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Inscribed in code: depictions of computational algorithms in twenty-first century fiction

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ABSTRACT
This essay offers an analysis of the representation of algorithms and their cultural consequences in three contemporary novels: Joshua Cohen's *Book of Numbers* (2015), Nicola Barker's *H(A)PPY* (2017), and Neal Stephenson's *Fall; or, Dodge in Hell* (2019). It considers how these novels reveal the technical systems which underpin digital culture to open up two key literary aspects of algorithms: that algorithms are inscribed in a form of language with characteristics and limitations distinct from the language in which the authors themselves operate; and that algorithms function through narrative (e.g. the connections between data objects). Two distinct strands of Ludwig Wittgenstein's philosophy of language are employed to observe how these novels draw distinctions between 'computer language' and 'human language'. Through this, fiction presents itself as a space within digital culture to articulate fuller accounts of identity and subjectivity. And at the same time it has the potential to speak to a knowledgeable reader and encourage them to consider how to address the limitations of a monosemantic technology and construct programmes that are better equipped to model a pluralistic world.

When Mira, the narrator of Nicola Barker's dystopian novel *H(A)PPY* (2017), describes how her community's metrics are tracked by 'a graph', she links the novel's critique of digital culture to the computational algorithms which underpin it. 'We call it The Graph—and it shows us how In Balance we are: as a person […] as a small community […] and as a broader society'.[1] Graphs are one of the more common data structures for modelling and manipulating data, in which data items (nodes) are connected according to their relationship with other items via vertices (edges).[2] Barker, in fictionalising a real life data structure, contributes to a growing body of fiction that

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touches on the algorithms in which digital culture is inscribed to open up how technical systems intersect and collide with social, political, and economic systems to shape subjectivity in the digital age. In doing so, these novels incorporate models not often seen in fiction, similar to the 'systems novels' defined by Tom LeClair in the late 1980s.[3] To this end, they serve as a bridge between the 'two cultures' C.P. Snow identified in his famously controversial Cambridge lecture.[4] In conceptualising algorithms as part of a broader cultural landscape, anthropologist Nick Seaver warns against treating algorithms as unknowable as it reinforces how algorithms are understood as and remain secret.[5] These novels approach digital culture with the goal of making the behaviour of algorithms legible. Much like the algorithmic processes they interrogate, the novels operate on both a micro and macro scale to place algorithms in a literary context in a way which opens up their literary aspects.

In doing so, they insert themselves into a wider debate which has gained increasing traction within the humanities: how digital culture is reshaping and sometimes infringing upon individual subjectivity and identity. The question of how literature can address these issues was central to the fifty-fourth instalment of McSweeney's Quarterly Concern, subtitled *The End of Trust* (2018), which departed from the journal's usual mix of fiction and non-fiction in its presentation of essays and debates that provide 'an investigation of surveillance in the digital age'.[6] The Electronic Frontier Foundation's executive director Cindy Cohn, in discussing her organisation's partnership with McSweeney's to produce the issue, explains that 'part of the reason why we're having this conversation in *McSweeney's* is to try to reach out to the artists, writers, and our culture more broadly'.[7] Cohn's call to move debates about digital culture from the realm of digital rights groups into the wider culture gestures towards the potential for cultural products to interrogate power structures. These debates often contend with what might be called 'digital utopian' ideals, which suggest that technological progress is inherently good. Eric Schmidt, the former CEO of Google, espoused such an ideal in his claim that 'the internet will disappear [so that] you won't even sense it. It will be part of your presence all the time'.[8] The speed with which internet technology has developed in the past two decades can perhaps be attributed to one of the tenets underpinning what David Brooks calls 'dataism', that 'data is a transparent and reliable lens that allows us to filter out emotionalism and ideology'.[9] Within recent years, humanities scholars have strongly pushed back against data's transparency and reliability, in particular highlighting how algorithms perpetuate and exacerbate existing socio-political inequalities. As Catherine D'Ignazio and Lauren Klein remind us, data does not 'speak for themselves' but is, rather, informed by biases embedded within the processes through which they are analysed.[10] Ruha Benjamin reveals how racism is similarly codified into software, emphasising how the 'racial codes' which are

reflected within code 'are born from the goal of, and facilitate, social control'.[11]

The feminist and racial critiques deployed by these scholars gestures towards the expression of identity at stake within how many algorithmic systems are formulated. For Andrew Bennett and Nicolas Royle, 'literature is the space in which questions about personal identity are most provocatively articulated'.[12] Fiction has the potential to interrogate how digital culture shapes subjectivity while simultaneously offering an alternative articulation of identity. Literary and cultural scholars have rapidly developed a number of often elucidating approaches for reading texts which engage with digital culture. Virginia Pignagnoli and James Ponsoldt offer analyses of fiction and film through the developing lends of surveillance studies.[13] Matthew Potolsky's *The National Secutiry Sublime* identifies an aesthetic mode, derived from the Romantic sublime, which has emerged in mainstream media to 'evok[e] a realm of secret knowledge and clandestine activity that the artist or viewer struggles to comprehend'.[14] Likewise, digital humanities methods, such as those conducted by the Stanford Literary Lab and EPFL's Digital Humanities Lab, have been developed to utilise algorithms themselves to deepen our understandings of literary works. Zara Dinnen's *The Digital Banal* explores with how cultural products engage with one way in which new media is shaping subjectivity, resulting in 'the condition by which we don't notice the affective novelty of becoming-with digital media'.[15] Her study is wide-ranging, from how David Fincher's films capture an aesthetic 'grammar of code' while novelists Ellen Ullman and Dave Eggers focus on the laborious task of programmers.[16] For Dinnen, cultural products 'record these stakes in ways that we can critically apprehend', concluding with a call to 'critically apprehend digital media'.[17] My research takes a step beyond this vital study to consider cultural products which, in their attempts to apprehend digital media, gesture towards and engage with the computational algorithms which underpin it. The novels in this study—Barker's *H(A)PPY*, Cohen's *Book of Numbers*, and Neal Stephenson's *Fall; or, Dodge in Hell* – are examples of a growing trend of fiction which, in the spirit of Seaver's call to treat algorithms as knowable, thus open up the hierarchical classification systems which they uphold.

