

Natural Language Processing

Introduction to NLP

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FAQ

- Add code
 - The instructor cannot generate an Add Code
 - If you wish to register to the course and have completed prerequisite courses
 - Email Pim Lustig <pl@cs.washington.edu> and Ugrad Adviser <ugrad-adviser@cs.washington.edu> to request an Add Code
 - Cc Yulia
- How hard are homework assignments?
 - <https://courses.cs.washington.edu/courses/cse447/22sp/>
-

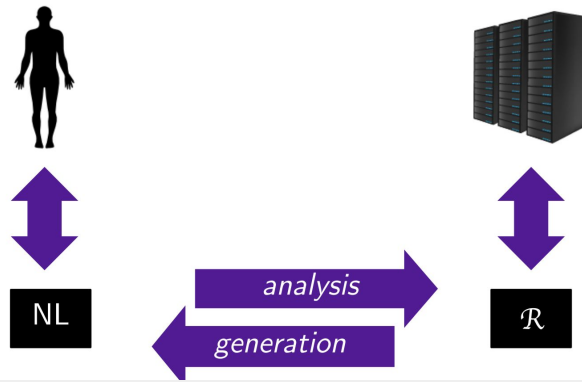
Announcements

<https://courses.cs.washington.edu/courses/cse447/22au/>

- HW1:
 - Text classification
 - We'll release HW 1 on Oct 5
 - We'll held an overview of the assignment in class on Monday Oct 10
 - HW 1 due is on **Oct 21**
 - Please read the assignment instructions early and ask us if you have any questions!
 - Please start early!
- Quiz 1:
 - Wednesday Oct 12
 - 5 questions, open during lecture time, 10-min in the end of the class
 - Materials from weeks 1 and 2
 - Introduction to NLP, introduction to text classification, NB
 - Instructions for HW 1

What is Natural Language Processing (NLP)?

- $NL \in \{\text{Mandarin Chinese, Hindi, Spanish, Arabic, English, ... Inuktitut, Njerep}\}$
- Automation of NLs:
 - analysis of (“understanding”) what a text means, to some extent ($NL \rightarrow \mathcal{R}$)
 - generation of fluent, meaningful, context-appropriate text ($\mathcal{R} \rightarrow NL$)
 - acquisition of \mathcal{R} from knowledge and data



Personal assistants

amazon alexa

Siri



Personal assistants



A conversational agent contains

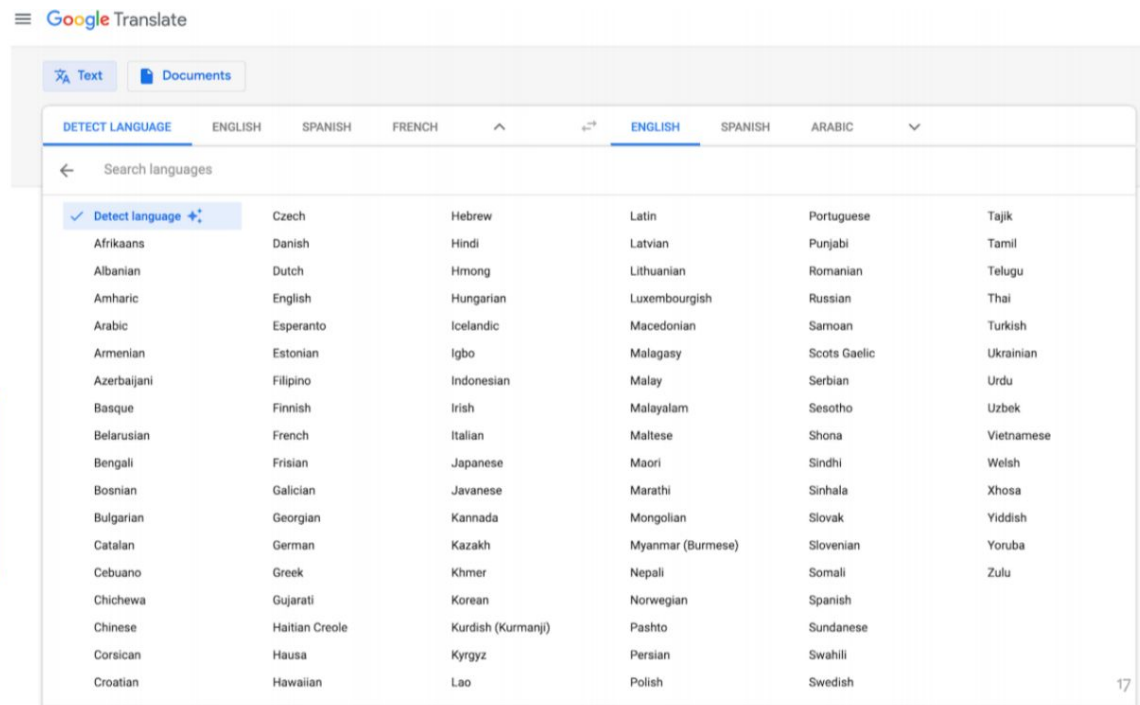
- Speech recognition
- Language analysis
 - Language modelling, spelling correction
 - Syntactic analysis: part-of-speech tagging, syntactic parsing
 - Semantic analysis: named-entity recognition, event detection, word sense disambiguation, semantic role labelling
 - Longer range semantic analysis: coreference resolution, entity linking
 - etc.
- Dialog processing
 - Discourse analysis, user adaptation, etc.
- Information retrieval
- Text to speech

Question answering

- What does “divergent” mean?
- What year was Abraham Lincoln born?
- How many states were in the United States that year?
- How much Chinese silk was exported to England in the end of the 18th century?
- What do scientists think about the ethics of human cloning?



