COLX-531: Neural Machine Translation

Muhammad Abdul-Mageed

muhammad.mageed@ubc.ca

Deep Learning & NLP Lab

The University of British Columbia

Table of Contents

Machine Translation

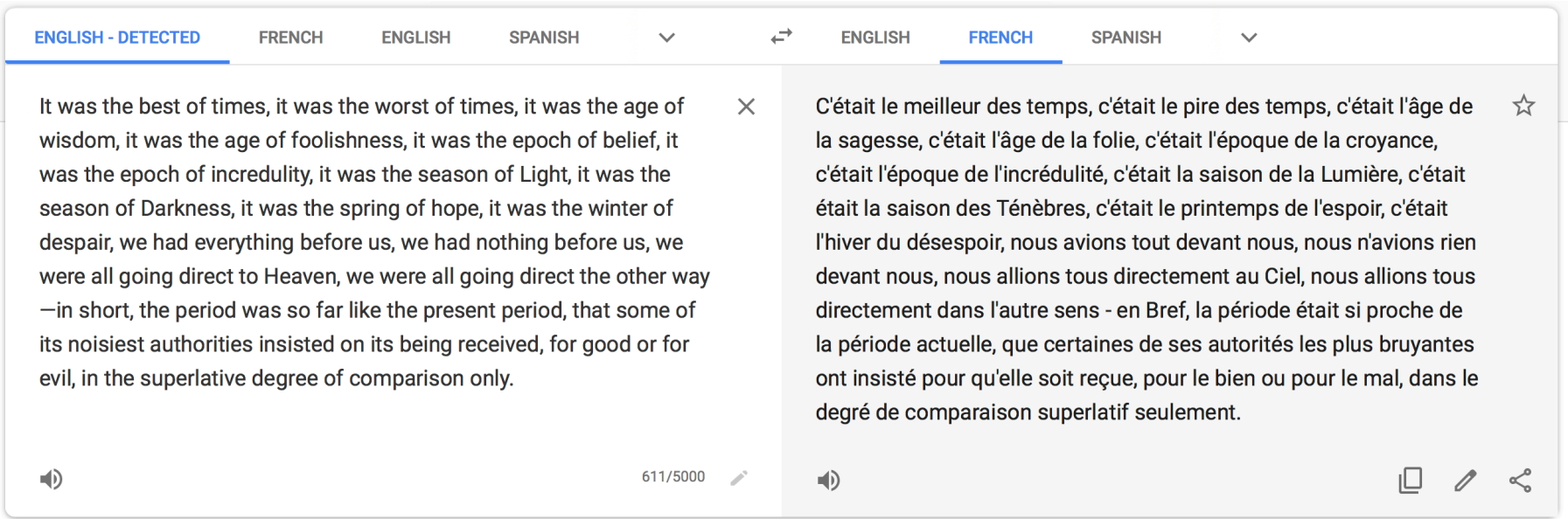


Figure: Google Translate | Charles Dickens, *A Tale of Two Cities*.

Why MT?

