Performance Analysis of Memorization Rate Models

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Abstract

This paper is to corroborate the validity of the rate of memorization model without forgetfulness factor and with forgetfulness factor. These models wereanalyzed and solved and were practicallyexperimented on students.We showed the possibility that short term and long term memory is different but essential for the establishment of long term memory.

Keywords- *Forgetfulness, Memorization model, memory storage*

1. Introduction

Due to the complexity of the human mind and its ability to store memory, the information received from short-term studies is limited. While memory is crucial for all of us, there is no time during which memory demands are greater than the school years. The school environment, however, is not often a "memory-friendly" one. Children are presented with new information all throughout the school day and given little opportunity to consolidate new information before more new information is presented to them [1]. Contrary to popular belief, being smart is not synonymous to having a good memory or good retention but lies in the lifestyle of a person, attitude, diet and habits [2]. Things learnt can also be forgotten just as for memorization, if they are not constantly revised or practiced. According to Cowan [3], new information must make contact with the long-term knowledge stored in order for it to be categorically coded. The person who actually learns, rather than merely memorizing is not only able to relate existing knowledge and apply it to new situations but more importantly, he can critically judge ideas of learned people.

Although humanmemory is usually robust and accurate, different disease processes can disrupt memory and cause either distortions or outright failure [4]. Forgetfulness can be attributed to both physical andpsychological causes. Some causes are reversible while others can be managed with medication [5]. We seek to perform anexperimental analysis on the rate of memorization model with and without forgetfulness.

2. The Models

A linear differential equation model of memorization without forgetfulness is given as[6]:

$$\frac{dL}{dt} = k_1(1 - L)$$

where

k_1 isa parameter that measures the retention after memorization, $L(t) =$ Fraction of list learned at time t, $L(t) = 0 =$ Knowing none of the list, $L(t) = 1 =$ Knowing the entire list, $(1 - L)$ says that the entire list learned is subtracted by a fraction of the list learned.

The model is based on the assumption that the rate of learning is proportional to the amount left to be learned.

$$\frac{dL}{dt} = k_1(1 - L)$$

$$\int \frac{1}{1 - L}\, dL = \int k_1\, dt$$

$$k_1 = \frac{-\ln|1 - L|}{t} \quad (1)$$

Equation (1) is used to measure the rate of retention. The solution to the differential equation gives a continuous function of the amount of the list learned with respect to time.

The fraction of items learnt at any time t is then calculated by plugging the value of k_1 into the equation and solving as in;

$$e^{\ln(1-L)} = e^{-k_1 t}$$

$$L(t) = 1 - e^{-k_1 t} \quad (2)$$

The parameter that measure the retention after memorization k_1 is different for each individual.

When forgetfulness is taken into account, the rate of memorization of a subject is given by[6]:

$$\frac{dL}{dt} = k_1(1-L) - k_2 L$$

Where $k_1, k_2 > 0$, and again, $L(t)$ is the fraction of material memorized in time t, and $1 - L$ is the fraction remaining to be memorized.

Assuming that $L(0) = 0$, solving for $L(t)$ and finding the limiting value of L as $t \to \infty$, we have:

$$\frac{dL}{dt} = k_1(1-L) - k_2 L$$

$$\frac{dL}{dt} = k_1 - L(k_1 + k_2)$$

$$\int \frac{dL}{k_1 - L(k_1+k_2)} = \int dt$$

$$\frac{\ln(k_1 1 - L(k_1+k_2))}{-(k_1+k_2)} = t + C$$

$$\ln(k_1 - L(k_1+k_2)) = -t(k_1+k_2) + C_1$$

$$L(t) = \frac{C_2 e^{-t(k_1+k_2)} - k_1}{-(k_1+k_2)} \quad (3)$$

Now, it is assumed that $L(0) = 0$, thus

$$\frac{C_2 - k_1}{-(k_1+k_2)} = 0$$

So that

$$C_2 = k_1$$

And

$$L(t) = \frac{k_1(e^{-t(k_1+k_2)}) - 1}{-(k_1+k_2)}$$

The limit as time approaches infinity is given as:

$$\lim_{t\to\infty} \frac{k_1(e^{-t(k_1+k_2)}) - 1}{-(k_1+k_2)} = \frac{k_1}{(k_1+k_2)}$$

$A = 0 < k_1 + k_2 < 1$ is the rate of absorption and

$C = \dfrac{k_1}{k_1 + k_2}$ is the constant of retention of the subject.

This implies $A = \dfrac{k_1}{C}$ which means that, the retention constant is inversely proportional to the rate of absorption. One can increase the rate of retention only (without increasing the absorption rate in the short term) by increasing k_2. This will result in the fact that the person is absorbing extra amount of information that will eventually not be retained [6].

3. Experimentation and Discussion of Results

The real data was compiled by testing two students with list**1** (list of integrals) and list **2** (three digit numbers). The list was studied at one-minute intervals and the students were then required to reconstruct the list from memory. The first part of the experiment did not take into account, the fact that a student can forget a number after memorizing. The process was repeated ten times or until the list learned in its entirety for each of the students. After compiling data, the experiment was repeated with the rate of forgetfulness factor taken into consideration. The results are shown in the figures below.

