Automatic Generation of Typicality Measures for Spatial Language in Grounded Settings

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Introduction

- Modelling spatial prepositions (‘in’, ‘inside’, ‘on’, ‘on top of’, ‘against’, ‘above’, ‘over’, ‘below’ & ‘under’) in situated dialogue - in particular in *referring expressions*
- Spatial prepositions exhibit *vagueness*
- Simple models do not align with human usage

Semantic Complexity

- Many features may influence spatial preposition usage with no clear boundaries demarcating when a preposition is, or is not, appropriate to use
- As well as representing geometric concepts, spatial prepositions denote functional relationships

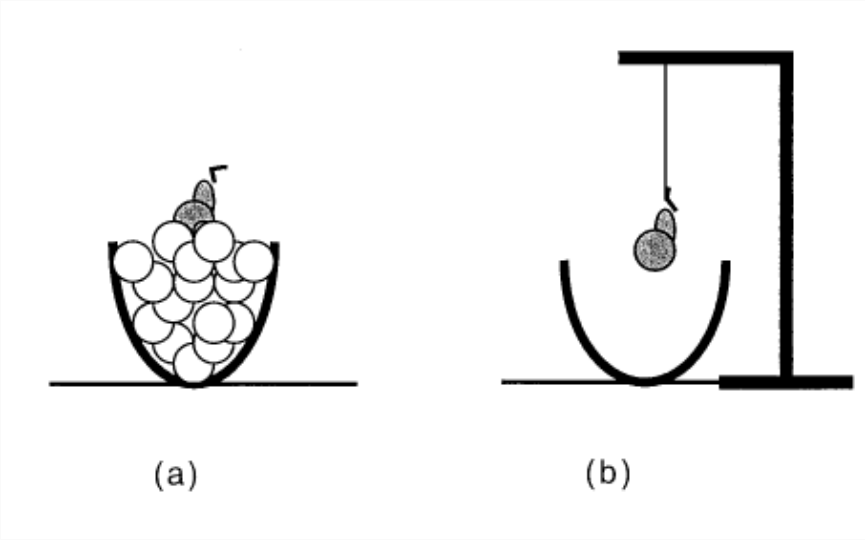

Figure 1: Example given in Garrod et al., 1999

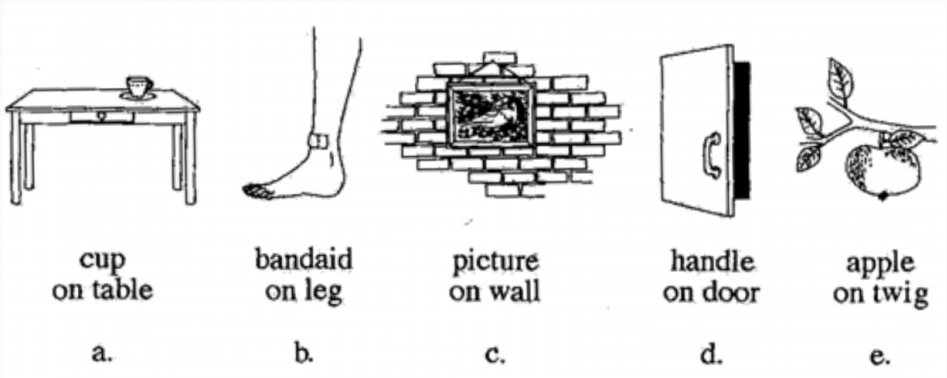

Figure 2: Examples from Bowerman and Choi, 2001

Modelling Issues

- Existing models are limited with regards to functional relationships
- Features are crudely approximated

