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Priscila Lena Farias & João Queiroz

Visualizing triadic relations

Diagrams for Charles S. Peirce's classifications of signs

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Charles S. Peirce designed many diagrams to model different aspects of his classifications of signs. Peirce scholars also contributed to the understanding of Peirce's classifications by designing new diagrams, eventually using colour, dimensions and movement. The 20 diagrams presented here were conceived to better explain the structural, hierarchical and dynamic relations found in Peirce's classifications of signs, a topic that should be of interest to anyone aiming to apply semiotics to design studies. The comparative analysis of those diagrams highlights commonalities as well as important differences, providing an interesting case of multiple diagrammatic representations of the same complex conceptual structure.

1. Introduction

In his work, Charles S. Peirce often emphasized the role of diagrams in reasoning—especially, but not exclusively, in mathematics, logic and thinking (De Waal 2013: 23)—, providing several examples of what he, in some occasions, has called *diagrammatic reasoning* (CP 4.571, 5148, 6.213;[1] Farias 2008, Queiroz and Stjernfelt 2011). In his 'Prolegomena to an apology for pragmaticism,' Peirce went as far as to assert that "diagrammatic reasoning is the only really fertile reasoning" (CP 4.571). This is an example of how strongly Peirce argued for an eminently visual kind of reasoning, based on the elaboration and manipulation of diagrams. In line with this argument, Peirce designed many diagrams to explain different aspects of his thoughts and ideas, including his conception of a classification of signs based on triadic relations.[2]

Besides his best known and widely discussed division of signs into icons, indexes and symbols, Peirce devised other classifications: a division of signs into 10 classes is extensively described in his 1903 Syllabus (MS 540, EP2: 289–99), while divisions into 28 and 66 classes are outlined in various passages of his December 1908 letters and manuscripts (L463: 132–46, 150; EP2: 478–91; Lieb 1977: 80–85).[3] Common to all those classifications are the categories of *firstness*, *secondness* and *thirdness* which constitute the base for Peirce's conception of a *triadic sign* (a *genuine* relation between sign, object and interpretant), as well as the (triple) modalities that derive from his *trichotomies* (or aspects regarding which sign could be described or analyzed). All those classifications are subject to the 'qualification rule' (Savan 1987–1988: 14) that guarantees the logical coherence of the possible classes of signs, ruling out, for instance, classes formed of *firsts* that are determined by anything but other *firsts*.

The combination of this principles result in specific numbers of classes, according to how many trichotomies are considered in a classification: 3 classes if we consider only one trichotomy (and this is the case with icon, index and symbol as 3 modalities of the relation between the sign and its direct object); 10 classes if three trichotomies are taken into account; 28 if we consider six trichotomies; and 66 if we consider ten trichotomies.

Since the 1980's, Peirce scholars interested in his classifications of signs have made efforts to contribute to its understanding by designing new diagrams that represent (or explain the relations between) different numbers of classes, eventually using colour, dimensions and movement. Taken as a whole, those are an intriguing set of diagrams that propose different ways for visualizing triadic relations—that is, the *irreducible* relations between three elements that are at the basis of Peirce's logic—, and also, eventually, the way in which one class of sign relates to another, as in the process of *sign action* or *semiosis*.

In this article, we present and discuss 20 diagrams designed for Peirce's classifications of signs. Those diagrams, conceived as visual models for Peirce's theory, reveal distinct structural properties of the modeled phenomenon. Through those models, competing and complementary hypotheses about the relational structure that characterize the classifications can be formulated and tested. We start with diagrams designed to depict one or more classifications. We then consider diagrams that use one or more colours. Next we look at diagrams that represent classes using two or more dimensions, and conclude by looking at diagrams that include movement or interaction.

While devised as tools for better explaining a theory—the logic behind the classes of signs, its constitution and relationships—, those diagrams also represent different ways for approaching the same diagrammatic problem: visualizing triadic relations. The relevance of this topic for information design is twofold: the diagrams help us to better understand an aspect of Peirce's theory of signs that is of great interest for analyzing informational or cognitive phenomena; and provide an interesting case of multiple diagrammatic representations of a complex conceptual structure.

2. Diagrams for one or more classifications

During the 1980's, a group of semioticians from the University of Perpignan, in France,[4] focused their efforts on the study of structures and relations present in Peirce's classifications of signs. As a result, one of the participants of this group, Michel Balat, proposed three diagrams for the 10 classes of signs: a *triangular* diagram (Balat 1990: 81, Figure 1), a *square* diagram (Balat 1990: 85, Figure 2), and a *three-dimensional* diagram (Balat 1990: 86, Figure 3).

In the three diagrams, the notation for the 10 classes are sequences composed of numerals 1, 2 and 3; and oriented connections (arrows) link certain classes. These connections are exactly the same in the three diagrams (i.e., they connect the same classes, pointing at the same directions), although the arrangements of the elements

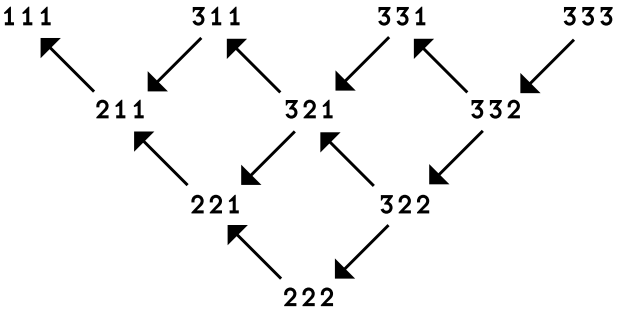


Figure 1. M. Balat's triangular diagram for Peirce's 10 classes of signs (adapted from Balat 1990: 81).

are different. The square diagram (Figure 2) and the 3D diagram (Figure 3) adopt the same convention to represent the trichotomic modalities (nature of the sign, relation of the sign with its object, and relation of the sign with its interpretant) that form the classes: roman numerals (I, II, III) for the modalities of the first trichotomy (nature of the sign); letters (A, B, C) for the modalities of the second trichotomy (relation of the sign with its object); and arabic numerals (1, 2, 3) for the modalities of the third trichotomy (relation of the sign with its interpretant).

Balat (1990: 86) describes three types of relation represented by the oriented connections—*incorporation*, *instantiation* and *regency*—, but does not describe all of them. He refers specifically only to the horizontal arrows seen in the square diagram (Figure 2), grouped according to the columns in which they are found (I, II, III). According to Balat, the arrows of column I mean *incorporation*, those of column II *instantiation* and those of columns III *regency*.

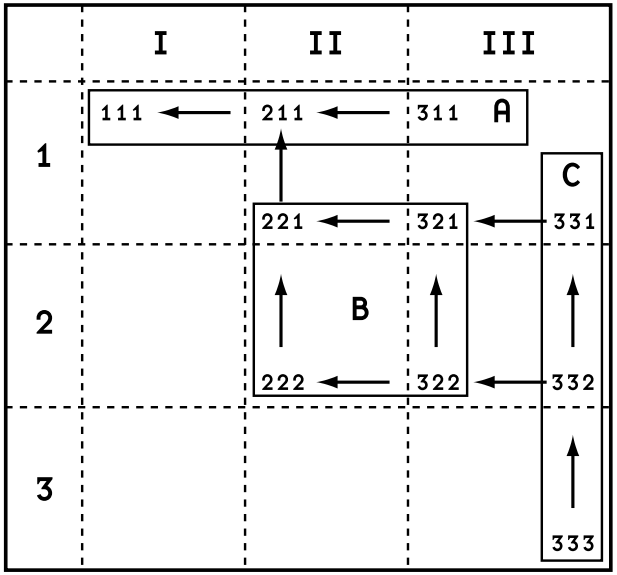


Figure 2. M. Balat's square diagram for Peirce's 10 classes of signs (adapted from Balat 1990: 85).

