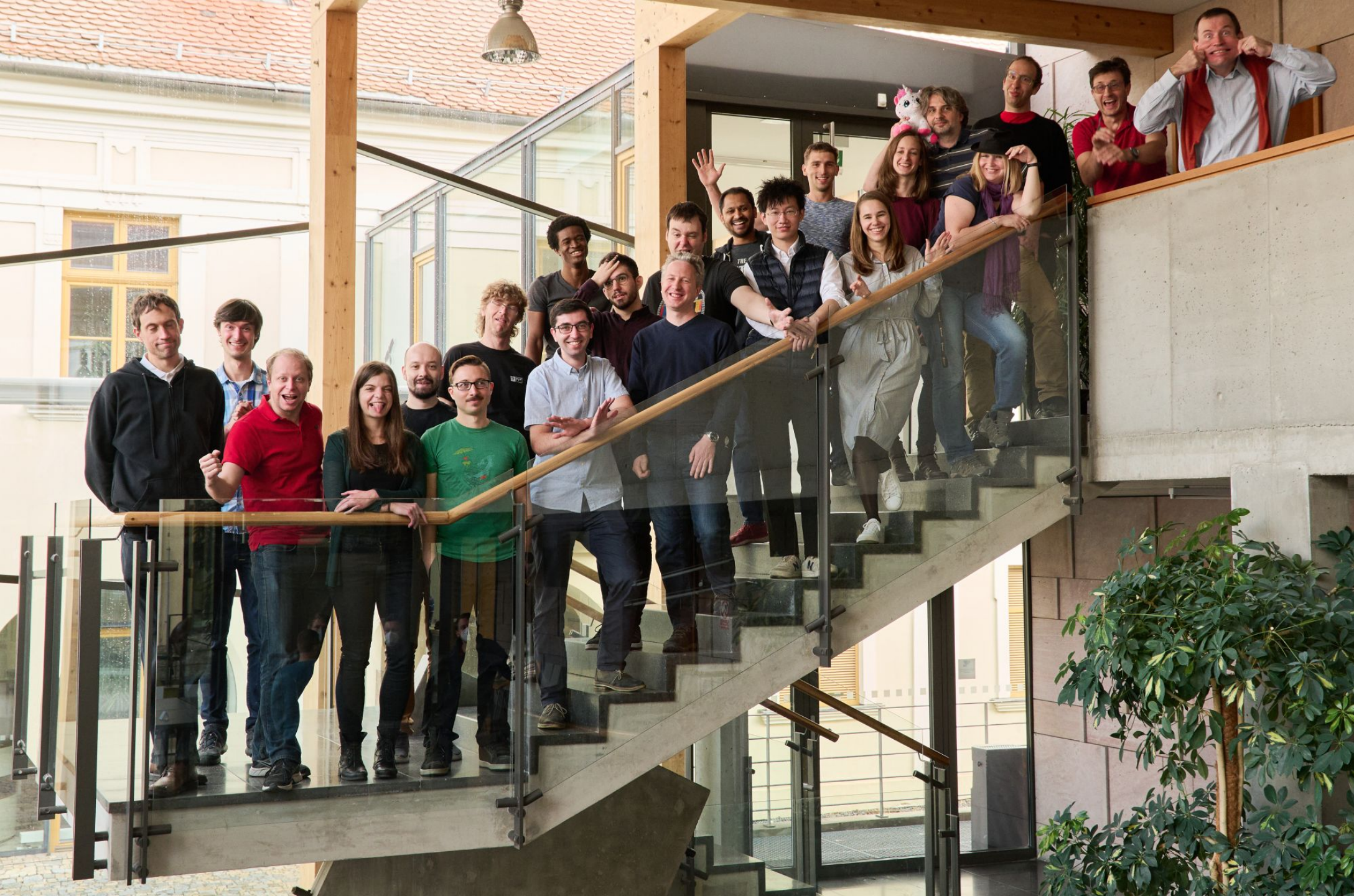


# CZECHIA - A SUPER-POWER IN SPEECH AND LANGUAGE TECHNOLOGIES

Honza Černocký, Brno University of Technology  
May 3rd 2022

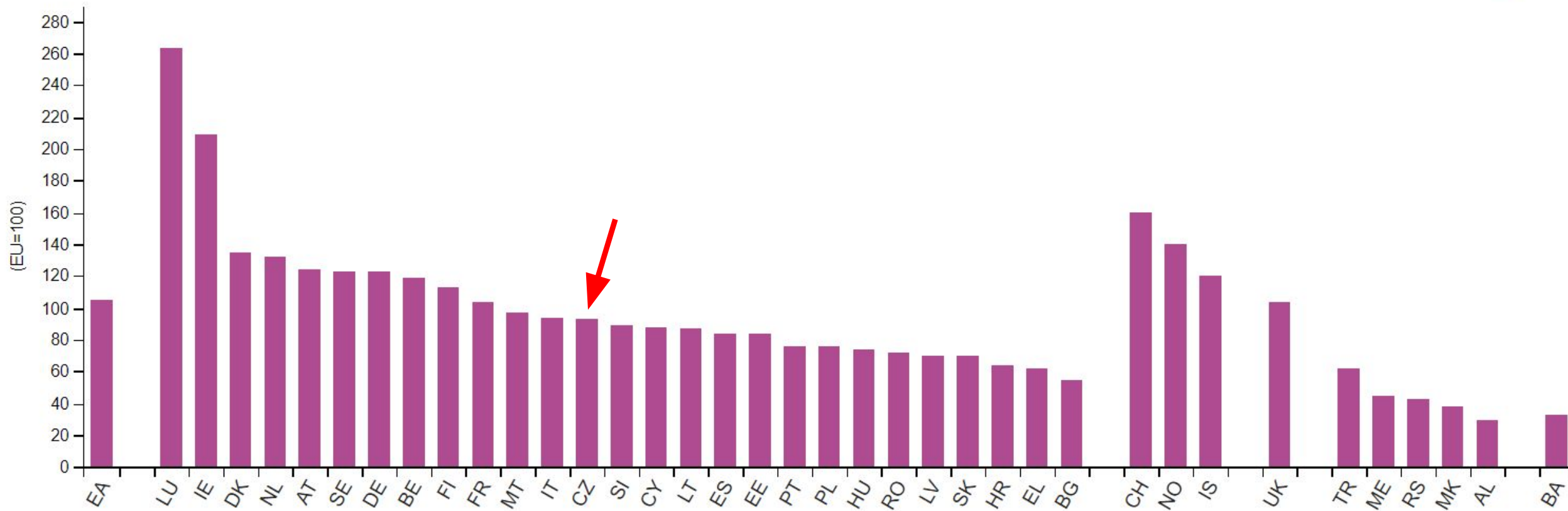






... JUST A MEDIOCRE COUNTRY ...

*Volume indices of GDP per capita, 2020*



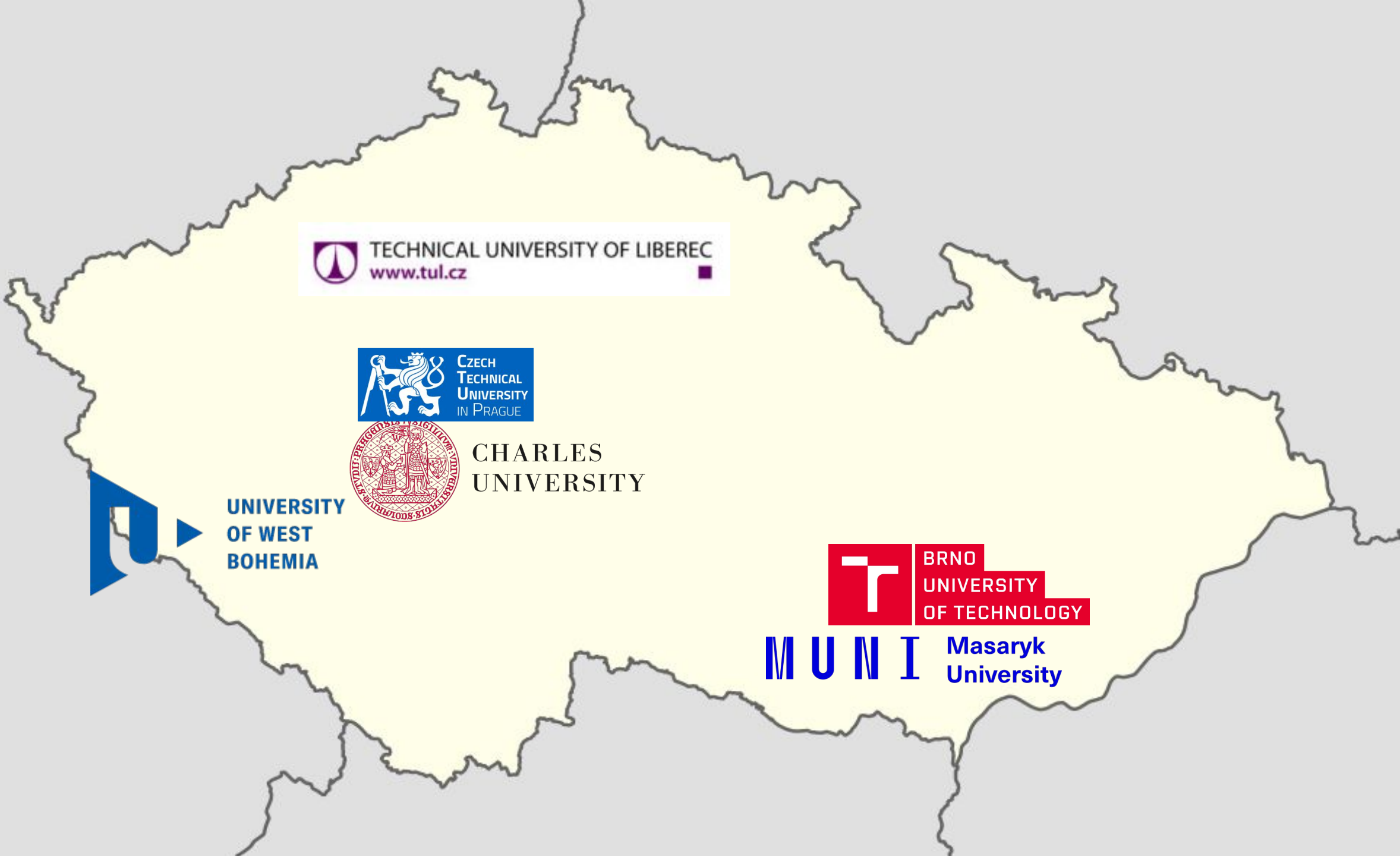
#	COUNTRY	AMOUNT	DATE	GRAPH
1	 <a href="#">Russia</a>	22,710	2008	
2	 <a href="#">China</a>	9,000	2014	
3	 <a href="#">United States</a>	8,725	2011	
4	 <a href="#">India</a>	5,978	2011	
5	 <a href="#">Egypt</a>	4,145	2011	
6	 <a href="#">Pakistan</a>	4,000	2006	
7	 <a href="#">Ukraine</a>	3,784	2011	
8	 <a href="#">Turkey</a>	3,763	2014	
=9	 <a href="#">North Korea</a>	3,500	2011	
=9	 <a href="#">Syria</a>	3,500	2005	
11	 <a href="#">Iran</a>	2,895	2006	
12	 <a href="#">Germany</a>	2,500	2014	
70	 <a href="#">Czech Republic</a>	123	2013	