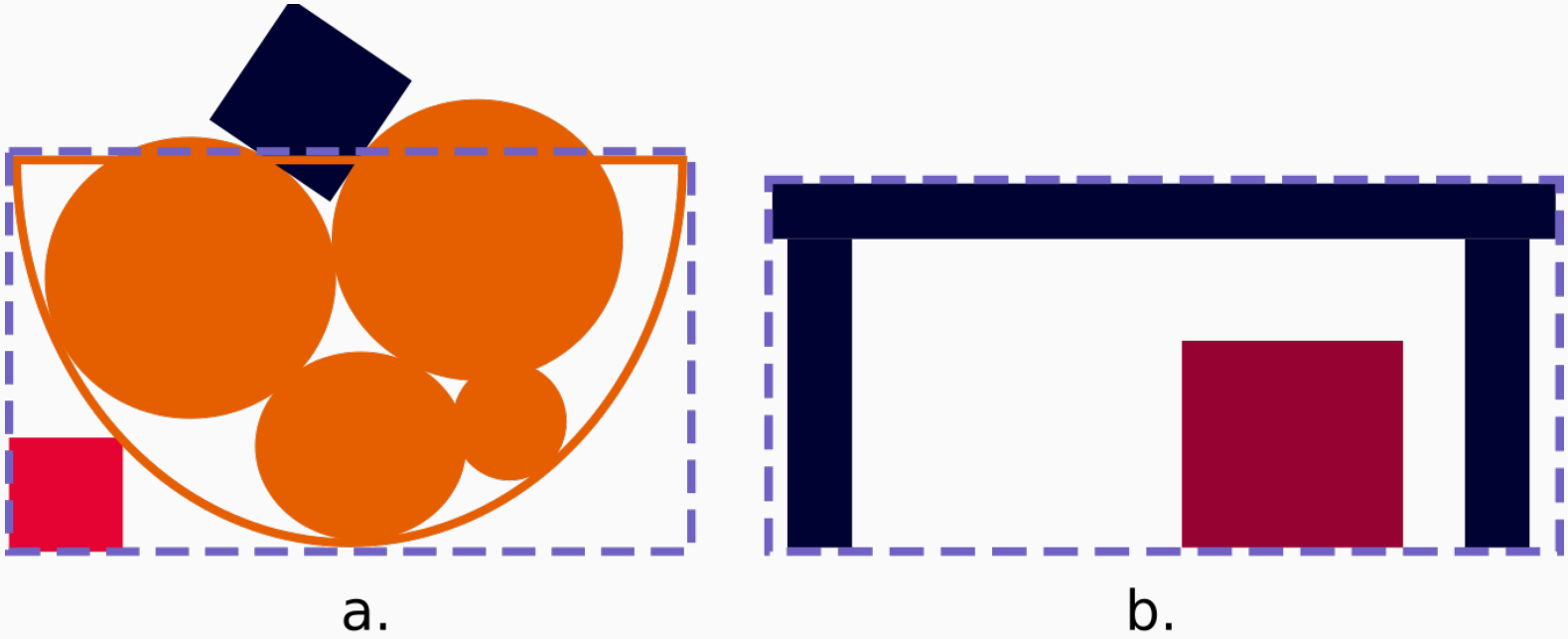

Figure 3: Containment issues

Data Collection

Framework

- Virtual environments built in Unity3D
- Provides a task for generating models and a task for testing models

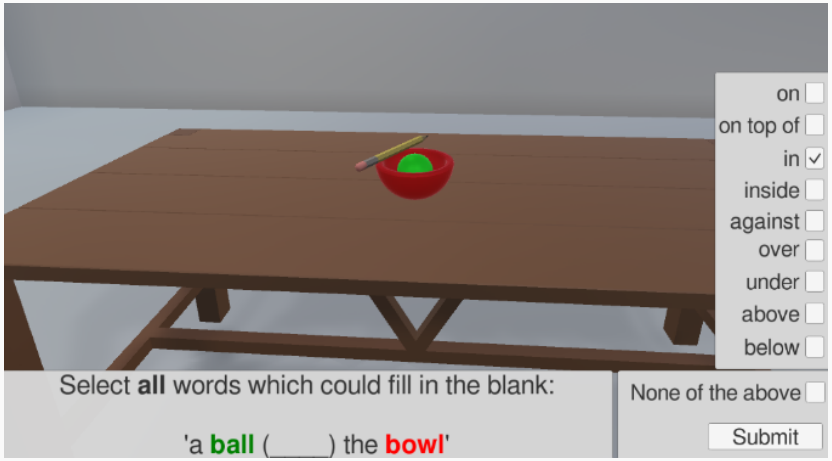

Figure 4: Preposition Selection Task

Figure 5: Comparative Task

Cognitive Models

Three main approaches:

