

## Thinkings: How Computers Change the Way We See By Altering the Way We Think

### The Automation of Variation

Jorge Luis Borges, the Argentine writer, has two wonderful stories that can help us to understand what I'm thinking about when I use the term "variation." And they will help us think about variation and how it's a concept that bridges the everyday experience of life and language, and the intellectual challenges related to our struggle to make sense of our experience of life. [When you have the chance, read the original stories; they are brilliant. My abridged retellings eviscerate the original poetics of Borges prose. Also, note that my examples here are ones that are typically used to explain new media.]

"The Garden of Forking Paths" was first published in 1941 and it concerns the confessions of a Chinese spy in England for the Germans during WWI. The narrative starts with the protagonist knowing that he will be caught and yet bound to execute a murderous plan that will complete his mission but result in his capture. He is aware simultaneously of the necessity of choosing a course of action and of being caught in his fate. Borges's consistent metaphor for this turning point is the forking path: the crossroads. We can of course recognize it as simply "the present" – in an existential sense, we experience all time as a point of decision. The character, Dr. Yu Tsun, says as much in the text, "... everything happens to a man precisely *now*." But Tsun produces for himself a counter fiction so that he can carry out the deed as if it is necessary: "The author of an atrocious undertaking ought to imagine that he has already accomplished it, ought to impose upon himself a future as irrevocable as the past."

So in the story, Tsun exits a train, knowing he is pursued and that his time is short. Tsun being asian, the boys on the platform deduce that he is headed for the home of a local sinologist and give him directions to Dr. Steven Albert's: "The house is a long way from here, but you won't get lost if you take this road to the left and at every crossroads turn again to your left."

The directions parallel the existential confinements that Tsun has just prescribed for himself. And they remind him that such directions lead to the center of labyrinths, and that his great-grandfather was renowned for having taken 13 years before his murder to create an impossibly populous novel and simultaneously an impossible to navigable labyrinth. On his great-grandfather's death, his heirs discover that the novel is filled with contradictory gibberish and the labyrinth seems not to even exist. But Tsun says of the latter, "I imagined it infinite, no longer composed of octagonal kiosks and returning paths, but of rivers and provinces and kingdoms ... I thought of a labyrinth of labyrinths, of one sinuous spreading labyrinth that would encompass the past and the future and in some way involve the stars." (Life is a labyrinth.)

So the good doctor greets Tsun, whom he does not know, and assumes that he wants to see what he calls "The Garden of Forking Paths," which, by the unlikeliest of coincidences he happens to be in possession of. He hands Tsun the key to the mystery on which is inscribed in elaborate calligraphy the message, "I leave to the various futures (not to all) my garden of forking paths." Doctor Albert explains that the labyrinth and the novel are one in the same. "In all fictional works, each time a man is confronted with several alternatives, he chooses one and eliminates the others; in the fiction of Ts'ui Pen,

he chooses—simultaneously—all of them. He creates, in this way diverse futures, diverse times which themselves also proliferate and fork." The novel then appeared contradictory only because it contained every variation of possible action among its protagonists.

By way of final explanation, the good professor says to his guest, "Time forks perpetually towards innumerable futures. In one of them, I am your enemy." Shortly thereafter, Tsun shoots Albert in the back in order to signal to his German compatriots that the secret base, the location of which is the object of his mission, is in the city of Albert, a fact conveyed in this way to his superior via the newspaper headlines which will recount the murder and Tsun's capture even as Tsun himself will be unable to directly.

The second story I'd like to retell, is Borges's "Library of Babel," which was published at the same time and contains an equally absurd parable of infinite variation. To quote:

The universe (which others call the Library) is composed of an indefinite and perhaps infinite number of hexagonal galleries, with vast air shafts between, surrounded by very low railings. From any of the hexagons one can see, interminably, the upper and lower floors. The distribution of the galleries is invariable. Twenty shelves, five long shelves per side, cover all the sides except two; their height, which is the distance from floor to ceiling, scarcely exceeds that of a normal bookcase. One of the free sides leads to a narrow hallway which opens onto another gallery, identical to the first and to all the rest. To the left and right of the hallway there are two very small closets. In the first, one may sleep standing up; in the other, satisfy one's fecal necessities. Also through here passes a spiral stairway, which sinks abysmally and soars upwards to remote distances. [...] Light is provided by some spherical fruit which bear the name of lamps. There are two, transversally placed, in each hexagon. The light they emit is insufficient, incessant.

[...]

There are five shelves for each of the hexagon's walls; each shelf contains thirty-five books of uniform format; each book is of four hundred and ten pages; each page, of forty lines, each line, of some eighty letters which are black in color. There are also letters on the spine of each book; these letters do not indicate or prefigure what the pages will say.

The librarian responsible for this explanation lays dying in his hexagon considering the implications of this vast complex where no two books are the same. The library is said to contain every possible book. But the peregrinations of the librarians and their search for truth are absurd since most books contain only nonsensical orderings of the letters.

Still, since the library is total, it contains, "... all that it is given to express, in all languages. Everything: the minutely detailed history of the future, the archangels' autobiographies, the faithful catalogues of the Library, thousands and thousands of false catalogues, the demonstration of the fallacy of those catalogues, the demonstration of the fallacy of the true catalogue, the Gnostic gospel of Basilides, the commentary on that gospel, the commentary on the commentary on that gospel, the true story of your death, the translation of every book in all languages, the interpolations of every book in all books."

Someone has helpfully calculated that Borges library as described must contain  $25^{1,312,000}$  books, which, is apparently more than the number of atoms that are supposed by physicists to be in our universe. If there were one true book, even the variants that simply differ by one character would likely fill the space of the known universe.

