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## Abstract Urbanism

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One of the first computational models of cities was Thomas Schelling's "Models of Segregation" in this, and related papers of around the same period (1969-71), he attempted to provide a logical model for understanding the dynamics of racial segregation in north American cities and laid much of the groundwork for what later became agent-based modeling.<sup>1</sup> Such work is expressed contemporarily for instance in the work of J.M. Epstein and others in the area of computational social modeling.<sup>2</sup> Although *Models of Segregation* did not at first use a computer, it sets up some of the basic characteristics of the field. We use this work as a starting point to think about the relationship between urban morphologies and the politics of models on the one hand and the way in which, with the increasing and multiform kinds of merger between computational systems, models, and city forms, what it means to live in a model.

The history of computing, from G.W. Leibniz onwards, tangles with the problematic of developing rational approaches to complex, multi-dimensional problems with a high-degree of what John Law describes as "messiness".<sup>3</sup> This paper will examine the ways in which logical forms are positioned in relation to urban life as a means of discussing the relations between the city and software. The paper will develop a discussion of such logics in relation to questions of abstraction, reduction and empiricism. By working with the materiality of computational systems, especially as they unfold into the urban – and the urban in a full sense, as something involving complex comings into being of desire, imagination, technologies, forms of power and so on - we can at the same time recognise and perhaps an art of working with the tendency to reductionism through which modes of abstraction may operate and also work with the highly and complexly empirical. As social simulations are increasingly embedded in or cleave close to lived social forms, the texture and reality-forming capacities of these logics and the fantasies they inspire and live by needs to be examined.

### Development of simulation as a scientific practice

One of the attractive aspects of modeling as a means of experimental understanding is that it offers a science of behaviours rather than of essences. It is peculiar therefore that one of the earliest examples of social simulation derives from a highly essentialist

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<sup>1</sup> Thomas Schelling, "Models of Segregation", *The American Economic Review*, vol. 59, no 2, *Papers and Proceedings of the Eighty-first Annual Meeting of the American Economic Association* (May 1969) pp.488-493.

<sup>2</sup> J. Epstein, "Modeling civil violence: An agent-based computational approach", *Proceedings of the National Academy of Sciences*, Vol. 99, Supplement 3, May 14, 2002, p.7243-7250. More recent work building on Epstein's model is, Antonio A. Casilli, Paola Tubaro, "Why net censorship in times of political unrest results in more violent uprisings: A social simulation experiment", *Journal of Urban Economics*, Vol. 99, Supplement 3, May 14, 2002, p.7243-7250. More recent work building on Epstein's model is, Antonio A. Casilli, Paola Tubaro, "Why net censorship in times of political unrest results in more violent uprisings: A social simulation experiment on the UK riots", *Social Science Research Network Working Paper*, August 14, 2011; and, Toby P. Davies, Hannah M. Fry, Alan G. Wilson & Steven R. Bishop, "A mathematical model of the London riots and their policing", *Nature Scientific Reports* no.3, Article number: 1303, 21 February, 2013.

<sup>3</sup> John Law, *After Method, mess in social science research*, Routledge, London, 2004.

ontology. Perhaps this can be seen as an example of a new epistemic form emerging out of a prior set of commitments that it has yet to break.

*Models of Segregation* builds on the game theory established in 1947 by Oscar Morgenstern and John von Neumann and provides an early formation what would later become the wide field of agent-based modeling.<sup>4</sup> Schelling's earlier work in *The Strategy of Conflict* of 1960 can be seen as a presiding spirit in its attempt to map and rationalize options in the decisions around actions in the space of conflict. What is particularly innovative here is the schematization of non-zero sum conflicts.<sup>5</sup> The paper later becomes material for Schelling's book of social modelling, "Micromotives and Macrobehaviour."<sup>6</sup> In the opening stages of his paper Schelling sets up segregation as a fundamental axiom of great applicability, he mentions men and women, Catholics and Protestants, boys and girls, officers and enlisted men in an army. Not all of them necessarily tend towards dichotomous formation. People are sorted by, "sex, age, income, language, colour, taste, comparative advantage and the accidents of historical location" amongst other factors. It is assumed that the sorting behaviour for each of these is the same.

A two dimensional line is drawn (It is important that this is a line, not a grid) with equal representations of space along its axis. It is populated with an equal number of blacks and whites.<sup>7</sup> Whilst the distribution looks even on the macro level at the micro level they are uneven. Maybe three blacks are conjunct with one white then a black and then three whites. If the whites and blacks are content with a 50% split between the colour of their neighbours then those who have a white neighbour on one side and black neighbour on the other reach the contentment threshold and stand still if the neighbourhood to be considered has a radius of one. Those with too many black neighbours or white neighbours will move in order to achieve contentment. In a neighbourhood with a radius of one, the line BBBBWWWW several iterations later would become BWBWBWBW. If the neighbourhood extends to two houses then the B and W coloured red in the following example BBBBWWWW would be looking for a new neighbourhood. Schelling takes this basic model changing the variables Contentment and Neighbourhood and plays out various scenarios. In Schelling's original paper agents move directly across populations to find contentment in more recent computational interpretations the application determine whether or not the agent is content or discontent. If the agent is unhappy, the algorithm will select an adjacent square. If the square is empty then the agent will move to it. If it is occupied, then stay where you are.

