A Formalism For Visual Query Interface Design

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INTRODUCTION OF THE FORMALISM

A visual information exploration environment supports querying, selecting a part of the data for special attention, and for visualizing, seeing a visual presentation of the data. Research into visual query interfaces has two goals, making query creation easier, and better integrating the visualization interface with the query one.

This poster describes a formalism for information exploration, which equally captures querying and visualizing.

The core of the formalism is in Figure 1, which resembles those that appear in category theory. The important operations of information exploration are mappings: querying maps data items to Boolean values; visualizing maps data items to graphical icons.

- *DS*: the data space of items to be visualized;
- *VS*: the visualization space of icons that represent data items;
- *QS*: the space of query fragments that are assembled into Boolean queries;
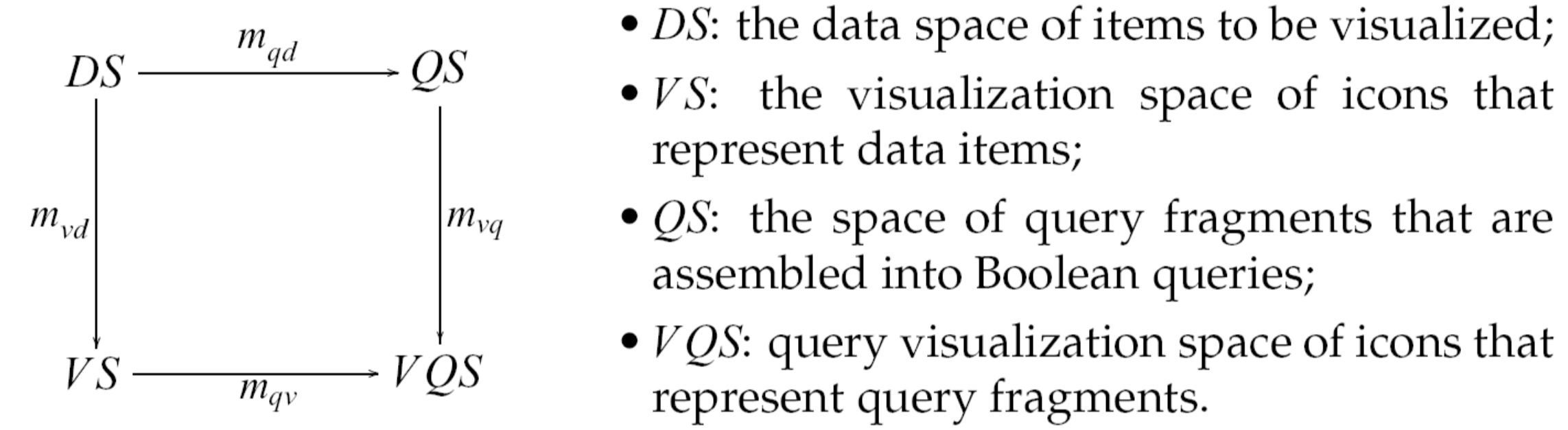- *VQS*: query visualization space of icons that represent query fragments.

Fig. 1: Transformation Model of Query Visualization.

All entities in the query/visualization environment can be represented as tables:

- Data to be visualized, as relations,
- Visualized data, as a table of visual attributes,
- Visualization mappings, as tables, and
- Queries, as truth-tables.

EXAMPLES OF QUERY VISUALIZATION

A query is defined as a multi-dimensional item set, which can be visualized, as illustrated in Figure 2 and 3.

Fig. 2: An iconic representation of Boolean queries.