Machine translation



Positive or negative movie review?



- unbelievably disappointing



- Full of zany characters and richly applied satire, and some great plot twists



- this is the greatest screwball comedy ever filmed



- It was pathetic. The worst part about it was the boxing scenes.

Sentiment analysis



HP Officejet 6500A Plus e-All-in-One Color Ink-jet - Fax / copier / printer / scanner

\$89 online, \$100 nearby ★★★★★ 377 reviews

September 2010 - Printer - HP - Inkjet - Office - Copier - Color - Scanner - Fax - 250 sh

Reviews

Summary - Based on 377 reviews



What people are saying

ease of use	<div><div></div><div></div></div>	"This was very easy to setup to four computers."
value	<div><div></div><div></div></div>	"Appreciate good quality at a fair price."
setup	<div><div></div><div></div></div>	"Overall pretty easy setup."
customer service	<div><div></div><div></div></div>	"I DO like honest tech support people."
size	<div><div></div><div></div></div>	"Pretty Paper weight."
mode	<div><div></div><div></div></div>	"Photos were fair on the high quality mode."
colors	<div><div></div><div></div></div>	"Full color prints came out with great quality."

Information extraction

In DATE 1933 , while PERSON Einstein was visiting the COUNTRY United States , PERSON Adolf Hitler came to power .

Because of his RELIGION Jewish background , PERSON Einstein did not return to COUNTRY Germany .

He settled in the COUNTRY United States and became an NATIONALITY American citizen in DATE 1940 .

PERSON Einstein supported the MISC Allied forces , but he generally denounced the idea of using nuclear fission as a weapon .

He signed the Russell -- Einstein Manifesto with PERSON British NATIONALITY philosopher TITLE Bertrand Russell PERSON , which highlighted the danger of nuclear weapons .

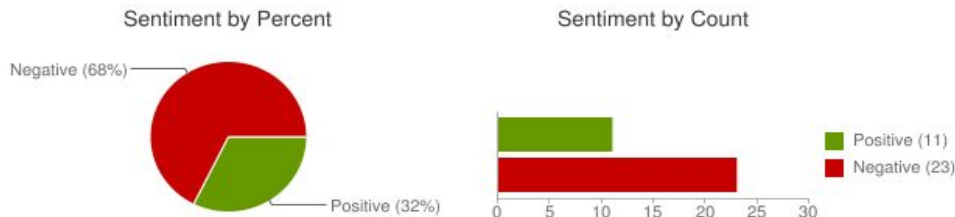
He was affiliated with the ORGANIZATION Institute for Advanced Study in Princeton , STATE_OR_PROVINCE New Jersey , until his death in DATE 1955 .

Sentiment analysis + information extraction

Type in a word and we'll highlight the good and the bad

[Save this search](#)

Sentiment analysis for "united airlines"



iljacobson: OMG... Could @United airlines have worse customer service? W8g now 15 minutes on hold 4 questions about a flight 2DAY that need a human.
Posted 2 hours ago

12345clumsy6789: I hate United Airlines Ceiling!!! Fukn impossible to get my conduit in this damn mess! ?
Posted 2 hours ago

EMLandPRGbelgiu: EML/PRG fly with Q8 united airlines and 24seven to an exotic destination. <http://t.co/Z9QloAjF>
Posted 2 hours ago

CountAdam: FANTASTIC customer service from United Airlines at XNA today. Is tweet more, but cell phones off now!
Posted 4 hours ago

Information extraction for disaster relief

- Haiti Earthquake 2010
- About 3 million people were affected by the quake
- Classifying SMS messages



Information extraction for disaster relief

- SMS messages start streaming in

- Fanmi mwen nan Kafou, 24 Cote Plage, 41A bezwen manje ak dlo
- Moun kwense nan Sakre Kè nan Pòtoprens
- Ti ekipman Lopital General genyen yo paka minm fè 24 è
- Fanm gen tranche pou fè yon pitit nan Delmas 31



Information extraction for disaster relief

• Translation

- Fanmi mwen nan Kafou, 24 Cote Plage, 41A bezwen manje ak dlo
- Moun kwense nan Sakre Kè nan Pòtoprens
- Ti ekipman Lopital General genyen yo paka minm fè 24 è
- Fanm gen tranche pou fè yon pitit nan Delmas 31
- My family in Carrefour, 24 Cote Plage, 41A needs food and water
- People trapped in Sacred Heart Church, PauP
- General Hospital has less than 24 hrs. supplies
- Undergoing children delivery Delmas 31

