

10cubes and 3N3: Using interactive diagrams to investigate Charles Peirce's classifications of signs*

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Computing provides philosophy with such a set of simple, but incredibly fertile, notions — new and evolving *subject matters, methods,* and *models* for philosophical inquiry.

—Bynum and Moor

Abstract

This article presents some results of a research on computational strategies for the visualization of sign classification structures and sign processes. The focus of this research is the various classifications of signs described by Peirce. Two models are presented. One of them concerns specifically the 10-fold classification as described in the 1903 Syllabus (MS 540, EP 2: 289–299), while the other deals with the deep structure of Peirce's various trichotomic classifications. The first is 10cubes, an interactive 3-D model of Peirce's 10-fold classification, as described in the Syllabus. The second is 3N3, a computer program that builds equivalent diagrams for any n-trichotomic classification of signs. We are specially interested in how a graphic design methodology, associated with computer graphic resources and techniques, can contribute to the construction of interactive models that serve as tools for the investigation of C. S. Peirce's theory of signs.

Introduction

As a consequence of several experiments, and pressed by several discoveries in different domains (existential graphs, phaneroscopy, pragmatism), Peirce develops, for more than 40 years, several classifications of signs based on different trichotomies (see MS 540; L 463: 132–60; CP 2.233–72 and 8.342–76; Lieb 1977: 80–85; EP 2: 289–299 and 478–491) — three trichotomies (10 classes), six trichotomies (28 classes), and ten

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trichotomies (66 classes). This implies a deep level of detail in the description of the relations observed in semiosis as a process involving the interaction of sign, object, and interpretant.

There are many questions not yet answered about those classifications. ‘How’ and ‘What for’ are the different trichotomic divisions conceived are the two questions we will deal with here. To answer the first question (*how* are the new trichotomic divisions and the new classifications conceived?), we suggested elsewhere (Farias and Queiroz 2001; Farias and Queiroz 2003) a principle able to graphically represent the operational complexity of the ‘cross-related’ (cf. Freadman 2001: 1) trichotomic considerations that produce the classes of signs. This principle mirrors the strategy adopted by Peirce to design the two known diagrams for ten classes of signs (Figures 1 and 2). These diagrams can be called ‘diagrams of periodic relations’, or diagrams of morphological ‘affinities’ based on relative proximities among its components (classes). In both diagrams, the relations are distributed according to a pattern of periodic intervals.¹

In order to investigate the patterns of relations between classes, and to answer the next question (*what* are the new trichotomic divisions and the new classifications conceived *for?*), we present a brief discussion on the order of determination of the trichotomies in different classifications and

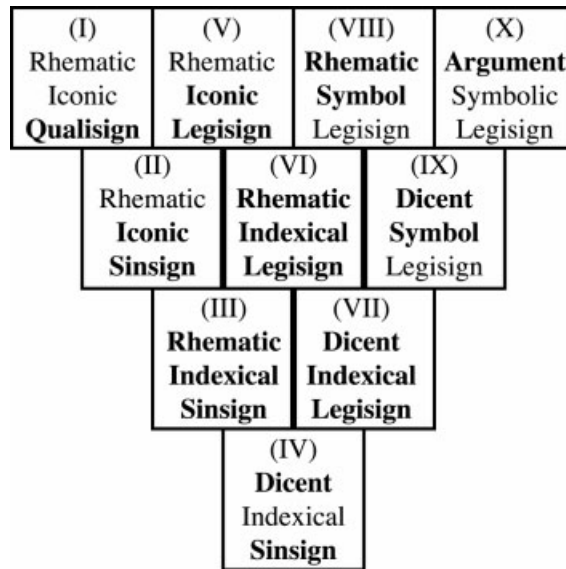


Figure 1. A diagram designed by Peirce for his 1903 Syllabus (MS 540: 17; EP 2: 296)

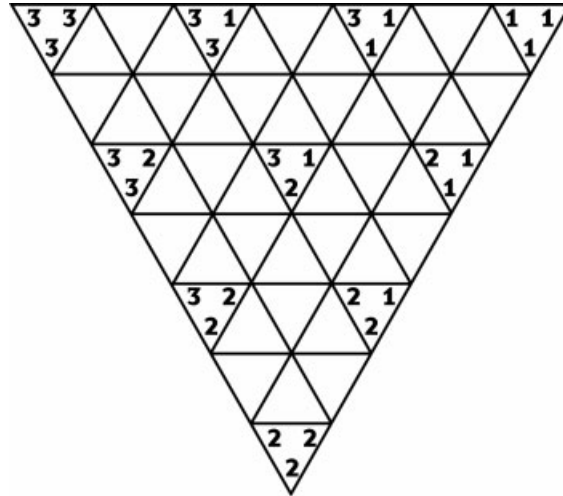


Figure 2. *A diagram, designed by Peirce, found in a letter to Lady Welby dated December 1908 (L 463: 146; EP 2: 491)*

two computational models that implement those classifications. We are especially interested in how a graphic design methodology, associated with computer graphic resources and techniques, can contribute to the construction of interactive models, that serve as tools for the investigation of C. S. Peirce's theory of signs.

