Code4Life

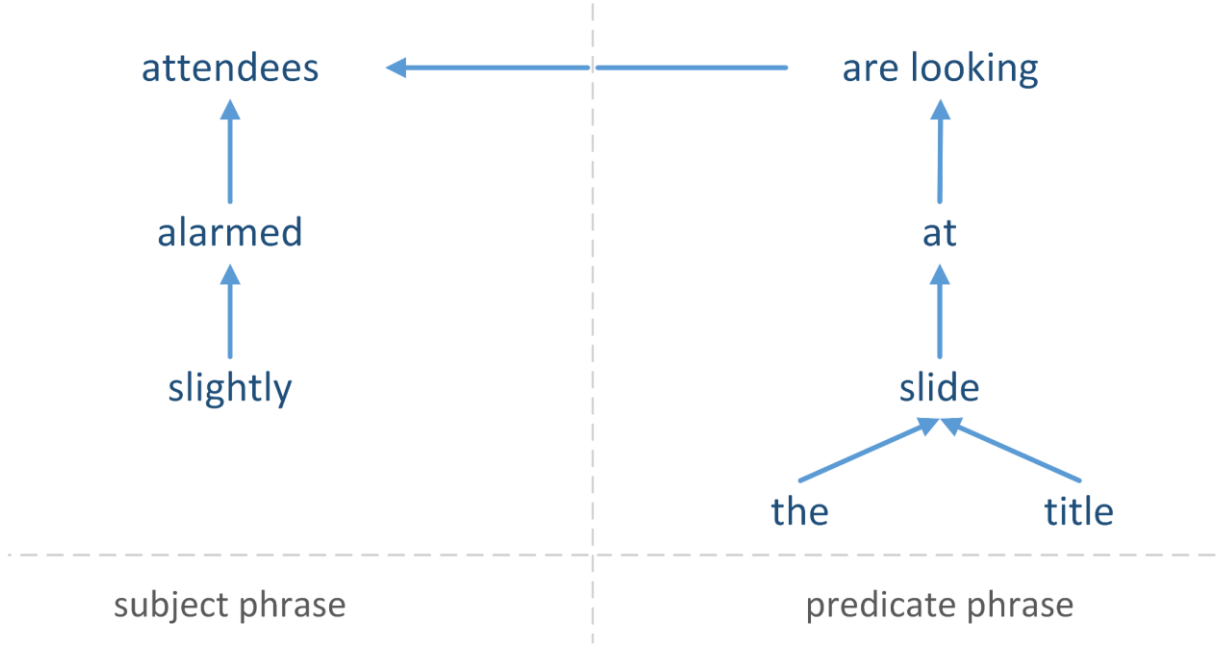
Roche

Do androids read about electric sheep?

Machine reading comprehension algorithms

Marek Grzenkowicz

Roche Global IT Solution Centre



About me

Marek Grzenkowicz

C64 BASIC → ... → ETL → Hadoop → **Python / Data analytics**

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Agenda

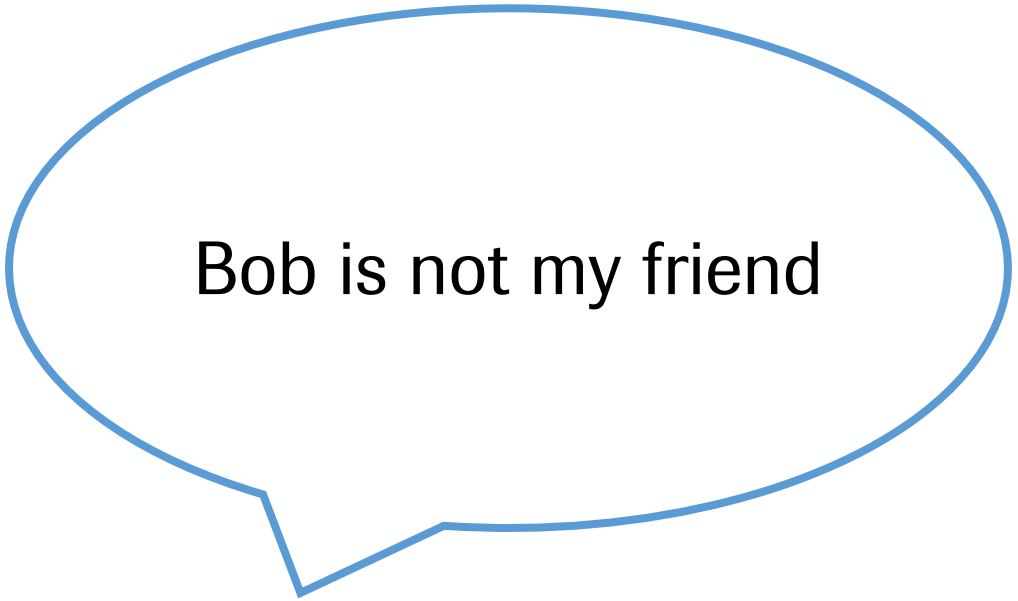
1. Natural language processing
   - What is it?
   - Why is it important?
   - Basic NLP operations [demo] 🤞
2. My vision
3. Do androids read?
   - Fundamental skills
   - The state of research
4. Summary

