A Disposal/Formal Requirement-Based Tool to Support Sustainable Collection Making

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Abstract— **Many of our modern computerized activities, may they be personal, professional or even artistic, involve searching, classifying and browsing large numbers of digital objects. The tools we have at hand, however, are poorly adapted as they are often too formal: we illustrate this matter in the first section of this article, with the example of multimedia collections. We then propose a software tool for dealing with digital collections in a less formal manner. Finally, we see that our software design is strongly backed up by both artistic and psychological knowledge concerning the ancient human activity of collecting, which we will see can be described as a metaphor for categorization in which two irreducible cognitive modes are at play: aspectual similarity and spatio-temporal proximity.**

Index Terms— **information retrieval, cognitive modeling, figural collection, class, spatial metaphor.**

I. Multimedia Collections

A. Technological context

Our Our modern WIMP-based interfaces were created in the early 70s, they were used on computers with low storage capacities, slow processing speed, relatively low connectivity and low resolution monitors. These computers were first used in offices and administrations, where the desktop metaphor fitted very well. Then, personal computers brought this kind of hardware to people's homes, and the desktop metaphor still fitted as computers were mainly used for editing and filing documents.

Since those times, the technology has leaped forward, and today a large portion of the population uses a computer and connects to the internet on a daily basis. Here in France[1], 9 out of 10 people in the 18-24 age group use a computer and the internet daily. Computers are equipped with high storage capacity hard drives, powerful processors, high bandwidth internet connections, to name but a few technological trends. These are still evolving but the fact is that today more and more people are using their computers not only for editing and filing documents, but also for collecting music, films, images, books... Large amounts of these can be stored on hard drives and DVD-ROMS. The contents can be downloaded from the internet, or imported from digital devices such as cameras, which have also become mainstream.

Not surprisingly, a huge market has emerged from these multimedia collections. We can now choose from a myriad of computerized tools which assist us in finding, retrieving, recording, creating, editing, browsing and classifying multimedia contents. The variety of tools at hand seems to fit with the variety of uses involved in multimedia computing, from the most creative ones - such as graphic design, audio synthesis, etc - to the most formal ones - classification in particular. However, there doesn't seem to be many tools bridging the gap between these two seemingly opposing polarities.

B. Collecting: between formalism and creativity

Let us illustrate this situation. First, let us suggest that looking for new material and classifying are two important processes involved in collecting. Indeed, when someone decides to start building a collection he usually already possesses a few items. Then, to extend this collection, new items must be added. In order to do so, the collector goes into the world and looks for these new items. Then as the collection builds up, the need to arrange the items into categories will become clearer, as the collection cannot simply remain a messy stack of unordered items.

So, in order to illustrate our point, let us describe a particular example: the music collector. As we have said, our collector will surely possess some initial items; these may be some CDs or vinyl records. His first action involved in extending his collection could be a visit to the record shop for example. Here, the music is classified conformingly to the record companies' desires, which can sometimes be confusing for our collector, who is a fan of Jimi Hendrix, and just does not know where to look for his albums: in the blues section? rock section? Is there a 'sixties' section? Anyway, despite finding them rather practical at first sight, our collector didn't create these labels, and finds it difficult adapting to them. However, as he browses through the shop, he also notices some nicely illustrated records, and discovers new artists he is interested in because their records are sitting next to Jimi's. Finally, when he has bought enough music records, and come back home, he will be able to start arranging his collection in a very personal and satisfying manner, which will be pleasing to the eyes, and also allow him to retrieve items quickly.

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[1] *Les Français et l'ordinateur*, phone survey by TNS SOFRES for the group Casino / L'Hémicycle, 15-16/04 2005

If he had decided to collect digital music, and go online to find new items for his collection, the process would have been rather similar. Commercial music download sites allow the user to browse through predefined music categories, thus implementing a kind of virtual record shop with the same problems mentioned earlier. The search tool however can come in handy, and allow the user to search for the name of an artist, a song, an album or even musical genre. All these are still editorial information, which aren't necessarily the most useful to the collector. Then, when the music is downloaded, the album consists of a group of compressed audio files, containing preset meta-tags, again storing editorial information. When browsing these files in his audio player, the songs are defined and classified automatically, not always according to the collector's desires. His final attempt is then to create a set of folders on his disk, and arrange his items in these folders. But how does he name these folders? What if he wants to arrange and browse the items in multiple ways? What if a particular item doesn't fit in any folder, or could be placed in two or three different categories? Pachet has also described many problems in the area of Electronic Music Distribution [1].

