

■ INTERPRETATION AND GENERATION OF METAPHORS AND METAPHORICAL EXPRESSIONS

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BACKGROUND & INTERESTS

- BSc, University of Wollongong, CS – Digital Systems Security
- MSc, University of Helsinki, CS – Machine Learning, Algorithms and Data Analytics
- PhD, University of Helsinki, CS – Computational Linguistic Creativity
 - Title: Computational Understanding, Generation and Evaluation of Creative Expressions
 - Almost done (expected to defend in early March)
- Oulu / Google
 - Created a tool for managing and generating dictionaries for low-resourced languages
 - Open source: <https://github.com/mokha/verdd>
- Joined UH-LT – interactive AI using multimodal communications



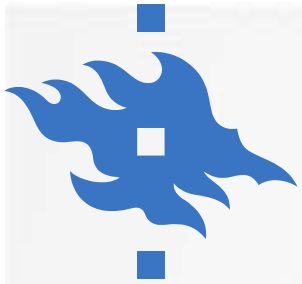
OUTLINE

- Introduction
- Interpretation of metaphors
- Generating of metaphorical expressions (slogans and poems)



CREATIVITY

- What is creativity?
 - Complex phenomenon
 - At least novelty and value are required (Mumford, 2003)
 - Aptness is usually considered too, but it can be seen as an extension of the value
 - Can be seen in various domains/fields
 - Focus: linguistic creativity



COMPUTATIONAL CREATIVITY

- A multidisciplinary endeavour that is located at the intersection of the fields of AI, cognitive psychology, philosophy, and the arts.
- Some of the main goals:
 - To build methods capable of producing creative artefacts
 - To understand our own creativity by modeling it computationally
 - To design tools that assist us in being creative
 - ...



LINGUISTIC CREATIVITY

- Creativity + Language
- Can be expressed in any of the language units:
 - Words
 - Sentences
 - Prosody
 - Semantics
 - ...



COMPUTERS AND CREATIVE LANGUAGE

- Generation
 - E.g. generating poems
- Interpretation
 - E.g. interpreting the meaning of a metaphor
- Detection, Recognition, Identification
 - E.g. “This presentation is great!”, irony?
- Evaluation
 - E.g. How “creative” is a given story?
- ...



FIGURATIVE LANGUAGE

- Going beyond the literal meaning of words
- To create:
 - New interesting expressions
 - Persuasive messages
 - Dramatic effects
 - ...



EXAMPLES OF FIGURATIVE LANGUAGE

- Metaphors
 - E.g. time is money
- Similes
 - E.g. brave as a lion
- Personification
 - E.g. the sky was full of dancing stars
- ...



METAPHORS

- A metaphor involves two concepts:
 - **Tenor** (target, topic)
 - **Vehicle** (source, subject)
- Can be expressed in various forms
 - E.g. verbal, visual
- Syntax of nominal metaphors: “**T is V**”
 - E.g. **Time is Money**
- Highlight some properties of the tenor or attribute new ones to it from the vehicle
- A given metaphor can have different meanings



APPLICATIONS OF VERBAL METAPHORS

- Poems
- Stories
- Advertising
- News
- Lyrics
- ...



FEATURES TO CONSIDER WHEN INTERPRETING METAPHORS

- Properties
- Domain
- Categories of the two concepts
- Context
- Phonemes
- ...



METAPHOR APTNESS

- Salience imbalance
- Similarities between tenor and vehicle
- Affect polarity
- Concreteness and imageability of vehicle
- Prosody
- Novelty
- ...



CLOUD IS A COTTON

Any interpretations?



CLOUD IS A COTTON

- Interpretations by Meta4meaning
 - Soft
 - White
 - Fluffy
 - Spin, ...
- How?
 - Mine collocations (with POS tags) from web corpora (UkWac)
 - Focus on certain associations (e.g. ADJ and VERB)
 - Perform vector operations on the two vectors to highlight their shared/distinct properties
 - Return the top features of the vector as interpretations



VECTOR OPERATIONS

1. Product of saliences

$$p_i = t_i \cdot v_i$$

2. Difference of saliences

$$d_i = v_i - t_i$$

3. Combined metaphor rank

$$c_i = \min(\text{rank}(i, p), \text{rank}(i, d))$$

where $\text{rank}(i, x) = |\{j \mid x_j \leq x_i\}|$.

