Capish®

Reflective Logic

Complex Questions Easily Resolved

REFLECTION IS THE FUNDAMENTAL FEATURE of Capish® Reflect. Technically it is a simple two-step query response which is a very crude mimicking of the immensely more complicated processes of the human brain's reasoning powers. Nevertheless, when applied to data modeled into a brain mapped conceptual information graph, it turns out that also a crude brain mimicry will greatly empower end-users by increasing the versatility and clarity of the user interface.

In order to position this new technology and understand what it can do today, and the implications for tomorrow, it is worthwhile to recapitulate some fundamental brain concepts and properties.

The ambiguous duck-rabbit figure published in the FLIEGENDE BLÄTTER *1892 is a classic illustration of our brains' conceptualizing abilities.*
CLICK IMAGE TO TOGGLE SIZE.

Brain Concepts

THE HUMAN BRAIN IS constantly and effortlessly conceptualizing everything we encounter. This is how we bring meaning to our experiences. Raise your eyes and look around you; you do not just see shapes and colors, but books, screens, lamps, and keyboards. The ambiguous duck-rabbit figure published in the *Fliegende Blätter* 1892 is a classic illustration.

When looking at the picture you either see a rabbit or a duck, but never both at the same time. The ability to classify things into concepts is extremely important for our brains since a concept occupies only one of the around seven slots we have in our short-term memory. Hence, they can be considered together with other concepts simultaneously which increases understanding and rapid decision making

Simple things like a date or more complicated entities like blood pressure are conceptualized and handled with the same ease. Concepts are also given names which are the fundamental building blocks of our language, and shared concepts are what makes meaningful translations between different languages possible.

Just take the word date in the example above, it would probably be translated to different words when translated from English to another language depending on whether the date refers to a point in time, a fruit, or a meeting. Most people are not aware of how fantastic their brain is in shoving concepts around for the purpose of analyzing data and information.

It is true that many people are not happy with the function of their memory, and frequently find it hard to remember, not only new words when studying foreign languages, but also names of people we meet. Already the ancient Romans knew that *repetitio est mater studiorum* (Repetition is the mother of all learning), but as we get older and wiser, we learn that just memorizing things like children do, is not always enough to get things into our heads.

We need to contemplate the new information by putting it in context with what we already know and play around with it in our heads; coming up with similar thoughts or concepts that will help us to associate to the new pieces of information.

We will try to put the new knowledge in perspective to everything else we know, and given time (by e.g., sleeping on the issue) our brain will come up with amazing new insights and understanding about what we learned the day before.

Sleep is especially useful since the brain during sleep moves new facts from the hippocampus to the cortex. This has two positive effects: first, it secures memories for long term use, and secondly, it clears out short-term memory to make room for new information which facilitates future learning.

Building blocks of memory. Sets of cells encode concepts in the brain. Each concept – each person or thing in our everyday experience have a set of corresponding neurons assigned to it.
R. Quian Quiroga, Itzhak Fried and Christof Koch: BRAIN CELLS FOR GRANDMOTHER, *2013.*
CLICK IMAGE TO TOGGLE SIZE.

Given time and education, our brain will organize new and old information into "mind maps" that relate the different pieces of information to each other in meaningful ways. But, in contrast to the data modelling powers of information professionals, our brain can add an enormous number of dimensions covering virtually everything.

We can always objectify concepts and group them into other concepts ad infinitum. Hence, a concept like King can be associated with anything from a four-letter word starting with a K, a pawn sacrifice in chess, to Elvis Presley or "What kind of association is that?". And you can probably come up with a hundred more examples.

The Capish Infograph

THAT SAID, IT IS OBVIOUS THAT OUR brain needs to have some additional provisions that will increase its ability to correctly interpret and handle the surrounding world by forcing it to think logically and straight. This ability is achieved by a process called neural efficiency, in which your brain directs focus by selecting important information and moving it up the ladder for deeper processing while suppressing interruptions from irrelevant bits and pieces. The frontal lobe plays an important part in this pruning of the brain network.

