User Instruction for VQFlow

The generation of table reports requires business analysts to describe query requirements, i.e., how to retrieve the required data from databases. Traditionally, two-dimensional tables are used to describe the logic of retrieving each column. However, when SQL queries become complex (for example, more tables and more columns are involved), the relationships between tables and columns become intricate, which makes describing query requirements extremely difficult.

To solve such a problem, we developed a tool called VQFlow (**V**isual **Q**uery **Flow**) to help business analysts quickly and clearly describe query requirements. VQFlow represents query requirements as a top-down data flow. Based on this diagram, developers can quickly and correctly understand query requirements and write SQL SELECT statements.

1 Basic Components

VQFlow consists of four components: Min-query, Requirements Module, Reuse, and Edge.

1.1 Min-Query

Min-queries are the basic units in VQFlow. It contains three elements (as shown in Figure 1): *Table*, *Filter* and *Columns*. Mini-queries are used to retrieve the rows that satisfy the condition in *Filter* from the table *Table*. *Columns* define the columns that belong to the final table report (can be calculated columns). If *Filter* is empty, all rows are outputted.

Figure 1 Visual representation of Mini-query

1.2 Requirements Module

The Requirements Module describes query requirements in a modular manner (as shown in Figure 2), where the header is a Requirements Description, which presents a brief description of the Requirements Module to help developers quickly understand requirements, and the body contains at least one Requirements Module/Min-query.
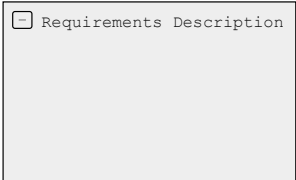

Figure 2 Visual representation of Requirements Module

When dragging and dropping a Mini-query or Requirements Module into a Requirements Module, the former becomes a part of the latter. When moving a Requirements Module, the internal components will follow it. When a component is moved across the border of its external Requirements Module, the external Requirements Module will automatically change its size to hold its internal components.

1.3 Reuse

Reuse is devised for reusing the existing Requirements Modules. For complex queries, some query logic may be used more than once. By copying the Requirements Description of a Requirements Module to the body of Reuse, business analysts can demonstrate that the Requirements Module is reused by the Reuse, as shown in Figure 3.
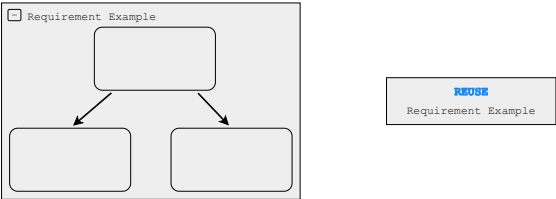

Figure 3 Example of Reuse

1.4 Edge

Edge is used to connect the above components to describe the connection among them. Edge contains three types: EXPAND connection, UNION connection, and REF connection.

1.4.1 EXPAND connection

EXPAND connection is used to expand the parent table (the exported table of Edge source): Obtain more relevant information from the child table (the *Table* in the target Mini-query). It consists of three elements: the first element indicates the number of the rows in the child table that match a row in the parent table (1/n), the second element indicates the columns that serve as the expanding condition, and the third element indicates the filter condition (when EXPAND connection is used for filtering).

An example is shown in Figure 4, the query first retrieves the student information from Student_Table, and then retrieves the information on the corresponding courses from Student_Course_Table according to student_id. The n on the edge indicates that one student may attend multiple courses. In addition, the EXPAND connection is also used for filtering, i.e., after expanding Student_Table, the rows in the exported table whose course_name is not 'Science' are removed.
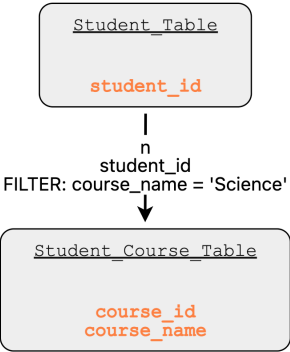