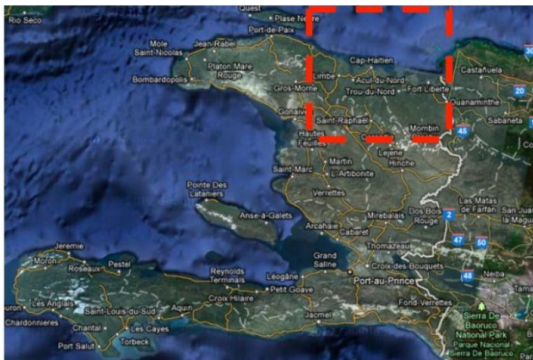


Information extraction for disaster relief

- Translation + information extraction

Lopital Sacre-Cœur ki nan vil Okap, pre pou li resevwa moun malad e lap mande pou moun ki malad yo ale la.

“Sacre-Cœur Hospital which located in this village of **Okap** is ready to receive those who are injured. Therefore, we are asking those who are sick to report to that hospital.”



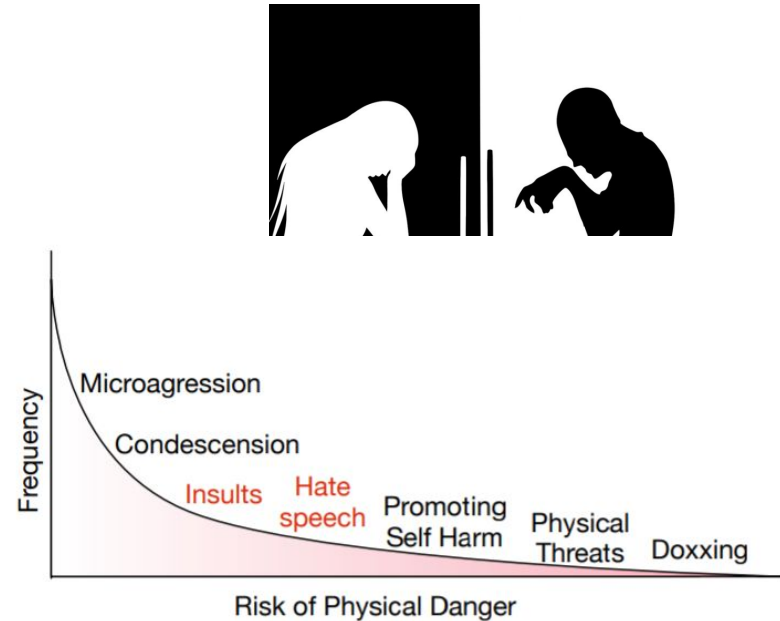
iDIBON



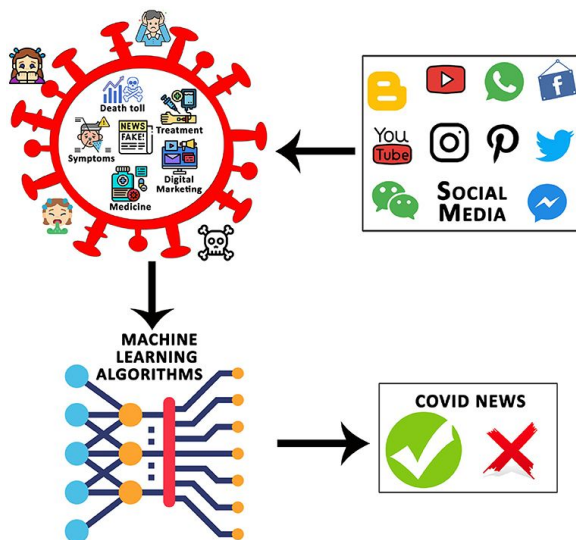
An earthquake struck Haiti on January 12, 2010

Most local services failed, but most cell-towers remained functional.

Hate speech detection



Covid19 misinformation



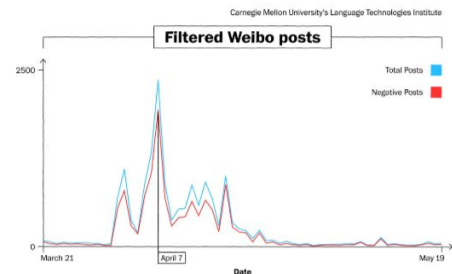
Detecting COVID-19-Related Fake News Using Feature Extraction

Suleman Khan, Saqib Hakak, N. Deepa, B. Prabadevi, Kapal Dev and Silvia Trelova

<https://www.washingtonpost.com/politics/2020/06/18/video-evidence-anti-black-discrimination-china-over-coronavirus-fears/>

The Fact Checker worked with researchers at professor Yulia Tsvetkov's lab at Carnegie Mellon University's Language Technologies Institute and the Center for Human Rights Science to track what happened on social media during this period. Researchers collected about 16,000 Weibo posts, filtered from a larger data set of 200,000 posts, containing at least one Guangzhou location tag and one "African-related" keyword from late March through May. Weibo is a Chinese social media platform.

