Computer Application for Mastering Memorizing Numbers

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SUMMARY The so-called numerical alphabet has been established as one of the various memorization systems. It enables numbers to be transformed into words. In that way memorizing numbers is highly alleviated, since words are to be memorized instead of numbers, which is substantially easier. In order to master the technique of transforming numbers into words (for memorizing them), as well as transforming words back to numbers, a person has to practice. Upon adopting the numerical alphabet, one then has to practice various examples and translate numbers into proper words and words into proper numbers. This paper describes the computer application we have developed that helps in this process. To our knowledge, this is the first complete application of this kind ever created. We also show the results of the students’ number-memorization tests, performed before and after using the application, which show significant improvements.

key words: education, learning, memorizing numbers

1. Introduction

University students who study for their exams have to memorize vast amounts of data. Memorizing numbers, from all possible types of data, is assuredly one of the most difficult tasks for many students. For other types of data we can usually assign some meaning and ease the process of memorizing. In the case of numbers there are 10 digits which may appear in any order with no particular meaning, so one is prone to easily make mistakes - was it 3785 or 3875? A previous work confirmed that memorizing numbers is a demanding task: 597 undergraduate students were tested for their ability to memorize 2-digit numbers [1]. The students had significant problems with numbers greater than 20, not equal to 22, 33, 44, ..., 99. From this group of numbers, the large tabled numbers (numbers which factor and therefore appear in the multiplication tables, such as 49, 36, 60, 27) had a recall rate of 42%, while the other numbers had a recall rate of only 34%. These rather low percentages show that students have difficulties with memorizing numbers, which is important in practically all scientific areas. Students of technical faculties need to memorize various mathematics and physics constants and other numerical values. Medical students have to memorize various drug and medicine amounts. History students have to memorize dates. Geography students also have to memorize various numerical data. Memorizing numbers is obviously an important task in the education process for many, if not all scientific areas.

It may be significantly improved by the use of the so-called numerical alphabet. In this paper we will explain the numerical alphabet and describe the application we have developed, that helps the user to master memorizing numbers. To our knowledge, this is the first complete application of this kind ever created. We will also show the students’ number-memorization tests, performed before and after using the application. The paper is organized as follows. In Sect. 2 we explain various memorization techniques, with an emphasis on the numerical alphabet. In Sect. 3 we describe the application we have developed, and in Sect. 4 we show the results of the students’ number-memorization tests. Section 5 considers related work and Sect. 6 is the conclusion.

2. Memorization Techniques

There are many memorization techniques, which may be applied to all sorts of data. The chain of association method [2], [3], used for memorizing a series of words, is a basis for many other techniques. Let us assume that we have to memorize a series of objects, such as ‘boat - giraffe - ball - cannon - cigarette - phone - skater - bottle’. First we should make an association between the first two objects: boat and giraffe. We should picture an image with these two objects, such that something illogical/impossible/comic is going on, i.e. the picture should contain something very unusual, since that is easily memorized. For example, we can imagine a giant giraffe standing in a lake up to its knees in the water and a boat passing under it, like under a huge bridge. Then, in a similar manner, we make an association for the rest of the pairs: giraffe - ball, ball - cannon, etc. For the last pair we could imagine a skater wearing bottles instead of skates performing various pirouettes. This method can be used for memorizing series of 10, 20, even 50 or more words. It is convenient for memorizing the sequence of main points for some lecture we have to give, sequence of chapters of a book, queue of themes when studying for an exam, etc. In [2] it is shown how this technique may be adapted for memorizing all sorts of data, not just objects.

