Network Culture
Politics for the Information Age

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BIOLOGICAL COMPUTING

Writing in 1934, a few years before the first digital computers were assembled in the United States, technology historian Lewis Mumford called for an end to the numbing power of the industrial technological milieu and for it to be replaced by a new technological age - free from the dominance of the mechanical rationality of the clock and the deadening sensorial influence of materials such as iron and coal. Mumford thought that the future of technological development lay in a return to the organic, a return that he also significantly saw at the heart of research into modern man media: the study of the ear, throat and tongue, he remarked, had been fundamental to the development of the phonograph and research on motion in horses, cows, bulls, greyhounds, deer, and birds provided the basis for the scientific study of the relationship between images and movements that produced the motion picture. Mumford suggested that technological innovation was not intrinsically tied to the domination of nature, as the Baconian model implies, but also entailed a more challenging relationship with the artificiality of the natural world. Human technique does not so much construct increasingly elaborate extensions of man, but rather intensities at specific points its engagement with different levels of the organization of nature. Such levels are abstracted and redeploved within the complex social machines within which human and technical segments arrange themselves. The nature that emerges out of this interaction is itself not so complex, but also 'artificial', that is inventive and productive. Far from being syndrome with an eternal and immutable essence, the natural world comes across as multiple and complex, endowed with its own ingenious, adaptive and inhuman creativity. And machines, as George Canguilhem and Felix Guattari would put it later, can be more than mere mechanisms.

Mumford's call for an organic complication of the mechanical would not sound out of place in an age where communication networks are often described as self-organizing, evolutionary and bottom-up. Above all, the explosion of the Internet phenomenon has induced a rush to compare and contrast its workings with those of other systems endowed with a similar logic (from swarms to markets). Drawing on the insights of population biology, apologists for free markets and bottom-up organization have pointed out the ubiquity of the latter in the realm of the 'made and the born'. New Economy' endorsers claimed to be inspired by the ubiquity of evolutionary processes and their capacity not only to sort out the fit from the unfit, but also actively to produce the variety of life as such. This use of evolutionary theory pointed to an artificial nature - that is a nature that was made and unmade by specific and complex techniques that it produced immanently and without a predefined purpose or aim.

Inspired by the work of formidable computing pioneers such as John von Neumann and Stanislaw Ulam, the field of biological computing that is the focus of this chapter has engaged with the techniciity of nature as expressed in evolutionary processes and has thus been criticized as a sustained and misleading attempt to naturalize technical and social relations - giving support to the notion of a self-organizing Internet intrinsically given over to the beneficial action of free-market forces. Biological computing, in fact, is centrally concerned with understanding phenomena of bottom-up organization by simulating the conditions of their emergence in an artificial medium - the digital computer. The term refers to a cluster of subdisciplines within the computer sciences - such as artificial life (which aims to develop lifelike behaviour within computer simulations); robotics (the engineering of mobile robots that are able to learn from their mistakes); and neural networks (a bottom-up approach to artificial intelligence that starts with simple networks of neurons rather than with top-down sets of instructions). What these subdisciplines share is a common reference to John von Neumann's work in the 1950s with cellular automata - a go-like game entailing an open checkerboard and a population of squares bound by local rules of interaction. Von Neumann’s cellular automata have been demonstrated to be capable of universal computation (just like the universal Turing machine).

Since von Neumann’s times, the field of biological computing has developed into a well-funded and profitable field of research with important applications in areas as different as animation and cancer research. It has absorbed insights from chaos theory, molecular
biology, population thinking and, of course, evolutionary theory. Its field of interest can be described as the capacity of acentred and leaderless multitudes of simple elements, bound only by local rules, to produce emergent phenomena able to outperform the programmers' instructions. Biological computing explores the larger plane of abstract machines of bottom-up organization, of which the Internet appears as a specific instance and product. What makes such machines abstract is their lack of qualities: they are no more technical than they are natural, not could they be described as biological rather than social. Their simulation involves the description of an abstract diagram that brings into relation almost indefinite entities, laws and capacities - acentred multitudes, local rules, global dynamics, capacity to engender emergence, relative unpredictability, refractority to control. What biological computing asks is: How do such systems come to be? What are they made of? What rules explain them? How can they be treated and what kind of control modes are better suited to their immense potential and refractory tendencies?

If the network is a type of 'spatial diagram' for the age of global communication, the self-organizing, bottom-up machines of biological computation capture the network not simply as an abstract topological formation - but as a new type of production machine. In this sense, as we shall see, the processes studied and replicated by biological computation are more than just a technico-ideological expression of market fundamentalism. Biological computation implies an informational milieu where each point is directly connected to its immediate neighbours (on whom it acts and to whom it reacts); and is indirectly, but no less effectively, affected by the movements of the whole. A self-organizing system engendering emergent behaviour (that is, behaviour that has not been explicitly programmed or commanded) expresses a mode of production that is characterized by an exce of value - an exce that demands flexible strategies of valorization and control. In the next pages, then, when we will explore that entanglement of the organic and the inorganic, the physical and the biological, and the natural and the technological, in order to catch a glimpse of the convergence of a kind of abstract machine of soft control - a diagram of power that takes as its operational field the productive capacities of the hyperconnected many. But first, we shall proceed to a preliminary outline of what the shift to biological computation implies and its relation to the larger epistemic field of contemporary scientific knowledge.
located in a specific part of the human body, which could be damaged and easily destroyed if the organ was attacked. Thus if by accident or experiment a part of the brain is destroyed, with it go some of our memories and capacity to grasp the world. Neural nets are inspired by connectionist approaches to cognition that reject an understanding of the mind in terms of the morphology of the brain (or imply the presence of a representational cognitive box), as Rodney Brooks has put it. Here the brain and the mind are dissolved into the dynamics of emergence, the outcome of a multitude of molecular, semi-ordered interactions from large populations of connected neurons.

While organisms haven’t stopped being damaged by the destruction of individual organs, and the rational and perceptive capacities of individuals can still be dramatically affected by a physical blow to the head, such a conception of cognition is no longer occupying the centre stage of contemporary research into the artificiality of the mind. From the conception of the brain as a specialized organ that acts like a storage for memories and a coordinator for the whole body, connectionism moves on to outline the feature of a mind that is no longer located anywhere specific. As Gregory Bateson put it:

"We may say that 'mind' is immanent in those circuits of the brain that are completely within the brain. Or that mind is immanent in circuits which are complete within the system brain plus body. Or finally, that mind is immanent in the larger system - man plus environment."

In biological computing, the organism is sidestepped from above and from beneath: from above it dissipates into the collectivity of the connections (the mind plus its environment); and from beneath it is sidestepped by the parallel-processing features of the neurons in the brain and the central nervous system. Thus cognitive science somewhere in the brain, but emergent events assembled out of many discrete fragments in an act of partial reinvention. ‘These pieces of half-thoughts have no fixed home; they abide throughout the brain ... the act of perceiving and the act of remembering are the same. Both assemble an emergent whole from many distributed pieces.’