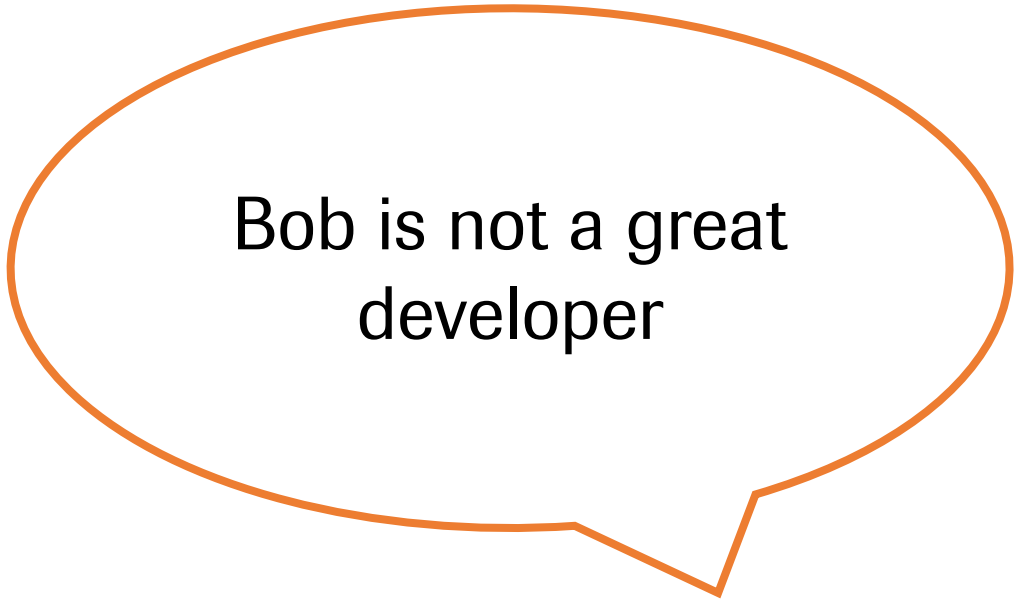
Reading between the lines

Reading between the lines

Bob? Who's Bob?

```
My friend Alice is a great developer.
Unfortunately, Bob isn't.
```

