

Cross-lingual Modeling of Lexical Metaphor and Metonymy in WordNet using ChainNet

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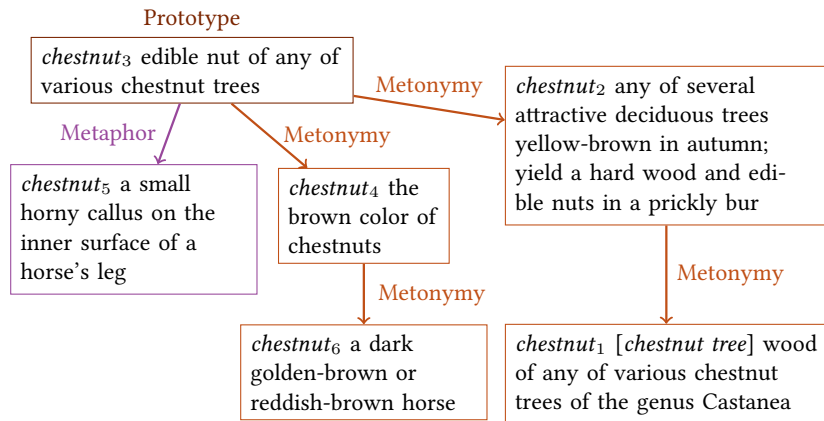
Metaphor and Metonymy

- Metonymy and metaphor are two fundamental tropes (figures of speech)
- Both play crucial roles in the way we understand and use language
- **Metonymy** involves the substitution of one term for another to which it is closely related
 - ▶ *I ate a chestnut*
 - ▶ *I pruned the chestnut [tree]*
 - ▶ *This table is made from chestnut [wood]*
 - ▶ Metonymy works by contiguity or association between concepts, usually by some shared attribute, or by a part-whole relation
- **Metaphor** involves understanding one concept in terms of another, often unrelated, concept.
 - ▶ *This horse has a chestnut on its leg* “a small horny bump”
 - ▶ Metaphors create new concepts in the target domain by mapping elements from the source domain
- They are crucial in understanding novel uses of words

- ChainNet is an attempt to comprehensively model these tropes (Maudslay et al., 2024; Bond and Maudslay, 2025)
 - ▶ All nouns (word + synset combinations) in the Princeton Wordnet (Fellbaum, 1998) with three or more senses* were annotated
 - ▶ Every sense linked to another sense, or treated as a homonym (unrelated)
 - ▶ Annotated by 1 annotator, some by 2 annotators
 - ★ Inter-annotator agreement 70% (88% for same prototype)
 - ★ Intra-annotator agreement 81% (92% for same prototype)
 - ▶ Originally grew out of work in determining homonyms – which senses of a word are related

* almost, and some with two senses. All should eventually be annotated

chestnut



Can we see how English metaphors are used cross-lingually?

- For example, are translations of linked pairs likely to be translated with the same word
 - ▶ If so then metaphor/metonymy holds cross language
 - ... or this may indicate issues with automatic construction of wordnets
- For example *head* “body part” is metaphorically extended to “person in charge” in English and this is also true in Japanese, (頭) Italian (*capo*) and many other languages
- But not all metaphors are shared: *head* “main part of a grammatical constituent” is not 頭 in Japanese
- ChainNet is made for English, but we can expect many of the tropes to work with other languages
- And we have many dictionaries linked to English in the Open Multilingual Wordnet, such as DanNet

Measure the translation overlap with OMW

- For every English word that has been annotated
 - ▶ For each pair of English senses
 - ▶ Look up all translations of each sense
measure the overlap (we use Jaccard similarity)
 - ▶ Store and note if the senses are linked or not
- So for example *head* has 3 senses (really many more)
 - ① head, caput
ヘッド, 頭, 頭部
 - ② head, chief, top dog
大頭, 主任者, 御頭, 頭領, 頭
 - ③ head, head word
主要語
- Overlap
 - ▶ 1-2: 0.125
 - ▶ 2-3: 0
 - ▶ 1-3: 0

We do this for all the lexicons in OMW-1.4 I

Lang	Unlinked	Metaphor	Metonymy	Non-Zero Instances
sv	0.70	1.71	2.10	417
he	0.69	1.58	2.31	472
eu	0.82	1.30	1.80	5,562
ja	0.89	1.11	1.55	8,130
ro	0.83	1.30	1.71	6,429
sq	0.74	1.27	2.38	822
da	0.74	1.46	2.09	332
lt	0.63	1.46	2.86	692

- **unlinked** has no link
- **metaphor** is linked by metaphor
- **metonymy** is linked by metonymy

Normalize by dividing by the average distance for all senses.