Trichotomies and classes

The classifications of signs are built upon two principles, carefully described within Peirce's philosophy: (i) an exhaustive list of irreducible relations and (ii) a sequence of trichotomic distinctions, according to which the triad S–O–I can be analyzed. Is there a correspondence between these principles? Assuming that this topic is not an exception to the systematic treatment given by Peirce to all subjects, the sequence of trichotomic distinctions must follow some kind of principle whose justification must be found in a deductive phase of analysis, or in an inductive phase of tests, according to phaneroscopy. In other words, those phases should *explain* the order of determination of the trichotomic divisions. This principle is clear in the three-trichotomic division of ten classes described in the Syllabus (MS 540, EP 2: 289–299): S (firstness) determines S–O (secondness), which determines S–I (thirdness). But the problem here is that

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the introduction of new divisions, after 1903, is not followed by a clear interpretation of the role of each new trichotomy. An attentive reading of several manuscripts, especially those found in the *Logical Notebook* (MS 339), strengthens the impression of an *ad hoc* development of such constructions.

Peirce notes: 'It is pretty clear that there are four more divisions that must be taken into account before order can be brought in. Perhaps even more' (MS 339: 504). This gives us ten trichotomies. On those trichotomies, Peirce affirms, 'I have a clear apprehension of some [...], an unsatisfactory and doubtful notion of others [...], and a tolerable but not thoroughly tried conception of others' (CP 8.340; EP 2: 483). Peirce refers to these trichotomies in different manuscripts, and especially in a letter dated December 23, 1908 to Lady Welby (L 463: 142–146, 150–160; EP 2: 478–491). In those drafts, Peirce presents 'the ten aspects according to which the chief divisions of signs are determined,' starting with 'the mode of being' or 'the mode of apprehension' of 'the Sign itself'.² These divisions are followed by three 'aspects' that refer to the Object, followed by three aspects that refer to the Interpretant:

- 1st, According to the Mode of Apprehension of the Sign itself,
- 2nd, According to the Mode of Presentation of the Immediate Object,
- 3rd, According to the Mode of Being of the Dynamical Object,
- 4th, According to the Relation of the Sign to its Dynamical Object,
- 5th, According to the Mode of Presentation of the Immediate Interpretant,
- 6th, According to the Mode of Being of the Dynamical Interpretant,
- 7th, According to the Relation of the Sign to the Dynamical Interpretant,
- 8th, According to the Nature of the Normal Interpretant,
- 9th, According to the Relation of the Sign to the Normal Interpretant,
- 10th, According to the Triadic Relation of the Sign to its Dynamical Object and to its Normal Interpretant. (L 463: 134, 150; EP 2: 482–483)

Although there is, among Peircean scholars, some agreement about the trichotomies involved in 28 and 66 classes of signs, it is not possible to say that there is a definite position concerning the ordering of these trichotomies. The ordering of trichotomies that gives rise to the classifications is extremely important in this context, to the point that some of the classes of signs that are formed by a certain order of determination might not even exist if we adopt a different order! For instance, if we invert the position of the first two trichotomies that form the ten classes, we would not have Indexical Legisigns anymore, nor Iconic Legisigns or Sinsigns. On the other hand, we would have Symbolic Sinsigns and Qualisigns, classes that make no sense among the ten-fold classification described by Peirce in his 1903 Syllabus.

We can say that, if the question of the division of signs in ten classes, as proposed in Peirce's 1903 Syllabus, is fairly well understood, and approached in a concordant way by Peirce scholars, the same cannot be said about the 28, and especially about the 66 classes of signs (compare, for instance the ordering of trichotomies found in EP 2: 482–483; EP 2: 478–481; EP 2: 484–491; Weiss and Burks 1945; Sanders 1970; Lieb 1977; Jappy 1984; Marty 1990; Maróstica 1992; Müller 1993; Linde 1996). While the dynamic diagram *10cubes*, described below, permits the visualization of the complex relations between trichotomies and classes found in the ten-fold classification described in the 1903 Syllabus, the software *3N3*, introduced in the next section, aims to be a contribution for a better understanding of general questions related to Peirce's classifications of signs, and in particular of the divisions in 28 and 66 classes.

Interactive models

10cubes and *3N3* are two items of software, developed in Java, that model the relations among the classes of signs, incorporating, by the use of computational tools, interactivity and the possibility of temporal changes. *10cubes* is an interactive tri-dimensional model of the ten classes of signs (as described in the 1903 *Syllabus*), while *3N3* is software that builds diagrams for different classifications of signs, based on the structure of Peirce's diagrams for ten classes (Figures 1 and 2).

The design of those diagrams was motivated by the detection of some limitations in the visual models for the classes and classifications of signs proposed by Peirce (MS 540: 17; L 463: 146; EP 2: 296, 491), and Peirce scholars (e.g. Balat 1989–1991; Merrell 1991, 1997; Marty 1990; Maróstica 1992; Müller 1993; Liszka 1996). Those limitations arise from the static, bi-dimensional, and monochromatic nature of such models (Farias and Queiroz 2000a). The application of design methodology and computer graphic resources resulted in a new family of diagrams, more efficient as tools for the investigation of the classifications of sign.