- ... more in the paper (Xiao, P., Alnajjar, K., Granroth-Wilding, M., Agres, K., & Toivonen, H. (2016). Meta4meaning: Automatic Metaphor Interpretation Using Corpus-Derived Word Associations. In ICCAC 2016.)



EVALUATION & RESULTS

- Dataset by (Carlos Roncero & Roberto G. de Almeida, 2015) where people gave their top 3 interpretations to nominal metaphors
- Look at how many of the gold standard interpretations fall in the top @n interpretations suggested by the system

Meta4meaning variant	Recall				
	@5	@10	@15	@25	@50
Product of saliencies p_i	0.215	0.274	0.304	0.325	0.466
Difference of saliencies d_i	0.193	0.227	0.27	0.308	0.391
Combined rank c_i	0.221	0.303	0.339	0.397	0.454
Sum of saliencies p_i^+	0.164	0.239	0.316	0.368	0.41
Combined sum rank c_i^+	0.184	0.254	0.299	0.384	0.462

- State-of-the-art results based on (Rai & Shampa, 2020)



EXTENSIONS TO THE WORK

- Cover proper nouns that are not in the corpus (e.g. Hillary Clinton is a Cat) (Alnajjar et al., 2017):
 - Smart
 - Intelligent
 - Independent
 - ...
- Release a Finnish model as part of a Python package for dealing with Finnish poetry
 - <https://github.com/mikahama/FinMeter/>



SLOGAN GENERATION

We present a method for automatically creating slogans

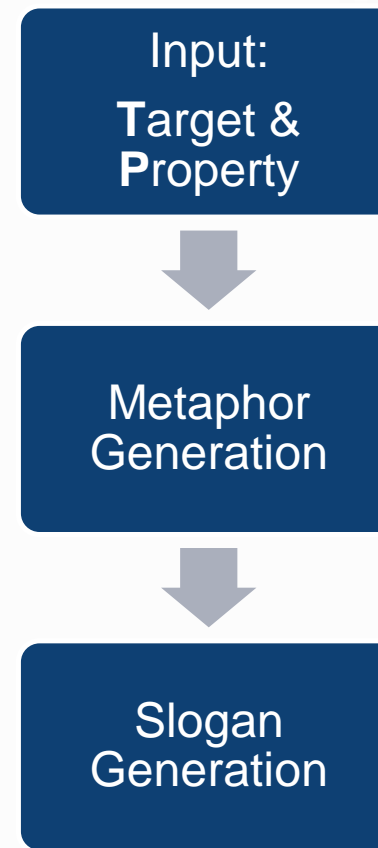
Alnajjar, K., & Toivonen, H. (2020). Computational generation of slogans. *Natural Language Engineering*, 1-33.

Motivations:

- 92% of slogans utilise rhetorical devices (Miller and Toman 2014)
 - Prosody (95%)
 - Metaphors (25%)
- Slogans containing rhetorical devices are more persuasive (Tom and Eves 1999)
- To assist a human slogan designer



SLOGAN GENERATION





RESOURCES

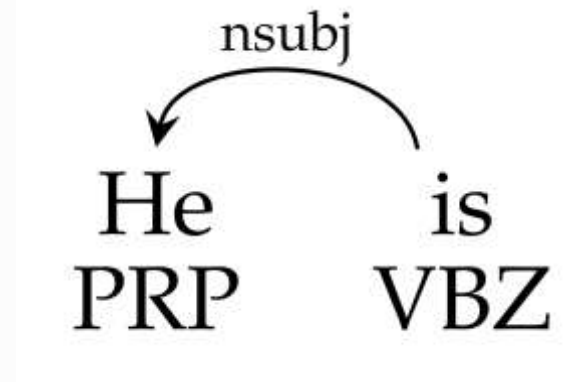
- UkWac Corpus (2 billion word web-based corpus)
 - Language Model (Bigram)
 - Semantic Model (Based on (*Meta4Meaning 2016*))
 - To measure semantic relatedness
 - To obtain related words
 - Grammatical Relations
- Nouns and Their Adjectival Properties
 - General Nouns (e.g. coffee): Thesaurus Rex (Veale and Li 2013)
 - Human Nouns (e.g. actor): Provided by Alnajjar et al. (2017)
- Expression Skeletons (i.e. the parse tree without content words)