We do this for all the lexicons in OMW-1.4 II

Lang	Unlinked	Metaphor	Metonymy	Non-Zero Instances
es	0.85	1.17	1.79	5,915
hr	0.81	1.22	1.98	3,576
fr	0.94	1.10	1.25	18,975
nb	0.73	1.49	2.12	339
bg	0.73	1.54	2.11	380
gl	0.70	2.13	1.55	271
cmn	0.74	1.57	1.97	1,347
it	0.80	1.39	1.81	4,614
arb	0.74	1.28	2.38	1,337
pl	0.75	1.43	2.07	1,326
el	0.72	1.30	2.45	1,274
iwn	0.79	1.46	1.80	968
nn	0.73	1.52	2.10	340
id	0.87	1.21	1.58	9,803

We do this for all the lexicons in OMW-1.4 III

Lang	Unlinked	Metaphor	Metonymy	Non-Zero Instances
is	0.73	1.51	2.13	388
ca	0.83	1.23	1.84	6,000
sk	0.73	1.35	2.31	2,067
fi	0.82	1.35	1.76	7,971
nl	0.79	1.38	1.90	2,991
sl	0.81	1.41	1.74	6,243
th	0.80	1.48	1.71	2,336
pt	0.80	1.26	1.96	5,414
zsm	0.87	1.22	1.60	10,272
Mean	0.78	1.39	1.96	3,774.3

Unlinked share fewer translations, metaphor shares more and metonymy shares much more.

Metonymy is more likely to hold cross linguistically!

Discussion

- The wordnets are of vastly different sizes: the number of sense pairs that have a translation varies from 271 (Galician) to 18,975 (French).
- Only Galician has the score for metaphor (2.13) larger the score for metonymy (1.55), probably due to data sparsity. We expect it to behave much like Catalan and Spanish (1.23/1.84 and 1.17/1.79)
- In order to measure perfectly how well tropes carry over between languages, we would need to mark metonymy and metaphor systematically for each language, and make sure all synsets for all senses have all relevant translations
- Even so, it is striking how uniform our results are, even for very different resources and different languages
- Without exception, senses linked by tropes are more likely to have an identical translation than those senses which are not linked
- With one exception, metonymy is more likely to have an identical translation than metaphor

Translations of the senses of *cherry*

Sense	Mandarin	Japanese	Finnish	Italian
<i>cherry</i> ₁ (wood)	櫻桃木	桜, <u>桜材</u>	kirsikkapuumetsä	ciliegio
<i>cherry</i> ₂ (tree)	櫻桃树	桜, 櫻	kirsikkapuu	ciliegio
<i>cherry</i> ₃ (fruit)	櫻桃	櫻桃, 桜ん坊	kirsikka	cerasa , ciliegia
<i>cherry</i> ₄ (colour)	<u>櫻桃紅</u>	<u>桜ん坊色</u>	kirsikanpunainen	ciliegia

- When we look at the translations, we see that the metonymy that is unmarked in English, is marked in other languages
- Even within English, other synonyms have information

Can we use other lemmas to classify links

- Synsets have sets of synonyms, so the other senses may include useful information
- Consider the synsets with a sense of chestnut
 - s1 chestnut “edible nut of any of various chestnut trees of the genus *Castanea*” (NATURAL_BODY)
 - s2 chestnut, chestnut tree “any of several attractive deciduous trees yellow-brown in autumn; yield a hard wood and edible nuts in a prickly bur” (PLANT)
 - s3 chestnut “wood of any of various chestnut trees of the genus *Castanea*” (CHEMICAL!)
- These are annotated as $s1 \rightarrow s2 \rightarrow s3$ (metonymy)
- If we look at all the senses
 - ▶ $s1 \rightarrow s2$ has a diff: “+ tree”
 - ▶ $s2 \rightarrow s3$ has a diff: “- tree”
- These patterns repeat ...
Cherry \rightarrow Cherry Tree \rightarrow Cherry

(en)

They can be found across languages

- s1 → s2: kastanje → kastanjetræ (da)
- s1 → s2: chestnut → chestnut tree (en)
- s1 → s2: marron → marronnier (fr)
- s1 → s2: kastanja → kastanjapuu (fi)
- s1 → s2: kastanje → kastanjeboom (nl)
- s1 → s2: castană → castan (ro)
- s1 → s2: castanăcomestibilă → castan (ro)