# Speech and NLP

# AGENDA

- How do we know ?
- Why ?
- Notable people
- Some industrial achievements
- Why not over ?
- Where can it serve ?
- Support needed



 TECHNICAL UNIVERSITY OF LIBEREC  
[www.tul.cz](http://www.tul.cz)

 CZECH  
TECHNICAL  
UNIVERSITY  
IN PRAGUE



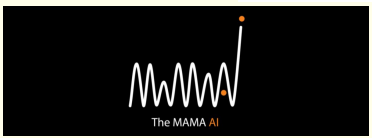
CHARLES  
UNIVERSITY

 UNIVERSITY  
OF WEST  
BOHEMIA

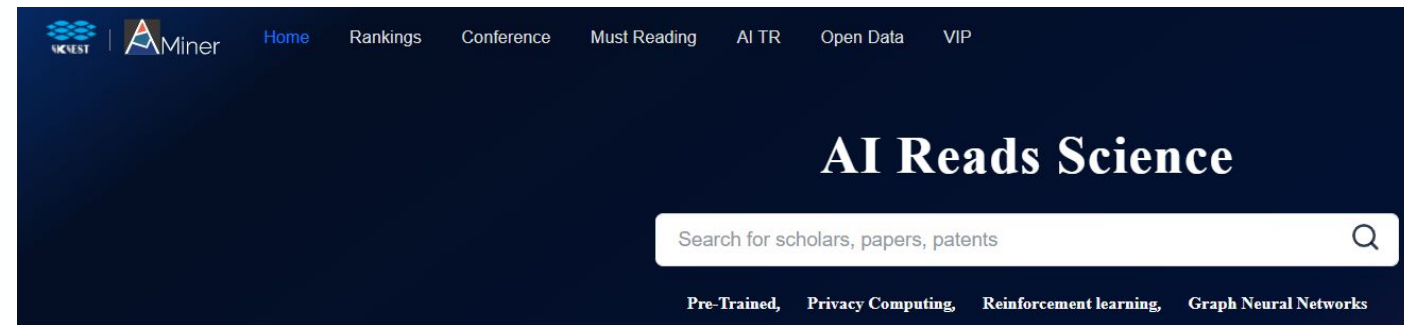
 BRNO  
UNIVERSITY  
OF TECHNOLOGY

**MUNI** Masaryk  
University





# JUST 2 ACADEMIC EXAMPLES (INDUSTRIAL WILL COME ...)



## Speech Recognition Most Influential Organizations



European Research Council

Established by the European Commission



Google

Scholar Num:24  
Paper Selected  
Num:284



Facebook

Scholar Num:6  
Paper Selected  
Num:44



Carnegie Mellon  
University

Scholar Num:4  
