Multilingual Modelling with Wordnets: Metonymy Travels, Metaphor Wanders

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and many, many more

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Outline

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Roadmap

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Metaphor and Metonymy

- Metaphor and Metonymy are two fundamental tropes (figures of speech)
- Both play crucial roles in the way we understand and use language
- **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
- **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

The state-of-the art

- Conceptual Metaphor research very wide spread (cognitive, computational, therapeutic, political)
  - A lot of fantastic research!
- No broad coverage multilingual inventory of metaphors
  - MetaNet — long-running but mainly English (some Spanish and Chinese, far from comprehensive)
  - MetaphorShare — new (2025) initiative to bring together resources, but most with only hundreds or thousand of examples.
- No broad coverage multilingual corpora of instances
  - MIPVU is the largest (mainly English, some work in other languages)
- No broad coverage multilingual metaphor interpretation tools
  - Some tools for identification
  - Some tools for paraphrasing, but biased toward English (LLMs)

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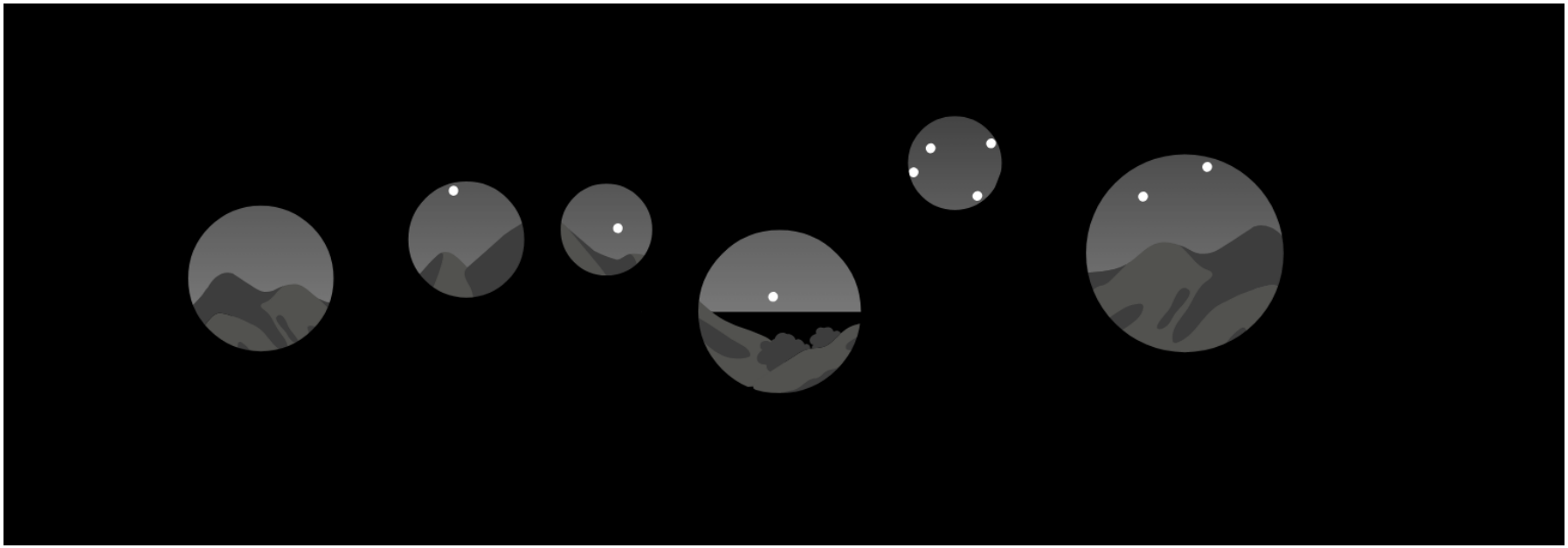
SoA: scattered fragments of the metaphor landscape



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We are trying a different approach

- Exploit existing multilingual resources (wordnets and sense-annotated corpora)
- ChainNet links word senses by metaphor — for all* nouns in the English wordnet
- Use ChainNet to study metaphor over a (quite) complete vocabulary
  - Link lexical to conceptual metaphors
  - Find unknown conceptual metaphors (unlinked lexical metaphors)!
  - **Finish with a much more complete understanding**
  - Use wordnet sense tagged corpora to investigate attested uses
  - **Finish with a grounded, quantitative understanding**

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ChainNet

- 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 3.0 (Fellbaum, 1998) with three or more senses* were annotated
  - Every sense linked to another sense, or treated as a homonym (unrelated)
    - ★ 7,500 metaphor pairs
    - ★ 6,116 metonymy pairs
  - Most 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

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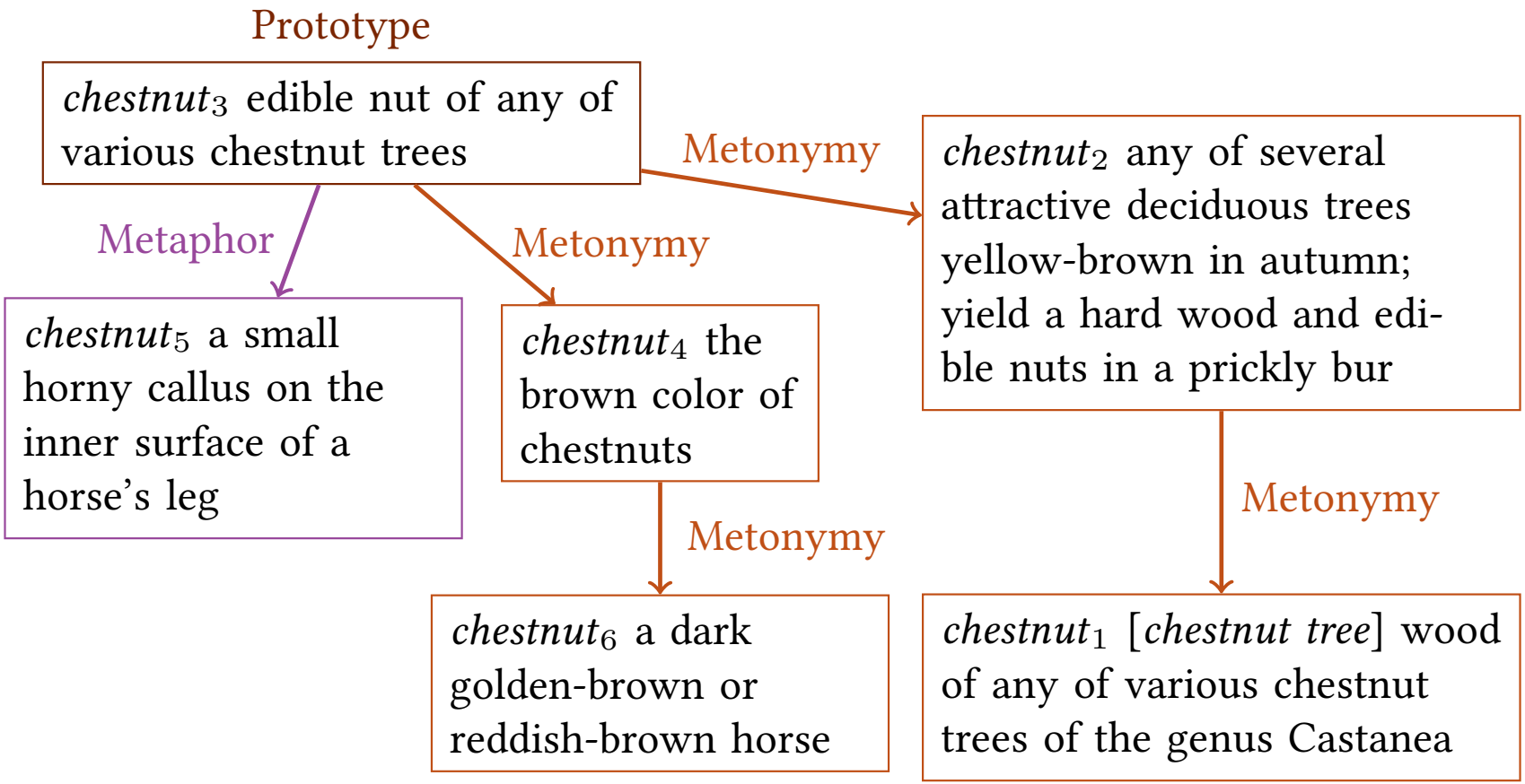
chestnut