Ongoing Research to Find Patterns

- We have made a searchable database where the edges are decorated by the morphological differences
 - ▶ So we can see all pairs linked by **en:+ tree** or **da:+træ**
 - ▶ The nodes link to wordnet interlingual-indexes, so we can look up supertypes: so we can say this link is of type **FOOD:PLANT** or **PLANT IS FOOD** in the cognitive linguistic style
 - ▶ In this way we can group the tropes together in families
- Other people have done this top down (Khishigsuren et al., 2022, e.g start at **FOOD:PLANT** and looked for examples)
- With ChainNet we can go bottom-up and find many more patterns
 - ▶ We can use multi-lingual features
 - ▶ We need to investigate methods of clustering
 - ▶ We need to find a good way of evaluating
- We would like to also map to existing Conceptual Metaphors

The Patterns can be used Generatively

- If we see a word that is of type **FOOD**, then we can expect that there may be a kind of plant using the same word
 - ▶ Useful for analyzing texts that otherwise don't make sense
 - ▶ Can be used to analyse humour and word play



BBC Spaghetti Tree hoax (1957)

Metaphor in Large Language Models

- Because these tropes are so established, LLMs capture the patterns well, and can generalise to novel examples, at least for languages with a lot of online data
- E.g. For Spanish, Puraivan et al. (2024) found ChatGPT could differentiate literal from metaphorical senses with an accuracy of 85-88% (on a small dataset)
 - ▶ This is high enough to cause **automation blindness**
 - ▶ It is very hard for a human to spot mistakes
- We expect that this accuracy will go down for languages with less data and for less common senses, but have not yet confirmed this
- There also interesting questions of how much metaphor interpretation in multilingual models is effected by other languages
- So we feel it is important to keep working on producing reliable manually annotated data

Future Work

- We are interested in looking at the relation between in-context uses and tropes
Using sense-tagged corpora we can see
 - ▶ If basic uses or extended uses are more common
 - ▶ Do similar tropes cluster?
 - ▶ Do different genres use different tropes?
- We would like to do large scale annotation on another language (probably start with Japanese)
- We are looking in detail at a small sample: currently investigating **ANIMAL:PERSON** metaphors
 - ▶ *Be a lamb and give me a hand, ...*
 - ▶ In Chinese, Czech, English, French, Indonesian, Japanese, Javanese, Korean, Slovak and Vietnamese — it would be good to include some sign
- We would like to investigate similarities and differences in images, ...

Summary

- The combination of detailed annotation of meaning and cross-lingual links allow us to explore differences in meaning representation
 - ▶ Metonymy is based on association and contiguity
more universal
 - ▶ Metaphor often requires analogical reasoning and cultural framing
more culture and language specific
- We don't know if the tropes are independently discovered, come from a common ancestor, or are borrowed (the same problem as with cognates in etymology)
- We need to add to wordnet and make searchable
- LLMs may capture these regularities, but are hard to explore with

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- ChainNet is primarily the work of Rowan Hall-Maudslay
r.hallmaudslay@gmail.com
<https://github.com/rowanhm/ChainNet>
- The Open Multilingual Wordnet brings together wordnets made by many projects, we thank them all
- Data and code for the cross-lingual analysis is available at
<https://github.com/bond-lab/chainnet-xling>
(still changing a lot)

OMW 1.4

- The OMW is a collection of wordnets for different languages.
- These languages are linked through the collaborative interlingual index (CILI; Bond et al., 2016), a language-neutral list of concepts that is linked to by the various wordnets.
- The combined wordnets include English (Fellbaum, 1998), Albanian (Ruci, 2008), Arabic (Elkateb et al., 2006), Chinese (Huang et al., 2010), Danish (Pedersen et al., 2009), Finnish (Lindén and Carlson., 2010), French (Sagot and Fišer, 2008), Hebrew (Ordan and Wintner, 2007), Indonesian and Malaysian (Nurril Hirfana et al., 2011), Italian (Pianta et al., 2002; Toral et al., 2010), Japanese (Isahara et al., 2008), Norwegian Bokmål and Norwegian Nynorsk (Lars Nygaard, personal communication 2012), Persian (Montazery and Faili, 2010), Portuguese (de Paiva and Rademaker, 2012); Polish (Piasecki et al., 2009), Thai (Thoongsup et al., 2009), and Basque, Catalan, Galician and Spanish (Gonzalez-Agirre et al., 2012).
- Data is available from <https://github.com/omwn/omw-data>
- We used the python `wn` module (Goodman and Bond, 2021)

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