Open-Source Tools for Relational Network Derivation, Visualization and Task Generation

Matthias Raemaekers

Department of Experimental-Clinical and Health Psychology, Ghent University, Belgium.

**Author note.** Author can be reached at [{matthias.raemaekers@ugent.be}](mailto:%7bmatthias.raemaekers@ugent.be%7d), or Henri Dunantlaan 2, 9000, Ghent, Belgium. The work presented here was supported by fundamental research grant (11M0323N) of the Flemish Research Foundation to MR. Preregistration documents, data and materials are available at open science framework repositories linked in the manuscript.

Abstract

Relational reasoning is a cornerstone of human higher cognition, and therefore a prime subject of psychological research. The current paper describes a set of tools designed to facilitate research into relational reasoning. Based on a thorough conceptual analysis of relations, software was designed to automatically derive relations given a (set of) source relation(s). Building on this simple idea, we introduce tools to easily and automatically (1) visualize a relational network of baseline and derived relations, (2) generate a match-to-sample procedure with user-defined task parameters and (3) generate a set of syllogistic reasoning problems provided user-specified task characteristics. It is often cumbersome for experimenters to construct large relational networks due to the combinatorial explosion (i.e., from a set of *n* relations, one can in principle derive *n²* new relations). However, it is likely this kind of complex relational behavior or reasoning that underpins most cognitive abilities interesting to psychologists. Few attempts have been made to facilitate the empirical study of such complex behavior, and those that exist are limited. The tools presented in this manuscript address some of these limitations and as such (we hope) facilitate relational reasoning research on more complex relational behavior.

**Keywords**. Relational Reasoning, Relational Networks, Syllogistic Reasoning, Relation Derivation, Software

Introduction

* Importance of relational reasoning
* RFT??
* Related work, e.g., Smith & Hayes (22) -> Extended and applied!

Method

Conceptual Analyses of Relations and Derivation Tables

* Cf. Allen (1983) – thorough analysis of relations and their mutual and combinatorial relations – follow distinct patterns as function of relation and linearity of combination
* Patterns can be exploited

\*figure of derivation tables for mutual relations and

Tutorials

Visualizing Relational Networks.

A first hurdle that researchers encounter in the study of complex relational behavior is due to the combinatorial explosion that occurs when even a relatively small number of relations is combined. One of the reasons that relational reasoning is such a powerful capacity is that it is generative: given information about n relations, one can derive n² novel relations from that information (Hayes et al., 2012

* Tool for now can handle (all? combinations of) same, different, opposite, more than, less than, before, after, contains, is part of/during (but many relations share pattern of comparative relations in that they are similarly asymmetrical, e.g., father-son).

Generate a Match-to-Sample Task.

* Dominant procedure in

Generate a Syllogistic Reasoning task.

Discussion

* Limitations: Limited to programmed relations or those that fit known patterns, until other patterns are discovered or generality of
* General patterns underlying multiple relations – possibility for scaling

Declarations

* **Funding** (information that explains whether and by whom the research was supported)
* **Conflicts of interest/Competing interests** (include appropriate disclosures)
* **Ethics approval** (include appropriate approvals or waivers)
* **Consent to participate** (include appropriate statements)
* **Consent for publication** (include appropriate statements)
* **Availability of data and materials** (data transparency)
* **Code availability** (software application or custom code)
* **Authors' contributions** (optional: please review the submission guidelines from the journal whether statements are mandatory
  + Also referred to as **Open Practices Statement**
  + E.g., all materials and code along with tutorials are made available at the OSF (link).

References

Smith, P., & Hayes, S. (2022). An Open-Source Relational Network Derivation Script in R for Modeling and Visualizing Complex Behavior for Scientists and Practitioners. *Frontiers in Psychology, 13*. Article 914485. doi: 10.3389/fpsyg.2022.914485