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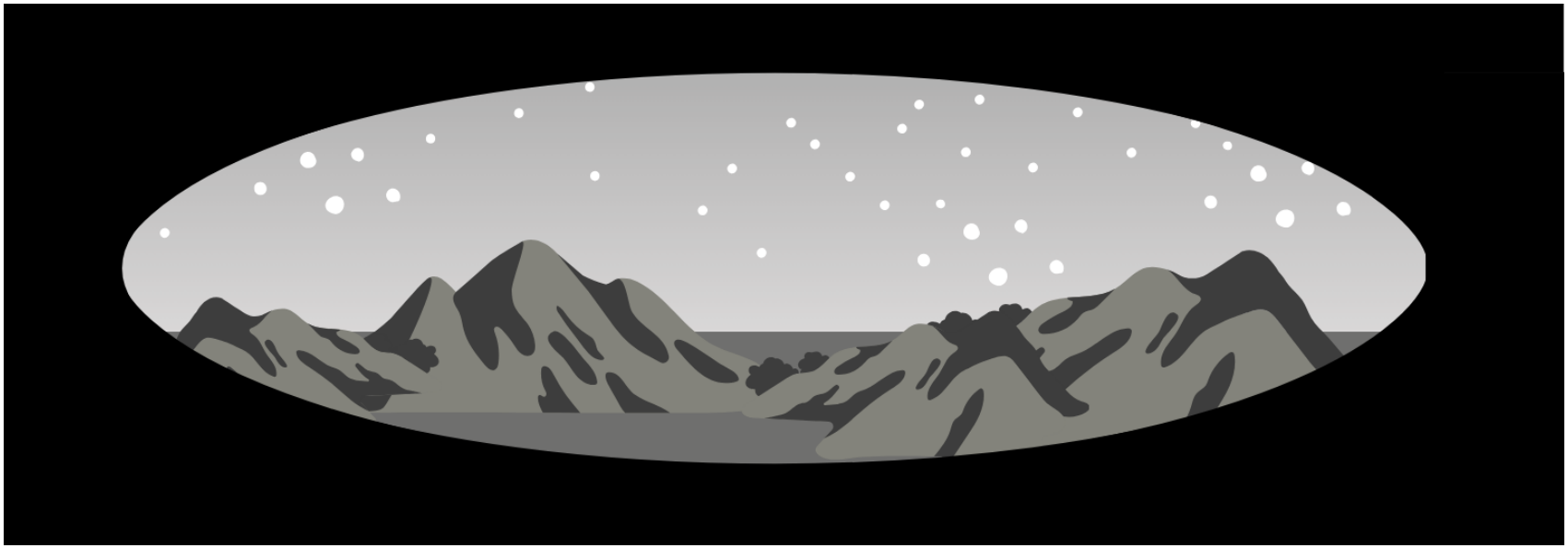
Metaphor viewed through the lexicon: a broader view



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How we proceed

- For every word with more than two senses
  - examine all pairs
  - determine if they are linked by metaphor or metonymy, or not at all

darkness $_1$ — absence of light or illumination (from wordnet)
darkness $_2$ — an unilluminated area "he moved off into the darkness"
darkness $_3$ — absence of moral or spiritual values "the powers of darkness"
darkness $_4$ — an unenlightened state "he was in the dark concerning their intentions" "his lectures dispelled the darkness"

---

darkness $_1 \rightarrow$ ***darkness*** $_2$ (metonymy)
darkness $_1 \rightarrow$ ***darkness*** $_3$ (metaphor)
darkness $_1 \rightarrow$ ***darkness*** $_4$ (metaphor)

Exploit wordnet for a richer view

- Once we have senses, we can look at supersenses

> ***darkness*** $_1$ (state) $\rightarrow$ ***darkness*** $_3$ (state)
> ***darkness*** $_1$ (state) $\rightarrow$ ***darkness*** $_4$ (cognition)

- Or indeed any hypernym

> ***darkness*** $_1$ (illumination|state|attribute|TOP) $\rightarrow$ ***darkness*** $_3$ (wickedness|condition|sate|attribute|TOP)
> ***darkness*** $_1$ (illumination|state|attribute|TOP)) $\rightarrow$ ***darkness*** $_4$ (unenlightenment|ignorance|knowledge|...|top)

- We will use these to establish Conceptual Metaphor Labels

> ***darkness*** $_1 \rightarrow$ ***darkness*** $_3$ = GOODNESS IS LIGHT
> ***darkness*** $_1 \rightarrow$ ***darkness*** $_4$ = UNDERSTANDING IS LIGHT

Link to Sense-tagged corpora

Finally, we combine this with examples from sense annotated corpora, giving frequencies of metaphorical and non-metaphorical uses.

Examples from *The Adventure of the Speckled Band* (English)

- *Oh, sir, do you not think that you could help me, too, and at least throw a little light through the dense* ***darkness***$_4$ *which surrounds me?*
- *"Do you know, Watson," said Holmes as we sat together in the gathering* ***darkness***$_1$*, "I have really some scruples as to taking you to-night.*
- *Then he turned down the lamp , and we were left in* ***darkness***$_1$*.*

We have at least one story manually annotated for Bulgarian, English, Mandarin Chinese, Indonesian, Italian, Japanese and Polish, and automatically for Dutch and German.

