Investigating the Dimensions of Spatial Language

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Abstract

- Spatial prepositions in the English language can be used to denote a vast array of configurations which greatly diverge from any typical meaning
- There is general agreement that non-geometric aspects play a significant role in spatial preposition usage. However, there is a lack of available data providing insight into how these extra semantic aspects should be modelled
- We introduce a framework intended to facilitate the collection of rich data; including geometric, functional and conventional features

Aims

- We aim to create a semantic model of spatial prepositions which:
  - Can be incorporated into a situated dialogue system to aid referring expression comprehension and generation
  - Support existing theories of spatial language

Semantic Domains

- Many features influence spatial preposition usage [1] and there are 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 [2,3]
- Figure 1 provides an illustrative example. In (a) the pear is generally considered to be ‘in’ the bowl, whereas in (b) it is not

Functional Features

- How can we quantify functional relationships like ‘support’ and ‘location control’?
- Using virtual environments allows assessment of features via simulation
  - If the ground is removed, how far does the figure fall?
  - If a force is applied to the ground, does the figure move?

Conventional Features

- Convention generally influences the acceptability of a preposition
- Some features also distinguish polysemes, affecting the salience of geometric and functional features
- We can extract some of these from the scene e.g. orientation of the ground [4]
- Others are inherent to objects e.g. whether the object is a container. We are exploring extracting these from the commonsense knowledge base ConceptNet [5]

References


Data Collection

- We set up a framework in order to collect richer data on spatial prepositions and explore these issues

Framework & Tasks

- Using the Blender game engine we created environments in which users can navigate, select objects and provide descriptions and developed two tasks. See the GitHub repository for the software
- The Selection Task asked users to select pairs of objects which fit a given preposition:
- The Description Task asks users to provide descriptions of given objects:

Preliminary Study

- Informed future studies and provided tentative insights:
  - Importance of conventional features
  - Similarity and vagueness of spatial prepositions
  - Success of simple models for REG/C
- Focus on open/unconstrained selections and descriptions hindered detailed analysis

Ongoing Work

- Improved and refined data collection
- We are currently running a study online
- Developing game-like testing environment to explore pragmatic aspects of referring expression generation and interpretation in more detail