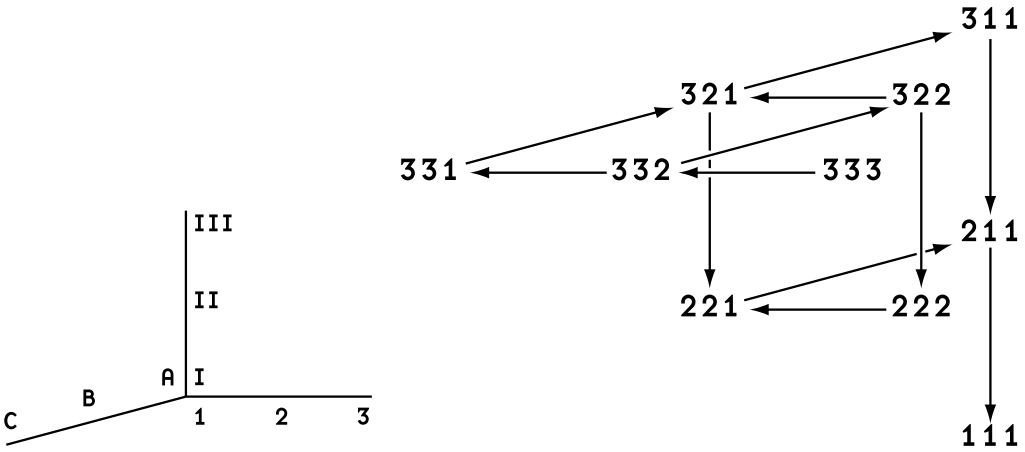


Figure 3. M. Balat's three-dimensional diagram for Peirce's 10 classes of signs (adapted from Balat 1990: 85).

Whereas the triangular diagram (Figure 1) stands out for the easiness and coherence in the interpretation of its oriented connections, the main advantage of the square diagram (Figure 2) is to present clearly the several subgroups that exist inside the 10 classes of signs. Once knowing that roman numerals correspond to the modalities of the first trichotomy; letters to the modalities of the second trichotomy; and arabic numerals to the modalities of the third trichotomy, it is easy to notice the presence of nine subgroups:

Qualisigns (first column, I)
Sinsigns (second column, II)
Legisigns (third column, III)
Icons (set delimited by the rectangle A)
Indexes (set delimited by the rectangle B)
Symbols (set delimited by the rectangle C)
Rhemes (first line, 1)
Dicisigns (second line, 2)
Arguments (third line, 3)[5]

In the 1990's, Floyd Merrell conceived several diagrams for the 10 classes of signs. Among them is a diagram (Merrell 1991: 17, Figure 4) depicting the 10 classes and their possible relations. Another diagram (Merrell 1997: 298–299, Figure 5) shows the relations between the 10 classes and the three kinds of hypoicons.[6]

Figure 4 is a simplified version of the diagram proposed by Merrell (1991: 17). The original version contains letters and other resources to facilitate reference to examples mentioned in the article (Merrell 1991). The version reproduced here preserves the structure of relations between classes, the most relevant property of Merrell's proposal. The classes, identified by the same notation adopted by Balat, are divided in three columns, according to the subgroup defined by the modality of the second trichotomy (icon, index, symbol) to which they belong.

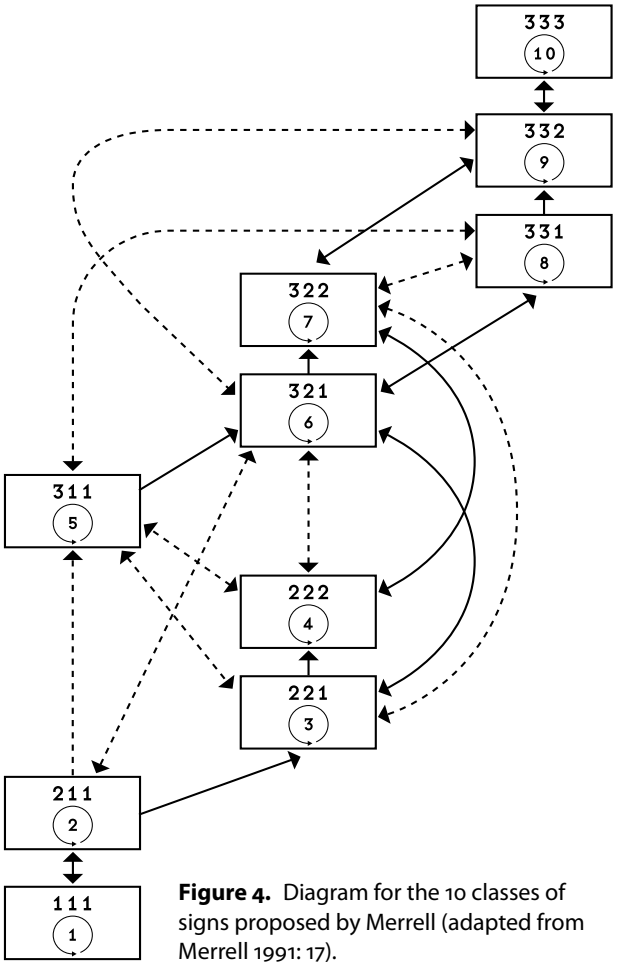


Figure 4. Diagram for the 10 classes of signs proposed by Merrell (adapted from Merrell 1991: 17).

According to Merrell (1991: 20), the oriented connections that appear in this diagram are "operators" that can be divided into four groups according to line appearance and direction. Continuous connections represent "normal paths of sign transmutation", while dashed connections represent "abnormal" paths. Unidirectional connections indicate paths of "generation" or "evolution"

of simpler to more complex signs, while bidirectional connections indicate a "development" path that may, in the opposite direction, signify a probable path of "subdivision" or "degeneration" (Merrell 1991: 20).

According to Merrell (1991), relations between classes such as those depicted in Balat's diagrams (Figures 1, 2 and 3) can be understood as "relations of generation" inside the process of semiosis, limited to the description of more general signs. The structure proposed in Figure 4, on the other hand, would be more adequate to describe the process of semiosis since it takes into account the paths of "degeneration".

The second diagram (Merrell 1997: 299, Figure 5) focuses on the structure, and not on the relations between the 10 classes, showing them as sets derived from trichotomic modalities. As in Figure 4 (based in Merrell 1991: 8), the classes are identified by numbers from 1 to 10, and the modalities are grouped according to the trichotomy to which they belong. Besides the three large ellipses that separate the modalities by trichotomy, we see a fourth ellipse that includes the "icon" modality and contains the three types of hypoicons (image, diagram, metaphor). Although this issue is not explicit in his text, this suggests that, for Merrell, the classes that contain this modality (iconic) could be further subdivided into hypoiconic classes: imagetic, diagrammatic and metaphoric.

Peirce described classifications not only for 10, but also for 28 and 66 classes. Robert Marty and Ana Maróstica are the semioticians who first devised models which allowed for the construction of diagrams for different numbers of classes, in the 1990's.

In his book *L'algebre des signes* (Marty 1990), and in several articles (e.g. Marty 1982a and 1982b), Robert Marty presented a mathematical treatment of the classifications, based on what he called "analytical phaneroscopy" (Marty 1990: 143).[7] With this approach, he not only mathematically justified the construction of classes, but also derived a series of relations between them.

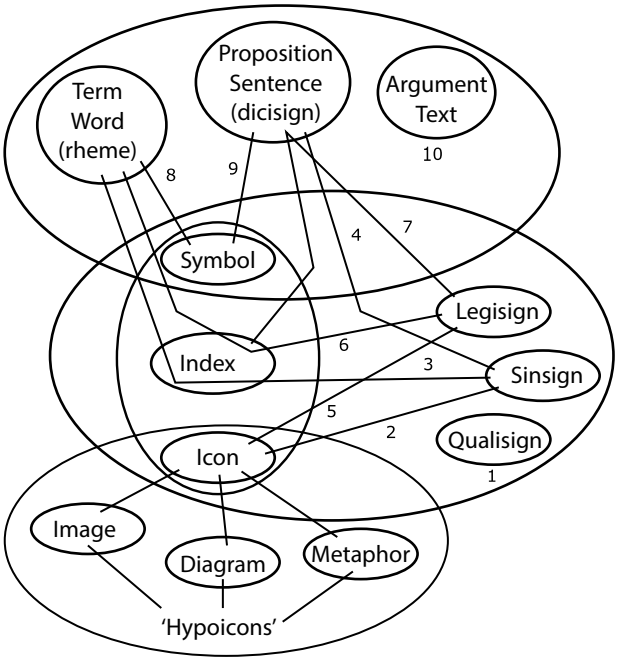


Figure 5. Diagram relating the 10 classes of signs with the three kinds of hypoicons, proposed by Merrell (adapted from Merrell 1997: 299).

