Supporting the learning process – more than a Braille transcription

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Abstract.

Objective. This article gives an analysis of what a good automatic Braille transcribing tool should propose to be suitable to inclusive education. We criticize existing technologies and present NAT Braille, a free software solution designed to respond to pedagogical specific needs.

Main content. We describe the situation of inclusive education for visually-impaired students and recall the main existing solutions. We then focus on two major facts : most teachers are not skilled in Braille and only few solutions are designed to teach Braille inside a classroom. Moreover, teachers and students need to communicate directly without the support of transcription centers, which produce high quality transcriptions but are inadequate during a lesson or to communicate between students working together. NAT Braille is a transcribing tool that has been designed to limit the time disability which is prejudicial to the visually impaired, especially during the learning process. It includes features allowing teachers to transcribe automatically composite documents following pedagogical scenarios, particularly for the contracted Braille learning (i.e different steps corresponding to the student's level in contracted Braille, also usable by a non Braille reading teacher). It contains a simple Braille and black interface where students and teacher may interact directly and produce instant Braille to black or black to Braille transcriptions, including mathematical and contracted Braille ones. Therefore NAT Braille allows immediate corrections, group work and mutual assistance between students. Moreover users can read and write with their own modalities and language. NAT Braille uses a high customizable set of rules instead of dictionaries and adapts to each profile.

Results. NAT Braille has been tested in real environments and will now widely be distributed in classes. Feedbacks are promising and raise new challenges, especially to make the software even more simple to use. Some features could be combined with other existing solutions to improve the understanding of formulas, to ease the transcriptions' edition or to include NAT Braille in publishing chains in order to produce adaptable documents.

Conclusion. We show that NAT Braille is a good solution for inclusive education, particularly in the case of non Braille reading teachers. In this idea we are developing foreign partnerships to propose NAT Braille into other languages. However it remains a tool and would be advantaged if combined with other assistive solutions. We must see it as a first step towards developing other assistive tools for Braille learning and transcribing.

Keywords. Accessibility, assistive technologies, Braille, inclusive education, adaptation of documents, composite documents, transcription, transcriber, learning

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Introduction

Inclusive education issues are still very active in a lot of scientific domains : assistive technologies, teaching methods, ergonomics... Concerning visually impaired students, [3] notices the numerous and various papers proposed to the last conference under the topic “Inclusive Educational Practices”. Moreover, he insists on the vocabulary used in English (inclusive education) and French (integration) to underline the difficulties encountered for a real *inclusion* of students into a class. We have considered ”integrating” as ”including” : visually impaired must have the same interacting possibilities as other students during a lesson and their disabilities must be limited to allow them to follow a common pedagogical process[8].

But visual impairement remains a real problem for both teacher and student, because most teachers are not skilled in Braille and only few solutions are designed to teach Braille inside a classroom. In this article, we focus on Braille and give an analysis of what a good automatic transcribing tool should propose to be suitable to inclusive education. [4] propose a good state of art of the main mathematical solutions. As for text transcribers, there are very few : DuxBurry's DBT[2] is the only good commercial solution for contracted Braille, Odt2Braille[3] uses the free LibLouisXML library[3] for text. Even if the transcribing result is good, none of these solutions propose a pedagogical approach for contracted Braille and they only offer a few possibilitities of customization. Moreover, only Odt2braille supports mathematics and text, and none implements chemical or music notation.

Another criteria to keep in mind is the “time disability”[6][7]. Very often, visually impaired waste a lot of time, even with accessible documents : getting lost throughout a document, trying to find a precise paragraph, etc. Real time interactions with the document are in fact very limited, and it is up to the pupil to sort himself out. The communication between students remains uneasy since they do not share a common working space. The MaWEN project[4] proposes a tool for mathematics to limit this situation.

In the following section we introduce our contribution, NAT Braille[4][1], a free software solution designed to respond to pedagogical specific needs. In section 2, we illustrate our solution with a typical use case. We end this article criticizing our contribution and raising new ideas and possible improvements or collaborations for inclusive education to visually impaired.