To summarise, in Schelling's model, each agent belongs to black or whites and aims to reside in a neighbourhood where the fraction of blacks/whites is above a predefined tolerance. Schelling's pattern of residence either creates a complete integration or segregation.

Curiously, there is no reflection on the constitution of racial sorting even in excusatory fig-leaf terms of politics, ethics, or even morality. Like the amusing stories of house-hunting amongst "professors and their wives"<sup>8</sup> that he also describes the specific categories upon and through which segregation operates are described as if natural, not even worthy of equivocation as to their relation to social structure. The

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<sup>4</sup> Oscar Morgenstern and John von Neumann, *A Theory of Games and Economic Behaviour*, 2<sup>nd</sup> ed. Princeton University Press, Princeton, 1947.

<sup>5</sup> Thomas Schelling, *The Strategy of Conflict*, Harvard University Press, Cambridge, 1960, 2<sup>nd</sup> ed., 1980.

<sup>6</sup> Thomas Schelling, *Micromotives and Macrobehaviour*, W.W. Norton and Company, New York, 1978.

<sup>7</sup> A Perl program to generate the Schelling Model is online at, <http://faculty.ucr.edu/~hanneman/spatial/schelling/schelling2.pl>

<sup>8</sup> In *Dynamic Models of Segregation* and the sorting and mixing chapter of *Micromotives and Macrobehaviour*.

racism of the work is both that it operates by means of racial demarcation as an autocatalytic ideological given and secondly that it provides a means of organising racial division at a higher level of abstraction. To say that Schelling operates within an ideologically racialised frame is not to aver either way as to whether Schelling as a person is consciously racist, but that, in these papers, racial division is an uncontested, “obvious” social phenomena that can be *reduced* in terms of its operation to a precise set of identifiers and operations. David Theo Goldberg’s formulation of the problem is useful here:

“The mark of racist expression or belief, then, is not simply the claim of inferiority of the racially different. It is more broadly that racial difference warrants exclusion of those so characterized from elevation into the realm of protection, privilege, property, or profit. Racism, in short, is about exclusion through depreciation, intrinsic or instrumental, timeless or time-bound.”<sup>9</sup>

Describing such a situation in a fragment from his diary written during an extended visit to the USA in 1959-60, the novelist Italo Calvino notes the ways in which urban form in the city of Cleveland is produced by the intersection of the cycling of consumption in neighbourhood level zones, where middle class white families buy cars, clothes, vacations in a pulsed frequency that synchronises identity and occupation with space and subjectivation. The poor areas are variations on this, with a hierarchy of racial types, Middle Class Blacks, Jews, Hungarians, Puerto Ricans, Mexicans, white Virginians, moving through cities as they degrade, stabilise or otherwise change.<sup>10</sup> The story is familiar, as are the many richly deserved parodies of it.

The naturalization of such a situation of depreciation by at a distance means in which entities kindly self-organise into ghettos out of their own otherwise unlimited choice must have been a marvelous boon to someone. What these papers offer is the construction of a machine for the operation of binary categorization that in turn becomes an engine for spatial organisation, of preference based segregation, as if the provision of housing in the form of a market is entirely smooth and demand driven, as if there are no variations in housing kinds and qualities, geographic features, cultural variations in population and so on. In the urban space described by this work it is as if the model were describing a landscape in part shaped by the car that makes every address as seemingly randomly accessible as a memory register on a hard-drive. A few years later, the architectural group Archizoom indeed produces an amplified representation of a city reduced to the most minimal form of grid, in *No Stop City* (1968-70) the city becomes a dromescape.<sup>11</sup> What better future can we imagine than a state of permanent white flight, with computing cycles speeding up, populations moving into mobile homes and urban planning becoming solely devoted to traffic massaging of a population fuelled on angst and cheap petroleum?

What Schelling’s work allows for is for an operation of governance that works by a means beyond that of direct sorting and selection, the direct command and control of populations, but rather by eliciting and installing an action grammar in which people “spontaneously” recognise, in the words of Nina Simone’s song, *Mississippi Goddamn*, “I don’t belong here, I don’t belong there”, moving on to make the proposition: “You don’t have to live next to me, just give me my equality.”<sup>12</sup> It is indeed the terms by which such an ostensive equality, once it has been given, sets to

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<sup>9</sup> David Theo Goldberg, *The Threat of Race, reflections on neoliberal racism*, Wiley Blackwell, 2009.

<sup>10</sup> Italo Calvino, “American Diary, 1959-60”, in, *Hermit in Paris*, Penguin, London, 2003, p.60.

