AnlamVer: Semantic Model Evaluation Dataset for Turkish - Word Similarity and Relatedness

The 27th International Conference on Computational Linguistics (COLING 2018)

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August 24, 2018

Main Contributions

1. First word similarity and word relatedness dataset for Turkish. [1]
2. An open-source web-based word similarity questionnaire software. [2]
3. Novel analysis and visualization of semantic spaces, owing to getting bi-dimensional scores for each word-pair.
4. Dataset design considerations where the main objective is balancing word-pairs by multiple morphological and semantic attributes.

[1] Publicly available at http://www.gokhanercan.com/anlamver

[2] Publicly available at http://www.gokhanercan.com/wsquest

SIMILARITY - RELATEDNESS DISTINCTION

Types of Distributional Relations

Syntagmatic: Words co-occur at the same time.[3]
→ semantic relatedness

Paradigmatic: Words share neighbors, but not at the same time.
→ semantic similarity (e.g. synonym, antonymy)
→ most likely in the same POS. Substitutional.

	Paradigmatic relations			
Syntagmatic relations	He	likes	white	wine
	She	loves	red	roses
	Mary	enjoys	colorful	flowers

Table: Orthogonality of syntagmatic and paradigmatic relations. Table adapted from Sahlgren's work.

[3] Magnus Sahlgren. "The Word-Space Model: Using distributional analysis to represent syntagmatic and paradigmatic relations between words in high-dimensional vector spaces". PhD thesis. Institutionen för lingvistik, 2006.

Similarity and Relatedness Distinction

Relatedness: Occur in similar contexts at the same time. Remind each others. *Ex: "gasoline - car"*

Similarity: Refer to same thing/person/concept/action. Share similar attributes. Substitutional. Occur in similar contexts but not in the same time. *Ex: "automobile - car"*

"rose - red" should be highly **related** →7,4

"rose - red" should not be **similar** →1,6

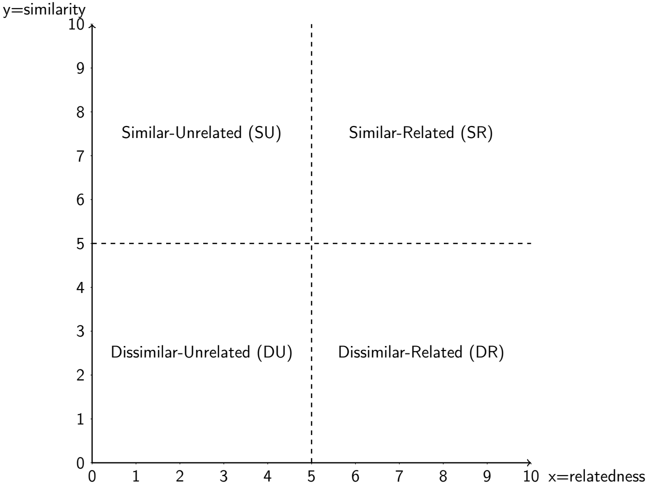
Why not having both scores at the same time?

Conventional Wordsim Datasets

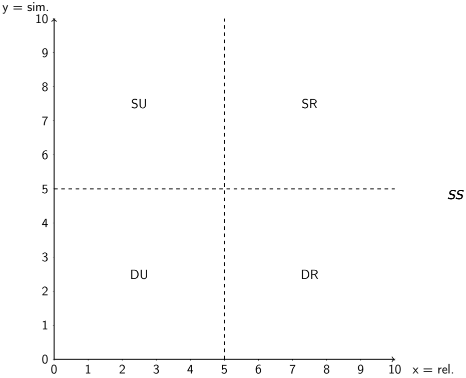
- Most *WordSim* datasets evaluates **relatedness**, not **similarity**.
- Most *WordSim* datasets lack in *clearly-defining* such distinction (WS353, RG, MC, MEN).[4] in their guidelines.
- **A "perfect" semantic model should predict two distinct scores for each word-pair.**
- Can a single model predict both?
- Decision: Getting two distinct scores for similarity and relatedness for each pair.