1. Going towards an “ideal” transcriber in classroom

NAT Braille was created in 2005 during a university project. It was further developed for almost two years without financing. In July 2007, the software received a first financial support from the European Social Fund and since July 2008 is entirely supported by the French Minister of Education. French laboratory LIRIS now supervises the project. An expert partnership with the INS HEA[5] has also been set to validate the quality of tran-

[2] `http://www.duxburysystems.com/`

[3] `http://code.google.com/p/liblouisxml/`

[4] downloadable at `http://liris.cnrs.fr/nat`; software under GLP licence.

[5] Institut National Supérieur de formation et de recherche pour l'éducation des jeunes Handicapés et les Enseignements Adaptés (National high institute of research and learning for impaired young and assistive education): this institute plays a role of main importance in the French public education system

scriptions. A fundation[6] has been created in order to follow up developments, maintain the software and set up partnerships.

This project mainly aims at resolving the problems previously described, and wishes to produce a solution which could be at the same time accessible to every one, independent from special configurations, highly customizable, and potentially integrated to other systems. The motive is not to compete with transcribing centers -they are far better than any automatic software could ever be- but on the opposite to give them a tool allowing a bigger efficiency and productivity.

Furthermore, we have focused on proposing non Braille readers (like most of teachers in inclusive education) a way to communicate with their students and helping them improve their Braille reading skills. We will essentially consider this use in this article.

1.1. Working principles

Taking the different constraints into account has led us to a modular organization, based on adaptation to each type of document (format, mixed contents, encodings, etc.). The structure proposes three main modules : conversion, transcription and post-processing. Ideally the user gives the system a file in a given format : the conversion module conforms to the document type and produces an internal format file. Then the transcription module transcribes the internal file with chosen filters. Finally the post-processing module manages the presentation, exportation or printing. The specific role of each component allows the system to be independent during the development process. A new format would only need that a specific converter be associated to it. Transcribing filters are also independent from the initial format. Note that users don't need to interact too much during the transcribing process.

The transcribing mechanism is original because the different filters and their specialization are interoperable. Their implementation is no longer based on dictionaries but on rules, and therefore gets as close as possible to a human reasoning when using different transcribing processes. Since these filters are interoperable, they allow each document to realize dynamically its own transcribing scenario : using abbreviated or literate Braille code, choosing encodings, choosing Braille code tables, whether transcribe mathematics or not, applying black to Braille or reverse transcription.

At the beginning of a transcription, the scenario is written according to many parameters. We will detail the most interesting features in the following section. This organization allows us to propose a wide range of customizations.

One of our important principle is to fully comply with the norms, even though we must sometimes make other choices. It seems to be the logical way to operate, but in fact many other softwares don't consider this essential, maybe for technical reasons or lack of tests.

1.2. Validation process and development

Since the efficient support of the French Minister of Education, we have split the original project team into two entities : applicated research and testing. The first one, supervised by our laboratory is charged to develop the software whereas the second (INS HEA) organizes tests and provides advice. The test team is not only composed of Braille experts

[6]this fundation is settled in the University Lyon 1 fundation

(most of them are members of the French Braille normative commission) : we have also included teachers and professors who have students in inclusive education (alone or UPI's ones). Some active users (school or university students) are invited to give their opinion as well.

This organization is really efficient because developers must consider several points of view depending on the way each tester uses Braille. It underlines the differences between a strict application of the norm and the real situation in a classroom. For example, one of the teachers who has quite good Braille skills has discovered that some notations she uses were not complying with the norm : the software she is using for mathematics has several Braille codes which do not correspond to the Braille norm.

Priorities are different for each member of our team : experts in transcribing essentially focus on the quality of the transcription whereas teachers are more interested in an easy-to-deploy solution, even if the software makes a few mistakes. The research team has sometimes to deal with these contradictions.

Another important idea is that expert transcribers have acquired a lot of implicit knowledge on Braille transcription. Most of the time, they are not aware of that. This knowledge isn't written in norms and it is very hard to find which implicit rule is involved, especially for contracted Braille and mathematics. Thanks to the cooperation between the two teams, researchers have been able to propose usage rules and to include them in the transcribing process.