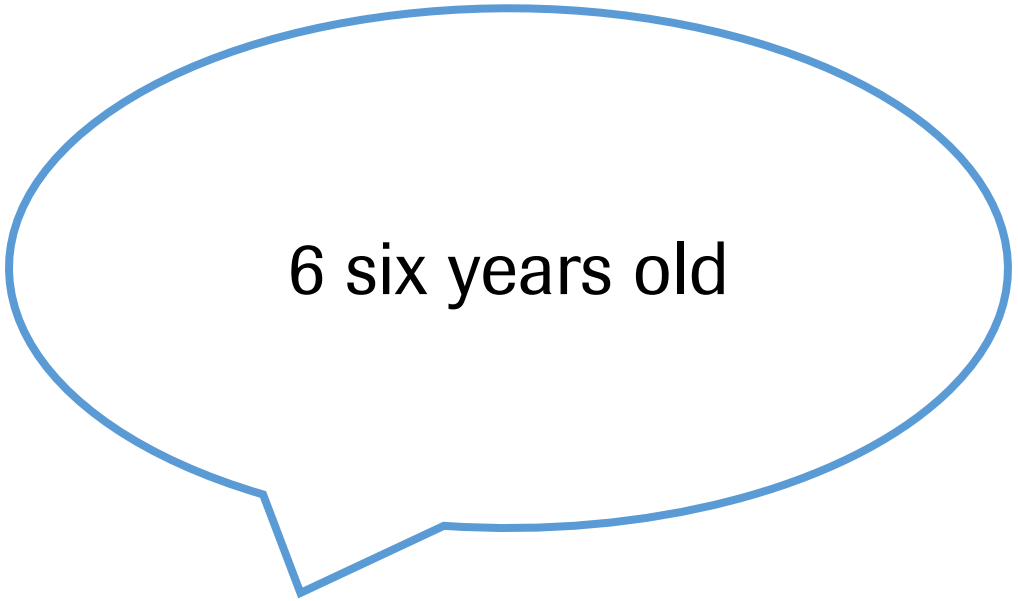




Reading between the lines

Charlie is 6

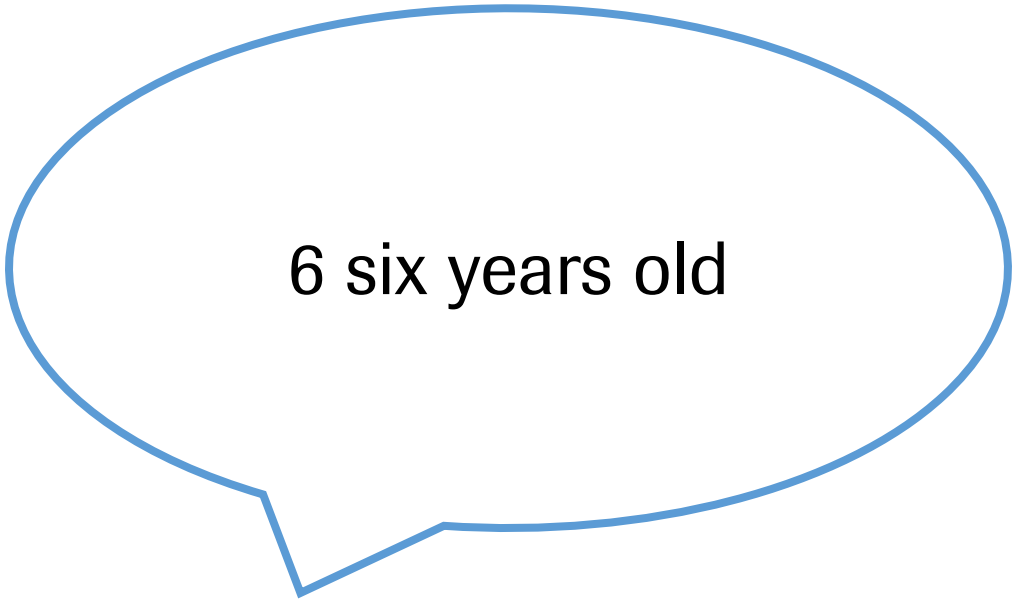
```
Charlie can already write, so he must be
at least 6!
```



Reading between the lines

Charlie is 6

```
Charlie plays basketball, so he must be
at least 6!
```



Reading between the lines

How's the water?

Chuck: How did you like the Canary Islands?
Frank: It was nice – sunny, not too humid.
The water was a bit cold though.