<sup>11</sup> Pier Vittorio Aureli, *The Project of Autonomy, politics and architecture within and against capitalism*, Princeton University Press, Princeton, 2008.

<sup>12</sup> Nina Simone, “Mississippi Goddamn”, in, *Nina Simone in Concert*, Philips, Eindhoven, 1964.

work that is of interest here: all those pennies on the board, looking so equal.

This form of equality, its seeming universality is a driving motivator in the transition in the work of William Bunge, initially a quantitative geographer and spatial theorist whose *Theoretical Geography*<sup>13</sup> and related work attempts to discern universal geometrical laws for spatial development, but who later coupled such an approach with a deep empirical and activist engagement with a particular square mile of Detroit, Fitzgerald.<sup>14</sup> Although in both cases Bunge consistently argued that geometrical patterns and morphological laws express disadvantage and injustice under contemporary capitalism, and that identified patterns could be remedied by rational methods there is a transition from the equality of uniformity, of what Sartre and Guattari call seriality, to the equality of the singular.<sup>15</sup> Schelling's "Models of Segregation" and Bunge's "Fitzgerald, geography of a revolution" are separated by less than three years both respond to questions of racialization and class in the United States of America and both use constructs drawn from mathematical logic as means to work into and sort social dynamics. Both have an enthusiasm for experimental forms. Both use relatively plain speech, and are praised in both cases for making contributions to fundamental problems and eschewing jargon. One of them ends up losing his job and working as a taxi driver, the other wins the Nobel Prize for Economics.

Schelling specifically offers the image of urban form being operated upon by an "invisible hand", emerging at a higher level in social and material creodisation or channeling.<sup>16</sup> There is a tension then between the figure of this invisible hand and the view of the agent. The hand operates in an ostensibly emergent natural way, arising out of the conditions of the situation as they are, beyond how they are seen by individual actants. In this, the work affiliates itself with the long term questions of social physics of August Comte and subsequent workers in this vein, and the formulations of right and proper order emerging at a macro scale out of the interactions of entities at a micro scale familiar from liberal economic thought. Although Jean-Pierre Dupuy calls the potential liaison between cybernetics and game theory a "missed rendezvous"<sup>17</sup> the work also has certain conceptual resonances with aspects of accounts of self-organisation achieved by logical forms coming into the discourse of second wave cybernetics a little earlier.<sup>18</sup>

### **Abstraction as Urbanism**

Schelling's abstract machine is a machine for the bipolar reduction of variation. The urban grid becomes equivalent to that of a truth table, but one of the advantages of such an abstraction is that it requires no specific material form simply logical equivalence. As recounted in a rather glowing chapter in a festschrift, Schelling used pennies, heads or tails up, on a draughts board to simulate, "what sort of segregation patterns develop given various types of preferences and alterative definitions of neighbourhood".<sup>19</sup> The scale of the board becomes the limit-factor of the diagrams

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<sup>13</sup> William Bunge, *Theoretical Geography*, Lund Studies in Geography, Gleerup, Lund, 1962.

<sup>14</sup> William Bunge, *Fitzgerald: Geography of a Revolution*, Schenkman Press, Cambridge, Massachusetts, 1971; reprint University of Georgia Press, (Geographies of Justice and Social Transformation), 2011.

<sup>15</sup> Jean Paul Sartre, *Critique of Dialectical Reason*, Routledge, London, and Félix Guattari, *The Three Ecologies*, Continuum, London, 2008.

<sup>16</sup> Christopher H. Waddington, *Tools for Thought*, Paladin, St. Albans, 1977.

<sup>17</sup> Jean-Pierre Dupuy, *The Mechanization of the Mind, on the origins of cognitive science*, Princeton University Press, Princeton, 2000. p.126

<sup>18</sup> Willard Ross Ashby, "Principles of the self-organizing system," in, *Principles of Self-Organization: Transactions of the University of Illinois Symposium*, Heinz Von Foerster and G. W. Zopf, Jr. eds., Pergamon Press, London, pp. 255-27.

<sup>19</sup> Richard Zeckhauser, "Thomas Schelling, Ricochet Thinker", in, Robert Dodge, ed., *The Strategist, the life and times of Thomas Schelling*, Hollis Publishing, New Hampshire, 2006. p.x.

published in a later paper, “Dynamic Models of Segregation.”<sup>20</sup> One can certainly imagine a media-archaeological analysis of the history of simulation starting with checkers or draughts boards. John Conway, in developing the game of life, famously extended his to cover most surfaces of his office.<sup>21</sup> Only having four significant neighbours, termed Neumann neighbours<sup>22</sup>, adds a certain simplifying factor to the board, the constraints of which in order to get certain kinds of effects need to be surpassed by the kinds of scale more recently offered by electronic computing.