GRAMMATICAL RELATIONS

Obtained from Ukwac

Retain relations with freq ≥ 50 , yields ~3M relations



Freq:
93711

Khalid Alnajjar. (2018). The 12 Million Most Frequent English Grammatical Relations and their Frequencies [Data set]. Zenodo. <http://doi.org/10.5281/zenodo.1255800>



METAPHOR GENERATION

Examine the effect of using a corpus-based metaphor interpretation model, *Meta4meaning*, in generating metaphors.

m4m(computer, artist):

1. Work
2. Graphic
3. Visual
4. Scientist
5. Professional
6. Creative
7. Digital

....

Get nouns (V) strongly associated with P

Construct candidate metaphors as “ T is v ”

Interpret using *Meta4meaning*

Keep apt metaphors (threshold & asymmetry)



SLOGAN GENERATION

Input: **T**arget, **P**roperty, **v**ehicle, and **s**keleton

Construction of Semantic Spaces

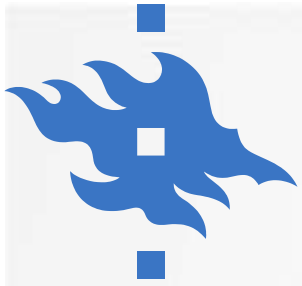
Interesting Space

- Related words to target/tenor and vehicle

Universal Space

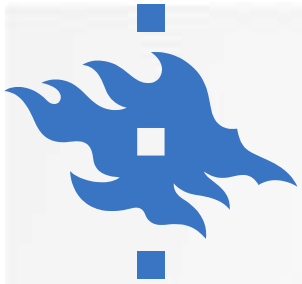
Construction of Search Space

All possible slogans constrained by **s** and semantic spaces



CRITERIA OF GOOD SLOGANS

- Filtering (boolean):
 - Relatedness between words within the slogan
 - Positive sentiment
- Evaluation (ratio):
 - Relatedness to the input
 - Language correctness and word frequencies
 - Figurative devices