As we see from this example, the tools that the everyday user has at hand are too formal, and are poorly adapted to the growing activity of collecting multimedia contents. Indeed, what we have said for music can also be said for the other kinds of media, and can also be said for information research, file sharing, etc.

Attempts have been made at putting the human user back in control of the collecting process, rather than relying purely on predefined categories and automated research algorithms. However, it has become obvious that the other extreme of handing complete control over to the user isn't optimal either. Let us take a look at online content sharing sites, such as the famous FlickR™. There is no categorization here, but there are three main strategies when looking for photos: date, location, tags. The first two are self-explanatory, but the tags are more interesting here. When someone uploads a photo to the website, they can link a certain number of keywords, called tags, to this photo. Then, we can either browse through the most popular tags, or type a tag into a textbox for a more precise search. The users then have complete freedom on the way they choose to define their photos. But the problem is that many photos aren't tagged, and the photos that are, often have poorly named tags, making them difficult to retrieve. Therefore, we believe that an optimal solution to the problem of digital collections could lie somewhere between these two polarities: predefined categories and total user creativity.

C. Examples of tools attempting to bridge the gap

MusicBrowser is a software which aims at indexing large and unknown music collections, and also helping the user find "interesting" music in these collections [2].

When digital sound files are imported into the system, they are analyzed, and a database of their acoustic properties is created / updated. Then the user can browse through the collection in a traditional manner, relying on editorial information. He can also create his own categories intuitively. He starts by creating a category, and giving it a name. This can be totally subjective if he wishes, he may call it "evening music", "happy music" or "favorite", etc. He then adds a few songs to this category, before asking the program to finish classifying, based on acoustic similarities. Of course, the more categories there are, and the more examples there are, the easier it is for the system to classify the entire collection. However, if there are mistakes, the user may simply move a song from one category to another, and ask the system to start again. This creative feedback loop, between user input and automated algorithms, will eventually lead to a satisfying classification for the user, who will have saved a lot of time in the process. He will then be able to create other classifications of the same collection if he wishes, and switch instantly between any of them. He may also share these classifications or download others.

IMEDIA is a research project focused on indexing large collections of photos, and interactive searching and browsing [3]. When photos are added to the system, they are analyzed and a database of visual descriptors is created / updated. One of the main features of the program is allowing the user to search for similar photos. At first, a list of random images from the collection is displayed, the user may browse them, or view another set of random images. When he sees a photo he likes, he can select it and ask the system to find similar ones. For example, if he chooses a photo of a beach, then the system will display a list of photos of beaches. Once again, if the user isn't completely satisfied with the results, a "relevance feedback" system allows him to select the errors, and the system will take this into account in order to display a more relevant list of results.

In these two systems, we have noticed a creative feedback loop between the human user's input (starting point, examples, relevance feedback…) and the computer (automated algorithms for classifying and searching). This helps the user build and browse his collection in a constructive process, leading to a result which neither he nor the computer could have achieved alone. Also, both editorial information and semantic information (invisible to the user) are taken into account. IMEDIA and MusicBrowser address the problems of music collections, and photo collections, but the same ideas may be applied to other media collections, such as texts or videos, for example. It is only a case of finding the appropriate descriptors. Also, both these ideas, interactive searching and browsing, can be transposed to different media.

We can even think further, and imagine a common environment for collecting multimedia files. This could be a system with a generic layout and set of functionalities that would give birth to different programs specialized in collecting certain types of media. In the next section, we shall present a software prototype that we have implemented in order to experiment with this idea. As we shall see in the next section, we have tried to create a program more suitable to the

particular process of collecting, which has an element of subjectivity, evolves over time and doesn't rely purely on similarities, as in the IMEDIA system for example. Indeed, we sometimes wish to expand our collection with something completely different, now how would we do that? We also believe that this process lies somewhere between formal classification/automated algorithms and total creativity. There are more and more examples of this, such as the two projects described previously, and we will try to take this process even further.

II. *ReCollection*: An Experimental Software For The Creation Of Multimedia Collections

ReCollection is a computer program for searching, arranging and browsing digital content.

As our collecting activities vary from one context to another, it is too ambitious to seek a general solution to the problem. Rather, particular application areas must be defined and isolated, in order for a specific answer to be given, however always relying on a set of basic principles. Here, we shall discuss the software prototype we have created for the digital opera / open form opera *Alma Sola*[2].