In artificial systems, the attempt to breed artificial forms of life is explicitly related to the dynamic of populations, whose local interaction produces a lifelike effect. ‘It is this bottom-up distributed, local determination of behavior that AI employs in its primary methodological approach to the generation of lifelike behavior.’ This can include the capacity of a robot to walk by letting its legs interact according to simple rules or the artificial evolution of software through genetic algorithms. Rather than being pre-programmed sequentially and built in hardware, these experiments aim to evolve lifelike behaviour. The biological turn is thus unabashedly mechanistic and reductionist: all life is reduced to a simple set of local rules governing the behaviour of simple machines. But, it claims, its mechanism is deeply different from the old one, ‘based as it is on multiplicities of machines and on recent results in the field of nonlinear dynamics, chaos theory, and the formal theory of computation.’

Biological computation is thus concerned with the power of the small. Small here should not be taken to indicate size and weight in the metrical sense. Smallness is not measured by rules and scales, but it is exterior and relational: it is described by an overall relation to a large number of variables, with no ultimate determination or central control. What determines the ultimate lack of any distinction between the natural and the artificial is the ultimate indetermination of a multitude. An individual broker within a large and turbulent stock market is as small as a molecule within a turbulent fluid. What makes the components of an open system small is not their size but the fact that they are grasped in terms of their overall relation to a large number of interchangeable components that interact on each other by way of recursive feedback loops. These systems do not simply die or reproduce themselves by way of an autopoietic movement, but they are always becoming something else: ‘They are forever dynamic and can be considered dead and of little interest when they come to thermodynamic equilibrium. It is really the dynamic properties of complexity, the motion pictures, not the snapshots, which characterize the systems in which we are interested.’

All these processes are grasped in terms not only of their risks but also of their potential conceived from the perspective of the replicability of open and productive structures. Thus Silicon Valley in the San Francisco Bay Area has been similarly analysed as a kind of ecosystem for the development of ‘disruptive technologies’, whose growth and success can be attributed to the incessant formation of a multitude of specialized, diverse entities that feed off, support and interact with one another. Such concerns have preoccupied different governments keen to replicate the success of the Silicon Valley postindustrial ecosystem. If the latter was not planned in any
traditional sense, but emerged as a host of technological innovations out of a multiplicity of different factors and connections, how can one replicate the same process elsewhere? A combination of the very small and the very large implies a shift in the organization of productivity, but how should this be accomplished if there is no formula that will fit all cases?

The matter is then not so much about cracking the secret of the micro in its entirety, but understanding the initial conditions, that, once got right, allow a certain kind of outcome to emerge spontaneously. Emergence must somehow be bound up in the selection of the rules (mechanisms) that specify the model, be it game or physical science. The outcome is not programmed step by step, but is, rather, carefully prepared at the beginning and there is no guarantee of success — as Manuel Castells and Peter Hall’s study of failed attempts at recreating the conditions for the emergence of millennials of innovation has also shown.

The most important feature of the systems studied and simulated within ecological computing is that they are not easily controllable or predictable. A multitude of simple bodies in an open system is by definition acenfused and leaderless. There is no single control structure that can be manipulated or attacked; the sheer multiplicity of nonlinear interactions, feedback loops, and mutations make the behaviour of such systems very hard to analyse, because it is impossible to control them completely and unequivocally (even the simple activity of observing them alters them). They cannot be known completely because they cannot be studied by dissection: once the connection and mutual affection with other elements is removed, the individual element becomes passive and inert. In the shift from the bug to the hive colony, from the individual to the population, from the internet user to a network culture, something happens and this something, although somehow inherent in the bug/individual, cannot be found in it by any of the traditional means (it is both pre-individual and collective). You can observe and kill an individual entity, anatomize it, and you still won’t find out what it is that will make it act in a certain way once it acts as an element within a population open to flows. You can collect as much data as you want about individual bees, but this won’t give you the dynamic of the overall network.

This leads us to wonder what else is packed into the bee that we haven’t seen yet? Or what else is packed into the hive that has not yet appeared because there haven’t been enough honeybee hives in a row all at once? And for that matter, what is contained in a human that will not emerge until we are all interconnected by wires and politics?

Knowing what it is that is packed into an individual but that is not reducible to it is a matter of some importance considering how inherently unstable such systems are. A multitude can always veer off somewhere unexpected under the spell of some strange attractor. On the other hand, while difficult to control, these systems are characterized by a potentially enormous productivity, what the literature on the subject describes as their dynamic capacity to support ‘engaging events’, while acting with a high degree of distributed ‘autonomy and creativity’. This autonomy and creativity is produced by a process of recursive looping that generates divergent and transmutable variations at all points. Such systems, that is, are characterized by their tendency to escape from themselves, continually diverging, at the same time, such divergence does not generate complete differentiation because such matrices are spread by way of diagonal and transversal dynamics. Finally, there is no guarantee that such bottom-up dynamics will lead to emergent behaviour: systems can also come to a standstill or veer off catastrophically in unforeseen directions.

A crucial problem for the simulation of the behaviour of such entities is that of reproducing the right speed, that is the right degree of boundedness, of a multitude. A bottom-up system, in fact, seems to appear almost spontaneously not so much as a result of a change in the composition of individual elements, but more in relation to how loosely such elements can interact with each other (it is a function of their overall speed). A multitude, for example, is quite foreign to sequentiality, whether it is the linear and closed sequentiality of the assembly line or the one-directional flow of broadcasting. When segments are connected together in a single line, they become immediately bound to each other and to the overall structure and hence geared towards reproduction rather than becoming. Similarly, a transversely-connected multitude is quite alien to the logic of mass societies, in as much as the solidity and boundedness of the mass tend towards the production of homogenization, that is an increasing homogenization, while a multitude tends to engender, multiply and spread mutations. ‘We should learn more about predicting and controlling critical stages in the process of emergence. This knowledge,
in turn, should help us to understand better the processes that crown human intellectual undertakings: innovation and creation.\textsuperscript{18}

SEARCHING A PROBLEM SPACE

New Economy capitalism made much of the relationship between bottom-up organization and speed and focused on the importance of fluidity as a physical condition. At a certain level of speed, in a semi-ordered or liquid phase, large numbers are subject to a different kind of rules than solid and bound entities.

It has long been appreciated by science that large numbers behave differently than small numbers. Moths breed a requisite measure of complexity for emergent entities. The total number of possible interactions between two or more members accumulates, exponentially as the number of members increases. At a high level of connectivity, and a high number of members, the dynamics of moths takes hold. More is different.\textsuperscript{39}

\textbf{Morbidity}, then, as Kevin Kelly put it, is explicitly linked to the need for a different inmanent logic of organization that demands new strategies of control to take advantage of its potentially infinite productivity while controlling its catastrophic potential. So it should not surprise us how much biological computing owes to the mechanics of fluids.

