Week 10

Mathematical Imagination outside of Mathematics

From *Manuscrit trouvé à Saragosse*, Jan Potocki, 1804

…la belle Juive, que nous n'appellions plus que Laure, se tournant vers Velasquez, lui dit: "Que pensez-vous Monsieur le Duc, des sentiments exaltés de ce jeune Soarez. Vous êtes vous jamais donné la peine de porter vos idées, sur ce qu'on appelle comunement amour."

—Madame (lui répondit Velasquez) mon sistême embrasse toute la nature & par la même, il doit comprendre tous les sentiments qu'elle a placé dans le cœur humain. J'ai du les approfondir tous& les définir, j'ai surtout reussi à l'egard de l'amour; car j'ai trouvé qu'il était possible de l'exprimer en termes algébriques & vous savez que les questions qui sont abordables à l'algêbre, donnent lieu à des solutions, qui ne laissent rien à désirer.

En effet supposons amour une valeur positive accompagnée du signe *plus*; haine qui est l'opposé de l'amour, sera accompagnée du signe *moins*, & l'indifférence qui est un sentiment nul, sera egale à *zéro*.
Si je multipliais l'amour par lui-même, que j'aime l'amour, que j'aime à aimer l'amour, j'ai toujours des valeurs positives, aussi plus par *plus*, fait-il toujours plus.

Mais si je hais la haine, je rentre dans les sentiments d'amour, où dans les quantités positives et c'est ainsi que *moins* par *moins* fait *plus*.

Au contraire si je hais la haine de la haine, je rentre dans les sentiments opposés à l'amour, c'est-à-dire: dans les valeurs negatives, tout de même que le cube de *moins* est *moins*.

Quand aux produits d'amour par haine, ou de haine par amour, ils sont toujours négatifs, tout comme les produits de plus par moins & de moins par plus. En effet soit que je haisse l'amour, où que j'aime la haine, je suis toujours dans les sentiments opposés à l'amour. —Trouvez-vous belle Laure, quelque chose à opposer à mon raisonnement?

—Rien du tout, répondit la Juive, et je suis convaincue, qu'il n'y a pas de femme qui ne se rendit à des arguments pareils.

—Ce ne serait pas mon compte, reprit Velasquez; car en se rendant si vite, elle perdrait la suite de mes corollaires où conséquences résultantes de mes principes. Je poursuis donc mon raisonnement, puisque amour & haine se comportent absolument comme des valeurs positives & négatives, il en résulte

qu'à la place de haine. Je puis écrire *moins amour*, qu'il ne faut pas confondre avec l'indifférence, dont la nature est d'être egale à zero.

Maintenant examinez la conduite des amants. Ils aiment, ils se haissent, puis ils detestent la haine qu'ils ont eue, ils s'aiment plus qu'auparavant, puis un facteur négatif change tous ces sentiments en haine. Or il est impossible d'y méconnaitre les puissances alternatives de *plus* et de *moins*,… Cela est si vrai, que vous voyez souvent l'amour commencer par une sorte d'aversion, petite valeur négative, que nous pouvons représenter par B. Cette aversion amenera une brouillerie, que nous representerons par moins C, c'est-à-dire une valeur positive, un sentiment d'amour."

Ici la fausse Uzeda, interrompit Velasquez & lui dit: "Monsieur le Duc, si je vous ai bien compris, l'amour ne saurait être mieux représenté que par le développement des puissances de X *moins* A beaucoup moindre que X.

—Aimable Laure (dit Velasquez) vous avez lu dans ma pensée. Oui charmante personne, la formule du binome inventée par le chevalier Dom Neuton, doit être notre guide, dans l'étude du cœur humain comme dans tous les calculs."