The first of algorithms' literary aspects is how algorithms are inscribed in a form of language with characteristics and limitations distinct from the language in which the authors themselves operate. Sandy Baldwin, in *The Internet Unconscious* (2015), makes the provocative claim that 'everything on the computer is writing'.[18] But considering software inscribed in programming languages as writing requires expanding the lens of writing beyond the traditional literary frame. Programming languages are a product of the intersecting disciplines of mathematics and logic, with Ramon Alvaro reminding us that algorithms are 'just math'.[19] When the

deuteragonist of Joshua Cohen's *Book of Numbers* (2015) presents the unorthodox view that programming languages are more precise in communicating complex ideas than natural language, he glosses over the assumption which underpins programming that real world problems can be meaningfully represented in predicate logic.[20] In *Tractatus Logico-Philosophicus* (1921), Ludwig Wittgenstein puts forth the idea that logical language has 'pictorial form' being 'a model of reality'.[21] While Wittgenstein, in this early work, posits a synecdochic relationship between philosophical logic and the world around it, he can help us understand the relationship between computational models, which are encoded in logic, and the real world. Algorithms cannot offer a one-to-one representation of the world, but if a software engineer appropriately selects and implements parts of the whole they can claim to tell us something meaningful about the world.

This synecdoche is not exclusive to logical language and its computational products, but extends to natural or ordinary language, which I will be referring to throughout this essay as 'human language' as opposed to logical 'computer language'. This distinction between human and computer language can be understood by extending two strands of Wittgenstein's philosophy of language. As anyone familiar with the philosopher is no doubt aware, Wittgenstein's oeuvre is often separated into two distinct phases, with his early work, collated in *Tractatus*, following from his mentor Bertrand Russell to argue that language has a logical structure and, as such, is comprised of facts which are either true or false. His later work, in contrast, refutes much of this to instead consider how ordinary language operates as a communicative tool between individuals. These two distinct frames encapsulate the two languages which dominate our daily lives, with computer languages necessarily tending towards the logical language of early Wittgenstein while human language remains a communicative tool as described in his later work. The novels' thematisation of language often intersects with how Wittgenstein has conceptualised language, with *H(A)PPY* gesturing in its conclusion to how, even as a communicative tool, language has its limits in articulating subjectivity.

In claiming that computer languages are more precise, *Book of Numbers*'s deuteragonist has accepted the ideal that Wittgenstein identifies in *On Certainty* (1951) that '[t]he mathematical proposition has, as it were officially, been given the stamp of incontestability'.[22] There is a contrast between mathematical precision and the pluralism of the ordinary language he describes in *Philosophical Investigations* (1953), where he states that:

> Our language can be seen as an ancient city: a maze of little streets and squares, of old and new houses, and of houses with additions from various periods; and this surrounded by a multitude of new boroughs with straight regular streets and uniform houses.[23]

The key distinction to draw out here is that computer languages operate on certainty while human language allows for contingency and ambiguity in meaning. As we will see, one of the points of critique that these novels offer is that algorithms are less capable of modelling the pluralities of the world than human speech. The novels I analyse tease out the difficulties in representing the world through computational models. They thus speak to an inherent reductiveness in algorithms and, at the same time, use their own language and narrative structure to suggest how fiction can offer a more complex articulation of the world.

The extent to which fiction is a picture of reality points to its own synecdochic nature. In his study, LeClair argues that systems novelists select and structure parts of systems in order to reflect on the whole system.[24] But to some extent this is true of all fiction. Its utility in providing insight into the world requires careful selection and arrangement of data so that, even in respect to non-realist forms, the reader accepts it as a mirror of reality. Bad fiction is often criticised for being reductive, but reducing data is inherent to all modes of fictional production. It is through mastering synecdoche that a talented author can produce fiction that rings true despite only gesturing towards a reality that is too vast for words. The implication of these novels is that fiction is more capable of speaking to a pluralistic world than algorithms due, in part, to its inscription in pluralistic language. But in addition to being a product of reduction, fiction, in particular the novel, has been implicated in aiding the production of a particular type of model subject. In *The Novel and the Police* (1988), D.A. Miller argues that the nineteenth-century novel developed to 'confirm the novel-reader in [their] identity as "liberal subject"'.[25] The concept of the 'liberal subject' invokes the subject as both a free individual and a product of discipline societies. Michel Foucault remains the key touchpoint for defining discipline societies, telling us that discipline operates through surveillance, normalising perceptions and prescriptions, and technologies of the self. Miller traces how each of these manifest in the novel form, with omniscient narrators normalising surveillance at the same time as they normalise norms by presenting an incontestable reality. Meanwhile, first person narratives and focalisation develop self-regulating characters. The novel, therefore, encourages readers to conform at the same time as it encourages them to think of themselves as individuals. In pushing back against digital culture, the novels discussed in this essay are not offering an articulation of identity and subjectivity outside of digital culture, but one which both remains within its structures and is complicit with other structures which shape subjectivity.