1.3. Adapting transcription to users

NAT is able to propose several kinds of French Braille transcription features : grade 1 or contracted (grade 2) Braille, mathematics and chemistry. Music is still under development. Mathematics and literal Braille codes (contracted or not) can be rendered into black.

But each notation contains several possibilities and parameters according to the user's skills. For example, beginners do not use the complementary rules in French grade one, nor specific trigonometric notation in mathematics. Later on they learn contracted Braille and apply these rules too.

Depending on the user's profile, we have to adapt the transcribing process to take into account the reader's skills. That is why NAT's core does not use any dictionary but is controlled with a large set of rules and parameters. Each of them can be set active or not. Figure 1 shows different possible renderings and explains which rules have been evolved to produce Braille.

Most of the existing solutions propose a set of options to slightly adapt the transcription, but none is able to manage the contraction rules by activating only a subset of them. This first advancement in French Braille adaptation does not respond to a major challenge : most of teachers which welcome visually-impaired pupils do not know how to teach Braille. The following section tries to respond to this problem.

1.4. Pedagogical uses

1.4.1. Learning contracted Braille

We have shown that NAT provides a solution in Braille adaptation by allowing the transcriber to activate the transcription rules or not. But most of the time, an unexperimented

Table 1. This table gives several transcriptions of the same expression "*La FONCTION* $sin(x)$" (The $sin(x)$ FUNCTION) according to the user's skill. Basic grade one rules don't make a difference between a full uppercase word :*FONCTION* (⠠⠋⠕⠝⠉⠞⠊⠕⠝) and *La* (⠠⠇⠁) use the same simple capital prefix ⠠. Then complementary grade 1 rules take this difference into account by using the double capital prefix ⠠⠠ for *FONCTION* (⠠⠠⠋⠕⠝⠉⠞⠊⠕⠝). "sin" (⠎⠊⠝) is represented by ⠩ in specific trigonomic notation. "la" (the) is one of the first contracted words learnt in French (⠇⠁). The contraction of "fonction" (⠋⠝) is learnt afterwards.

Possible user	**Braille result**	**Rules activated**
Primary school (beginner)	⠠⠇⠁ ⠠⠠⠋⠕⠝⠉⠞⠊⠕⠝ ⠎⠊⠝ ⠣⠭⠜	basic g1
Primary school (advanced)	⠠⠇⠁ ⠠⠠⠋⠕⠝⠉⠞⠊⠕⠝ ⠎⠊⠝ ⠣⠭⠜	complementary g1
College student (beginner)	⠠⠇⠁ ⠠⠠⠋⠕⠝⠉⠞⠊⠕⠝ ⠩ ⠣⠭⠜	trigo. & basic g2
College student (advanced)	⠠⠇⠁ ⠠⠠⠋⠕⠝⠉⠞⠊⠕⠝ ⠩ ⠣⠭⠜	grade 2

transcriber is not able to choose which rules have to be activated. Moreover, they are more than 100 signs and locutions, 800 symbols and 75 contraction rules depending on the context or the subset used (signs, symbol, other word...).

NAT is able to manage special configurations (pedagogical scenarios) containing steps which activate a set of rules. Scenarios have been made to follow the progression of Braille contraction learning methods like "Étudions l'abrégé"[5]. Each step has been checked by professional transcribers and Braille teachers to validate the quality of the produced Braille and the pedagogical consistence.

A teacher only has to know which step must be activated and may follow a pedagogical sequence given by someone more skilled in Braille. For example, at the beginning of November, students should begin lesson 4 : the transcriber goes from step 3 to step 4 in the software.

We should consider a last point : some word transcriptions are too context-dependent to allow the computer to make a single proposal. For example, names can't be contracted, words may come from two distinct roots and be pronounced differently (like "convient" example in figure 1).

Ambiguous cases are detected thanks to two modules : one to list all used names, one proposing several choices and solutions for problems implicating words' roots. Ambiguities and their possible solutions are explained for non Braille readers in order to allow them to chose without knowing the consequences in the transcription. Figure 1 shows the resolution process of two ambiguities.