In his eulogy of bottom-up organization written at the height of the 'free market' digital wave, Kevin Kelly quoted the writings of C. Lloyd Morgan, who in his 1923 book \textit{Emergent Evolution} defined emergent phenomena as 'a different variety of causation'.\textsuperscript{40} The emergent step, though it may seem more or less salutory [a leap], is best regarded as a qualitative change of direction, or critical turning-point, in the course of events.\textsuperscript{50} In this sense, the biological turn entails a rediscovery, that of the ancient \textit{cinnamon} (or sweerz) – the explanation given by the pre-Socratic philosopher Epicurus for the existence of a principle of indeterminacy in the form of chance in atomic theory.\textsuperscript{25} This sweerz or cinnamon, a principle of chance and indetermination, is identified by Ilya Prigogine and Isabelle Stengers as a crucial intuition into the features of \textit{low-entropy-equilibrium systems}, systems that are that are very sensitive to fluctuations.\textsuperscript{22} Michel Serres associates the cinnamon with the ancient Lucretian notions of \textit{turbo} and \textit{turb}.\textsuperscript{21}

The minimal angle of turbulence produces the first splash here and there. It is literally revolution or it is the first evolution toward something else other than the same. Turbulence perturbs the chain, troubling the flow of the identical as Venus had troubled Mars.\textsuperscript{33}

For Michel Serres, the sciences of the climenary take as their central concern fluctuations, deviations, and instability. In the biological turn such features are not discarded or pushed outside the perimeter of legitimate scientific investigation, as was the case, as Prigogine and Stengers argued, with classical science from Aristotle to Clausius. The acknowledgement of an original difference of cinnamon/deviation (a microdeterritorialization or line of flight) is taken as the object of study in order to develop a better knowledge of, and implicit control over, the action of randomness and chance in populations at the point where they have lost all social qualities and qualifications. Within financial and investment banking, for example, in the randomness and chance inherent in markets characterized by high fluidity of currency and investment patterns, such uncertainty is considered a source not only of potentially immense profitability but also of dreaded, abrupt changes – the kind of changes that can depress stock markets for years or trigger new types of global wars. For management theory, autonomy in the workplace is a similarly volatile compound: it represents a highly productive source of value but can also dangerously veer in unprovable directions. Within bureaucratic organizations such as governments, banks, and corporations, flows are looked at with mixed feelings, from glee and greed to suspicion.

The biological turn in computing gives such mixed feelings a solid basis in scientific knowledge and technical experimentation, where fluid states are considered essential conditions for emergence. The synthesis of emergent phenomena out of a fluid and hence uncertain organization is described as a search for a particular 'phase space', which is characterized by a specific level of speed:

\ldots there was a certain area where information changed but not so rapidly that it lost all connection to where it had just been previously. This was akin to a liquid state. It was the liquid regime that supported the most engaging events, those that would support the kind of complexity that was the mark of living systems.\textsuperscript{41}

The question is how to maintain the productivity of a fluid space, dynamically perched between the unproductive extremes of solidity
and gaseous chaos. Or as Tim Berners-Lee put it, 'we certainly need a structure that will avoid those two catastrophes: the global uniform McDonald's monoculture, and the isolated Heaven's Gate cults that understand only themselves.' It is a matter thee of finding the right speed that facilitates activity.

To use somewhat anthropomorphic language: in equilibrium matter is 'bland', but in far-from-equilibrium conditions it begins to be able to perceive, to take into 'account' in its way of functioning, differences in the external world (such as weak gravitational or electrical fields). A fluid state is thus defined as a relation of speed determining the level of connection between molecules or components which allows them the capacity to deviate and spontaneously produce turbulent phenomena. A space of flows engenders emergent phenomena but does not guarantee that they will always be of use or even advantage to the experimenter or the planner, because they are open to sudden transformations or catastrophes. Since planning is confined to the initial conditions, preferred outcomes can only be hoped for rather than counted on. Emergent output needs to be carefully collected and valorized at the end of the process with a very fine-toothed comb; it must be modular with a minimum amount of force. It cannot be analysed, but only synthesized, by experimenting with the set of constraints that facilitate it. This is a control of a specific type, it is a soft control. It is not soft because it is less harsh (often it has nothing gentle about it) but because it is an experiment in the control of systems that respond violently and often suicidally to rigid control.

GLOBAL COMPUTATION

Biological computing applies the algebraic logic of Boolean functions to local interactions among artificial populations of code. In this, biological computing follows population thinking - a perspective on life that brings together evolutionism and genetics.

In a nutshell what characterizes this style may be phrased as 'never think in terms of Adam and Eve but always in terms of larger reproductive communities'. More technically, the idea is that despite the fact that at any one time an evolved form is realized in individual organisms, the populations not the individual is the matrix for the production of form. Population thinking considers a given form, such as an animal, as the statistical result of a larger process of diffusion of genetic material at different rates and different times. Population thinking has produced a great awareness of transversal genetic lines cutting across biological forms, their variations and the coevolutionary processes that have produced the variety of populations and complex organisms on earth. Although some populations can become isolated by geological accidents (as with the Ma in New Zealand, for example), generally speaking populations operate as open systems. The differential rates of diffusion of genetic material across and within populations can be computed over time and such computation highlights the fluctuations and leaps that characterize the evolution of life. For Stuart Kauffman, the meeting between population biology, Darwinism and genetics is crucial to contemporary understandings of life. Contemporary evolutionary biology has learned to connect the historical variation of species and populations in terms of the diffusion of genes and genetic variations under the aegis of natural selection. The link between evolutionary biology and computation dates back to John von Neumann's work in the aftermath of World War II with a computational experiment called 'cellular automata': (or CAS - "a relatively new field that appeared in the midst of the intellectual dust that accompanied the development of the first digital computers"). This interest was a recurring concern of information theory and computer science (Claude E. Shannon's mentor, Vannevar Bush, also encouraged him to write his MA thesis on the relationship between information and genetics). Von Neumann's CAS, however, are the most common point of reference for biological computation. They were devised as an alternative approach to computation that was originally developed as a means to formalize the characteristics of life - in tune with the formalist spirit that we know informed the emergence of the Turing machine. As can also be seen as a complex kind of game, and it is as a game, such is John Conway's game of life, that CAS are probably best known outside computational circles.

According to John Holland, a leading researcher in artificial life, the original impulse for the construction of cellular automata came from Stanislav Ulam, who was interested in 'model physics', that
is mathematical models of the physical universe that obeyed the two main laws of physics: they had to have a geometry and a set of locally defined laws that held at every point of the geometry. In a series of lectures entitled 'General and Logical Theory of Automata', von Neumann showed how such model physics could be used to replicate one of the key formal features of life, that is, self-reproduction. He thus embarked on building a formal model that could be shown as capable of making copies of itself by simply following a set of mechanical and local rules. His models of self-reproducing automata, or CAs, were shown to correspond to the mechanisms driving the replication of genetic material in the cell and are also considered today as serious alternatives to Alan Turing's universal computer. Variations of von Neumann's CAs (such as quantum cellular automata) are also researched in terms of their potential to take computing power beyond the limits of current microchip manufacturing technology. Cellular automata machines (such as Tom Toffoli and Norman Margolus's dedicated CA computer CAM-B) have been shown to be able to simulate dynamical systems that are beyond the reach of conventional computers and even supercomputers, such as fluid mechanics. The particles in fluids can be represented in such detail that Toffoli now considers that he is not working with a computational system but instead he says he is manipulating "programmable matter". The key idea of CAs is that there are formal structures that are able to perform global computation through a system of local rules that simply dictate the relationship of each cell/particle/node with its neighbours. In a cellular automata system, every cell reacts exclusively to the state of its neighbours and it is on this basis that it changes. The cumulative result of these changes has been shown to be capable of universal computation, with some classes of cellular automata able to model the behaviour of chaotic and open systems. CAs can be played like a game, in as much as they involve the invention of rules and their application to a population of cells. In spite of their random appearance, cellular automata have been shown as capable of computing. This is no mean feat, since to use a cellular automaton to solve an equation requires asking hundreds of thousands of components to produce a reliable result by reacting individually but in a strictly determined manner to the behaviour of their neighbours. Any computer simulations of CA systems have, however, proved that you can solve equations in this way, even though it involves a process of trying, testing and running hundreds of simulations until one hits on the solution. A classic example of a cellular automata system able to perform very complex computations is the nervous system - with its millions of simultaneous local interactions producing conscious perception by way of emergence. CAs have also been shown to be able to successfully model complex phenomena ranging from the role of neural and selective mutations in cancer to the dynamics of neural nets; from cell-robotics using adaptive pricing to the emergence of social morals and computer assisted design in architecture.