The second literary aspect of algorithms is how they function through narrative. This is depicted in the outward manifestation of *H(A)PPY*'s graph, an 'Information Stream' which organises data into a narrative amenable to the grand narratives that define the community. An appealing

interpretation of the novel's gesture towards how algorithms construct narrative is to consider it in relation to Peter Brooks's definition of plot in *Reading the Plot* (1984), which encompasses insurrection plots, plots of land, and plotting a graph.[26] From object-oriented programming, with its focus on discrete objects which have a description (in terms of an object's attributes) and events (in terms of an object's methods or behaviours), to the aggregation of data objects in machine learning which makes the claim that a given object is like those that it is clustered with (x and y are alike), narrative is as fundamental to computational theory as it is to fiction and is evident at all levels of software development. There is nothing inherently sinister in algorithms curating data in order to create a specific narrative: the purpose of automation is to learn something meaningful from data which would otherwise be too unwieldy. But if, as Dinnen claims, narrative is the means by which we critically apprehend the world around is, a contention arises when the narratives constructed by algorithms are privileged over all others – or as philosopher of law Antoinette Rouvroy puts it, 'if [data] were to speak for us'.[27] In *H(A)PPY*, the threat posed to individual narrative is played out in the attempted suppression of Mira's singular narrative by Kite, a member of the System's 'Design Team'. The point of contention is how algorithms aggregate subjects together to make general inferences about them as a group to the erosion of individual identity. Aggregation is an inescapable component of data processing, as data is grouped or linked based on similarities through a multitude of techniques, such as clustering or classification. As I will explore, *H(A)PPY*, whose narrator initially favours plural pronouns, depicts a society in which aggregation has become totalising to the detriment of articulations of individual identity.

The narratives of novels which depict computational algorithms provide an alternative to the aggregative and reductive narratives offered by computer systems, drawing on a range of techniques to draw out a potential individuating remedy to reductive algorithmic narratives. The aim of this essay is to examine the representation of computational algorithms in three novels that take digital culture as their subject and in doing so consider how they open up how algorithms function through language (the code in which they are described) and narrative (e.g. the connections between data objects). The ubiquity of digital technology is such that it is hard to imagine a return to a pre-digital subject. Instead the value of fiction, as articulated through these texts, is to offer a space within digital culture for alternatives to the impoverished language and narratives of algorithms.

Algorithmic articulations of identity

The digital culture which we live in, and with which these novels engage, is distinct from the digital cultures that precede it. The current digital culture

has its beginnings circa 1998, the year that saw the incorporation of Google and the establishment of the Persuasive Technologies Lab at Stanford, and is defined by two broad characteristics.[28] The first of these is that participation in contemporary digital culture is unconditional, regardless of the extent of the subject's interaction with technology. As William Davies, Professor of Political Economy at Goldsmiths, reminds us, we are constantly 'leaving a trail of data wherever we go'.[29] The nature of ubiquitous computing is that data gathering sensors are a persistent presence in our everyday lives. Secondly, our digital culture is characterised by a move towards what anthropologist Nick Seaver calls a 'mind-oriented approach to software design' in which humans are treated 'as instinctual minds, susceptible to subtle outside influences'.[30] These two characteristics obviously go hand-in-hand, with the abundance of observed data enabling deeper understanding of users' behaviours and thus encouraging the gathering of more and more data.

This distinct digital culture is woven into the fabric of *H(A)PPY*, a novel which implicates algorithms in creating the novel's dystopian future. *H(A)PPY* imagines a future in which physical life has become inseparable from a vast digital social network known simply as 'the System', the primary purpose of which is to maintain a particular level of 'happiness' across the entire population. Key to this is a device called a 'Sensor', which mediates the subject's access to the System. Despite Mira's claim that 'the Sensor isn't […] "censored"', the homophone that this wordplay foregrounds points to a double function of devices used to connect to the internet, whereby they collect data on users and their surroundings, and play a curatorial function in delivering information to the user.[31] The revelation of the extent to which Cambridge Analytics used behavioural data and targeted media to encourage groups of users to vote in certain ways on Brexit and the 2016 US presidential election is but one recent example of how data can be curated to shape subjects' behaviours. Barker introduces the concept of data curation early in the novel when Mira discovers information on a girl in the 'margins' of an article about a luthier.[32] There is a hint of the human biases which determine which information is made visible (or 'in focus' as it is framed in the novel) and which is rendered marginal or invisible. Considering this bias opens up the paradox of Google's mission statement to 'organise the world's information and make it universally accessible and useful', with its contradictory goal of making all data available while simultaneously limiting this availability to only that deemed, by the corporation, 'useful'.[33] Instead there is a clear imbalance as the system retains access to all data and controls what subset of data users have access to. Barker subsequently draws out the binary nature of this dichotomy in a way which implicates the logic underpinning the technology as contributing to it.

Binary oppositions form the texture of how the System operates, with classifications and counter-classifications frequently drawn up, such as between 'the Young' and 'the Old' or 'the Known' and 'the Unknown'. Sociopolitical binaries do not indicate neutral positions of opposite characteristics, but are hierarchical, a facet Barker draws out through the novel's interweaving of colonial themes. By invoking them in the System, the novel places the social binaries of the community within the binary logic of its technical systems. The binary or base-2 logic upon which digital technology functions allows for each bit (binary digit) to be one of two states, but due to how logic operates on certainty, the state of the bit must necessarily preclude the other state. The binary classes described by Mira point to the function of the System as a binary classifier, which as the name suggests classifies objects in a dataset into two distinct groups on the basis of a classification rule. Binary classification is key to even multivariate classification functions with more than two potential classes, with methods such as a support vector machine (SVM) often implemented with a series of binary classifications which systematically divide data into their appropriate 'final' classifications. This binary structure informs the System's metanarratives, with everything within the System positioned as 'Known' and that outside as 'Unknown'. In recent years, much scrutiny has been placed on how algorithms are informed by biases and perpetuate inequalities, such as the aforementioned work of Benjamin and D'Ignazio and Klein. Barker's use of colonial themes reveals how binary logic lends itself too easily to sociopolitical binaries so that the narrative connections drawn by algorithms can perpetuate them.