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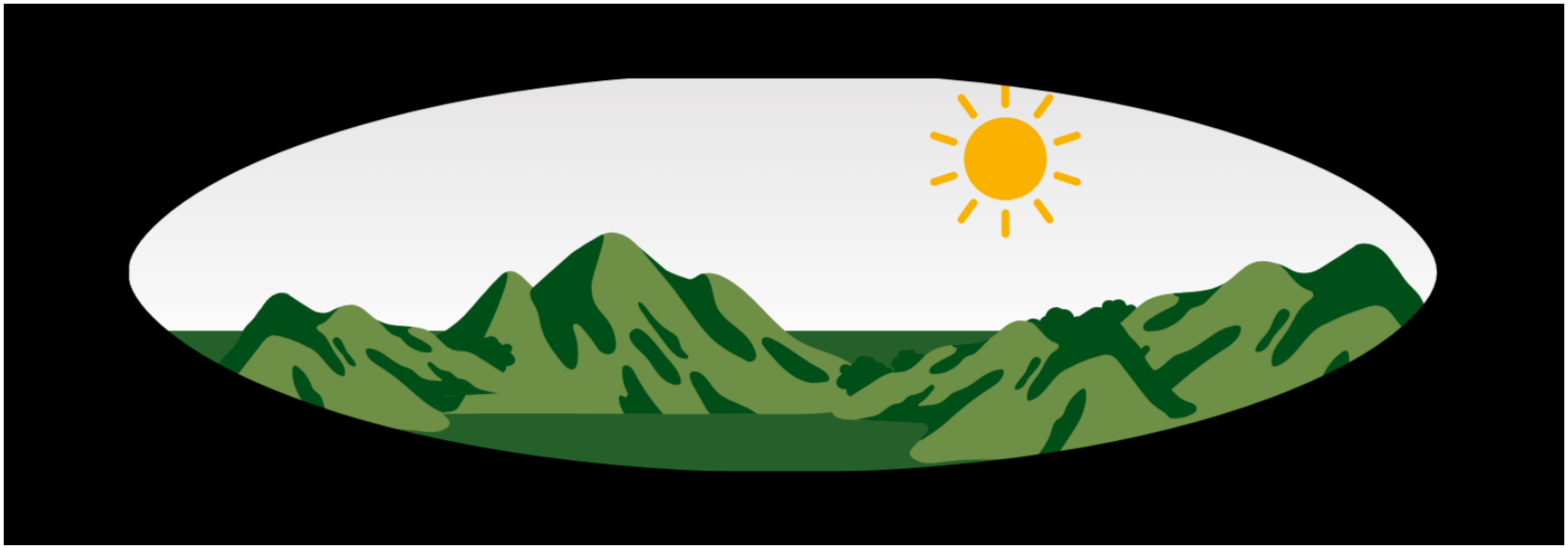
Metaphor linked to wordnet and corpora: a richer view



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Differences Between Metaphors and Metonyms

We can use the wordnet graph to compare the two

- For all trope pairs we measure the path distance between the source and target
- We measure the depth in the hierarchy (distance from root)
- We measure the number of synonyms of source and target
- We also look at the distribution of the topics, ...

These are new results (unpublished)

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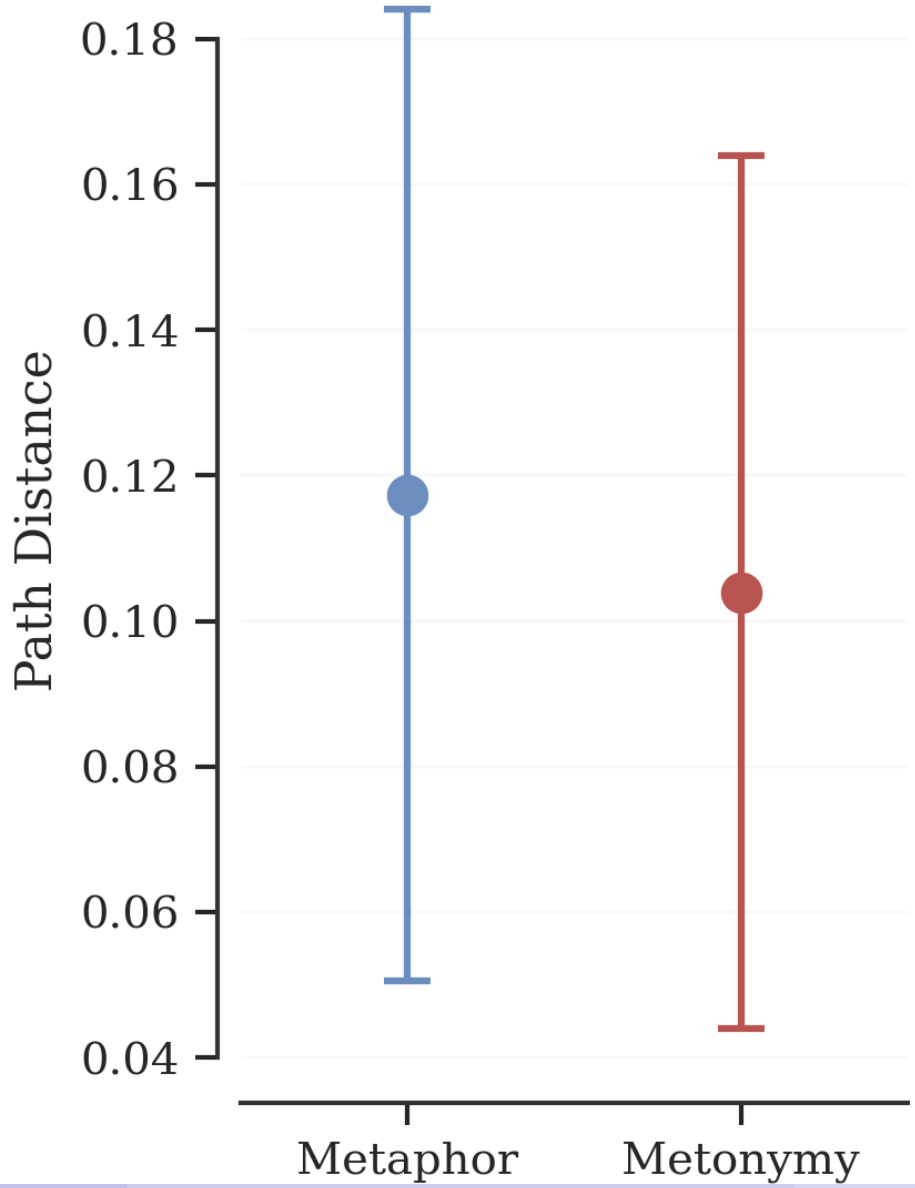
Path Distance Comparison