In later work by Epstein, marking a fundamental shift in agent-based modeling, the environment was considered as a partially ordered list where each element on that list is a scalar of a fixed range of values to be thought of as resource bearing sites. Unlike living organisms, in ABM the medium (environment) is fully separate from the agent on which they operate and with which they interact. Indeed, a media analysis of the field would tend to divulge a number of aspects of its material practice that are rendered conceptually and procedurally invisible. One of these would be the way in which models tend to be bound by the temporal constraints of “turns” in which all agents shift at the same time. Most computer science models need to have all variables change at the same time – but models of sociality need to vary the time in which all variables change. Equally, the model’s interaction with hardware, and the need to represent data to human users also renders the use of CPU cycles for drawing graphical representations as something of an interference, when compared with how many agents could be processed instead.

A few years after Schelling’s work was published, and amidst the rise of the counterculture, Ted Nelson stated in *Computer Lib* that, “Simulation is always political”.<sup>23</sup> Computers as an abstract machine for the integration of all symbol systems, that is to say of all systems operated upon by discrete values, or that can be rendered as digital provide in a certain sense a great degree of plasticity in the social forms they might generate: hence the significance of Nelson’s formulation. The specific kind of politics simulated is also articulated by the specific qualities of the mathematical structures that comes into composition with them. (For instance, systems of four or eight neighbours; bounded, unlimited or wrapping grids and so on.) It is a very rare case in which there is a direct correlation between the various scales of model, media, mathematics, the social form modeled, the ideological commitments specified as politics in such simulations, and the actual politics of the material operations of such systems in use.

### **Diagram City**

Joshua Epstein and Robert Axtell’s book *Growing Artificial Societies, Social Science from the Bottom Up* was based on “Models of Segregation” and refined and developed using concepts drawn from the Game of Life developed in 1970 by John Horton Conway.<sup>24</sup> In Conway’s cellular automata and Schelling’s space of segregation the environment has no proprieties other than to be bounded or not, something that has consequences for the way in which these models carry over into urban planning and the modelling of cityscapes. Epstein and Axtell’s innovation was to place agents in an active environment in which the agents were pre-programmed to explore the

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<sup>20</sup> Thomas Schelling, “Dynamic Models of Segregation”, in, *Journal of Mathematical Sociology*, 1971, vol.1, pp.143-186.

<sup>21</sup> Martin Gardner, “The fantastic combinations of John Conway’s new solitaire game “life””, *Scientific American*, no.223, October 1970, pp.120-123.

<sup>22</sup> Edward F. Moore gives his name to systems of eight neighbours in a rectilinear grid.

<sup>23</sup> Ted Nelson, *Computer Lib*, 1974 “All simulation is political. Every simulation program, and thus every simulation, has a point of view. Just like a statement in words about the world, it is a model of how things are, with its own implicit emphases: it highlights some things, omits others and always simplifies”

<sup>24</sup> Joshua Epstein, Robert Axtell, *Growing Artificial Societies, social science from the bottom-up*, The MIT Press, Cambridge, 1996.

environment to find a simple codification of some basic property such as sugar to keep their metabolism alive. Agents have internal states and behavioural rules that are fixed at the start or that can inherit change in interaction with environment or other agents. This is a model as a form of regression analysis, or rather of using regression as a form of proposition, where the relations between entities are fixed but variable. The environment is a lattice of resource bearing sites in a medium that is separate from the agents, but on which they operate and with which they interact. Both agents and the environment have rules. This innovation adds another level of complexity to the ecology of agents, developing newer models working with forms of emergence.<sup>25</sup>

Joshua Epstein has produced a body of work discussing the ethics around agent based modelling that seek to affect US governmental policy by creating explicit models that can be used to create an explanation of social phenomena that he is very careful to distinguish prediction from explanation. In his article *Why Model?* Epstein challenges the assumption that scientific theories are created from the study of data.<sup>26</sup> He asserts that without a good theory, it is not clear what data should be collected. The model requires theorisation; his main assertion is that modelling creates habits of mind essential to what he calls freedom and to enquiry.<sup>27</sup>

Agent-based models have been eagerly taken up as objective explanations of conflictual social forms. The capacity to express forms of emergence, with the invisible hand effectively rationalizing commonsensical observations of the inevitability of racial segregation exciting dreams of implementation. As such, this work evinces a fascination with finding fundamental laws of social aggregation, rhetorically building on those found in natural sciences, in turn triggered by those historically associated with mathematics. At this stage we can say that the model and the discourse around it still act in a representational mode.