A. The digital opera / open form opera Alma Sola

Alma Sola is a digital opera / open form opera, composed by Alain Bonardi. It is made up of thirty temporal "blocks", which can be assembled in any order. This order is built up live, during the performance, allowing in theory for a different story at each show. The temporal arrangement of the blocks constitutes the open form, relying here on a dialog between the singer and the computer. A program analyses the singer's voice, and detects the appropriate emotions. It then chooses the next block to play, based on these emotions and the previous blocks that have been played.

During some of the performances, sounds have been recorded, photos taken. We also have some videos of performances, and the lyrics. These fragments constitute a collection of digital material, and our desire is to create a software environment that would assist in the creative building, managing and browsing of *collections* of these objects. This could be a tool for composition, or presentation of the opera. An idea we would like to experiment is allowing the spectators to revisit the opera, after the performance, through our software, or even view it from home. By building a collection of the opera fragments, a new kind of interaction would take place during the viewing of the opera. So it is this kind of environment our first software prototype *ReCollection* is aiming to be.

B. A useful metaphor: the art collection

Artists and philosophers have described some very particular characteristics of collections. One of those, as noted by Wajcman, is that of *excess* in a collection [4]. This means that the number of collected items exceeds the collector's capacity of memorization, but also of physical storage and exposition in the gallery. Thus, there is a need for at least one *reserve,* where the excess can be stored. For example, the George Pompidou National Museum of Modern Art, Paris, owns about 59000 artworks, making it one of the largest modern and contemporary art collections in Europe. Obviously, all the items cannot be *exposed* in the galleries at once, so a very large portion is stored in the reserves. Often, the items in reserve are stored in heaps, in random locations, and they aren't always labeled, which makes it difficult to find and retrieve objects.

The reserve allows us to handle the excess in collections, which is a problem in many of today's computer applications. Our multimedia collections, for example, are becoming very large and we are often losing control over them.

On the other hand, objects which are currently exposed are found in the *gallery*. Here, the objects follow a spatio-temporal arrangement defining a finite number of visitation paths. The closeness in space of certain artworks and the chronological order in which they are approached are set carefully by the curator, as they strongly influence the visitors' experience. This aspect is also very important, and we shall discuss it later in detail.

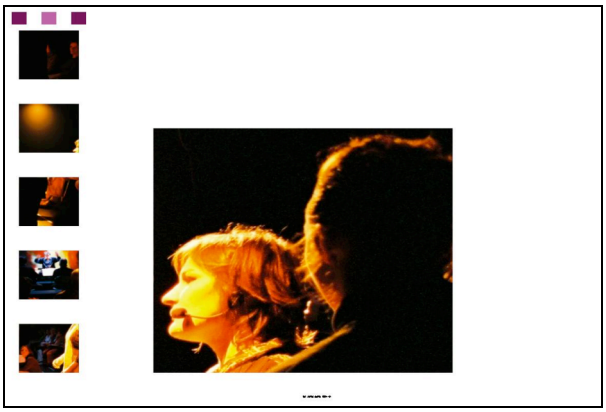
C. The Reserve

The *ReCollection* software has two main modes: reserve and gallery. The reserve allows us to store our objects which aren't exposed in the gallery. There are many objects in the reserve, and these are not always labeled; also they are rarely arranged in an orderly and tidy manner. So when we visit the reserve, we have no choice but to wander around, picking up objects, inspecting and identifying them one at a time. The reserve can also be compared to the attic, in which our family possessions are stored similarly. As we explore our attic, we can happen to pick up an old photo album, which we had completely forgotten about. This item will surely bring back memories and emotions. We can then choose to keep this album under our arm, as we continue to explore the attic, or we can leave straight away, and put it on our fireplace, for

[2] Designed by Alain Bonardi, IRCAM, Paris and performed at Le Cube, Issy les Moulineaux, October 2005.

example, making it visible to visitors. It is all these pleasant and familiar experiences which we believe can be recreated thanks to the modeling of the reserve in our computer program.

The user can create any number of reserves. However, he must create at least one, and store at least one object in this reserve. When he is in reserve mode, he can only view one object at a time. When he decides to view another object, it is chosen randomly from the remaining items in reserve. During a visit, each object is viewed only once. If the user wants to view an item he has already visited, he may go through the history of items on the left side of the screen, as shown in figure 2. When he finds an object of interest, he can move it to the gallery. It will then be removed from the reserve, and saved in memory, with a group of objects waiting to be imported in the gallery. Then, in gallery mode, the user will see this heap of objects, and will be able to import it in the desired gallery, at the desired location.