Similarly, the Capish Reflect software only gives useable results when applied to a mind map that is clear, logical, and understandable to the user of the system. Such a mind map will in the forthcoming be named an **Infograph**, and it is the mind map that remains after a curation process, resembling the pruning for neural efficiency, has been done by down prioritizing paths of relationships that we do not want to keep in the chain of relationships. Information about which relations and pieces of information that are useful and to be kept in the Infograph is described in the Capish Ontology. Having an ontology that correctly describes the information we want to analyze within the knowledge area that is relevant, is an absolute necessity for the relationships and reflections to return relevant results. If we want to analyze adverse events in a clinical study, we want to be sure that the relationship goes from the medication, via the patient, to reported adverse events of the same patient, after the medication was taken, and not some other spurious way like lumping together patients sharing interests in the Beatles. The first response will provide the user with relevant and repeatable results for making informed decisions, while the latter more falls into the realm of artificial intelligence.

Figure 1. The Infograph visualizes available Holons and their relations. This is the backbone for any Capish Reflect application. CLICK IMAGE TO TOGGLE SIZE.

The generic terminology used for describing the parts of a graph is nodes for the circles, and edges for the connecting lines. In the Capish Infograph the nodes are made up of pieces of information that are called **Holons**, and the edges are the relations that connect these Holons. A Holon is a piece of information that is large enough to be understood by itself

(having content), but small enough to be put in relationship with other Holons (placed in a context). Taken together, the Holons and the relationships can create a larger network of connected information that tells a broad story.

In addition, a Holon is always of a specific Holon Type and placed within a knowledge discipline specified by the internationally recognized Dewey Decimal System, used for classifying books and journals in scientific libraries. The important aspect here is that the use of concepts and Holon types, roots the Holons in a particular field of knowledge making them understandable for anybody who is knowledgeable within this field.

Returning to the previous example, the involved concepts *Clinical study*, *Patient*, *Adverse event*, and *Medication* are all well-defined Holon types and understandable by any trained physician, and by adding other concepts and Holon types, the Holons can cover any number of medical disciplines providing a 360-degree medical record of a patient.

The Advantage of Vantage Points

AN IMPORTANT CONCEPT OF THE Infograph is **Vantage Point**. The Vantage point is named such since it denotes the Holon type in the Infograph from which you want to observe the rest of the graph. This mimics your brain's ability to see things from different perspectives.

Returning to the clinical trial, typical Vantage points could be patient (sex,age, genes), treatment (efficacy, adverse reactions, ...), health care (intensive care, days as inpatient, relapses, tests, ...) or simply adverse events (occurrence, severity, ...). Every area of interest will have its own set of interesting Vantage points, but the common denominator is the need for every user to easily change perspective. Selecting a Vantage point is also necessary for comparing different groups with each other using Set Theory.

Here the Vantage point (e.g., Patient) will define the set type, the individual patient Holons are the members of the set, and reflective queries are used to define the different sets to be compared.

Having a defined Vantage point is also necessary for resolving queries within fields that include AND or negations. This will in detail be discussed below in this paper.

Obviously, having Vantage points is a prerequisite for more advanced logical operations. But there is one thing that is even better than having Vantage points, and that is to be able to switch between different Vantage points. This gives you the possibility to change your perspective of the Infograph and define which type of information that shall be close to you, and which shall be more distant.

All these features are made possible through the new reflective technology introduced by Capish.

Processing the Infograph

THE CAPISH REFLECT INTERFACE utilizes a patented indexing algorithm that makes it possible for end users to perform a wide range of advanced information handling on their own. Tasks like detailed fact checking, self-service visualizations, strategy evaluations, set comparisons and descriptive statistical analysis can now be done directly by the person that really understands the meaning of the information.

To avoid user programming while still allowing all relations to be instantaneously included in every search, the Infograph has been simplified in that there are no named relations

(just relations), and in keeping with the neural efficiency of our brain, circular thinking is avoided by adding the rule that a chain of relationships is only allowed to pass through the same Holon type once.

Relational and Reflective Logic

TO ILLUSTRATE THE LOGICAL BASICS of Capish Reflect, we will look at six different wines from the author's wine cellar. In real-world models Capish Reflect normally handles millions of values in hundreds of fields, but this small number makes it possible to easily track, check and thereby understand everything that is going on when applying different queries.

As has been described above, the associative and reflective powers of Capish Reflect work best when the underlying information model is as close to the real world as possible.

A simple but useful Infograph may look like the one below which states that a wine can contain one or many grapes, is of a certain color (red, rosé, white) and type (sparkling, still), and produced in a district located in a country.