*10cubes: An interactive tri-dimensional model of the 10 classes of signs*³

The main goal of *10cubes* is to allow the observation of the relations between the trichotomies and the categories in Peirce's 10-fold classification, as described in the 1903 Syllabus, as well as of the relations between the ten classes of signs described in the same document (cf. Balat 1989–1991, Marty 1990). Through discrete modifications of the represented

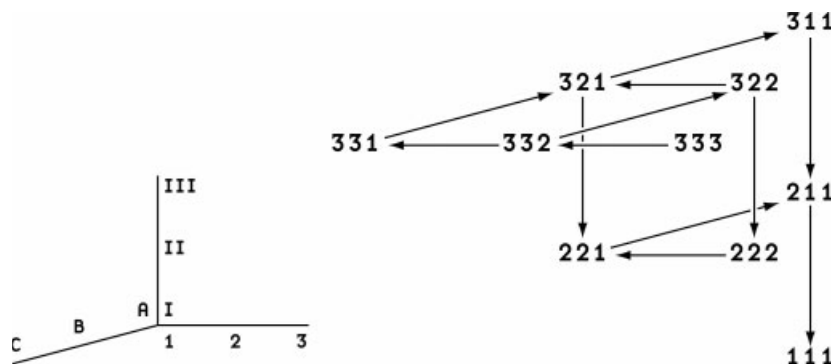


Figure 3. *The tri-dimensional structure for ten classes proposed by Michel Balat (1989–1991: 86)*

structures, and with variations of the observed perspective, it permits the identification of patterns of relations among classes, trichotomies, and categories.

The model is based on a tri-dimensional structure proposed by Balat (1989–1991: 86; see Figure 3). A new notation for the classes was developed, based on Balat’s structure — color cubes were used in the place of numbers — while the relative position of classes was preserved. In the diagram proposed by Balat, the classes are distributed in a (x, y, z) space where each axis corresponds to a trichotomy, and each position in the axis corresponds to a modality (firstness, secondness, and thirdness as they are presented in each trichotomy). Classes are represented by sets of numbers, while arrows between them correspond to relations between the ten classes of signs. In *10cubes*, each cube corresponds to a class and is placed in the same relative position found in Balat’s diagram. Firstness, secondness, and thirdness, represented in Balat’s diagram by the Arabic numerals 1, 2, and 3, are replaced by colors (respectively red, blue, and green). The three trichotomies are represented, in *10cubes*, by three planes (S, O and I) and by the faces of the cubes that are parallel to those planes.

***10cubes* interactive features**

As we enter *10cubes*, we have an interface constituted by, from left to right, a column with the software name and a series of buttons, a model of the classes with ten colored cubes disposed within three transparent planes, and, in the upper-right corner, a Help button. The Help button

gives access to a page with instructions on how to use the software. The main interactive features in *10cubes* are as follows:

1. It is possible to rotate the model by clicking and dragging over it. Once this can be done all the time, this feature makes it possible to examine the presence and position of any cube at any given moment.

2. Clicking on a cube makes a legend appear above the model with the class description in verbal and numerical terms (see Figure 4). This feature makes the identification of cubes with classes easier. The relation between numerical, verbal, and spatial notation is reinforced by the use of colors that refer to the components of firstness (red), secondness (green), and thirdness (blue) present in each class or cube.

3. It is possible to select a certain view (parallel to plane S, O, or I) by clicking on the planes of the 'perspective' button on the upper-left corner of the interface (see Figure 5). Such views are accompanied by a verbal description of the trichotomy represented by the selected plane and a list of modalities related to this trichotomy. Each modality is colored according to the principle described above, allowing a fast detection of the cubes/classes where each modality is present.

4. Clicking on one of the modalities that appear above the model highlights the corresponding faces of the cubes. This feature is particularly relevant when rotating the model, allowing a complete examination of the relative position of the selected group of cubes/classes. Combined with feature 2 (above), it facilitates the examination of the relative position of a specific class among a group (see Figure 6).

5. It is possible to rotate the model 180° by clicking on the 'arrow' button, just below the 'perspective' button, allowing a fast check of an opposite view.

6. It is possible to reset the model's position by clicking on the 'target' button, to the left of the 'arrow' button. This is particularly useful when the user wishes to start again from the beginning, with no special views or classes selected.

7. Clicking on the 'cube and arrows' button, just below the 'perspective', 'arrow' and 'target' buttons, shows a menu of two kinds of 'relations between classes'. Those are two possible interpretations for the relations between classes described by Peirce in his Syllabus. From this menu, it is possible to choose between the relations of 'instantiation/involvement' between classes described by Balat (according to Liszka 1996, Serson 1997) or the relations of 'implication' described by Marty (1982) (see Figure 7).