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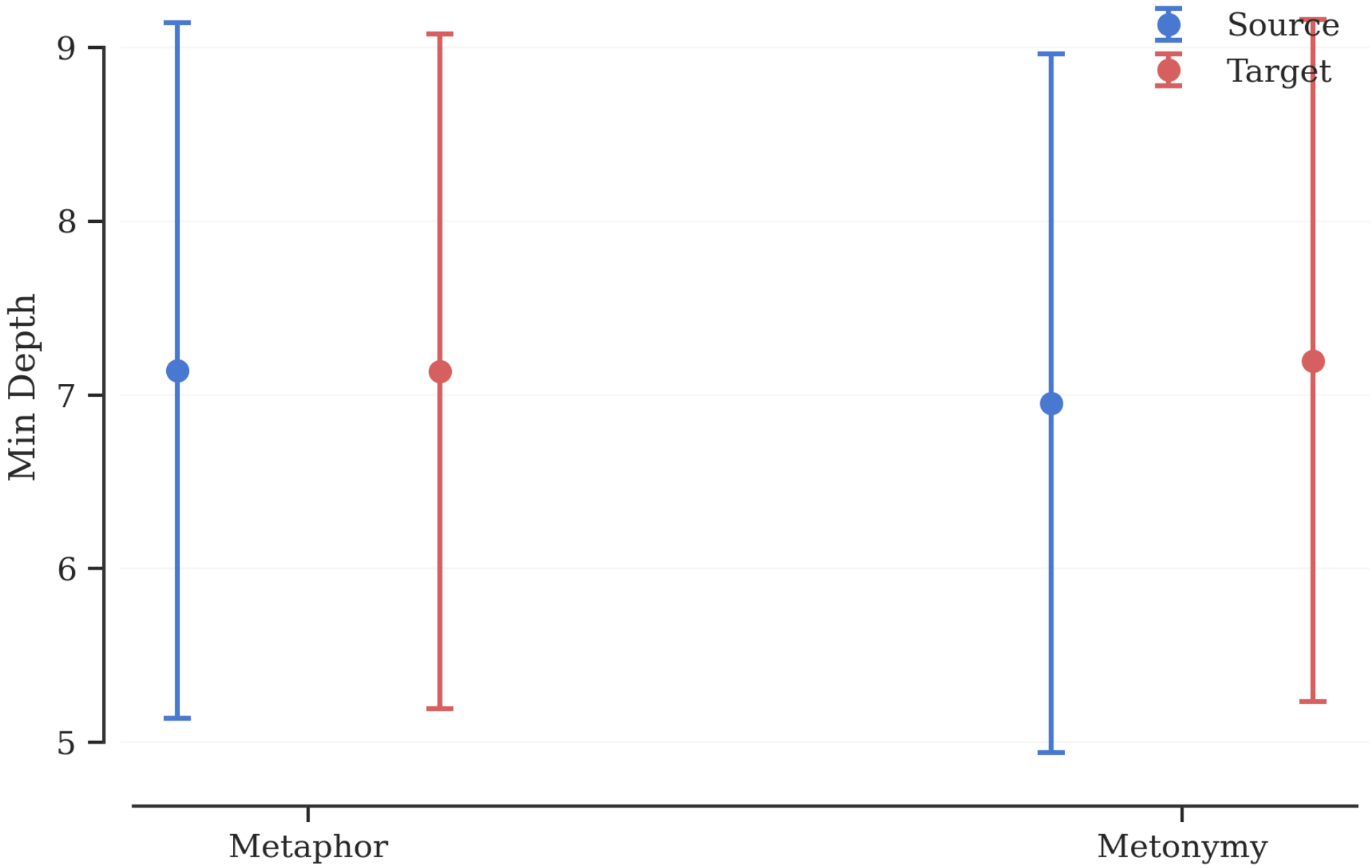
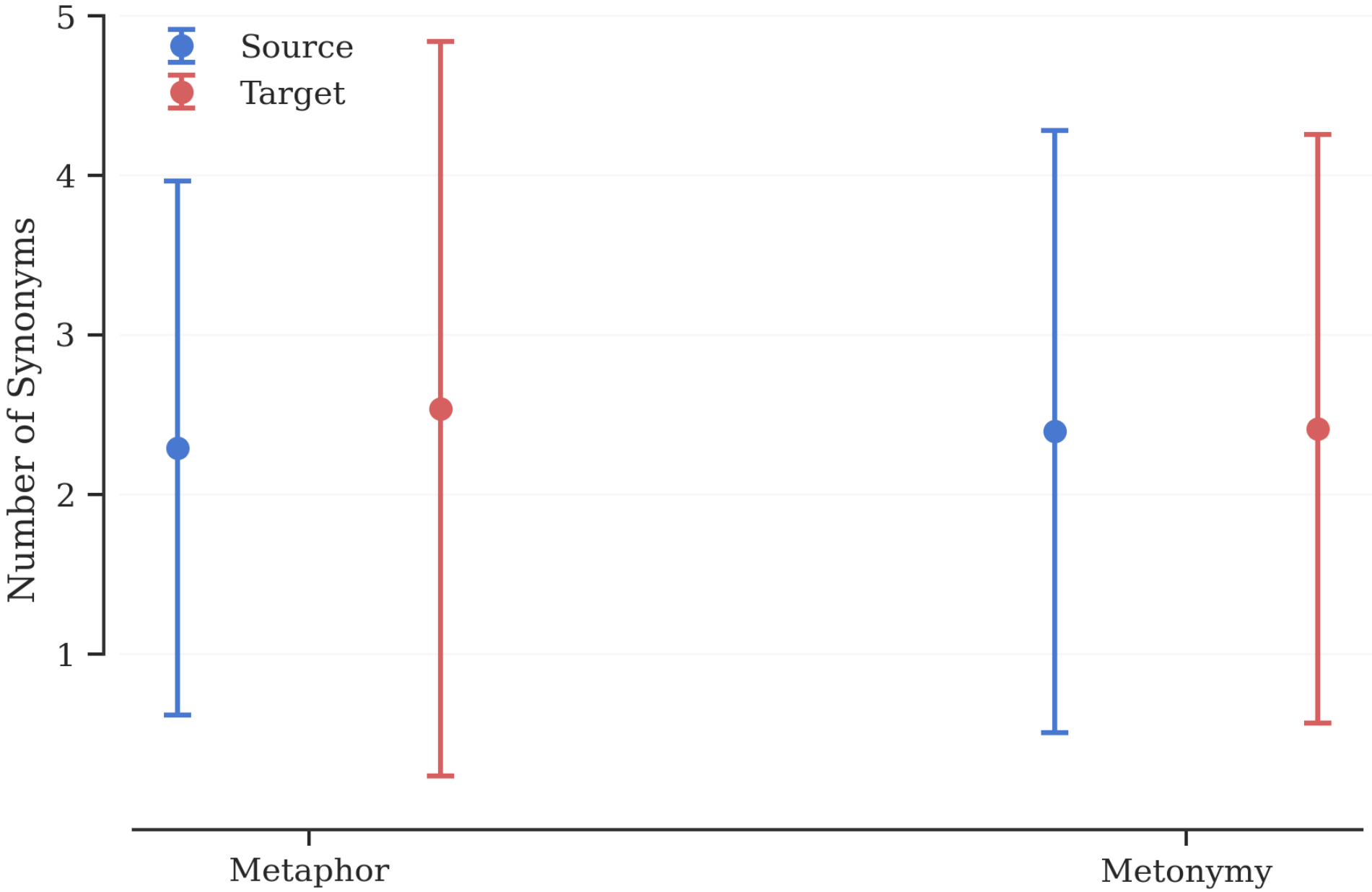
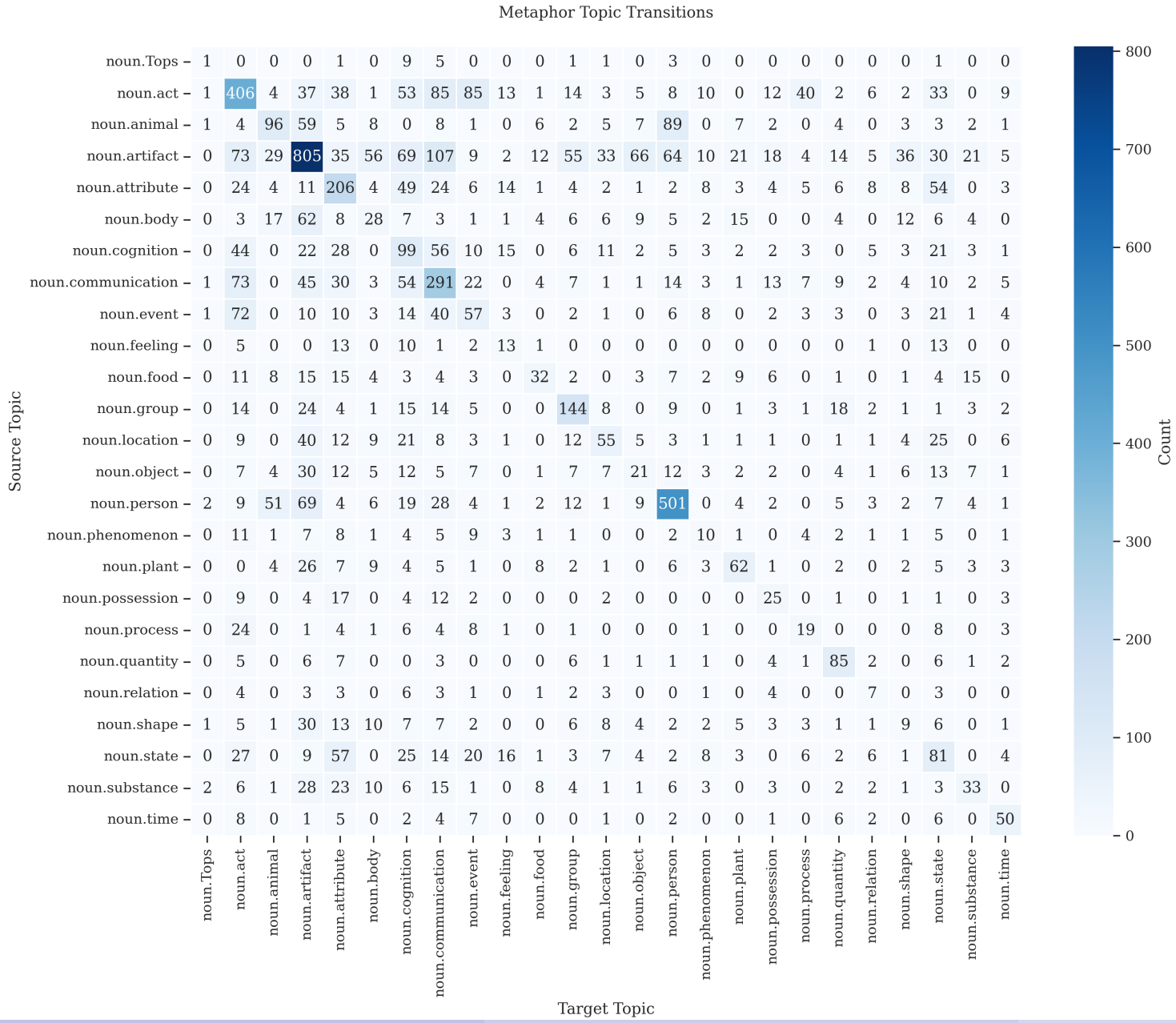
Depth in Hierarchy