Figure 4 Example of Expand connection

1.4.2 UNION connection

The UNION connection is used to merge the rows of the tables outputted by the two connected components, as shown in Figure 5.
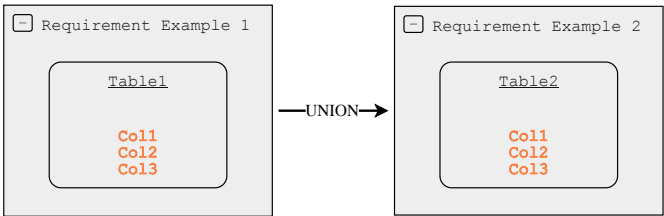

Figure 5 Example of UNION connection

1.4.3 REF connection

The REF connection is used to connect a Requirements Module (source) to a Mini-query (target). The exported table of the Requirements Module (source) is the *Table* of the Mini-Query (target) so that the target Mini-query can perform further operations (such as filtering) on the exported table, as shown in Figure 6.
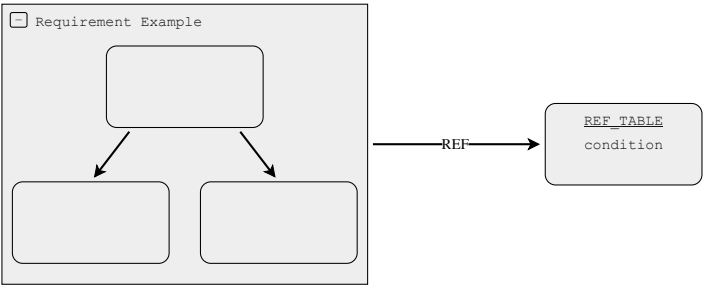

Figure 6 Example of REF connection

2. Other Functions

The interface of VQFlow is shown in Figure 7. The left panel contains three components: Requirements Module, Mini-query, and Reuse. The middle panel is the drawing panel. Business analysts can add the components to the drawing panel by dragging and dropping. The right panel in Figure 7 shows the state when no component is selected, which consists of two parts: Introduction and Upload JSON, which are the brief introduction of our tool and the file-upload function. The graph in our tool can be exported to a JSON file, and the JSON file can be imported to our tool for modifying the saved graph.
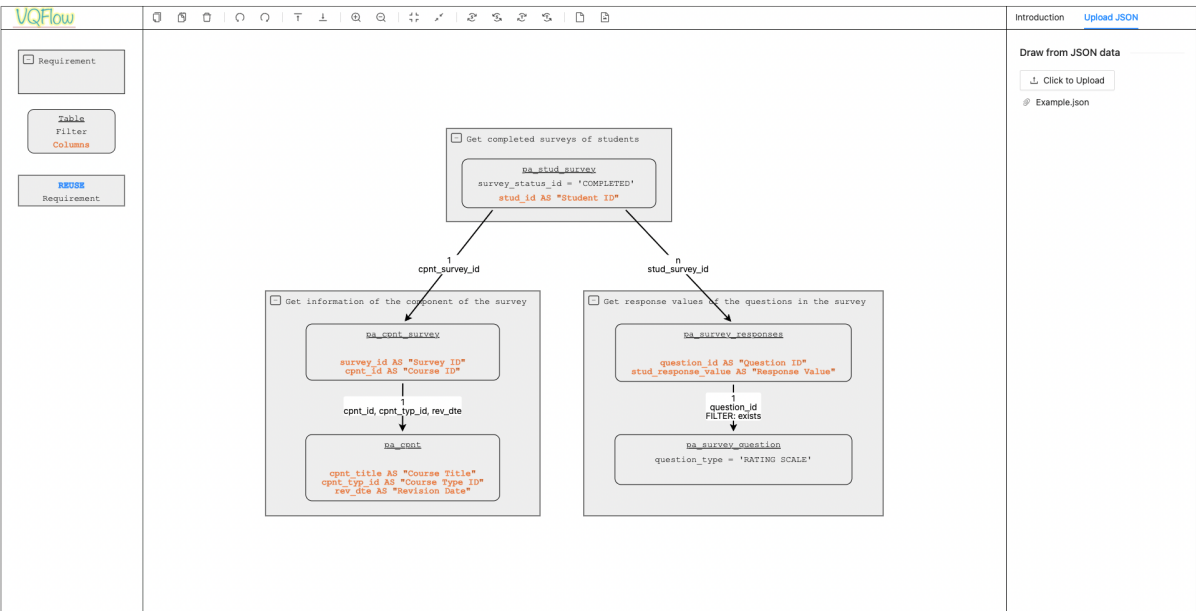