The insufficiency of binary classification in describing the nuance of a pluralistic world is evident in the novel's frequent references to Paraguayan guitarist Agustín Barrios, whose dualistic Spanish colonial and indigenous Guarani descent is resistant to an either-or classification. Throughout these references, Barrios emerges as the producer of a highly individualistic artistic expression, in contrast to the aggregated culture of those under the influence of the System. At several points, Mira dreams of Barrios exercising a 'terrible discipline' as he tasks himself to play a song perfectly one hundred consecutive times, using a bag of stones as a counter.[34] The recurring reference to 'discipline' invites a reading of the scene through a Foucauldian lens, with Foucault reminding us that power can be productive as well as repressive.[35] Through Barrios, Barker reveals how a rigorous self-discipline can aid an artist in achieving artistic expression. There is a sense too that the subject, in deploying technologies of the self, is behaving algorithmically. To demonstrate, I have implemented Barrios's process in pseudocode like so:

```
set number of stones on tiles = 0;
        while stones on tiles < 100
        {    start to play;
             if played the song perfectly
             {    take out a stone;
                  place it down on to the tiles; }
             else
             {    scoop up all the stones;
             }
        }
```

In Foucault's conceptualisation, technologies of the self are abstract methods which the individual adheres to. But these methods lend themselves to being reproduced in or aided by physical technologies, with fitness and mindfulness apps two examples of how digital technology has been developed to encourage the subject to deploy these methods in improving themselves. Like Barrios, Mira's community, referred to throughout as 'the Young', exercise terrible discipline, but do so in order to align their behaviour towards an impersonal goal – the 'balance' defined externally by the System. Barker thus draws a distinction between technologies of the self for individuating and dividuating purposes. At first glance this is somewhat unusual, as disciplinary power, of which technologies of the self are a key component, is a normative power which has been conceptualised as eliminating deviations or anomalies. Barrios's individuation is successful only insofar as it is oriented within larger structures. For the Young, technologies of the self are employed as a more intense normative tool, so that individuality is lost. This is obviously not a one-to-one mapping to how the algorithms that surround us function, as they are rarely designed with the explicit purpose of herding subjects towards a shared goal, but the distinction that Barker draws between artistic creativity and conformity explicates the subtle ways that algorithms can function as normative devices.

Through an experimental style incorporating colours, typefaces, and other formatting embellishments, the novel itself, like Barrios's music, stands as an emblem of individualistic expression in contrast to digital culture's conformity. Naomi Wood, in awarding *H(A)PPY* the Goldsmiths Prize, cited the novel's 'innovation of form [which] only ever enriches the story'.[36] The use of colour, the most frequent of these flourishes, renders in the text the graph which tracks Mira's language usage, providing visual feedback which shows how this usage deviates from norms. The array of colours used by 'the System' is a sequential palette, where a continuum of colours based on hue are used to represent numeric data. Narrative is once again key here, as data visualisation exists to tell a story about data, in this case when a subject deviates from preferred norms. What is striking is how Barker subverts this tool to become a mode of artistic experimentation. Just as 'the Graph' provides visual feedback to Mira, the text gives visual

feedback to the reader. But while the use of colour in the System guides the Young towards conformity, Barker's use of colour individuates *H(A)PPY* from other novels. As we have seen, Barrios's ability to articulate identity through music remains firmly embedded in the context of disciplinary modes of power. And the same is true of Barker's novel, which gestures towards how fiction can articulate identity and subjectivity in the context of digital culture.

At the same time, the novel's formal flourishes encourage the reader to process data in a way which is distinct from how algorithms functions. The latter half of the novel increasingly takes information flows as its aesthetic model, with Chapter 13 being the clearest example. This chapter dramatises an episode of information overload experienced by Mira, with disparate pieces of information delivered to her by her 'Sensor'. The rapid bombardment of a diverse range of information is formally captured in the reproduction of several historical sources, such as extracts from Augusto Roa Bastos's *I the Supreme* (1974) and an anthropological account on Enlhet culture in a slab serif.[37] The disjunction between these sources is reinforced by how they are each rendered in distinct typefaces. The chosen fonts resonate with the content, with the Bastos extract in a gothic typeface while the Enlhet is presented in a slab serif. Gothic typefaces derive from blackletter developed in twelfth century Western Europe, while slab serifs emerged in response to Napoleon's Egyptian campaign, deriving from European interpretations of Egyptian script. As such, the choice of fonts reflect the content by correlating Bastos's dictatorship with its Western European roots and the Enlhet testimony with European colonialism. *H(A)PPY* rapidly cycles between the sources, creating an effect similar to social media feeds which are constructed of disparate pieces of information. Unlike the digital feeds which are being echoed and which are curated by algorithms for the purpose of keeping the subject engaged with the social media platform, the novel encourages the reader to consider the relevance of these sources to the overall plot. It thus persuades the reader to make narrative connections – thereby equipping them with the ability to develop narrative from data, in a way which is distinct from how information is processed automatically. The novel thus serves a dual function, on the one hand individuating the work of the author through an experimental style, while on the other encouraging the reader to individuate themselves through interpretation.

