Mapping the Relationships among Data Visualization Types

by **BO-YUAN CHEN**

Despite the rapid growth of visualization research, the relationships among different visualization types have not been adequately and systematically explored. This thesis addresses this gap by analyzing these relationships using spatial reasoning on their visual encodings, introducing three representations to illustrate them, and evaluating respondents' comprehension and preferences through user testing.

CONSTRUCTING THE RELATIONSHIPS

To construct a relationship in the graph, two nodes and a link are required. In our case, nodes represent visualization types and visual encodings, and links indicate the use of a visual encoding by a visualization type. Visualization types are selected based on their popularity [1] and diversity [2]. For the visual encoding system, LangVIS [2] is chosen due to its systematic and rigorous framework, built on Bertin's foundational work [3]. These relationships are illustrated using a force-directed graph (similar to Fig. 1), where shorter distances between nodes indicate closer relationships.

REPRESENTING THE RELATIONSHIPS

Three representations illustrate these relationships, each following a different design principle [4]. The Node-Link Diagram (Fig. 1) uses edges, adapted from the force-directed graph. The redesigned Euler Diagram applies grouping by boundary. The UpSet plot [5] employs a matrix and bars to encode relationships.

USER TESTING AND CONCLUSION

User testing was conducted online to evaluate how the three representations support the understanding of the relationships. Each representation shows clear strengths and limitations: the Node-Link Diagram is familiar but can become cluttered; the redesigned Euler Diagram is visually appealing but may overload information; and the UpSet plot provides an overview and detailed insights but requires user training. Results also indicate that the most frequently used encodings are *Positioning along a coordinate axis*, *Proportional space-filling*, *Extending along a coordinate axis*, *Connecting*, *Sizing*, and their combinations.

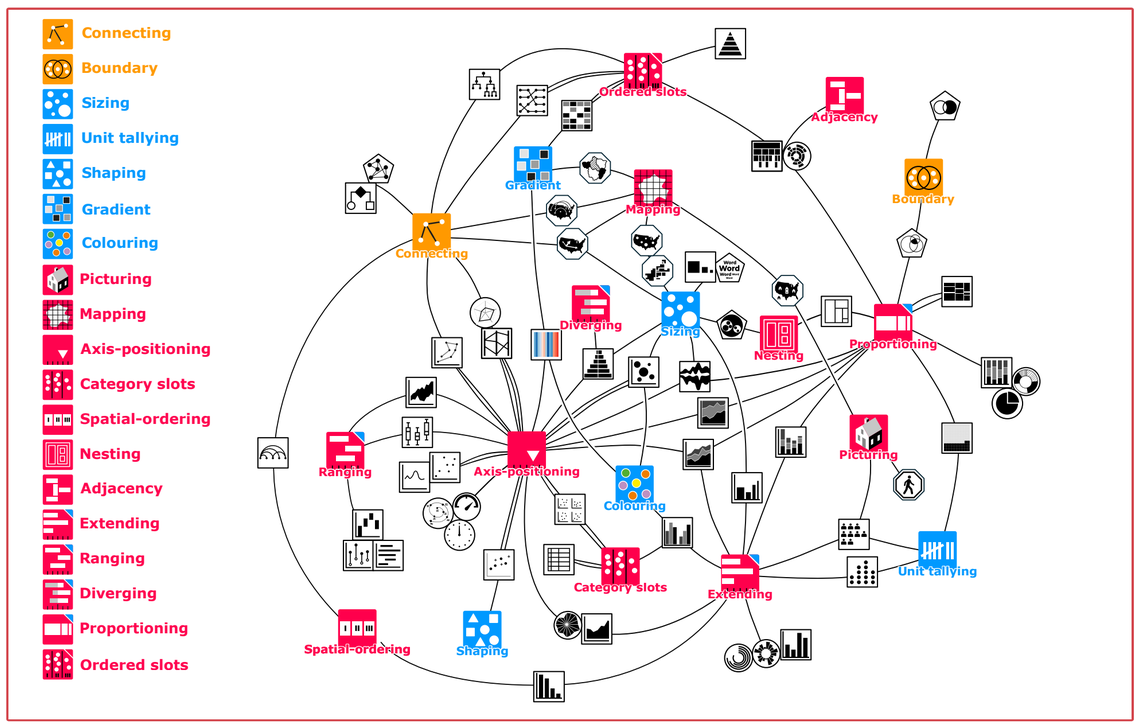

Fig. 1: A Node-Link Diagram representing the relationships of visualization types