[4] Felix Hill, Roi Reichart, and Anna Korhonen. "Simlex-999: Evaluating semantic models with (genuine) similarity estimation". In: *Computational Linguistics* (2016).

Sim-Rel Space: Sub-spaces

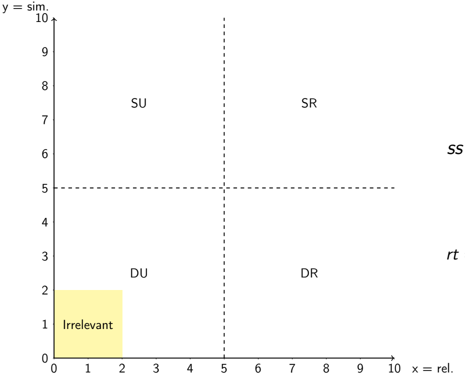


Sim-Rel Space: Sub-spaces



$$ss = f_1(r,s) = \begin{cases} \text{SU}, & \text{if } s \geq 5 \text{ and } r < 5 \\ \text{SR}, & \text{if } s \geq 5 \text{ and } r \geq 5 \\ \text{DU}, & \text{if } s < 5 \text{ and } r < 5 \\ \text{DR}, & \text{if } s < 5 \text{ and } r \geq 5 \end{cases}$$

Sim-Rel Space: Relation Types - Irrelevant



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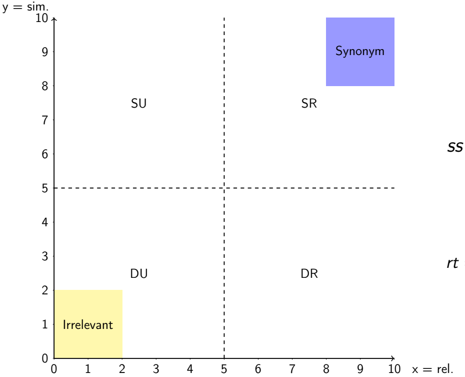
$$rt = f_2(r,s) = \begin{cases} \text{irrelevant}, & \text{if } t \geq r \text{ and } t \geq s \end{cases}$$

"loose - statue"

Sim-Rel Space: Relation Types - Synonym

"automobile - car"



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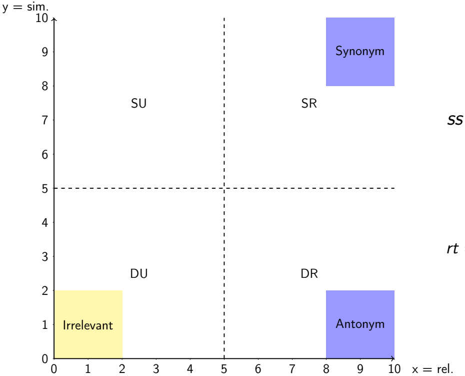
$$rt = f_2(r,s) = \begin{cases} \text{irrelevant}, & \text{if } t \geq r \text{ and } t \geq s \\ \text{synonym}, & \text{if } 10 - t \leq s \text{ and } 10 - t \leq r \end{cases}$$

Sim-Rel Space: Relation Types - Antonym



$$ss = f_1(r,s) = \begin{cases} \text{SU}, & \text{if } s \geq 5 \text{ and } r < 5 \\ \text{SR}, & \text{if } s \geq 5 \text{ and } r \geq 5 \\ \text{DU}, & \text{if } s < 5 \text{ and } r < 5 \\ \text{DR}, & \text{if } s < 5 \text{ and } r \geq 5 \end{cases}$$