Paper Selected  
Num:67



Brno University of  
Technology

Scholar Num:3  
Paper Selected  
Num:68



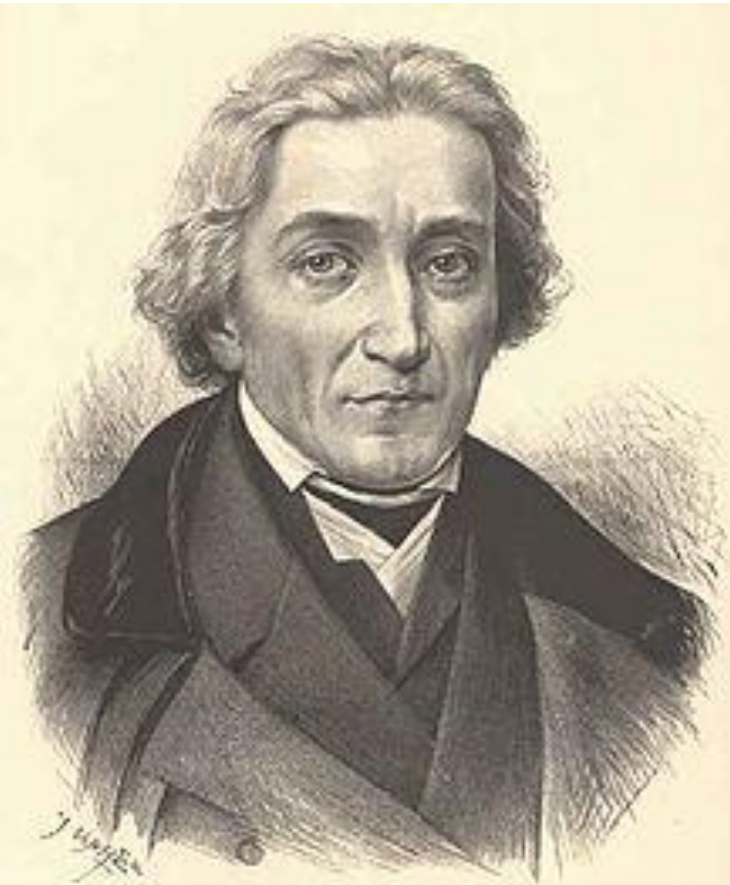
IBM

Scholar Num:3  
Paper Selected  
Num:89

# AGENDA

- How do we know ?
- **Why ?**
- Notable people
- Some industrial achievements
- Why not over ?
- Where can it serve ?
- Support needed

## CZECH IS A COMPLEX SEMI-ARTIFICIAL LANGUAGE RECOVERED BY SCIENTISTS ...



JOSEF DOBROVSKY.



1. Jan Hajič
2. Jana Hajiče
3. Janu Hajičovi
4. Jana Hajiče
5. Jane (Jene) Hajiči !
6. Janu Hajičovi
7. Janem Hajičem

## CZECH KIDS DO THIS FROM THE 3RD GRADE ...

PO                      PUZ                      PŘ                      PKS                      PT (4. pád)

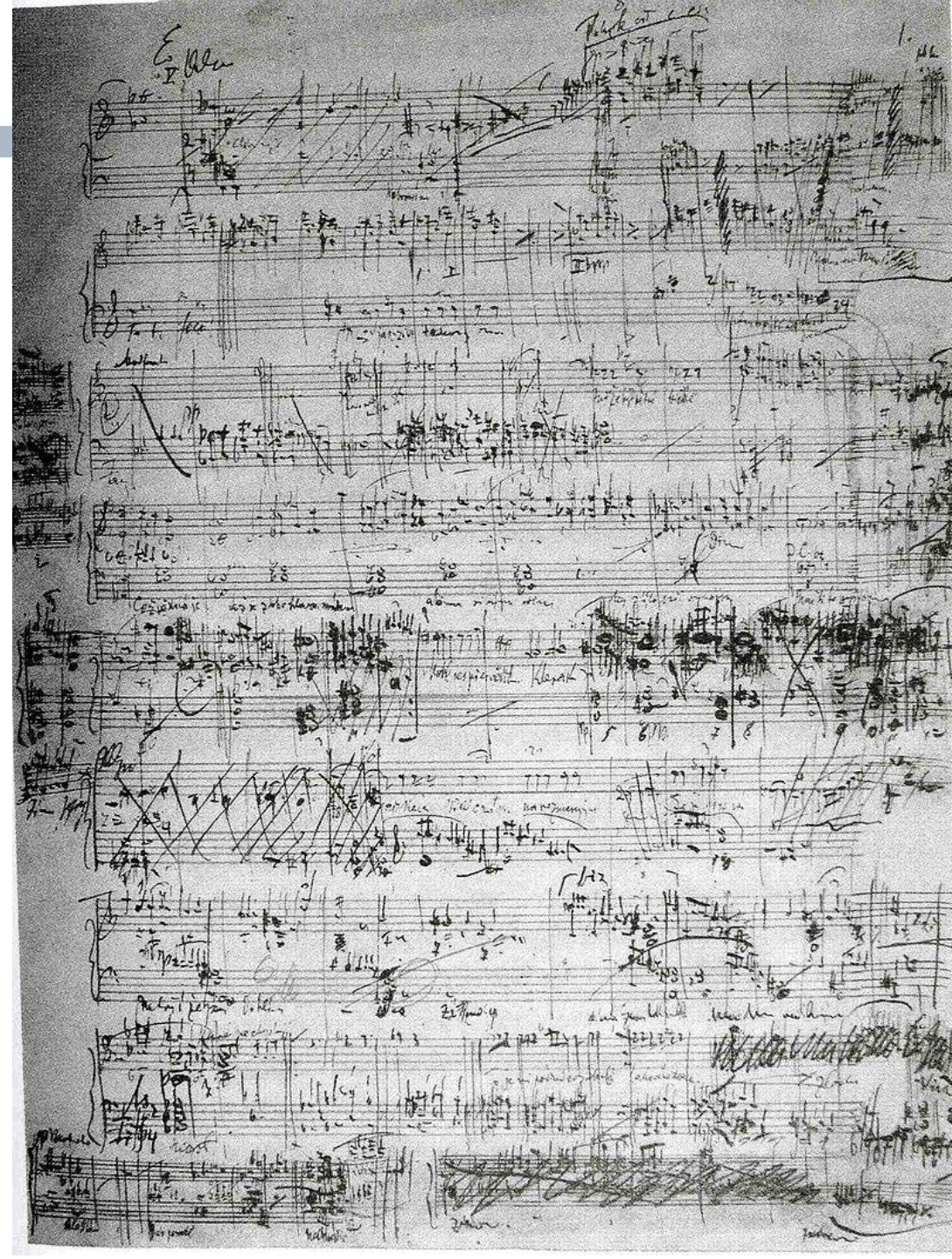
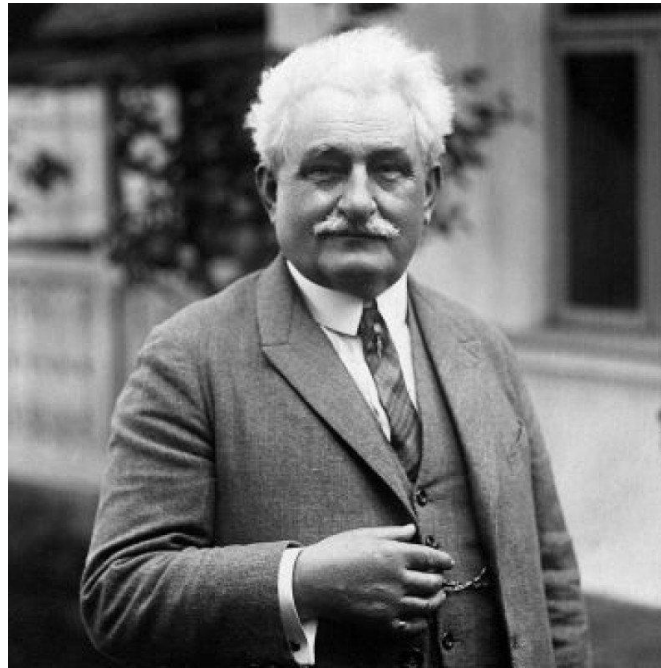
Diváci napjatě sledovali fotbalový zápas.