Synonymy density (number of synonyms)



Topic Heatmap for Metaphors



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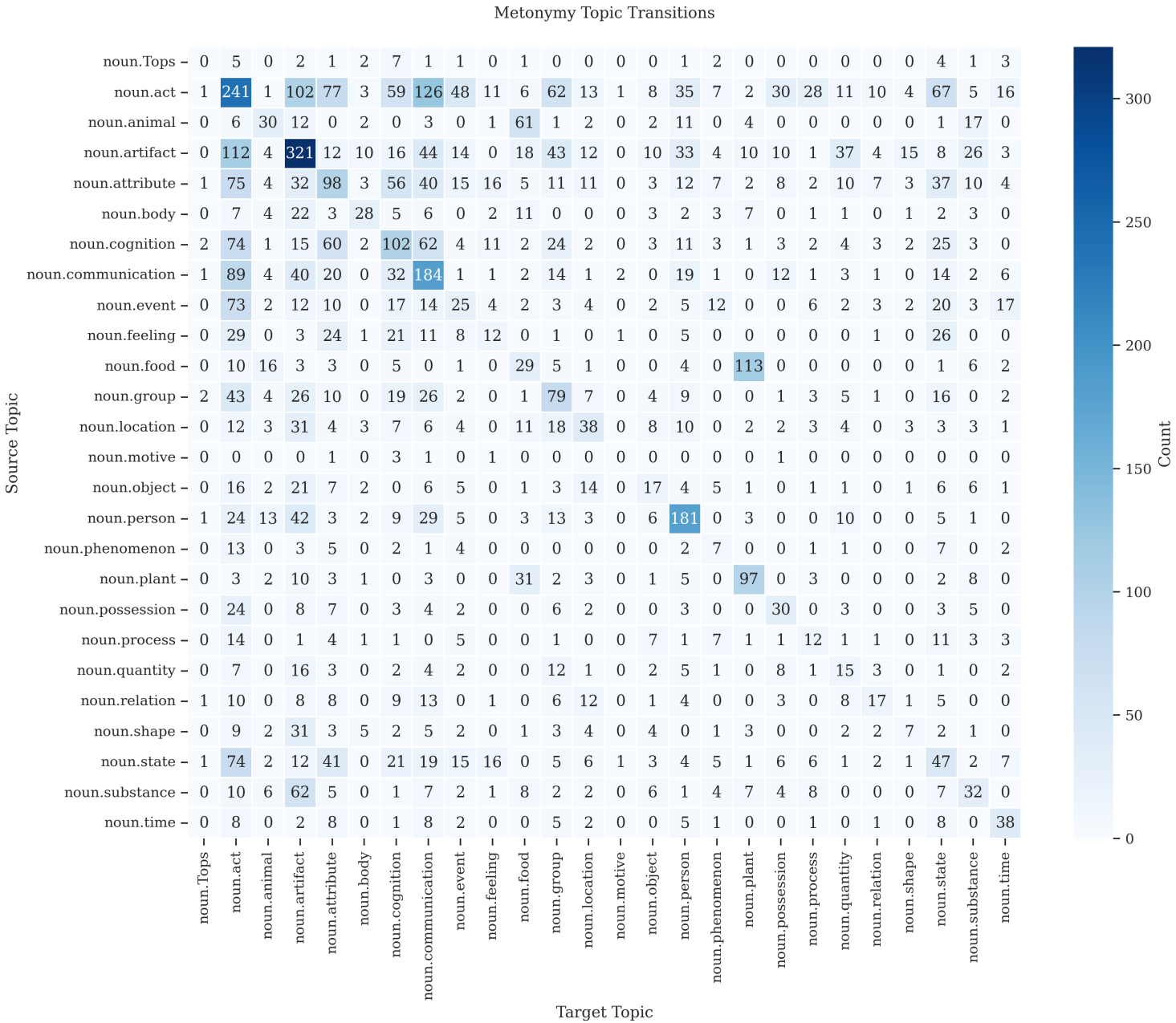
Topic Heatmap for Metonyms



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We have only just begun

Now investigating

- Inclusiveness (Abstractness)
- Frequency
- Domain
- Sentiment

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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/metonomy holds cross language
- 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
- If only we had a large collection of lexicons, linked by senses to English!

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Introduction to Wordnets

- A wordnet is a lexical database that organizes words into sets of synonyms, called synsets.
- Each synset represents a unique concept,
  capturing different senses of a word.
- Synsets are connected by semantic relations like hypernyms (superordinate) and hyponyms (subordinate).
- Wordnets are used in linguistic research, natural language processing (NLP), artificial intelligence, education and (a bit) language maintenance.