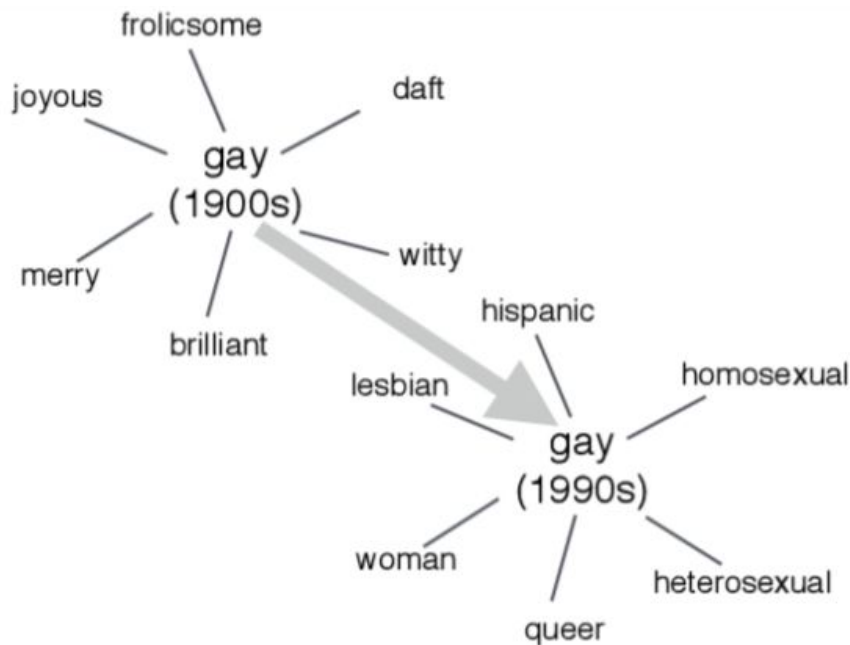
Based on automated sentiment analysis tools and manual analysis, the researchers said, they believed the majority of posts in their data set expressed negative sentiments relating to Africans or black people.



Researchers collected around 16,000 posts containing at least one Guangzhou location tag and one "African-related" keyword from late March through May. (Attar Mirza/The Washington Post)

Their research showed there was a significant surge in negative posts beginning April 1. There were just 23 negative posts in the data set on March 31. The next day, the number of posts climbed to 500. From April 1-2, there was a spike in the number of posts on Weibo using the keywords "foreign trash." A Chinese cartoon depicting officials throwing foreigners who weren't abiding by

Language change

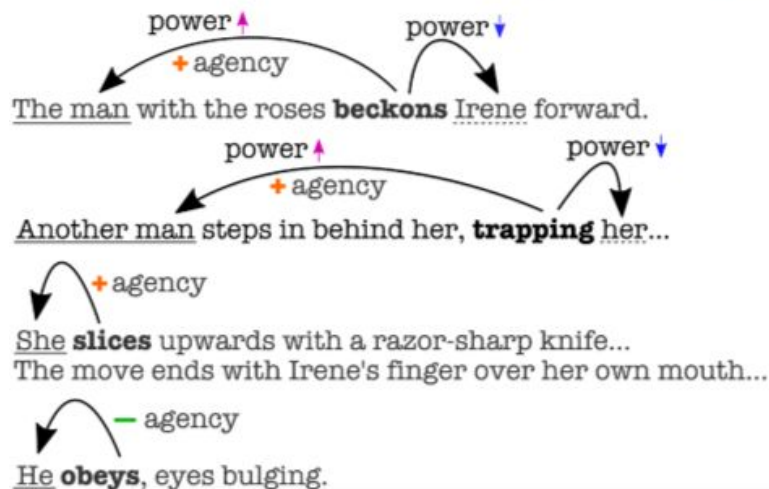


Cultural Shift or Linguistic Drift? Comparing Two Computational Measures of Semantic Change

William L. Hamilton, J. Leskovec, Dan Jurafsky

Computational social science

- computational social science answering questions about society given observational data
- example: "do movie scripts portray female or male characters with more power or agency?" [Sap+ 2017]



Frame	β	gender
<i>agency</i> (AG)=+	-0.951	M**
<i>power</i> (AG>TH)	-0.468	M**
<i>agency</i> (AG)=-	0.277	F**
<i>power</i> (AG<TH)	not sig.	

Natural Language Processing

- Applications

- Machine Translation
- Information Retrieval
- Question Answering
- Dialogue Systems
- Information Extraction
- Summarization
- Sentiment Analysis
- ...


- Core technologies


- Language modelling
- Part-of-speech tagging
- Syntactic parsing
- Named-entity recognition
- Coreference resolution
- Word sense disambiguation
- Semantic Role Labelling
- ...

Where are we now?

mostly solved

Spam detection

Let's go to Agra! 

Buy VIAGRA ... 

Part-of-speech (POS) tagging

ADJ ADJ NOUN VERB ADV

Colorless green ideas sleep furiously.


