Project ART/264CP:

Product description

- Grouping and Comparison System

Documented by Charles Chen

Supervised By Carol Wen

Vehicle data

Given a batch of vehicles in either image and text format, we provide a state-of-the-art system to extract damage and attribute information in the vehicles. This extracted data will be called vehicle data for the rest of the article. A vehicle data contains attribute values, including *Color, Model, Make, Car type, Vehicle Type* and *Component*. Different attributes can hold a single value or a list value with a confidence level in the scale of 0 to 1 denoting the certainty of the value predicted by our system. For details of what type of data each attribute holds, refer to the table below.

Attribute Name	**Value type**
Color	*List Value*
Model	*List Value*
Make	*Single Value*
Car type	*Single Value*
Vehicle Type	*Single Value*
*Component**	*List Value*

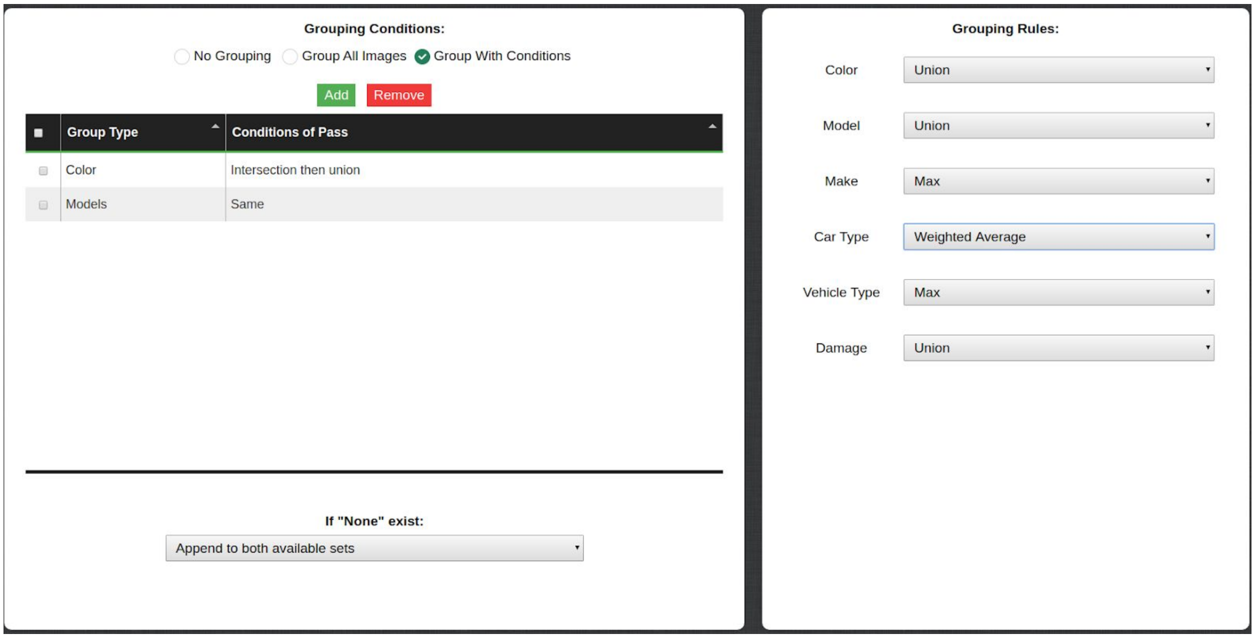
Table. Attribute value type

* *Component attributes contain complicated values including the type, area, color and damage of the specific component.*

Vehicle data involved in our systems are those which are extracted from either one text data or a batch or image data. We here further provide two systems to achieve the goal of comparing the conformity of text and image data.

Grouping System

Grouping System provides an innovative feature for combining image vehicle data. Since multiple images can describe the same vehicle from different perspectives, the system operates on a batch of vehicle data in image form and creates combined data within which contains all of its related information. Based on user specific conditions and rules, the system can eventually output one or more vehicle data that contains mutually exclusive information. Images data describing the same vehicles will be combined together. There are three options for grouping: *No Grouping*, *Group All Images,* and *Group with Conditions*.



Grouping Conditions:

○ No Grouping ○ Group All Images ✓ Group With Conditions

□	Group Type	Conditions of Pass
□	Color	Intersection then union
□	Models	Same

If "None" exist: Append to both available sets

Grouping Rules:

Color	Union
Model	Union
Make	Max
Car Type	Weighted Average
Vehicle Type	Max
Damage	Union

Figure. Grouping System

The option *No Grouping* means that the user wishes to treat every image data as those which describe different vehicles no matter what. *Group All Images* means the opposite. Both options are not supported by the conditions and rules that may affect the grouping result. Nevertheless, the option *Group with Conditions* will require users to specify their ideal way of processing the data with conditions and rules.