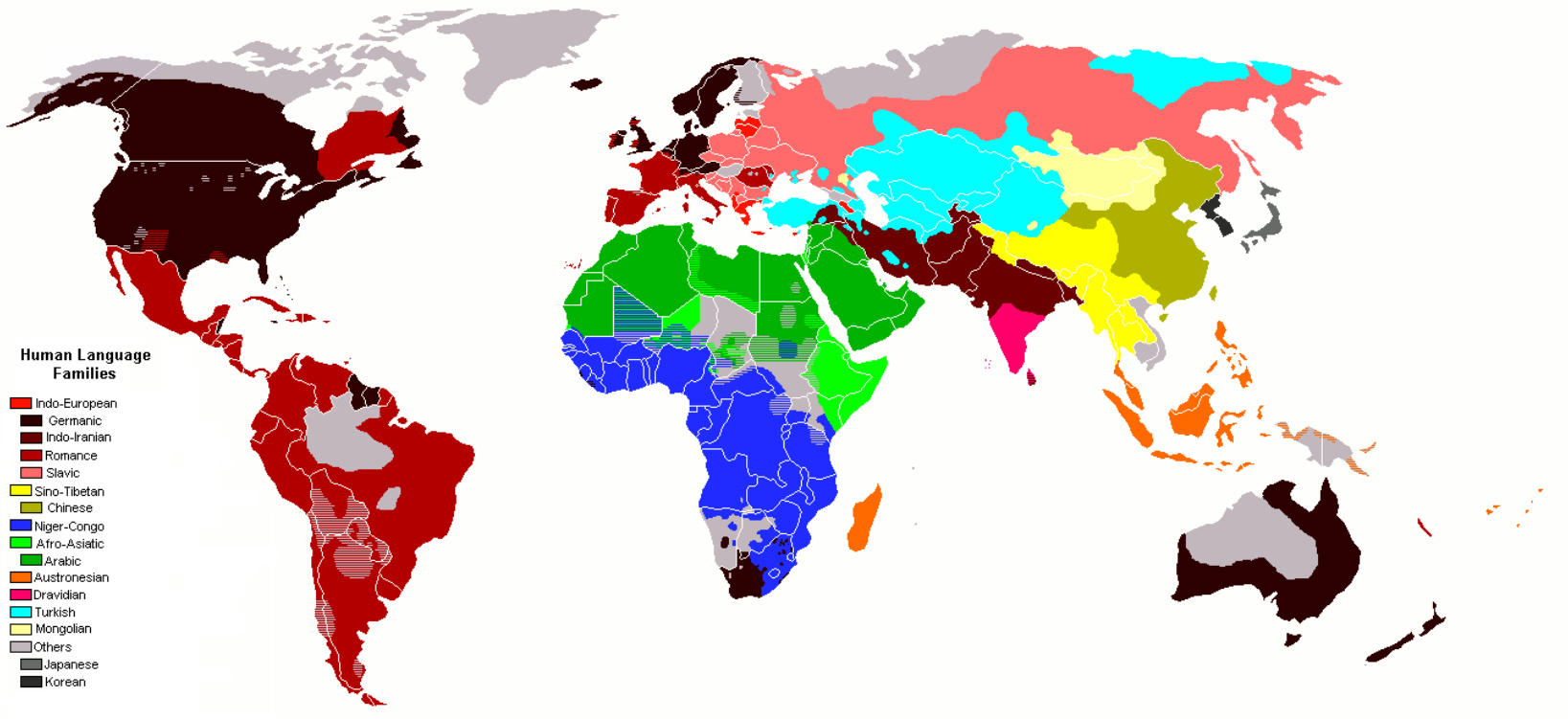


Figure: Human language families. Source: Wikipedia.