Simulations now operate for an enormous range of activity. They act as a form of prognosis and forecasting, of pre-emption and the maintenance of irresolvability as well as the ability to formulate an explanation with empirical traction without having to be true. Simulations also develop specific kinds of techniques and vocabularies, as well as the software to handle and interpret them – object orientation being one such example.<sup>28</sup> OOP is fundamental to how agent based modelling conceives of itself in that it allows objects to hold data and functions – data fields hold the object's instance variables – in internal states. The object exports a limited set of methods with which to interact with the object – and generally the data is held private to the object. It is not globally addressable. This is why the behaviour of objects comes to the surface – rather than the data that underlies them. Functions or methods are the agents' rules of behaviour. Equally, we can say that simulations may act as a kind of theory of mind for the state and other institutional and organisational forms. Jean Baudrillard's surprisingly notorious formulation about the first gulf war not happening should be remembered in this sense, in that it was an event that rolled out after having been pre-effectuated by models, plans and fantasies of action.<sup>29</sup> Political elections, car interiors, football stadia, economic plans, the design of traffic systems, not to mention the psychic life of persons, are all deeply

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<sup>25</sup> Along with Robert Axtell, Epstein created Sugarscape, a software system for agent based modelling.

<sup>26</sup> Joshua Epstein, "Why Model?" *Journal of Artificial Societies and Social Simulation* vol. 11, no. 4 12

<sup>27</sup> Joshua Epstein, Advances in Agent-Based Computational Modelling, Lecture at Johns Hopkins Global Centre on Obesity, 11<sup>th</sup> November, 2013, online at: <https://www.youtube.com/watch?v=DAAvrfzJ0Ec/>

<sup>28</sup> See, Matthew Fuller and Andrew Goffey, "The Unknown Objects of Object Orientation", in Penny Harvey et al. eds., *Objects and Materials*, Routledge, London 2014.

<sup>29</sup> Jean Baudrillard, *The Gulf War did not Take Place*, The Power Institute, Sydney, 1995.

interwoven with and activated through modelling and anticipatory axiomatisation.

What we see as a novelty in this kind of work is the way in which particular forms of computational abstractions themselves become operative elements in social and urban formations. Computation becomes folded into the operations of societies, and social forms become computational problems. As the programmable city begins to incorporate models such systems cease being merely representational.

Here we can see that there is a correlation between formulations such as those of Epstein and Schelling, (and those that followed in developing simulated societies) and the social sorting by software described by Steven Graham in his *Software Sorted Geographies*.<sup>30</sup> Where there is a difference however is that Graham describes a disciplinary sorting *on* the social. In agent based modeling by contrast, there is an interplay between the schema of sorting and the actions of individuals and social formations without engaging with the level of implementation. There are kinds of sorting occurring, but more adequately expressed as a multi-scalar, multi-variable sorting enacted by agents bearing seemingly lucid, seemingly operable, preference lists arrayed in relation to the behaviour and imagined preferences of others and seemingly reducible to hard and fast dualistic organisation. A particularly interesting moment to anticipate and to watch for is that when the two merge to some extent or other, either in actual implementation, or in the seductive idea that such reductions are fully adequate explanations of specific slices of reality.

In the case of the racism of Schelling's Models of Segregation the categories pre-exist the machine, the machine is there to sort them, to anticipate their actualization, to provide a degree of abstraction in which they can be reckoned, but by which the abstraction too can be worked up into an actor of a kind in itself. This operation of abstraction is crucial to understand software as a cultural, city-making force. Computational systems and urban situations fundamentally mix in the present, but with vast and multiform differentiation of intensity and kind.

Media theorist Claus Pias specifies the way in which simulations act as a means of arranging governmentality in a manner that corresponds to Foucault's discussions of biopolitics. Speaking of an agent based modeling system for epidemiology, he specifies that, "This 'intervention in the environment', this 'playing with the rules of the game', this 'optimisation of systems' and this 'free play' of individuals and their practices – all of this is precisely what is subjected to experimentation in simulations."<sup>31</sup> There is a generalization of strategy that temporally accompanies, coevolves with, but is distinct from, moves towards the generality of computation. Simulation allows for a pre-emptive action on action and it is a way of applying logics to territories, spatial forms of any scale understood in relation to Deleuze and Guattari's formulation of territorialisation and deterritorialisation.<sup>32</sup>

## Logics

Programming and the use of computers implies the inter-relation of different forms of logic, both at the level of programming the machine to perform calculations and regulating the behaviour of users in pushing around mice and navigating menu systems to produce desired results. One way to think about how the mass adoption of these forms of logic effects the broad reach of society is in the mode Foucault

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<sup>30</sup> Steven Graham, "Software-sorted geographies", *Progress in Human Geography*, vol.29, no.5, pp.562-580.

<sup>31</sup> Claus Pias, C 2011, "On the Epistemology of Computer Simulation", *Zeitschrift für Medien- und Kulturforschung*, Nr. 1, S. pp.29-54.