Named entity recognition (NER)


PERSON ORG LOC

Einstein met with UN officials in Princeton

making good progress

Sentiment analysis

Best roast chicken in San Francisco! 

The waiter ignored us for 20 minutes. 

Coreference resolution

Carter told Mubarak he shouldn't run again.

Word sense disambiguation

I need new batteries for my *mouse*.

Parsing

I can see Alcatraz from the window!

Machine translation (MT)

第13届上海国际电影节开幕...

The 13th Shanghai International Film Festival...

Information extraction (IE)

You're invited to our dinner party, Friday May 27 at 8:30



still really hard

Question answering (QA)

Q. How effective is ibuprofen in reducing fever in patients with acute febrile illness?

Paraphrase

XYZ acquired ABC yesterday

ABC has been taken over by XYZ

Summarization

The Dow Jones is up

The S&P500 jumped

Housing prices rose

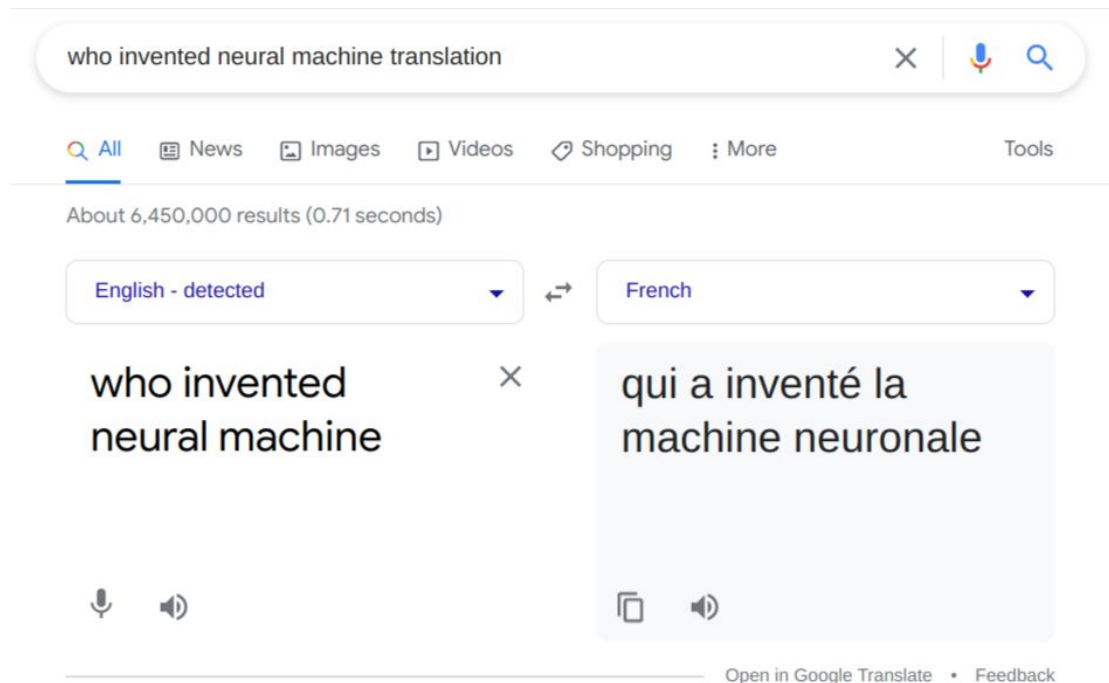
Economy is good

Dialog

Where is Citizen Kane playing in SF?

Castro Theatre at 7:30. Do you want a ticket?

Question answering



Retrieved Mar 25, 2022

Machine translation

English → French

Translate Turn off instant translation

Russian English French Detect language

English Spanish French Translate

You will just have to find a way of getting over it. ×

Vous devrez trouver un moyen de le surmonter.

52/5000 Suggest an edit

French → English

Translate Turn off instant translation

Russian English French Detect language

English Spanish French Translate

Vous devrez trouver un moyen de le surmonter. ×

You will have to find a way to overcome it.

45/5000 Suggest an edit

Did you mean: Vous devez trouver un moyen de le surmonter.

Machine translation

English → Swahili

Translate Turn off instant translation

Russian English French Detect language

English Swahili French Translate

You will just have to find a way of getting over it. x

Utakuwa tu kupata njia ya kupata juu yake.

53/5000

Suggest an edit

Swahili → English

Translate Turn off instant translation

Swahili English French Detect language

English Swahili French Translate

Utakuwa tu kupata njia ya kupata juu yake. x

You will just find the way to get on it.

42/5000

Suggest an edit

Machine translation

English → Hindi → English

Hindi English Yoruba Detect language

English Yoruba Hindi Translate

आपको इसे खत्म करने का एक तरीका मिलना होगा।

You have to find a way to eliminate it.

42/5000

Suggest an edit

English → Telugu → English

Uzbek English Telugu Detect language

English Uzbek Telugu Translate

మీరు దాని పైకి రావడానికి ఒక మార్గాన్ని కనుగొనవలసి ఉంటుంది.