Applying the same modeling treatment to the 10 and 28 classes, Marty arrived at the diagrams presented in Figures 6 and 7. In both diagrams, the classes are presented in a hierarchical structure (Marty 1982: 178) in which, according to the author, each class implies the presence of the classes beneath. The segmented connections in the diagram for 10 classes (Figure 6) indicate relations of a special type (*replicas*) between legisigns and sinsigns.

For Marty, this treatment allows to establish coherent relations between the 10 and the 28 classes of signs (Marty 1990: 225–228). Figure 8 reproduces a diagram

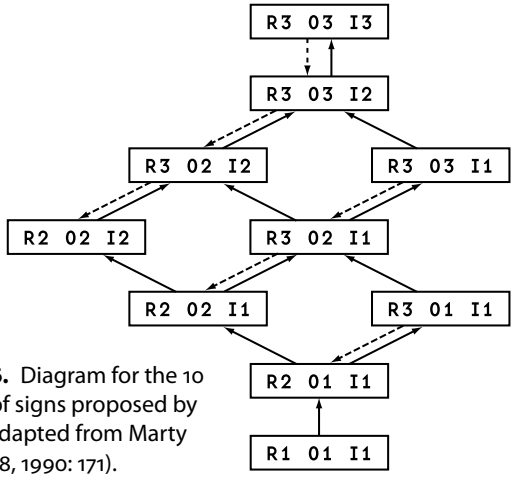


Figure 6. Diagram for the 10 classes of signs proposed by Marty (adapted from Marty 1982a: 178, 1990: 171).

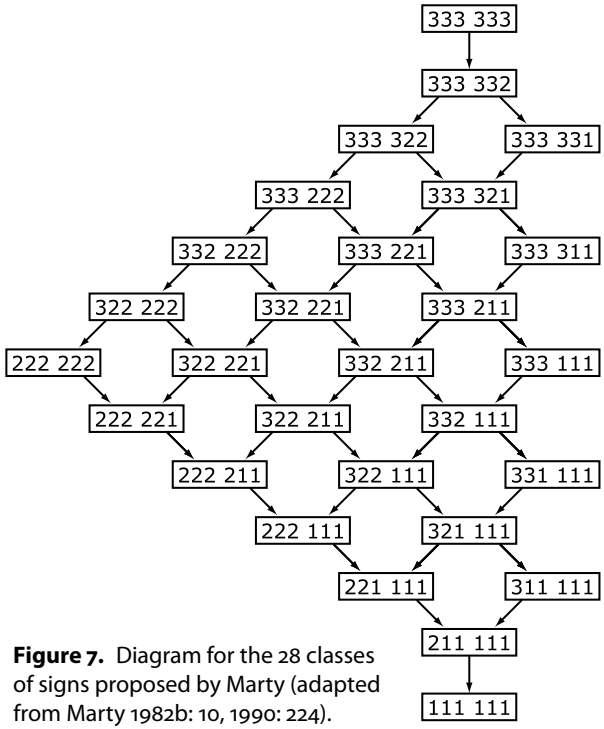


Figure 7. Diagram for the 28 classes of signs proposed by Marty (adapted from Marty 1982b: 10, 1990: 224).

whose structure is similar to Figure 6, in which Marty replaces the contents in the original position by a numbering system that indicates which of the 10 classes correspond to each of the 28 classes. The author, however, does not apply the same treatment to the 66 classes, and argues that the classifications beyond the division in 28 classes are redundant (Marty 1990: 228–235).

Also in the 1990's, noticing a relation between the quantity of trichotomies and the number of classes in Peirce's description of the division of signs, Ana Maróstica (1992) proposed an approach to the classifications based on combinatorial equations. The numerical results obtained are the same obtained through Weiss & Burks (1945) equation, $(n + 1)\ (n + 2) / 2$, in which n represents the number of trichotomies. The most interesting aspect of this work is the proposal of a diagrammatic structure that can contain any number of classes (Figure 9). This structure was based on a diagram originally proposed by Peirce in a letter to Lady Welby (L463: 132–146, EP2: 483–491).

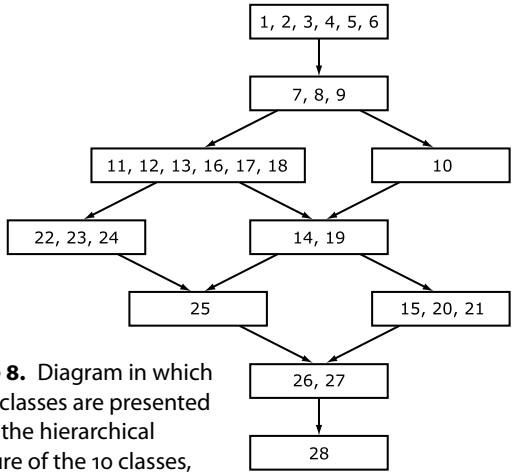


Figure 8. Diagram in which the 28 classes are presented within the hierarchical structure of the 10 classes, proposed by Marty (adapted from Marty 1990: 228).

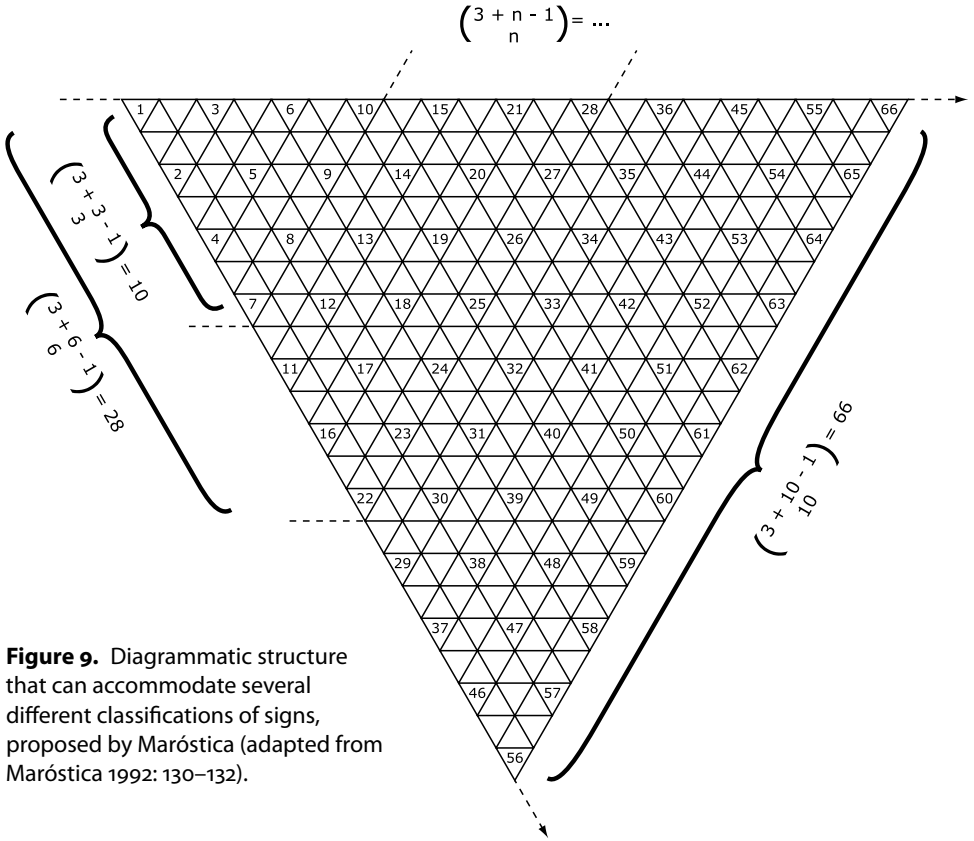


Figure 9. Diagrammatic structure that can accommodate several different classifications of signs, proposed by Maróstica (adapted from Maróstica 1992: 130–132).

3. Diagrams with one or more colours

The diagrams designed by Peirce, as well as all the diagrams described so far, were designed in one colour, as colour was then irrelevant. Since the late 1990's, diagrams for the classes of signs using different colours in a significant way have been proposed by a number of authors.

In 1999, Len Olsen proposed a notation for the classes of signs using yellow, red and blue to represent the Peircean categories of firstness, secondness and thirdness (Figure 10). This notation comprised three correlates (represented by the circles numbered 1, 2 and 3) and its relations (connections between circles). According to Olsen, this structure, composed only of dyadic relations between correlates, combined with a trio of colours that correspond to the categories (firstness/yellow, secondness/red, thirdness/blue),[8] would be sufficient to model the "10 classes of triadic relations" described by Peirce (Olsen 1999: 8).