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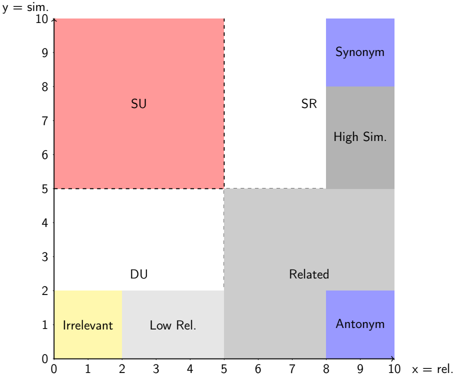
"loss - profit"

Sim-Rel Space: Similar-Unrelated (SU)



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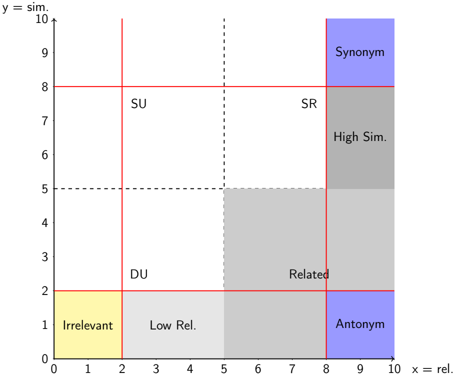
Sim-Rel Space: t-Threshold



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TURKISH MORPHOLOGY

Turkish Morphology

- Agglutinative (Highly Inflectional and Derivational)
- 47% of word types (277K) occur only **once** in the corpus

Word	Decomposition	Sense	Frequency
maymun	maymun	monkey	very
maymunları	maymun + lAr + sH	their monkeys	medium
maymunsu	maymun + sI	ape, like monkeys	rare
maymungilleri	maymun + gil + lAr + yH	family of monkeys, primades	oov
maymuncuk	maymun + CHk	skeleton key, picklock (tool)	rare

Table: Morphological decomposition of various words sharing the same lexeme.

Problems to Address:

- OOV (out-of-vocabulary)
- RareWords

Made-up Words

Ex: "üşengeç - üşengen*" (lazy - lazy). Users scored sim: 8,2, rel: 7,8.

- Concept borrowed from phrase level model of Vecchi et al.[5].
- Even if people hear a word for the first time and it might sound odd to them, people have the intuition to make sense of the intended meaning.
- We assume that Turkish affixes can change the meanings of the words in a consistent manner, which is called *acceptable semantic deviance*.
- Our experiment showed that people can successfully understand made-up words.
- **Generalization power:** Perfect model should be able to relate made-up words as humans. Challenge for subword level models.

[5] Eva M Vecchi et al. "Spicy adjectives and nominal donkeys: Capturing semantic deviance using compositionality in distributional spaces". In: *Cognitive science* 41.1 (2017), pp. 102–136.

METHODOLOGY

Dataset Translation Issues

1. Both words in a source-pair maps to a same single word in the target language:
   Ex: ***"football - soccer"*** → ***"futbol - futbol"***
2. A word in a source-pair maps to a phrase:
   Ex: *"asylum - madhouse"* → *"tımarhane - akıl hastanesi"*.
3. Meaning loss in translations requires human re-annotation of every word-pair anyways (cross-lingual benchmarking is not possible).
4. Targeting language specific problems (OOV, rarewords). Frequency, derivations, inflections, polysemy are language dependent.

Workflow

	Stage 1	Stage 2	Stage 3
	1) Word Candidates (starts)	2) Word-Pool Selection	3) Word-Pairs Selection
Goals	1.1) Reusing existing resources	2.1) Balancing word attributes by estimations	3.1) Balancing word-pairs by estimations
Input	1.2) TKN (600) + MC (39)	2.2) Stage1 output (639) + new derivational words (99)	3.2) 320 Stage2 words
Process	1.3) Attaching frequencies, morphological tags	2.3) Filtering for balancing	3.3) Mapping pairs (every word used 2-5 times building word-pairs)
Output	1.4) 639 words	2.4) 320 words	3.4) 500 word-pairs (ends)

Stage 1: Word Candidates Selection

- Turkish word norms dataset TKN (Türkçe Kelime Normları) used. (Tekcan et al., 2005)
- Consists of 600 words annotated by 100 students.
- 480 in root form, 108 derivational, 12 inflectional.
- Has concreteness/abstractness attributes [1-7]. 'gül' is concrete (6.79), 'mutluluk' is abstract (1.85).
- Very frequent words. No OOV or rare-word based-on BOUN Corpus stats (Sak et al., 2009).