Mathematics in literature

These and similar passages from Potocki's novel represent the earliest appearance of mathematical themes I have found in European literature. Mathematics enters through the character of the geometer Velasquez, who speaks as a figure of the enlightenment (like Potocki, who was also trained in mathematics). It does not (manifestly) shape the form of the novel — in contrast to Broch's *The Sleepwalkers* which, according to Nina Engelhardt's text, was consciously influenced by the Foundations Crisis and the philosophy of the Vienna Circle. It does not provide the material of the fiction, in contrast to Stoppard's *Arcadia* and a number of 20th century texts (e.g., Zamyatin's *We*, or De Lillo's *Ratner's Star*, or Kehlmann's *Measuring the World*).

Mathematics: art or science?

Although the answer for Aristotle and al-Farabi was obviously that mathematics is a science, this has been an open question for mathematicians at least since Leopold Kronecker's thesis defense of 1845. Gayatri doesn't like institutional explanations, but Columbia maintains confusion on this point by including the mathematics department in the Division of Natural Sciences [but what is "natural" about mathematics?] while aligning mathematics **graduate student stipends** with those in the humanities, rather than those in other science departments. Perhaps it is on the basis of this bureaucratic confusion that Gayatri assumed that the novel *Subscript*, written in close consultation with paleontologists, could provide the starting point for an interdisciplinary dialogue involving a mathematician who has no disciplinary expertise whatsoever in any of the natural Natural Sciences.

In this Gayatri was not entirely mistaken. By ricochet, I was led to consider the paradigmatic interdisciplinary experiment between mathematics and the "human sciences" that took place in France in the 1960s, around the interaction between Bourbaki, Oulipo, and the nascent French structuralist movement.

Unfortunately, I couldn't find any way to link this to *Subscript*, even though Brooke-Rose spent 20 years teaching at the Université Paris-Vincennes whose initially experimental form grew out of the movement of 1968. However, out of respect for the Brooke-Rose novel, here are a few illustrations of the mathematical models of the processes described in the very first few pages, which amount to the creation of life — structure — where there was none previously.