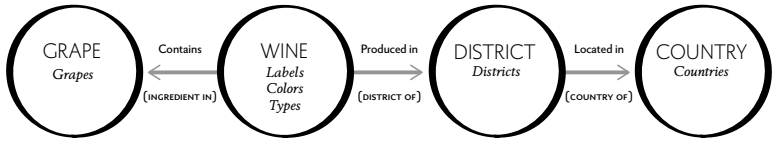


Figure 2. Infograph for the Wine cellar examples.
CLICK IMAGE TO TOGGLE SIZE.

A tabular version of the wines is given in the upper panel of figure 3, together with the corresponding listboxes for making queries in the different fields (lower panels). The number to the right in the listbox is a resulting frequency count for the respective fields from the Vantage point of the Holon type given at the top of the column (*Wine* in this case). Already at this point it is easy to understand the importance of having Holon types and an understandable data model. It is easy to see that all six wines come from France: one from Bourgogne, three from Loire, and two from Champagne. Only five wines have *Type*, something we will return to later.

Table: Wine Cellar

Label	Grape	Color	Type	District	Country
My Bubble	Chardonnay	White		Champagne	France
My Champ	Chardonnay	White	Sparkling	Champagne	France
My Champ	Pinot Noir	White	Sparkling	Champagne	France
My Merlot	Merlot	Red	Still	Loire	France
My Red	Pinot Noir	Red	Still	Bourgogne	France
My Rosé	Pinot Noir	Rosé	Still	Loire	France
My Rosé	Sauvignon Blanc	Rosé	Still	Loire	France
My White	Chardonnay	White	Still	Loire	France

LB: Label

Label	Wine
My Bubble	1
My Champ	1
My Merlot	1
My Red	1
My Rosé	1
My White	1

LB: Grape

Grape	Wine
Chardonnay	3
Merlot	1
Pinot Noir	3
Sauvignon ...	1

LB: Color

Color	Wine
Red	2
Rosé	1
White	3

LB: Type

Type	Wine
Sparkling	1
Still	4

LB: District

Dist	Wine
Bourgogne	1
Champagne	2
Loire	3

LB: Country

Ctry	Wine
France	6

Figure 3. Tabular data and associated listboxes for the Wine cellar examples.
CLICK IMAGE TO TOGGLE SIZE.

In figure 4 you see the same listboxes, but now the Holon type for the frequency calculation has been changed to *District*. You immediately can see that the six wines from France

LB: Label

Label	District
My Bubble	1
My Champ	1
My Merlot	1
My Red	1
My Rosé	1
My White	1

LB: Grape

Grape	District
Chardonnay	2
Merlot	1
Pinot Noir	3
Sauvignon ...	1

LB: Color

Color	District
Red	2
Rosé	1
White	2

LB: Type

Type	District
Sparkling	1
Still	2

LB: District

Dist	District
Bourgogne	1
Champagne	1
Loire	1

LB: Country

Ctry	District
France	3

Figure 4. Listboxes of Wine examples with counts changed from Holon type 'Wine' to 'District'.
CLICK IMAGE TO TOGGLE SIZE.

now are replaced by showing that they come from three different districts in France (listbox: *Country*), that every wine only comes from one district (listbox: *Label*), and that there are Pinot Noir wines from all three districts (listbox: *Grape*).

Relational Logic

USING CAPISH RELATIONAL LOGIC, it is possible to make queries either in a list box or directly in a table. The functionality is in this case identical to the row-selecting slice-and-dice properties of traditional BI tools, and well recognized by more advanced spreadsheet users.

It is also possible to make text searches to faster zoom in on desired field values when the lists are long. As soon as you generate a query and filter based on the selection, both the listboxes and the table are immediately updated (figure 5).

A standard feature of listboxes or column queries is that you can make either single or multiple selections. As is the case in table based tools like spreadsheets there is an implicit OR within a field and an implicit AND between different fields (figure 6).