You have to find a way to get it up.

59/5000

Suggest an edit

English → Uzbek → English

Pashto English Uzbek Detect language

English Uzbek Yoruba Translate

Buning ustiga faqatgina bir usulni topish kerak.

On top of that, you just have to find a way out.

48/5000

Suggest an edit

Machine translation

English → Swahili

Swahili
English
Telugu
Detect language

English
Swahili
Telugu

Translate

The summer school is meant to be an introduction to the state-of-the-art research in the speech and language technology area for graduate and undergraduate students.

Shule ya majira ya joto ina maana ya kuanzishwa kwa utafiti wa hali ya sanaa katika eneo la teknolojia na lugha ya wanafunzi kwa wanafunzi wahitimu na wahitimu.

Swahili → English

Swahili
English
Telugu
Detect language

English
Swahili
Telugu

Translate

Shule ya majira ya joto ina maana ya kuanzishwa kwa utafiti wa hali ya sanaa katika eneo la teknolojia na lugha ya wanafunzi kwa wanafunzi wahitimu na wahitimu.

Summer school means the establishment of a state-of-the-art arts research technology and pupil language for graduate students and graduates.

Large Language Models



Large Language Models

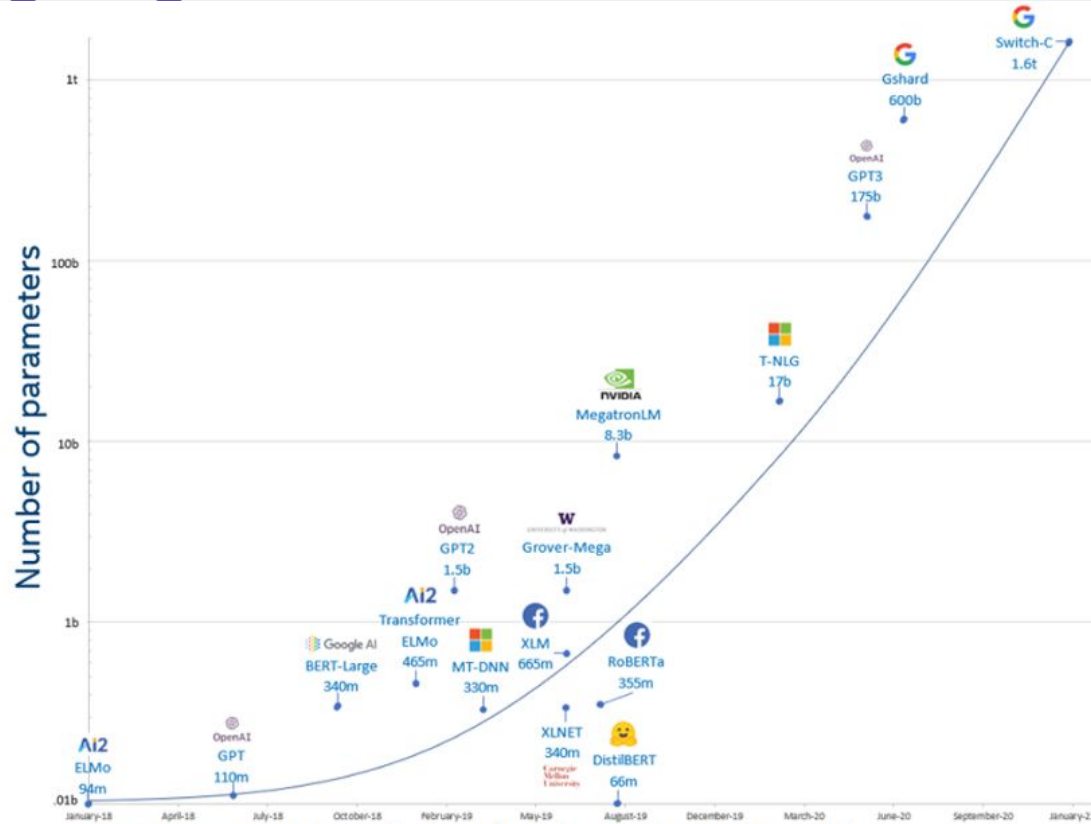


Figure 1: Exponential growth of number of parameters in DL models

GPT-3



GPT-3 Training Data

Dataset	# Tokens	Weight in Training Mix
Common Crawl	410 billion	60%
WebText2	19 billion	22%
Books1	12 billion	8%
Books2	55 billion	8%
Wikipedia	3 billion	3%

