AC³ – Automatic Cartography of Cultural Contents

Jean-Gabriel Ganascia

LIP6 - Université Pierre et Marie Curie (Paris VI), 8, rue du capitaine Scott,
75015, Paris, France
Jean-Gabriel.Ganascia@lip6.fr

Abstract. Experiences with e-books show that the principle obstacle to electronic reading is neither the weight, nor the autonomy or the discomfort of reading on screen, but the absence of reference mark which makes it possible to replace the current window of reading in the whole of the book. We present an automatic cartography of electronic documents which constitutes an attempt to facilitate navigation, reading and memorization of contents. It is to automatically build a singular picture which is designed to be associated to our remembering of each document, i.e. to our mental image. This picture corresponds to the cartography of an island. Its shape is build from the document structure; its coloring reflects the affective content of the text extracted by keywords spotting techniques while icons associated to document topics are added to textual legends as in ancient geographical maps.

1 Introduction

Nowadays, electronic versions of almost all classical books are freely available through internet. There exist many open access electronics libraries (e.g. Guttenberg project, Bibliothèque Nationale de France, etc.) where those electronic texts are stored and obtainable. The Google Print project is intended to increase even more the number of those digitalized books accessible on line. Most of the newspapers propose free electronics versions of their papers. More generally, new devices such MP3 players (e.g. Apple IPOD) make everybody able to store and hear a lot of music which is now easily available on the web. Let us note that, for instance, the Apple IPOD has a 60 Gigabytes memory, which roughly corresponds to 1000 audio CD. Similarly, new on demand radio and TV will store 40 hours of TV (and far more of radio). Therefore, many cultural contents (novels, music, photos, videos, etc.) are now accessible through electronic files.

Nevertheless, more the quantity of accessible and storable contents increases, more difficult it becomes to navigate through all those cultural contents and, consequently, to take advantage of all the possibilities opened by new devices. Past experiences [1, 7] show that the principal impediments are due to the difficulty to materialize virtual contents which appear very abstract. As a consequence, people are lost in electronic libraries, whatever they contain, texts, music, photographs or movies. For instance, the failure of e-books [12, 13] which were build a few years ago to ease the electronic reading is neither due to their cost, nor to their weight, their autonomy or the discom-

fort of reading on screen, but to the lack of reference mark which makes it possible to replace the current window of reading in the whole of the book. This absence makes people lost which requires considerable efforts to navigate in the text and to memorize the content. The e-book designers introduced a lift which does not appear to be sufficient. Even if the position in the page and the thickness of the section in classical books are not always consciously perceived, they provide precious information which appears to be lost in e-books.

Our goal here is to mitigate these deficiencies and to improve existing e-reading interfaces by "embodying" virtual contents into a 2D picture where each picture elements, i.e. pixels, correspond to text fragments viewed at different scale: sentence, paragraph, section, chapter, etc. To achieve this "embodiment", we propose a visualization tool which automatically builds a map helping people to find their way in virtual worlds. More precisely, it is to cartography the structure of electronic documents making navigation through them easier. The key idea is to project the abstract structure of the book into a spatial imaginative territory which can be represented on an automatically generated map. It will then be possible for readers to plan new travels through books or multimedia contents on this map and to keep tracks of their past travels. Since each book fragment – sentence, paragraph, section, chapter ect. – is associated to a pixel, the general map that organizes all those book pixels constitutes a "pixelisation" of the book.

Apart the introduction and the conclusion, the paper is divided into three main parts. The first is dedicated to the depiction of the main idea, which is to automatically draw a map reflecting the document structure. The second presents some technical aspects of the shape generation process while the third will describe augmentations of generated maps through colors, icons and active traces.

2   Memory Islands

The main idea of this paper comes from the old *arts of memory* [4, 11, 19] which were based on the spatial representation of contents. It means that in the Antiquity and in the Middle Age, people developed a way to improve their memory abilities by localizing things in virtual architectures. We transpose that idea to the content of electronic book: our hypothesis is that the main obstacles to electronic reading could be solved if we were able to place what we call the "Reading Space" by analogy to the Bolter's "Writing Space" [2] in virtual territories.