The chain of association method can also be used for memorizing numbers, if the numbers are previously transformed to words. One way for doing this is to use the mnemonic peg system [4]. This system utilizes vocal sound similarities, e.g. one -> sun/gun, two -> shoe, three -> tree, or shape similarities, e.g. one -> candle/straw, two -> swan/duck, three -> heart. That way, memorizing a 20-digit number is reduced to memorizing 20 words. A drawback of

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Table 1  Numerical alphabet for Serbian (‘Nj’, ‘Lj’ and ‘Dζ’ have no proper Latin equivalents, and are shown as 2-letters).

| Digit | Consonant | Digit | Consonant |
|-------|-----------|-------|-----------|
| 0     | C, Z, S   | 5     | L, Lj     |
| 1     | D, T      | 6     | S, Z, C, Dζ, D |
| 2     | N, Nj     | 7     | G, K      |
| 3     | M, J      | 8     | V, F      |
| 4     | R, H      | 9     | B, P      |

This method is that we have to use a word for each digit. This problem may be resolved if one adopts (pre-memorizes) a list of 99 words (for numbers from 1 to 99), or a list of 999 words (for numbers from 1 to 999). That way each 2-digit or 3-digit number will be linked to a single word, which reduces a 20-digit number to a list of 7 to 10 words. The adoption of 999 words or even only 99 words, however, obviously demands a proper amount of time. An easier way is to use the numerical alphabet, which assigns different consonants to different digits. To memorize a number, one combines the consonants with vowels, to make a convenient word. That way a 20-digit number can also be reduced to 7 to 10 words, but now we have to adopt (pre-memorize) only a couple of similar consonants for each digit (as we will see in the next section). This is easier, as there are only 10 digits, compared to 99 (or 999) numbers. The numerical alphabet, defined in [2] for the Serbian language is given in Table 1. We used the Serbian language, since our application was developed mainly for students of the University of Nis in Serbia. This, with proper adaptations, can also be done for other languages. For example, a similar English version of the numerical alphabet is used in [3], [5]–[7]. An interesting thing to notice is that the author of [3] is a USA memory champion.

Let us give an example how the numerical alphabet is used for transforming numbers into words. Let us say we have to memorize the 6-digit number 579340. The first thing is to separate this number into 2-digit numbers - we will have 57, 93, 40. For the first number, 57, we can form words like LeG or LooK – ‘L’ stands for the digit 5 and ‘G’ or ‘K’ stands for the digit 7. Then for 93 we can have BaM - ‘B’ for 9 and ‘M’ for 3. Finally for 40 we can have RaCe - ‘R’ for 4 and ‘C’ for 0. Of course, each person will come up with their own words that will suit them best. Now all that is left is to memorize the obtained words. If we apply the Chain of association method, we could visualize legs that are running so fast that they make the sounds bam in some sprint race. It will be enough to see and hear this for a few seconds and we will practically memorize the 6-digit number above. After a little practice a person may start to form groups of 3 digits. This demands more skills to form proper words, but it also demands less number of words that have to be memorized. For the same example we will have two 3-digit numbers: 579 and 340. For these two numbers we could, for example, use the words LooKuP and MaRS.

Two advantages of using the numerical alphabet are easier than adopting a list of 99 (or 999) words for the mnemonic peg system, one still needs time to master this technique. A proper training where numbers are translated into proper words and words into proper numbers is also needed. Even though a motivated person is able to do this on her own, while practicing ‘on paper’, it is easier if other tools are used, such as a proper computer application. In the next section we will describe the application we have developed.

3. The Application

The application was developed using php and html, with a MySQL database, used for the words of the Serbian language, integrated into a WampServer. It consists of 3 main parts: rules of the numerical alphabet, transforming words to numbers and transforming numbers to words.

The first part, rules of the numerical alphabet, teaches the user which consonants are assigned to which digits. Let us explain the proper ‘rules’, given in Table 1.

The letter ‘C’ looks like the digit ‘0’, it is almost like a full circle, so ‘C’ is assigned to ‘0’. The letters ‘Z’ and ‘S’ are pronounced similarly to ‘C’ (at least in Serbian), so they are also assigned to the digit ‘0’.

The letter ‘T’ looks like the Roman sign for ‘1’, it just needs the lower line, so ‘T’ is assigned to the digit ‘1’, and the letter ‘D’ is pronounced similarly to ‘T’, so it is also assigned to the digit ‘1’.