Grouping Conditions:

○ No Grouping ○ Group All Images ✓ Group With Conditions

Figure. Three ways of grouping

Grouping Conditions

Grouping conditions are conditions that two data will be grouped together if held true. One may specify one or more conditions for grouping, and the grouping will only be processed if all of the conditions hold true. For each attribute in a vehicle data, a choice of grouping condition is provided, with its value *same* or *intersection*.

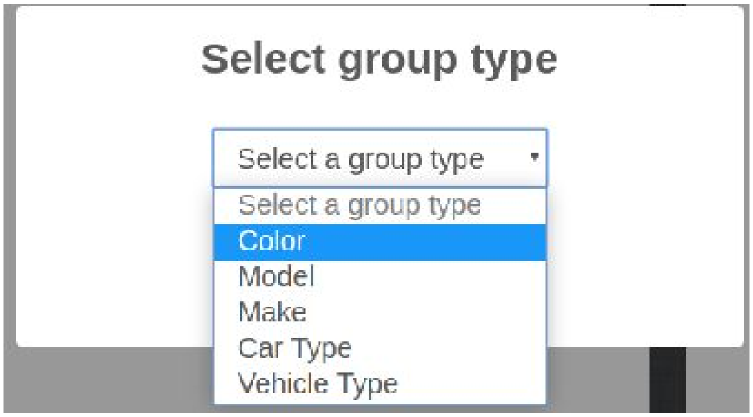
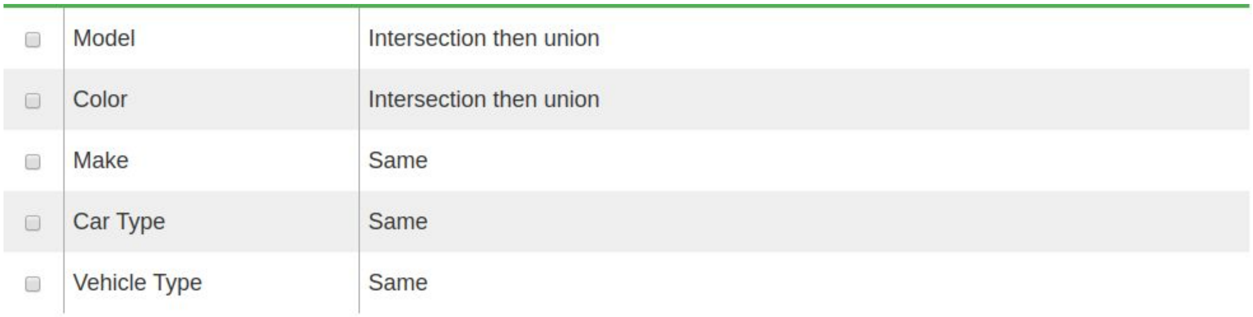


Figure. Group Attributes

The option *same* will check if two attributes have identical value, regardless of whether they are represented by a single value of list value. The option *intersection* will only be available to those holding list values. The calculation will check if there is at least one value that both lists possess.



□	Model	Intersection then union
□	Color	Intersection then union
□	Make	Same
□	Car Type	Same
□	Vehicle Type	Same

Figure. Grouping Options

Attribute	**Value**
Color	*Same/ Intersection*
Model	*Intersection*
Make	*Same*
Car type	*Same*