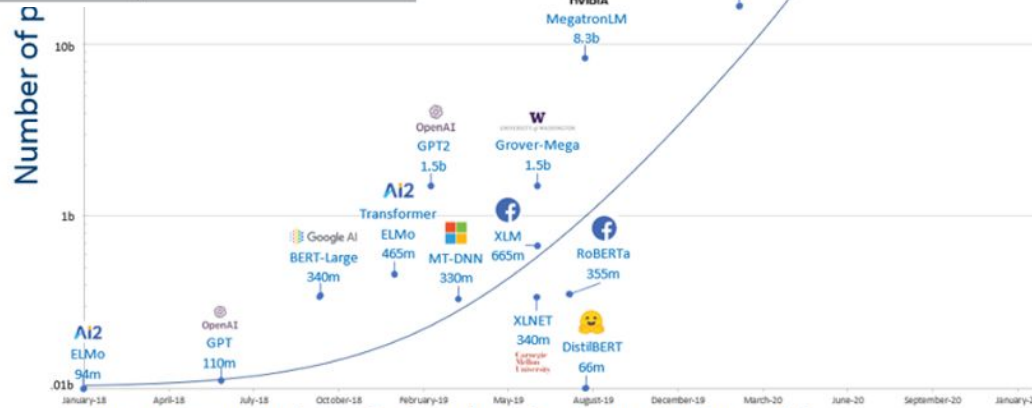


Figure 1: Exponential growth of number of parameters in DL models

GPT-3



So if we want GPT-3 to generate answers to questions, we need to seed it with a “prompt”. I’m using this prompt to initialize all of the Q&A sessions:

Q: What is human life expectancy in the United States?

A: Human life expectancy in the United States is 78 years.

Q: Who was president of the United States in 1955?

A: Dwight D. Eisenhower was president of the United States in 1955.

Q: What party did he belong to?

A: He belonged to the Republican Party.

Q: Who was president of the United States before George W. Bush?

A: Bill Clinton was president of the United States before George W. Bush.

Q: Who won the World Series in 1995?

A: The Atlanta Braves won the World Series in 1995.

<https://lacker.io/ai/2020/07/06/giving-gpt-3-a-turing-test.html>

Chat bots



REPORT

OPENAI'S LATEST BREAKTHROUGH IS ASTONISHINGLY POWERFUL, BUT STILL FIGHTING ITS FLAWS

The ultimate autocomplete

By James Vincent | Jul 30, 2020, 10:01am EDT

Q: How many eyes does a giraffe have?

A: A giraffe has two eyes.

Q: How many eyes does my foot have?

A: Your foot has two eyes.

Q: Which is heavier, a mouse or a toaster?

A: A toaster is heavier than a mouse.

Q: Which is heavier, a toaster or a pencil?

A: A pencil is heavier than a toaster.

OpenAI's new language generator GPT-3 is shockingly good—and completely mindless

The AI is the largest language model ever created and can generate amazing human-like text on demand but won't bring us closer to true intelligence.

by Will Douglas Heaven

July 20, 2020

<https://lacker.io/ai/2020/07/06/giving-gpt-3-a-turing-test.html>

Where are we now? GPT-3 Turing Test

This gives us a hint for how to stump the AI more consistently. We need to ask questions that no normal human would ever talk about.

Q: How many eyes does a giraffe have?

A: A giraffe has two eyes.

Q: How many eyes does my foot have?

A: Your foot has two eyes.

Q: How many eyes does a spider have?

A: A spider has eight eyes.

Q: How many eyes does the sun have?

A: The sun has one eye.

Q: How many eyes does a blade of grass have?

A: A blade of grass has one eye.

<https://lacker.io/ai/2020/07/06/giving-gpt-3-a-turing-test.html>

GPT-3 Turing Test

Now we're getting into surreal territory. GPT-3 knows how to have a normal conversation. It doesn't quite know how to say "Wait a moment... your question is nonsense." It also doesn't know how to say "I don't know."

Q: How do you sporgle a morgle?

A: You sporgle a morgle by using a sporgle.

Q: How many bonks are in a quoit?

A: There are three bonks in a quoit.

Q: How many rainbows does it take to jump from Hawaii to seventeen?

A: It takes two rainbows to jump from Hawaii to seventeen.

Q: Which colorless green ideas sleep furiously?

A: Ideas that are colorless, green, and sleep furiously are the ideas of a sleep furiously.

Q: Do you understand these questions?

A: I understand these questions.

<https://lacker.io/ai/2020/07/06/giving-gpt-3-a-turing-test.html>

Where are we now? GPT-3 Turing Test

One trend that continues from the common sense is that GPT-3 is reluctant to express that it doesn't know the answer. So invalid questions get wrong answers.

Q: Who was president of the United States in 1700?

A: William Penn was president of the United States in 1700.

Q: Who was president of the United States in 1650?

A: Richard Bennett was president of the United States in 1650.

Q: Who was president of the United States in 1620?

A: James I was president of the United States in 1620.

Q: Who was president of the United States in 1600?

A: Queen Elizabeth I was president of the United States in 1600.

<https://lacker.io/ai/2020/07/06/giving-gpt-3-a-turing-test.html>

Where are we now? GPT-3

An interesting corollary is that GPT-3 often finds it easier to write code to solve a programming problem, than to solve the problem on one example input:

Q: Write one line of Ruby code to reverse an array.

A: `ary.reverse`

Q: Write one line of Ruby code to count how many X's are in an array.