8. When a kind of 'relation between classes' sequence is selected, it is possible to click on one of the steps to see this step, or to click on 'loop' to see all steps in the sequence. The relations between classes are

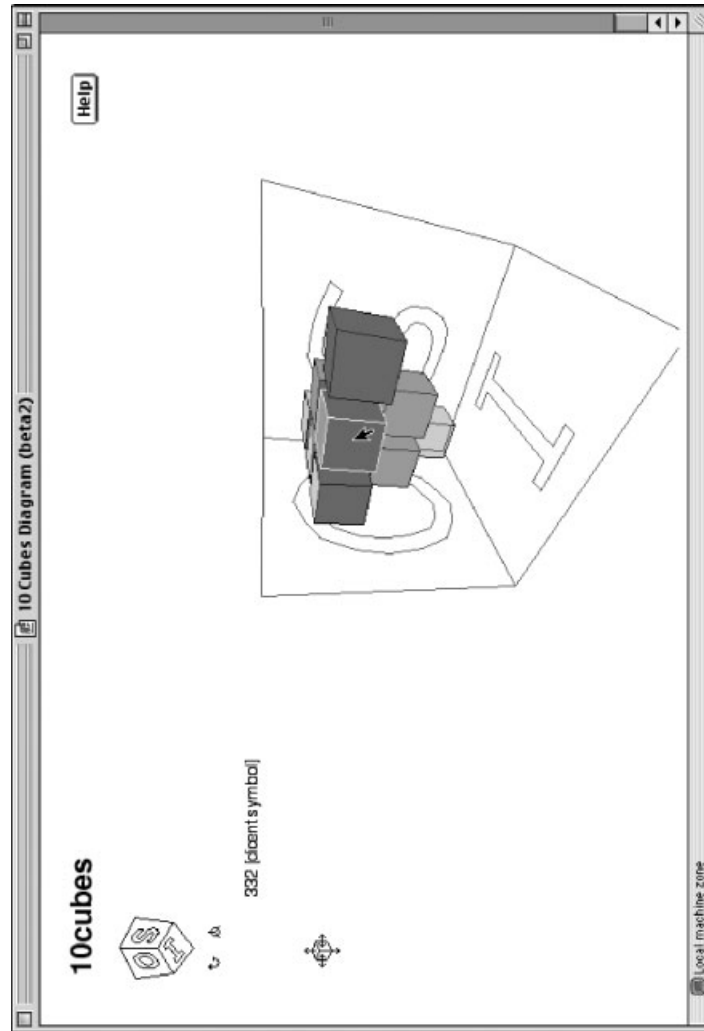


Figure 4. 10cubes with cube 332 selected

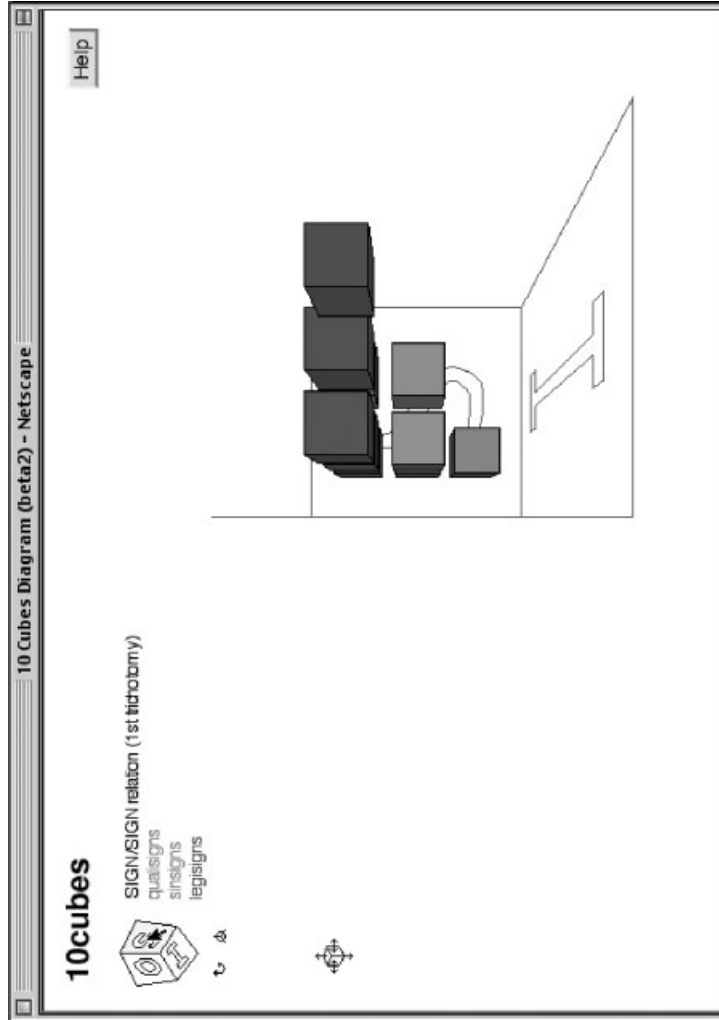


Figure 5. 10cubes seen from the S (sign) plane perspective

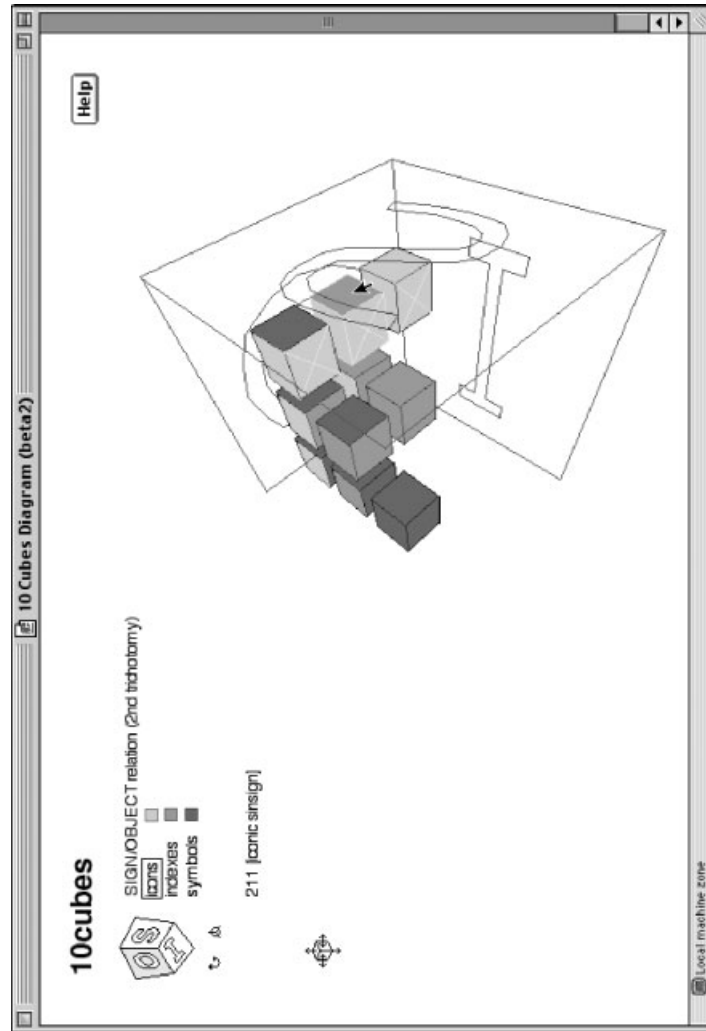


Figure 6. 10cubes with 'icon' and cube 211 selected

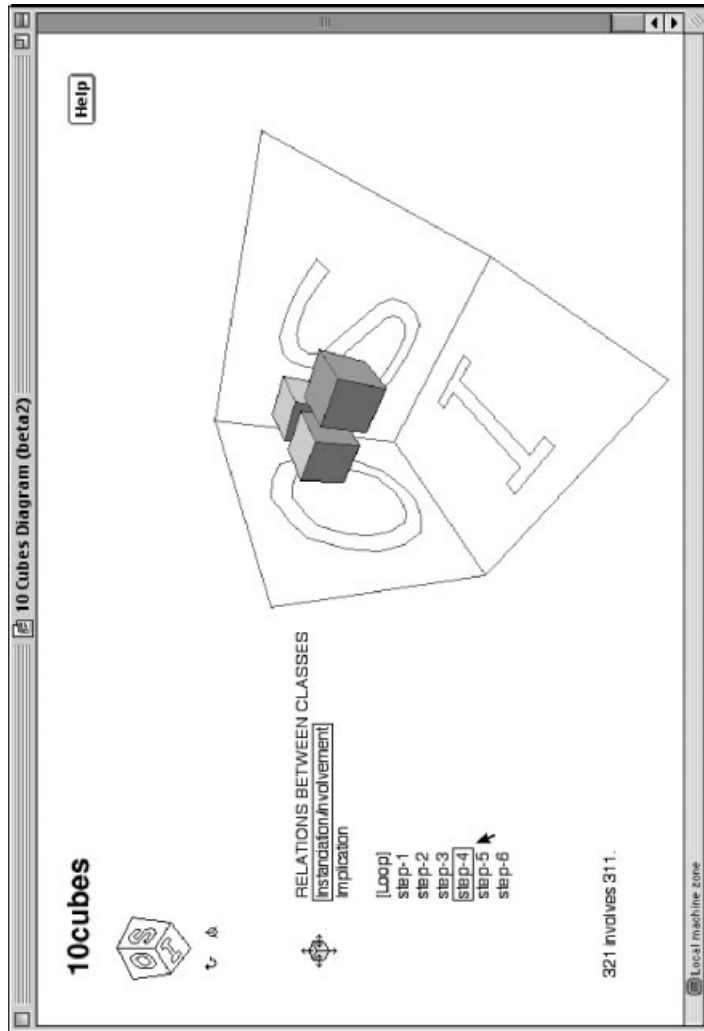


Figure 7. 10cubes with the relation between classes 'instantiation/involvement, step 4' selected

animated sequences, and each step describes a key moment in this sequence. Those descriptions are given in the form of texts that appear at the bottom-left corner of the interface, and accompanied by the appearance or disappearance of cubes within the planes of the model.

*3N3: Software that builds diagrams for different classifications of signs*⁴

Much less discussed than the ten-fold division of signs, the divisions into 28 and 66 classes appear in several manuscripts and drafts of letters to Lady Welby written in December 1908 (L 463: 132–160; CP 8.342–76; EP 2: 478–491; Lieb 1977: 80–85). Such divisions are based, respectively, on six and ten trichotomies. Although several scholars (e.g. Houser 1992: 501–502; Müller 1993: 135; Santaella 1995: 125) agree on the relevance of those classifications for the understanding and application of Peirce's system, those divisions of signs never received, not even from their own author, the same exhaustive treatment given to the ten classes described in the Syllabus. Peirce also designed several diagrams for ten classes of signs, but never did the same for the divisions into 28 and 66 classes.