Why MT? *Contd.*

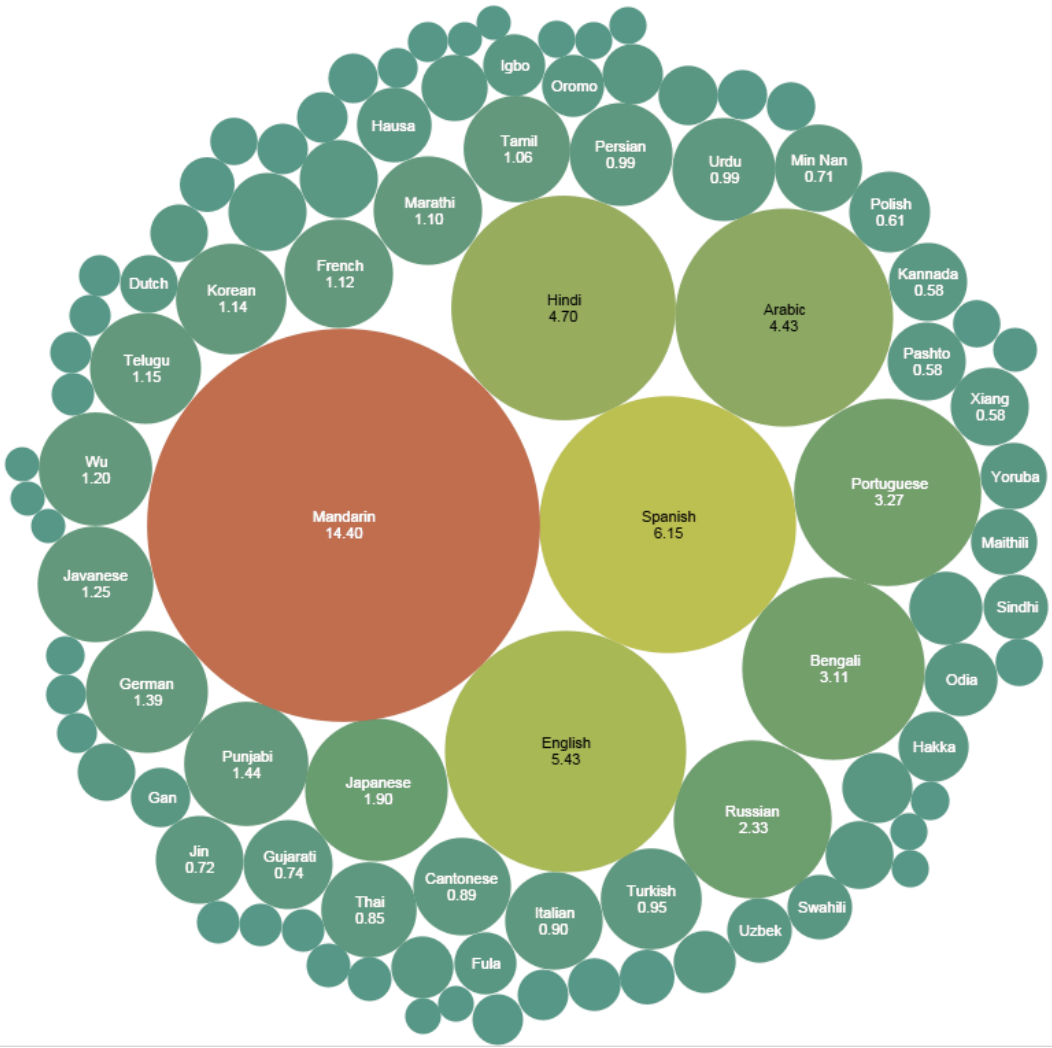


Figure: Languages by native speakers. Source: Wikipedia, based on Enthnologue.

Why MT? *Contd.*

Top Ten Languages Used in the Web - April 30, 2019
(Number of Internet Users by Language)

TOP TEN LANGUAGES IN THE INTERNET	World Population for this Language (2019 Estimate)	Internet Users by Language	Internet Penetration (% Population)	Internet Users Growth (2000 - 2019)	Internet Users % of World (Participation)
English	1,485,300,217	**1,105,919,154**	74.5 %	685.7 %	25.2 %
Chinese	**1,457,821,239**	**863,230,794**	59.2 %	2,572.3 %	19.3 %
Spanish	520,777,464	**344,448,932**	66.1 %	1,425.8 %	7.9 %
Arabic	444,016,517	**226,595,470**	51.0 %	8,917.3 %	5.2 %
Portuguese	289,923,583	**171,583,004**	59.2 %	2,164.8 %	3.9 %
Indonesian / Malaysian	**302,430,273**	**169,685,798**	56.1 %	2,861.4 %	3.9 %
French	422,308,112	**144,695,288**	34.3 %	1,106.0 %	3.3 %
Japanese	126,854,745	**118,626,672**	93.5 %	152.0 %	2.7 %
Russian	143,895,551	**109,552,842**	76.1 %	3,434.0 %	2.5 %
German	97,025,201	**92,304,792**	95.1 %	235.4 %	2.1 %
TOP 10 LANGUAGES	5,193,327,701	**3,346,642,747**	64.4 %	1,123.0 %	76.3 %
Rest of the Languages	2,522,895,508	**1,039,842,794**	41.2 %	1,090.4 %	23.7 %
WORLD TOTAL	7,716,223,209	**4,386,485,541**	56.8 %	1,115.1 %	100.0 %

NOTES: (1) Top Ten Languages Internet Stats were updated in April 30, 2019. (2) Internet Penetration is the ratio between the sum of Internet users speaking a language and the total population estimate that speaks that specific language. (3) The most recent Internet usage information comes from data published by Nielsen Online, International Telecommunications Union, GfK, and other reliable sources. (4) Population estimates are based mainly on figures from the United Nations Population Division and local official sources. (5) For definitions, methodology and navigation help, please see the Site Surfing Guide. (6) These statistics may be cited, stating the source and establishing an active link back to Internet World Stats.

Figure: Source: Internet World Stats.