Authorial curation of data

A similar critique of how computational algorithms tend towards the creation of hierarchies is present in *Book of Numbers*, a novel which focuses on a fictional company, Tetration, which purveys search engine technology

analogous to Google. As such, Tetration's business is structured around ordering and curating information. In an interview with Michael Silverblatt for *Bookworm*, Cohen reveals how he, like Wittgenstein, sees plurality as inherent to language, with 'every word' being 'the history of the usage of that word through time'.[38] The novel enacts this in one episode, in which the narrator searches for the definition of the word 'firewall' and contemplates 'which site to hold with? the most popular or most reputable?'.[39] This contemplation carries with it the implicit answer 'all of them' as the narrator draws on a number of the definitions he finds to chart a history of the word from its first use in Austro-Hungarian theatre to its present day meaning as a piece of software created to maintain network security. *Book of Numbers* thus puts forth an argument that rejects hierarchy altogether while celebrating the author's ability to articulate a fuller narrative history of a word.

The implication that computational logic is, in part, responsible for reductive understandings of the world is brought to the forefront when the deuteragonist, the CEO of Tetration who shares the author's name but is referred to throughout as 'Principal', describes his attempt, as a teenager, to craft 'his own private language, an unpronounceable language that would never be named' which goes further than binary's two digits and is instead comprised 'of a single letter'.[40] The phrase 'private language' speaks directly to Wittgenstein, who in *Philosophical Investigations* explores how language can be private in two distinct ways – the epistemic, in which language can necessarily only have one speaker, and the sense that language can be privately owned. Wittgenstein's Private Language Argument concludes that there can be no language which is created by and understood by one person. This follows from his insistence that language is an essentially public communicative tool, with private language being an act of 'pointing-into yourself' rather than engaging with the outside world.[41] Principal's language is shown to have limited utility as a means of communication, with his parents struggling to decode and respond to it.[42] Principal's claim that computer languages are more precise is ostensibly true, but ignores the fact that this precision aids communication between machines rather than humans. It is through this language that Principal attempts to describe his relationships with the outside world, rotating the character 90°, 180°, and 270° to indicate his relationship with his father, mother, and both parents respectively. For the young Wittgenstein, logical language is made up of a series of 'facts' which 'can be the case or not the case', with each fact in turn being a combination of a series of objects which each has their own internal properties.[43] When Principal describes a digit with four possible rotations, he touches on an object which can record states much like the language described by Wittgenstein. By allowing for multiple states, Pincipal's language more closely resembles a computational object rather than a single letter.[44] To the

extent that Principal's language allows him to articulate his identity, it's an articulation with limited communicative utility as only he can translate it.

The narrative of *Book of Numbers* itself acts as a counterpoint to that told through Principal's private language, articulating a subjective account in natural language which strives to reclaim the pluralism lost in the aggregated narratives constructed by algorithms. *Book of Numbers*'s complex conceit, in which a narrator called Joshua Cohen is hired to write the biography of a billionaire tech CEO with the same name, embeds one personal narrative (that of the CEO) within another (that of the biographer). The biographer explains that 'Principal' is a common term for the subject of a biography, but at the same time the word suggests an order of preference where the writer's role has been subjugated by the tech CEO. The narrator pushes against this with a personal narrative that dominates and sandwiches the CEO's narrative. For narratologist Adriana Cavarero, narrative is central to personal identity, and the narrator's account appears to articulate their own subjectivity in resistance to a digital culture which has privileged the voice of a CEO. But the narrator's attempt is undercut almost immediately, with the claim in the opening pages that the September 11 attack were a personal attack on his 'Life & Book' raising questions of his reliability which are confirmed late in the novel when it is revealed he has been withholding information about his relationship with his estranged wife.[45] For Cavarero, an individuating narrative is one which is 'irrefutably [the subject's] story'.[46] In claiming the September 11 attack as a personal one, the narrator claims too much for his personal narrative and does so in a heightened rhetoric which is detached from fact similar to the types of conspiracy narratives that propagate online. While algorithms are inherently monosemantic, the ease with which both information and misinformation can find traction through online platforms has a pluralising effect, in which agreed upon facts fracture and alternative truths multiply. The ease with which the narrator's claims are refuted speaks to how articulating identity and subjectivity is not, in a digital culture with a persistent connection between subjects and information, enough by itself but rather requires the observer of this expression to be able to trust its veracity.

A more successfully articulated personal narrative emerges in *H(A)PPY*, as Mira begins to individualise herself with singular pronouns with a narrative distinct from that of the System but which remains grounded in verifiable fact. The curatorial function enacted in Chapter 13 is similar to that of the pluralistic definition of 'firewall' enacted by Cohen's narrator, one which is once again distinct from how algorithms, such as those that populate social media feeds, tend to curate information for the purpose of keeping the user engaged with the platform. Curatorial algorithms and authors alike strive to communicate something to their reader. But what Barker's novel gestures towards is how fiction has the potential to offer a dialogic communication

which seeks to capture the essence of a mutual exchange, in contrast to the unidirectional transfer of information on social feeds. The connection between the disparate pieces of information that Barker presents is often elusive, as with information of social media feeds, but the care of the authorial hand in piecing this information together implies a deeper meaning and thus asks the reader to interpret it. Fiction, through this openness to interpretation, can encourage a subject to articulate a subjective reading. At first glance, the same may appear true of curatorial algorithms, whose ordering of information on social media feeds can encourage a user to see connections between said data. But the authorial hand in the curation of information presented through a carefully constructed piece of fiction implies a meaningful connection, distinct from the placement of information seeking to maintain engagement. Whereas algorithms may invite apophenia, the reading of an open literary text ensures any subjective interpretation is grounded, not in fact as with a preferred articulation of identity, but in a narrative articulated by another human being.