Biological computing envisages an abstract computational diagram able to simulate (and hence capture) the productive capacities of multitudes of discrete and interacting elements. The most productive challenge of CA systems to the sequential computer lies in the fact that they do not start with the easily controllable linearity of a tape, but with the multiplicity of a population. What produces the computation is not a sequence of instructions carried out by an individual probe head, but a multitude of simultaneous interactions performed by a potentially infinite population. A CA system, in fact, can be imagined as an open chessboard space divided into a potentially infinite number of cells/nodes each one of which can be in a number of states (von Neumann devised a very complex CA with 29 states, but the game of life has only two: dead or alive). In a two-dimensional CA, each node is linked to eight neighbouring nodes. The single node would change its state by following a rule table that dictates what it should do in relation to each specific configuration of the other eight cells. Thus, if the eight neighbouring cells are true, for example, the central cell would obey an instruction that says that if they are all blue, it should turn yellow. Its turning yellow would in turn affect the states of neighbouring cells, and so on. All changes of phase happen simultaneously according to discrete time steps. CA researchers have shown that simply by playing around with the initial configurations and the rule table, one can get such populations of cells to replicate any other machine - exactly like a universal Turing machine, but using a different logic that involves the collective and decentralized work of populations in synchronized, local and nonlinear relations. Different CA systems differ in terms of the number of dimensions considered (there are one-dimensional and two-dimensional CAs although they could theoretically have any number of dimensions); and the states which the cells can be in (they range between the dead/alive state of the game of life to von
Neumann's 29 states. More importantly, CA systems can differ in terms of the rule tables that dictate the changes of state of each node (what Christopher Langton has called the 'genotype' of the CA). Each rule table will produce different configurations depending on the initial state of the cells in 2D life (or gliders, the name for these different configurations engendered by identical rule tables is 'phenotypes'). This simple model constitutes a type of computation that is locally connected but spatially extended and capable of global computation. There is no central control determining which each cell should do according to a general blueprint or master plan. Each cell is subject to the sample of rules according to which it changes state at every time step together with all its neighbors. All the interactions take place at the local level, depending simply on the relationship between each cell and its neighbors. And yet this decentralized system of rules has been shown to be capable of producing a high-level computation that cannot be explained through the action of individual cells. CAs underplay the importance of individuals in favor of collective dynamics. This collective dynamics, however, is not related back to the action of a central agency in charge of regulating the fluctuations, but is capable of spontaneous self-regulation. CAs form dynamic millefui, space-time blocks, that have real territorial qualities but do have rich topographies and challenging dynamics.

Unlike Turing machines, which George Cafleretti has likened to a kind of Taylorism of intellectual work, CA machines cannot really be programmed in the usual sense. It is impossible, that is, to develop in advance the sequence of configurations that running a CA experiment will produce, once a set of rules and an initial configuration are given. There is no prediction involved, but a strategy of proliferation and selection. If one runs a CA genotype long enough, something good may come out of it. If it doesn't, however, there is no point in trying to fix it. Other genotypes, involving different sets of rules, will be found that are more successful in completing the task. CAs systems can be classified only a posteriori, that is after they have been tried out.

Researchers such as Stephen Wolfram and Christopher Langton have tried to produce some kind of classification of such distributed computational systems. Wolfram was the first to accomplish an empirical classification of CA dynamical systems by cataloging 100 runs of the game of life. As a result of his survey, he found that most CAs fit within four classes. Class I CAs were those programs that for some reasons ended up running out of computational capabilities very quickly by reaching a limit or end point after which no computation was possible. Class II CAs, on the other hand, are characterized by what chaos theorists describe as 'limit cycles': they produce self-replicating structures (such as gliders) that spread across the computational space by self-replication. Class III and IV CAs, however, express a qualitative jump in complexity with relation to the spatially extended and capable of global computation. That do not simply repeat themselves, like those of Class II, but that are also capable of scaling and hence of progressively structuring the CA space. Class III CAs have proved to be good models of how the basic function of metabolism is carried out in similar ways in organisms of very different sizes (from oxen to squirls). Finally Class IV systems are chaotic, that is unstable and random but with no predictable time limits (a Class IV CA, for example, is the weather where specific rules produce a high degree of randomness and unpredictability).

Artificial Life pioneer Chris Langton also attempted Wolfram's repeated runs of CA systems (still running them thousands rather than hundreds of times). What he came up with was not only a different order of classification (I, II, IV and III), but also a key metric or lambda, which is correlated to the rate of information flow within a CA system. What lambda measures, that is, the fluctuation of different CA systems with relation to their computational abilities. What Langton found was that this metric could vary between 0 (defining a state where a system is in a random that is incapable of computing) and 1 (defining a highly structured system that is not flexible enough to compute). A key finding was that the most interesting computational activity takes place at around the value of 0.5 – a value that within chaos theory is associated with phase transitions, that is with the points at which a system changes its state, such as for example when water starts to boil. Within CAs, then, the key area of computation is identified with a border zone fluctuating between highly ordered and highly random CAs. Within this phase significantly, the behaviour of each node ceases to be strictly determined by its immediate neighbours and starts being affected by the overall fluctuation and propagation of information across the CA space. These fluid CAs have been shown to be capable of the most complex computation thus constituting a real alternative to Turing's universal machine, but one that does not respond to direct control.
SOCIAL EMERGENCE.

The outcome of a CA run, then, cannot be predetermined or planned in its entirety (and as such, as Kevin Kelly put it, it is 'out of control'). Being out of control does not mean to be beyond control. The type of control that such fluid populations respond to, however, is quite different from the negative control of autopoietic living organisms that self-reproduce within closed boundaries. The fluidity of populations, their susceptibility to epidemics and contagion, is considered an asset: at a certain value or informational speed, the movement of cells turns liquid and it is this state that is identified as the most productive, engendering vortex structures that are both stable and propagating. It is these dynamic structures, as they are produced by the propagation of movement in a CA world, that are considered computationally interesting. This liquid behaviour is typically characterized by a swerve - that between the moment when the model is constructed, through a rule table and an initial configuration, and the moment of emergence of useful or pleasing forms. Ideally, CAs should always produce a level of surprise and unexpectedness for the human observer.

Getting CAs to compute, therefore, is no easy feat, for it requires a very careful fine tuning: the rules that define the transition functions between the different possible states of the cell must be determined with the utmost care. This fine tuning can only be carried out by successive runs until one is able to find the right computational level able to carry out a specific task. On the other hand, the fact that a CA system is in principle capable of carrying out a computation does not mean that it will actually do it spontaneously. This is why a new level of control is introduced - not just the fine tuning of initial conditions but also the modulation of the global aims and objects of the computation.