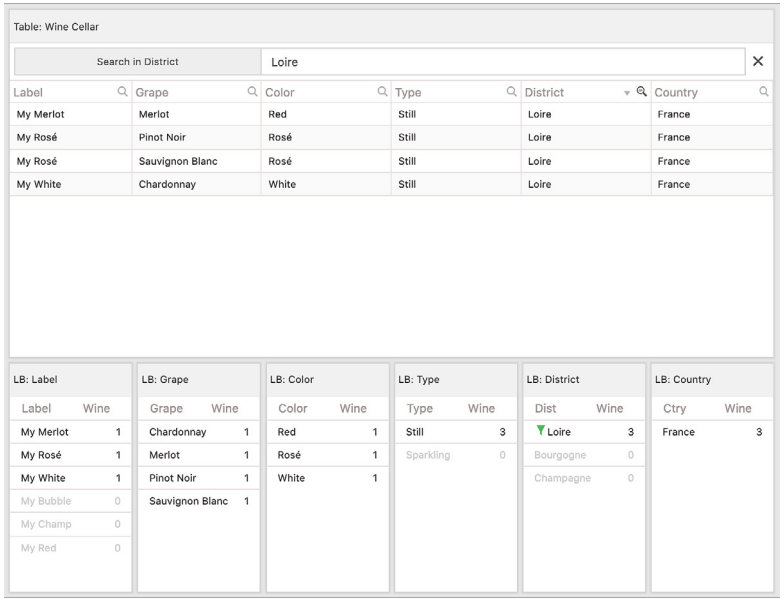


Figure 5. Query and filter based on text search in the table column and listbox. CLICK IMAGE TO TOGGLE SIZE.

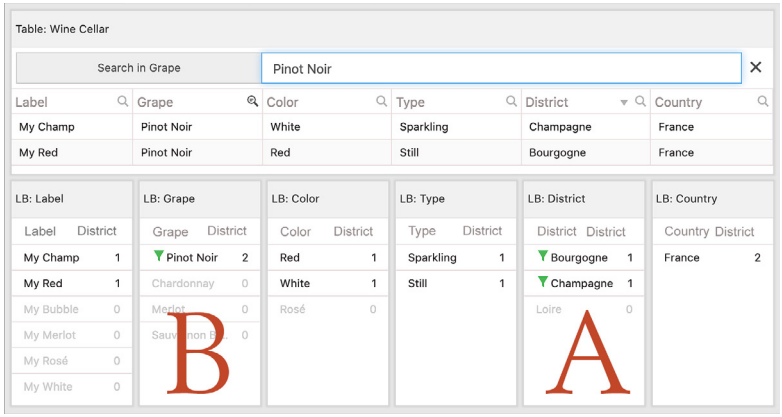


Figure 6. Let us look for what Pinot Noir wines from Bourgogne or Champagne we have in the cellar. A query based on an implicit OR *between districts in listbox (A) combined with an* AND *in a different listbox (B) generates the result in the table..* CLICK IMAGE TO TOGGLE SIZE.

In the absence of a stated Vantage point there is, as previously has been discussed, no other technical solutions but selecting table rows in this way.

In relational logic mode Capish Reflect works like traditional BI tools, the only added functionality being that you can use the Holon type in graph functionality to decide the frequency count. However, this is no small matter since counting conveys a lot of information by itself. Our brain loves to know how common things are from different perspectives.

It also illustrates the importance of having a correct and relevant Infograph. Otherwise, the counts would not be understandable.

Reflective Logic

THE REFLECTIVE LOGIC IS THE HALLMARK of Capish Reflect and sets it apart from all slice and dice BI tools. This logic makes it possible for end users to look at data from different perspectives by selecting different Vantage points from which the Infograph is analyzed. It also opens up the possibility of using AND and NOT within field selections.

Another feature is that all pieces of information that are associated with any selected set of the Vantage point, can be generically highlighted in all graphical visualizations and statistical analyses, and thus easily compared to a previously defined set of data.

This is extremely useful when you want to compare two data sets with each other by comparing their positions in different visualizations.

The Reflective Logic consists of a two-step data querying process. In the first step all Vantage points that are associated with a traditional relational query are detected. In the next step the query is reflected in the Vantage point by firing off a new relational query starting with a list of all the Vantage points found in the first query and returning all Holons associated with these Vantage points.

The effect is that regardless from which Holon type is used for initating the query, the result will always be given from the selected perspective. We call it Reflective Logic because it supports the next thought you as a thinking person make when you reflect over a problem.

The functionality is best illustrated with some examples where the resulting wine table will be displayed (left panel) together with the query listbox (upper right panel) and the Vantage point listbox (lower right panel).

Each reflective listbox explicitly displays **Field@Vantage Point** in the title in order to clearly show the associated logic e.g. Color@Wine means a query from the color Holon type having wine as Vantage point.