In other words, to "embody" the virtual content of books, we anchor it on an automatically generated territory. In a way, it is to represent on a plan, i.e. on a 2D space, the book content that appears at first sight to be linear. It corresponds to an increase of dimensions, which is quite unusual in information visualization, since generally the goal is to reduce data dimensions [15, 16, 17]. The adopted solution is to map each book onto a small deserted island, because uninhabited islands are known just by sailors who usually make simply the turn of it, and therefore know and name only their coast, i.e. a 1D space, without worrying about their surface.

These imaginary territories are designed to strike imagination and to remain anchored in our memory. Consequently, they must as much as possible be distinguished the ones from the others. Moreover, it would be preferable that they reflect the structure of the books to ease navigation. The map generation program endeavor to do it by printing forms as diversified as possible and while exploiting the colors. More precisely, the program builds a realistic map of a territory on which it is possible to have an overview of contents. This cartography takes advantages of historical studies of old maps [8], for instance, the introduction of legends, texts and colors, and, more amazingly for us, the insertion of icons associated with the content. As an example, the map of North Africa presented in figure 1, shows flags, elephants, lions, camels, castles and caravans, that are drawn to localize places where visitors could find elephants, lions, camels, cities and caravans. Moreover, always in this map, the red sea is colored in red. Even if they are not realistic, the icons and colors help to memorize the map. They strike our imagination in a way which facilitates our internal visualization and consequently our remembering. Similarly, the artificial maps our program build are enriched by colors and icons correlated to the topics under consideration. It is not to summarize the content, but to stimulate our memory with an easy to remember picture.

Fig. 1. An old map of Africa ("Aphrica" on the flag) attaching colors and icons to territories

3. Shape Generation

E-document structure can be assimilated to an ordered weighed tree, i.e. to an ordered tree of which each node is associated to a number corresponding to the weight of the corresponding part, for instance to the number of pages for texts or to the required space for other multimedia contents i.e. for MP3 files. Then, a shape is generated from this tree. Let us recall that the goal is to generate singular forms attached to each par-

ticular e-document that have both to be easy to retain in our memory and to reflect the document structure, which facilitates the navigation. Therefore, the goal of the shape generation process is to differentiate forms as much as possible.
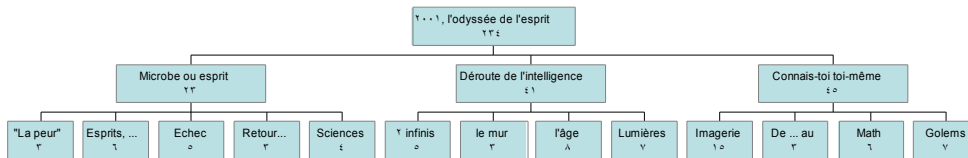
More precisely, the shape generation algorithm considers each weighted node of the e-document structure, i.e. each part of the document, as a sector of a disk, i.e. as an angle associated with a radius. The angle corresponds to the proportion of the section in the whole book while the radius is computed taking into account the size of the section and its level. Moreover, some blank pages are virtually considered to separate sections, which cut out the coast of the artificially generated island. For more details, about the algorithm, see [6].

As an illustration, let us consider a given book [5] of which structure is given in its table of contents (see figure 2).

Fig. 2. Table of content showing chapters and sections associated with page numbers

From this table of content, it is possible to generate a weighted ordered tree (see below, figure 3) where chapter and section weights correspond to number of pages they contain.