(a) Karnaugh Map (b) TreeMap Representation (c) Circular Gray Code Arrangement
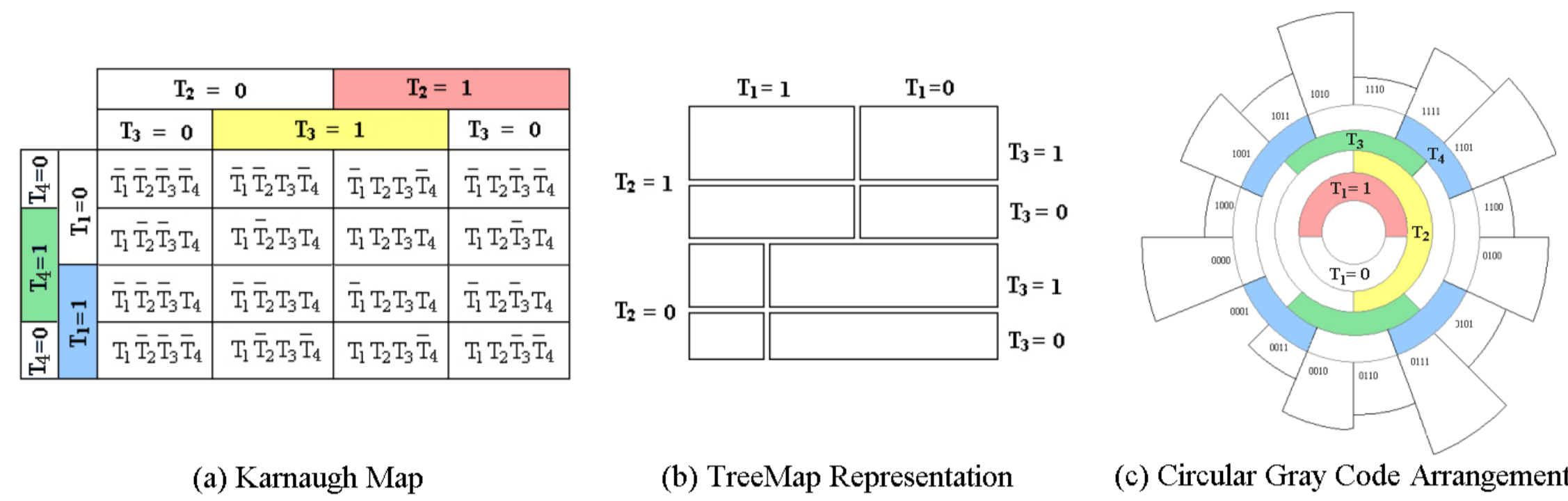
Fig. 3: Examples of Query Visualization.

THE MODEL OF QUERY RESULT VISUALIZATION

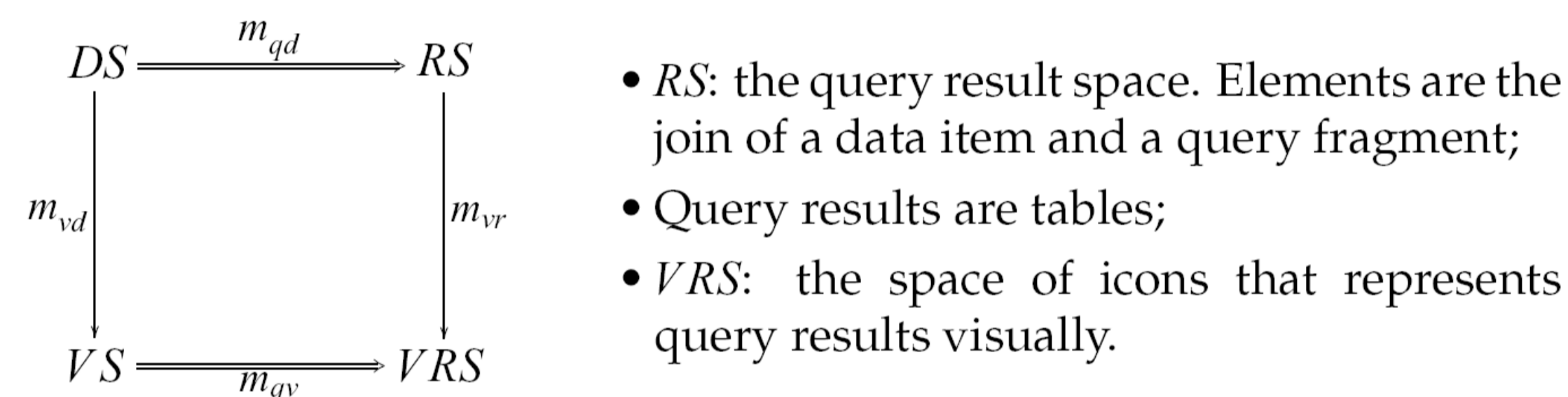Query results are visualized to reveal the relationship between data items and query fragments.

- *RS*: the query result space. Elements are the join of a data item and a query fragment;
- Query results are tables;
- *VRS*: the space of icons that represents query results visually.

Fig. 4: Transformation Model of Query Result Visualization.