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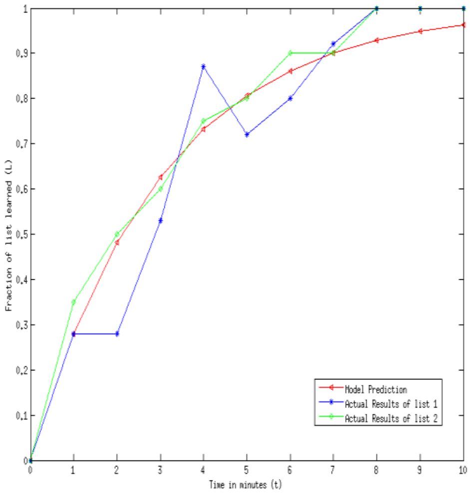

Figure 1: Rate of memorization for student A on list 1 and 2 without forgetfulness factor.

From Figure 1, it is observed thatstudent A has low retention rate compared to studentB in Figure 2. The curves show a good approximation of the rate for this person's memory. It will take student A and B 20 minutes and 11.25 minutes to study a list of 50 three digits numbers, and 40 minutes and 22.5 minutes to study a list of 100 three digits numbers respectively. We now assume forgetfulness in the model.

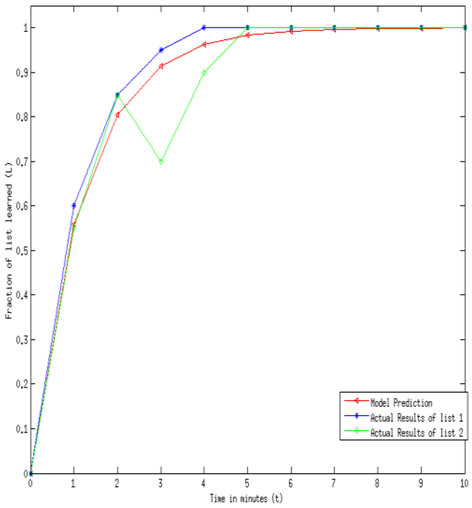

Figure 2: Rate of memorization of student **B** on list 1 and 2 without forgetfulness factor.

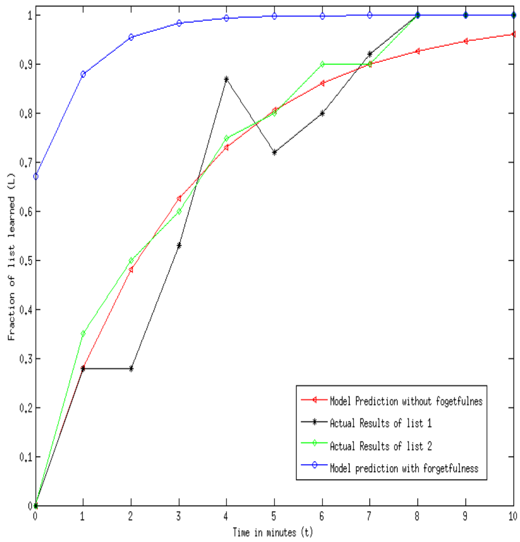

Figure 3: Rate of memorization of student A on list 1 and 2 with forgetfulness factor.

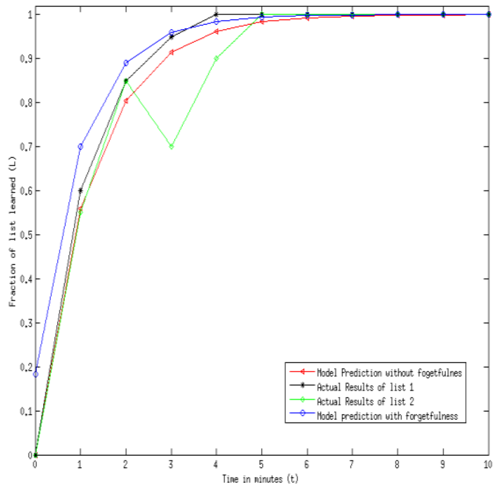

Figure 4: Rate of memorization of student B on list 1 and 2 with forgetfulness factor.

From figure 3 and 4 it can be seen clearly that, the model predictions with forgetfulness did not start from zero (0). The rate of memorization of student A on the list with forgetfulness factor taken into consideration started from a fraction of about 0.6 while that of student B on list 1 and 2 with forgetfulness factor started from a faction of about 0.2. This means that taking into consideration forgetfulness; it has reduced the proportion of the total amount L to be memorized. The explanation to this is that with time, the student can memorize a fraction of the list of L information available due to the fact that he will forget some of the information learned.

4. Conclusion

Two differential equations are practically analysed in this study, the rate of memorization model with and without forgetfulness. These models were solved and were experiment on two students. The model works better than one might reckon, notwithstanding the complexity of the human mind.These differential equations are good model for describing the rate of remembering without taking into accounts forgetfulness on a short term basis and taking into account forgetfulness on a long term basis.

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