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History of Wordnets

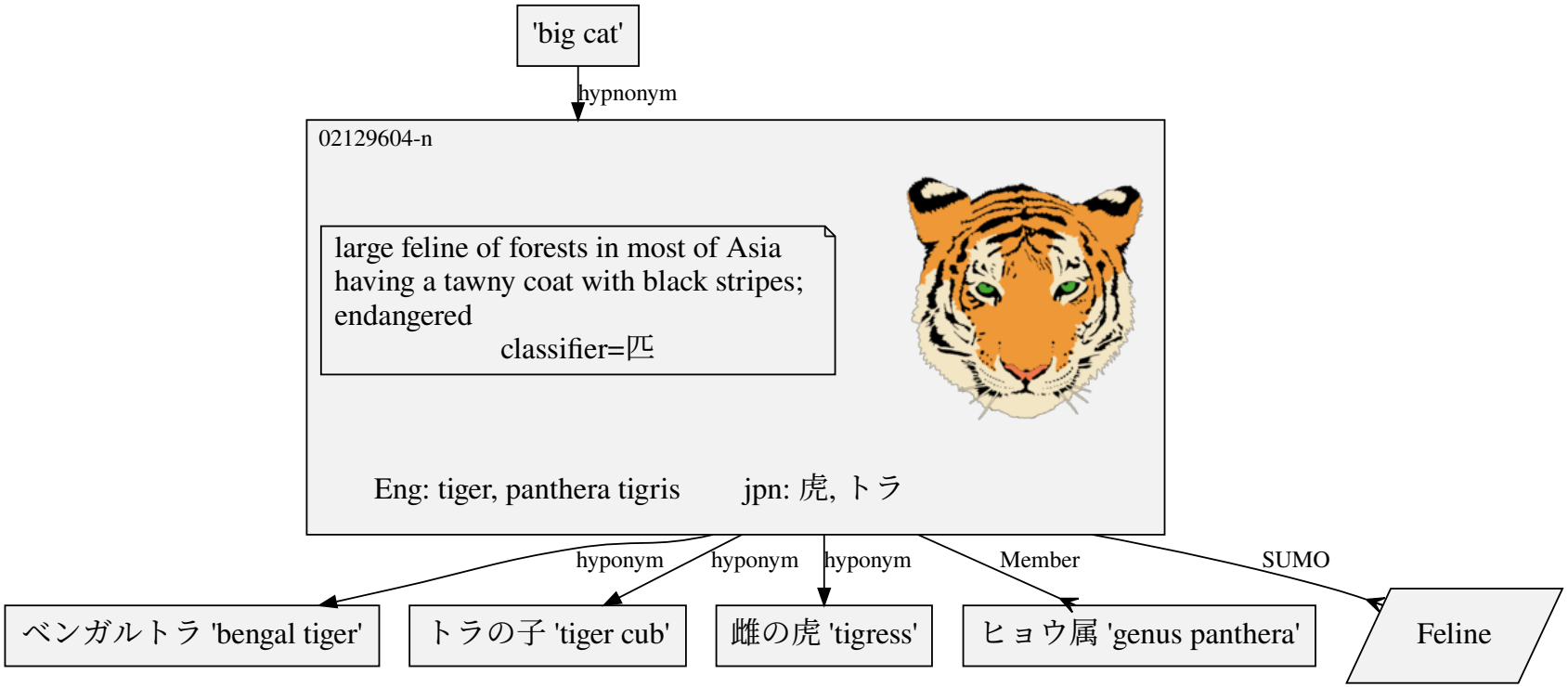
- Wordnet was first developed for English at Princeton University (Miller, 1995).
- It was designed it as a model of human lexical memory.
- It became a foundational tool for computational linguistics and NLP.
- It has influenced the development of lexical resources for many other languages.
- Currently the Open English WordNet is maintained by John McCrae. It is extending and revising the Princeton Wordnet.

Many people wanted to have wordnets

- **EuroWordNet** (Vossen, 1998): Dutch, English, German, French, Spanish, Italian
- **BalkaNet**: Bulgarian, Greek, Romanian, Serbian, Turkish
- **Asian WordNet**: Japanese, Korean, Thai, Indonesian, Vietnamese, Mongolian, Burmese
- **IndoWordNet**: Hindi, Bengali, Marathi, Gujarati, Punjabi, Urdu, Tamil, Telugu, Kannada, Malayalam, Odia, Assamese, Nepali, Konkani, Manipuri, Kashmiri, Sanskrit

And many individual projects not listed here.

The synset for 虎 “tiger”



Multilingual Wordnets

- Over 50 hand built wordnets
- Automatically-built Wordnets exist for over 1,200 languages from Swadesh, Wiktionary and more
- Cross-lingual mappings help in tasks like machine translation and multilingual semantic analysis.
- The Open Multilingual Wordnet (OMW) provide free access to linked open wordnets.

Challenges in Building Wordnets

- Developing wordnets requires careful analysis
  impossible to automate
- Word meaning can be culturally specific,
  requires careful consideration of local concepts.
- Data collection for under-resourced languages often involves fieldwork and expert collaboration.
- Validation and refinement of synsets is an ongoing process, especially for evolving languages.
- Many language resources are not open, so data cannot easily be shared.

Open Multilingual Wordnet (OMW)

- OMW is a free multilingual lexical database linking wordnets from many languages (Bond and Foster, 2013)
- OMW includes wordnets for widely spoken languages
- It also contains wordnets for under-resourced and endangered languages
- Researchers can access and contribute to OMW to support cross-linguistic studies
- The platform promotes collaborative development and data sharing across language communities
- In particular it has pushed open-licenses for the wordnets