On other occasions (Farias and Queiroz 2000b, 2001; Farias 2002a), we presented the diagrammatic principle according to which both diagrams were designed, and generalized this principle to the construction of any n-trichotomic diagram. We then called *Triangular Diagrams* the project for the implementation of this strategy (Farias and Queiroz 2000b; Farias and Queiroz 2003). *3N3* was designed to help in the construction and analysis of these diagrams, automatizing the process of production of triangular diagrams. It assists in the modeling of structures for n-trichotomic classifications of signs, allowing 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.

3N3 interactive features

The interface opening of *3N3* is composed of a column with the name of the software, some fields and a button on the left, and a Help button in the upper-right corner that gives access to a page with instructions on how to use the software (see Figure 8). Only the first two fields ('number of trichotomies' and 'number of classes') are active at this moment, and there will be nothing on the left of the column or in the bottom field while no value is entered and the 'build diagram' button is not pressed. The main interactive features in *3N3* are as follows:

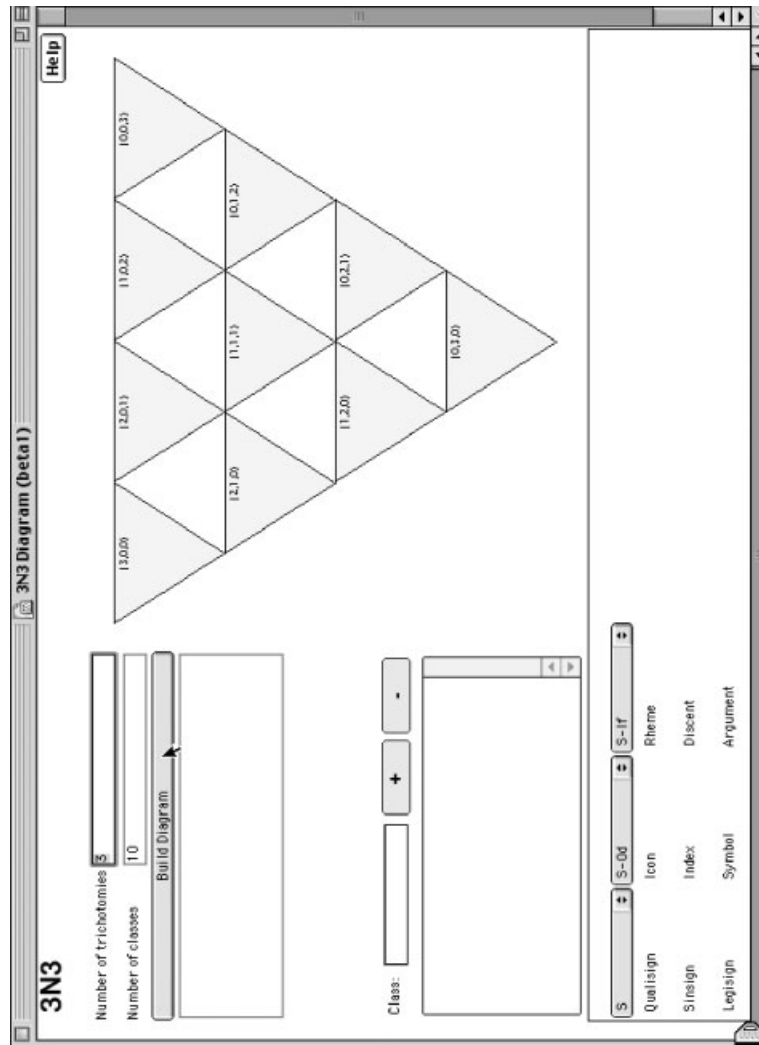


Figure 8. 3N3: A diagram for three trichotomies/ten classes

1. Entering a value in the ‘number of trichotomies’ field or in the ‘number of classes’ field and then clicking on the ‘build diagram’ button enables the software to create a new diagram, based on those values. *3N3* will calculate the correct number of classes from the number of trichotomies given, and vice-versa. It will also warn if a value is not acknowledged by Peirce scholarship, and substitute it if it is out of bounds (see Figure 8). Warnings and error messages will appear in the field just below the ‘build diagram’ button. A triangular diagram with the corresponding number of classes will be built, and a table with the corresponding trichotomies and modalities will appear in the bottom field.

2. Once the diagram is built, clicking on one of its triangular cells will show the corresponding numeric class description in the ‘class’ list field and the related verbal class description (highlighted cells) in the classification table just below it (see Figure 9). If more than one triangular cell is selected, a list of all corresponding numeric class descriptions will be shown in the ‘class’ list. The classification table will show in red shading the verbal descriptions that apply to all selected triangular cells and will outline in red the verbal descriptions that apply only to some of them. This feature provides explicit and complete descriptions of each class in the diagram and also permits users to check for common attributes of a group of classes.

