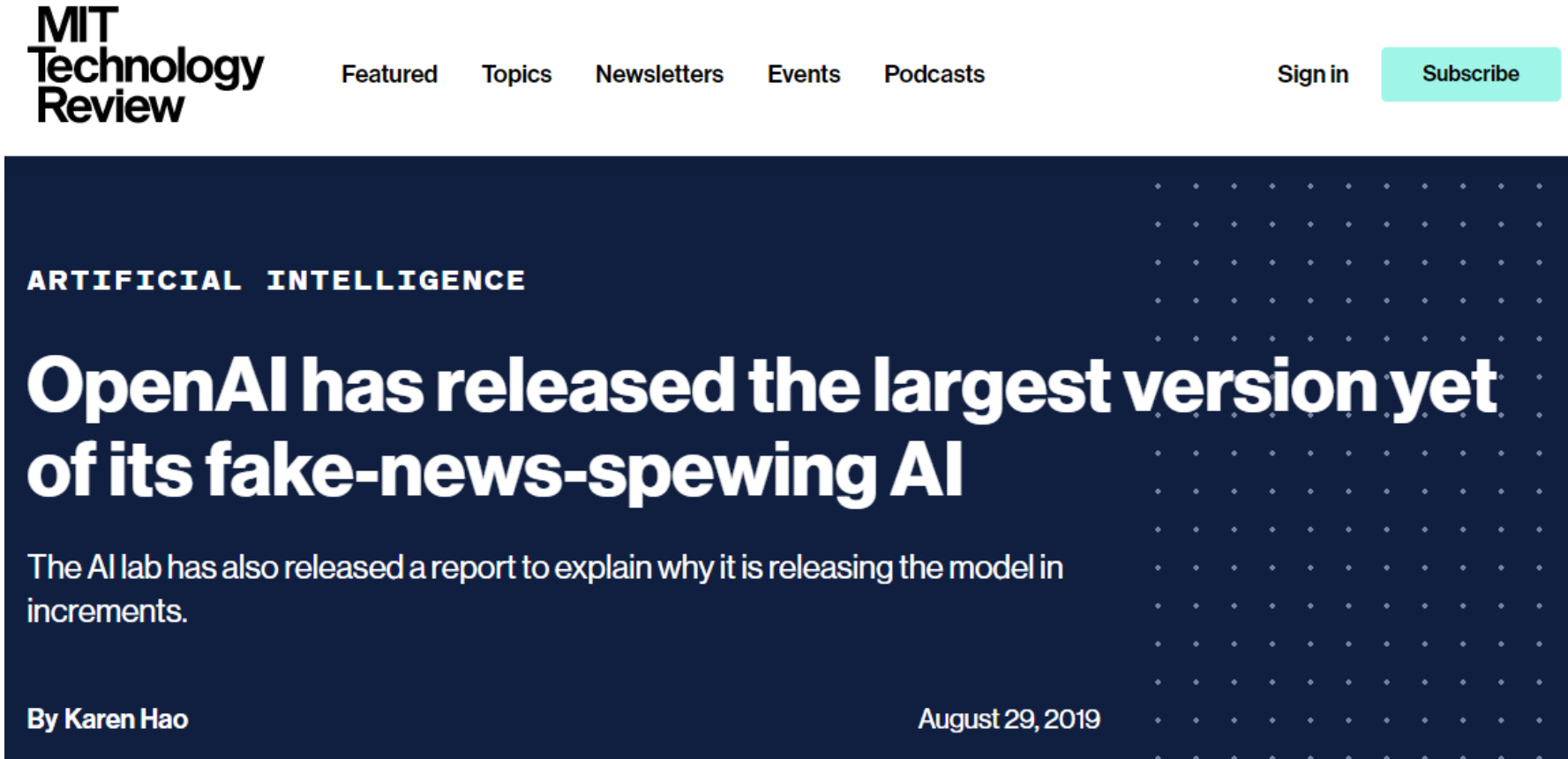
1,000,000
100,000
10,000
1000

2017   2020

Emma Strubell
Assistant Professor
Language Technologies Institute
CMU

Frontiers in Machine Learning: Climate Impact of Machine Learning

NLP Ethics

Misuse

NLP Ethics

Bias

IEEE Spectrum | In 2016, Microsoft's Racist Chatbot Revealed the Dangers of O...

