Animal, Body, Data: Starling Murmurations and the Dynamic of Becoming In-formation

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Abstract
The aim of this article is to demonstrate that data modelling is becoming a crucial, if not dominant, vector for our understanding of animal populations and is consequential for how we study the affective relations between individual bodies and the communities to which they belong. It takes up the relationship between animal, body and data, following the datafication of starling murmurations, to explore the topological relationships between nature, culture and science. The case study thus embodies a data journey, invoking the tactics claimed by social or natural scientists, who generated recent discoveries in starling murmurations, including their topological expansions and contractions. The article concludes with thoughts and suggestions for further research on animal/data entanglement, and threads the concept of databodiment throughout, as a necessary dynamic for the formation and maintenance of communities.

Keywords
animal, community, COVID-19, data, embodiment, information, movement, murmuration, starling, swarm

Introduction
This article will consider the intersections between animal studies and data studies as they manifest in the collective bodies of starling murmurations, taking seriously the conclusions that animals are and contain data related to the movement of other animals. Once, the murmuration was consulted as a carrier of the messages of gods, and

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later, it was the psychic transference of bodies. Now, in the con-
temporary world, the starling murmuration is understood as indi-
viduals following the movements of their nearest neighbours. This
discovery was facilitated through algorithmic studies and tracking
technologies that datafied the murmuration. Instead of critiquing
the datafication of a natural formation, this article will examine
how the end result – the datafication of the murmuration – has
become integrated into new formations that incorporate the
dynamics of information into the formation of new imaginary bod-
ies. This includes popular ideations about the COVID-19 pandemic,
some of which have been expressed in the emergence of an aesthet-
ic and ethic of the starling murmuration that grows from com-
putational datafication. The article will consider computational
datafication as a model for reimagining what it means to have and
be a body.

On 11 December 2019, on a lane on Anglesey in North Wales, 225
birds were found motionless on the road. An eyewitness reported that
it was as though ‘they had dropped down dead from the sky’ (BBC
News, 2019). Concerns were raised that the starlings, whose popu-
lation is already on the decline according to long-term environmental
monitoring, were victims of an infection, carriers of a new ‘bird-flu’
(ironically just before the onset of the COVID-19 pandemic). In
February 2020, toxicology tests revealed that the birds had died of
‘blunt force trauma’ (Daily Post, 2020). Similarly, on 14 September
2018, in Tsawwassen, British Columbia, south of Vancouver, 42
birds died instantly as they flew into a concrete road. Eyewitness
accounts claimed many more lay there, broken and twisted, described
appropriately by one as ‘terrifying’ and ‘like Alfred Hitchcock
creepy’, while another described it colourfully as ‘Birdageddon’.
As news of the deaths spread on social media, comments sections
were rife with the usual delight of fearful speculations: The magnetic
poles of the earth have been changing, confusing birds in migration;
it signifies a species in the midst of a mass suicide; people are
throwing objects into the air on purpose to confuse them into thinking
they are chasing food straight into the ground. In other words, causes,
causes everywhere. Surely it was a sign. Surely it meant something.
Surely it manifested some palatable, immediate and measurable proof
that something disastrous, like climate change, could explain away
the irrational action of the birds.
Days later an explanation was offered with the usual pace of scientific sobriety, and one that seemed to put the issue to rest: It was (most likely) the edge of a murmuration of starlings that hit the ground as its flock was evading a predator (Duncan, 2018). With such a massive formation, and with their swoops and dives happening close to the earth, those on the outside of the formation will face a greater risk of peril from predators and from collisions with other objects – in this case, the ground. The centre of the murmuration is thus considered to be the safest for the individual; nevertheless, no firm evidence exists that the individuals within a flock express an interest to occupy the centre, though it would obviously serve them better as individuals (Skoyles, 2016).

This is not the usual opening of a piece on starling murmurations. We are more accustomed to reading about the beauty of the murmuration as it unfolds, twists and dances through the air in Brighton or Rome. In his study of leisurely observers of murmurations, Andy Morris (2019) writes the following, for instance:

The murmuration serves as a neat illustration of the way that an established tradition of ‘natural’ and “social” spaces can be disrupted and questioned. Not only are the bounded natural spaces of the reserve reframed by the ‘socialising’ agency of people, the agency of starlings is also at work in reframing the residential street as a spontaneous site of natural-social encounter. (p. 306)

Such a sentiment echoes Couze Venn’s (2010) article on individuation and affect, in which he writes: ‘We have all watched in fascination the amazing swirl of a flock of starlings in the evening sky, or followed the movement of seagulls as they swoop together in a large bunch on a freshly ploughed field’ (p. 130). Both examples suggest that such formations invite us to create models of community and becoming ‘that would not only allow us to better understand the mechanisms at work, but also [to] show the proximity of all living beings at this level of processes that involve non-conscious, visceral, propriocentric, affective processes connecting bodies’ (p. 130). Individual entities, for Venn, are defined through their immediate and ongoing relations. And these models go against the dominant models of Science (deliberately with a capital ‘S’), which reduce such displays to the reified object. I suggest that instead we might read ‘nature’ as inherent to the relationality of data objects such as
murmurations – so that we can objectively make sense of form but also make room for how we subjectively shape those realities.