Speaking to non-tech-literate and tech-literate readers

Neal Stephenson's *Fall; or, Dodge in Hell* (2019) follows a similar line of argument about the reductiveness of computational models, but the author's working knowledge of new technology makes his approach distinct from that offered by Barker and Cohen.[47] Between 1999 and 2006, he moonlighted at Amazon CEO Jeff Bezos's Blue Origin, a privately funded aerospace manufacturer, where he described his role as 'perform[ing] operations as prosaic as punching down Ethernet cable, operating a plate grinder, and passivating rocket parts […] but the bulk of my efforts were devoted to investigating possible alternatives to conventional rockets as ways of getting into space' ('Blue Origin').[48] This hands-on approach has continued into his current role as 'Chief Futurist' for startup Magic Leap, which seeks to develop retinal display technology for augmented reality applications. While the critique of digital culture in *Fall* is particularly severe, Stephenson comes from a digitally optimistic position, believing in technology's transformative potential while holding that fiction can serve to inspire future creators. By hoping to inspire his readers, Stephenson adds another dimension to fiction as a communicative medium. LeClair's work on systems novels touches on how literary scholars can, through fiction, encounter frameworks from non-humanities disciplines. But fiction also has the potential to speak to those with expert knowledge in scientific or technologic disciplines, placing frames which they have knowledge of in a wider humanistic context. Stephenson has expressed an awareness of the difficulty of maintaining synecdoche when fictionalising complex technical subjects to a degree

which rings true for a knowledgeable reader, describing a need to negotiate retaining 'a higher level of accuracy' without 'alienating normal readers'.[49]

This negotiation is clear in *Fall*'s depictions of computational algorithms. The novel centres on video game developer Richard 'Dodge' Forthrast, who dies during a routine medical procedure in the opening chapter and whose 'connectome' (a map of the neural connections of the brain) is subsequently digitised and uploaded to a virtual world of his own creation. *Fall* is a complex project, broken into fourteen parts which reveal a society progressively reshaped by advances in technology, with progressively more and more of the plot shifting to focus on the virtual 'Bitworld', with the novel crossing genre boundaries from a technothriller to science fiction to fantasy. The episode in which the digital process modelled on the protagonist's brain is activated presents one of the more deftly handled depictions of complex concepts, drawing on neural networks and machine learning in a way which speaks to casual and knowledgeable readers alike. In *Fall*, the key to digitising a human brain is a 'connectome' which constitutes 'the pattern of connections among the neurons of the brain'.[50] Describing the brain in these terms reduces it to a network not dissimilar to the Graph in *H(A)PPY*. It is this network of nodes and connections which is 'activated' midway through the novel as a disembodied process without 'memories, or coherent thoughts'.[51] Stephenson focuses on the process and draws a disturbing depiction of a 'brain', which lacks any knowledge of its surroundings, learning through associative memory. Upon activation, the 'process' senses a virtual space of 'visual and auditory static' which surrounds it.[52] It repeatedly cycles between reaching out and sensing this static until it gradually becomes aware of the repetition: '[t]he third, or the seventy-fifth, or the millionth time it came and went, he had a vague awareness that it had happened before', which results in a developing self-consciousness as 'he now recognised in his own being a pattern of response'.[53] As it continues to reach out into its surroundings, it builds up recognisable thought processes which are 'built up over time as his thought-ways began to follow creases, grooves, canyons. Deepening them, reinforcing them with each trip along the same path'.[54]

For a general audience, *Fall* presents a Shelleyan horror as a digital brain is turned on for the first time and gradually learns to think. But at the same time it speaks to a tech-literate reader – fictionalising and humanising actual algorithmic behaviours.[55] In particular, this section draws on how neural networks function as the process learns to exist in this disembodied state. As the name suggests, neural networks are systems inspired by the neurological processes of a biological brain, therefore providing an apt model for Stephenson to consider the behaviours of a digitised brain. A neural network contains a number of artificial neurons which can transmit signals between each other like the synapses of the brain. What distinguishes

neural networks from the majority of programmes is that they have not been programmed to follow a series of steps, but instead learn to complete tasks through trial and error and by considering examples, generally without being given any rules. The lack of 'memories, or coherent thoughts' as the Dodge process is activated therefore reflects the initial state of a neural network. A neural network's learning process is based on repetition as the network tries out new paths and 'learns' as a result. The Dodge process undertakes a similar iterative process ('the third, or the seventy-fifth, or the millionth time') – until it begins to achieve progress. By the time it begins tracing 'creases, grooves, canyons' it is in the full flow of 'neuroevolution', as the neural network generates and learns parameters, topology, and rules. Whether or not a reader is able to recognise the correlation between the Dodge process and a neural network, the effect is the same – the process's 'awakening' is grotesque and alien. But by clearly couching its awakening in the behaviours of a neural network, Stephenson ensures that the uncanniness is not lost on a tech-literate audience, who can see how it relates to actual technology.

In his study of logical language, Wittgenstein argues that 'the limits of my language mean the limits of my world'.[56] This limitation is on display in the virtual world constructed by the Dodge process, as it creates a palace called 'Palace', a garden called 'Garden', a town called 'Town', and so on. Within this world, the word and the object appear inseparable in a way that resonate with how algorithms adhere to abstract concepts such as objects and classes rather than specific real world instances. There is a stark contrast between the names the Dodge process assigns objects in Bitworld and the words coined by Dodge the human earlier in the novel, where we learn that he has given his colleague Corvallis the nickname 'C-Plus' and calls the Internet 'the Miasma'.[57] There is a creativity, which has a pluralising effect on the world as words take on new meaning, which is missing from the process's world.