PKS                      PUM                      PŘ                      PKS                      PO

Za naší vesnicí se rozkládá smrkový les.

## CZECHS HAVE MUSICAL EARS

- 2-4 Czech composers in Top-100
- Leoš Janáček was the pioneer in using natural spontaneous language in classical music



# AGENDA

- How do we know ?
- Why ?
- **Notable people**
- Some industrial achievements
- Why not over ?
- Where can it serve ?
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Vilém Mathesius

## PRAGUE LINGUISTIC CIRCLE

- 1930s - Vilém Mathesius, later Roman Jakobson, Petr Sgall & their students
  - “structural linguistics” - before Noam Chomsky
  - Functional Generative Description (1980s)
    - linguistic theory based on “dependencies” x U.S. theories
- Renewed after 1990
  - Charles University - Faculty of Mathematics and Physics
  - Institute of Formal and Applied Linguistics + Faculty of Arts, FF UK
  - FGD now reflected in a worldwide “Universal Dependencies” project of linguistic resources



## BEDŘICH (FREDERICK) JELÍNEK

- \* Kladno 1932  
† Baltimore 2010
- Founder of statistical approach to speech and language processing
- IBM T.J.Watson, Johns Hopkins and Charles University (dr.h.c.)

*"Every time I fire a linguist, the performance of the speech recognizer goes up"*



By Bayes' rule

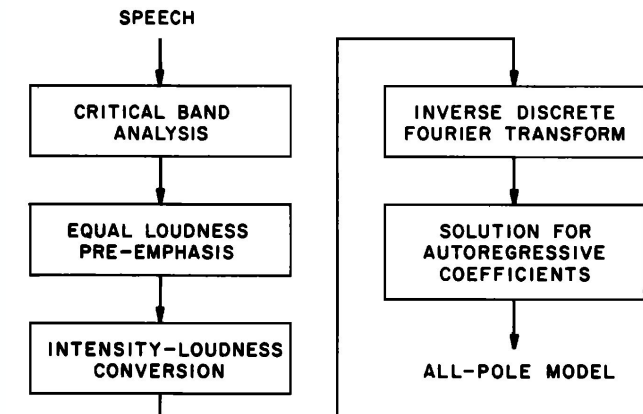
$$P(\mathbf{w}|\mathbf{y}) = \frac{P(\mathbf{w})P(\mathbf{y}|\mathbf{w})}{P(\mathbf{y})}. \quad (3.2)$$

Since  $P(\mathbf{y})$  does not depend on  $\mathbf{w}$ , maximizing  $P(\mathbf{w}|\mathbf{y})$  is equivalent to maximizing the likelihood  $P(\mathbf{w}, \mathbf{y}) = P(\mathbf{w})P(\mathbf{y}|\mathbf{w})$ . Here  $P(\mathbf{w})$  is the *a priori* probability that the word sequence  $\mathbf{w}$  will be produced by the text generator, and  $P(\mathbf{y}|\mathbf{w})$  is the probability with which the acoustic channel (see Fig. 1) transforms the word string  $\mathbf{w}$  into the AP output string  $\mathbf{y}$ .