1.4.2. Interacting with students

We have introduced the interactive learning issue above. We have to offer fast and intuitive interaction possibilities in order to facilitate communication between pupils and teacher during a lesson. That is why NAT provides a reverse transcribing tool that is able to show both Braille and black notations. The window contains two parts : one for the Braille edition and one for the black edition. The teacher or sighted students can edit texts and formulas without writing them in Braille. The visually impaired pupil can edit

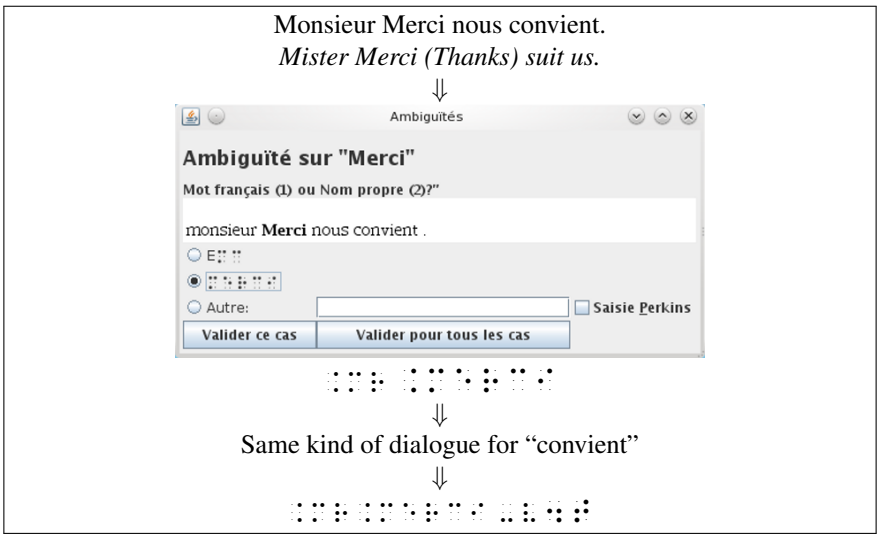

Figure 1. This figure shows the ambiguity's resolution process. There are two possible ambiguities : one with *Merci* and one with *convient*. The first dialogue box proposes two possibilities for *Merci* : common French noun (1) or name (2). This ambiguity has been raised thanks to the user's list of names. The second dialogue (not shown) has two solutions depending on the etymological root of *convient* : the verb *convier* (to invite) in the third person plural (1) or the verb *convenir* (to suit) in the third person singular (2).

Braille text (in grade one or two) and mathematical expressions in Perkins mode[7] or directly with the Braille table codes.

In case of Braille syntax error, the teacher does not know exactly why the rendering is bad, but he may warn the student that there is a problem. This feature may save a lot of time, increase the pedagogical possibilities and is a true inclusive approach for communication. It is an important part of the next section presenting a full use-case of the software.

2. A use-case of NatBraille in classroom

In this section we will present an “ideal” illustrated use-case of NAT Braille. Let's suppose a mathematics teacher (Thomas) has a visually-impaired student (Louis) in his class. Thomas does not know anything about Braille, but Louis knows contracted and mathematical Braille quit well.

Thomas wants to give his class an exercise. The evening before he wrote this exercise on openoffice (the same document for the entire class) and has transcribed it into Braille using a configuration given by Thomas. Figure 2 shows the original document and the Braille text.

[7]Perkins mode is a way to write Braille using only 7 keys : [space, s, d, f, j, k, l] for [Braille space, dot 3, dot 2, dot 1, dot 4, dot 5 dot 6]. Each letter activates a Braille dot when you press it. To obtain the letter ‘o” (, you have to press simultaneously f( ), s( ) and k( ). This input mode comes from the Braille typewriters. It is really usefull when typing special characters, especially in mathematics and contracted Braille codes because corresponding black ones are sometimes difficult to produce (for example ó which codes).