Visual encoding for the query fragments

Visualization of the data set

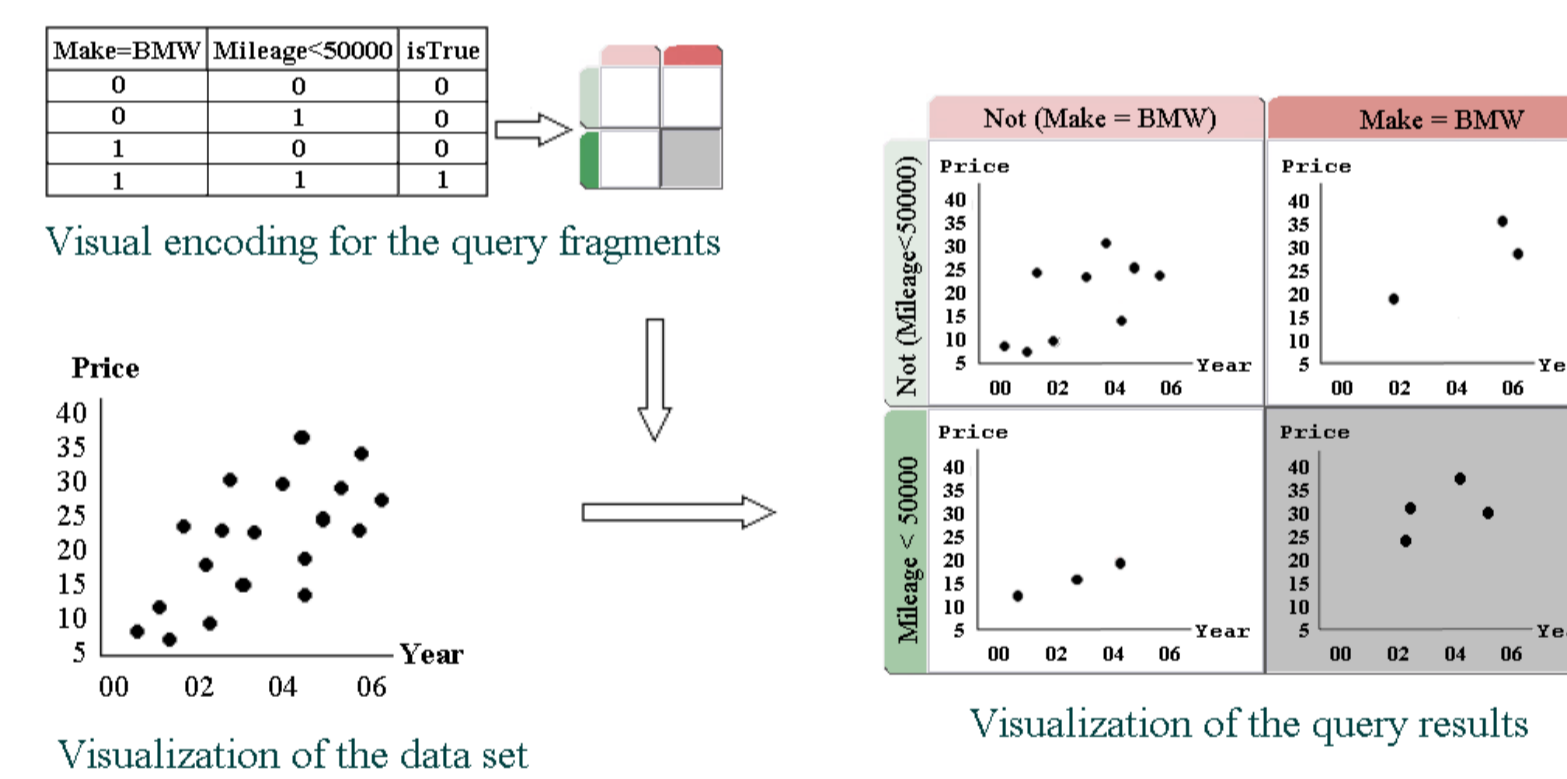Visualization of the query results

Fig. 5: Example of query result visualization.

RECURSIVE MODELS

All entities in the query/visualization environment are tables:

- Data, including queries and visualizations, and
- mappings, including visualizing and querying.

The formalism defines applying tables to tables:

- querying a query,
- visualizing a visualization,
- querying a visualization, and so on.

The transformation models are able to be extended unlimitedly in both the horizontal and vertical directions.