A common way in which such global modulation of aims is carried out in CA systems is through the 'genetic algorithm' model. Genetic algorithms are a special type of search algorithm, like the ones that run a popular search engines such as Google. Genetic algorithms work by searching the computational space and measuring the success rate of different CAs (defined by their genotypes or rule tables) on the basis of their phenotypes (that is the actual performance produced by the rules when starting from different configurations of the state of the nodes). What determines the outcome of the competition among CAs is a fitness function that defines the different scores attributed to different CAs. Inefficient CAs are screened out, while the most efficient systems are left to compete and even swap traits with each other. This model has proved to be highly effective in determining optimal solutions to specific problems, in as much as this CA race usually ends up by reaching an optimal zone where the task is computed efficiently and in a minimum amount of time. Successful genotypes, whose phenotypes have proved more successful than others, are thus selected for analysis or targeted use. Genetic algorithms thus act as virtual sieves whose meshes can be adapted to the specific purposes of simulation. All that remains after this process is the cells that do not conform to the patterns and so form boundaries between the regions of cells that do.33 The behaviour of these active boundary particles is then analysed to see if it conforms to any kind of rule.

If such a rule does exist (and can be found), then the CA has been explained. ... If no such rule exists, there the process must be repeated, once again trying to extract patterns out of the mess of particles this time, yielding perhaps meta-particles and so on.34 The genetic algorithm approach to CAs has been criticized as being unable to produce true emergence, that is phenomena of self-organization and computation that are not explicitly programmed by a human agent. The genetic algorithm model of control is thus deemed insufficient by some A.I. researchers in as much as it does not leave enough space to genuine emergence. If the fitness functions are too strict and too task-oriented, CAs cannot compute a task that has been given to them, but they cannot produce genuine novelty, that is events which are not prescribed by initial rules and conditions.35 The genetic algorithm thus describes both a mode of control and its limits (those of 'true' emergence, that is, a potential for transformation that cannot be programmed or even aimed for).

The control of acedent multitudes thus involves different levels: the production of rule tables determining the local relations between neighbouring nodes; the selection of appropriate initial conditions; and the construction of aims and fitness functions that act like sieves within a liquid space, literally searching for the new and the useful. These sieves separate those configurations that seem to produce static outcomes from those dynamic particles that deviate the most from the structure. These dynamic particles do not obey laws of statistical regularity. Because they do not fall within the regular (or the ordinary)
they can perform computations at the cutting edge. At the same time, these configurations cannot be allowed to pass all the way into randomness, where the turbulence is so strong that no real control can be exercised. The particles selected thus come to constitute a visible and dynamic boundary zone or active limit capable of emergent computation. What the von Neumann machine reveals is a kind of content for a cybernetic machine of social control: not a stabilizing life threatened by entropic forces, as in the first cybernetic wave, but a level of indeterminate production entrusted to acented multitudes that potentially never run out of energy. The content of such control is not a population understood as a mass that must be kept from undergoing dangerous swerves, but a multiplicity of computational milieu spread over a fluid and dynamical space.

**HACKING THE MULTITUDE**

In the late 1990s, the 'out of control' techniques of biological computations found particular favour with capitalist corporations, which have been important sponsors, for example, of the Artificial Life Center at the Santa Fe Institute. Cellular automata, in fact, model with a much greater degree of accuracy the chaotic fringes of the social — zones of utmost fluidity, such as fashions, trends, stock markets, and all distributed and acented informational milieus. Biological computation parallels the emergence of a larger set of social techniques that are concerned with inducing and controlling the formation of bottom-up milieus of self-organization. Outside the computer world, that is, biological computation expresses a socio-technical diagram of control that is concerned with producing effects of emergence by a multiplication of the rules and configurations within a given milieu.

If we were to look for human CA experiments, for example, we would find them in the organizational models of the New Economy, such as those documented by Andrew Ross's ethnography of New York's 'Silicon Alley' company Razorfish. For Ross, Razorfish, with its open-plan offices and its enthusiastic labour force who did not consider work as 'labour', constituted an important moment of experimentation with alternative modes of organization able to capitalize on the productive capacities of an educated and alienated GenX milieu. A dynamic and turbulent company that enjoyed an exponential expansion in the late 1990s, Razorfish was proud of its stimulating working environments that guaranteed a high level of innovation and professionalism in digital design. Razorfish's working environment, in its turn, expressed an encounter between the American East Coast bohemian profile and the Silicon Valley start-ups ecology — a highly successful model of a decentralized/robotted technological innovations. In this sense, the social experiment of the New Economy, i.e., biological computation itself, expressed an encounter between the introductive edges of the capitalist economy and the relapse of a 1960s counterculture and its ejection of dull and repetitive forms of labour.

Another description of the Razorfish offices by Lev Manovich can further illustrate the point:

The large, open space houses loosely positioned workspaces occupied mostly by twenty-something employees. The manager proudly points out that the workers are scattered around the open space regardless of their job titles — a programmer next to an interface designer next to a Web designer.  

Manovich describes the space design as defined by computer culture's key themes 'interactivity, lack of hierarchy, modularity'. But these features are also those of the CA machines: a world without qualities, where all elements of a population are conceived exclusively from the point of view of local interactions with a view to the modulation of global entities and goals (such as staying on top of the digital design game). The work culture of the New Economy was informed by a movement of reform in management theories which emphasized the value of letting teams of workers control the production process by introducing a new set of management rules (decentralization, delegation, deadline, etc.). The New Economy CA proved itself a highly turbulent and productive one, but was ultimately selected out of existence by the algorithms of a capitalism undergoing another of its energy crises. Whatever the fate of singular social CA's, biological computation is indicative of a mode in which the productivity of the milieu, as opposed to the territory, is highlighted: not a closed system (a people; a group; a class), but an open milieu (a dynamic multitude spreading across a smooth space).

Biological computing offers us an insight into a wider mode of soft control that takes as its focus the space-time of the werve — that between the moment when the model is constructed, through the positioning of constraints, and a local determination of behaviour.
and the moment of emergence of useful or pleasing forms that are selected by exercising pressure or looked for through the elaboration of searching devices. Control is located at the two ends of the process: at the beginning, when a set of local rules is carefully put together and fine tuned; and at the end, when a searching device or a set of aims and objectives aim at ensuring the survival of the most useful or pleasing variations.

It is in this larger framework that we should understand the definition of a network offered by Kevin Kelly as ‘the least structured organization that can be said to have any structure at all’ but also ‘one of the few structures that incorporates the dimension of time. It honors internal change. We should expect to see networks wherever we see constant irregular change, and we do.’

It is not just any network that will do to support the interaction of such large numbers, of this multitude in continuous variation. It is the network as ‘a grand mesh’, a form able to accommodate all variation and its mutations – an abstract machine that goes beyond the model to become the actual terrain for the study and engineering of complex and innovative behaviours. The open network is a global and large realization of the liquid state that pushes to the limits the capacity of control mechanisms effectively to mould the rules and select the aims: ‘Running genetic mechanisms online puts heavy constraints on the selectionist mechanisms that can be used but it brings the experimental conditions closer to real autonomous robotic agents.’