Why MT? *Contd.*

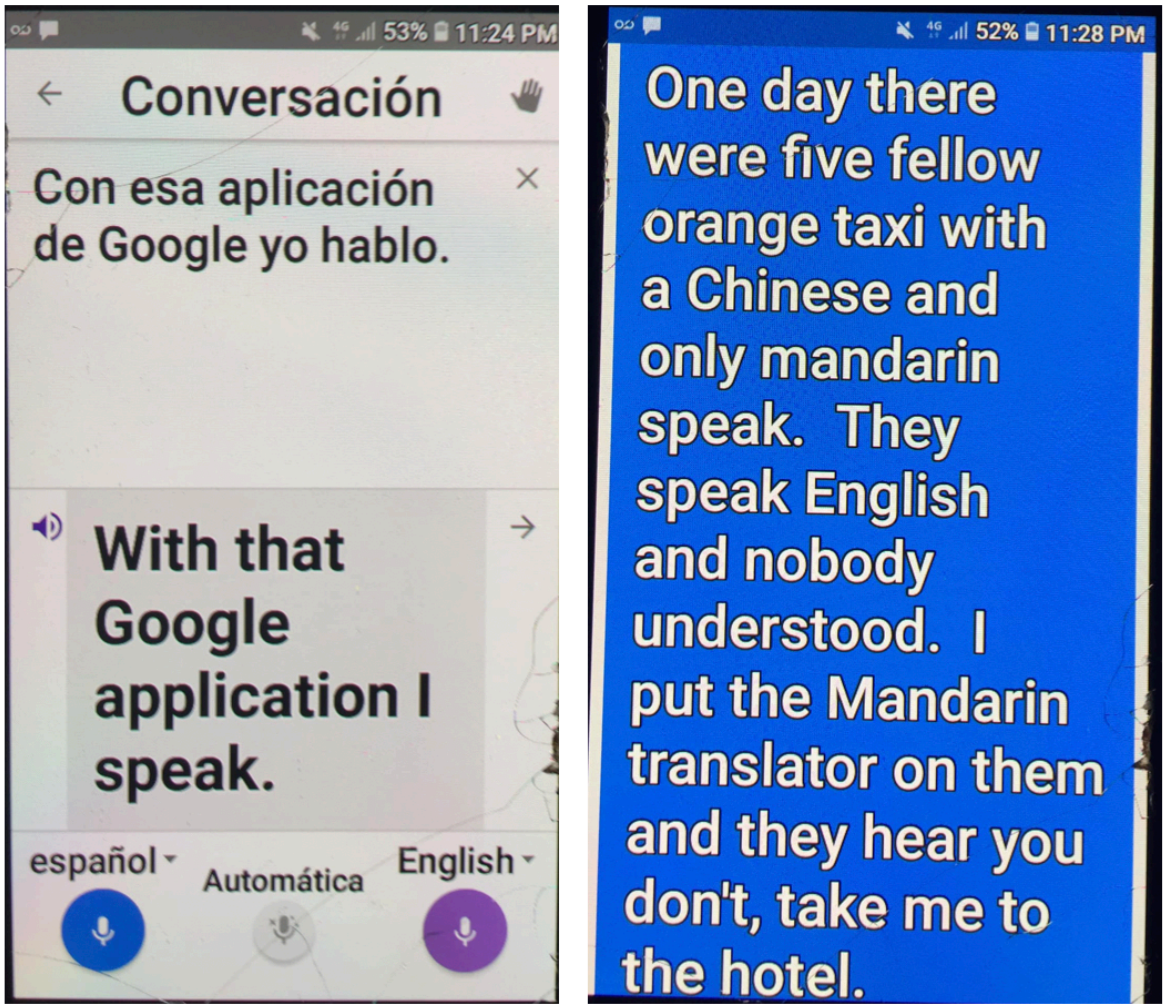


Figure: Taxi driver story in Costa Rica, Feb. 2020.

Translation is Hard! (But Fun!)

ISTOCK

Figure: “9 little translation mistakes caused big problems" on mentalfloss.com. Quotes from “Found in Translation" book by Nataly Kelly & Jost Zetzsche.

Translation is Hard! (But Fun!) *Contd.*

2. Your lusts for the future

When President Carter traveled to Poland in 1977, the State Department hired a Russian interpreter who knew Polish, but was not used to interpreting professionally in that language. Through the interpreter, Carter ended up saying things in Polish like "when I abandoned the United States" (for "when I left the United States") and "your lusts for the future" (for "your desires for the future"), mistakes that the media in both countries very much enjoyed.