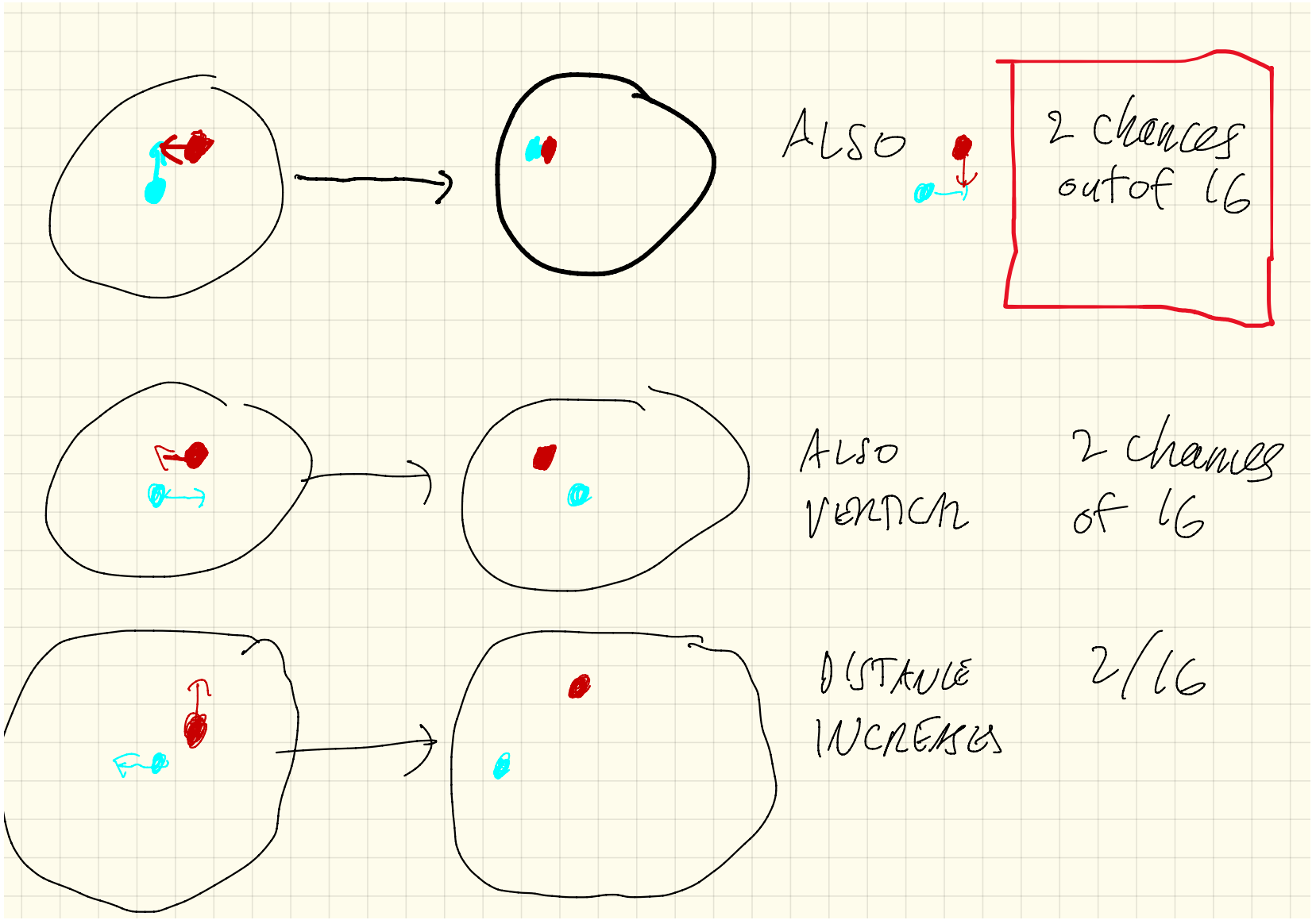
A superficial reading makes it clear that the first few pages draw attention to the biochemical processes (nucleic acids, catalytic reactions, etc.) as well as biophysical aspects (the role of the cell membrane, energy generation), in particular by using non-standard terminology ("sweeties," "lethal light," "foodmix," etc.) The only allusions to mathematical considerations refer to the time scale ("foreverness," "repeating") and especially the evolution of structure ("the code"). Both of these are illustrated by the theory of cellular automata, of which the most famous is the Game of Life invented by John Conway. Is this a convincing simulation of life? It is completely rule-bound — it can be used as a universal Turing machine — and the rules don't evolve, but it is self-replicating.

Zing!