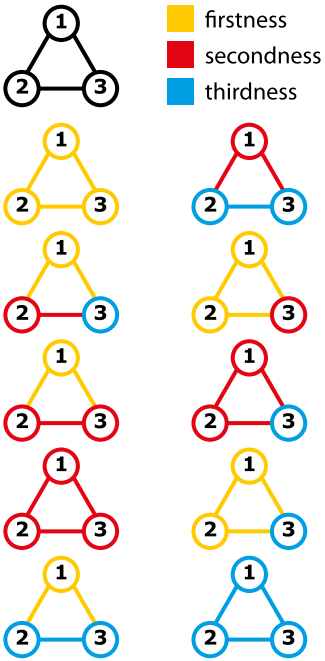


Figure 10. Model for the 10 classes of triadic relations proposed by Olsen (adapted from Olsen 1999: 8).

This structure, together with a supplementary notation for the triadic relations, leads Olsen to a notation for the 10 classes of signs as described in the Peirce's Syllabus (Figure 11). Olsen's conclusion is that the logic of division of signs presented in the Syllabus allows for the existence of six different types of qualisigns (111), and three different types of iconic sinsigns (211), rhematic indexical sinsigns (221) and dicent sinsigns (222).[9]

The introduction of colour differentiations (including shades of gray) in diagrams allows the observer, among other things, to establish relations between spatially distant elements. Although generally recognized as an important aspect of visual representations, the use of colour in diagrams is rarely discussed by specialists in diagrammatic reasoning.

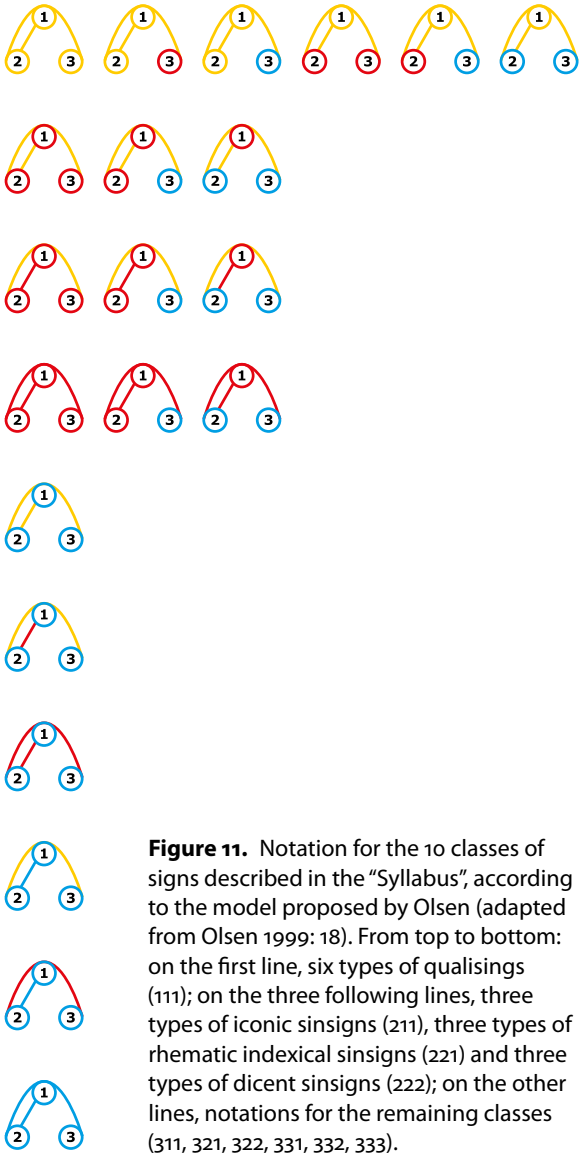


Figure 11. Notation for the 10 classes of signs described in the "Syllabus", according to the model proposed by Olsen (adapted from Olsen 1999: 18). From top to bottom: on the first line, six types of qualisigns (111); on the three following lines, three types of iconic sinsigns (211), three types of rhematic indexical sinsigns (221) and three types of dicent sinsigns (222); on the other lines, notations for the remaining classes (311, 321, 322, 331, 332, 333).

In 1998, Anderson & Armen (1998) presented a generalization of the *theory of inter-diagrammatic reasoning* proposed a few years earlier by Anderson & McCartney (1995), incorporating the use of colour as an operational dimension, in formal terms. This theory associates knowledge from theory of colour to the study of what can be computationally processed through diagrammatic representations. The strategy consists in associating values of a chromatic scale to the elements of a problem, and functions of combination of these values to the operators that help to define and solve a problem. Applied examples offered by Anderson & Artmen (1998) included meeting schedules and the combination of DNA sequences. In meeting schedules, the availability of each participant at each time of the day was represented by a grade in the colour scale, and the combination of these offer, for each hour, a general degree of availability. In the case of DNA sequencing, the sequences of bases were represented by sequences of tones in a chromatic system, and the various possibilities of combination of sequences were explored in terms of combinations of colour.

Figures 12 and 13 show how this strategy was later applied by Farias (2002) to represent the 10 classes of signs in terms of colour combinations in *RGB* (red, green, blue) and *CMY* (cyan, magenta, yellow) systems. Figures 14 and 15 show the result of the same strategy applied to the 66 classes, represented as triplets that indicate the amount of digits 1, 2 and 3 that compose the numerical notation for each class. Figures 12 and 14 use the RGB system, and in both of them, *R* (red) corresponds to the Peircean category of firstness, *G* (green) to secondness, and *B* (blue) to thirdness. The classes are seen as combinations of elements of these three categories, translated in terms of quantities of 1s (firstnesses), 2s (secondnesses) and 3s (thirdnesses). The graduated scales above the diagrams indicate the correspondence between the quantity of elements of a specific category in a class, and a point in the colour scale. In Figure 12, for example, two thirdnesses (as in 331 and 332) correspond to 66% of blue (or 170 of *B*, in an RGB scale that ranges from 0 to 255). In Figures 13 and 15, which use the CMY system, the same rules were adopted, but here *M* (magenta) corresponds to firstness, *Y* (yellow) to secondness and *C* (cyan) to thirdness.

One last example of a diagram for Peirce's classes of signs using colour is 'signtree' (Figure 16), a diagram proposed in 2010 by Priscila Borges (Borges 2010). This diagram suggests the structure of a tree to represent the inner structure of the 66 classes. The different modalities of the first two trichotomies (nature of the dynamic and immediate object, DO and OI) are represented as roots, while the nature of the sign itself (S) and the following trichotomies are represented as branches. Colour is used for differentiating firstness (red circles), secondness (green squares) and thirdness (blue triangles) within each of the 66 classes represented, and also for differentiating groups of classes related with Peirce's 10 classes of signs (areas with different colours).

4. Three-dimensional diagrams

Michel Balat's three-dimensional diagram is the earliest example of a graphic model for Peirce's classes of signs that uses more than two dimensions. In the early 2000's, Michael Hoffmann (2001, Figure 17) and Carlos Amadori (2001: 34, Figure 18) proposed diagrams which were very similar, regarding their internal structure, to Balat's three-dimensional diagram (Figure 3). The relations of proximity between the cubes that represent classes are exactly the same, although, in comparison with Balat's three-dimensional diagram, the set of cubes in Amadori's diagram looks like it has been turned around—and also mirrored, in the case of Hoffman's.