- Rule-based
- Exemplar
- Prototype

\+ Conceptual Space

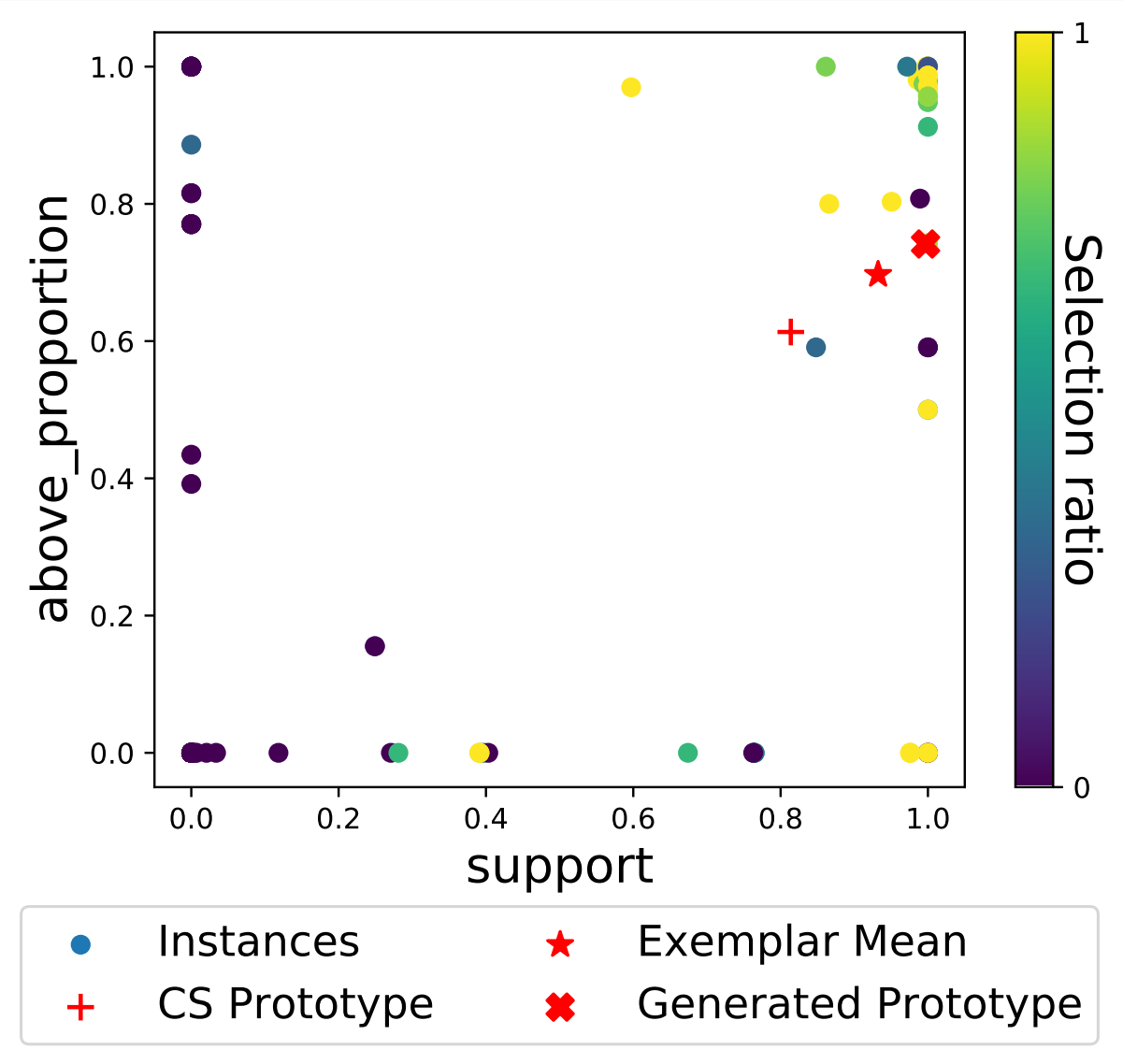

Figure 6: Instances of ‘on’

