

# Filling the Gap: Decoding of Word Embeddings for Generation of Coherent New Words

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M2 — Software Project



- 1 Reminder
- 2 Our approach
- 3 Regression task
- 4 Results & discussion
- 5 Software
- 6 Future work

# Reminder of our aim

- Regression task based on transfer

$$A : B :: C : X \xrightarrow{X=?} A : B :: C : D$$

e.g. *dog : dogs :: chat : X*  $\rightarrow$  *chats*

- Input: A and B in language 1, C in language 2
- Output: D in language 2
- Same transformation for A, B and C, D

# First trial results

	hungarian, german	turkish, finnish	hungarian, finnish
Cosine similarity	<b>58.9</b>	<b>39.5</b>	<b>18.9</b>
Euclidean distance	57.7	39.1	16.8

Table: Accuracy for the regression task on the three (source, target) language pairs.

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# 3 approaches

- ① Comparable data
- ② Omnilingual model
- ③ Sigmorphon 2019

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# New results

Table: Accuracy (in %) of 3 runs of the regression model.

Language	ANNr (previous) (mean $\pm$ std.)	actual
Arabic	<b>77.97</b> $\pm$ 16.03	<b>61.13</b> $\pm$ 0.83
Finnish	<b>37.78</b> $\pm$ 9.28	<b>77.56</b> $\pm$ 1.78
Georgian	<b>94.66</b> $\pm$ 1.13	<b>86.40</b> $\pm$ 0.62
German	<b>86.38</b> $\pm$ 0.45	<b>86.93</b> $\pm$ 0.78
Hungarian	<b>53.83</b> $\pm$ 3.12	<b>78.98</b> $\pm$ 0.50
Maltese	<b>75.00</b> $\pm$ 5.08	<b>79.66</b> $\pm$ 1.11
Navajo	<b>31.74</b> $\pm$ 0.90	<b>45.88</b> $\pm$ 0.24
Russian	<b>75.15</b> $\pm$ 0.44	<b>70.53</b> $\pm$ 0.37
Spanish	<b>86.27</b> $\pm$ 0.71	<b>91.12</b> $\pm$ 1.06
Turkish	<b>61.95</b> $\pm$ 10.86	<b>80.34</b> $\pm$ 0.79
Japanese	<b>61.60</b> $\pm$ 1.33	<b>79.92</b> $\pm$ 0.02



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# Bilingual analogies

In our dataset:  $\text{WORD}_1$  FEATURES  $\text{WORD}_2$

An analogy:  $\text{WORD}_{1,A}:\text{WORD}_{2,A}::\text{WORD}_{1,B}:\text{WORD}_{2,B}$   
where  $\text{FEATURES}_A = \text{FEATURES}_B$