The great discovery of the biological turn is not only that there exists an abstract machine that can facilitate, contain and exploit the creative powers of a multitude (human and inhuman). It is also about the discovery of the immense productivity of a multitude, its absolute capacity to deterritorialize itself and mutate. What gives the biological turn its mystical tone is the discovery of this productive line of flight, associated with the unpredictability of this middle zone, a relative autonomy and creativity, that is decoded, freed up from the constraints of sequential programming, almost at the same time as it is recoded, brought back into the fold by selection in the form of fitness functions. None of these considerations however takes away from the fact that a new content is entered the control of production: not simply a vague assemblage of information flows and feedback loops, but a spontaneously productive and autonomous force, endowed with its own specific activity that can be modelled and determined only at certain points, by exercising pressure selectively and moderately. Between local microdeterminism and the transcendent fitness functions, we find that the power of the middle zone can only be partially controlled. It is this middle, autonomous and productive zone, in between local determination and global selection, that the term ‘emergence’ partially captures.

One of the reasons why modelling emergence seems to be important is because it offers the key to a mode of control that does not require an absolute and total knowledge of all the states of each single component of the system or a rigid specification that rules behaviour exactly and sequentially. This new mode of control is ‘soft’, it applies a minimum amount of force, and modulates ‘specification vs. creativity, closure and replicability vs. open-endedness and surprise’. The abstract machine of soft control is thus concerned with fine tuning the local conditions that allow machines to outperform the designers’ specifications, that surprise the designers but spontaneously improve on them, while also containing their possible space of mutation.

Thus, the founders of the Institute for Bionomics, for example, confidently argue for the necessity of abandoning the dependence of economic science on Newtonian physics.

Where mainstream economics is based on concepts borrowed from classical Newtonian physics, bionomics is derived from the teachings of modern evolutionary biology. Where orthodox thinking describes the economy as a static, predictable engine, bionomics sees the economy as a self-organizing, ‘chaotic’ information ecosystem. Where the traditional view sees organizations as production machines, bionomics sees organizations as emergent social organisms. Where conventional business strategy focuses on physical capital, bionomics holds that organizational learning is the ultimate source of all profit and growth.

We have come to associate such statements with a short-lived phase of capitalist euphoria, but notions of bottom-up organization of large numbers within fluid spaces are still central categories in our apprehension of a medium such as the Internet. To many, in fact, the strange behaviour of the Internet, especially its capacity to expand and mutate with no plan and no central controller in charge, has appeared uncannily lifelike. The Internet as a medium and a culture appears to many as a macroscopic demonstration of the existence and feasibility of acentred and leaderless forms of organization that mirror some of those that we are familiar with
in the natural world. After all, the Internet mainly developed as a parallel, piecemeal, localized activity, so that it can be classified, according to Sadie Plant for example, as 'bottom-up'. Electronic Frontier Foundation pioneer Jon Gilmore's claim to immortality is probably to have coined the sentence: 'The Net interprets censorship as damage and routes around it.'

This catchy statement, a refrain of network culture, is grounded in important technical features of the Internet and guaranteed by a socio-technical culture that similarly emphasizes autonomous and distributed forms of organization of labour. The popularity of peer-to-peer networks, open-source software or recent phenomena such as web logs is only the most recent example of what seems to many an intrinsic vitality of a bottom-up, piecemeal, parallel approach to organization and the culture that it supports. This spontaneous productivity is said to be intrinsically related to the distributed and decentralized organization of large numbers of interacting peers and to be a feature of social, technical and natural systems. It is an excessive production of cooperation and interaction that has brought forth the development of new techniques of control.

Does this imply, then, that the Internet as a medium and as a cultural multiplicity is a virtue of its loose, bottom-up technical structure, has managed to replicate some of the features of the natural world? The description of the Internet as an ecosystem, inhabited by knowledge, and substantially self-organizing was common in the mid 1990s, when neoliberal and conservative writers such as Alvin Toffler, George Gilder, Esther Dyson and Newt Gingrich used it to forcefully reject the Clinton administration's description of cyber-space as an 'information superhighway'. In Being Digital, Nicholas Negroponte's popular columnist on Wired and director of the Media Lab at MIT, similarly considered the Internet to be a remarkable example of something that has evolved with no apparent designer in charge, keeping its shape very much like the formation of a flock of ducks.

Controversy around such statements marked the 'California ideology' wars of the early 1990s, controversies that pitted the techno-utopianism of Californian hippy entrepreneurs against the critical objections of sociologists and cultural activists. The controversy around the self-organizing and lifelike nature of the Internet split the 1990s cybercultures along neat ideological lines. Such an opposition could be possible in an atmosphere where social scientists and humanities scholar had mostly aligned themselves with a radical social constructionism, according to which nothing social can also be natural. Starting from the notion that everything that is natural is fixed and predetermined, many writers rejected the analogy between the Internet and natural systems on the basis of the idea (often justified) that such statements implied a kind of neo-social Darwinism. To say that the Internet might be lifelike was the equivalent of sanctioning the ravages brought by rampant free-market capitalism on the 'excluded' masses.

But wasn't somehow such an exclusive and often vehemence rejection of 'natural metaphors' and 'analogy' as they were called missing something as well? The notion that the Internet presented features and behaviours that could also be observed amongst natural phenomena was not simply a set of statements meant to organize the perception that gave social form to a new medium. The study of lifelike behaviour, in fact, is not simply a rhetorical exercise but has been accompanied by a larger move that connects social to natural and technical components. The biological turn is, as we have seen, not simply a new approach to computation, but it also aspires to offer a social technology of control able to explain and replicate not only the collective behaviour of a distributed network such as the Internet, but also the complex and unpredictable patterns of contemporary informational capitalism. Thus, the simulation of the behaviour of 'a multitude of simultaneous actions' is also seen as the key to understanding not only the behaviour of stock markets, but also that of 'fashion and fads'.

The biological turn thus seems to extend from computing itself towards a more general conceptual approach to understanding the dynamics of the Internet, network culture, milieus of innovation and contemporary 'derigulated' markets – that is of social, technical and economic structures that are characterized by a distributed and dynamic interaction of large numbers of entities with no central controller in charge. These systems are not unstructured or formless, but they are minimally structured or semi-ordered. Since the turbulent flow of information ensuing from a multitude of nonlinear simultaneous actions is not exclusive to the Internet and market economies, but can also be observed in a variety of natural phenomena, then it is quite appropriate that this specific potential of the natural world should become the object of intense technical, cultural and economic interest. The 'business network' of the Institute for Complexity in Santa Fe, for example, includes Citibank/Citicorp, Coca-Cola, Hewlett-Packard, Intel, Intervia, John...
Deere, Shell International R.V., Xerox and a variety of financial advising companies. Early on, the CEO of Citibank/Citicorp became interested in SFI and helped begin SFI's program in understanding the world economy as a complex evolving system. Any discussion of the Internet as a life-like phenomenon seems thus to be entangled with the reformulation of the problem of control, in terms which are more appropriate to the behaviour of the new entities that contemporary scientific and technological research are literally discovering, as Ilya Prigogine put it, after years of neglect: open systems subject to a large variety of semi-autonomous variables. Control here is cybernetically defined in two ways: as the opposite of mechanical rationality (step-by-step programming), because the latter is too rigid and ultimately too brittle to operate on such terrain; and also as the antithesis of centralized government, because the latter presupposes a complete knowledge of each individual component of the overall system, which is impossible to achieve in these three types of structure.

