Construction of Acceptability Computation Algorithm for Projective Spatial Terms

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Introduction
This study proposes Acceptability Computation Algorithm for Projective spatial terms (ACAP). ACAP is based on the applicability computation algorithm for projective spatial terms contained in the situated language interpreter (SLI) model (Kelleher, 2003). Cognitive studies have validated the algorithm contained in the SLI, but three problems remain: (1) its distance-based deviation hypothesis has no empirical support; (2) it does not address the change in the acceptability distribution for a term with a reference object’s rotation on a level plane in three-dimensional (3-D) space; and (3) it does not compute a prototypical point for a projective spatial term.

We have examined these problems by psychological experiment (Kojima & Kusumi, 2006a, 2006b, in press). Our results demonstrate (1) the empirical validity of the introduction of the distance-based deviation into the acceptability computation of projective spatial terms; (2) the characteristics of the acceptability distribution change with a reference object’s rotation on a level plane in 3-D space; and (3) a method to compute a prototypical point.

Parameters
ACAP modifies and extends the algorithm in SLI, based on our experimental results. The new factors are the rotation module (R module) and the prototypical-point module (P module). R module accommodates the acceptability distribution on a spatial template (Logan & Sadler, 1996) to the rotation of a reference object in both 2-D and 3-D space. P module calculates the location of a prototypical point for a projective spatial term in a given situation. It enables ACAP to be applicable to different projective spatial terms in different languages.

Figure 1 shows basic parameters of ACAP on a spatial template. The square is the center of a reference object. The smaller circle is the center of a located object in location \( i \). The larger circle is the prototypical point \( p \) in a given scene. The vertical line is a base axis for a projective spatial term. \( \theta \) is an angle between the base axis and a vector rooted at the center of the reference object to the center of the located object. \( \beta \) is the maximum angle of the angular deviation (usually set to 90\(^\circ\)). The diagonal line is the boundary of the area affected by the rating parameter \( g \). \( \varepsilon \) is the angle between the boundary of the affected area and the base axis (\( \varepsilon \leq \beta \)). \( d_i \) is the distance between the prototypical point and the located object. \( \gamma \) is the maximum distance on the given spatial template. R module controls \( g \) and \( \varepsilon \). P module controls \( p \).

Algorithm
An acceptability \( \psi \) in location \( i \) for a projective spatial term is computed in ACAP as below.

\[
\psi_i = \begin{cases} 
1 & (0 < \theta_i \leq \varepsilon) \\
\frac{d_i}{\gamma} & (\theta_i > \varepsilon) 
\end{cases}
\]

\[
\delta_i = \begin{cases} 
1 & (d_i \leq \gamma) \\
0 & (d_i > \gamma) 
\end{cases}
\]

\[
\alpha_i = \begin{cases} 
1 & (1 - \frac{\theta_i}{\beta}) \cdot r_i > 1 \\
0 & (\theta_i > \beta) 
\end{cases}
\]

References