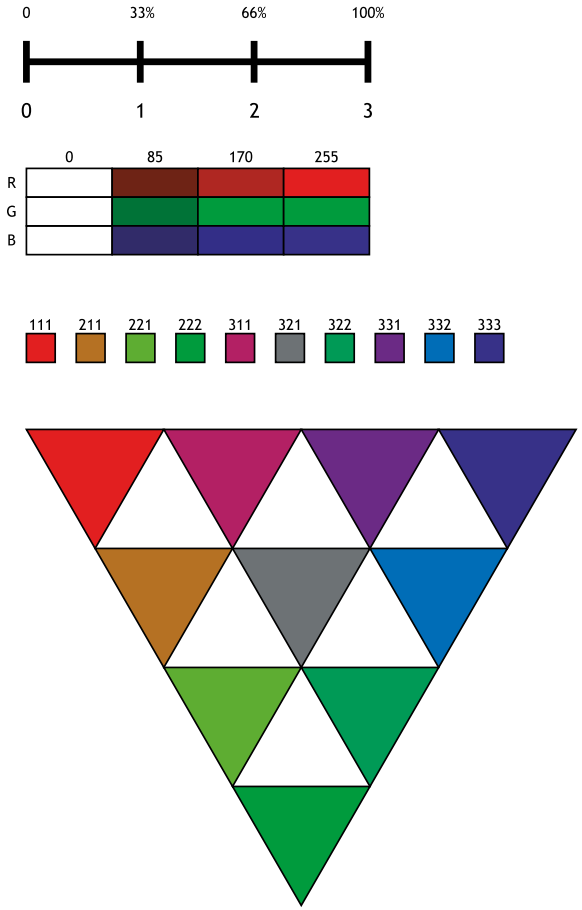


Figure 12. Diagram for the 10 classes of signs, represented as colour combinations in the RGB system (Farias 2002: 119).

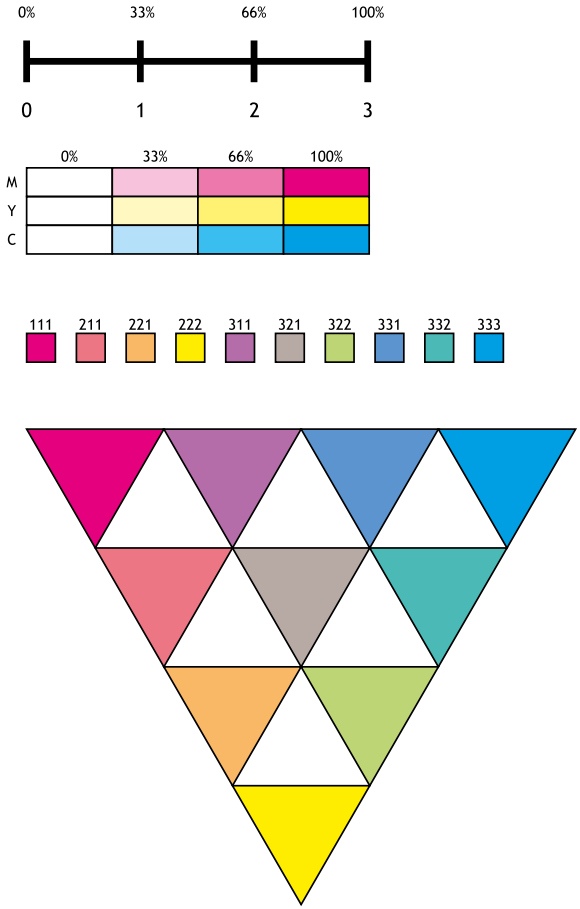


Figure 13. Diagram for 10 classes of signs, represented as colour combinations in the CMY system (Farias 2002: 119).

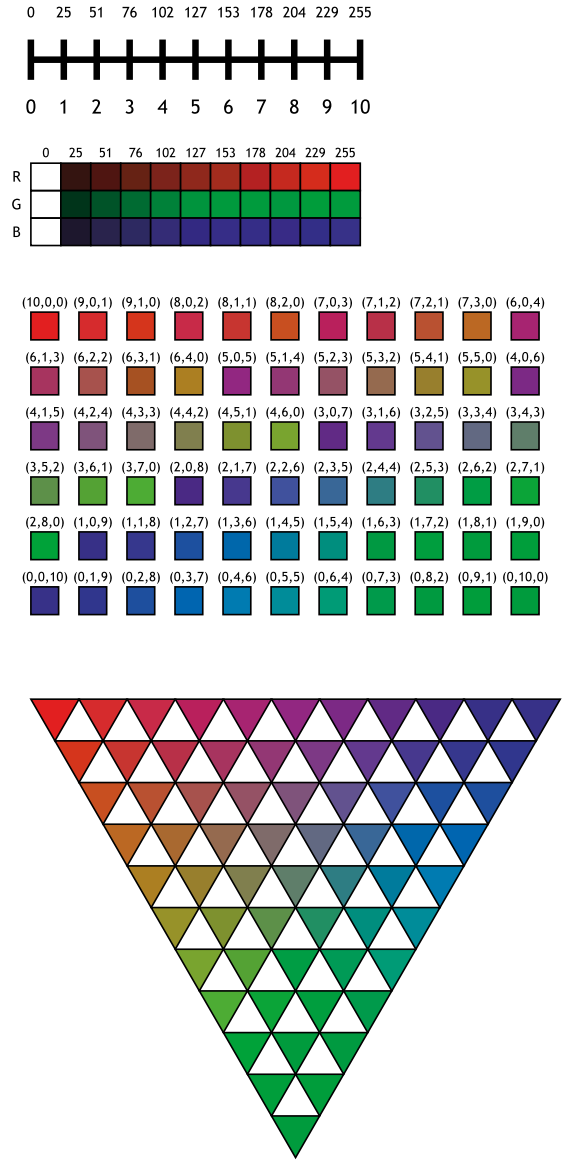


Figure 14. Diagram for 66 classes of signs, represented as colour combinations in the RGB system (Farias 2002: 120).

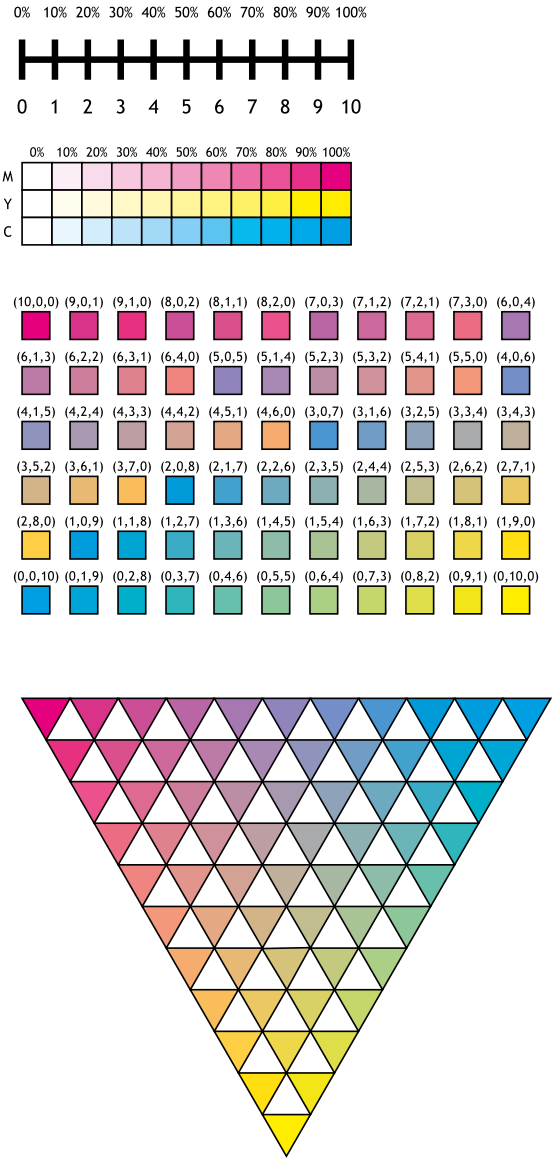


Figure 15. Diagram for 66 classes of signs, represented as colour combinations in the CMY system (Farias 2002: 120).

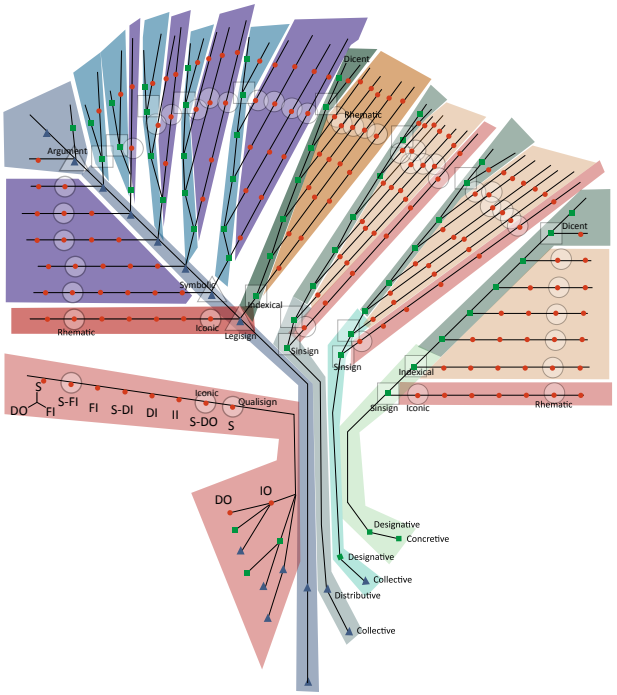


Figure 16. Aspect of *signtree*, a diagram for Peirce's 66 classes of signs proposed by Borges (2010).