<sup>32</sup> Gilles Deleuze and Félix Guattari, *A Thousand Plateaus, capitalism and schizophrenia volume two*, trans. Brian Massumi, Athlone, London 1988.



described as discipline, one that analyses and breaks down a phenomena through modeling it to produce a kind of remote control. Computation, disciplines the way a phenomena is approached and analysed, so that when it becomes visible again from within the computer, it makes the phenomena materially available for comparison and modification. As users participate in the flows of power created by comparing information they become normalised to its process and themselves entailed into the inter-relation of logics at different scales.<sup>33</sup>

Expressing this differently, computational forms of normalization establish the configuration of logics needed to make the materiality of the phenomena available for modification in a scalar of abstraction, verification and reward. The repeated construction and use of these forms of logic fixes what Foucault would call “progressive training”<sup>34</sup> for those that model, feed, collect, process and react to the logics, as well as those objects that are the subject of its calculations. Logics decompose processes and the entities, including people, that are aggregate with such process and the routine processing/interaction with such models set a stage, a collective logic to be applied to all areas of society and the natural world. The move beyond discipline is characterised by the absence, further withdrawal or multiplicity and duplicity of the, ultimately reliable, central control discipline implies as a structuring principle.

### **Promissory inputs**

Contemporary to Archizoom, another architectural practice Archigram, building on the work of Cedric Price, proposes a model of a *Computer City* which saw the urban fabric as a nomadic, energy and activity saturated conglomeration of interactive parts in which “First the computer processed the desires of its inhabitants as data; then, depending on the sensorial input, structure adapted to create an environment conducive to the required activity or state.”<sup>35</sup> There is an assumption here that each of these stages correlate to each other either directly, or by means of a mutual figuring out. Seductive as a model, this is also an image of the city as fantasy a key mode of which in turn is that desire is itself computable.

Importantly, one of the key factors of these technologies is that they don’t have to get reality right, at the level of representation or understanding, but solely to intervene and shape realities at multiple scales in some way that is directly or indirectly conducive to sustention of the model. One of the key lessons of information theory is that to start processes of control and communication, one has to start first entraining the subject or social, feeding it information, around which process a new formation can crystallise. Feed logics into social formations and see what congeals around them: this is what is known as policy, or fantasmatic experiment.

Ashby specifies in his work on self-organisation that communication requires constraint, with organisation - and a self, a system - arising out of this consistency. In her work on modelling in *Cosmopolitics*, Isabelle Stengers reverts this notion of constraint as the quality of a system or a phenomenon being “promising”, a quality that consists of the interplay between an obligation and a certain possible likelihood.<sup>36</sup> Probing the interaction between these two qualities of constraint, indeed setting up, or tendentially amplifying, the terms of their interaction, is key to experimental practice,

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<sup>33</sup> In creating a database, normalization is the process of organizing it into tables in such a way that the results of using the database are always unambiguous and as intended.

<sup>34</sup> Michel Foucault, *Security, Territory, Population, lectures at the Collège de France*, trans. Graham Burchell, Palgrave Macmillan, London, 2009.

<sup>35</sup> Hadas A. Steiner, *Beyond Archigram, the structure of circulation*, Routledge, London, 2009, p.205.

<sup>36</sup> Isabelle Stengers, *Cosmopolitics 2*, University of Minnesota Press, Minneapolis, 2011, p.143.

but also to modes of governance in the present. This nature of the promising qualities of experiment also makes such work one also of the imagination of what such a promise consists and the exertions and operations of powers in relation to the exploitation of such a quality.

### **Logic Gates**

Part of the legacy of Schelling's and Epstein's work is in the various police, academic and intelligence projects that aim to predict riots via sentiment analysis aimed at identifying tipping points. "Negative words", "hate-speech", "positivity" and expressions of anger stand in for a population of shifting emotional registers, moving from stable states to those that can be used to require the maintenance of policing budgets, harsher policy and sudden rushes of inflamed and excited research budgets. In such cases, the scale of imaginary analysis moves ever more to the macro-scale. The operators of such machines imagine that their technical fix provides a neutral oversight, in which the free expression of populations and individuals can be neutrally mapped and cross-checked for naughtiness and appropriate measures deployed. What happens is rather more complex, social forms are flooded with those of the state, which itself attempts to follow too many filiations and clusterings. In the meantime, academic chancers position themselves as dubious mediators, by being able to appear to delve into the firehouse of text produced by a population mapped according to strings of characters. We enter into a condition of a generalised politics of experiment. What is rather lacking are the means to conceptualise and actualize such experiments from the position of anything other than increasingly narrowly defined bands of social and economic interest.

Pias suggests that recent theories such as actor network theory and radical constructivism come from the same stock of ideas as simulation, since for both: "Their knowledge is consciously – and as a matter of course – furnished with a hypothetical index, they admit to their fictional components, they position themselves within their conceptual frame of reference, they thematize their performance, they are aware of their problematic genesis, and they specify their limited application."<sup>37</sup> A useful provocation following such a proposition is to be found in Latour and Lépinay's reading of Tarde: "If you really want to quantify – which is after all the foundation of all sciences – you should try to find all the available types of quantum, instead of just using one to analyse all the others."<sup>38</sup> This premise underlies some of the enthusiasm for big data analysis at present. It also perhaps implies that social reality is a simplified model of more adequately complex modeling schema. But we can also suggest that William Bunge's later mode of maximalist empiricism coupled with high degrees of statistical abstraction is of great relevance here. The proposition that to study is to become actively involved, to observe is to change, but also to recognise, that though such change may be reciprocal, it may not be symmetrical and equivalent. These are the stakes now of watching and participating, since in the city understood as a platform for self-organisation, algorithms, rule sets, data-structures and procedures have highly and perhaps questionably promising agency.<sup>39</sup> The recent scandal of researchers from Facebook and the Universities of California and Cornell using Facebook's news feed to operate an experiment on whether people responded to the filtering of what appeared in their news feed on the basis of whether it was

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<sup>37</sup> Pias, op cit

<sup>38</sup> Bruno Latour and Lépinay, *The Science of Passionate Interests, an introduction to Gabriel Tarde's economic anthropology*, Prickly Paradigm Press, Chicago, 2009, p.19.