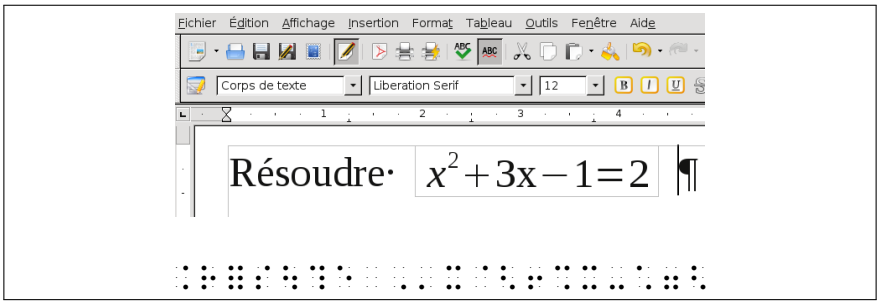

Figure 2. Thomas uses a common word processor (openoffice) to write his exercice : Solve $x^2 + 3x - 1 = 2$. He transcribes his file directly thanks to NAT using the profile of Louis (an advanced Braille grade 2 reader) which is stored in the software.

At the beginning of the lesson, Louis loads the Braille file into NAT's reverse and starts answering the question as shown in figure 3. Louis uses contracted Braille and the Perkins input mode. Thomas looks at his student's work and sees a mistake in the Δ calculus : he edits the formulas by clicking on them and explains the mistake (figure 4). Louis converts his teacher's annotations into Braille and reads the explanations in Braille grade 2.

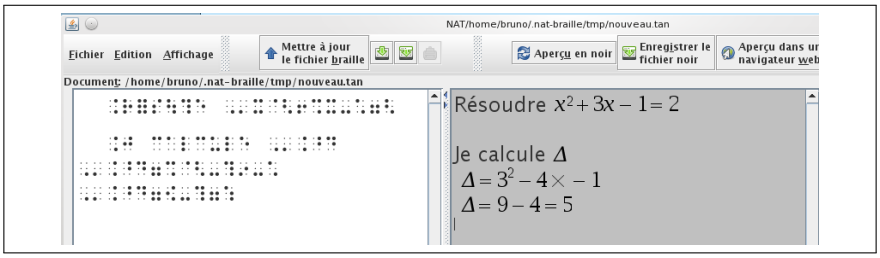

Figure 3. This figure shows the NAT's graphical user interface for entering Braille or black text. Louis opens the Braille file given by Thomas and starts answering in Braille. Since Thomas wants to read his work, Louis updates the black screen for him.

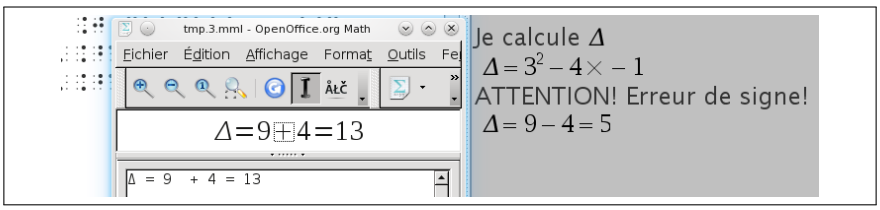

Figure 4. Thomas see an error in an equation (a sign problem). He edits directly the formulas by clicking on it and using open office. Then Thomas will update the braille screen to gives his changes to Louis.

3. Discussion

We show that NAT Braille is a good solution for inclusive education, particularly in the case of non Braille reading teachers. However it remains a tool and would be advantaged if combined with other assistive solutions.

Our transcribing tool is a first step towards developing other assistive tools for Braille learning and transcribing. Some other assistive tools propose interesting features which could be combined or implemented into NAT to improve the understanding of formulas for example. A promising possibility would be to underline the current position in both Braille and black texts like in MaWEN[3].

Scenarios could also be further developped thanks to dedicated software[9][10]. Interaction traces[2] could help their adaptation. Finally we are developing foreign partnerships to propose NAT Braille into other languages and include NAT Braille in publishing chains for producing adaptable documents.

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