D. The Objects

The items in the *Alma Sola* collection are made up of three components:

- a photo of the performance,
- a sound recording of a few seconds of the singing,
- a text, the line which is sang in the corresponding sound file.

These are all regular files stored on disk (bitmap, wave and .txt formats). Each item also has a name. In a more general context, the objects can be made up of any one of these types of media, a video (though not implemented in this version), or any combination of these.

Also, each object has a set of descriptors attached. There is a specific set of descriptors for each type of media, which describe the contents of the object, for example the average volume of the sound, the brightness of the photo, the number of words, etc. Depending on the application, we could also include editorial information, such as date, author, etc.

These descriptors may be assimilated to the private properties of traditional computer objects. But in the context of collecting objects, we also need to account for other properties that come from the activities in which these objects collectively engage.

E. The Gallery

A collective activity involving a number of objects at a time is their relative arrangement in the gallery space. To the location of objects in this space, we have added their color; these two properties make up an extra conceptual layer which is the framework for the creation and management of our collections.

In *ReCollection*, there is always at least one gallery, and the user can create as many as he wishes. There is always at least one item in a gallery, some basic content that the user can interact with, a starting point for his collection.

The objects can be placed and arranged manually in the gallery space, using *click and move*, just as in common user interfaces. The user can also rely on two algorithms to automatically dispose the objects. The first one, inspired by *cataRT software* [5], calculates the objects' positions and colors according to descriptors chosen by the user. The second calculates the positions depending on a sample of objects selected by the user. A Principal Components Analysis (PCA) finds out which descriptors vary most amongst the objects of the sample, the system can then rearrange the whole gallery according to these descriptors, as in the first method.

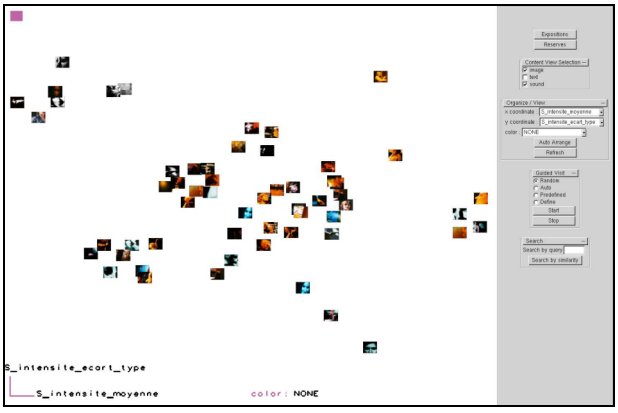
The arrangements resulting from the algorithmic calculations can always be modified manually in order to correct them (in the eventuality of rather subjective descriptors), to build up a global figure, or to bring items together. This way, through creative human-computer feedback loops, meaningful global figures can emerge through the arrangement in space of collected items, as well as local figures, soft pseudo-categories which are heaps of objects brought together by the system and/or the human user. These pseudo-categories are the building blocks for the classes the collection is implicitly aiming for. They are easily and constantly updated; items are added and removed instantly by being moved in space. They are loosely defined and never completely closed off from others, allowing some objects to be lost somewhere in between several heaps, when they cannot be placed in any one category. In a nutshell, this system allows for the creation of collections in which classes are in constant evolution, and are built by exploiting not only the objects' degree of similarity, but also their relative location in space and time.

Furthermore, the user may wish to search for objects in the gallery or in the reserve, in order to build on these categories, look for new kinds, or even fill in gaps in the gallery space. For this, the *ReCollection* system has two search tools he can use. The first is a simple 'keyword query', which searches for a keyword within the text or names of the objects. The second is a 'search by similarity'. The user selects an object, or group of objects, and the system searches for items which are similar (according to the descriptors). In both cases, the search is

carried out in both the gallery and reserve, and a list of results is displayed in the gallery, ordered by similarity.

Once all the items of interest have been imported from the reserve, through browsing or searching, and once they have been arranged in the gallery space, the user has a first *disposition* he can play with. When he will browse the gallery space, his experience will be influenced by the fact that certain objects are close in space, and in time of visitation. Although this is interesting in itself, the system can help the user go further, by defining a set of guided visits, which are simply an order of visitation of selected objects in the gallery. The objects and their order of visitation can be defined manually. The defined guided visits are then saved, and the user can later select one from the list. During a guided visit, the view will move automatically from one object to another, as defined previously. There are two other guided modes: random and automatic. The first is self explanatory. The second moves the view to a manually selected starting point, then automatically jumps to the closest object in the gallery space, and so on until the user ends the visit.