<sup>39</sup> Samir Chopra, "Computer Programs are People Too", *The Nation*, May 29, 2014.

associated with emotional “negativity” or “positivity” should be seen as a part of this tendency. The researchers note that Facebook constantly experiments with the algorithm to fine-tune this aspect of their “product”.<sup>40</sup> It is this state of perpetual experiment, linking different scales of realities that is characteristic of the condition of abstract urbanism and the kinds of operations that the integration of modeling with cities encourages.

This operation of the city as an open experiment is of course one subject to the analysis of power. For Epstein and Axtell, agent-based modeling enforces habits of mind that are essential to intellectual and democratic freedom. An agent-based model must be explicit and open (in a certain way, FLOSS-like) and be able to be examined and doubted, reconfigured and rerun. Epstein aligns agent-based modeling to scientific modes of inquiry that he sees as antithetical to established discursive intellectual systems.<sup>41</sup> Agent-based modeling is the freedom to doubt large monolithic systems of knowledge that he characterises as being based on deductively-established theorems. Epstein and Axtell propose that we are on the edge of a new enlightenment based on the ubiquity of computing in which, “Intellectuals have a solemn duty to doubt, and to teach doubt. Education, in its truest sense, is not about ‘a saleable skill set.’ It's about freedom, from inherited prejudice and argument by authority.”<sup>42</sup> The question of whether the enlightenment can be fully and undifferentiatedly called upon in this way is in turn open to doubt, but there is something here that suggests some possibilities in that it is a science that explicitly calls subjects into being.

This proposed new mode of science of active abstractions involves cities and social forms in what Stuart Kauffman calls “the physics of semantics”, logics that have effects in the organisation of conjunction, calculation, control and communication of the kind that also create cities.<sup>43</sup> Such a physics of semantics can be seen, at other scales, in the way that the agent-based model is involved in the specific forms of hardware and software development that conjoin both meaning-making scaffolds and physical properties. Object-orientation in programming is seen as a cogent worldview capable of answering difficult questions about behaviour that emerges from complex subjects in the social or in economics, where, “It facilitates essentially any interaction structure (social network) and activation regime.”<sup>44</sup> In contemporary accounts, Agent-based modeling also links its ambition to the growth of CPU processing and the availability of hard disk space and network processors assumed under Moore’s Law.<sup>45</sup> The “promising” nature of abstract cities is thus also instantiated into multiple scales of their materiality.

This suggests that there is the possibility for a mode of experimentation, and of experimental politics and urban living that moves from the logics of theorems or axioms to an abstract empiricism. Throughout this text we have contextualized the development of agent-based modeling and social simulations through reference to historical material in cybernetics and self-organisation; to literature, music and architecture as well as to changes in the practice of geography.<sup>46</sup> Software based

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<sup>40</sup> Adam D. I. Kramer, Jamie E. Guillory, and Jeffrey T. Hancock, “Experimental evidence of massive-scale emotional contagion through social networks”, *Proceedings of the National Academy of Sciences of the United States of America*, June 17, 2014, vol. 111, no. 24, pp. 8788–8790.

<sup>41</sup> See, Epstein, *Advances in Agent-based Computational Modelling*.

<sup>42</sup> Epstein, “Why Model”.

<sup>43</sup> Stuart Kauffman, *Investigations*, Oxford University Press, Oxford, 2000.

<sup>44</sup> Robert Axtell, “Economics as Distributed Computation”, *Post-Proceedings of the Second International Workshop on Agent-Based Approaches in Economic and Social Complex Systems*, Springer, Heidelberg, 2003, pp.3-23, p.10

<sup>45</sup> See the attention given to the “Prospective growth of agent capabilities on single workstations” & “Growth of agent capabilities on single workstations, native source code in C++” in Axtell’s, *Economics as Distributed Computation*.

<sup>46</sup> There has also been something of a historical leapfrogging of systems implementations such as those of Jay Forrester and the

simulations essentially replaced the kinds of hardware based simulations or analogues of biological, cognitive and social systems being developed in places such as Heinz von Foerster's Biological Computer Laboratory in Illinois.<sup>47</sup> The questions they pose, change in this transition, and they become allied less with the philosophical concerns of the lab, with its great emphasis on epistemology, into those of other conditions. One of these is the question of abstraction and reduction from material empirical conditions. We are now well into another similar transition, where instead of moving from hardware to software (with hardware concomitantly becoming less experimental and idiosyncratic in the form of commodity electronics) social and urban forms become places of computational inter-operation and experiment.