The implications of these limitations for the subject is developed, as the population of Bitworld grows, through a pastiche of the Tower of Babel story which sees Dodge destroying a tower higher than his palace and scattering the people with the order that they should 'not speak in the same tongue' but 'clump according to their manner of talking'.[58] In the biblical version of the story, the destruction of the tower can be interpreted as a failed attempt for individuals to overcome the limitations placed upon them: God orders the Babelians not to build a tower that will reach Heaven and subsequently punishes them for eschewing this restriction. Reading the story through the lens of Wittgenstein, the tower can be viewed as an attempt to overcome the limitations of language. Trying to create a tower whose verticality extends beyond defined limits is analogous to trying to overcome common language by creating a language separate from agreed upon rules. In this

reading, the subsequent confusion as the Babelians are scattered into disparate communities can be read as a warning against private language, with the disparate pockets of people unable to communicate with each other as their language has no common referents.

Stephenson's pastiche of the Babel myth shifts the locus of critique in this Wittgensteinian reading to logic-based language rather than private language. Dodge's language is not simply rooted in the world, but it is the world – a flattened, one-dimensional world. While language allows him to shape this world, the novel repeatedly undermines his ability to communicate with other processes.[59] Those other processes are instead shown to develop a communal language which exceeds Dodge's, one which is based upon rules and therefore distinct for the Babelians' private languages. The chaos that ensues after the tower's destruction therefore is not so much due to people attempting to overcome the limitations of *all* languages rooted in the world (as in the Babelians' case), but an attempt simply to overcome the limitations of a monosemantic computer language. As the Dodge process is the one whose language has defined Bitworld, other processes are limited to its perspective. There's a clear parallel here between software developers and software users, with the code that developers write having a direct impact on the subject's ability to articulate identity and subjectivity through a given platform. And it's here that Stephenson most clearly articulates a call for a tech-literate reader to be conscious of how the algorithms they develop may shape subjectivity beyond their intended function and, thus, encourage them to minimise this impact.

Stephenson, whose novel *Snow Crash* (1992) has been cited as an inspiration by key Silicon Valley figures such as LinkedIn founder Reid Hoffman, Google co-founder Sergey Brin, and Google Earth creator Avi Bar-Zeev, perhaps has a broader tech-literate readership than Barker and Cohen. But at the same time Barker and Cohen reveal how the limitations of algorithms, such as how binary logic lends itself to easily replicating sociopolitical binarisms, can have broad social implications. In 2017 Tracy Chou, a software engineer whose previous roles include working for Pinterest, Quora, Facebook, and Google, posted a blog with the provocative suggestion that 'every tech worker needs a humanities education'.[60] Fiction is a location with the potential for encounters between the humanities and technology, which can reveal how systems on a micro level shape digital culture on a macro one. As we have seen, it can act as a space through which individual identity and subjectivity are articulated within the context of digital culture. But at the same time, it has the potential, through its interrogation of the constraints of the technology in which digital culture is inscribed, to encourage that technology itself to be shaped in new ways which minimise the impact of these limitations and instead ensure that technology strives towards its transformative potential.

Notes

1. Nicola Barker, *H(A)PPY* (London: William Heinemann, 2017), p. 3.
2. The usefulness of graphs in data analysis is outlined in Roy Marsten, 'Is Graph Theory Key to Understanding Big Data?', *Wired* (n.d.). https://www.wired.com/insights/2014/03/graph-theory-key-understanding-big-data/ For Marsten, graphs are 'the way we [will] think about data in the future'.
3. Tom LeClair, *The Art of Excess: Mastery and Contemporary American Fiction* (Urbana and Chicago: University of Illinois Press, 1989).
4. Charles Percy Snow, *The Two Cultures and the Scientific Revolution* (New York: Cambridge University Press, 1961).
5. Nick Seaver, 'Captivating Algorithms: Recommender systems as traps', *Journal of Material Culture* 24.4 (2018), pp. 421–436. https://doi.org/10.1177/1359183518820366
6. Claire Boyle (ed.), *McSweeney's 54: The End of Trust* (San Francisco: McSweeney's, 2018).
7. Alvaro Bedoya and Cindy Cohn. 'Alvaro Bedoya talks with Cindy Cohn', in Claire Boyle (ed.), *McSweeney's 54: The End of Trust* (San Francisco: McSweeney's, 2018), 191.
8. Eric Schmidt, 'The Future of the Web', *World Economic Forum* (25 January 2015).
9. David Brooks, 'The Philosophy of Data', *The New York Times* (A.G. Sulzberger, 4 February 2013).
10. Catherine D'Ignazio and Lauren F. Klein, 'The Numbers Don't Speak for Themselves', *Data Feminism* (Cambridge, MA: MIT Press, 2020). https://data-feminism.mitpress.mit.edu/pub/czq9dfs5/release/3
11. Ruha Benjamin, *Race After Technology* (Cambridge: Polity, 2019), p. 6.
12. Andrew Bennett and Nicholas Royle, *An Introduction to Literature, Criticism and Theory*. 4th ed. (Harlow: Pearson Longman, 2009), p. 130.
13. Virginia Pignagnoli, 'Surveillance in Post-Postmodern American Fiction: Dave Eggers's *The Circle*, Jonathan Franzen's *Purity* and Gary Shteyngart's *Super Sad True Love Story*', in Susan Flynn and Antonia Mackay (eds.), *Spaces of Surveillance: States and Selves* (London: Palgrave Macmillan, 2017), pp. 151–168.
    James Ponsoldt, 'Surveillance and Spectacle Inside *The Circle*', in Susan Flynn and Antonia Mackay (eds.), *Surveillance, Architecture and Control: Discourses on Spatial Culture* (London: Palgrave Macmillan, 2019), pp. 275–293.
14. Matthew Potolsky. *The National Security Sublime: On the Aesthetics of Government Secrecy* (New York: Routledge, 2019).
15. Zara Dinnen, *The Digital Banal* (Columbia: Columbia University Press, 2018), p. 1.
16. Dinnen, p. 22.
17. Dinnen, p. 2; p. 167.
18. Sandy Baldwin, *The Internet Unconscious: On the Subject of Electronic Literature* (New York: Bloomsbury, 2015), p. 1.
19. Ramon Alvaro, quoted in Louise Amoore, *Cloud Ethics: Algorithms and the Attributes of Ourselves and Others* (Durham, North Carolina: Duke University Press, 2020).
20. Joshua Cohen, *Book of Numbers* (London: Penguine, 2015), pp. 190–91.
21. Ludwig Wittgenstein, *Tractatus Logico-Philosophicus*, trans. D.F. Pears and B.F. McGuinness (London and Henley: Routledge and Kegan Paul, 1981 [1921]), 2.12.