Fig. 3. Ordered tree corresponding to the book structure extracted from the table of content given in fig. 2

Then, the shape generation algorithm builds a map of an imagined island corresponding to this structure (see figure 4).
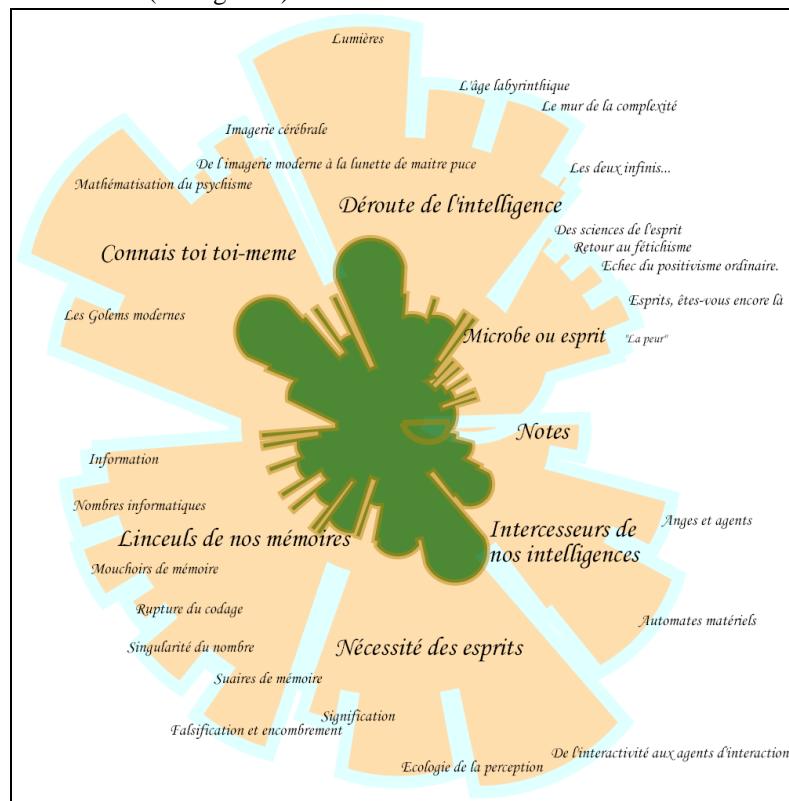
Fig. 4. The map generated from the table of content given in figure 3 using two levels of color

The important point is to make the reader able to localize all part of the book or of the library on the map. It is also required to have a specific form which is easier to remember and where the reader can attach souvenirs to each subpart, as we do on a geographical map.

4. Augmentations

To make the map more singular and, consequently, to ease the memorization, the program insert texts, colors and icons. Texts correspond to titles of chapters, sections and subsections. Colors are associated to affective content of different book subparts while icons match topic categories.

4.1. Texts

As in traditional maps, texts are associated to places. Since places represent parts of books, texts name parts of books, i.e. chapters, sections, subsections etc. More precisely, the coast corresponds to the fine structure of the book, i.e. to the subsections. So, all details of the coast, all capes and almost all the bays, are generated by subsections which title may name the capes of the bays on the map. The section and chapter titles may also name parts of the map, but it corresponds to internal parts, as shown in figure 4. The localization of the text on the map (i.e. the eccentricity of its placement) and the size of characters help to distinguish the levels (i.e. chapter, section, subsection etc.) of the corresponding book part.

The only practical difficulty is to correctly place the title to make them easily readable, without overlapping each others. We take advantage here of algorithms based on optimization techniques (i.e. simulated annealing, genetic algorithms, etc.) which were developed in computer graphics for geographical maps. See, for instance [12] for more details about the problems and the solutions developed to solve them.

4.2. Coloring the Map

Colors may help to make the map more singular and consequently easier to remember. It is especially true if they are extracted from the text which means that they reflect, in a way, the structure of the text. However, the attribution of color to pixel may be problematic, because, there are two requirements that are somehow antagonistic.

On the one hand, the map constitutes a pixelisation of the text; as a consequence, the color of each pixel has to be meaningful since it is an attribute of each pixel. Following existing works, we choose to insert colors using affective computing techniques. The colors correspond then to the affective tonality of the text, which is automatically extracted using keywords spotting techniques. It is based on cognitive science works describing a scale of seven basic emotions and associating colors to each of one [3, 9, 18]. Obviously, this association depends on culture, but the range of color could easily be changed and a legend associated to the map explains the meaning of each color.