Selecting 'Color' with Vantage Point 'Wine'

FIGURE 7 SHOWS THE RESULTS after querying white in the Color@Wine listbox. Since, *Color* is a field within the wine Vantage point, the query Holon type is the same as the Vantage point. Hence, you simply get all the wines that are white. After some afterthoughts we can conclude that a reflected query that is reflected in itself, actually is identical to a relational query.

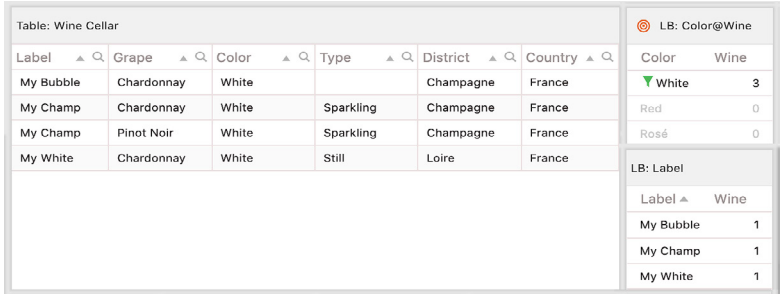


Figure 7. What white wines can we find in the cellar? There are three wines, two Chardonnays and one with Pinot Noir and Chardonnay. CLICK IMAGE TO TOGGLE SIZE.

Now let us see what happens when we make the same query selection but choose another Vantage point.

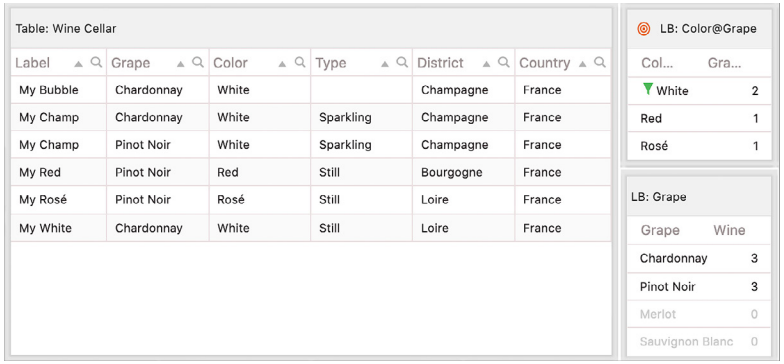
Querying 'Color' with Vantage Point 'Grape'

FIGURE 8 (BELOW) SHOWS THE RESULTS after querying white in the Color@Grapes listbox. Here the color white results in the grapes Chardonnay and Pinot Noir that both are to be found in white wines. Since these grapes also are ingredients in red and rosé wines, those colors will be displayed in the color list-

box together with the original query selection white. The filter icon of the original query selection persists in order to show that this was the selection of the original query.

If we were not aware of the fact that the same grapes can be ingredients in both red, white and rosé wines, we have learned something that we could not see using relational logic.

Figure 8. Let us assume that we want to find what wines that include the same grapes as the white wines have. The upper listbox shows that there is one red and one rose wine that contains the sames grapes. CLICK IMAGE TO TOGGLE SIZE.

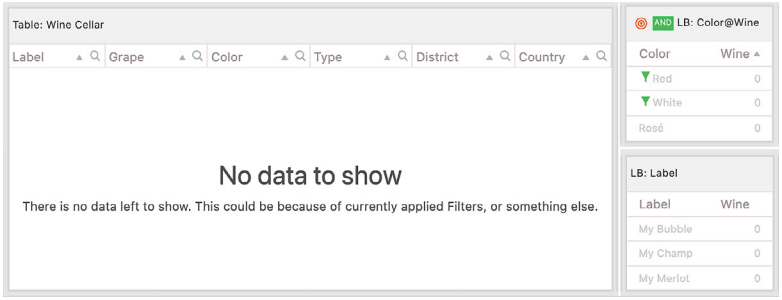


Now let us see what happens when we introduce the logical AND in a color selection.

Querying 'Colors' using AND *with Vantage Point 'Wine'*

FIGURE 9 SHOWS THE RESULTS after querying red AND white in the Color@Wine listbox. We realize that there are no wines

Figure 9. For the fun of it, querying which wines are both Red AND *White with Vantage Point 'Wine', obviously leads to no particular result.* CLICK IMAGE TO TOGGLE SIZE.



that are both red and white, something we probably knew from previous observations. But let us switch Vantage point to *Grape* and see what happens.