Water in the ocean was cold

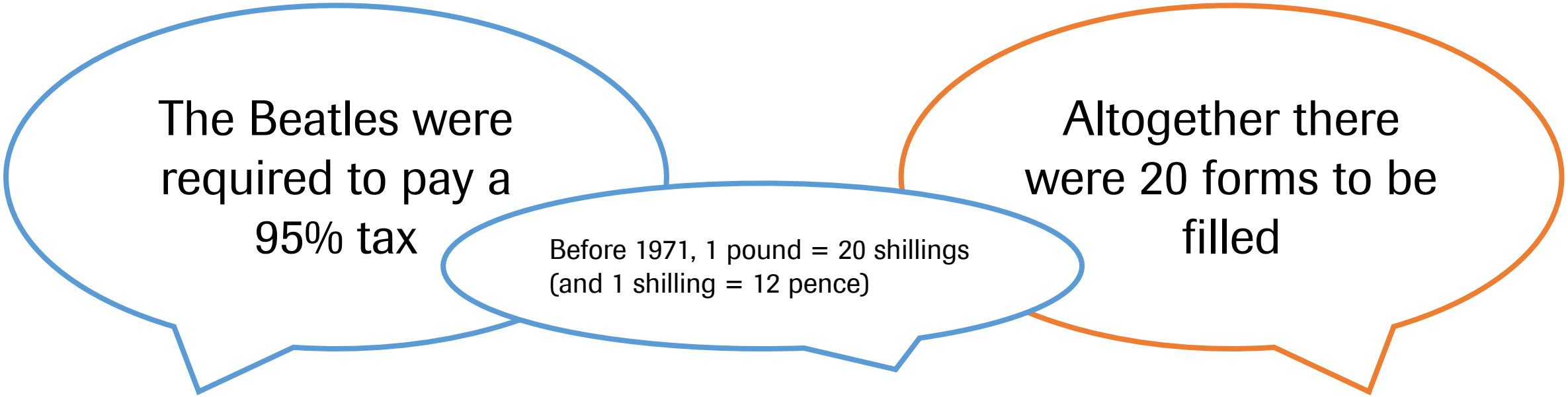
Water in the shower was cold

Reading between the lines

Nothing is certain

Let me tell you how it will be
There's one for you, nineteen for me
'Cause I'm the taxman, yeah, I'm the taxman

The Beatles – Taxman



Reading between the lines

Album 1, side 1, track 1

She was born in November 1963
The day Aldous Huxley died

Sheryl Crow – Run Baby Run

Aldous Huxley

From Wikipedia, the free encyclopedia

Aldous Leonard Huxley (26 July 1894 – 22 November 1963) was an English writer and philosopher.[1][2][3][4] He wrote nearly fifty books[5][6]—both novels and non-fiction works—as well as wide-ranging essays, narratives, and poems.

John F. Kennedy

From Wikipedia, the free encyclopedia
(Redirected from John Fitzgerald Kennedy)

"JFK", "John Kennedy", and "Jack Kennedy" redirect here. For other uses, see JFK (disambiguation), John Kenn (disambiguation).

John Fitzgerald Kennedy (May 29, 1917 – November 22, 1963), often referred to by initials **JFK** and **Jack**, was an American politician who served as the 35th president of the United States from January 1961 until his

Natural language processing

Natural language processing

Selected areas and tasks

Syntax

- Lemmatization
- Stemming
- POS tagging
- Text segmentation

Speech

- Speech-to-text (recognition)
- Text-to-speech (generation)

Semantics

- Machine translation
- Optical character recognition (OCR)
- Named entity recognition (NER)
- Sentiment analysis
- Natural language understanding (NLU)
- Natural language generation (NLG)
- Topic modelling
- Word sense disambiguation

Natural language processing

Why?

For millions of years, mankind lived just like the animals.

Then something happened which unleashed the power of our imagination. **We learned to talk** and we learned to listen.

Stephen Hawking

Natural language processing

Publication overload

PubMed.gov

5 000+ life sciences and biomedical journals

813 598 citations in FY 2017

2 000+ articles daily

Only a fraction of available knowledge and data is used

Sub-optimal results

- Research
- Drug development
- Patient treatment
- Software development

Source: MEDLINE/PubMed Resources - Detailed Indexing Statistics: 1965-2017

Natural language processing

Basic NLP operations [demo]

spaCy

My vision

My vision

Tailored reading recommendations

High-level requirements for a novel project

1000’s of articles and research papers

Recommended materials

My vision

Text summarization (Pharma)

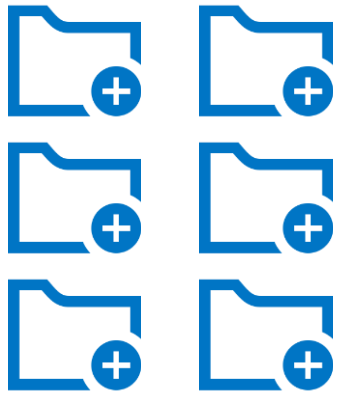
Audit protocols
Observation notes
FDA inspection forms

Executive summary slide for the annual meeting

My vision

Decision support system for complaint handling (Diagnostics)

Complaint handling manual



New complaint cases

PRI	PSI
NORMAL	NORMAL
NORMAL	PRI

Suggested case classification

PRI = Potentially Reportable Incident, **PSI** = Potential Safety Issue

Do androids read?