On the other hand, to ease map reading, it is necessary that the colors obey a certain number of classical coloring rules stated for instance by Edward Tufte [15, 16, 17]. For instance, the contrast of color has to be low; it is not possible to have bright color closed to each other, etc. We have to introduce those coloring rules and to specify, in each case, a legend where the meaning of each color is designed.

Affective tonality is computed at different levels of granularity – sentence, paragraph, sub-section, section, chapter etc. [9]. Colors are then affected to each of the map sector, depending on the considered level of granularity. In other words, the resulting map is obtained by the superposition of overlapping drawings corresponding each to a level of granularity. For instance figure 4 shows the superposition of two levels of granularity of which, for the sake of clarity, color is manually attributed. More precisely, the kernel of the island reproduces the form of the island with the same shape generation algorithm as mentioned before, but with different parameters, making the form a little bit different.

4.3. Adding Meaningful Icons

Moreover, to guide the readers both during his travel of after, memorizing what he had seen, small drawings are placed onto the map. This insertion is similar to an ancient practice of cartographers. Usually, icons refer to general idea by analogy or metonymy. Once a table of conventional icons is established, a content analysis helps to categorize the meaning each part of the text and to associate it a relevant icon. Moreover, it could also be possible for the reader to manually add its own icons corresponding to bookmarks, to notes or to reminders. For instance, the figure 5 shows icons associated to a map automatically generated from the structure of a talk about memorization strategies using artificial maps.

All the icons are manually introduced on the map; they facilitate memorization of the content. The future step is to generate automatically those icons using a search engine, for instance "google image".

Let us note that the map presented figure 5 has been drawn to accompany a power point presentation. In the future, it would be a challenging application for artificial map, to support presentation, helping the participants both to follow the structure of the talk and to memorize its content.

4.4. Transforming Map and Tracing Reader Travels

To finish, it is possible transform the map according to the needs of the reader which can focus on such or such part of the map with the help of a zooming mechanism. It is also possible to access any particular page, or section, by clicking on the map, since each point of the map is linked to the original text or to MP3 files.

Last of all, users' courses may be tracked with a colored ribbon drawn onto the map, which remind the history of the reading. For instance, the reading course of a reader starting the book presented in figure 2 at the beginning and reading linearly until section entitled "*Les Golems modernes*", is presented figure 6. It is also possible to com-

pute the width of the ribbon with respect to the time spent to read the different page. It can be very useful, since it may help to distinguish jumps, simple browsing and in-depth reading.

Fig. 5. Artificial map enriched with icons

5. Evaluation

The last point concerns the evaluation of the efficiency of the Memory Islands. Let us first note that most studies concerning e-books have focused on the speed and comfort of reading. However, experiments have shown that the problem does not lie in the ergonomics of reading, which appears to be satisfactory, but on the effectiveness of the reading process. In other terms, reading on an electronic support, i.e. on a screen, is relatively fast and comfortable: it does not provoke tiredness, although the vertical position may cause neck stiffness. New platforms such as TablePCs or Pocket PCs will prevent it. The three main issues with the digital reading terminal are:
1. difficulties with spatial and temporal navigation;
2. lack of landmarks for memorizing and understanding the structure of the document;
3. the underlying model of the book: Codex or Scroll, both having important advantages and pitfalls.