(a) The Model of Visualizing Visualizations (b) The Model of Querying on Queries (c) The Iterative Model
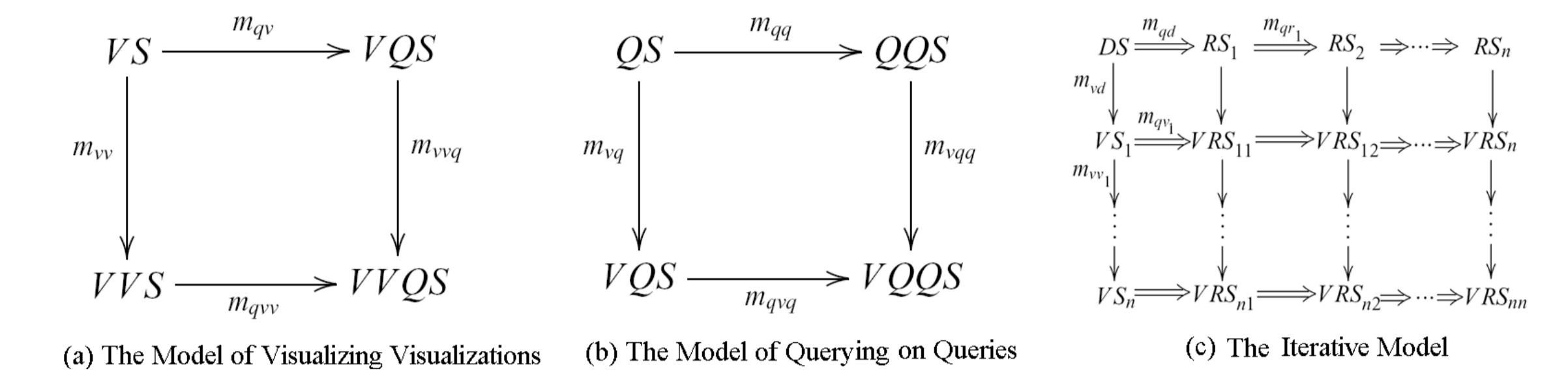
Fig. 6: Recursive Models: (a)recursive visualizations; (b)recursive queries; (c)iterative model.

Figure 7 not only shows the result of visualizing a visualization, but also gives a visualization for the mapping itself.
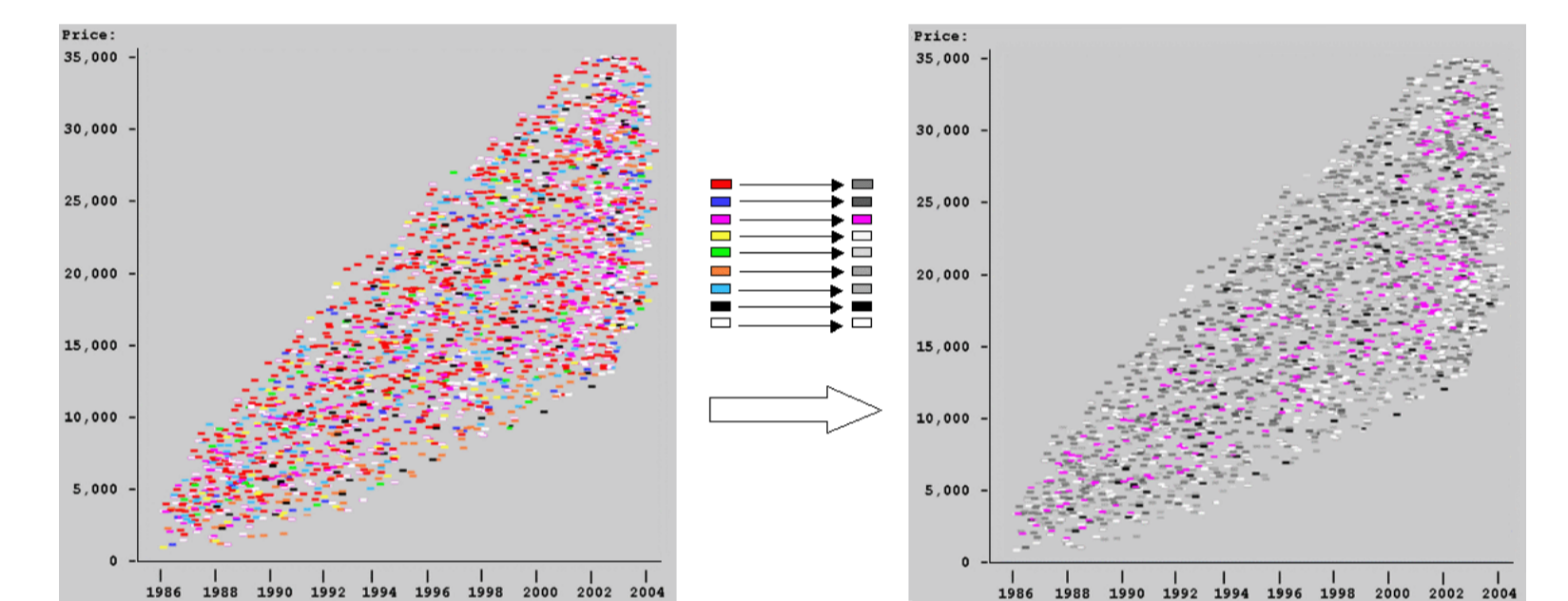
Fig. 7: Visualizing Visualization.