Vehicle type	*Same*

Table. Options for each attribute

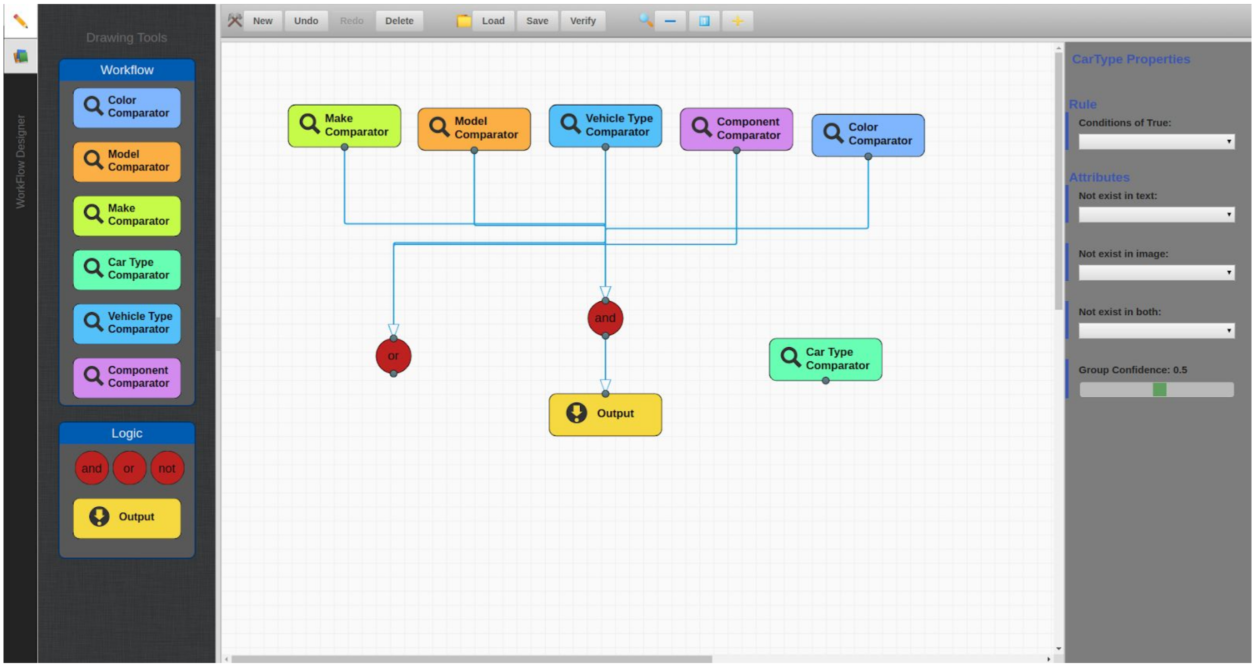
Exception handling upon grouping is handled under the option of *If "None" exist.* It determines which group a targeted data is to combine when the targeted data has no such attribute. Two options are available, *Append to both available sets* and *separate as a new set*. The option *Append to both available sets* will group the data with all other possible grouped vehicle data as its non-existing attribute may be ambiguous, while the option *separate as new set* will do the opposite, i.e., grouping the data to neither existing groups but to its own.

Grouping Rules

Grouping rules are rules that control the attribute value of grouped data. The grouping options can be *Union* for attributes with list values and *Max/ Weighted Average* for those with single values. The option *Union* will generate the union set of values. *Max* will select the value with maximum confidence level to be the new value of the grouped vehicle data. And *Weighted Average* will select the value with highest frequency-normalized confidence level to be the value of the attribute.

Comparison System

Comparison system provides a solution for checking if text and grouped image vehicle data are describing the same entity. The system provides various functional widgets for comparing different attributes of the vehicle data with user specified connections and rules.



Conditions of True:

Not exist in text:

Not exist in image:

Not exist in both:

Group Confidence: 0.5

Figure. Comparison System

Comparing Widgets

Comparing widgets consist of widgets of three types with mutual connections: *Attribute Comparator*, *Logic Operator* and *Output.*

The widgets provide linkage so that one may be connected to another. The connection is unidirectional, denoting the direction of feeding outputs towards widgets as their inputs. The connections allow users to create a self-defined comparing system and the calculation will all start from comparators. Consequently, connections involved in comparators are only outgoing, while those involved in logical operators can be either ingoing or outgoing depending on the position of previous connections with comparators.

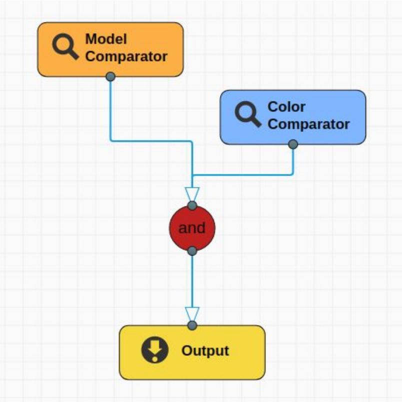


Figure. Sample Connection

Attribute comparators provide a feature to compare a single attribute among two vehicle data. There are six comparable attributes supported: *Color*, *Model*, *Make*, *Car Type*, *Vehicle Type*, and *Components*. Each comparable attribute can be compared with its corresponding comparator, with the comparing rules specified (See **Comparing Rules** for details). Each comparator will only output the boolean value, i.e., true or false, in correspondence to the exact attribute and rules.