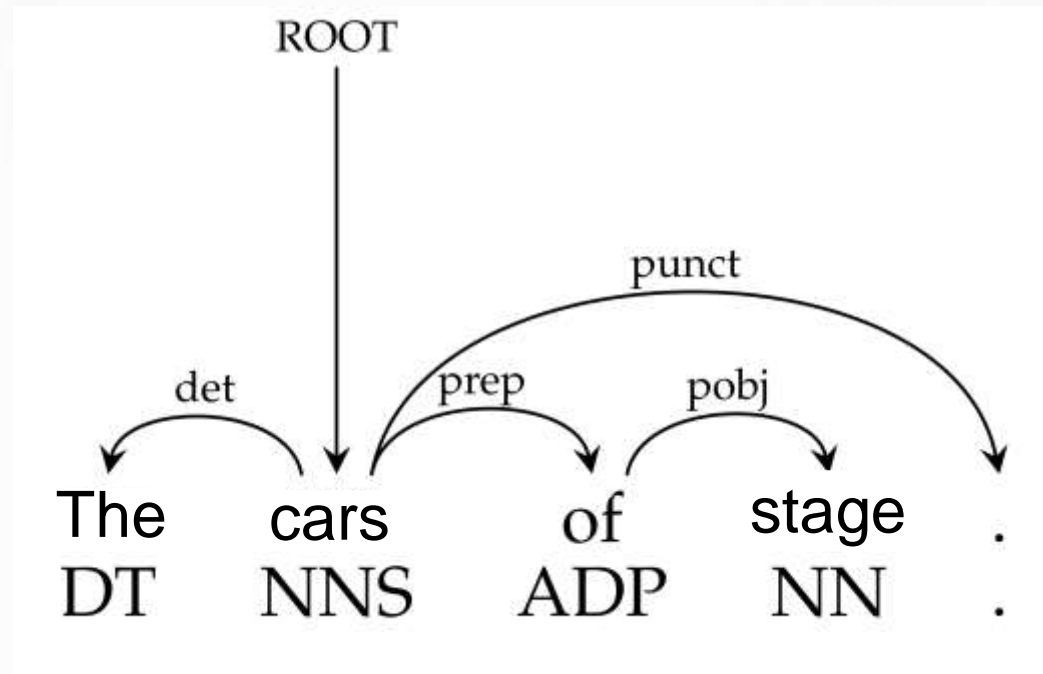
TRAVERSING THE SEARCH SPACE

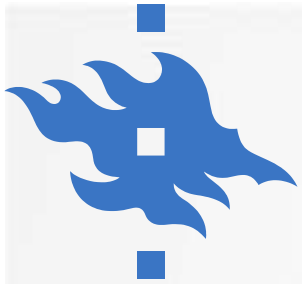
- Genetic Algorithms ($\mu + \lambda$)
 - Initial Population
 - Mutation and Crossover
 - Filtering
 - Internal Evaluation
 - Selection



INITIAL POPULATION

Fill in **s** starting with the slot with the most dependent words.





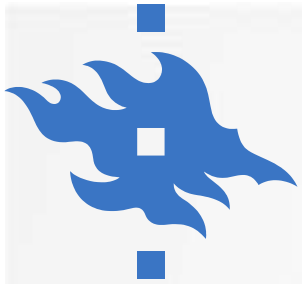
MUTATION AND CROSSOVER

- Mutation:
 - At random, substitutes a content word
 - E.g. replace “stage” -> “professional”
- Crossover:
 - One-point crossover
- All grammatical relations are checked.
 - Parents are kept in case of a failure



FILTERING

- Relatedness of words in slogan against each other
- Sentiment
 - Using *Pattern* (Smedt and Daelemans 2012)
- Duplicates

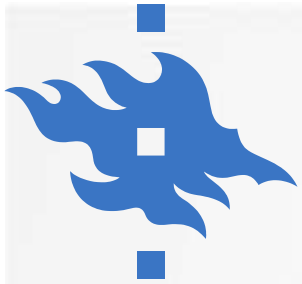


INTERNAL EVALUATION

Four dimensions:

1. Relatedness to the input:
 - Relatedness to Target
 - Relatedness to Property

2. Language:
 - Bigram Language model
 - Word infrequencies (Özbal et al (2013))



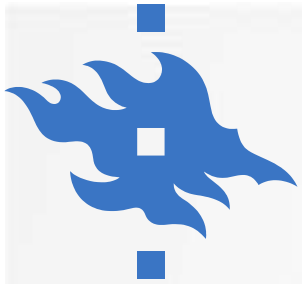
INTERNAL EVALUATION

3. Metaphoricity

- A slogan has words related to both the tenor/target T and the vehicle
 - $metaphoricity_2 = \max_rel(T) \cdot \max_rel(v)$
- At least a word that is strongly related to the vehicle but not to the tenor
 - $metaphoricity_2 = \operatorname{argmax}(rel(w, v) - rel(w, T))$

4. Prosody (The CMU Dictionary)

- Consonance
- Assonance
- Alliteration
- Rhyme



SELECTION (NSGA-II)

- Multi-objective selection
- Conflicting dimensions
- Reduce imbalanced slogans with a dominant dimension

- Test whether slogans with balanced dimensions are considered better



EVALUATION

- Evaluate both methods
 - Crowdsourced
 - English speaking countries
 - 5-point Likert scale
- Input (35 concept-property pairs):

Concept	Properties	Concept	Properties
book	wise, valuable	chocolate	healthy, sweet
computer	creative, mathematical, powerful	painting	creative, majestic, elegant
car	elegant, exotic, luxurious	university	diverse, valuable
coke	sweet, dark	museum	ancient, scientific
love	wild, beautiful, hungry	professor	old, wise, prestigious, smart
newspaper	commercial, international	paper	white, empty, scientific
politician	powerful, dishonest, persuasive, aggressive		



EVALUATION METAPHOR GENERATION

- 53 apt vehicles
- For each:
 - Strongly Related
 - Related
 - Random
- 10 judges evaluate if "T is v" expresses P
- Randomized order