The type of interface we have chosen to implement these functionalities is a 2D zoomable user interface (ZUI), inspired by Ken Perlin's *Pad* [6]. All objects are in the same 2D space, which has no borders. The point of view can be moved vertically and horizontally, and the user can zoom in and out. If he zooms in on an item, until it fills the screen, the sound is played back. This kind of interface has been experimented; it has obtained good results, and has been proven reliable [7]. Its intuitive approach is seducing to us, particularly in our goal of intuitively collecting digital media. Finally, the spatial metaphor takes advantage of the users' spatial memory and cognitive abilities [8], [9].



F. *Case study: an inspired use of our software*

Here we shall illustrate the practical usefulness of the collecting metaphor with an example of an inspired use of *ReCollection*.

In this particular scenario, let us imagine a photographer, planning to expose a collection of photos in a gallery, who wishes to use this program to help him choose his photos and arrange them in space. He may begin by choosing a theme for this exposition, and typing this theme in the search by keyword box. He then adds some results to the current gallery, now all or some of the objects contain the theme of the exposition in their title or textual description. Next, he can select the key photos of the exposition, according to his personal tastes, or the chosen theme. Once he has picked a handful of representative works, he selects them in the interface and asks the system to rearrange the whole gallery according to this selection (using PCA as explained previously).

He now has a new arrangement of the objects, which is becoming interesting. However, he notices that one particular part of the gallery is relatively empty. So he selects the objects surrounding it, and searches for objects similar. He chooses some of the top search results, and places them in this gap, to make the arrangement more homogeneous. Now that he has all the items he needs, he can begin arranging the items finely. This way, the arrangement will form a cleaner shape, and some heaps of objects will become more apparent, probably representing separate rooms in the gallery. Finally, he may view different kinds of information, by linking descriptors to the color of the items. He may for example view the color spectrums of the photos, and eventually relocate some photos according to his needs.

In this scenario, both similarity and proximity are used, sometimes separately, sometimes closely linked one to another, following the user's needs. Also, the user, who is deeply involved in the creation of this exposition, has consciously switched between both manual and automated relocation of the objects. Furthermore, we believe he wouldn't have been able to obtain such results, had he relied purely on automatic algorithms - as when using search engines on the internet, for example, which return the results in a fixed list according to similarity calculations. It is in this kind of human-computer collaboration that the user takes full advantage of the *ReCollection* software.

G. *Potential uses: a non-exhaustive list*

The *ReCollection* prototype has been programmed in an artistic context, the open form opera *Alma Sola*. We can think of many other artistic applications, including synthesis: a granular sound synthesis tool, a poetic text generator, visual synthesis software for building images from heaps of small images (similar to Robert Rauschenberg's *Combines*), or any kind of multimedia synthesis. It could obviously be of use for museum and art gallery curators, to help keep track of objects in gallery and reserve, help design expositions, or create and manage interactive catalogs. They could even allow the public to browse these digital collections on dedicated computers accessible in the museum. Another important area which could benefit from the use of figural collections is interactive art, in which artists are often facing large collections of digital material (sounds, visuals, texts…) and interactions (movements, trajectories…).

A very interesting use we have thought of was inspired by a conversation with a photographer, who was telling us how he had worked recently when preparing a film. This was a kind of slide show of his travel photos, in which he also included some sounds he had recorded during the trip. He would use a

special luminous table on which he disposed the negatives, and try placing different photos next to each other. When placing photos close to each other on the table, he could tell if they should follow each other in the slide show. Our software could easily replace the table and negatives, and even bring new functionalities. Also, the photographer could hear the sounds at the same time, and even create a slide show prototype, using the guided visits. This conversation was very inspiring as we have a perfect example of building an art work, by collecting items both through similarity and spatial closeness. We will go into further detail regarding this dual similarity/proximity process in the next section.

Throughout this article we have also exposed the context of multimedia collections of the general public. With the advent of broadband internet, high storage capacities, and devices such as digital music players and digital cameras, the general public is dealing with ever-growing collections of photos, music, films, e-books, etc. The tools they have in hand are often poorly adapted. They are based on formal classification, and their use can seem rather abstract and complex to the general public. This is in part responsible for the current digital gap, which we hope to reduce through the design of computerized tools for multimedia collections.