Reading comprehension

Definition

Reading comprehension is the ability to:

1. process text,
2. understand its meaning,
3. integrate with what the reader already knows.

Reading comprehension

Fundamental skills

Knowing **meaning of words**

Understanding meaning of words from discourse context

Ability to identify the main thought of a passage

Ability to **answer questions** answered in a passage

Ability to recognize the **literary devices** used in a passage and determine its tone

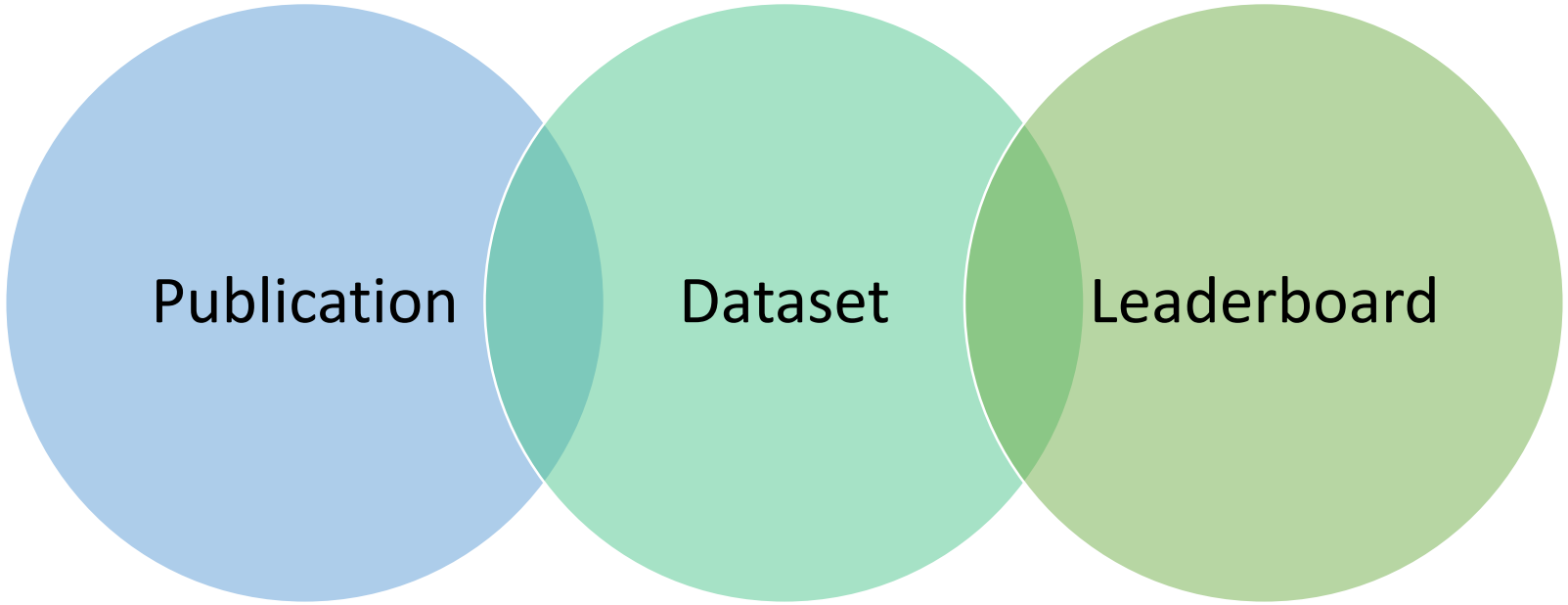
Information integration

- real-world knowledge
- common sense

Reading comprehension

Current research

1. Stanford Question Answering Dataset (SQuAD)
2. Reading Comprehension with Multiple Hops (QAngaroo)
3. NarrativeQA Reading Comprehension Challenge