Taylorism and governmentality are thus both rejected as unsuited to this new turbulent, but also hugely productive terrain. At the same time, however, cybernetic control as defined by the first wave of cybernetics, that is to say the work of Norbert Wiener, is also rejected. It no longer sufficient to neutralize all positive feedback, that is all new variations and mutations, by bringing the system back to a state of equilibrium (negative control is acknowledged as ultimately ineffective in staying off the forces of chaos). The open and productive systems studied by the biological turn are, by definition, always operating in far-from-equilibrium conditions, dynamically perched between two layers and conditions: one rigid, unmoving and ultimately sterile, associated with permanence and static and another chaotic and turbulent, opening up onto unexpected and potentially catastrophic transformations. The problem of contemporary modes of control is to steer the spontaneous activities of such systems towards plateaus that are desirable and preferable. What we seem to have then is the definition of a new biopolitical plane that can be organized through the deployment of an immanent control, which operates directly within the productive power of the multitude and the citizen.

THE UNHAPPY GENE

It seems then, as if the science of multitudes has definitely given up on the individual, which it dismisses as an epiphenomenon that is simply too coarse and rigid to be more than a by-product of emergence. If there is an abstract social machine of soft control, it takes as its starting point the productivity of an acented and leaderless multitude. However, we might also say of the individual what Michel Foucault said of the family in his analysis of the rise of governmentality in the modern state. Talking about the new place of the family in the mode of governmentality, Foucault comments that the family disappears as a model but is kept as a tool of government. We could say a similar thing for the development of soft control. The new place of the individual in the mode of immanent control is not a model or the organization of a multitude, but as a tool that allows the overcoding and the ultimate containment of the productive power of flows. To the decoding of the mass into a network culture, to the dissolution of the individual into the productive powers of a multitude, corresponds an over-coding of the multitude onto the individual element understood as a unit of code modelled on the biological notion of the gene.

Amoq the mixture of disciplinary insights drawn upon by biological computing, in fact, we find the controversial thesis of sociobiological thinkers such as Richard Dawkins, author of pop science bestsellers such as The Selfish Gene, The Blind Watchmaker, and River Out of Eden. To simplify Dawkins' work somewhat, we might say that he understands the variations of populations as ultimately determined by the 'selfish' drive of individual genes. This selfish drive compels them to replicate themselves at the expense of other competing genes. The human body, or for that matter the whole of the world of organic and inorganic life, is simply about the set of devices through which selfish genes manage to replicate and protect themselves by competing with other genes in an environment characterized by scarce resources. Dawkins himself experimented with biological computation (and he wrote about it in The Blind Watchmaker).

The concept of the selfish gene is crucial to biological computing, and therefore relevant to our understanding of soft control. It is here not simply a matter of ideological affinity between the white male milieu of Affle researchers (as described by Stephen Heitmceh) and the sociobiological perspective. It is not so much, in fact, that biological computing is influenced by sociology, as that they both share a keen understanding of the necessity of introducing some kind of 'cut' in the fluid fabric of a population for the purposes of artificial synthesis of the computational capacities of natural life.
this sense, sociobiological work such as Dawkins’ does not so much inform as clarify the modalities according to which the individual is given a new role to play within the open plane of emergence.

Dawkins defines a gene in computational terms as ‘a sequence of nucleotide letters lying between a START and an END symbol and coding for one protein chain’. What characterizes this unit is its capacity to replicate itself and to survive through a large number of successive individual copies. There is no fixed measure for such units:

I am using the word gene to mean a genetic unit that is small enough to last for a large number of generations and to be distributed among the form of many copies. This is not a rigid all-or-nothing definition, but a kind of fading-out definition, like the definition of ‘big’ or ‘old’. The more we look at a chromosome is to be split by crossing-over, or altered by mutations of various kinds, the less it qualifies to be called a gene in the sense in which I am using this term.

This unit is endowed with a minimum set of capacities: the capacity to replicate itself, where replication is a kind of dynamic mobility, because by replicating, genes also tend to mutate; the capacity to compete for scarce resources; and the capacity to collaborate, but only if collaboration suits the selfish aims of the gene, that is its freedom of replication.

What I have done is to define a gene as a unit which, to a high degree, approaches the ideal of indivisible particularities. A gene is not indivisible, but it seldom divided. It is either definitely present or definitely absent in the body of any given individual.

What Dawkins’ theory allows is the replacement of the individual by the unit or, as Deleuze named it, a ‘dividual’ resulting from a ‘cut’ within the polymorphous and yet nondeterministic mutations of a multitude. Dawkins is very explicit in defining the individual as an unsuitable basic unity for the kind of giant computational capabilities that underlie the evolutionary process. It is not a matter of immortality, because individual genes or units of code are not immortal. They have emerged at some times out of the chemical interactions of a turbulent matter-energy continuum and will die eventually, even if their lifespan can be measured in thousands or even millions of years. Genes, however, are not individuals but units in the sense that they do not grow senile, they are never young or old, that is they are not subject to the second law of thermodynamics that decrees that the individual organism is bound to die and decay.

As informational units, all that matters is their capacity to replicate themselves and survive in their many copies – or fail in replicating successfully and hence disappear. In this sense, the life of a unit is binary: it is either there or not there; it does not grow any older or younger with time; it is a cut in the body of the multitude that makes it more manageable from the point of view of the replicability and synthesis of a specific type of control diagram.

Dawkins’ formulation of the gene is thus perfectly suitable to find its application in the biological turn, because it defines genes by means of the cut that gives a program a functional beginning and an end. The computational abilities of the gene unit are not constructed or attributed by Dawkins to the gene, but, on the basis of contemporary scientific knowledge and research, they have been shown to correspond to some of the capacities of genetic molecules. They have also provided the basic concept through which the biological turn has managed to translate these ideas into actual working pieces of software, that are capable of producing their own emergent phenomena. In this sense and at its most basic level, Dawkins’ understanding of the gene is of genuine relevance to any attempt at modelling natural laws in a technical machine. If a gene is a unit of code, that is identifiable as lying between two symbols, one designating Start and the other End, then it can be easily coded by a computer. If one writes several units of codes and lets them be free to pursue their survival by replication, they will at some point manifest different degrees of emergent behaviour. At the level of simulation, identifying a unit of code as an individual allows better manipulation, and greatly enhances the possibility of determining and applying local rules of behaviour. It also allows the identification of units that can be rewarded and/or punished, selected and/or rejected.

Biological computing suggests that the bounded organism contains both the pre-individual and the collective – two levels of being that are infinitely more productive than the individual as such. They are more productive because they do not produce thermodynamically, like the organism, for example, that burns heat and progressively drives itself to a slow decay and finally death. As we have seen, units of code are mortal, but they do not grow old. They are either there or
not there and when they are there they are always productive, always doing something.

The most common critique to Dawkins' theory from sociologists and culture theorists is that this little unit of code is classified as 'selfish', that it is juxtaposed with a category that belongs to very different planes of organization — those of a Protestant-capitalist apparatus of subjectification.93 Why should a unit of code be subjected to the moral universe of good and evil, which is where 'selfishness' and 'altruism' are located? In the passage from the description of the gene as a unit of code and the unconvincing description of the gene as 'selfish' like a 'trade unionist', or a 'Chicago Gangster', something else happens. The unit of code that we know as the gene has been returned to individuality so that it might assume the attributes of selfishness and altruism, competition and cooperation. The mode of existence of the selfish gene (the individual) as opposed to the 'gene' (unit of code; generic algorithm) is the distance that separates the simulation of molecular life and the capture of the power of a multitude in a network culture. If the gene is a unit of code that makes evolution a computing machine, the selfish gene is the subjectifying function that turns a multitude into an assembly of isolated individuals.