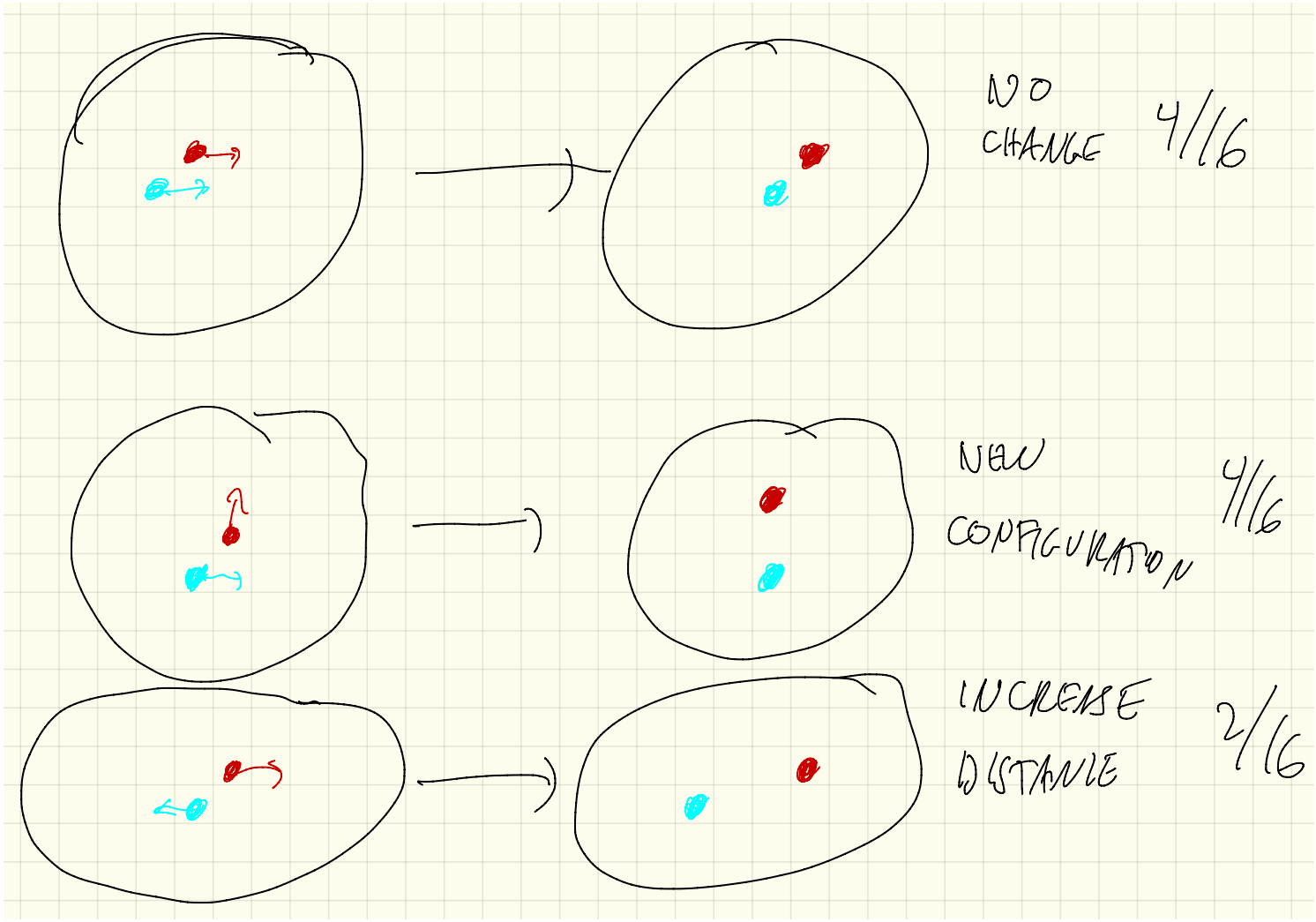
Subscript alludes to the long time-scale needed for major developments, like the main event of Chapter 1 — the formation of "the first" eukaryotic cell by the incorporation of a nucleus in a prokaryotic cell — but not to the kind of mathematics used to model such a process. This can be broken down very coarsely into (a) the evolution of structures that can enter into such a process, and (b) determining how the conditions come about to make such a process possible.

At least one of the mathematical ideas behind (b) is much simpler than the rest: if future nuclei and future external cells are floating at random in the ocean, how to model the chance that they will meet? The next few pages indicate a highly simplified model in a 2-dimensional ocean, where the cells make simultaneous moves along a rectilinear grid. A similar model can be made to simulate automated generation of a proof.

(But in the model time is immobilized…)



(The cells are in color, the outer ovals are snapshots of a part of the medium)


NO CHANGE
4/16
NEW CONFIGURATION
4/16
INCREASE DISTANCE
2/16

Other approaches to structure

Catastrophe theory (René Thom, *Structural Stability and Morphogenesis*, around 1970), the evolution of a dynamical system that depends on parameters, as the parameters change. Influenced by structuralism and by *On Growth and Form* by D'Arcy Thompson. Thom analyzed language itself, in its phonetic, syntatic, and semantic aspects, as a system of oppositions (following the structural linguists) where any opposition can be represented by a catastrophe.

Chaos theory (1960s-70s) Studied much more general dynamical systems and proved the existence of "strange attractors," stable patterns that are approximately but not precisely repeating and not effectively predictable.

Santa Fe Institute More sophisticated (and less strictly mathematical) synthesis of methods from statistics, information theory, and game theory with attention to physical properties of matter.