The small letter ‘n’ is written with 2 strokes downward, so ‘N’ is assigned to the digit ‘2’, as well as the Serbian letter ‘Nj’, which is similar to ‘N’.

Similar to the previous case, the letter ‘m’ is written with 3 strokes downward, so ‘M’ is assigned to the digit ‘3’, as well as the letter ‘J’, since we get a symbol similar to ‘3’ if we write two letters ‘J’ one above the other.

The letter ‘R’ is the last consonant in the word ‘four’ in many languages (English, French, German, Serbian, etc.), so it is assigned to the digit 4. The letter ‘H’ is also assigned to the digit 4, since the small letter ‘h’ looks like a symbol similar to 4 if rotated for 180°.

The letter ‘L’ is the Roman sign for 50, so it is assigned to the digit ‘5’, as well as the similar Serbian letter ‘Lj’.

The Serbian word for number six is ‘šest’, so the Serbian letter ‘S’ is assigned to the digit 6. This digit also gets all the rest of the Serbian letters similar to ‘S’ and an interesting convenience is that there are 6 of them.

The letter ‘K’ can be ‘written’ with two 7s, one written ordinary and the other rotated for almost 180°, like it is shown in Fig. 1 (left), so ‘K’ is assigned to the digit 7. The letter ‘G’ is pronounced similarly to ‘K’ (in Serbian), so it is also assigned to the digit 7.

The hand written small letter ‘f’ reminds of the digit ‘8’, so ‘F’ is assigned to the digit ‘8’, as well as the similarly pronounced letter ‘V’.

Finally, the letters for the digit 9 are ‘B’ and ‘P’. Both small letters ‘b’ and ‘p’ look like the digit 9, if rotated for 180°, the letter ‘b’ rotated relative to its center and the letter ‘p’ rotated relative to its vertical axis.

For each of the above rules we developed a proper
Flash animation, showing the consonants assigned to that digit. Unfortunately, we cannot show animations in a paper like this one. However, to give an example, we have taken several screen shots of the animation for the digit 9, that represent several phases of the described rotations of the letters 'b' and 'p'. They are shown in Fig. 1 (right). The animations for the other digits are similar to this one and, in a convenient way, help the user to adopt the rules of the numerical alphabet.

The second part of the application trains the user to transform words into numbers. The user first has to choose the number of 'valid' consonants, with 3 possible choices: 2, 3 and all. The first two choices (2 or 3) essentially mean that only the first 2 or the first 3 consonants in a word will relate to digits, and the rest of them (if they exist) will be ignored. For example, if only first 2 consonants are valid then the words 'MaP' and 'MaPping' will both indicate the same number - 39. Practically, a beginner will always choose the first option (first 2 consonants are 'valid') and a more experienced user will choose the second option (first 3 consonants are 'valid'). The last option (all) is not practical at all for memorizing numbers, but can be a good choice for really advanced users, when practicing.

After this a word is chosen randomly from the database and shown on the screen, and then the user has to enter the appropriate number that represents this word in a text field. In the case of a correct answer the user gets a congratulation message and in the case of an incorrect answer one gets both a message that the answer was incorrect and the correct answer. Then another word is chosen from the database and everything is repeated.

The third part of the application trains the user in transforming numbers into words. This is the most complex part of the application, for two reasons. First of all, while one word always represents only one number (for a fixed number of starting 'valid' consonants), each number may be transformed to many words. This means that in this part of the application the user may enter several words. Second, it is important that the user enters words that really exist, not some nonsense, which might be interpreted as valid, according to the numerical alphabet. For example, for the number 27 the user could enter 'ng'. This is a correct answer, according to the rules - 'n' stands for 2 and 'g' stands for 7, but there is no such word as 'ng'. In order to resolve the last issue, the existence of each word is checked in the database of words. On the other hand, it is possible that the user finds a word, which really exists but is not present in the database. For this purpose the user also has an option to add the new word into the database.