EVALUATION METAPHOR GENERATION

'computer is an artist' expresses that the computer is creative (required)

Strongly disagree

Disagree

Neutral

Agree

Strongly Agree

'computer is a child' expresses that the computer is creative (required)

Strongly disagree

Disagree

Neutral

Agree

Strongly Agree

'computer is a novelist' expresses that the computer is creative (required)

Strongly disagree

Disagree

Neutral

Agree

Strongly Agree

'computer is a tansy' expresses that the computer is creative (required)

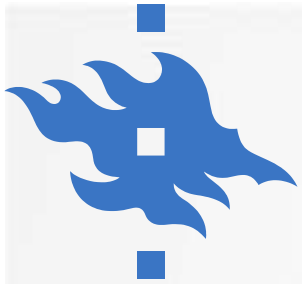
Strongly disagree

Disagree

Neutral

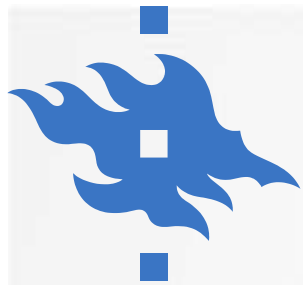
Agree

Strongly Agree



EVALUATION OF SLOGAN GENERATION

- For every input and apt vehicle:
 - Randomly select 2 skeletons to be filled
- From final population, 8* slogans are selected:
 - A random slogan with all four dimensions are positive
 - Two random slogans with relatedness + language + either of the rhetorical dimensions
 - Maximising individual dimensions
 - Least
- In total, 684 slogans
- Detokenized using NLTK
- Each slogan evaluated by 5 judges



EXAMI

Topic: diverse university

Slogan: "You Ca Not Beat The Top Path."

The slogan is related to the topic: diverse university. (required)

Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

The language of the slogan is correct. (required)

Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

The slogan is metaphoric. (required)

Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

The slogan is attractive, catchy or memorable. (required)

Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Overall, this is a good slogan. (required)

Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

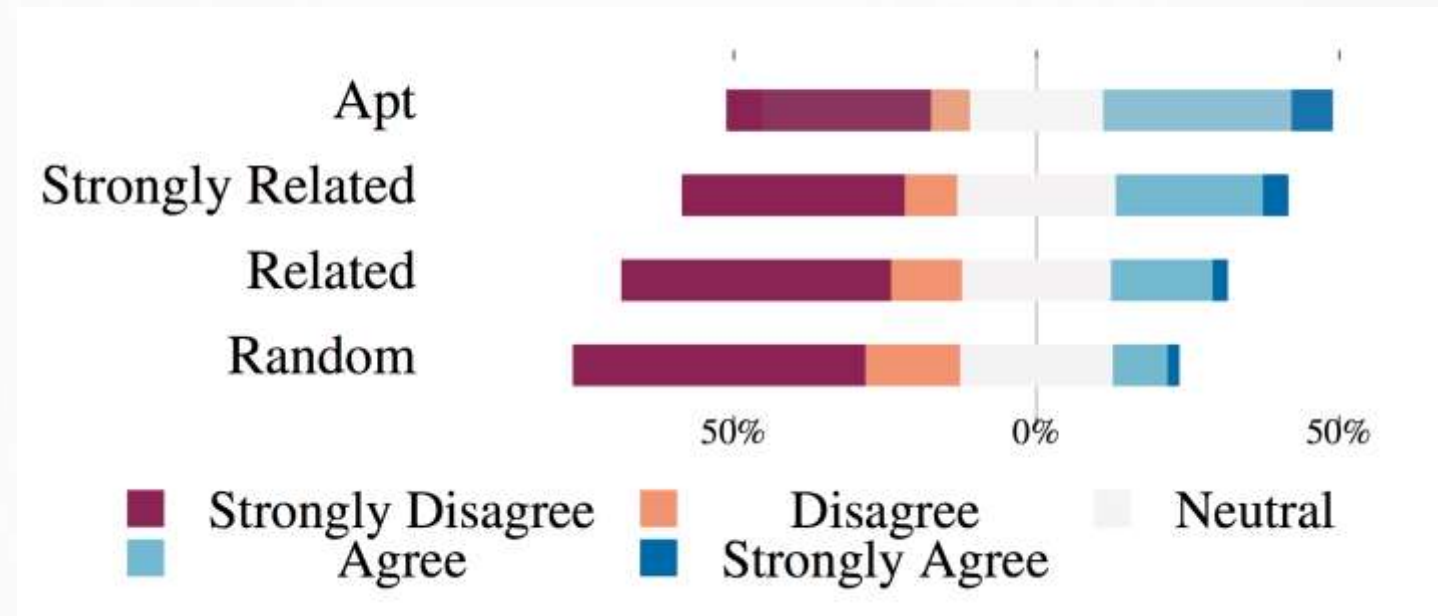


EXAMPLE OF GENERATED SLOGANS

Concept	Property	Vehicle	Output
computer	creative	artist	Talent, Skill And Support.
			Follow Questions. Start Support.
		poet	Work Unsupervised.
			Younger Than Browser.
car	elegant	dancer	The Cars Of Stage.
painting	creative	literature	You Ca N't Sell The Fine Furniture.
politician	persuasive	orator	Excellent By Party. Speech By Talent.
	dishonest	thief	Free Speech.
	aggressive	predator	Media For A Potential Attack.



RESULTS OF METAPHOR EVALUATION

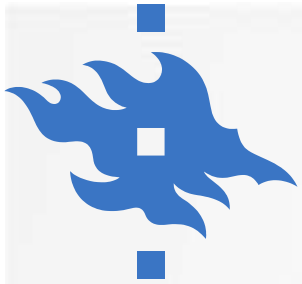




RESULTS OF SLOGAN EVALUATION

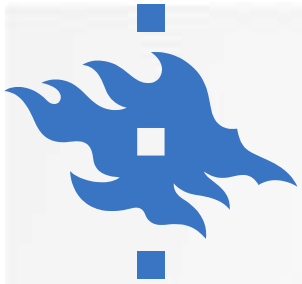
- 35% of generated slogans were considered suitable
- Mean and SD:

Selection	<i>n</i>	Relatedness		Language		Metaphoricity		Catchyness		Overall	
		μ_x	<i>SD</i>	μ_x	<i>SD</i>	μ_x	<i>SD</i>	μ_x	<i>SD</i>	μ_x	<i>SD</i>
<i>pos(r, l, m, p)</i>	262	3.05	0.69	3.15	0.67	2.91	0.60	2.98	0.67	2.92	0.68
<i>pos(r, l, m)</i>	93	3.01	0.76	3.06	0.72	2.93	0.61	2.93	0.71	2.87	0.70
<i>pos(r, l, p)</i>	111	3.00	0.73	3.17	0.63	2.91	0.63	2.88	0.59	2.86	0.66
<i>max(r)</i>	100	3.11	0.70	3.19	0.66	2.90	0.61	2.95	0.68	2.90	0.70
<i>max(l)</i>	105	2.89	0.70	3.16	0.70	2.83	0.59	2.91	0.65	2.80	0.68
<i>max(m)</i>	88	2.94	0.73	3.01	0.64	2.90	0.62	2.91	0.66	2.83	0.67
<i>max(p)</i>	96	2.93	0.76	3.11	0.71	2.91	0.68	2.86	0.67	2.83	0.69
<i>min(r, l, m, p)</i>	104	2.77	0.69	2.98	0.65	2.78	0.65	2.82	0.65	2.75	0.70



