Image Schemas: Sensorimotor Experiences in Natural Language

Dagmar Gromann,
University of Vienna, dagmar.gromann@univie.ac.at

EuroMov Digital Health in Motion
15. December 2022

Overview

01

Introduction

Embodied Cognition and Image Schemas

02

Natural Language

Image Schemas in Natural Language

03

Neural Processing

Neural Processing and Explainability

04

Representation

Knowledge Engineering and Explainability

Embodied cognition

- cognitive processes are considered as deeply rooted in the body's interaction with the world
- cognition depends on bodily features of an agent
- Image Schemas introduced by George Lakoff (1987) and Mark Johnson (1987) are rooted in embodied cognition

Image Schema

- “is a recurring dynamic pattern of our perceptual interaction and motor programs that gives coherence and structure to our experience” (Johnson 1987, xiv)
- spatiotemporal relations between agents, objects and the environment
- shapes higher-level cognition, e.g. natural language and problem-solving

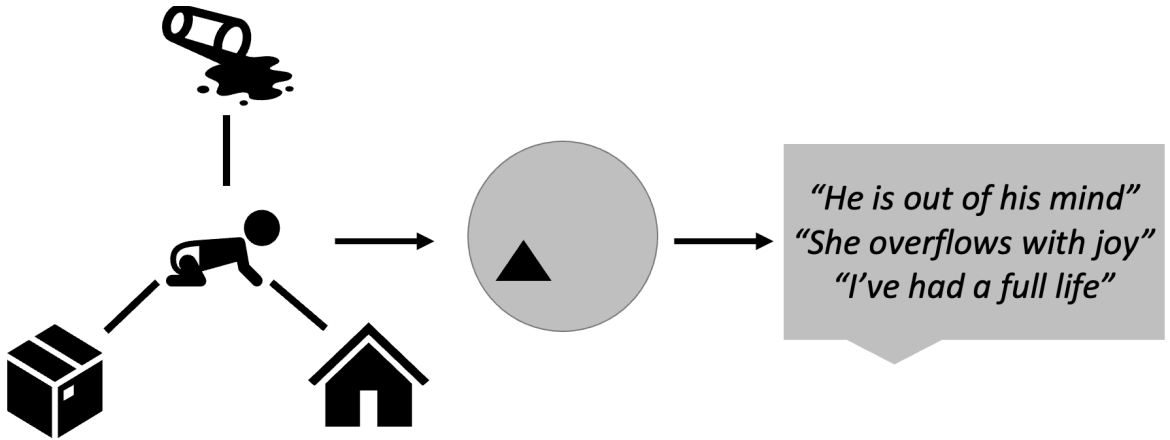
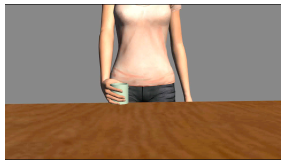
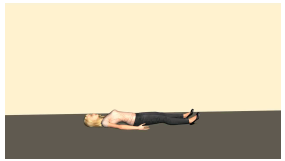


Image Schemas

- represent early experiences of spatial boundedness
- directly meaningful experiential gestalts - internally structured compositions
- structured and composed by spatial primitives, e.g. CONTAINER in CONTAINMENT (Mandler & Pagan Canovas 2014)
- static or dynamic (Lakoff & Nuñez 2000)

Selected Image Schemas and Conceptual Metaphors

Image Schema	Sensorimotor Experience	Conceptual Metaphor	Linguistic Example
CONTAINMENT		CONTAINER FOR CONTAINED	go for a glass, the whole town participated
VERTICALITY		UP IS MORE	high-end product, pay raise, sales increase
SOURCE-PATH-GOAL		LIFE IS A JOURNEY	to be on track, career path life path

Video sources: http://www.imagact.it/

Natural Language

- is believed to provide evidence of image-schematic cognitive building blocks
- allows to systematically analyze differences of learned patterns across languages and cultures