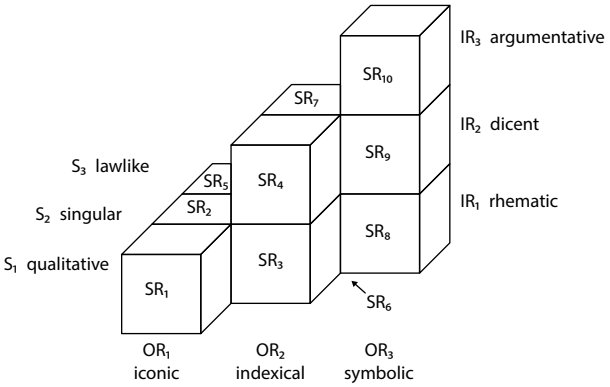


Figure 17. Three-dimensional diagram for the 10 classes of signs proposed by Hoffman (2001).

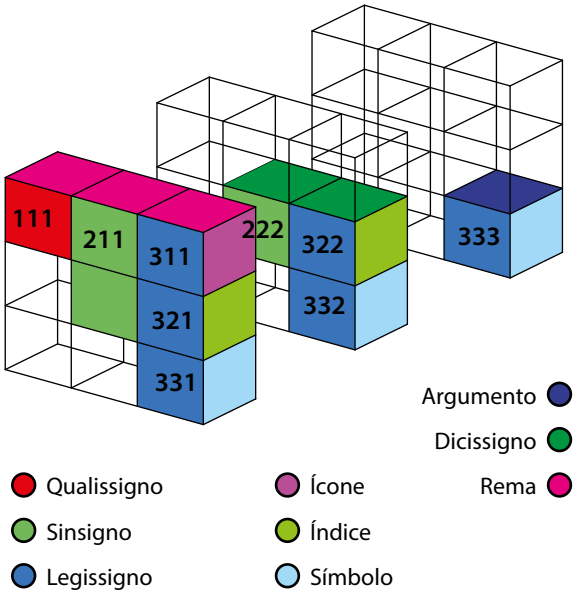


Figure 18. Three-dimensional diagram for the 10 classes of signs proposed by Amadori (2001: 34).

Hoffman's diagram (2001, Figure 17) does not use colours, and the classes are identified by numbers from 1 to 10 placed under the letters *SR* (which stand for *sign-relation*) in each cube. Beside and below the cube we see the letters *S* (for *sign itself*), *OR* (for *object relation*) and *IR* (for *interpretant relation*), followed by the numbers 1, 2, 3, indicating the trichotomic modalities represented in each of the diagram's axis.

In Amadori's diagram (2001: 34, Figure 18), the classes are identified by their habitual numerical notation, and by a system of colours. As we follow the labels below the diagram, the modalities of firstness

are represented by three shades of red, secondness by shades of green and thirdness by shades of blue.

5. Dynamic and interactive diagrams

Most of the diagrams for Peirce's classes of signs are bi-dimensional, static and monochromatic, restrictions caused by typical limitations of printed media. These characteristics, however, should not be mistaken for proper limits of the visual diagrammatic forms. On the contrary, since the late twentieth century, researchers such as Harel (1995: 263) have proposed the solution of specific notational problems through the use of three-dimensional visual formalisms and dynamical graphic simulations. Sivasankaran & Owen (1992) are among those who have emphatically defended the elevation of the status of diagrams as investigative tools through the use of computational graphics.

Most of the diagrams that simulate or indicate a third spatial dimension are hampered by being, in fact, static and bi-dimensional printed figures. For example, one of Hoffman's cubes (correspondent to class 321, or SR_6, Figure 17) is hidden, and its position indicated by an arrow, due to the overall visual arrangement. In Amadori's diagram (Figure 18), the numerical label for class 222 had to be superposed on cube 311, contrary to the rules of perspective, in order to remain visible. The advantages of the inclusion of a third spatial dimension are more appropriately realized in a three-dimensional environment, where the observer can change position in relation to the observed object.

However, certain precautions have to be taken so that three-dimensional resources are not mistakenly interpreted. Differences in size, for example, may be wrongly interpreted as differences of distance in relation to the observer. Bounford and Campbell (2000: 80–83) demonstrate how this problem can be solved, in some cases, by the use of grids applied to the forms, so that size can be more easily compared. The use of colours in three-dimensional objects also requires attention, since variations in intensity (for example, blue, light blue, dark blue) can be mistakenly interpreted as variations in shadow and light. This occurs, for example, in cube 333 of Amadori's diagram (Figure 18), which can be seen as an object with only one colour and different shadows, if we are not attentive to the labels.

The first, and so far the only diagrams to use dynamic resources to model Peirce's classes of signs were proposed by the authors of this paper between 2000 and 2002 (Farias & Queiroz 2000 and 2004, Farias 2002). The first of them, *10cubes* (Figures 19, 20 and 21), was proposed as an interactive tri-dimensional model of the 10 classes of signs described by Peirce in his 1903 Syllabus. The second, *3N3* (Figures 22 and 23), as a software that would build diagrams for different classifications of signs, based on the structure of Peirce's original diagrams for 10 classes.

10cubes aimed not only at the observation of the relations between the trichotomies and categories present in the 10 classes described by Peirce in the 1903 Syllabus, but also at the visualization of the relations between those classes as described by members of the Perpignan group, Balat (1990) and Marty (1990). The diagram was based on the three-dimensional structure proposed by Balat (1990: 86, Figure 3); and a new notation for the classes was developed, based on Balat's structure—colour cubes were used in the place of numbers, while the relative position of classes was preserved. 10 cubes representing the classes of signs were placed in the same relative position found in Balat's diagram. Firstness, secondness, thirdness, represented in Balat's diagram by the Arabic numerals 1, 2 and 3, were replaced by colours—red, blue and green, respectively. The 3 trichotomies were represented by 3 planes (S, O and I) and by the faces of the cubes parallel to those planes. The interactive features of *10cubes* included the possibility of rotating or choosing

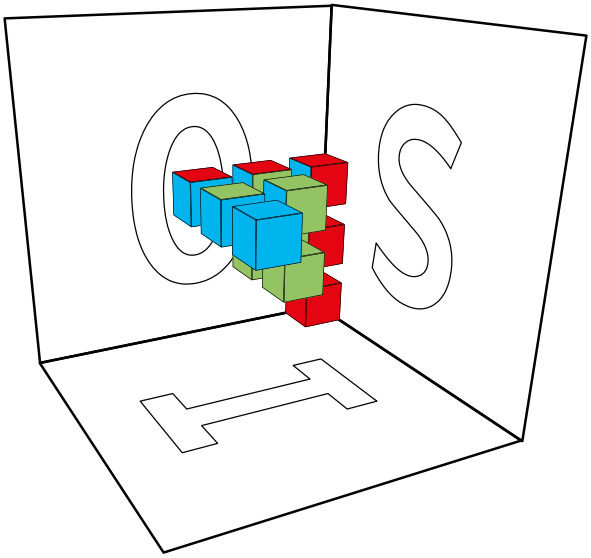


Figure 19. Early conceptual model for the dynamic diagram *10cubes* (Farias & Queiroz 2000: 36).

specific angles to observe the diagram, of clicking on the faces of a cube to examine or select modalities (Figure 20), and of watching animations of the relations of instantiation/involvement or of implication among the classes (Figure 21).

