Reasoning on the Patterns of Spatial Arrangements between a Path and a Region-Like Landmark

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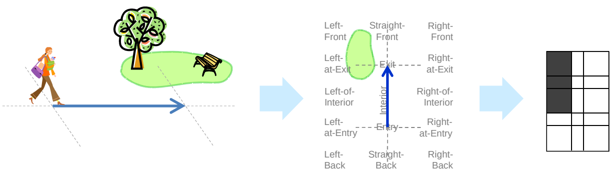
Research Goal

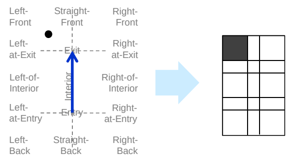
We develop a foundation of spatial reasoning on the patterns of path-landmark arrangements modeled by **RfDL$_{3\text{-}12}$**



What is RfDL$_{3\text{-}12}$?

- The finest model in the **RfDL model series** [1], which consists of eight models that categorize the spatial arrangements between a straight path and a region-like landmark with different levels of granularities
- **RfDL** = **R**egion-in-the-**f**rame-of-**D**irected-**L**ine
- RfDL$_{3\text{-}12}$ considers *left-right*, *front-side-back*, and *entry-interior-exit* distinctions with respect to the path

  → **3 fields** on the path + **12 fields** around the path
- Essentially, RfDL$_{3\text{-}12}$ is an extension of **Double Cross** [2]



- RfDL$_{3\text{-}12}$ is useful for capturing the motion concepts that concern the direction and extent of the landmark as seen from the path [3, 4]

  e.g., 'go toward …', 'pass … on the left', 'go until … comes to the right', 'go across …', 'go into …', and 'go out of…'

References

[1] Kurata & Shi (2008) RfDL: Models for Capturing Directional and Topological Characteristics of Path-Landmark Arrangements. Workshop on Moving Objects.

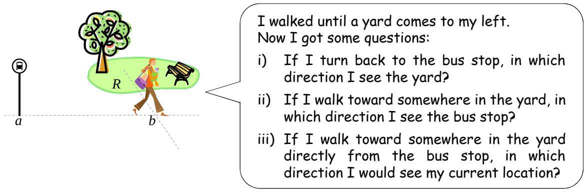
[2] Freksa (1992) Using Orientation Information for Qualitative Spatial Reasoning. International Conference GIS, LNCS 639, 162-178. Springer.

[3] Kurata & Shi (2008) Interpreting Motion Expressions in Route Instructions Using Two Projection-Based Spatial Models. KI-2008.

[4] Shi & Kurata (2008) Modeling Ontological Concepts of Motions with Two Projection-Based Spatial Models. Workshop on Behavioral Monitoring and Interpretation.

[5] Zimmermann & Freksa (1996) Qualitative Spatial Reasoning Using Orientation, Distance, and Path Knowledge. Applied Intelligence 6:49-58.

Inversion, Homing, and Shortcut

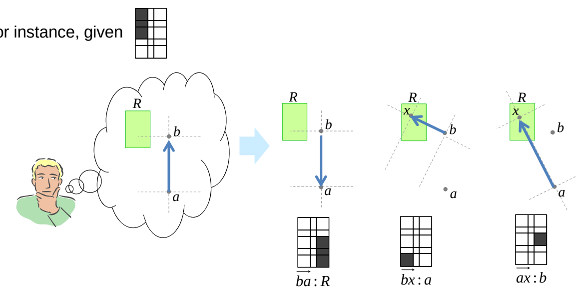


The answer to these questions are derived computationally by the **inversion**, **homing**, and **shortcut** of an RfDL$_{3\text{-}12}$ pattern $\overrightarrow{ab}:R$, respectively

Given $\overrightarrow{ab}:R$

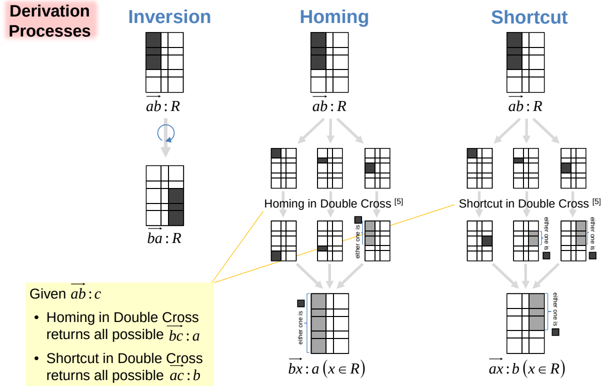
- Inversion returns $\overrightarrow{ba}:R$
- **Homing** returns all possible $\overrightarrow{bx}:a\ (x \in R)$
- **Shortcut** returns all possible $\overrightarrow{ax}:b\ (x \in R)$

For instance, given



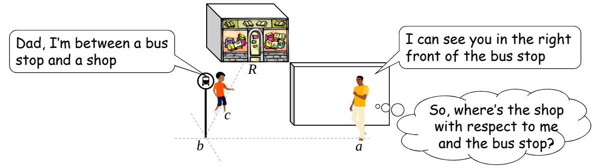
What other possibilities?

Derivation Processes



Composition

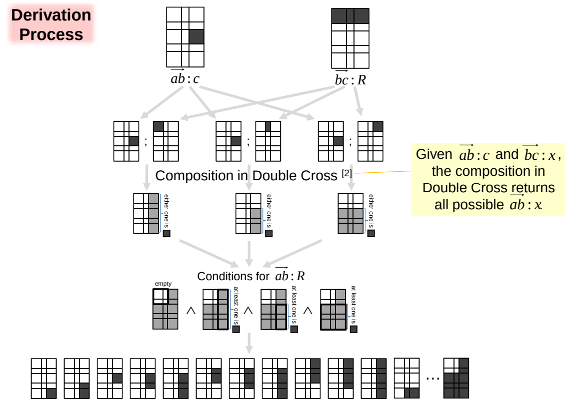
(i) Composition of a Double Cross Pattern and an RfDL$_{3\text{-}12}$ Pattern



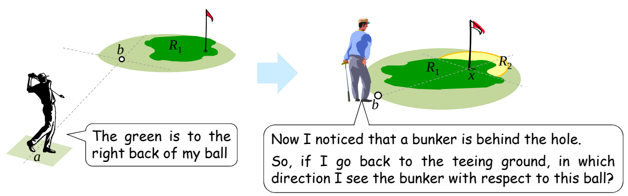
The answer to this question is derived computationally by the composition of a Double Cross pattern $\overrightarrow{ab}:c$ and an RfDL$_{3\text{-}12}$ pattern $\overrightarrow{bc}:R$

The composition $\overrightarrow{ab}:c;\overrightarrow{bc}:R$ returns all possible $\overrightarrow{ab}:R$

Derivation Process



(ii) Composition of Two RfDL$_{3\text{-}12}$ Patterns



The answer to this question is derived computationally by the composition of two RfDL$_{3\text{-}12}$ patterns $\overrightarrow{ab}:R_1$ and $\overrightarrow{bx}:R_2\ (x \in R_1)$

The composition $\overrightarrow{ab}:R_1;\overrightarrow{bx}:R_2\ (x \in R_1)$ returns all possible $\overrightarrow{ab}:R_2$

This composition is derived in the similar way as (i), considering the synthesis of the results of the Double Cross composition $\overrightarrow{ab}:x;\overrightarrow{bc}:y$ where x and y moves in R_1 and R_2, respectively