Stage 2: Word-pool Selection

- Database size target was 500 word-pairs.
- 600 words transferred from the first stage.
- Added 135 OOV and rare-words words to balance frequencies (mostly derivational).
- Grouped words in 6 frequency groups (including OOV). $(0-32, 32-320, 320-3200, 3200-32000, 32000-\infty)$.
- Frequencies numbers from Boun Corpus[6] which contains 3.2 million token types. Rare words groups defined by $gr(n, voc, g)$:

$$gr(n, voc, g) = (voc \times 10^{-(g-n+3)}) \;\&\; \texttt{"-"} \;\&\; (voc \times 10^{-(g-n+2)})$$

[6] Haşim Sak, Tunga Güngör, and Murat Saraçlar. "Resources for Turkish morphological processing". In: *Language resources and evaluation* 45.2 (2011), pp. 249–261.

Stage 2: Groupings of Word-pool

	G0	G1	G2	G3	G4	G5	Total
Frequency	OOV	RW1	RW2	RW3	RW4	RW5	
	31 9.6%	33 10.3%	30 9.3%	62 19.3%	111 34.6%	53 16.5%	320 100%
Concreteness	no value	abstract	medium	concrete			
	149 46.5%	35 10.9%	30 9.3%	106 33.1%			320 100%
Root Form	root	non-root					
	182 56.8%	138 43.1%					320 100%
Derivations	no der.	der1	der2+				
	198 61%	81 25.3%	41 12.8%				320 100%
Inflections	no inf.	inf1	inf2+				
	277 86.5%	17 5.3%	26 8.1%				320 100%

Stage 3: Word-pairs Selection

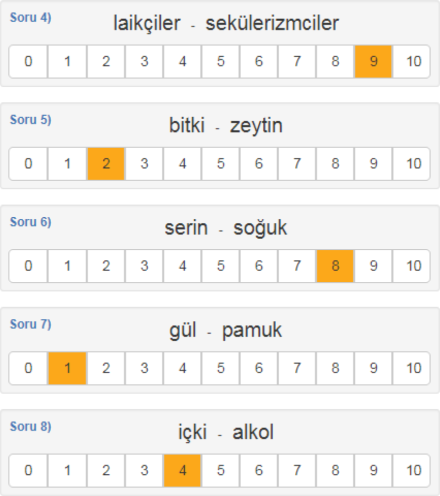
- Target: Balancing word-pair relation type ratios.
- Targeting 50 synonym, 50 antonym, 50 meronym, 50 hypernym relations.
- Pairing word manually based on our own relation type estimations.
  Ex: Paired "otomobil" and "araba" as a strong synonym candidate.
- End up with 500 word-pairs.

Methodology: Groupings of Word-pairs

	G0	G1	G2	G3	G4	G5	Total
Est. Synonyms	synonym	antonym	other				
	50 10%	50 10%	400 80%				500 100%
Est. Relatedness	high	medium	low				
	200 40%	150 30%	150 30%				500 100%
Est. Rel. Type	hyponym	meronym	other				
	50 10%	50 10%	400 80%				500 100%
OOV	no oov	any oov	two oov				
	434 86.8%	66 13.2%	42 8.4%				500 100%
Min. Derivations	no der.	der1	der2+				
	231 46.2%	166 33.2%	103 20.6%				500 100%
Min. Inflections	no inf	inf1	inf2+				
	424 84.8%	32 6.4%	44 8.8%				500 100%
Min. RareWord	rw0 (oov)	rw1	rw2	rw3	rw4	rw5	
	66 13.2%	65 13%	62 12.4%	130 26%	142 28.4%	35 7%	500 100%