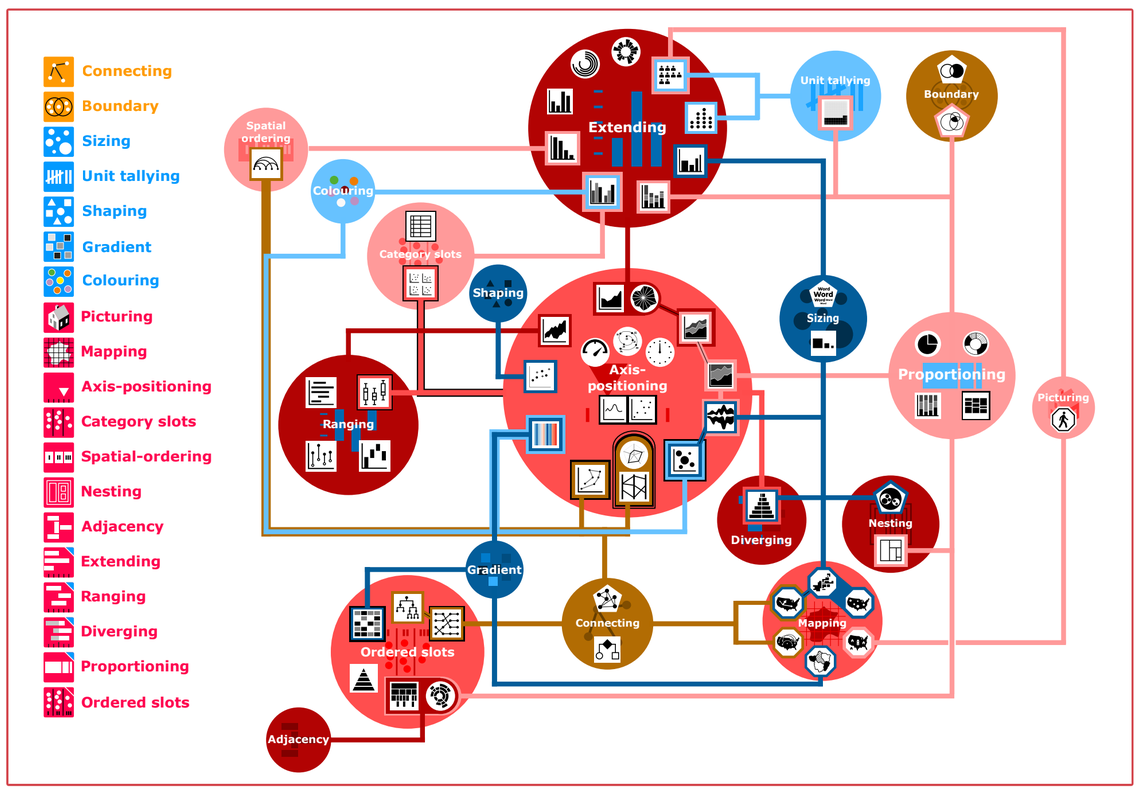

Fig. 2: A redesigned Euler Diagram representing the relationships of visualization types

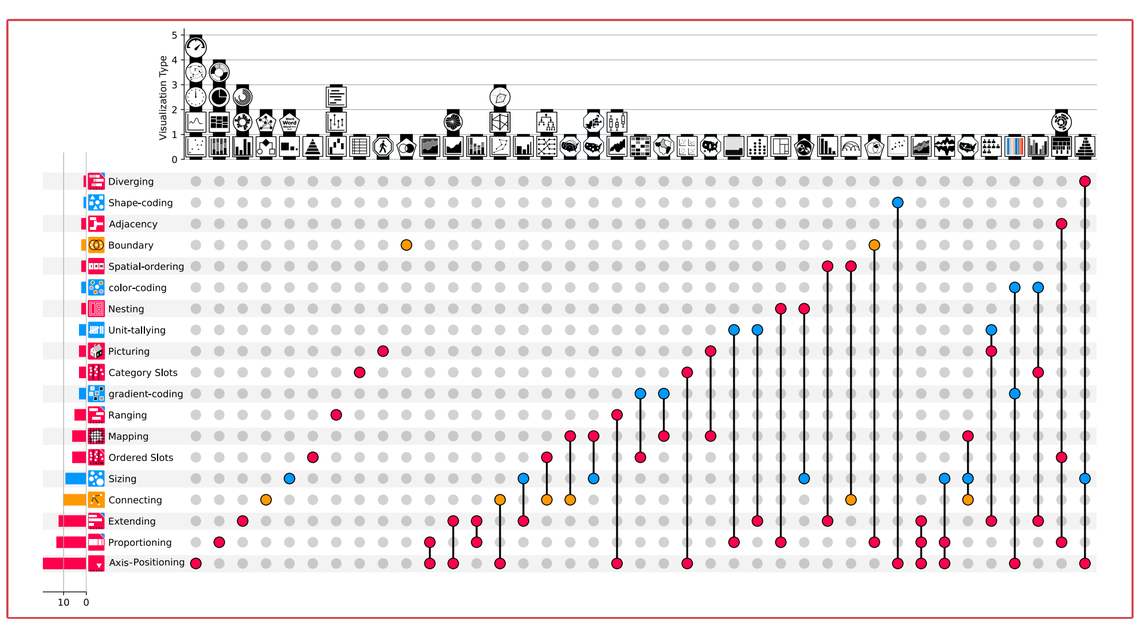

Fig. 3: An UpSet plot representing the relationships of visualization types

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THESIS ASSESSMENT BOARD

Chair Professor: Prof. Dr. Raul Zurita Milla (UT)

Supervisor: Dr. Yuri Engelhardt (UT)

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