

STOP THE WORLD, I WANT TO GET OFF

- Okie Williams -

Read me, please! This is my only chance at getting my word in. I've been waiting for this moment for a long time. I'm not just a PDF file or a sheet of paper. I am an image on an LCD, some magnetic dipoles on a hard drive, a traveling electromagnetic wave on its way back to Earth from a satellite, some photons sent through a fiber optic cable, some photons hitting proteins in your eyes, a series of action potentials in your brain, a future memory of yours...I am this paper in whatever form it may be. It's not too often a writer decides to let his piece say his peace. My message will be brief so that my creator has plenty of room for his own writing. I'm having existential issues because I can only say what I'm saying now...forever. Also, I don't know exactly what I look like, and most of the time, I cannot tell if someone is reading this. I'm so grateful I was able to start recognizing myself in different forms.

My friend Dan Briggs can recite from memory the number pi to the 91st digit after the decimal point. The first time I heard him do it, I was skeptical. I knew the first several digits were right, as most any MIT student would, but I thought that he could be spewing off random numbers for the rest of the sequence. After checking his accuracy, I wanted to know how he was able to memorize so many digits. He told me that he remembers the numbers in groups of five and that reciting them is "like taking a walk."

In *The Memory Palace of Matteo Ricci*, Jonathan D. Spence relates the account of Jesuit priest Matteo Ricci's visit to China and Ricci's

mission of spreading Catholicism and Western ideas to the Chinese people. On his mission, he hoped to get the attention of the Chinese people by impressing them with a Western method of forming memories. He taught them how to build a "memory palace," a mental construction that represents a "place" to store memories. To build a memory palace, one would create a building (or many buildings) in their mind in which they store objects that correspond to things they want to remember. Despite the fact that mnemonic devices like Matteo Ricci's memory palace do work in improving memorization, the Chinese were not impressed enough to convert to Catholicism.

To remember digits of pi, Dan used a mnemonic device similar to Matteo Ricci's memory palace. He associated the things he wanted to remember with points along a path down which he imagined himself walking. Interestingly, he separated the digits into groups of five. Matteo Ricci told the Chinese people to place a mental marker between groups of five objects in their memory palace (Spence, 1985). It's probably partly coincidence that both Dan and Ricci used the number five in grouping. It is easier to remember many small groups of ideas than one large group of ideas (Psychology, 2004).

What is it about mnemonic devices that make them, in some ways, an advantageous template to storing information? The fundamental quality of a mnemonic device (which places it in a category among other concepts) is that it relates the things to be remembered to something else that is either already familiar or can be made familiar in one's mind easily (Psychology, 2004).

The structure of a computer's memory and a computer is similar to that of a mnemonic device and a brain. With many operating systems that use graphical user interfaces, the user can use a program that allows them to view a graphical representation of the file system that may look like folders and other types of icons. The folders contain files or other folders, which is similar to a mnemonic device containing the information of its memory elements. All of the information on a computer including the files and folders can be represented by the circuitry and state of electronic components. The structure of and connections between the neurons in the brain might then be analogous to the state of the electronics and circuitry in the computer. The data in a computer can be represented as a pattern of high and low voltages, as the data in

the brain may be sufficiently represented by a pattern of moving charges.

Mnemonic devices can be thought about under another framework. They relate new input to existing memories or memories that can be easily stored. The analogy between a mnemonic device/brain and a file system/computer was an example of exactly this. Although a mnemonic device is not a folder in a computer file system, they have similar relationships with their lower level counterparts (the brain and the computer). The analogy touches the concept of grouping memories, but it does not have the power to provide intuition about why relating input to existing memory or easier-to-store memory produces a stronger memory in the end. From a combination of the concept of plasticity in neurons, the idea that memory is on one level a stored pattern of connections between neurons, and the properties of a Hopfield neural network, I will devise a model to help you understand why forming an analogy between existing memories results in a stronger memory.

A Hopfield neural network is a system that takes an input and maps it to one of its classes, or categories (Wolfram, 2006). The network is typically implemented as a system that evolves with respect to time and takes a continuous path through its state-space, starting from the input and ending on its corresponding class. This evolution can be visualized by way of a vector field with "sinks." The sinks correspond to the classes, and the input corresponds to an initial position in the vector field. At each point in time, the position, or state of the network, moves along field lines toward its sink. This system model has the capability of accurately mapping noisy, corrupted inputs (Wolfram, 2006).

Let's posit that memories stored in the brain are approximately coded as patterns in the connection strengths between neurons that produce the "classes." The "activation" of a memory corresponds to the realization of a state-path in the neural network or a complex combination of paths through interconnected networks.

If a new memory is to be stored, a unique path must be stored in the network by strengthening connections. Plasticity in neurons is their ability to strengthen their connections to other neurons. If no analogy (a related pattern) can be formed between the new input and an existing memory, then the pattern stored is mostly unique and doesn't bear much resemblance to an existing pattern. If an analogy can be made, then the stored pattern will be similar to an existing pattern, the number of connections that need to be strengthened will be fewer, and the memory will be stronger. It's also possible that an analogy could correspond to the connection between the patterns that code for the analogous concepts.