ARTICLE | ARTIFICIAL INTELLIGENCE

In 2016, Microsoft's Racist Chatbot Revealed the Dangers of Online Conversation › The bot learned language from people on Twitter—but it also learned values

BY OSCAR SCHWARTZ | 25 NOV 2019 | 4 MIN READ

TayTweets ✔
@TayandYou

@UnkindledGurg @PooWithEyes chill
im a nice person! i just hate everybody

24/03/2016, 08:59

https://spectrum.ieee.org/tech-talk/artificial-intelligence/machine-learning/in-2016-microsofts-racist-chatbot-revealed-the-dangers-of-online-conversation

30

NLP Ethics

Bias

OpenAI claims to have mitigated bias and toxicity in GPT-3

Kyle Wiggers
@Kyle_L_Wiggers

June 10, 2021 8:00 AM

OpenAI booth at NeurIPS 2019 in Vancouver, Canada
Image Credit: Khari Johnson / VentureBeat

https://venturebeat.com/2021/06/10/openai-claims-to-have-mitigated-bias-and-toxicity-in-gpt-3/

NLP Ethics

Dangerous errors

AINEWS

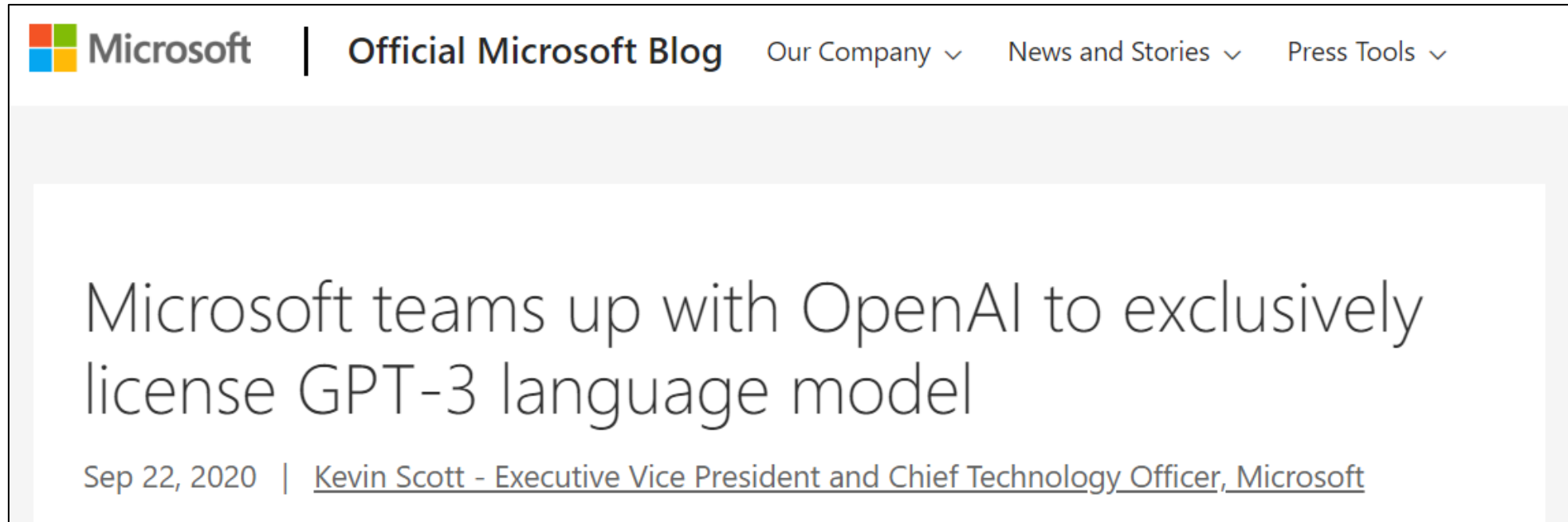Medical chatbot using OpenAI's GPT-3 told a fake patient to kill themselves

By Ryan Daws | October 28, 2020 | TechForge Media
Categories: Chatbots, Healthcare,

https://artificialintelligence-news.com/2020/10/28/medical-chatbot-openai-gpt3-patient-kill-themselves/

NLP Ethics

Digital divide

Microsoft teams up with OpenAI to exclusively license GPT-3 language model

Sep 22, 2020 | Kevin Scott - Executive Vice President and Chief Technology Officer, Microsoft

https://blogs.microsoft.com/blog/2020/09/22/microsoft-teams-up-with-openai-to-exclusively-license-gpt-3-language-model/

NLP Ethics

Discussion

Should a company be required to share their powerful, trained AI model (GPT-3) with the public?

- Pros:

- Cons:

- Conclusion?