Figure: Source: mentalfloss.com.

Translation is Hard! (But Fun!) *Contd.*

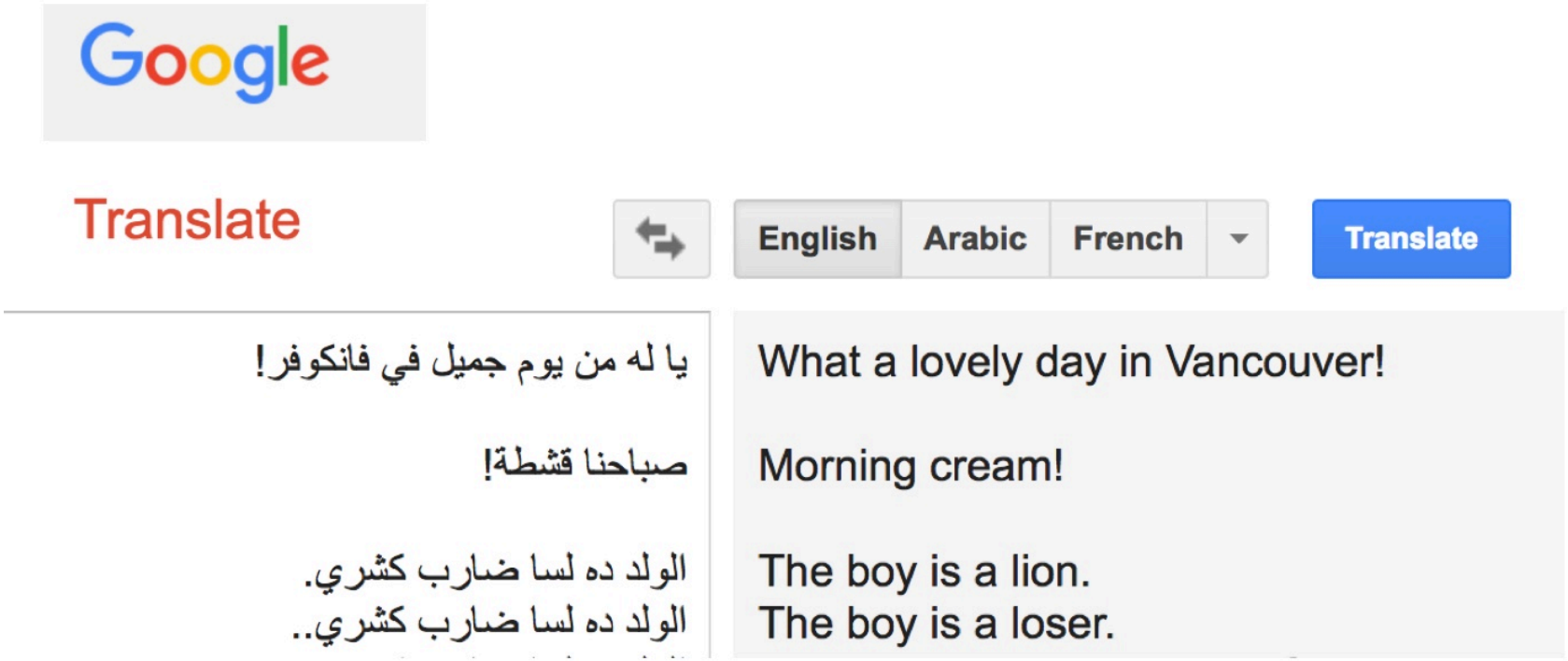


Figure: Google Arabic/Egyptian Arabic-English Translation samples, Oct. 24, 2018

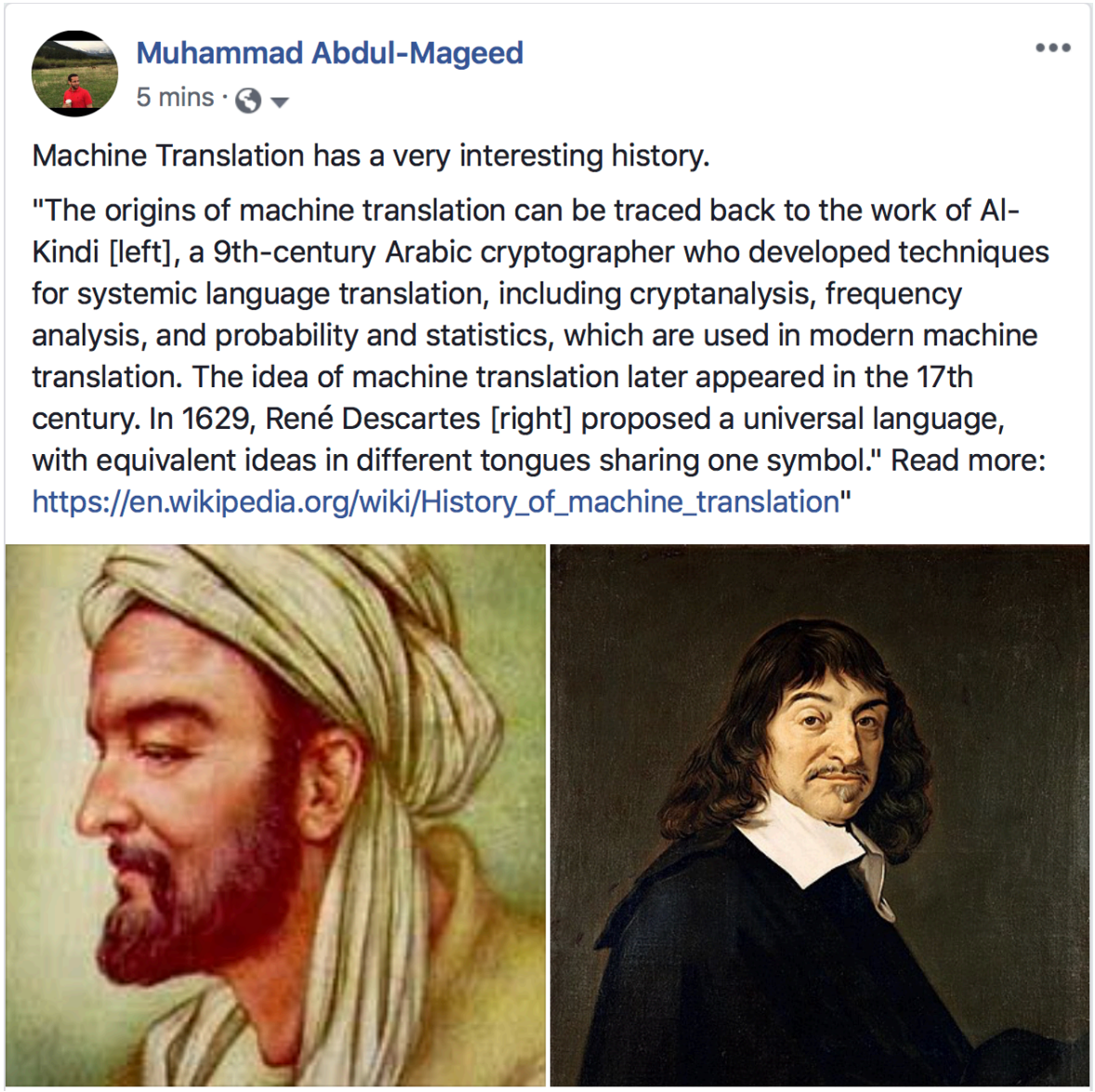
MT: Active Field of Research

Facebook's AI Just Set A New Record In Translation And Why It Matters

Hieroglyphics are seen on the sarcophagus once belonging to the judge and prime minister Gemenefherbek of Sais at the Egyptian Museum in Turin, Italy, Tuesday, February 21, 2006. Photographer: Adam Berry/Bloomberg News

Figure: Source: Forbes. (More than 10 BLEU points improvement!)

History of MT: Origins



History of MT: **Warren Weaver**

Warren Weaver's "Translation" memorandum (1949)

- Goal: **Going beyond word-for-word translation**. (4 proposals)
  1. Use **context** to solve word sense **ambiguity**
  2. Translation could be addressed as *a problem of formal logic*, **deducing "conclusions" in the target language from "premises" in the source language** (seq2seq?)
  3. **Cryptographic methods applicable** to translation
  4. There may be linguistic universals underlying all human languages (cross-lingual methods?)