Reading comprehension

Current research

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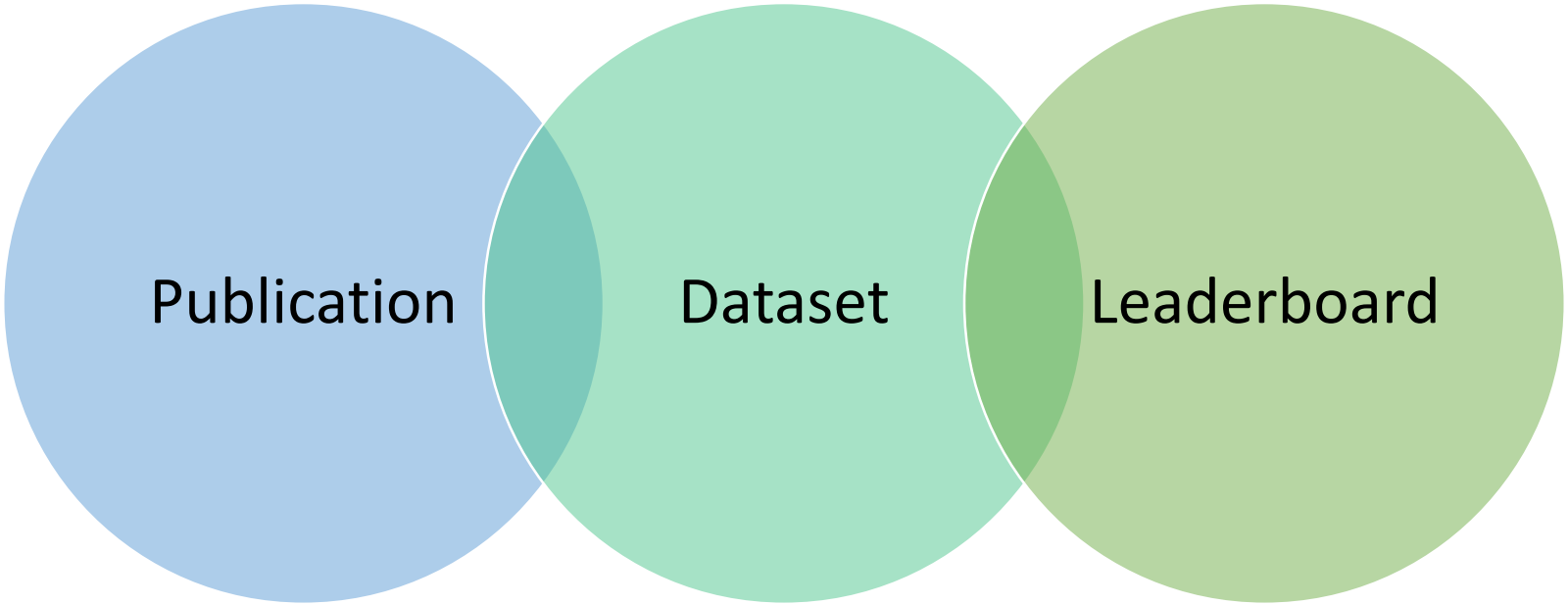

SQuAD dataset

SQuAD v1.1

- 100,000+ question-answer pairs
- extracted from 500+ Wikipedia articles

SQuAD v2.0

- v1.1 combined with 50,000+ new, unanswerable questions

SQuAD dataset

Example

Document: The heat required for boiling the water and supplying the steam can be derived from various sources, most commonly from burning combustible materials with an appropriate supply of air in a closed space (called variously combustion chamber, firebox). In some cases the heat source is a nuclear reactor, geothermal energy, solar energy or waste heat from an internal combustion engine or industrial process. In the case of model or toy steam engines, the heat source can be an electric heating element.

Question: What is the usual source of heat for boiling water in the steam engine?

SQuAD dataset

Example

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Question: What is the usual source of heat for boiling water in the steam engine?

Answer: burning combustible materials

SQuAD dataset

Results

	Correct answers (exact match)
Human performance	86.83 %
Best model (Sep 2019)	**89.73 %**

Results for SQuAD v2.0

SQuAD dataset

Limitations

☒ Limited lexical and topical diversity

☒ The documents are short (i.e. paragraphs of text)

☒ Each answer is a span of text from a single document (→ QAngaroo)

☒ Shallow pattern matching may suffice to produce correct answers (→ NarrativeQA)

NarrativeQA dataset

- 1,500+ documents
  - books (Project Gutenberg)
  - movie scripts (Internet Movie Script Database and other websites)
- 45,000+ question-answer pairs

NarrativeQA dataset

Example

Full story snippet:
As he spins around one of the attackers jams all eight inches of his bayonet blade into Jacob's stomach. Jacob screams. It is a loud and piercing wail.