3. Clicking on the classification table cells highlights the classes (triangular cells) that encompass the selected modality. The classification table will also highlight the verbal descriptions that follow from the one in the selected cell. The ‘class’ list will display a list of the corresponding numeric class descriptions. The classification table will show in red the cells that correspond to verbal descriptions that must necessarily follow from the one selected, and will outline in red the ones that belong to a column where there is more than one choice (see Figure 10). This feature allows users to promptly spot all classes in the diagram that share the same modality, while also indicating related modalities.

4. By holding the Control key while clicking on classification table cells, it is possible to select more than one modality at once. The corresponding triangular cells will be highlighted in the diagram, and the corresponding numeric class descriptions will be shown in the ‘class’ list. This feature allows users to locate, for instance, one of the ten classes described in the Syllabus among a diagram for 66 classes (see Figure 11).

5. It is possible to select and deselect classes by entering number sequences in the ‘class’ field, and then clicking on the ‘plus’ or ‘minus’ button (see Figures 8–11). Entering a number and clicking on the ‘plus’ button adds a class to the ‘class’ list. Selecting a number sequence in the ‘class’ list and clicking on the ‘minus’ button removes a class from the

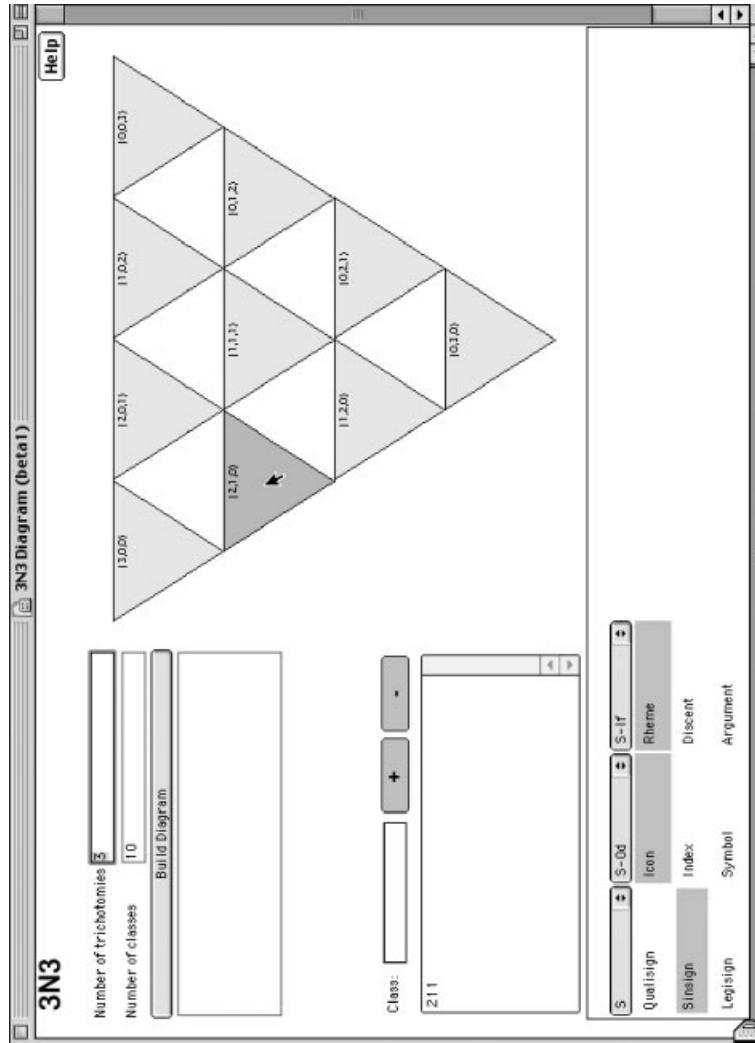


Figure 9. 3N3: A diagram for three trichotomies/ten classes, with one triangular cell selected