History of MT: **The Georgetown Experiment**

Georgetown Experiment (Jan. 7, 1954)

- **Leon Dostert**, a French-born American scholar of languages with impact on MT
- **Paul Garvin** had a knowledge of Russian and carried out the linguistics part of the demonstration
- System had only **six grammar rules** and **250 lexical items in its vocabulary**
- A **toy system**, but was covered by journalists and received well by the public
- Encouraged **governmental funding** in computational linguistics
- Read more on Wikipedia...

History of MT: **The ALPAC Report**

ALPAC Report (1966)

- **The US government**: Concerned about lack of progress despite significant funding
- **ALPAC**, the Automatic Language Processing Advisory Committee, 7 scientists convened by US government
- **ALPAC concluded:**
  - MT *more expensive*, *less accurate*, and *slower* than human translation
  - MT *not likely to reach human quality in the near future*
- Research "almost completely abandoned" for over a decade in the **US**, and to a lesser extent in the **Soviet Union** and **United Kingdom**
- Research continued in **Canada**, **France**, and **Germany**
- Read more on Wikipedia...

History of MT: **The 1980s** | **Example-Based MT**

Muhammad Abdul-Mageed

11 mins ·

During the 1980s there was a lot of activity in MT in Japan. Methodologically, translation was done through some variety of intermediary linguistic representation involving morphological, syntactic, and semantic analysis

Kyoto Nago, who received his PhD in Engineering from Kyoto University (1961) and later became a President (1997–2003), and his group popularized example-based MT. The approach `neglects` syntactic and semantic rules and relies instead on the manipulation of large text corpora. Read more: https://en.wikipedia.org/wiki/History_of_machine_translation

The Early 1990s | Industry

The 1980s: A lot of activity in Japan

- Research began into speech translation with the development of the **German Verbmobil project**
- Development of the **Forward Area Language Converter (FALCon) system** by the Army Research Laboratory, fielded 1997 to aid soldiers in Bosnia
- Transition away from **large mainframe computers** toward **personal computers and workstations**
- **AltaVista's Babel Fish** (using Systran technology) and **Google Language Tools** (also initially using Systran technology exclusively)
- Read more on Wikipedia...

The 2000s: Industry

- Focus **statistical MT** and **example-based MT**
- **Speech translation** expanding to more domains (e.g., parliamentary and news)
- **Multi-lingual MT** (e.g., web content, including audio and video) (See Wikipedia)

Neural Machine Translation (NMT) | Industry

NMT

- Sparked by work on **word embeddings** (e.g., Bengio et al., 2003; Collobert & Weston, 2008; Mikolov et al., 2013)
- **Sequence-to-sequence models** (Sutskever, 2014)
- **Attention** (Graves, 2013; Bahdanau et al., 2014; Vaswani et al., 2017)
- Use of **monolingual data**, including **backtranslation**
- Use of **sub-word units** (byte-pair encoding) and **large vocabularies**
- **One-shot** and **low-resource MT**

Tools

Word, Phrase, & Eval Tools

- **GIZA++**: Implementation of IBM word-based models; used for word alignment (link)
- **SRILM**: A tool for language modeling (link)
- **Moses:** a decoding tool offering phrase-based and tree-based decoding (link)
- **Pharaoh:** Predecessor of Moses, a a beam search decoder for phrase-based SMT (link)
- **BLEU; METEOR:** Evaluation metrics implemented in various tools (e.g., Pytorch, NLTK)

Corpora

Various Datasets

- **LDS data:** Arabic-English, Chinese-English, French-English, etc. (link)
- **European:** European Parliament Proceedings Parallel Corpus (link)
- **OPUS:** An open source parallel corpus; a growing collection of translated texts from the web (link)

Eval Campaigns

Eval Campaigns

- **NIST:** National Institute of Standards and Technology; focus on **Arabic-English** and **Chinese-English**; Since 2002, has coordinated evaluations of text-to-text MT technology through OpenMT series (link)
- **IWSLT:** The International Workshop on Spoken Language Translation; focus on **speech translation** (2019; 2020; 2021)
- **WMT:** Workshop on SMT; focus on **European languages** (2020; 2021)
- Note: **Focus shifts**, depending on funding, interest, and progress in the field