...

A doctor leans his head in front of the lamp and removes his mask. His expression is somber. He shakes his head. His words are simple and final.

DOCTOR: He's gone.

The doctor steps away. A nurse rudely pulls a green sheet over his head. The doctor turns to one of the aides and throws up his hands in defeat.

Question: What is the fatal injury that Jacob sustains which ultimately leads to his death?

NarrativeQA dataset

Example

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Question: What is the fatal injury that Jacob sustains which ultimately leads to his death?

Answer: a bayonet wound

NarrativeQA dataset

Results

	BLEU-1	BLEU-4	METEOR	ROUGE-L
Human performance	**44.43**	**19.65**	**24.14**	**57.02**
Best model (Dec 2017)	19.09	2.11	4.37	14.03

Results for models processing full stories

NarrativeQA dataset

Results

	BLEU-1	BLEU-4	METEOR	ROUGE-L
Human performance	44.43	19.65	**24.14**	**57.02**
Best model (Dec 2017)	19.09	2.11	4.37	14.03
Best model (Jan 2019)	**48.70**	**20.98**	21.95	54.74

Results for models processing full stories

NarrativeQA dataset

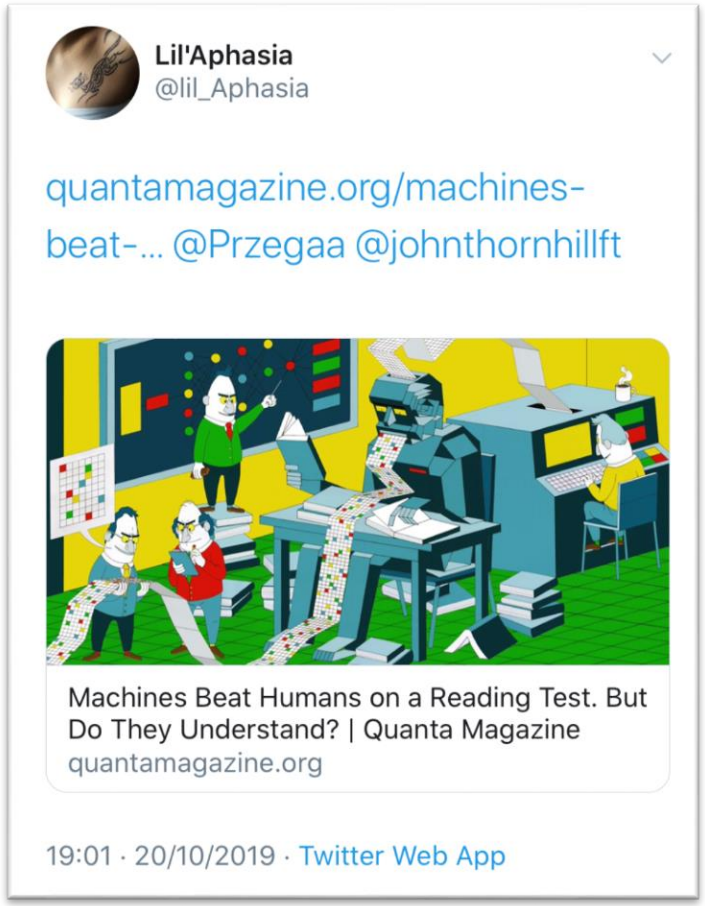
Summary

- ☒ No integration of external information
  - ☒ Every question can be answered using a single document
- ☑ Decreasing performance gap between humans and machines – impressive progress made in less than two years
- ☒ These models don’t generalize well
  - ☒ Researches fine-tune their models to get to the top of the leaderboard

Summary

Reading comprehension

Erase and rewind?



- ❑ General Language Understanding Evaluation (**GLUE**)
- ❑ Still **no real understanding** of the language
- ❑ Models learn to **cheat** at standardized NLP tests
- ❑ Datasets must be checked for **bias** and **repetitive examples**
- ❑ New datasets with **adversarial examples** (SuperGLUE)

Source: Machines Beat Humans on a Reading Test. But Do They Understand?

Reading comprehension

Do androids read about electric sheep?

~~No.~~

Not yet.

Slides, code, papers, datasets, leaderboards, etc.
https://go.roche.com/reading

Doing now what patients need next