Finally, another huge area open to these kind of tools is the industrial sector. Extremely large sets of heterogeneous data are handled with increasing difficulty by current tools which are based on formal classification. These kinds of data sets are a problem in many areas, for instance: counter-terrorism surveillance (NVAC), medical diagnoses, scientific analysis…

In the next part of this article, we shall discuss in detail some key characteristics of collections, as identified by artists, philosophers and psychologists. This theory is at the foundation of our work, and it demonstrates the novelty and usefulness of the collections metaphor in computer science.

III. The Strange Epistemological Status Of Collections

Object-oriented computer science was invented to assist the task of classifying objects in a structure where different classes are distinguished [10] - [12].

As we all know, this innovation quickly became a success.

A. Collections, between order and disorder

Recently, an innovative trend is mobilizing computer objects for the organization of our collections, considered like a group of objects waiting to be organized in ad hoc classes that must be created simultaneously [13] - [15].

Because our collections seem to be nearer to order than disorder, attempting to assimilate them in classes is not so surprising. At least, collections look like they are waiting for their completion within a classification order, with the aim of turning into canonic achieved structures made of objects and classes. But something is also resisting this assimilation, as artists and philosophers have always noticed.

B. Artists' fascination for collection regimes

As a matter of fact, artists and philosophers have always been fascinated by the rebellious nature of collections and have demonstrated this in their own way [16], [4], [17], [18].

Here, for example, is the analysis of Gérard Wajcman (Catalog *for the inaugural exhibit of the Maison Rouge*) on the status of excess in a collection:

"Excess in a collection does not mean disordered accumulation; it is a fundamental principle: for a collection to exist as such-in the collector's eyes the number of objects must exceed the physical possibilities of exposing and storing the entire collection at home. Therefore, someone who lives in a studio can have a collection: it is only necessary for him to have at least one work he cannot hang in his studio. That is why the reserve is an integral part of collections. Excess also applies to the capacity of memorization: for the collection to exist, it is necessary for the collector not to be able to remember all the works he owns. In fact, the number of objects he owns must be so important that it becomes too important, so that the collector can forget one of them or leave a part of his collection outside of his home. To say it differently, for a collection to exist, the collector must not have full control over his collection anymore."

Certainly thinking of Gertrude Stein (Collection), Gérard Wajcman goes on saying:

"If nobody ever looks at a collection, it is because the collection is not a whole made up of works but a vague series of unique objects, a work + a work + a work..."

The process of extending a collection is potentially infinite, even if the collection is necessarily undetermined, *temporarily* finished. Practically speaking, a collection ceases to exist as something other than a commonplace correlate whenever the collector loses interest in its extension: he then stops reiterating the acquiring gesture and/or the reconfiguration of the collection. Both acts have the same essence: in order to keep it in an intimate sphere, the collector re-generates the collection, using his very own logic of growth, yet unaware of it. Re-production balances the collection's heavy trends and facilitates new links among the pieces, hence setting up new similarities that will eventually influence the acquiring logic. Strangely enough, desire becomes tightly knotted to difference. Objects enter the collection via the predicate of *being different*; they only become similar later on, as being different is what they have in common, hence setting up what Jean-Claude Milner calls a *paradoxical class*.

"A private collector's scene is not his apartment but the whole world. It's important to stress that the major part of his collection in not to be found at his place, his collection is yet to come, still scattered all over the world. Any gallery or fair represents the possibility of chancing on his collection yet to come." [4]

IV. Computer Scientists And Collections

Undoubtedly impressed by artists and philosophers who considered the strange status of collections, "object-oriented"

computer program designers understood that computer modeling of object collections would necessarily involve the creation of hybrid structures including private characteristics – by which the collected objects are usually referred to – but also including characteristics that come from the activities in which these objects collectively engage.

A. A parsimonious, conservative, and indeed seductive, approach

Often, the approach implicitly chosen to characterize a collection is parsimonious and consists of over-determining the private referencing of the collected objects through a minimal description of the collective activity's context, even if it means predicting that the collection shall become a class or set of classes.

This practice presents the unquestionable advantage of not fundamentally opposing the traditional modeling of objects. However, it does not always live up to the collectors' high standards.