22. Ludwig Wittgenstein, *On Certainty*, trans. Denis Paul and G.E.M. Anscombe, in *Major Works* (New York: Harper Perennial, 2009 [1969]), p. 655.

23. Ludwig Wittgenstein, *Philosophical Investigations*, trans. G.E.M. Anscombe (Oxford: Basil Blackwell, 1968 [1953]), p. 18.

24. LeClair, *The Art of Excess*, p. 18.

25. D.A. Miller, *The Novel and the Police* (Berkeley: University of California Press, 1988), p. x.

26. Peter Brooks, *Reading for the Plot: Design and Intention in Narrative*, (Oxford: Clarendon Press, 1984), p. 52.

27. Antoinette Rouvroy, 'The Digital Regime of Truth: From the Algorithmic Governmentality to a New Rule of Law'. trans. Anaïs Nony and Benoît Dillet. *La Deleuziana* 3 (2016), pp. 6–29. https://doaj.org/article/01436a349461450ba4bebf820fbdedc9.

28. Fogg's lab was subsequently renamed the 'Behavior Design Lab' as it grew to consider how its models and methods had applications beyond computing technology.

29. William Davies, 'Who Gains from Big Data?', *Weekly Economics Podcast* (13 July 2017). https://soundcloud.com/weeklyeconomicspodcast/who-gains-from-big-data.

30. Seaver, 'Captivating Algorithms', p. 423.

31. Barker, *H(A)PPY*, p. 37.

32. Ibid., p. 5.

33. Google, 'About', *Google* (n.d.). https://about.google/intl/en-GB/.

34. Barker, *H(A)PPY*, pp. 194–5.

35. Foucault, p. 194.

36. Naomi Wood, quoted in Martin Doyle, 'Nicola Barker wins Goldsmiths Prize with H(a)ppy', *The Irish Times*, 15 November 2017. Web. https://www.irishtimes.com/culture/books/nicola-barker-wins-goldsmiths-prize-with-h-a-ppy-1.3292656.

37. Barker, *H(A)PPY*, pp. 156–8.

38. Joshua Cohen, 'Joshua Cohen: Book of Numbers', *Bookworm*. KCRW, 10 March 2016. https://www.kcrw.com/news-culture/shows/bookworm/joshua-cohen-book-of-numbers.

39. Cohen, *Book of Numbers*, p. 87.

40. Ibid., p. 191.

41. Wittgenstein, *Philosophical Investigations*, p. 275.

42. Cohen, *Book of Numbers*, p. 194.

43. Wittgenstein, *Tractatus Logico-Philosophicus*, 1.2–1.21.

44. In object-oriented programming languages, an 'object' collects multi-varied data in a single data structure. It is typically modelled after a corresponding real world object or concept. Each object will have attributes (fields or variables) and behaviours (methods).

45. Cohen, *Book of Numbers*, p. 10.

46. Cavarero, p. 87.

47. Neal Stephenson, *Fall; or, Dodge in Hell* (New York: HarperCollins, 2019).

48. Neal Stephenson, 'Blue Origin', *NealStephenson.com* (n.d.). https://www.nealstephenson.com/blue-origin.html.

49. Neal Stephenson, 'Cryptonomicon cypher-FAQ', *Cyberpunk.us*, 30 March 1999. https://barzha.cyberpunk.us/lib/critica/cry_faq.html.

50. Stephenson, *Fall; or, Dodge in Hell*, p. 59.

51. Ibid., p. 300.
52. Ibid., p. 301.
53. Ibid.
54. Ibid., p. 302.
55. In the broadest sense, I am using 'tech-literate reader' to define all readers with the ability to use, manage, understand and assess technology on an above average level.
56. Wittgenstein, *Tractatus Logico-Philosophicus*, 5.6.
57. Stephenson, *Fall; or, Dodge in Hell*, p. 26, p. 20.
58. Ibid., p. 451.
59. Ibid., p. 375.
60. Tracy Chou, 'A Leading Silicon Valley Engineer Explains Why Every Tech Worker Needs a Humanities Education', *Quartz*, 28 June 2017. https://qz.com/1016900/tracy-chou-leading-silicon-valley-engineer-explains-why-every-tech-worker-needs-a-humanities-education/.

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