Urban space is increasingly produced in the production, circulation and analysis of large volumes of structured and unstructured data. Models and modelisations are being integrated into the design of spatial forms at conceptual, pre-emptive and in certain cases, agents become active as urban entities installed and active in symbolic and materials orders of the city.<sup>48</sup>

Here it is worth thinking back to William Bunge's work in *Fitzgerald, geography of a revolution*. This work combines knowledge extracted by verifiable methods, abstracted into quantified information with other forms of situated knowledge that come about through more informal processes of observation and action of the people of Fitzgerald. Quantification is seen as a revolutionary tool in which people compute information from their lives and environment to put forward logical arguments about injustice. Pedagogy about research methods becomes important in this context, and is developed by expeditions and community alliances with universities. Key too to this research is the way in which the environment, from the geology up, through history and social and technical formations shape its development. As such it poses another mode of the relation between synthesis and analysis. What might be a form of research about abstract urbanism that took into account some of the lessons of Bunge's Fitzgerald, in the wider context of computational transformation?

Just as computational forms structure reality, so do other kinds of model. Abstract urbanism is hypothetical, fictional, maximally empirical, and of course abstract. This means that the way in which abstractions become materially operative have to operate through these conditions, and also - under certain regimes of rhetoric - to shield them, as simply fact-based extrapolations. To recognise that they are imaginary, as models, without being merely false, or simple reifications is part of the art of abstract urbanism. To recognise agent-based modeling in such a way is to recognise that models are also partial cities operating like partial objects, formalised slivers of an urban configuration taken for a whole and working drives into active diagrams. Such a condition, in which the possibilities of social fractures being triggered in the models and then implemented are manifest, cannot but add an ambiguous potency to the operations such an art promises. To work abstract urbanism then in the condition of models becoming cities is also to open the possibility to operate, like Bunge, with a maximalist empiricism, of the abstract as

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System Dynamics Group of the 1970s embodied later in software systems such as Dynamo and Stella or the history of modeling in climate such as that discussed by Paul Edwards, in, *A Vast Machine, Computer Models, Climate Data, and the Politics of Global Warming*, The MIT Press, Cambridge, 2010.

<sup>47</sup> Albert Müller and Karl H. Müller, eds., *An Unfinished Revolution, Heinz von Foerster and the Biological Computer Laboratory, BCL 1958-1976*, edition echoraum, Vienna, 2007.

<sup>48</sup> There is a growing market of more or less convincing companies offering services, consultancy and software for market analysis; traffic and pedestrian behaviour and other phenomena. *Aimsun* road traffic analysis software for instance provides real time forecasts of road activity that can be directly integrated into traffic management processes. In these cases, there is a tendency towards integrating models and what they model with potentially novel behaviours arising as a result.

much as of the street or the experience of concrete social relations. It is to operate with delicacy and attentiveness in the design of models, but also to the arguments, spaces and politics that they bear, that they determine and into which they are smuggled, driven and suffused, and which in turn they rely on to sustain themselves. It is to saturate models with variables, and to open abstraction to social disruption rather than to prepare the abstract retrenchment of urban injustice.

But to recognise abstract urbanism is not solely to postulate an interesting set of potential political practice, but more, to come to terms with a fundamental change in the consistency of cities today, that they are suffused with logics. This is not simply to say that streets are data structures, people are variables and that the city is a grid, laced with numerical nutrients, in which in their interaction produce an adequate if simplified mimicry of urban life; but that the city, the exemplary space of modernity in all its complexity of desire, violence, multi-scalar layering, imagination, invention and struggle is also a place of experiment with its modes of composition of self-emergence at multiple scales of abstraction. Such a space is one where fantasies of control, of understanding, of ordering, of establishing implicit and explicit co-ordination and pre-emption co-exist with their enactment, their failure, their use as excuse, and as a space where reason co-exists with the surprise of the unpreforeseen. Agent based modelling provides a means for the fantasmatic appearance of reason as an always present compliment of reason itself in that it mobilises means by which things occur in and for themselves in the mode of emergence, and for a space for arranging the coming into being of ideas of the city that are beyond the habitual means of interrogating existing co-ordinates. Here, in the state of being promising, reason both pre-empts surprise and relies upon it for its prowess in providing a gateway to emergence understood as the self-constitution of reality; a reality that is on the one hand seemingly unblemished by mess, or on the other, one forged in the full ongoing complications of the city-scape in which it becomes manifest and which by positing a modelisations it becomes manifest. This is a deeply ambivalent position. The physics of semantics in which such emergence is made is therefore worthy of attending to with all the precision and inventiveness that can be mustered, as it too becomes a space in which the city occurs.