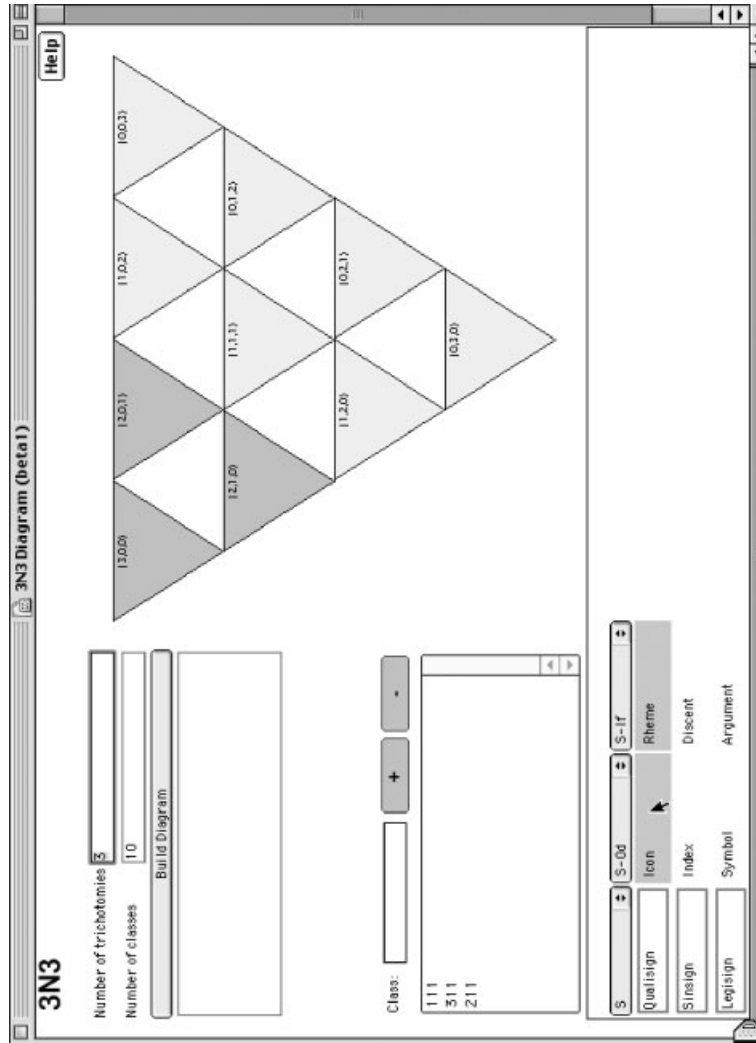


Figure 10. 3N3: A diagram for ten classes with one table cell (icon) selected

'class' list. Triangular cells that correspond to the added or removed classes will be selected or deselected. Changes will also affect the highlight status of trichotomy table cells.

6. It is possible to change the default order of trichotomies in the classification table by clicking and dragging over the menus in the first row of the table (see Figure 12). The abbreviations shown in the menus correspond to the following trichotomy descriptions:

S = [nature of the] Sign: Qualisign, Sinsign, Legisign

Oi = [nature of the] Immediate Object: Descriptive, Denominative, Distributive

Od = [nature of the] Dynamic Object: Abstractive, Concretive, Collective

S–Od = Relation of Sign to Dynamic Object: Icon, Index, Symbol

Ii = [nature of the] Immediate Interpretant: Hypothetical, Categorical, Relative

Id = [nature of the] Dynamic Interpretant: Sympathetic, Percussive, Usual

S–Id = Relation of Sign to Dynamic Interpretant: Suggestive, Interrogative, Cognificative

If = [nature of the] Final Interpretant: Gratific, Practical, Pragmatistic

S–If = Relation of Sign to Final Interpretant: Rheme, Dicient, Argument

S–Od–If = Relation of Sign to Dynamic Object and to Final Interpretant: Instinctive, Experiential, Habitual

7. It is possible to give a different name for a trichotomy or for the corresponding modalities by choosing 'other' in the classification table menu and then typing the desired names. While feature 7 (above) allows users to check the effects of different orders of determination based on known trichotomies and modalities, this last feature adds another degree of freedom, permitting the use of alternative names in the whole table.

Conclusion

The computer's impact on philosophy is well known (see Bynum and Moor 1998). The use of computing technology in philosophical research includes a large range of topics and applications. Computer technology related to research on Peircean philosophy, however, has been, with the exception of Sowa's Conceptual Graphs (Sowa 1984), restricted to digital resources and databases, like versions of books and manuscripts (e.g. the CD-ROM version of *The Collected Papers of Charles Sanders Peirce*), digital encyclopaedias and dictionaries (*Arisbe, Digital Encyclopedia of C. S. Peirce, The Commens Dictionary of Peirce's Terms*), online forums

and courses (*Cyber Semiotic Institute*, *Virtual Centre for Peirce Studies at the University of Helsinki*, the *online forum for discussion of the philosophy of Charles Peirce and related topics*), and web sites (*The Peirce Edition Project*, *Grupo de Estudos Peirceanos*). None of those applications is a tool for investigation and testing of theory and hypothesis.

What this paper proposes can be considered a new kind of investigative framework for Peirce's Semiotic.⁵ The two items of software presented here are the first attempts to model sign structures and processes based on graphic design methodology and leading to the implementation of computational tools. *3N3* models the structure of periodic relations described by Peirce as 'affinity relations' between the ten classes of signs and can be generalized for any n-trichotomic structures. *10cubes* is the first step to model the dynamic relations of sign processes and is based on Balat's (1989–1991) and Marty's (1982) interpretations of those processes in the context of ten classes. We believe that the use of interactive computational strategies to investigate topics of Peircean philosophy can have a deep impact on semiotics, leading both to advanced research on theoretical problems and to the design of other tools of this kind.

Notes

- * The authors would like to acknowledge the support received, in the form of research grants, from FAPESP — Fundação de Amparo à Pesquisa do Estado de São Paulo. They would also like to thank Antonio Gomes for the implementation of the Java code.
1. Very appropriately, 'periodic' here has the same meaning as in the 'periodic table' for chemistry. For Scerri (1998: 78), 'the term "periodic" (in the expression "periodic table") reflects the fact that the elements show a pattern in its chemical properties in regular intervals'.
 2. The expression 'the mode of being of the Sign itself' appears in two manuscripts (L 463: 134, 150), but in L 463: 150 the word 'being' is substituted by 'apprehension'.
 3. The current version of this software can be found in Farias 2002b.
 4. See Farias 2002b.
 5. More recent developments in a similar direction include Gomes, Gudwin, and Queiroz (in press).

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