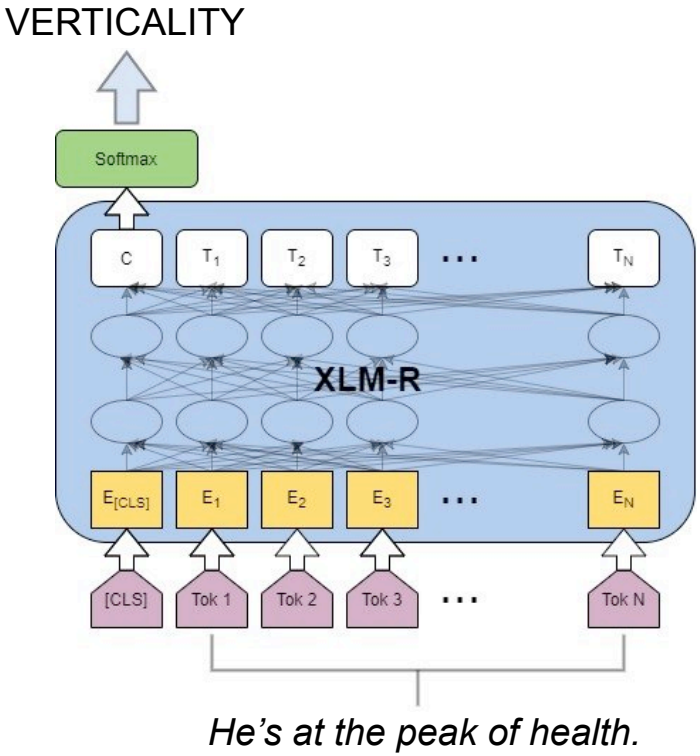
Natural Language Understanding

- humans are excellent at interpreting incomplete information
- *get the milk*
- CONTAINMENT (*fridge*, *bottle*) and SOURCE_PATH_GOAL (*fetch*)
- image-schematic grounding of natural language for action and event analysis
- Fetching and Placing Actions in Image Schema Logic (RCC, CD, QTC, RTL; Hedblom et al. 2021)

Image Schemas: Neural Language Processing

- Automatically analyze how we think and talk about concrete and abstract topics
- Computational analysis can help analyzing how image schema use differs across languages, cultures, or developmental stages
- Analyze domain specific corpora, political speech, or literature

Neural Language Processing



Wachowiak & Gromann (2022)

Image Schemas: Neural Language Processing

- Multilingual dataset of examples from literature: English, German, French, Russian, Mandarin
- 8 Image Schemas
- Fine-tuning XLM-R (Conneau et. al. 2020)

CENTER-PERIPHERY	*The issue is central to these negotiations.*
CONTACT	*как Бог коснулся их жизни (how God touched their lives)*
CONTAINMENT	*他怒火中烧 (He has an angry fire burning inside him)*
FORCE	*…et comme si le vent poussait son ballon…*
PART-WHOLE	*Das ist der falsche Weg… (That's the wrong way)*
SCALE	*…*
SOURCE-PATH-GOAL	
VERTICALITY	

Wachowiak & Gromann (2022)

Results

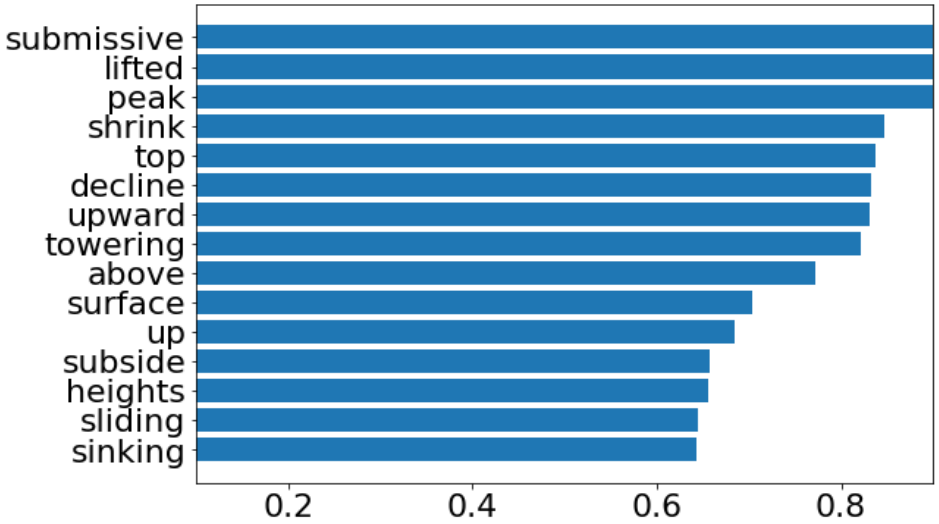
Language	Acc.
English	68.6
German	79.8
Russian	61.2
French	56.6
Mandarin	63.2

Explainability

- LIME (Ribeiro et al. 2016):
  - explains the predictions of any neural classifier with an interpretable model
  - assigns weights to different input features
- input features here: words of a natural language sequence

Explainability

Which words indicate VERTICALITY?