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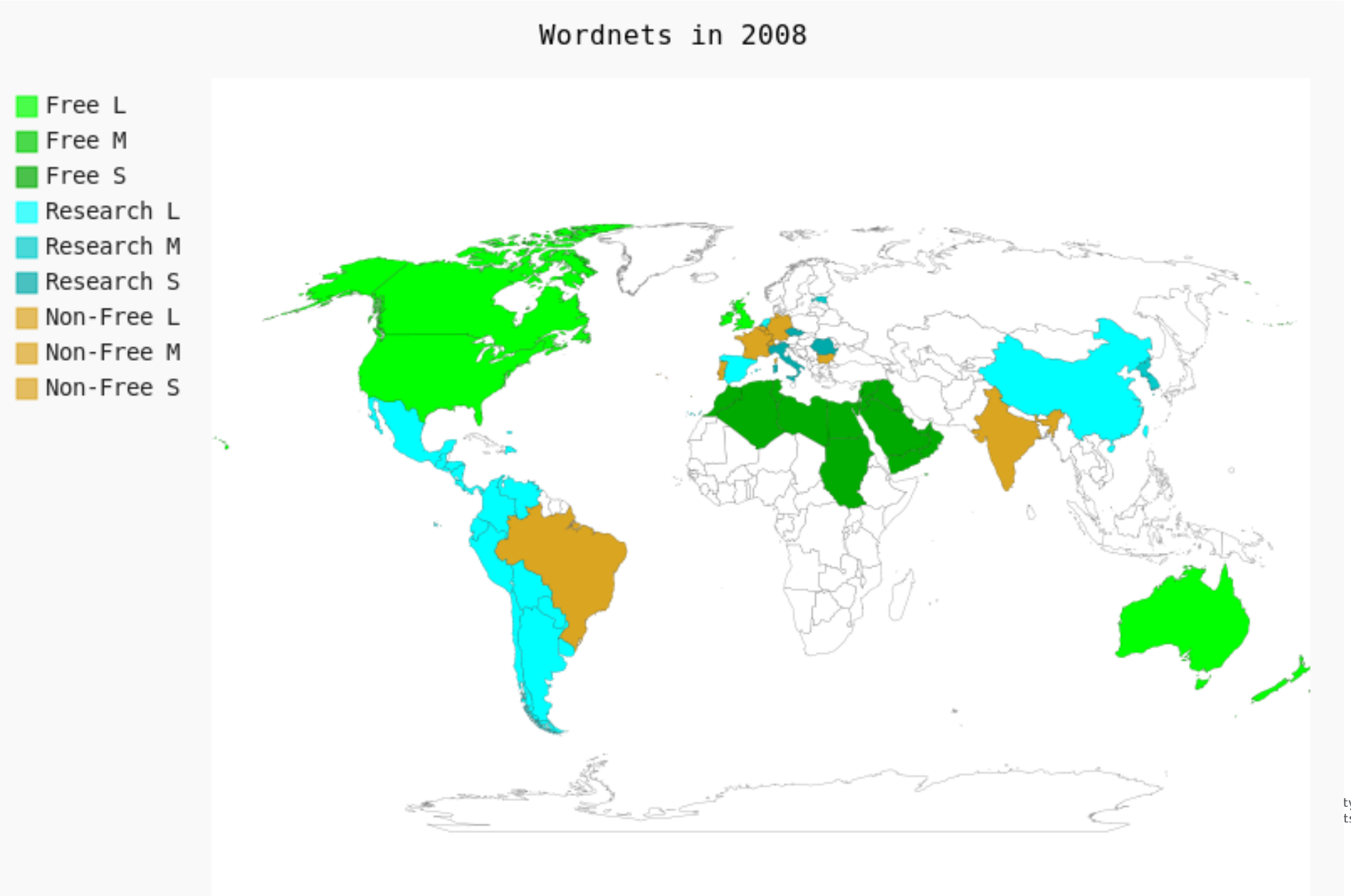
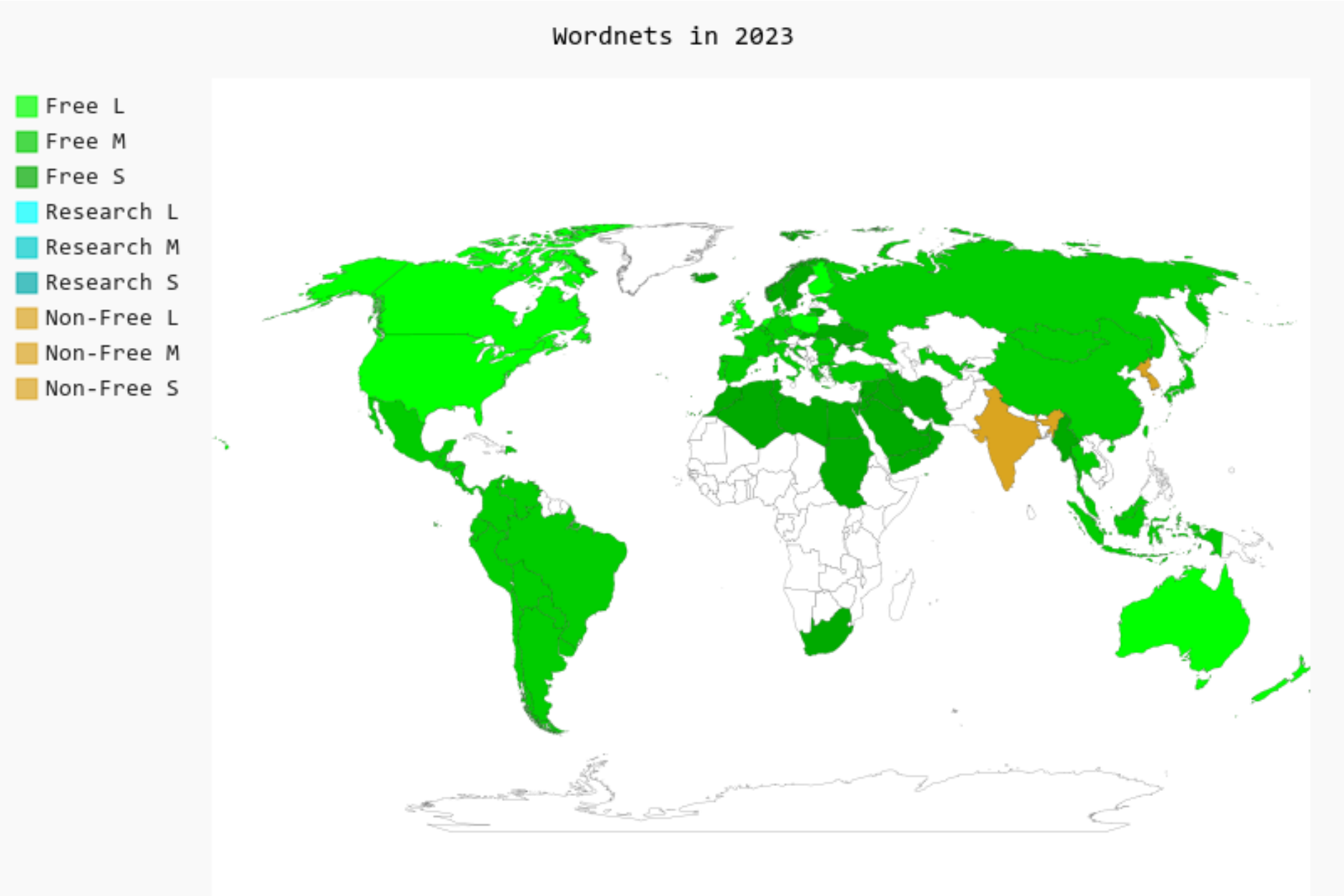
Wordnets in the world 2008



Wordnets in the world 2023



The situation is much better! But not perfect

- The map shows the situation only for the major language for each country
  - India has over 450 living languages
  - Indonesia has over 700 living languages
  - Australia has over 100 indigenous languages and probably at least that many immigrant languages
  - Even Czechia recognizes Belarusian, German, Polish, Hungarian, Ukrainian and Vietnamese as official minority languages
- We are missing most of the world's languages
  - Most wordnets start by exploiting existing resources
    - ★ bootstrap off English
  - But most of the world's languages do not have lexicons linked to English!

How are wordnets built?

- Most new wordnets built be the **expand** method — the structure of Engish is used as a base, and new lemmas are added to the synsets
- Some wordnets are built by the **merge** method — an existing lexical resources is merged with the English Wordnet
- The IndoWordnet (Bhattacharyya, 2010) used a clever hybrid
  - a new structure was made for Hindi, using existing lexical resources
  - other Indic languages used this as a base for expand
  - but it is not under an open license, ...

So we have many lexicons, linked to English senses, of various sizes and qualities, built with different methods by different people, ...

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

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

Lang	Unlinked	Metaphor	Metonomy	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.

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

Lang	Unlinked	Metaphor	Metonomy	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

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

Lang	Unlinked	Metaphor	Metonomy	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 metonomy shares much more.

Metonomy is more likely to hold cross linguistically!

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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 would expect it to behave much like Portuguese (1.26/1.96).
- 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, ...
- Without exception, senses linked by tropes are more likely to have an identical translation that those senses which are not linked
- With one exception, metonymy is more likely to have an identical translation then metaphor

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Translations of the senses of *cherry*

Sense	Mandarin	Japanese	Finnish	Italian	F
$cherry_1$	樱桃木	桜, 桜材	kirsikkapuumetsä	ciliegio	c
$cherry_2$	樱桃树	桜, 櫻	kirsikkapuu	ciliegio	c
$cherry_3$	樱桃	桜桃, 桜ん坊	kirsikka	cerasa , ciliegia	g
$cherry_4$	樱桃红	桜ん坊色	kirsikanpunainen	ciliegia, rosso ciliegia	c

- 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

Ongoing Research to Find Patterns

- We can make 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 synsets, so we can look up supertypes: 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
  - Similar to Stoyanova et al. (2025)
- 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

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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)

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We will mark metaphor/metonomy in more languages

闇 *yami* (Japanese)
yami $_1$ — absence of light or illumination (Japanese wordnet)
yami $_2$ — an unilluminated area “he moved off into the darkness” (Japanese wordnet)
yami $_3$ — absence of moral or spiritual values “the powers of darkness” (Japanese wordnet)
yami $_4$ — an illegal market [...] (not in English)

yami $_1 \rightarrow$ ***yami*** $_2$ (metonymy)
yami $_1 \rightarrow$ ***yami*** $_3$ (metaphor)
yami $_3 \rightarrow$ ***yami*** $_4$ (metaphor)

We can start by projecting from English, then use the morphological patterns, ...