The selfishness of the subject of informational capitalism which is the underlying metaphor here has little to do with actual genes. As Dawkins himself admits, genes have no 'purposes', they obey obscure impulses dictated by complex chemical laws. With no sense of purpose, arguably, there is no self and hence no selfishness. What the theory withholds is, however, is to betray some of the ways in which the social powers of the multitude are captured. Selfishness is defined by Dawkins as a sociobiological tension between competition and collaboration — where the gene is like a calculating machine always weighing the advantages of collaborating or competing in order to gain in advantage of survival. If the selfish gene is a subject, it is because I think, and it can think only two thoughts: in a particular situation, do I increase my chances of survival by collaborating or competing with other units? Or am I better off looking after number one to the exclusion of and in competition with others? Selfishness closes the open space of a multitude down to a hole of subjectification.

The selfish gene is a simple diagram of the apparatus of subjectification that the abstract machine of soft control distributes and perpetuates not so much among molecules as among collectivities.
It is understandable, then, that rebellion to the claustrophobic selfishness structure (with its two poles of competition and collaboration) should be explicitly marked by the rejection of being subjectified as selfish genes striving for survival at the expense of others. The most challenging areas of network culture in terms of control are those that emerge out of a choice for the chemical interaction of relationships of affinity and/or war within a space that is radically open over that of selfishness/cooperation within a close subjectivity structure. Not altruism against selfishness, but relationships of affinity and war (a whole different economy of relations) that cut through the space of the individual without reducing it to a unit — but freeing up a potential for transformation and even catastrophe. From the point of view of the abstract machine of soft control, there is no ontological difference between the threat of a global network of terrorists able to carry out devastating attacks on the heart of empire and the threat of a global network of anticapitalist activists (hence the recurrent and contested claims, after 11 September, that the movement for global justice was potentially terrorist, or the movement of connected peers exchanging copyrighted files without payment on peer-to-peer networks. I am not implying that they are all the same, of course, or that the punishments can be compared. The potentials for destruction and creation are also very differently weighted. But from the perspective of this mode of cybernetic control they do express different sides of the same rebellion: the rejection of the existential condition of living as a stripped-down selfish gene, endowed with the intoxicating capacity to form a multitude, but recoded within the claustrophobic black hole of the selfishness structure (cooperation/competition). The threat of these swarms, from the perspective of the engineers of control, is that by rejecting the system’s most basic sets of constraints, by rejecting the micromoulding of individualism, they might push it out of control, towards a new plateau, whose outcome not only cannot be predetermined but might also very see the system violently towards catastrophic transformations.

There is a big gap, of course, between the small pieces of code that we know as genetic algorithms and cellular automata, and the dynamics of political resistance in network societies — a gap that actualizes itself in divergence and turbulence. The selfish gene, however, is not just a metaphor, or a moralization of natural life or an ideological justification of cutthroat competition in the ’free’ market economy. It is, however, a technique. It is a mode of capture of value produced by an increasingly interconnected and interdependent culture in as much as the latter is also an industry — and hence a mode of labour. This excessive value that can never be really reabsorbed in a logic of exchange and equivalence is frequently referred to in autonomist Marxist writings as a kind of biopower of labour — that is a power of making and remaking the world through the reinvention of life. That nothing could be further away and yet so close to the models of biological computation says something about the political stakes involved in the emergence (and control) of network societies.

CODA ON SOFT CONTROL

If we open up a path for critical inquiry and conceptual engagement with biological computation beyond the deconstructive critique, are we necessarily playing the game of power, that is accepting the naturalization of social relations? In a way, we are, in the sense that we accept that the game of power is the only game in town in as much as it identifies and enacts an indetermination of the social and the natural across a microphysical continuum that denies the human the ontological status of an exception. On the other hand, beyond the easy rhetoric of popular accounts of self-organization, the natural that emerges out of biological computing is as artificial as the social — indeed it is the artificiality of the natural that the social takes over and reinvents.

In this sense, biological computing opens up two interesting questions for a cultural politics of network culture. On the one hand, it challenges us to think about how a certain mode of distributed organization can become also the milieu for the development of new modes of control. Thus it takes the notion of self-regulation and organization in large numbers outside any mythological landscape of a utopia to be realized and places it firmly within the horizon of emerging modes of power. Self-organization, in other words, is not incompatible with transcendent control or with the ’unhappiness factory’ assembled by informational capitalism.

On the other hand, and more intriguingly, an engagement with biological computation and the sciences of emergence offers us a way to engage with the political concept of the ’multitude’ beyond the temptation of reconstituting a new, indefinite subject of history. As defined by Harud and Negri in Empire, and as adopted within the activist milieu of network culture, a multitude defines a political mode of engagement that is located outside the majoritarian and
representative model of modern democracies in their relation with the recomposition of class experience. Unlike class, however, a multitude is not rooted in a solid class formation or a subjectifying function (although it is also a matter of class composition). It is too indefinite a concept to carry such power. For Franco Berardi, "[t]he notion of the multitude describes a tendency to dissolution, the entropy that is diffused in every social system and which renders impossible ['asintotico,' infinite, imitable] the labour of power but also the labour of political organisation." Like the smooth milieu of biological computation, the multitude too is a necessarily vague term that is defined mainly by a fluidity of movement and by the formations that such fluidity leaves behind as a kind of after-effect. As such, it does not deny the existence of the stratifications of identity and class, but it opens up another dimension where such positions are caught in terms of other types of capacity. If this is the case, then logical computation (in its widest possible sense) is an attempt to 'hack the multitude' — to hack the social at its most fluid and least stratified, wherever it escapes the constrictions of rigid forms of organization but also of identity and class. As such and beyond some of its most simplistic applications, the CA model has much to offer to any attempt to think about processes of bottom-up organization and emergence in network culture, their relationship to the recomposition of capitalist modes of production and the political potentials that such recomposition opens up. Hacking the multitude is still an open game.

5 Communication Biopower

THE NEW SUPERPOWER

In his bestselling critical account of his time as the chief economist and senior vice-president of the World Bank, Joseph Stiglitz repeatedly suggests that one of the problems with international institutions is their lack of transparency and hence accountability. The systematic manner in which the International Monetary Fund managed effectively to undermine growth in developing countries and enrich foreign investors was for him a result of a culture of secrecy in which the actions of the Fund were not subject to a sustained public scrutiny (whilst also being skewed in favour of US lobbies' economic interests).

Secretary also underlines democracy. There can be democratic accountability only if those to whom these public institutions are supposed to be accountable are well informed about what they are doing — including what choices they confronted and how those decisions were made.

Thus for Stiglitz, freedom of information is paramount and 'sunshine is the best antiseptic', that is exposure of such dealings to the light of public opinion is conducive to healing the malaise of international governance. Or, as it has also been put, within a one-world power system, 'public opinion is the new superpower.' In asking for more transparency and better accountability, Stiglitz is echoing one of the most fundamental assumptions of modern political thought, in which the relationship between transparency of communication and democracy is foundational. From Diderot and Voltaire to Thomas Payne, modern conceptions of democracy start from the demands of bourgeois revolutionaries for free speech and political representation. A democracy does not just guarantee but is guaranteed by the rights of its citizens to representation in the spheres of both politics and communication. These rights include that of accessing information concerning the exercise of public authority.