Entropy

The fundamental paradox in basic physics: **mechanics** (Newtonian or relativistic) is deterministic and therefore reversible in time, whereas **thermodynamics**, which is based on deterministic (statistical) mechanics, defines an arrow of time. This is independent of quantum mechanical effects.

Laure St. Raymond: the paradox can perhaps be resolved by recognizing that the comparison of the two kinds of equations introduces approximations that become increasingly inaccurate on small scales.

In *Subscript* the constant reference back to evolutionary memory and "the code" suggests that the evolutionary process can be rewound to reconstruct the past.

Oulipo: mathematics and the humanities

(from the book *The Oulipo and Modern Thought*, Dennis Duncan, 2019)

Calliope's electronic poems raise the possibility of the text voided of intention, free of authorial subjectivity, an idea which will find its theoretical apotheosis fifteen years later in Barthes's famous 'Death of the Author' essay. [Calliope was a poetry-writing robot, created by Albert Ducrocq around 1953.]

The similarities between a robot-poet rearranging the readymade words fed into it and the dethroned Author shuffling the terms of their ready-formed dictionary may appear tenuous or coincidental. Nevertheless, as a growing body of scholarship has begun to demonstrate, a fascination— and serious, grant-funded engagement—with cybernetics was instrumental in shaping the thought of structuralism's prime movers. In the early 1950s, Le Lionnais ... as Director of Science Education at UNESCO, set up a working party that… 'travaillait sur les rapports mathématiques-sciences humaines.' ... a few names: 'Guillebeau [sic], Claude Berge, Rémi Chauvin, Benveniste, Lacan, etc.' ... the same group that Elisabeth Roudinesco identifies in her history of French psychoanalysis: 'In 1951, Lacan, Lévi-Strauss, ... Guilbaud, and ...Benveniste met to work on

structures to establish bridges between the human sciences and mathematics'. Thus, we find a pair of future Oulipians, Le Lionnais and Berge, in the same working party as ... Lévi-Strauss, Lacan, and Benveniste, along with the mathematician Guilbaud whose La Cybernétique (1954) will become one of the most influential early expositions of cybernetics in French.

Two years after the UNESCO group was formed, Lévi-Strauss would convene another regular group that would draw heavily on the membership of the original working party:

> *With [Roman] Jakobson's help, Lévi-Strauss secured $2000 for MIT's Centre for International Study (CENIS), a center for cybernetic research covertly funded by the CIA, in order to organize an interdisciplinary seminar on cybernetics in Paris.*

Lévi-Strauss's grant application, submitted to CENIS in January 1953, outlines an extraordinarily distinguished line-up of speakers for the seminar—the psychologist Jean Piaget, the mathematicians Benoit Mandelbrot and Roger Penrose—but alongside these are the members of the earlier group: Guilbaud and Lacan, plus Lévi-Strauss himself. ... Lacan's language is replete with images of cybernetics, of 'thinking machines', of 'the rotating memories of our

machines-that-think-like-men'….describing a machine capable of linguistic output:

> *From the point of view of language, these little machines purr something new for us, perhaps an echo, an approximation let us say. One can't resolve the issue simply by saying that it is the builder who put it there.…*

It won't do, in other words, simply to say that the machine's message comes from the programmer determining the machine's input. … The literature machine—the system which generates meaning by its organization, by the play of combinatorics and difference—will become one of structuralism's key metaphors.

…Queneau's Cent mille milliards de poèmes—is described by Calvino as 'not so much a book as the rudimentary model of a machine for making sonnets' (and … quotes Alan Turing for its epigraph); …[Oulipo] announce themselves in … their first publication with the declaration that 'the time of created creations … the literary works we know, should cede to the era of creating creations, capable of developing from themselves and beyond themselves, in a manner at once predictable and inexhaustibly unforeseen'. From the start, the very idea of

potential literature has been about the agency of the text itself, developing from itself and not the expression of an author. It is only natural then that the possibilities of cybernetics within the literary sphere should be of fundamental interest.