Here it is important to distinguish between figural and non-figural collections. This subtle distinction, introduced in the 1970s by Piaget and his research teams of child psychologists [19], brings more light to the situation. If it is certain that (non-figural) collections that adapt well to the aforementioned parsimonious approach exist, it is because they are completely independent of their spatial configuration. In that, they are already close to classification, of which they can only envy the formal completeness. On the other hand, there are collections we can label as *figural* because both their arrangement in space and the private properties of the collected objects determine their meaning.

B. Collections versus classes

In their book *La genèse des structures logiques élémentaires* (lit: *The Genesis of Elementary Logical Structures*), Jean Piaget and Bärbel Inhelder provide a precise distinction between figural and non-figural collections, which are still called classes or categorical collections. For the authors, a class requires only two categories or relationships, both necessary and sufficient, for its actual definition as a class (page 25):

1) The qualities common to its members and to those of the classes it belongs to, as well as the specific differences that distinguish its own members from the members of other classes (comprehension);
2) The relationship of a part to the whole (membership and inclusion) determined by the quantifiers "all", "some" (including "one") and "none" applied to the members of the class in question and to other members of the classes it belongs to, defined as extensions of that class.

For example, cats share in common several qualities owned by all cats, some being specific and some others belonging also to other animals. But no spatial considerations ever enter into such a definition: cats may be grouped or not in the space without any change concerning their class definition and properties 1) and 2).

Piaget then introduces *figural collections*, in which meaning defined by properties 1) and 2) is linked to the spatial arrangement of its elements. A figural collection composes a figure, through the spatial relationships between its elements, whereas non-figural collections and classes are free of any figure.

C. Figural versus *non-figural collections*

It is precisely these figural collections that object-oriented computing is promising more and more an effective modeling of, pushed by an ever-growing social demand for on-line digital media browsing and information research amongst multiple sources [20], [21].

But as we now understand, figural collections adapt poorly to their assimilation into non-figural collections or classes. Although according to Piaget, collections are destined to become classes, in the same way as subjects will grow psychologically so as to improve their cognitive capacity to classify. Still referring to Piaget, it is a *radical lack of differentiation* that nudges figural collections out of the classical modeling field.

To be convinced, let us look at the way the great Swiss psychologist explained the experimental situation of the child that makes up a figural collection ([19], page 51 of the 1980 French edition):

"While the child is certainly capable once he has reached the Sensory-Motor Stage of successive assimilations that form resemblances, when these assimilations begin there can nonetheless exist a sliding from resemblance to proximity, creating the principle of broader similarities originating from the geometric form of the whole, or from the empiric unity. But, above all, as these assimilations are only successive, nothing yet allows the subject to quantify his results and assign them an extension by gathering together simultaneously as a 'whole' the elements that they apply to. The problem is therefore creating a substratum that can be used as an extension of this understanding brought about through successive assimilations. Attempting to construct a collection that corresponds to his successive assimilations, but without having acquired all the tools necessary to translate these assimilations into 'all' or 'some' that guarantee the adjustment of the corresponding extensions, the subject sometimes proceeds from understanding to extension, sometimes from extension to understanding and not according to a principle of univocal and reciprocal correspondence, but through a simple lack of differentiation and through *indifferentiation* that prolongs, but also considerably reinforces the resemblance and proximity already at work from the beginning of the assimilations.

Sometimes the child places 'the same' with the same, and here understanding determines extension, as will be the case for later logical classification. However, sometimes the child adds an element to finalize the collection he began in the direction of its growing extension, and it is precisely this extension that

establishes understanding. This establishment can present itself in two different, but equivalent, manners. It is either the geometric shape of a collection and an element is added to others with that group's shape as a goal, without there necessarily being a specific resemblance between the elements; or, it is random objects and an element is chosen to be added to the others in the aim of creating a coherent whole in such a way that this time, the resemblance is forgotten in favor of an empirical convention, the outcome of the subject's previous experiences. In both cases, only the general shape of the collection provides its conditions and therefore it is this physical and autonomous extension that establishes comprehension."

V. We Are All Collectors

In everyday life, we are often faced with collections, even when we are far from imagining that that is what we are doing. This does not only concern the collector of works of art (paintings, for example), the visitor at an exhibition, or even the shipping agent responsible for moving the collection to its next location. Collections are far more present in our everyday lives than we think.

As a matter of fact, numerous existing or potential computer applications assist us in our constituent relationships to collections[3]. Music devotees looking for works using an interactive search tool, students drawing up a document browsing on the web looking for inspiration, engineers interacting with colleagues in order to create a work plan [20] all are building collections.