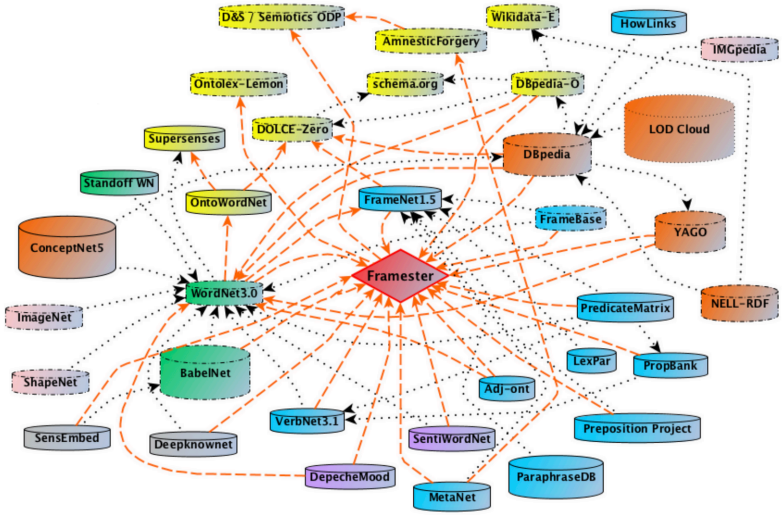


Commonsense knowledge

- derives from subjective perception of the external world
- intertwined with embodied cognition
- linked to human sense-making, pattern recognition and ability to frame knowledge

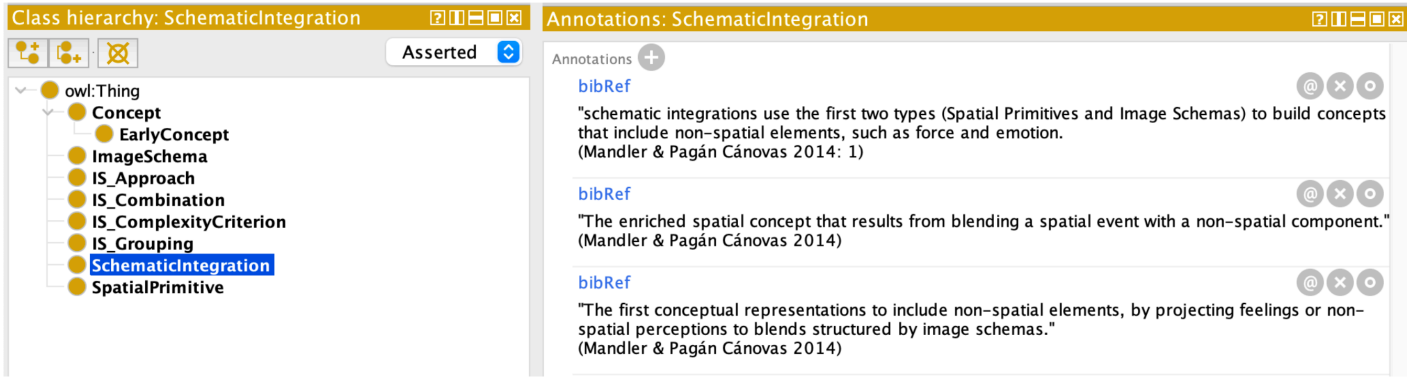
ImageSchemaNet

- image-schematic layer in the Framester hub
  - linked to FrameNet, WordNet, VerbNet
  - SPARQL endpoint
  - identify image schemas in natural language (OpenSesame, FRED)
- relies on Image Schema Abstraction And Cognition ontology (ISAAC) that compares theories from Johnson, Hedblom, Mandler & Pagan Canovas



De Giorgis et al. (2022a, 2022b, 2022c)