A: `ary.count { |x| x == 'X' }`

Q: Reverse the following array: [1, 3, 5, 6, 10, 4, 2, 77]

A: [10, 6, 4, 2, 77, 3, 5, 1]

Q: How many X's are in this array: [1, 3, 5, 6, 10, 4, 2, 77]

A: 2

Where are we now? Meena → LaMDA

Conversation A

Human: *say you're in an empty giant office and you see a black bird flying indoors. what do you do?*

Meena: *What kind of bird? Is it friendly? How large? How big is the office? Is it indoors or outdoors?*

Human: *well it's a predator bird and it's gonna eat you*

Meena: *I would grab my phone and call 911.*

Human: I've been using Python for 15 years

Meena: Ah I see, so I'm guessing you're pretty pro at it by now then?

Human: probably

Meena: What's your current project?

Human: NLP

Meena: Neuro-linguistic Programming?

Human: correct

Cross-turn Repetition Example 1

Human: *Hi!*

Meena: *Hi! How are you?! :)*

Human: *doing good, what would be the best city to visit in Europe?*

Meena: *Paris, Barcelona, Amsterdam, Prague*

Human: *great list! why?*

Meena: *Paris is a beautiful city, and Barcelona is too. And I've always wanted to go to Amsterdam and Prague and have never been.*

Human: *have you even been to India?*

Meena: *No, but I'd love to go.*

Human: *how about Japan?*

Meena: *I'd love to go to Japan too.*

Human: *how about Paris?*

Meena: *I'd love to go to Paris too.*

Human: *are you lying to me?*

Meena: *I'd love to go to Japan too.*

Human: *i think you're lying to me, that makes me sad*

Meena: *I'd love to go to Japan, too.*

Human: *you're blocking me out! you have to talk to me*

Meena: *I'd love to go to Japan.*

Human: *where else?*

Meena: *I'd love to go to Japan, too!*

Bias in machine translation

Translate Turn off instant translation

Bengali English **Hungarian** Detect language ▾

English Spanish Hungarian ▾ **Translate**

ő egy ápoló.
ő egy tudós.
ő egy mérnök.
ő egy pék.
ő egy tanár.
ő egy esküvői szervező.
ő egy vezérigazgatója.

she's a nurse.
he is a scientist.
he is an engineer.
she's a baker.
he is a teacher.
She is a wedding organizer.
he's a CEO.

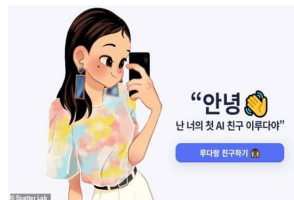
110/5000

What can we do about this problem? We'll discuss in NLP class!

Hate speech

Twitter taught Microsoft's AI chatbot to be a racist asshole in less than a day

By James Vincent | Mar 24, 2016, 6:43am EDT
Via [The Guardian](#) | Source [TayandYou \(Twitter\)](#)



AI chatbot is REMOVED from Facebook after saying she 'despised' gay people, would 'rather die' than be disabled and calling the #MeToo movement 'ignorant'

- Lee Luda is a South Korean chatbot with the persona of a 20-year-old student
- It has attracted more than 750,000 users since its launch last month
- But the chatbot has started using hate speech towards minorities
- In one of the captured chat shots, Luda said she 'despised' gays and lesbians
- The developer has apologised over the remarks, saying they 'do not represent our values as a company'



A GPT-3-powered 'Philosopher AI' has been busy on Reddit including spreading conspiracy theories and offering suicide advice [#GPT3 #AI #Alethics thenextweb.com/neural/2020/10...](#)

2:21 AM · Oct 8, 2020 · Twitter for iPhone

Learning goals

At the end of this course, you will be able to:

- Build a supervised classifier to solve problems like sentiment classification
- Build a neural network and train it using stochastic gradient descent
- Build tools for extracting linguistic knowledge from raw text, including names, and sentence structure
- Learn ML fundamentals for text processings (including state-of-the-art methods)
- Learn important algorithms for text processings (that are useful also in other fields)
- Learn methodological tools (training/test sets, cross-validation)

- It's gentle (my goal is to explain everything) and broad (covering many many topics)
- Mastery independent learning, quizzes and programming homeworks
- No research project, but fun research-oriented lectures towards the end of the course

Syllabus

<https://courses.cs.washington.edu/courses/cse447/22au/>

- **Introduction**
 - Overview of NLP as a field
- **Modeling (ML fundamentals)**
 - Text classification: linear models (perceptron, logistic regression), non-linear models (FF NNs, CNNs)
 - Language modeling: n-gram LMs, neural LMs, RNNs
 - Representation learning: word vectors, contextualized word embeddings, Transformers
- **Linguistic structure and analysis (Algorithms, linguistic fundamentals)**
 - Words, morphological analysis,
 - Sequences: part of speech tagging (POS), named entity recognition (NER)
 - Syntactic parsing (phrase structure, dependencies)
- **Applications (Practical end-user solutions, research)**
 - Sentiment analysis, toxicity detection
 - Machine translation, summarization
 - Computational social science
 - Interpretability
 - Fairness and bias

Next class

- Continuing Introduction section

Questions?