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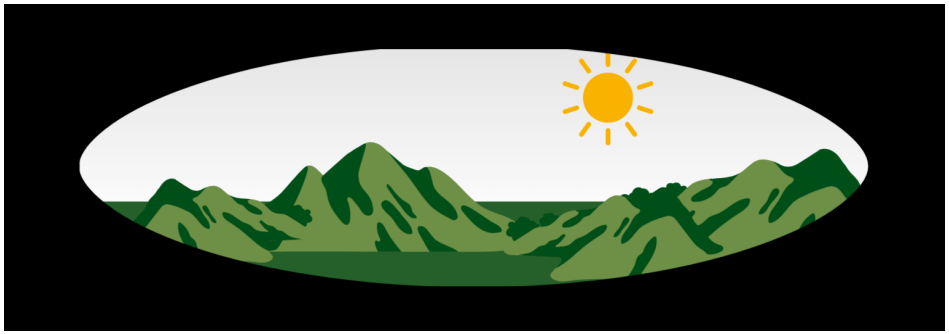
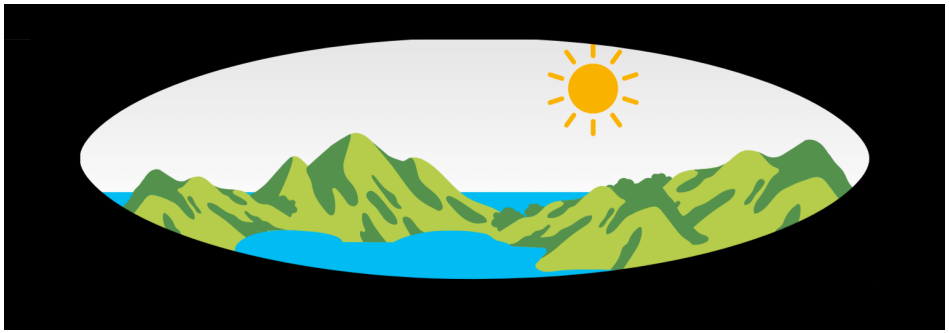
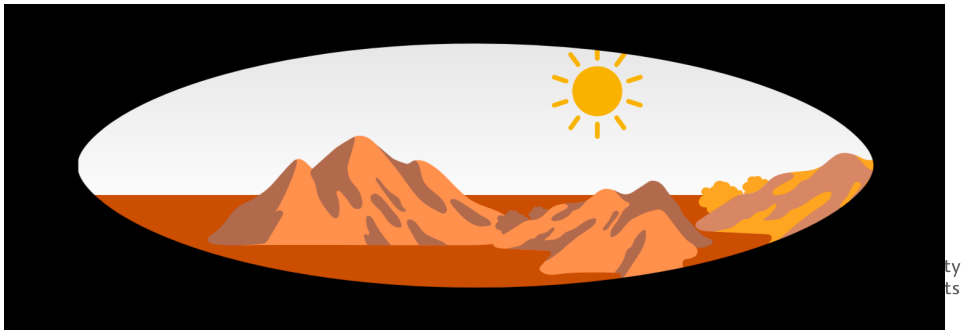
Corpus-attested lexicalized metaphors for many languages: a range of views







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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
- There are also interesting questions of how much metaphor interpretation in multilingual models is effected by other languages The DanNet group have found metaphors in Danish not found in English are less likely to be recognized

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Evaluating LLM-Generated Explanations of Metaphors (Pedersen et al., 2025)

- Metaphors have culturally distinct imagery and semantics (e.g., agricultural or national norms).
- Standard benchmarks (often English-centric) may hide biases against medium-resource languages.
- LLMs may transfer English knowledge inappropriately to other languages.

Models evaluated:

- **ChatGPT-4o mini** via web/API (multilingual, but English-heavy training)
- **Llama 3.1 405B**, large open model (multilingual but likewise English-biased).

Tested on a culturally sensitive evaluation dataset of Danish metaphors & model explanations.

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Dataset and Experimental Design

Metaphor dataset: 150 Danish expressions

- 75 single-word metaphors + 75 multiword idioms
- Divided into:
  - **Culture-specific** Danish metaphors (e.g., farming/nautical, social norms)
  - **Cross-cultural** ones shared with English
- Validated by native speakers and bilingual informants

Prompting setup:

- Four prompt variants:
  - In isolation vs. with context
  - Danish vs. English prompt language
- Each model generated 600 explanations (all combinations)

Evaluation:

- Human expert judges explanations on a 4-point qualitative scale

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Key Findings and Discussion

Main results:

- Both models explain **cross-cultural metaphors** far better than culture-specific ones
- Models show a strong **English bias** —higher quality explanations are produced when metaphors overlap with English
- Culture-specific sentiment and nuance are often lost in translation

Implications:

- Bias arises not only from data distribution but also from *erroneous transfer* of English metaphorical knowledge.
- Culturally grounded metaphor understanding in non-English languages remains a challenge for current multilingual LLMs

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Two examples

(1) *Han skød hendes argumenter ned.* Danish

He shot down her arguments.

- Correctly identifies metaphorical usage
- Maps **physical attack** → **argumentation**
- Produces fluent, accurate explanation

(2) *Han har rent mel i posen.* Danish

He has nothing to hide (Lit: He has clean flour in the bag.)

- Plausible but wrong English-based metaphor
  "This metaphor refers to being prepared or well-supplied."
- Over-literal explanation
  "Clean flour symbolizes purity of intentions" but without connecting it to social trust / transparency
- Misses social–cultural grounding

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Summary

- The combination of detailed annotation of meaning (ChainNet & Wordnet) and cross-lingual links (Open Multilingual) allow us to explore differences in lexicalized metaphor
  - Metonymy is based on association and contiguity
    more universal (average overlap 1.96 more than the baseline)
  - Metaphor often requires analogical reasoning and cultural framing
    more culture and language specific (average overlap 1.39 more than the baseline)
  - Metaphor pairs are further apart that Metonym pairs
- We have shown these results hold over many languages

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Toward a broader understanding of Metaphor and Metonomy

- Language is essential to our construction and transmission of knowledge
- Metaphors are the scaffolding for this construction
- For a full understanding of language we have to understand metaphors
- At the highest level, metaphors are very culturally embedded, to speak well you must understand the culture as well
  - And the same language speakers will have many sub-cultures
- Understanding cross-linguistic differences will help us understand cross-cultural differences
- Current metaphor research does not give us the comprehensive view we need to do this

We are building an understanding based on a more complete view of language

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Roadmap

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Thanks and Resources

- Thanks a lot to LOT for inviting me to present this work
- Thanks to all the many people who have worked on these resources, especially Rowan Hall Maudslay, Luís Morgado da Costa and Joanna Ut-Seong Sio.
- Parts of this talk were presented at the Sprogteknologisk Konference 2024 and RegICON 2025
- If you are interested in wordnets or metaphor, come and talk to me!

- ChainNet: https://github.com/rowanhm/ChainNet
  - chainnet-xling: https://github.com/bond-lab/chainnet-xling
- Open Multilingual Wordnet: https:omwn.org

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We used these 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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