ImageSchemaNet



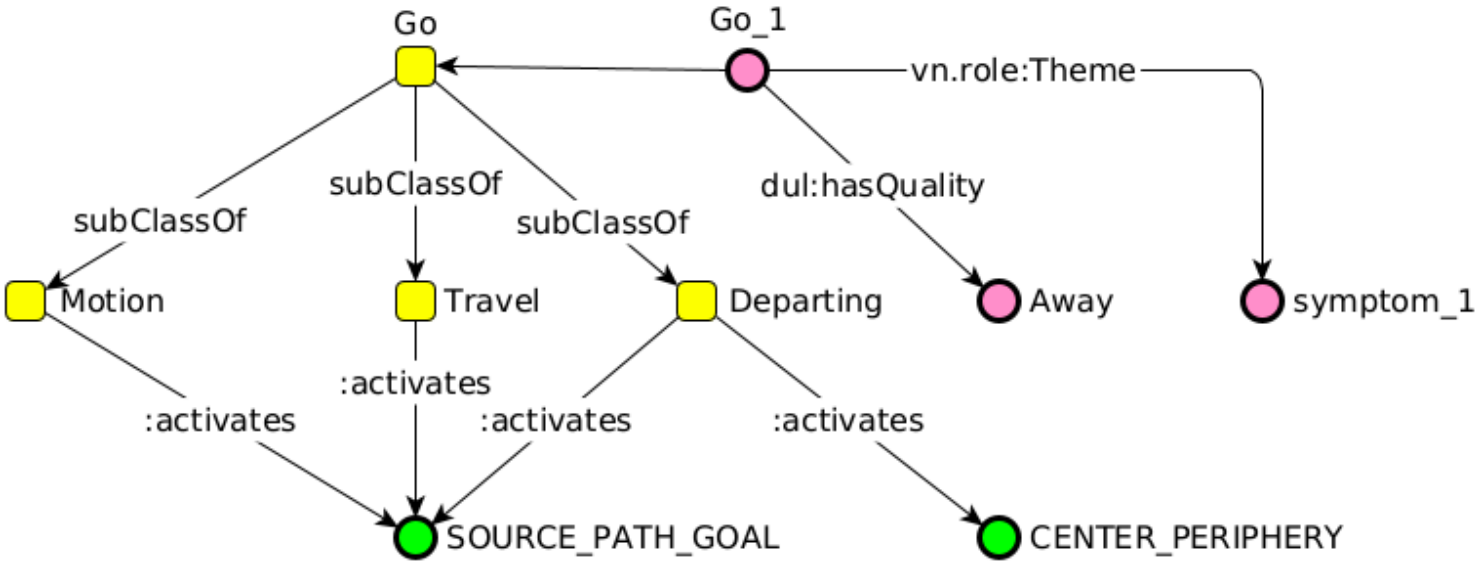
MPC module

- `:ImageSchema` general concept of image schema
- `:SpatialPrimitive` parts to form coherent whole
- `:IS_Profile` collection of image schemas activated, e.g. by a sentence
- `:activates` activation from a frame to an image schema

De Giorgis et al. (2022a, 2022b, 2022c)

Natural Language Parsing with FRED

My symptoms went away.



De Giorgis et al. (2022a, 2022b, 2022c)

Open issues and next steps

- Explainability: reliable, curated knowledge representation vs. flexible, faster processing of deep learning
- More datasets needed not only from introspective method
- (Semi-)automated cross-cultural analysis
- Validate value for action and event analysis and planning

Thank you for your attention!

Dagmar Gromann
dagmar.gromann@univie.ac.at

References

Conneau, A., Khandelwal, K., Goyal, N., Chaudhary, V., Wenzek, G., Guzmán, F. & Stoyanov, V. (2020). Unsupervised cross-lingual representation learning at scale. In: Proceedings of the 58th Annual Meeting of the Association for Computational Linguistics, 8440–8451, DOI: 10.18653/v1/2020.acl-main.747

De Giorgis, S., Gangemi, A., & Gromann, D. (2022a). ImageSchemaNet: Formalizing embodied commonsense knowledge providing an imageschematic layer to Framester. Semantic Web Journal.

De Giorgis, S., Gangemi, A., & Gromann, D. (2022b). The Racing Mind and the Path of Love: automatic extraction of image schematic triggers in knowledge graphs generated from natural language. In: Sixth Image Schema Day. CEUR Workshop Proceedings, Vol-3140.

De Giorgis, S., Gangemi, A., & Gromann, D. (2022c). Introducing ISAAC: Image Schema Abstraction and Cognition ontology. In: Proceedings of CAOS VI: Cognition And OntologieS, CEUR Workshop Proceedings, Vol-3249.

Goller, F., Lee, D., Ansorge, U. and Choi, S. (2017). Effects of language background on gaze behavior: a crosslinguistic comparison between Korean and German speakers. Advances in Cognitive Psychology, 13(4).

Hedblom, M. M., Pomarlan, M., Porzel, R., Malaka, R., & Beetz, M. (2021). Dynamic Action Selection Using Image Schema-Based Reasoning for Robots. In: JOWO 2021, CEUR Workshop Proceedings, Vol-2969.

Johnson, M. (1987). The body in the mind: The bodily basis of meaning, imagination, and reason. The University of Chicago Press.

Lakoff, G. (1987). Women, fire, and dangerous. things. what categories reveal about the mind. The University of Chicago Press.

Lakoff, G., & Núñez, R. (2000). Where mathematics comes from (Vol. 6). New York: Basic Books..

Mandler, M. & Pagán Cánovas, C. (2014). On defining image schemas, Language and Cognition, 1–23, DOI:10.1017/langcog.2014.14.

Ribeiro, M. T., Singh, S., & Guestrin, C. (2016). "Why should I trust you?" Explaining the predictions of any classifier. In: Proceedings of the 22nd ACM SIGKDD international conference on knowledge discovery and data mining,1135-1144.

Wachowiak, L., & Gromann, D. (2022). Systematic Analysis of Image Schemas in Natural Language through Explainable Multilingual Neural Language Processing. In: Proceedings of the 29th International Conference on Computational Linguistics, 5571-5581.