Bilingual analogies:  $\text{LANGUAGE}_A \neq \text{LANGUAGE}_B$

→ keep only the subset of *shared features*

# Shared features

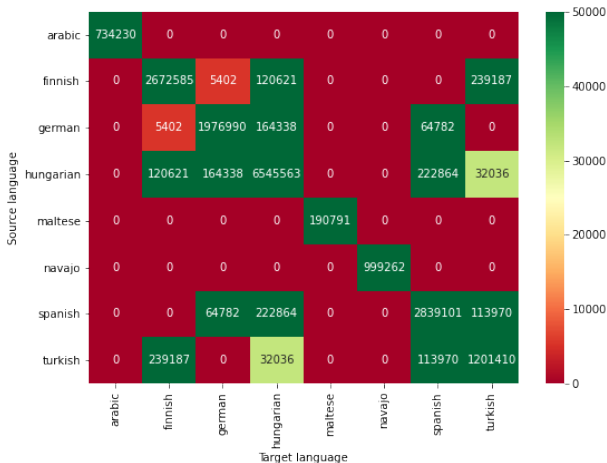


Figure: Number of possible analogies for each pair of languages

# Comparison between monolingual and bilingual results

	Finnish	German	Hungarian	Spanish	Turkish
Finnish	/	43.96 $\pm$ 1.48	80.93 $\pm$ 1.94	/	82.00 $\pm$ 1.90
German	92.63 $\pm$ 0.10	/	68.17 $\pm$ 3.12	68.17 $\pm$ 3.12	/
Hungarian	43.07 $\pm$ 0.48	85.92 $\pm$ 0.83	/	85.92 $\pm$ 0.83	40.92 $\pm$ 2.46
Spanish	/	93.97 $\pm$ 0.25	93.97 $\pm$ 0.25	/	94.05 $\pm$ 0.31
Turkish	65.89 $\pm$ 1.59	/	71.76 $\pm$ 0.92	93.18 $\pm$ 1.90	/

Table: Monolingual analogies: Accuracy ( $\pm$ std) on 3 runs

	Finnish	German	Hungarian	Spanish	Turkish
Finnish	/	<b>81.88</b>	35.88	/	30.19
German	80.31	/	30.41	35.10	/
Hungarian	48.83 $\pm$ 3.19	78.41 $\pm$ 1.59	/	<b>91.62</b>	33.93
Spanish	/	17.63	83.26	/	40.63
Turkish	45.81 $\pm$ 0.17	/	16.17	70.27	/

Table: Bilingual analogies: Accuracy ( $\pm$ std) on 3 runs

# Omnilingual model

Languages which share features with at least one other language: Finnish, German, Hungarian, Turkish, Spanish

	Finnish	German	Hungarian	Spanish	Turkish
Finnish	$60.30 \pm 1.26$	$3.08 \pm 0.86$	$31.78 \pm 1.79$	/	$52.62 \pm 1.84$
German	$3.08 \pm 0.86$	$63.27 \pm 0.68$	$57.71 \pm 0.48$	$62.47 \pm 2.41$	/
Hungarian	$31.78 \pm 1.79$	$57.71 \pm 0.48$	$71.12 \pm 1.04$	$62.89 \pm 1.86$	$24.73 \pm 1.26$
Spanish	/	$62.47 \pm 2.41$	$62.89 \pm 1.86$	$66.82 \pm 1.34$	$62.20 \pm 6.57$
Turkish	$52.62 \pm 1.84$	/	$24.73 \pm 1.26$	$62.20 \pm 6.57$	$49.73 \pm 0.82$

Table: Accuracy ( $\pm$ std) on 5 runs

# Next time: Sigmorphon 2019 [McCarthy et al., 2019]

88 languages: 8/10 from Sigmorphon 2016 [Cotterell et al., 2016]

→ Arabic, Finnish, German, Hungarian, Russian, Spanish, Turkish, Maltese  
(Georgian and Navajo missing)

Aim: apply trained models to the new dataset

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# What we want

- Solving analogies: monolingual and bilingual
- Use the omnilingual model



# What it looks like

The interface is a web-based tool for generating bilingual analogies. It features a light purple background with white input fields and purple buttons. At the top, there are two input fields for 'Source language' and 'Target language', both containing the word 'Hungarian'. To the right of these fields is the text 'Bilingual analogies?'. Below these fields is a large purple button labeled 'Generate an example'. To the right of this button is the text 'What is a valid example?'. Below the button, there are four input fields arranged horizontally. The first three fields are white and contain the words 'apple', 'is', and 'a', respectively. The fourth field is greyed out and contains the word 'fruit'. The fields are separated by colons: the first and second by a single colon (:), the second and third by a double colon (::), and the third and fourth by a single colon (:). Below the input fields are two purple buttons: 'Get closest result' on the left and 'Shuffle the words' on the right. To the left of the 'Get closest result' button is the text 'How is an analogy solved?'. To the right of the 'Shuffle the words' button is the text 'Does the order matter?'.

Source language: Hungarian Target language: Hungarian Bilingual analogies?

Generate an example What is a valid example?

apple : is :: a : fruit

How is an analogy solved? Get closest result Shuffle the words Does the order matter?

Figure: Preview of our software

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# Future work

- Run final experiments
- Improve and adapt our software
- Continue writing the report

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Thank you

Merci

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Obrigado

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