The visualization tool we design and experiment within the framework of the Memory Islands paradigm should help memorization, at least if our hypothesis holds that the main obstacles to reading on electronic support are due to the three cited issues. More precisely, the goal of memory islands is to implement visual representations, to add landmarks helping memorization and to implement a new model of book, which will improve on both Codex and Scroll.
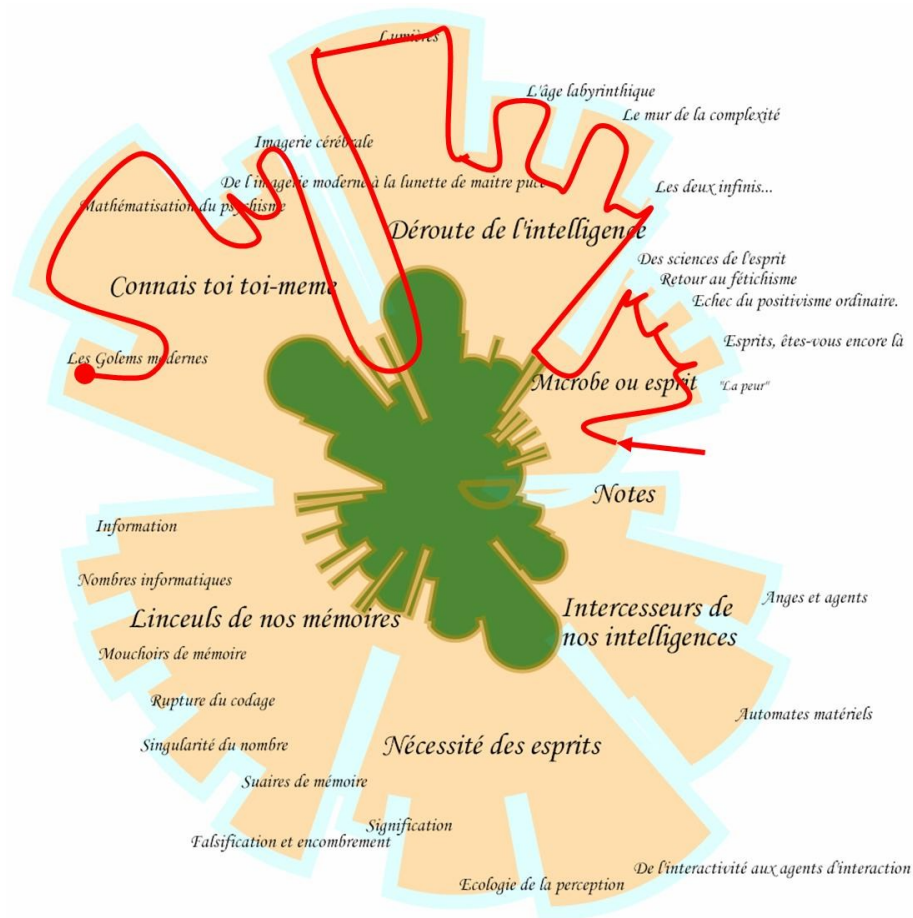
Fig. 6. Tracking the reader course on the map

Our goal, through evaluation, is provide some empirical evidence confirming our hypothesis. The evaluation makes use of TablePCs and couples them with existing reading software. It is to validate the reading efficiency improvement, due to memory islands through controlled and longitudinal evaluations. This validation will relate to various reading situations (technical reading, reading of newspapers, continuous reading), on various populations (young students, students, and elder people) and it will be

carried out in of two phases: immediately after the readings (controlled evaluation) and on a longer term – one week or one month after the readings. Since the goal is not to study reading speed, but efficiency of reading through memorization, we have to test the ability to remember what people have read with and without the Memory Islands visualization software.

More precisely, the experimental protocol will take into consideration two populations: young students and elder people. Each of those populations will be divided into two subsets; the first will have to read e-books with the Memory Islands visualization tool, the second without. For each of those populations, we define two reading situations: technical contents and continuous reading for students, newspapers and continuous reading for elder people. Then, each of the reader will have to answer two questionnaires about what he had read, the first will be given just after reading, i.e. one day after, the second ten or twenty days after. Since our hypothesis is that the use of Memory Island visualization tools will improve memorization, the result of this experimentation should confirm or disconfirm our hypothesis.

As a consequence, the result of this study should substantially improve the design of effective reading tools for screens. Furthermore, it will show specific needs and capabilities of the different populations and provide specific improvements for each of these segments.

6. Conclusion and perspective

A first prototype of the map generation system has been achieved for texts. It is coupled with Mozilla navigator which contains a native SVG viewer. The input texts have to be written in HTML. Then the structure of document is extracted and the corresponding shape generated. The map is drawn in a small floating window which may be enlarged to the entire screen. Up to now, colors and icons are manually inserted. However, we plan a new version with automatic coloring based on affective computing techniques.