## HYNEK HEŘMANSKÝ

- \* 1946 Nové Město na Moravě
- Antropomorphic speech processing
- Proponent of neural networks in “NN winter”
- Author of RASTA-PLP feature extraction

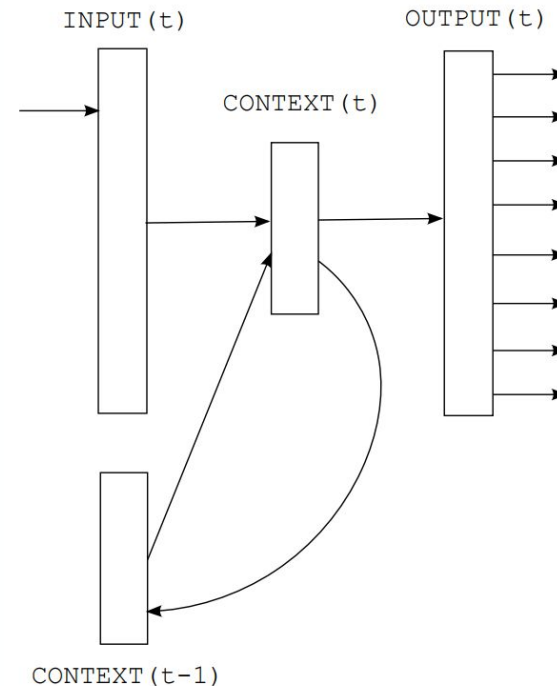
U. Tokyo, Panasonic, OGI Portland, IDIAP  
Switzerland, Johns Hopkins and Brno  
University of Technology



# TOMÁŠ MIKOLOV

- PhD at BUT
- Google, Facebook
- now back in Czechia: CIIRC CTU

Recurrent NNs for language modeling => embeddings



# AGENDA

- How do we know ?
- Why ?
- Notable people
- **Some industrial achievements**
- Why not over ?
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# SF7NAM.C7

SEZNAM.CZ

Internet   Firmy   Mapy   Zboží   Obrázky   Slovník   Jízdní řády   Video

...najdu tam, co neznám

Vyhledat



Právě se hledá: Zemřela Meda Mládková   Jiřina Bohdalová   Nehoda u Jičína   Eva Burešová

Změnit mapu   Z letadla   Turistická   3D pohled

Hledání   Trasa   Moje mapy   JC

Šarm aš-Šajch (شرم الشيخ)

Šarm aš-Šajch  
شرم الشيخ  
Město  
guvernorát Jižní Sinaj, Egypt

Trasa   Uložit   Sdílet   Tipy na výlet

www.sharmelsheikh.com

Počasí 29°

# PHONEXIA SPEAKER IDENTIFICATION



PRODUCTS

USE CASES

PARTNERS

SERVICES

BLOG

COMPANY

Free Demo

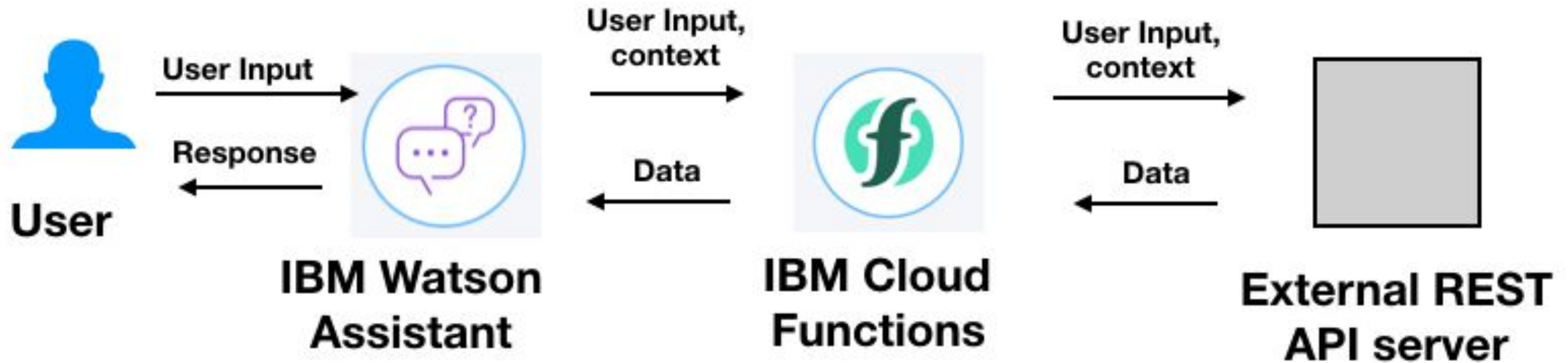
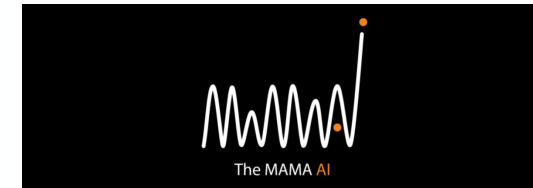
## Speaker Identification