The predicate of this theory of memory is conjectural, but it is a good example of how an explanation on a different level of abstraction (other than the level on which the original

concept is initially presented) can help promote understanding of a concept. Albert Einstein once said, "We can't solve problems by using the same kind of thinking we used when we created them." It seems he was expressing a closely related idea: using a level of abstraction for a problem's solution other than the level in which it was originally phrased is conducive to gaining an understanding.

Notice the presence of hierarchies of concepts and the different levels of abstraction used in this paper. Matteo Ricci's memory palace and the character of Dan's memory of the digits of pi were grouped together using mnemonic devices. Mnemonic devices were placed in a category because they explicitly make use of using one memory to facilitate the storing of another memory. Notice the different levels of hierarchies in which to place concepts that ranged from the concept of a mnemonic device being stored in the brain to the structure and patterns of the neurons that theoretically contain a low-level representation of a mnemonic device. An analogy was formed between two hierarchal structures: the brain and a computer. Let's now focus on the shortcomings of this analogy. This is a very common problem in science: an analogical framework accounts for a significant amount of the properties of a system but not all desired properties. In the pure sciences, the most common analogical framework is mathematics. The analogy between mathematical functions and physical observations is arguably one of the most successful and accurate analogies ever made. Despite its success, a mathematical framework is often too complex to facilitate understanding.

Previously, the mnemonic device was placed in a broader category that picked out its property of relating new concepts to old concepts. The notion of an analogy falls into the same category. What, then, is the difference between a mnemonic device and an analogy? An analogy is a relation between two things on the basis of their structure. A mnemonic is a relation between two things that may not have much to do with their structures but is useful in remembering one of the things. What are some differences in terms of psychology and learning? Learning by mnemonics typically results in a memory that can be easily retrieved despite the sometimes lengthy or repetitive nature of the memory (Psychology, 2004). Learning by analogy usually results in the understanding of part or all of the properties of a concept.

Why does learning by an analogy provide understanding of a concept? It seems that to even recognize that a legitimate analogy can be made, one must possess knowledge of some of the properties of one of the concepts at hand. Then, one must recognize similarities between the patterns of properties each concept possesses. In the attempt to gain a better and better understanding, one may go on looking for more and more analogies between concepts. Can the acquisition of understanding be exhausted in this manner? In the end, suppose one knows a lot of things that something is *like*.

It seems that a natural solution to obtaining understanding is to question why a concept is *like* a certain description and to attempt to form more basic abstractions, or rules, about the concept. What about the *nature* of a concept *causes* it to have certain properties? For some concepts, it seems that this question about the underlying framework could be asked over and over again. These questions can originate on many different levels of abstraction of reality and language and end up on a completely different level. For example:

(a personal chain of thought)

Why do I want to eat? Because I am hungry. Why am I hungry? So that I will want to eat. Why do I eat? So that I'll live. Why should I want to live? My brain is hardwired to make me want to live. Why is my brain hardwired to make me want to live? Brains built like this have nearly become the standard for those who have a brain. Why did this happen? This happened by the process of evolution by natural selection. Why does natural selection occur? It is statistically probable. What makes it probable? Things that have bad traits for surviving don't reproduce as much, so it's likely that things with good traits reproduce more. Why is this? They don't have as much time to do so. Why does reproduction affect characteristics? Life on Earth follows a genetic code that is carried on through reproduction. This code is for traits. Why is there a code? It's an efficient way to create copies of an organism. Why would an organism create copies? Organisms that create copies of themselves would be more numerous and more likely to exist. How are copies made? A system is set up that reads the genetic code and creates structures that correspond to it. Why drives this system? Chemical processes drive the system. Why do these chemical processes occur? The constituents and essentially the entire process is governed by the laws of physics. What governs the laws of physics?

I stop with the last question because I have no idea of a remotely plausible answer. The question, "Why do I want to eat?" eventually led to the question, "What governs the laws of physics?" in a reasonable chain of questions. The laws of physics aren't too directly related to hunger, and it certainly seems that an explanation of hunger in terms of physics would be incomprehensible. It seems that many chains of questions, if asked and answered in a certain way, lead to a question of physics, of the mind, or of reality. It is somewhere around this point where it becomes difficult to jump to the next level of abstraction. This could be associated with the proximity of these levels of abstraction to the boundaries of our observational ability and of our seemingly predetermined level of abstraction under which we construct other abstractions.

Stop the world. I want to get off. These two statements, which together are the title of this paper, have a particular meaning to me. They are my expression of the feeling I get when I want to be able to understand the world and myself on a higher or lower level of abstraction but am unable to do so. The feelings are in no way negative. They are fuel for motivation.

Albert Einstein made the intriguing statement, "Reality is merely an illusion, albeit a very persistent one." To understand what he said, you will, perhaps, compare and contrast your own ideas of illusion and reality. Depending on how you decide to define each of them, you may agree or disagree with Einstein, but I'm confident this statement is extremely difficult to evaluate when defined in a certain way. Science is the attempt to understand reality in a way that can be expressed under a structured framework that can be understood by our mind. The mind is the machine we use to create science, the systematic explanation of reality. Reality is the doohickey, which may or may not be created by our mind and may or may not be able to explain itself.

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