Figure 7 Interface of VQFlow

When business analysts select a component in the drawing panel by mouse, the text areas for inputting attributes of the selected component appears in the right panel. The following figure shows the status when a Requirements Module is selected.
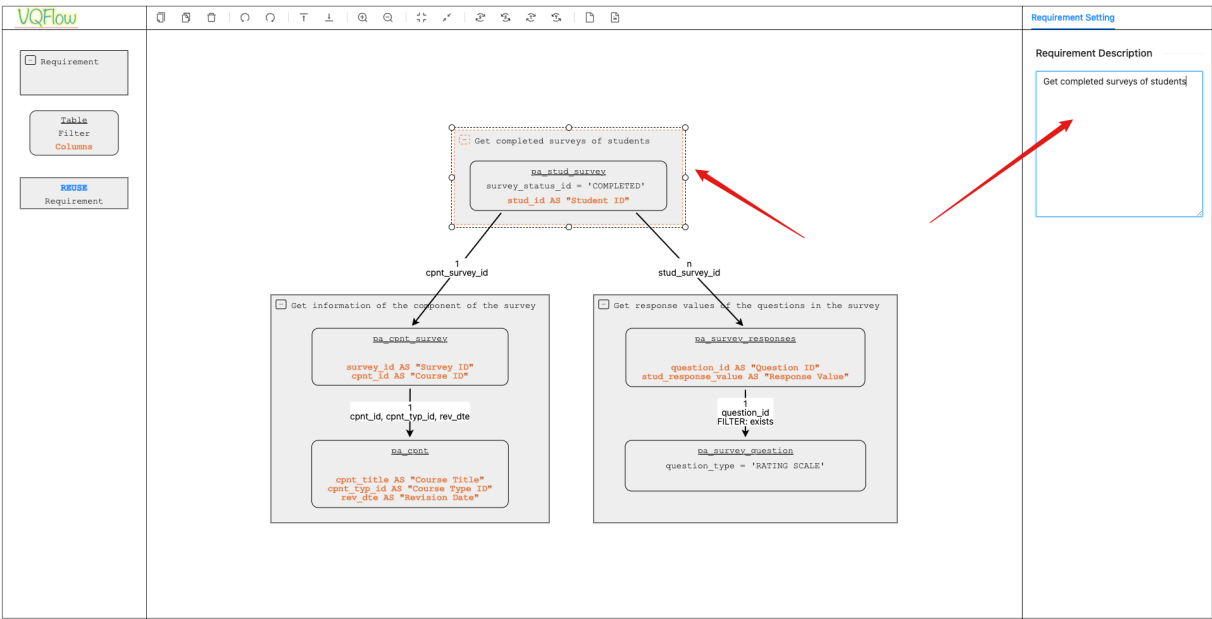

Figure 8 Inputting attributes of components

The upper side of the drawing panel is the drawing toolbar (Figure 9), which contains functions to improve the efficiency in describing complex queries and the aesthetics of the drawn graphs.
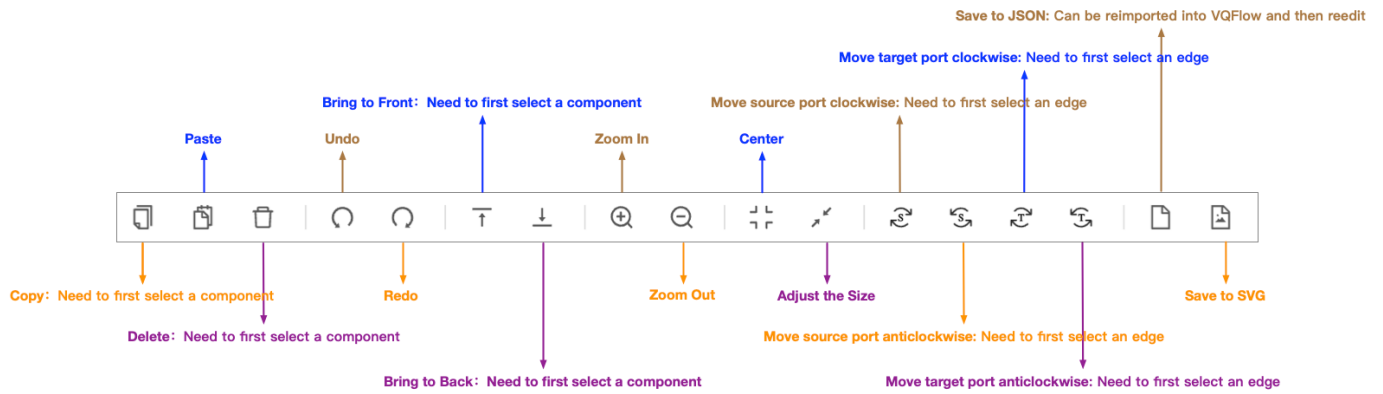
Figure 9 Menu of VQFlow