Querying 'Colors' using AND *with Vantage Point 'Grape'*

FIGURE 10 SHOWS THE RESULTS after querying red AND white in the Color@Grapes listbox. Now you can observe that the Pinot Noir grape exists in both red and white wine. In addition, you can see that the Pinot Noir grape also is an ingredient in the rosé wine My Rosé.

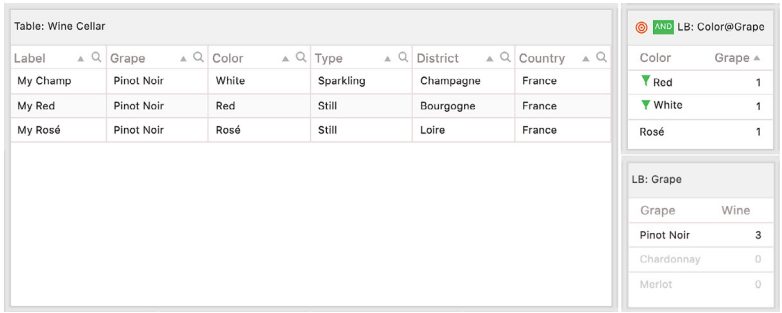


Figure 10. Let us use Grape as Vantage Point to see which red and white wines that are made from the same grape. The table returns one red and one white, but also a rosé where the Pinot Noir grape is an ingredient. CLICK IMAGE TO TOGGLE SIZE.

So, we can safely deduce that the Pinot Noir grape can be used in any wine regardless of *Color* and *Type*. You also see that all three districts are represented by the three wines.

Let us move on and see what happens when we reflect the same query in the Vantage point *District*.

Querying 'Colors' using AND *with Vantage Point 'District'*

FIGURE 11 SHOWS THE RESULTS after querying red AND white in the Color@District listbox. From this search you understand that Loire is the only district in the author's wine cellar that has supplied both red and white wines. There is also a rosé wine

from Loire, making this district a complete supplier of wine of any color.

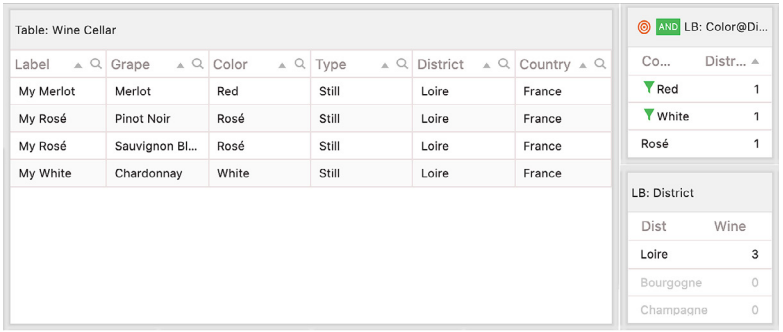


Figure 11. Let us switch to use District as Vantage Point. Here we find which red and white bottles we have that comes from the same District, in this case it is only Loire. By using reflection logic we also see all other wines from that District which is the reason there is an additional rosé.
CLICK IMAGE TO TOGGLE SIZE.

Now, suppose we select *Country* as Vantage point. What would the result be? Not surprisingly, nothing will happen at all (figure 12). Since there is only one country (France), it returns the entire database.

Having a common denominator in an Infograph is a pretty common situation, and it implies that in many cases all

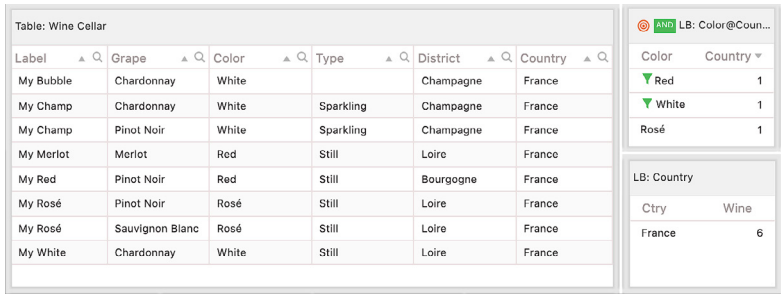


Figure 12. Here we use vantage point Country to do the same kind of query as above. Since all our wines come from France the table includes all our wines.
CLICK IMAGE TO TOGGLE SIZE.