Results

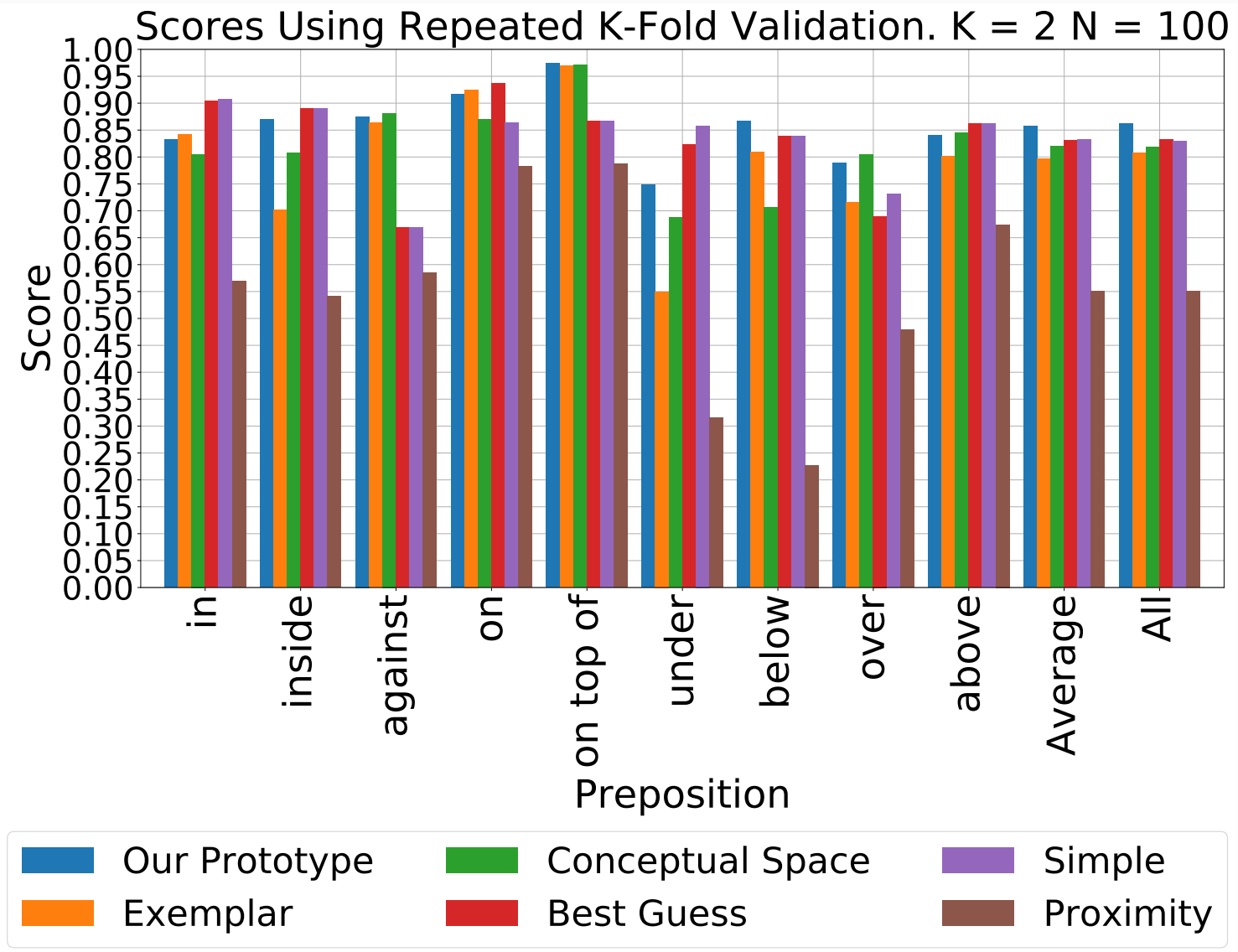

Figure 7: Scores with 100 repetitions of 2-fold cross validation

Future Work

- Account for polysemy: Richard-Bollans, A., Gómez Álvarez, L., & Cohn, A. G. (2020). Modelling the polysemy of spatial prepositions in referring expressions. In *Proceedings of 17th International Conference on Principles of Knowledge Representation and Reasoning*
- Explore the relation between categorisation and typicality in more detail

Contact mm15alrb@leeds.ac.uk for further details, questions or comments!

References i

- Bowerman, M., & Choi, S. (2001). Shaping meanings for language: Universal and language-specific in the acquisition of semantic categories. In *Language acquisition and conceptual development* (pp. 475–511). Cambridge University Press.
- Garrod, S., Ferrier, G., & Campbell, S. (1999). In and on: Investigating the functional geometry of spatial prepositions. *Cognition*, *72*(2), 167–189.
- Richard-Bollans, A., Gómez Álvarez, L., & Cohn, A. G. (2020). Modelling the polysemy of spatial prepositions in referring expressions. In *Proceedings of 17th International Conference on Principles of Knowledge Representation and Reasoning*.