We explain several functions in detail as follows:
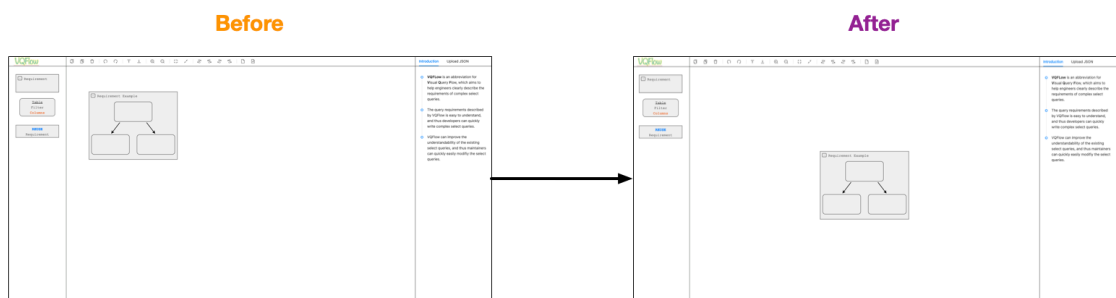
- Center: Center the entire graph.

Figure 10 Center

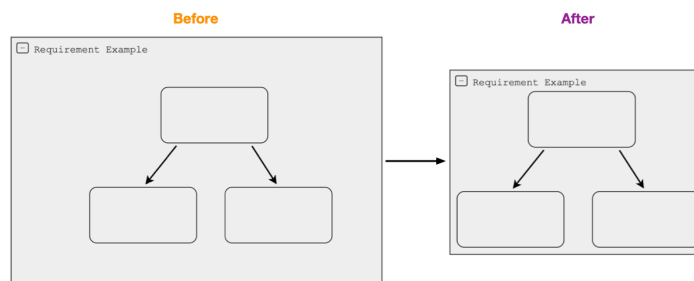- Adjust the Size: Automatically adjust the size of a Requirements Module

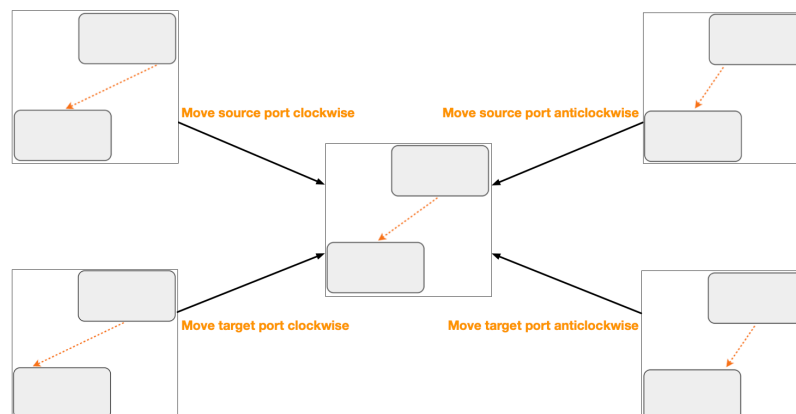*Figure 11 Adjust the size of a requirements module*

- Adjust the positions of ports

Figure 12 Adjust the positions of ports