But why place the emphasis on the collection instead of on the collected objects themselves? Ordinarily, a collection is understood to be a *collection of something*, and these objects are thought to have pre-existed the collection, to have value in themselves, apart from the group. Let us be clear: in affirming the primacy of the collection over the collected objects, we are not simply offering a lexical amendment in order to talk about collections where one normally talks of sets, classes, groups, categories, masses and objects. Rather, what we wish to demonstrate by introducing the idea of a collection being at the origin of our thoughts about things, is that its implementation at the foundation of our categorical and conceptual systems makes it possible to truly reexamine a number of our cognitive activities, and therefore to better target the adequacy of our computer tools that assist us in these activities.

In our lives, we can most surely say that we act, live and imagine within a given perspective, a given set of circumstances that are limited and defined, like a journey by train or a performance at the opera. Of course, these circumstances are impermanent; they change and evolve through the decisions that we make, and the way in which we carry them out. But still, there seems to *always-already* be, for any given set of circumstances, a kind of staging, a project, a plan, an intent that defines our interest in and our relation to things.

And this is the reason why our interpretation activities are *always-already* involved in their continuation and their survival, and find meaning only in the horizon and perspective of the attempts that preceded them. Operational fictions of the social realm are often used to create a sanctuary for our individual experiences, by giving us the opportunity to particularize our singular experiences, but most of all they provide "comfortable exits" from potentially devastating episodes. This is how we can feel strong emotions at the opera for example, counting on the intermission and the end of the performance to extract ourselves from the fictive situations we had previously found so moving.

Therefore, it is vain to attempt a description or model of the feelings and sensations experienced by a person listening to a piece of music, while suggesting that it all happens in an immediate and amnesic relationship between this person and the object. In short, what I hear in a certain piece of music is a part of a project and has inherited a previous motivated conduct and specific direction. It is precisely in this sense that the current piece enters a collection of pieces already heard, and completes the collection like a flexible whole [22].

VI. Conclusion

Husserl used to say that consciousness is always consciousness of *something*, that consciousness always *pre-dates* the subject and the object, and *puts them together* in the process. There are no subjects or objects already existing independently that meet in the world to fill out a journal of experiences (the subject) and perhaps adapt to each other by induction. In the same fashion, we could say that a collection is always a *collection of something*, in that the original process of categorization is the activity of collecting, implacably mixing abstraction and spatio-temporal arrangements, and producing as many metastable categories.

The current models for information search are too formal, and they assume that the function and variables defining the categorization are known in advance. In practice, however, when searching for information, experimentation plays a good part in the activity, not due to technological limits, but because the searcher does not know all the parameters of the class he wants to create. He has hints, but these evolve as he sees the results of his search. The procedure is dynamic, but not totally random, and this is where the collection metaphor is interesting.

The collector's experimentation is always carried out by placing objects in temporary and metastable space/time. Here, the intension of the future category has an extensive figure in space/time. And this system of extension (the figure) gives as many ideas as it does constraints. What is remarkable is that when we collect something, we always have the choice between two systems of constraints, irreducible one to the other. This artificial indifferentiation for similarity/contiguity is the only possible kind of freedom allowing us to categorize by experimentation.

[3] Interesting arguments have been made by ([Pachet, 2004]) concerning this question.

Our prototype implements these ideas by allowing the user to dispose his objects in 2D space. This arrangement may be manual, automated or both; it may be based on similarity, spatial proximity or both. A global figure may emerge from this arrangement, influencing the browsing and also the extension of the collection. Local figures emerge, which are the temporary pseudo-classes illustrating the pre-categorization building process of collecting. The art gallery metaphor fits very well, as it adds further meaning to the arrangement of the collected items in space, and models the excess in collections thanks to the reserve.

Through exploiting space in this way, the software interface takes advantage of our cognitive abilities in dealing with spatial information, and also our ability to collect information and acquire knowledge. Our next step is experimentation in order to validate our work. This could simply take the form of a series of sessions in which both novice and experimented users are asked to build up collections using the software. Through user-feedback, we will have a first idea of how well the interface is understood, how useful the users find it and how easy it is to use. If this experiment is a success, as we believe it will be, we will continue our research and bring it to the next level. Through integrating new functionality focused on indifferentiation for similarity/proximity, we will be able to build specific tools for a variety of applications in which the user's activity may be – at least metaphorically – described as building a *figural collection*.

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