QUESTIONNAIRE

Methodology: Questionnaire Design - Annotation Page



Soru 4) laikçiler - sekülerizmciler

0 1 2 3 4 5 6 7 8 [✓ 9] 10

Soru 5) bitki - zeytin

0 1 [✓ 2] 3 4 5 6 7 8 9 10

Soru 6) serin - soğuk

0 1 2 3 4 5 6 7 [✓ 8] 9 10

Soru 7) gül - pamuk

0 [✓ 1] 2 3 4 5 6 7 8 9 10

Soru 8) içki - alkol

0 1 2 3 [✓ 4] 5 6 7 8 9 10

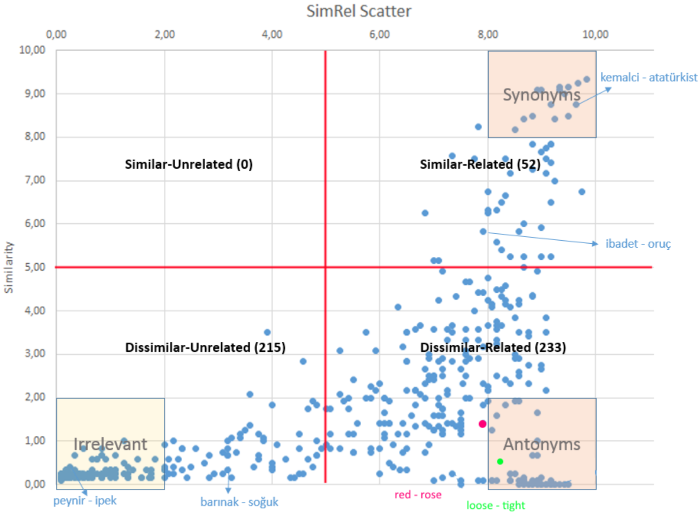
DATASET ANALYSIS

Dataset Analysis

w1	w2	avg sim	avg rel	oov	avg c.	type
otomobil	araba	9,1	9,4	no	6,87	HS,HR
üşengen	yedigen	0,5	0,1	two	-	LR,LS
kırmızı	gül	1,6	7,4	no	6,79	LS,HR
zarar	kazanç	0,18	8,8	no	3,25	ANT

- 4 participants' data removed after post-processing due to the low correlation with other participants.
- Average pairwise Spearman (ranking) correlation score: 0.748.
- Self-correlation of one participant: 0.928 (4 months between surveys)
- Lowest = 0.474, Highest: 0.847
- 0.1% null rate. Null rates replaced with average word-pair scores.

AnlamVer Sim-Rel Space Scatterplot



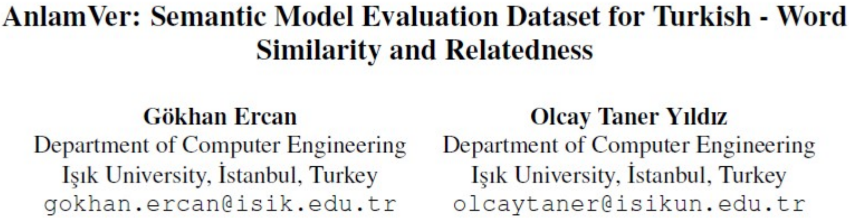
Conclusion - Possible Insights

Conventional Wordsim Dataset:
Your model's performance: %65

Proposed Dataset:

- Overall relatedness: %76, overall similarity: %36
- Abstract synonyms: %45
- Concrete antonyms: %18
- OOV performance: %32
- Irrelevants: %87
- 2+Derivations: %38
- Relatedness on SR Sub-space: %60

Thank you. Questions?



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