The contemplation of this corrosive system of variation leads the librarians to insanity destruction and suicide. This is in a way a mirror inverse of the forking paths idea where the fated-ness of life is a perspective on selecting a path that always sees the choice as having taken place in the past so that the present appears as inevitable and fixed. Though the future holds the promise of infinite digression and divergence, we are always anchored at one end to a fixed and unchangeable past. The librarians of Babel have no such anchor and therefore search for the one true book. Every hint of veracity in one book is contradicted in the next – it's not just that the next book contradicts the last, it's that knowing the nature of the system confirms that the contradiction can theoretically be found: that every perversion of truth exists, is even more certain than the existence of one true book.

Both of these stories describe a particular system of variation. They are both in some way open-ended and infinite (or at least overwhelmingly enormous). And they produce, or contain specific examples, or the results of the system. The structure of variation can be described as a relationship between a system of possibilities and their instantiations—their actual examples, selections, products, choices, variations. The instantiations might appear as a sequence just as the decisions in a life add up to a personal history. Or, they might appear as a collection, like in the library of Babel, or in the garden of forking paths, which, accumulates all the possible narrative variations of the protagonists' actions.

One final literary example. This is from 1961 and was created by Raymond Queneau, one of the founders of the Oulipo, *Ouvroir de littérature potentielle* or "workshop of potential literature." "A Hundred Thousand Billion Poems" consists of ten, fourteen line sonnets, published so that the pages can be cut between each line. As a result, the reader constructs one of the possible poems by choosing subsequent lines from any of its pages. This exercise in permutations results in the universe of a hundred thousand billions possible poems. The author brags it would take 200 million years to read them all.

Alan Turing has written, "Only a machine can appreciate a sonnet written by another machine," but let's see:

Don Pedro from his shirt has washed the fleas  
 Since Elgin left his nostrils in the stone  
 Upon his old oak chest he cuts his cheese  
 Which neither time nor tide can long postpone

Oh how oh how he hates such pilferings  
 Filching the lolly country thrift helped save  
 Proud death quite il-le-gi-ti-mate-ly stings  
 Victorious worms grind all into the grave

Poetic license needs no strain or stress  
 One tongue will do to keep the verse agog  
 From cool Parnassus down to wild Loch Ness  
 Bard I adore your endless monologue

Ventriloquists be blowed you strike me dumb  
 Soliloquies predict great things old chum

Now, we should consider what allows a system to be so productive. How is it that systems can instantiate massive or even infinite variations? The answer, is simply that they have a space in them, a hole, a piece missing. And what happens in the process of producing variations is that that hole, like a container, is filled over and over with different content.

The possible content of the hole is another series and it might be taken from a finite or an infinite set (letters of the alphabet, possible actions in the world, a ten syllable phrase ending with a word that rhymes with fleas, etc.). The books in the library of Babel have millions of "places" on the pages where one of the 25 available orthographic symbols of Babel's writing system can be inscribed. And if the text of the book is taken to be a series—letter after letter, word after word, sentence after sentence—that hole is equivalent to a single empty space which is filled sequentially as the book is written letter by letter, line by line.

In life imagined as a forking path, the number of possible actions at any given moment are impossible to calculate. The present is, none the less, a kind of empty place that will be filled with some action or another.

And in Queneau's poem, each line in the reading takes its place in the space that the system of the poem defines. Notice that the instantiation of the poem requires that the space be filled with one from a set of just 10 possible entries. In composing the poem, Queneau, from the infinity of possible lines was constrained by rules of the sonnet so that each line had to conform to the meter, rhyme, and topic specific to its place in the sequence of lines. The set of possibilities for each place in the poem inherits these particular constraints. Further, consider that Queneau's "A Hundred Thousand Billion Poems" is but a small subset of the all the possible sonnets. The sonnet form is itself a generative system that is instantiated endlessly – at least potentially.

A system productive of variation then is combination of constraint and possibility, of rules and freedom, of restriction and play, of solidity and emptiness.

A philosophical digression: Gilles Deleuze writes in *The Logic of Sense* that, "there is no structure without the empty square, which makes everything function." The empty square allows for substitution where one instance of its content is replaced by another within a serial chain. Emptiness is made to work as a machine.

Interestingly, the computer works in just this way. Alan Turing's 1936 thought experiment that inaugurates modern computing has this, now familiar structure. [There is a diagram of the Turing Machine on page 17 of the book.] It's an infinitely long piece of paper with empty squares on it. A machine can move the paper and write a symbol on it or erase a symbol. The machine has a finite number of states, and it has a table of instructions. Turing proved that such a machine – one that can read the symbol on the paper one square at a time, and act according to its state, the symbol it is currently reading, and the instructions for the situation so defined—can calculate anything that it is possible to calculate.

Contemporary computers don't have that exact structure but they do have empty squares that work in the same way and allow for the production of variation in the same way. They are called fields, variables, parameters, memory locations, etc. And as in the Turing machine, they are able to circulate the contents of those containers automatically by using a system of symbolically coded rules that allows the process to proceed without human intervention. This is essentially what is called automation. In human systems people perform the actions which proliferate variation. Under the regime of computation, the system runs itself by rules and variation proliferates at the touch of a button.

The automation of variation involves the encoding of systems and their instantiations so that they can be "run" by a computer. Under conditions of computation, every constant can become a variable: there are more and more holes, more and more places to circulate difference, more ways to diverge.

It's not that systems of variation hadn't existed in the past. Systems of variation are arguably a centrally human preoccupation with a past that is coextensive with human culture and history. What has changed, perhaps, in our present situation is that variability has intensified because of the way its automation has made it easier, more common, and even habitual.

Moreover, the quality of human styles of variability, what we might want to think of under the rubric of improvisation (governed perhaps by associative tendencies of divergence), differ considerably from either the systematic or the random procedures that are usually employed by computational systems.