This part of the application begins in a similar way as the previous one; by choosing the number of 'valid' consonants, i.e. by choosing to practice with 2-digit or 3-digit numbers. After that the application randomly chooses a number and shows it on the screen. The user has to enter as many words that could be used for memorizing this number as one can form, and the application shows the results. The answer whether a word was correct or not is shown for each entered word. For incorrect words one gets their numerical values. For words that are correct, but not present in the database, it is shown that the answer was correct and the user is informed that there is no such word in the database, with an option of adding the word.

The application also has several additional features. Let us just name a few of them. During the part for practicing transforming words into numbers, as well as the part for practicing transforming numbers into words, the user has an option to show/hide the table that describes the numerical alphabet. This option may really be helpful for novice users. In the part for practicing transforming numbers into words, for each given number, the application shows the number of words in the database representing the given number, with an option for the user to see these words. The application also has a separate part for database manipulation, in which the user can see the words in the database with their numerical values, add new words, or do a special number based query. The last option is particularly useful if the user wants to memorize a specific number and needs help in forming words for that particular number - one may simply enter the number in a text field and the application will show all the words from the database that represent this number.

4. Results

We tested the application with a group of students of the University of Niš. Their task was to memorize as many numbers as possible from 20 2-digit numbers in 200 seconds - every 10 seconds the next number was shown. This was done before and after practicing. The students practiced for 2 to 3 weeks in their free time. The total time spent practicing was 2 hours. The students were divided into 2 groups: a group of 20 students who practiced numerical alphabet 'on paper', without using the application (Paper), and a group of 20 students who practiced with the computer application (Computer). The results are shown in Fig. 2. Before practicing, the average number of correctly memorized numbers

Fig. 1 Letter 'K' formed with two 7s (left) and consonants for the digit 9 (right).

Fig. 2 Results.
is similar for both groups, 7.2 for Paper and 7.1 for Computer, while after practicing this number is equal to 11.8 for Paper and 17 for Computer. The proper improvements are: 1.64x (or 64%) for Paper and 2.39x (or 139%) for Computer. These results confirm the merits of the numerical alphabet, and prove the usefulness of the described application for practicing number-memorization.

5. Related Work

There are several computer/mobile applications we have found that deal with memorizing numbers. Applications [5]–[8] give help in memorizing numbers - after the number(s) is(are) entered, these applications show appropriate words [5]–[7] or images [8] that may be used for memorizing the entered number(s). In [5] there is also a part in which the user may time oneself while memorizing a series of numbers. These applications are good help when one needs to memorize numbers. They, however, do not train the user to be able to memorize numbers by oneself, without help, like our application does. Applications [9]–[12] are developed mainly for practice - the user is given a task to memorize a group of numbers in some way. The application [9] also has a part in which text and/or an image may be associated with numbers from 0 to 999. These applications are good for practicing but they lack explanations on how to memorize numbers in an efficient way. They do not even mention the numerical alphabet or some other technique for memorizing numbers.

As we can see, neither of the mentioned applications is complete in a way our application is. Our application not only explains the numerical alphabet, helps in adopting its rules through interesting animations and gives the user a possibility to see what words can be used for the number(s) entered, but it also trains the user in transforming numbers into words and words into numbers, which means that it helps the user to become capable to memorize any number in any situation by oneself (without any external help).

6. Conclusion

There are a lot of memory techniques which may help students. This is particularly useful in the case of techniques that transform a difficult and arid task such as memorizing numbers into an easy and fun process. In this paper we described an application developed to help the user to master the process of memorizing numbers. To our knowledge this is the first complete application of this kind. Other applications either just show candidate words for entered numbers, or just require the user to memorize randomly generated numbers without explanations on how to efficiently memorize numbers. Our application helps the user to adopt the numerical alphabet, it helps in choosing proper words for particular numbers that are to be memorized and, most important, it trains the user in transforming numbers into words and words into numbers, which means that it helps the user to become capable of memorizing any number in any situation by oneself. These qualities are confirmed by the results of the students’ tests of their capabilities to memorize numbers, done before and after practicing with the application.

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