3N3, on the other hand, was designed to help in the construction and analysis of triangular diagrams (Farias & Queiroz 2001, 2003) for any number of classes coherent with Peirce's theory. The software developed implemented the diagrammatic principle according to which the original diagrams for 10 classes proposed by Peirce were designed (Farias & Queiroz 2014a, 2014b), and generalized this principle for the construction of any n-trichotomic diagram. That allowed for the observation and comparison of different hypothesis about the ordering of trichotomies in any classification, as well as the testing of the consequences of such hypothesis. Once a diagram with the desired number of classes or trichotomies was created, it was possible to select triangular cells in the diagram or rectangular cells in

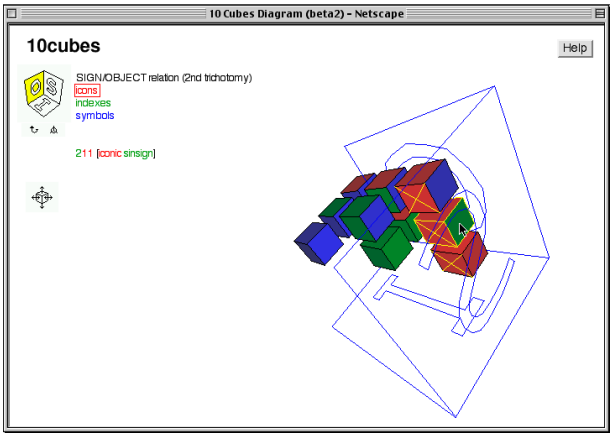


Figure 20. Aspect of *10cubes* with 'icons' and cube 211 selected (Farias & Queiroz 2004: 50).

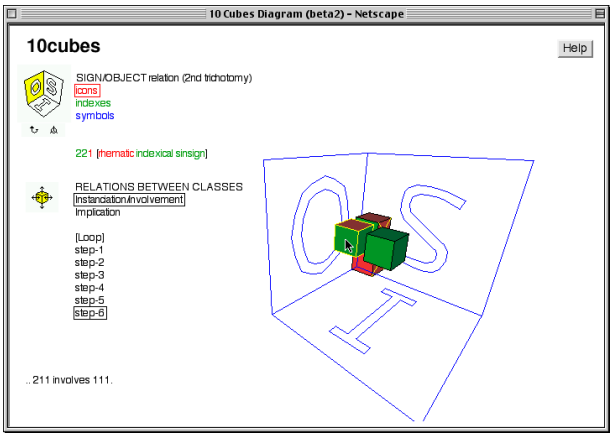
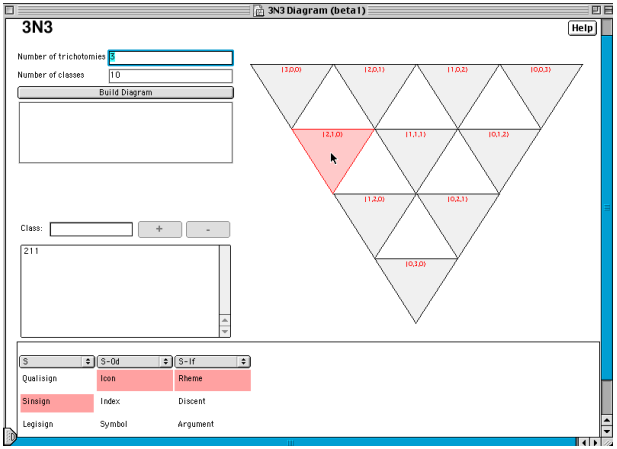


Figure 21. Aspect of the 'instantiation/involvement' animation in *10cubes* (Farias 2002: 142).



the corresponding table of trichotomies/modalities to inspect and analyze them (Figure 22). It was also possible to choose a different order of trichotomies by clicking and dragging over the menus in the first row of the table (Figure 23), or even to create new trichotomies. This last feature was particularly important for investigations on the 66 classes of signs, once there is no consensus on the order of trichotomies (or the composition of the classes created by them) among scholars.

Figure 22. A diagram for 3 trichotomies / 10 classes, created in *3N3*, with the triangular cell corresponding to rhematic sinsign selected (Farias & Queiroz 2004: 55).

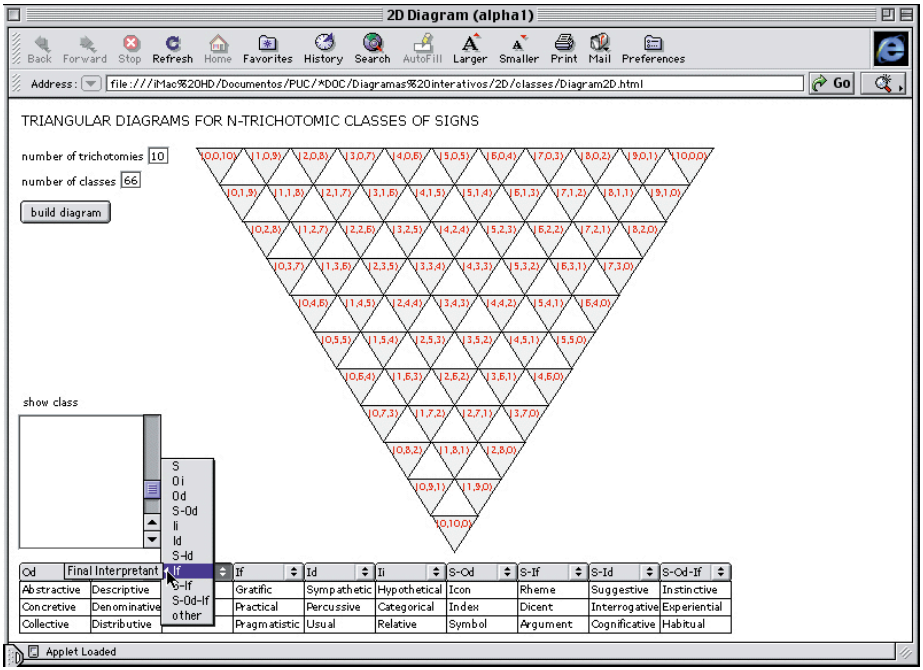


Figure 23. A diagram for 10 trichotomies / 66 classes, created in *3N3*, and the options in the trichotomies menu (Farias 2002: 168).

6. Discussion

Diagrams are special kinds of icons. As soon as an icon can be considered as consisting of interrelated parts, and the relations among those parts are subject to experimental manipulation governed by laws, we are working with diagrams. They are the principal way of modeling relations (Johansen 1993: 99). The term *model* is used to define a broad range of entities, which can be used for the purposes of scientific reasoning and design of experiments (Knuuttila, 2005). A diagram represents, through the relations between its parts, the relations that constitute the related parts of the object it represents.

The 20 diagrams discussed in this paper model, represent from different perspectives, the structural, hierarchical and dynamic relations found in Peirce's classifications of signs. The main contribution of the analysis presented here to the field of information design lies in the fact that those diagrams should help us to better understand a particular aspect of Peirce's theory of signs—the classification of signs. The classification of signs is of great significance when investigating informational or cognitive phenomena, and thus should be of special interest to researchers who apply semiotics to design studies. The comparison of the aspects highlighted or modeled in each diagram provides an interesting case of multiple diagrammatic representations of the same complex conceptual structure. It also contributes to the advancement of knowledge in the field of information design practice concerned with the design of diagrams and visualization of complex data.