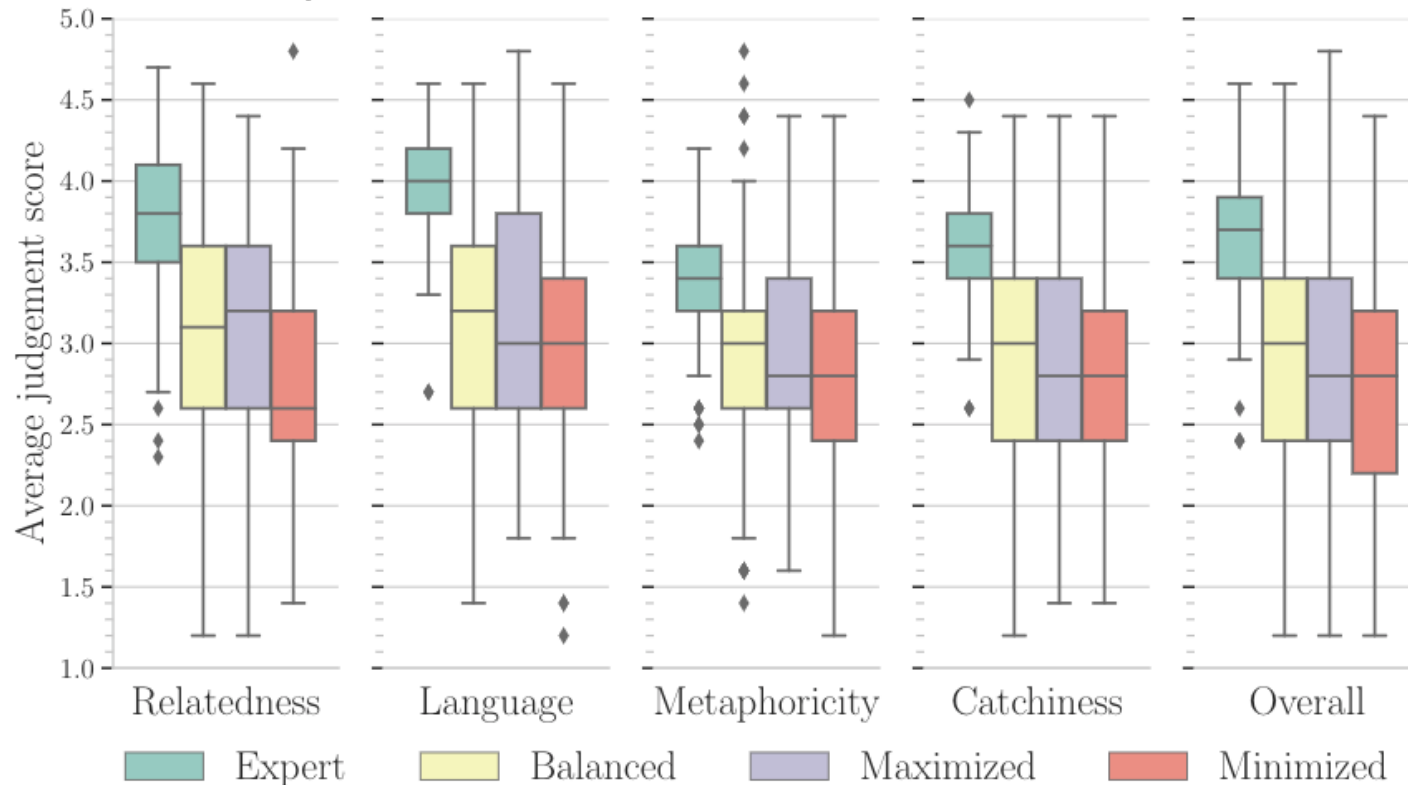
RESULTS OF SLOGAN EVALUATION

- Permutation test:
 1. $\mu_x(\text{balanced}) > \mu_x(\text{maximised})$
 2. $\mu_x(\text{balanced}) > \mu_x(\text{least})$
 3. $\mu_x(\text{maximised}) > \mu_x(\text{least})$
- Statistical Significance only in 2nd test
 - p-value of 0.0286



ADDITIONAL EVALUATION

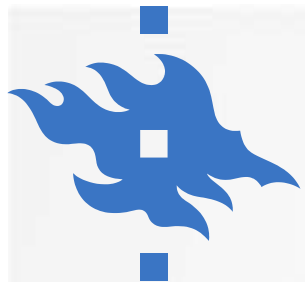
- Comparison to expert-made slogans (Distributions of mean judgements of slogans)





METAPHOR INTERPRETATION AND POEM ANALYSIS IN FINNISH

- Mika Hämäläinen and Khalid Alnajjar (2019). Let's FACE it. Finnish Poetry Generation with Aesthetics and Framing. In the Proceedings of The 12th International Conference on Natural Language Generation. pages 290-300
- <https://github.com/mikahama/FinMeter>
 - Semantic clusters
 - Concreteness
 - Metaphor interpretation
 - Sentiment analysis
 - ...



THANK YOU