Phonexia Speaker Identification uses biometrics to recognize a speaker based on their voice. Its latest generation uses deep neural networks for enhanced accuracy.

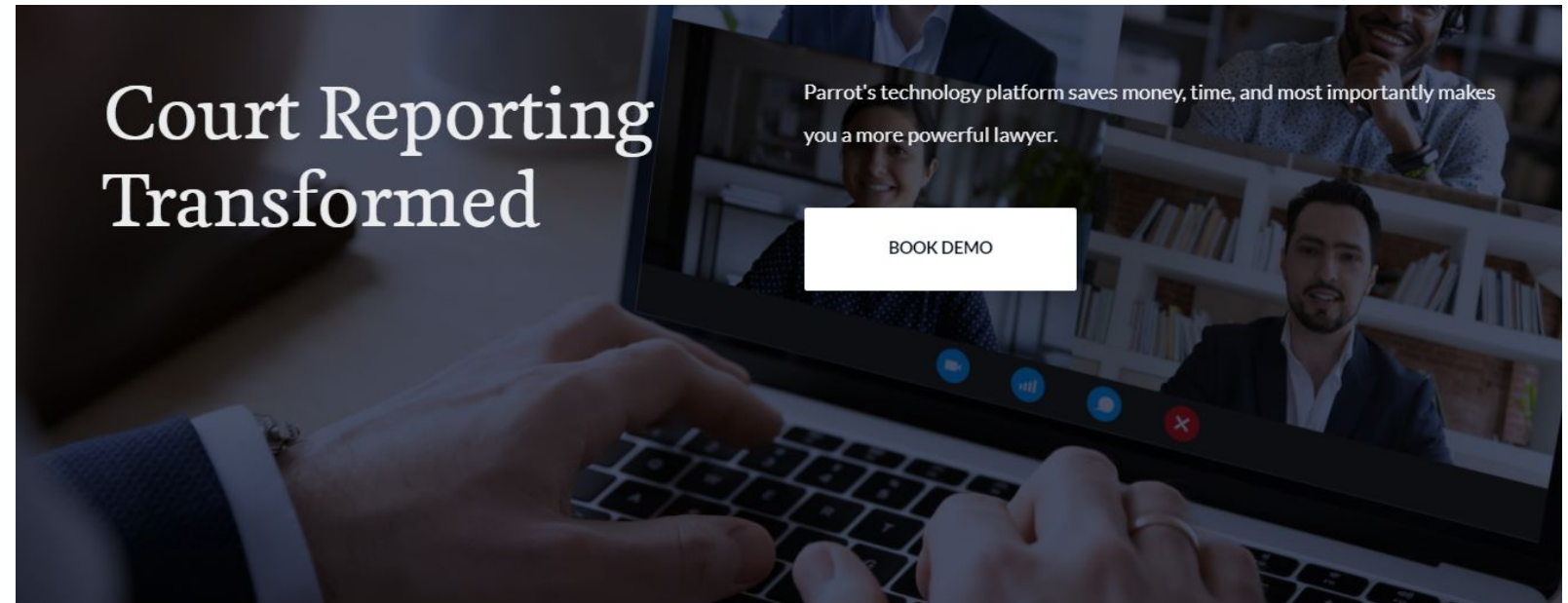


60+

# THE MAMA.AI BEHIND IBM WATSON



## PARROT IN U.S. COURT REPORTING MARKET



79%

Of clients say Parrot's technology features have helped them win a case

91%

of Parrot clients agree: Parrot makes their teams more efficient

32%

Average cost savings firmware among Parrot clients

24h

Schedule your depositions with one day notice



# AGENDA

- How do we know ?
- Why ?
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- **Why not over ?**
- Where can it serve ?
- Support needed



Google Translate

Text

Documents

Websites

DETECT LANGUAGE

ENGLISH

CZECH

SPANISH



CZECH

ENGLISH

RUSSIAN

research in speech and language processing is over

výzkum v oblasti zpracování řeči a jazyka skončil



51 / 5,000



## STILL QUITE SOME RESEARCH TO BE DONE !

- **Multilinguality** – if we have a good system trained on N well resourced languages, how to port it to (N+1)st one with limited or no resources ?
- **Robustness** – for speech recorded over clean telephone lines, some applications are more precise than humans, but how about very noisy military-grade channels with strong background noise ?
- **Far-field microphones** – how to improve performance of speech data mining for one or more distant mikes (assistants, IoT, covert listening, etc.)
- End-to-end training – how to train the whole p[rocessing chain as one block ?
- High quality supporting (less “sexy”) technologies such as **voice activity detection, diarization, punctuation...**
- **How do we combine structured knowledge (e.g. databases) with deep learning ?**
- **How to approach big pre-trained models** (Google, Facebook, etc) we’ll never have enough data and machines to compete with ?
- How to ensure **explainability and controllability of neural models**, so that they don’t do stupid mistakes and are not offensive ?