As Table 1 shows, there are some similarities in the diagrams analyzed here. In what regards form, triangles, rectangles and cubes are more frequent than other shapes for representing the classes. In what regards structure, most diagrams represent full classes (identified by name, number or combination of colours);

Table 1. Synthesis of the analysis of 20 diagrams for Peirce's classifications of signs (continued)

Fig.	Name	Classes represented	Mode of representation for the classes	Relations	Forms	Colours	Dimensions	Motion / interactivity
1	Balat's triangular diagram	10	numerical notation	relations between classes	triangle	1	2	static
2	Balat's square diagram	10	numerical notation	relations between classes; groups of classes	rectangles	1	2	static
3	Balat's three-dimensional diagram	10	numerical notation	relations between classes; groups of classes	3D coordinates	1	3	static
4	Merrell's classes and relations diagram	10	numerical notation, numerical sequence	relations between classes; groups of classes	rectangles, circles	1	2	static

Table 1. Synthesis of the analysis of 20 diagrams for Peirce's classifications of signs (continued)

Fig.	Name	Classes represented	Mode of representation for the classes	Relations	Forms	Colours	Dimensions	Motion / interactivity
5	Merrell's classes and hypoicons	10, and 3 hypoicons	connections between modalities, numerical sequence	relations between modalities; groups of classes	elipses	1	2	static
6	Marty's 10 classes diagram	10	numerical notation and indication of trichotomy	relations between classes	rectangles	1	2	static
7	Marty's 28 classes diagram	28	numerical notation	relations between classes	rectangles	1	2	static
8	Marty's 10 and 28 classes diagram	10 and 28	position, numerical sequence	relations between classes; correspondence between classifications	rectangles	1	2	static
9	Maróstica's diagrammatic model	10, 28, and 66	numerical sequence	none	triangles	1	2	static
10	Olsen's model for 10 classes	10	color arrangements	relations between trichotomies	triangles, circles	3	2	static
11	Olsen's notation for 10 classes and triadic relations	10, plus 2 or 5 variations for 4 of them	color arrangements	relations between categories and trichotomies; relations between different types of signs	triangles, circles	3	2	static
12	Farias' RGB diagram for 10 classes	10	color combinations	relations between categories	triangles, squares	3 basic colours, 10 combinations	2	static
13	Farias' CMY diagram for 10 classes	10	color combinations	relations between categories	triangles, squares	3 basic colours, 10 combinations	2	static

Table 1. Synthesis of the analysis of 20 diagrams for Peirce's classifications of signs

Fig.	Name	Classes represented	Mode of representation for the classes	Relations	Forms	Colours	Dimensions	Motion / interactivity
14	Farias' RGB diagram for 66 classes	66	color combinations	relations between categories	triangles, squares	3 basic colours, 66 combinations of these colours	2	static
15	Farias' CMY diagram for 66 classes	66	color combinations	relations between categories	triangles, squares	3 basic colours, 66 combinations	2	static
16	Signtree	10 and 66	branching sequences, form and color of the nodes; areas of color	relations between categories and trichotomies; correspondence between the 10 and 28 classes	triangles, squares, circles, arborescent structure	3 basic colours, 10 combinations	2	static
17	Hoffmann's three-dimensional diagram	10	numerical sequence	groups of classes	cubes	1	3	static
18	Amadori's three-dimensional diagram	10	numerical notation, color arrangements	relations between modalities; groups of classes	cubes	3 basic colours, 9 combinations	3	static
19–21	10cubes	10	color arrangements, numerical notation, names of the classes	relations between modalities; groups of classes; relations between classes	cubes, triangular coordinates	3 basic colours; black for contours and text; yellow for highlights	3	dynamic and interactive
22–23	3N3	any number of classes coherent with Peirce's theory	numerical notation, category triplets, names of the modalities that form each class	relations between modalities; groups of classes	triangles, rectangles	2 basic colours; shades of those colours	2	interactive

while the inner structure of each class is made more explicit in just a few of them, such as Signtree (Figure 16), and 3N3 (Figures 22 and 23). As for the use of colour, RGB is the most frequently used system with red being usually associated with firstness, green with secondness, and blue with thirdness.

The recurrence of form might be explained by the fact that Peirce himself used triangles and squares for his diagrams (Farias & Queiroz 2014a, 2014b). The same is true for structures that represent relations between whole classes. The coded use of colour, on the other hand, might be explained by Peirce's recurring example of "a feeling of red" for firstness, and is consistent in academic works and published papers since 2000 (Farias & Queiroz 2000 and 2004, Amadori 2001, Farias 2002, Borges 2010).

Dynamic diagrams are the only ones that actually allow for live testing of hypotheses. In order to overcome digital obsolescence, however, a continuous effort is required to keep them updated. The only dynamic diagrams shown here (*10cubes* and *3N3*), unfortunately, although still available online, cannot run on current operating systems and browsers. There is still need, therefore, for further research and further developments in this area, in particular in what regards digital and interactive features applied to Peirce's theory of signs.

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Notes

1. Following a scholarship tradition, Peirce's work will be referred to as CP (followed by volume and paragraph number for quotes from *The Collected Papers of Charles S. Peirce*, Peirce 1866–1913), EP (followed by volume and page number for quotes from *The Essential Peirce*, Peirce 1893–1913), and MS or L (followed by manuscript or letter number and page number according to Robin 1967).

2. A detailed description of the diagrams designed by Peirce for the classifications of signs can be found in Farias & Queiroz 2014a and 2014b.

3. For an introduction to Peirce's extended classifications of signs, see Savan (1986), Liszka (1996), Parker (1998), Houser (2010); on the modeling of empirical semiotic phenomena (Queiroz 2012).

4. Michel Balat, Robert Marty, Antony Jappy and Joelle Rethoré.

5. The terms used on this list are at the core of Peirce's extended classifications of signs. Peirce's classifications of signs are based on *trichotomies* (EP 2: 289–299 and 478–491), aspects according to which semiosis can be described. The first trichotomy considered on this list describes the nature of the sign: a qualisign is a quality "in so far as it is a sign" (CP 2.254); a sinsign "is an actual existent thing or event which is a sign" (CP 2.245); a legisign is "a law that is a sign" (CP 2.246). The second trichotomy describes the relation between the sign and its object: an icon (similarity); an index (existence); a symbol (convention). The third trichotomy describes the relation of the sign and the interpretant, or the way in which the sign tends to be interpreted: as a rheme, or a possibility; as a dicent, or a sign of fact; as an argument, or a sign of law. Those nine modalities combine to form the 10 classes of signs, which are the only 10 combinations allowed by the 'qualification rule' (Savan 1987–1988: 14). A more detailed description can be found in Farias & Queiroz (2000) and Farias (2002).

6. Hypoicons are instantiated iconic signs, which share some likeness with their objects. According to Peirce (CP 2.277, EP2: 274), hypoicons can be divided into *images* ("Those which partake of simple qualities"), *diagrams* ("those which represent the relations … of the parts of one thing by analogous relations in their own parts"), and metaphors ("those which represent the representative character of a representamen by representing a parallelism in something else"). More detailed discussions on hypoicons, including the possible contribution of this concept to information design, can be found in Farias & Queiroz (2006) and Farias (2003).

7. According to Peirce, "Phaneroscopy is the description of the phaneron; and by the phaneron I mean the collective total of all that is in any way or in any sense present to the mind, quite regardless of whether it corresponds to any real thing or not" (CP 1.284). As "the most primal of all the positive sciences"

(CP 5.39), theoretically based on "pure mathematics" (CP 5.40), the task of phaneroscopy is to provide an exhaustive catalogue of mental elements (CP 1.292).

8. In a later, published version of the 1999 manuscript (Olsen 2000), colours are substituted by different line weight.

9. [Rhematic iconic] qualisigns, [rhematic] iconic sinsigns, rhematic indexical sinsigns, and dicent [indexical] sinsigns are four of the ten classes of signs that derive from the trichotomies and modalities explained in note 4, above. The terms between brackets are omitted because, according to the 'qualification rule,' which states that "a First can be qualified only by a First; a Second can be qualified by a First and a Second; and a Third can be qualified by a First, Second, and Third" (Savan 1987–88: 14), qualisigns can only be rhematic and iconic, iconic sinsigns can only be rhematic, and dicent sinsigns must be indexical. Signs that are feelings or sensations such as "a feeling of 'red'" (CP 2.254) are [rhematic iconic] qualisigns. A [rhematic] iconic sinsign is an existing thing or event, such as "an individual diagram" (CP 2.255) that relates to its object by some sort of similarity, while a rhematic indexical sinsigns, such as "a spontaneous cry" (CP 2.256) is a token interpreted as possibly standing for its object (another event) (CP 2.259). A dicent [indexical] sinsign, such as "a street cry" (CP 2.260), is a token interpreted as spatio-temporally reacting with its object (another event) (CP 2.260).

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About the authors

Priscila Lena Farias, PhD, is Associate Professor of Design at the University of São Paulo School of Architecture and Urbanism, where she coordinates the Visual Design Research Lab (LabVisual), and is currently the head of the Design BA. Her ongoing research projects focus on typography, public lettering, and visual culture.

Email: prifarias@usp.br

João Queiroz, PhD, is professor at the Institute of Arts, Federal University of Juiz de Fora, Brazil. He is member of the Linnaeus University Centre for Intermedial and Multimodal Studies (Sweden), and associate researcher of the Linguistics Department, University of the Free State (South Africa). His research interests include Peirce's philosophy and cognitive semiotics.

Email: queirozj@gmail.com