Moreover, our prototype is designed to be coupled with an e-book reader. Nevertheless, we plan a new version dedicated to manage TV content on intelligent TV decoders.

The system is currently under experimentation. The protocol has to test the efficiency of reading with such an "embodiment" of content. Let us note that, contrary to most of e-reading experiments, our goal is not to evaluate the speed of reading, but its efficiency in terms of memorization and knowledge acquisition. More precisely, it has to give students e-books to read and to evaluate their ability to memorize contents with and without the content map, just after reading and a week later.

Lastly, let us note that even if the first and main goal of the project is to improve efficiency of reading and to facilitate navigation through virtual contents by making them more concrete, one of its side effects is to make able to visualize users' travels through documents. Therefore, it could be used to facilitate user centered design of electronic books or multimedia by visualizing users' feedback.

References

1. Back Maribeth, Cohen Jonathan, Gold Rich, Harrison Steve, "Speeder Reader: An experiment in the Future of Reading", *Computers and Graphics*, Vol. 26 (3), June 2002

2. Bolter J. D., *The writing space : the computer, hypertext and the history of writing*, Paperback 1991

3. Boucouvalas A, "Real Time Text-to-Emotion Engine for Expressive Internet Communications", *Being There: Concepts, effects and measurement of user presence in synthetic environments*, G. Riva, F. Davide, W.A IJsselsteijn (Eds.), Ios Press, 2003, Amsterdam, The Netherlands

4. Carruthers Mary J., *The Book of memory : a study of memory in medieval culture* Paperback 1992

5. Ganascia J.-G., *2001, l'odyssée de l'esprit* – Flammarion (Collection essais) 1999.

6. Ganascia J-G, "RECIT : représentation cartographique et insulaire de texts", *proceedings of CIFT 2004* (Colloque International sur la Fouille de Texte), June 2004, la Rochelle, France

7. Harrison, S. R.; Minneman, S. L.; Back, M. J.; Balsamo, A. M.; Chow, M. D.; Gold, R.; Gorbet, M.; MacDonald, D. W. "The what of XFR: eXperiments in the future of reading". *ACM Interactions*. 2001 May/June; 21-30.

8. Jacob C., *L'empire des cartes*, Albin Michel 1992

9. Liu H., Selker T., Lieberman H. (2003). "Visualizing the Affective Structure of a Text Document. *Proceedings of the Conference on Human Factors in Computing Systems", CHI*

10. Prendinger H, Ishizuka M., *Life-Like Characters Tools, Affective Functions, and Applications*, series Cognitive Technologies, Springer 2004

11. Rossi Paolo, *Clavis universalis: Arti della memoria e logica combinatoria da Lullo a Leibniz,* Il Mulino 1983

12. Ryall Kathy, Marks Joe, Shieber Stuart, "An interactive constraint-based system for drawing graphs", *Symposium on User Interface Software and Technology*, Banff, Alberta, Canada, Proceedings of the 10th annual ACM symposium on User interface software and technology, 1997, pp. 97 - 104

13. Shilit B., Morgan P., Golovchinsky G., "Digital Library Information Appliances", Digital Libraries 1998, Pittsburgh USA, ACM

14. Shilit B., Morgan P., Golovchinsky G., Tanaka K., Marschall C., "As We May Read, The Reading Appliance Revolution", Computer, IEEE, January 1999

15. Tufte Edward, *The Visual Display of Quantitative Information*, Graphics Press, 2nd edition, 2001

16. Tufte Edward, Visual *Explanations: Images and Quantities, Evidence and Narrative*, Graphics Press, February 1997

17. Tufte Edward, *Envisioning Information*, Graphics Press, 1990

18. Valdez, P., Mehrabian, A. *Effects of color on emotions.* Journal of Experimental Psychology: General, 123, 394-409. (1994).

19. Yates F., *The Art of Memory*, Penguin Books, 1969