Figure 8 presents querying on queries by specifying query terms on the query space, which allows reducing the complexity of query formulation and help users understand complex queries.
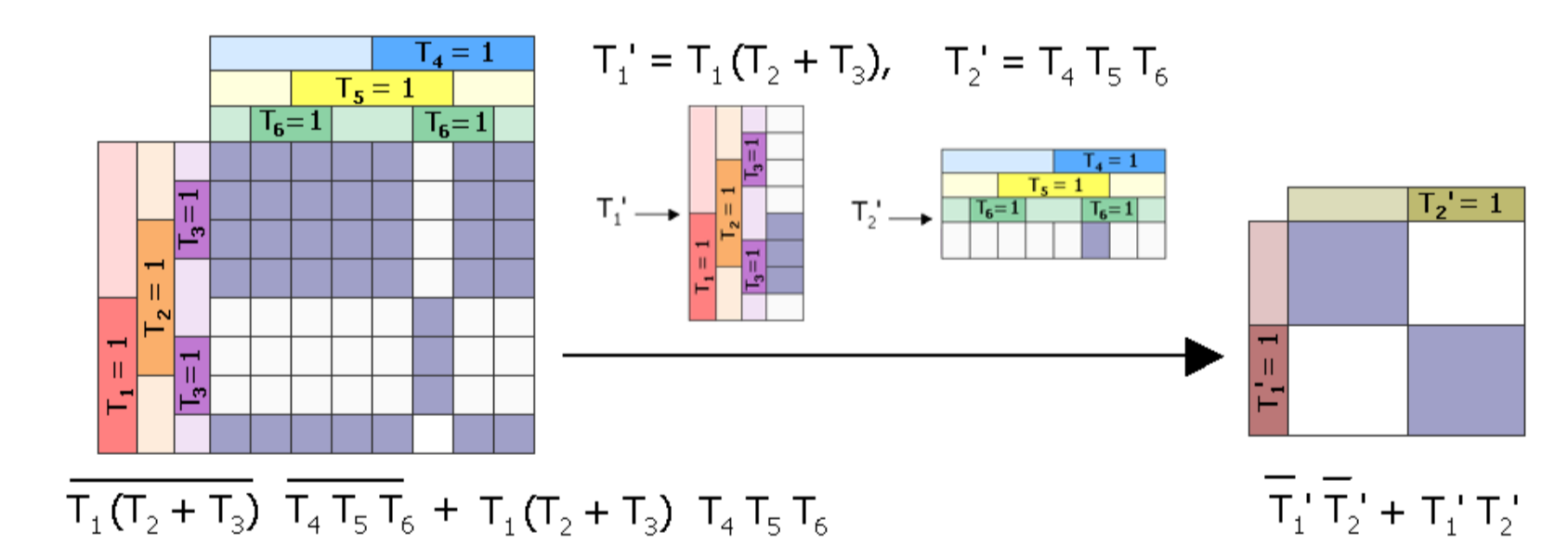
Fig. 8: Querying on Query.

BENEFITS OF THE FORMALISM

A formalism is a tool to assist thinking. The formalism for information exploration provides:

- A systematic integration of querying and visualization.
- A foundation for analyzing information exploration environments.
- A controlled set of required capabilities against which an implementation can be organized.
- Concepts for designing new interfaces for querying and visualizing.
- Opportunities for extending existing visual query interfaces.

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