Holons are directly or indirectly connected to all other Holons. This is the reason why an association chain only can pass through the same Holon type once when traversing the Infograph during an indexing procedure.

Querying 'Type' using NOT

ABOVE WE HAVE DWELLED in a rather small database consisting of six wines with different properties. Nevertheless, we have succeeded in cutting the database into many new, interesting pieces by using the logical AND operator and selecting different Vantage points.

It is time to add NOT - meaning; show me things that are not associated.

To illustrate the powers of NOT let us try to find out how we can answer the following two questions; first are there districts that only produce sparkling wines, and secondly, are there any wines that lack type?

The solution to the first questions is straight forward. Figure 13 displays the result from the query: sparkling AND NOT still with *District* as Vantage point. The NOT icon is a red funnel. The result shows the not too surprising result that Champagne is the only district with only sparkling wines. Why should they produce anything else?

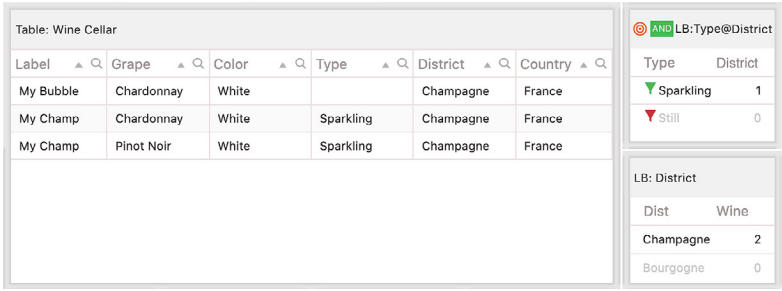


Figure 13. Using District as Vantage Point when looking for sparkling and not still wines gives us all wines in the Champagne district.
CLICK IMAGE TO TOGGLE SIZE.

The solution to the second may seem a bit odd at first sight, but thinking about it, it is pretty logical. You simply ask for all wines that cannot be associated with neither sparkling nor still by querying: NOT sparkling AND NOT still with *Wine* as Vantage

point. The result is shown in figure 14. It turns out that My Bubble Chardonnay is the only wine that lacks type.

It happens to be a Champagne and the producer obviously assumes that it is universally known that Champagne is sparkling, so why put it on the label?

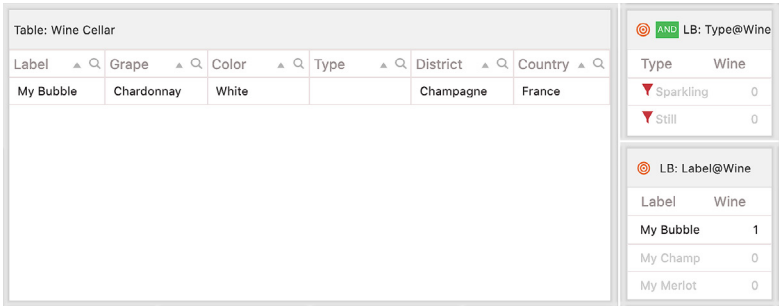


Figure 14. The last example is a double negation. Asking the database which wines are NOT *Sparkling* AND NOT *Still actually returns a bottle of Champagne, since this particular producer sees no reason to define Type.*
CLICK IMAGE TO TOGGLE SIZE.

Conclusions

THE ABOVE EXAMPLES HAVE served as an introduction to the basic functions of Capish Reflect. It has been shown that by switching from relational logic, which is like making selections in traditional slice-and-dice tools, to the new Reflective logic, opens up a whole new world of possibilities.

In the Infograph familiar concepts are associated in familiar ways thanks to a functional mimicking of the concepts and relationships of the end-user. And when the Reflective Logic is added — the inherit powers of the Infograph is released. Suddenly common logical operators like AND and NOT can be used everywhere and queries that before were extremely hard to pose are now made with ease.

The familiar concepts also make the understanding of the results clear. The feeling is more like chatting with a knowledgeable person that understands what you are looking for than interacting with a major database.

The result is empowered users that can perform a wide range of advanced information handling themselves. Tasks like detailed fact checking, self-service visualizations, strategy evaluations, set comparisons, charting and descriptive statistical analysis can now be done directly by the persons that really understand the meaning of the information.

How about a normal query like Chardonnay OR Champagne? Since Chardonnay and Champagne are values in different columns, this is an example of a query that challenges the intrinsic AND between queries from different columns.

