A Strategy for Drawing a Conceptual Neighborhood Graph Schematically

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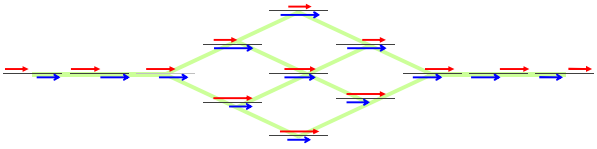
Motivation

Conceptual Neighborhood Graph [1] (CNG) is a diagram in which spatial/temporal relations are networked based on their similarity.
Well-designed CNGs highlight the symmetric structures of the relation set and, therefore, they are useful for schematizing the relations.

e.g., A CNG for 13 temporal relations [1]



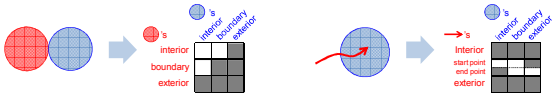
However, **how to design such schematic CNGs** is not well discussed except the definitions of 'neighbors'.

Research Goal

To propose a strategy for arranging spatial relations in a CNG such that the CNG becomes schematic

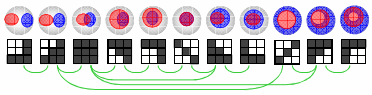
This problem is essentially **to optimize the spatial arrangement of relations** in a graph under the following criteria:
- to place the symmetric relations at symmetric locations
- to avoid the crossing of links as much as possible
- if possible, to draw the graph in a two-dimensional plane

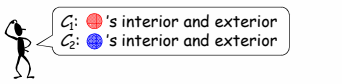
Note:
We use the **9⁺-intersection**[1] for modeling spatial relations (topological relations), by which the relations are distinguished by the patterns of icons

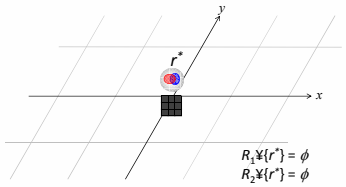


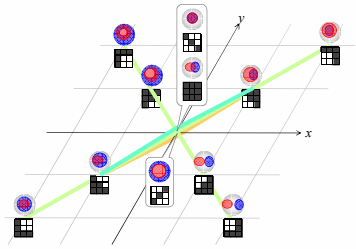
Proposed Strategy

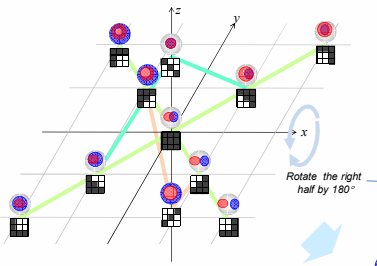
Example 1:
Relations between Two Regions in a Sphere

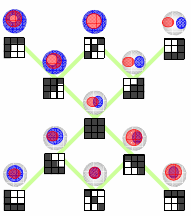












The CNG developed by Egenhofer [2]

Step 1
Determine the 'neighbors' (links) among the given set of relations R based on the similarity

Step 2
Decide one or two 'symmetry concepts' C_i

Step 3
For each C_i, identify R's subset R_i that is self-symmetric with respect to C_i. Then, among the relations in $\bigcap R_i$, identify the relation r^* that has the largest number of neighbors, and place r^* at (0, 0, 0).

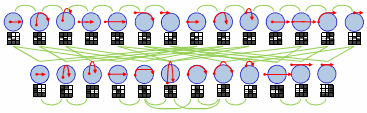
Step 4
Locate the relations in R_1¥{r^*} on the x-axis at (a, 0, 0) ($a \in \mathbf{Z}$), such that the length of each link becomes two. Leave the relations that have no link with the other relations in R_1.
In a similar way, locate the relations in R_2¥{r^*} on the y-axis.

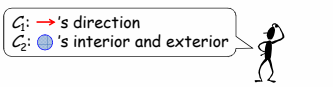
Step 5
Locate all remaining relations at (a, b, 0) (a, $b \in \mathbf{Z}$) successively, such that:
- each relation is located at equal distance from its neighbors, whenever possible;
- the remaining relations in R_1 and R_2 are located on the x- and y- axes, respectively; and
- pairs of symmetric relations with respect to C_1 and C_2 are located symmetrically with respect to x- and y-axes, respectively.

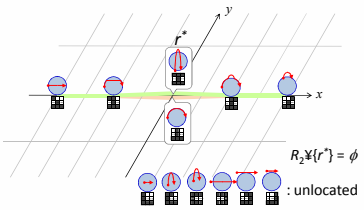
Step 6
If two or more relations are placed at the same locatrion, then relocate each of them from (a, b, 0) to (a, b, c) ($c \in \mathbf{Z}$), such that the links do not intersect with each other and the total length of the links becomes the smallest

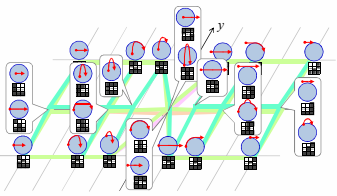
Step 7
If preferable, simplify the CNG by continuous transformation

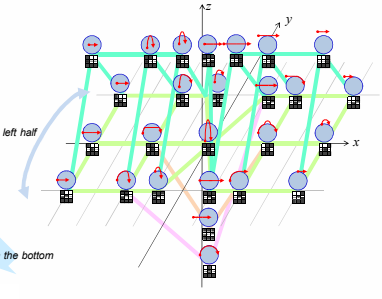
Example 2:
Relations between a Line and a Region in a Plane

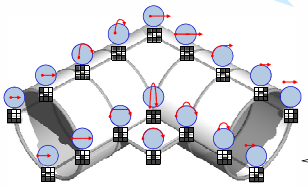








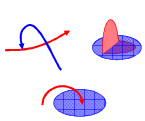




The CNG developed by Kurata and Egenhofer [3]

Future Work

- To **examine the applicability** of the proposed strategy to more complicated topological relations and other sorts of spatial relations
- To **fully automate** the above process



References
[1] Freksa (1992) Temporal Reasoning Based on Semi-Intervals. Artificial Intelligence 54, 199-227
[2] Egenhofer (2005) Spherical Topological Relations. Journal on Data Semantics III, 25-49
[3] Kurata & Egenhofer (2007) The 9⁺-Intersection for Topological Relations between a Directed Line Segment and a Region. Workshop on Behavioral Monitoring and Interpretation, 62-76