# AGENDA

- How do we know ?
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- **Where can it serve ?**
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## BUSINESS — VOICEBOTS AND CHATBOTS EVERYWHERE

- an important business for Europe: 35,000 contact centers generate 3.2 Million jobs (~1% of Europe's active population).
- Need to go multi-lingual to boost European business !



# REFUGEES

**WELCOME**

[The project](#) ▾ [News and articles](#) [Use cases](#) ▾ [Related projects](#) [Demos & Videos](#) ▾ [Newsletters](#)

## Reception, Management and Integration of Third Country Nationals

 ÚFAL Translator

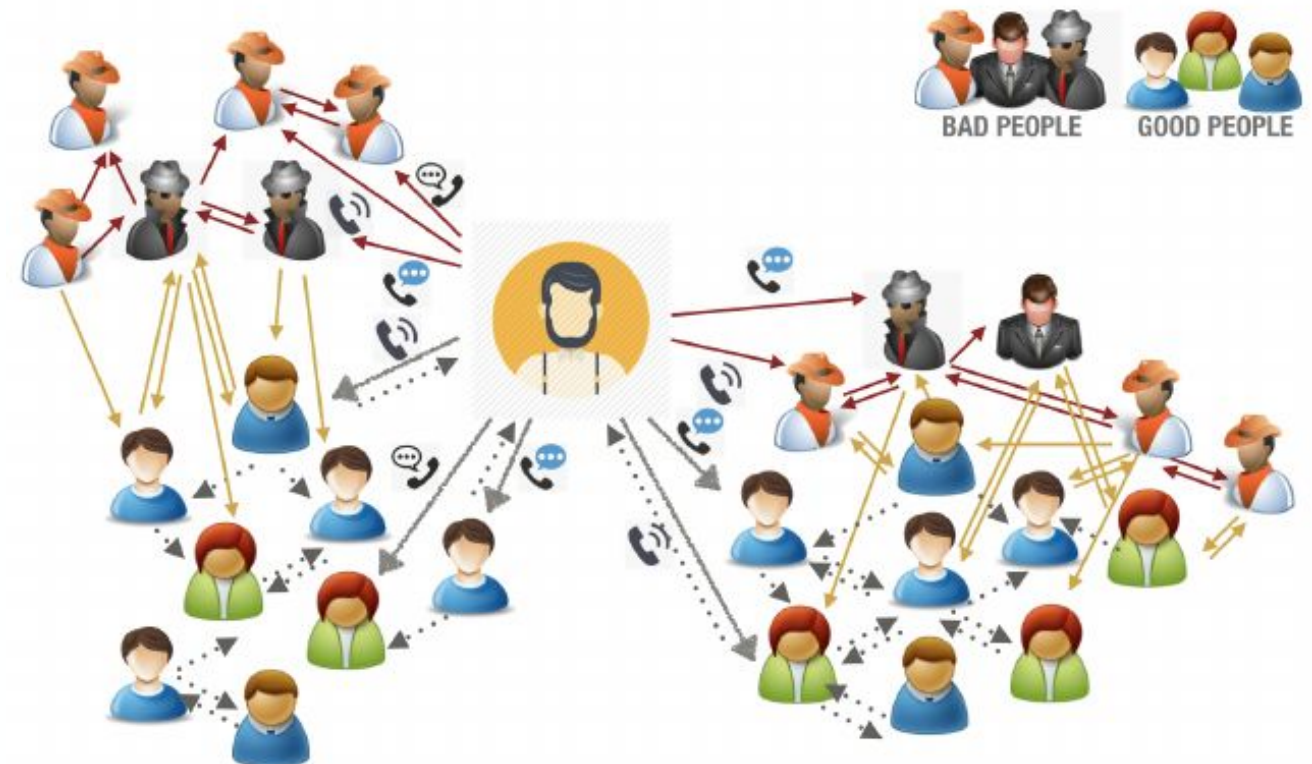


Українською

Česky



# SECURITY / INTELLIGENCE / DEFENSE



# AGENDA

- How do we know ?
- Why ?
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- Some industrial achievements
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- Where can it serve ?
- **Support needed**



## How ?

- Stop claiming “it’s done” - remember cancer drug research ...
- Consider speech / NLP as key areas for EU economic development
- Support projects
- Support infrastructure
- Enact legislation supporting using data for training AI models.

THANK YOU FOR YOUR ATTENTION!

<http://www.fit.vutbr.cz/~cernocky>

<http://speech.fit.vutbr.cz>