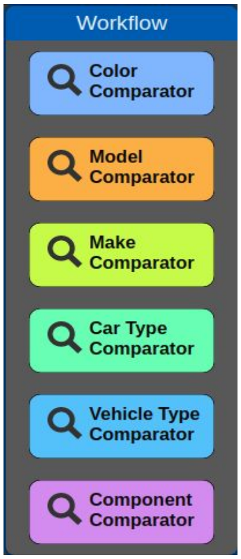


Figure. Compartors

Logic Operators provide a visualizable logical operation on the outputs of the comparators. We provide three logical operators, *And*, *Or*, and *Not* for this purpose. Users may connect different operators in order to combine comparing results from different attribute comparators.

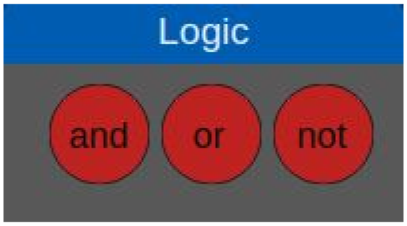


Figure. Logical Operators

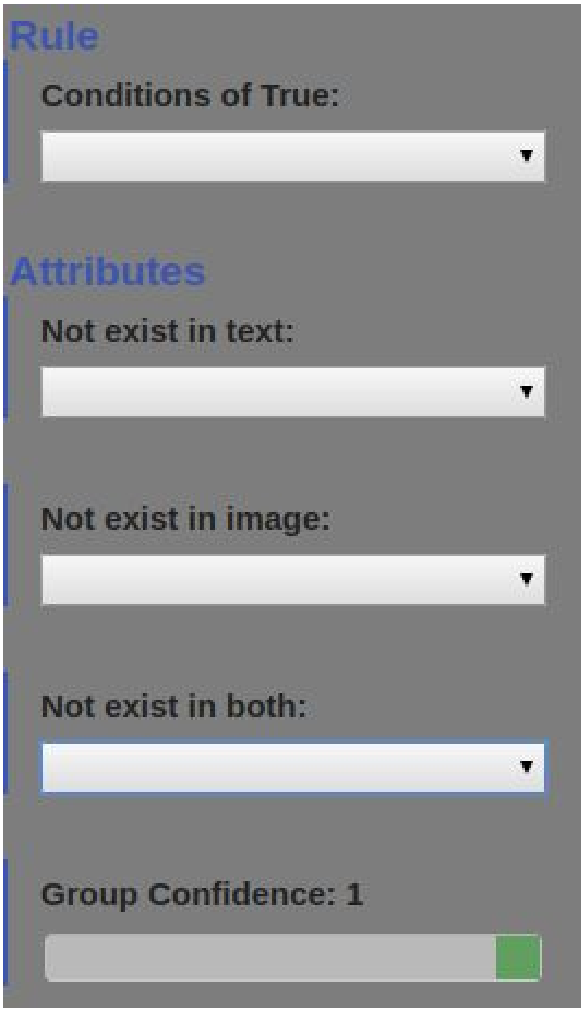
Output denotes the ending point of the entire comparison procedure. It does no extra operation nor calculation but freezes the connection it involves in and ignores other irrelevant connections. It contains only ingoing connections and will output the result for the entire customized comparison procedure.

Figure. Output

Comparing Rules

Users may specify the comparing rules for attribute comparators since different attributes will hold different data types and exceptions.

Each comparator will possess the comparing rules (*Conditions of True*), three exception handling rules (*Not exist in text/image/both*) and the confidence threshold (*Group Confidence*) that the attribute shall be considered valid.



Rule

Conditions of True:

Attributes

Not exist in text:

Not exist in image:

Not exist in both:

Group Confidence: 1

Figure. Comparing Rules

- *Conditions of True*
  The conditions can be the *same*, *intersection exists* or both. The option *same* will return a value of true if two attributes have identical value, regardless of whether they are represented by a single value of list value. The option *intersection exists* will only be available to those holding list

values. The calculation will return true if there is at least one value that both lists possess.

- *Not exist in text/image/both*
  The option will handle if at least one attribute does not exist. The comparator will automatically return either true or false based on users' choice.

- *Group Confidence*
  The drag bar scaling from 0 to 1 denotes the filtering confidence. Any attribute value with confidence level below this threshold will be ignored and treated as non-exist during comparison.

As to which rules apply to what attribute, one may refer to the table below.

Attribute	**Rules**
Color(List)	*Same / Intersection*
Model(List)	*Intersection*
*Component(List)**	*Same / Intersection*
Make/ Car Type/ Vehicle Type (single)	*Same*

Table. Attribute Rules

* *The component attribute involves complicated nested comparison. It will verify whether the name, areas, colors, and damages are completely identical.*