Here again, as was the case with AND and NOT within columns, a Vantage Point is needed to resolve the query. This type of questions can easily be posed and resolved in Capish Reflect by creating a set of Vantage points.

Creating and using different sets of Vantage points is an extremely powerful tool that can be used in a multitude of ways, especially when comparing groups to each other. However, this is a feature that is not covered in this particular white paper.

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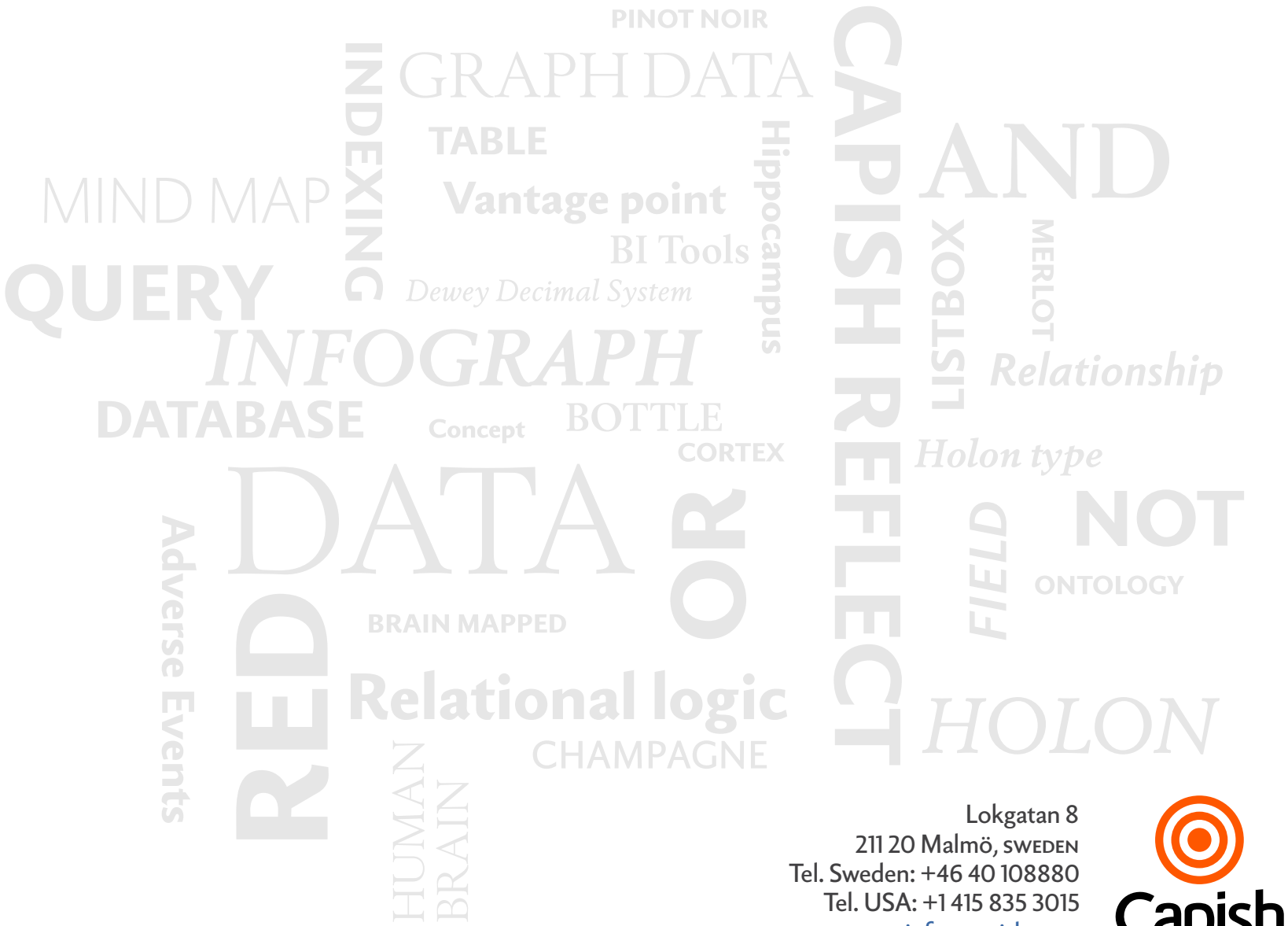
founder, Capish



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