Witnessing the body/road collision offsets marvel and wonder, insofar as it ruptures what we consider harmonious within nature. When these creatures cease dancing through the air, they become something unrecognizable. Individually, the starlings are meaningless: tragic, twisted bodies. They make little sense until they are contextualized in their group – that their end was a consequence of the community’s movements, that the community moved through the body, as much as the body through the community. Each bird’s trust in and dependence on its neighbours is so great that the birds will follow one another head first into concrete if their formation, in its changes, deems this necessary in that moment. Individually, each bird did nothing but follow its neighbours, while each was individually responsible for its neighbours’ movements into the ground. Each one carries within it the information of its neighbours while it emits information back out to its neighbours.

The perceived birdageddon and its scientific explication are variously mediated – linked to science – but to different ends. One of our connections, based on first-hand observation, seems immediate, visceral, affective. The second is epistemological, based on a readily acknowledged recourse to explanatory causations such as ‘predator evasion’. The first is an encounter of shock at the sight of birds raining like stones from the sky. The second is a logical conclusion about the underlying rule of nature, drawn from nature’s datafication. In this article, I seek a third position, where the objective science of murmurations is worked through serial empirical examples, a speculative account of what draws each smaller body, in the larger body, down into the ground. What is the process by which a bird in the flock trusts its neighbour? How does an individual bird differentiate between trusting its neighbour and protecting itself? The point of interest in both accounts is in the immediacy of mediation, the flows of data, the becoming in-formation of information: How does the body of the swarm distribute information through this network of smaller bodies?

This article thus seeks an ecological position that reads the flowing, topological bodies of starling murmurations as the condition against which such phenomenological and epistemological disparities emerge. This condition I describe as a databodiment, which
refers to an entangled embodiment between the data contained and distributed through smaller bodies into the larger body of the swarm, as well as a radical openness preceding the emergence of a topological body – from the etymology of *data*, meaning ‘something given’, and from *embodiment* as the dynamic movement between inner and outer, subject and object, inside and outside. In short, databodiment bridges the dynamic forces permeating both the individual and the swarm. Databodiment requires the oscillation between *becoming information* and *becoming in-formation*. This dynamic is quilted throughout the flowing, expanding body of the starling murmuration as it ceaselessly swells and bursts from form to form.

Here, we are interested in two bodies involved in an informational relation with one another. There is the small body of the starling who contains and distributes information, and the larger porous body of the murmuration through which that information is distributed. But the large body also contains information that is distributed back into the smaller bodies as well as outside of itself to telegraph confusion to predators and wonder to human observers. My focus here is largely on the dynamic interplay between the two entities: the starling and its murmuration. Data are what bind the relation between the two. Certainly, the nature of the murmuration and the nature of the individual starling are different. A field scientist, for instance, studying the anatomy of starlings, needs to be intimately familiar with the location of the starling’s heart (beneath the triangle outlined by its ribs, coracoid and scapula) so as to execute an ethical rapid cardiac compression for a quick death in case the bird is injured (see Engilis et al., 2018). Alternatively, a computer scientist may be interested in the distance each individual in the murmuration keeps from its neighbouring entities (see Bonabeau et al., 1999). But it is in the *flow of experience* where we may understand how data flow between interdependent and co-emergent entities.

On another level, however, I argue that databodiment mediates a new topological relationship between nature and culture and that the conclusions of scientific research become the raw material for new dynamics in such a relationship. This article elucidates this topology by following a murmuration of starlings as they traverse in a continuous fold encompassing bioinformational, algorithmic and aesthetic forms. The case study thus embodies a data journey, employing the tactics claimed by science that generated recent
discoveries in starling murmurations, including the topological expansions and contractions. Scientific research has so far concluded that each starling in a murmuration abides by a rule – for each starling to follow its closest neighbours and to keep its own movements in check in relation to those others. This rule, then, is the starting ground for recharging a philosophical interest in flocks and swarms – the dynamic of becoming information to become in-formation.

**Animals as Data**

While the arrival of the animal in media and cultural studies research raised new questions about the limits of knowing and anthropocentric reasoning, it also carried with it robust methodological possibilities. Much of contemporary animal studies would be untethered without Jacques Derrida’s influential contribution in *The Animal that Therefore I Am* (Derrida, 2009), where he argues against the generality of the term *animal*. Instead, he pursues individuated encounters. Similarly, Donna Haraway’s *When Species Meet* (Haraway, 2008) assumes a co-evolutionary perspective that underlies the companionship between people and their animal kin, through ‘stories about immigration, indigenous worlds, work, hope, love, play, and the possibility of cohabitation through reconsidering sovereignty and ecological developmental naturecultures’ (2008: 98). The animal and the human, in the relationship they build with one another’s quasi-compatible worlds, engage in a process of becoming-with one another. To become-with means to engage in a dynamic interlocking choreography with another species and to adopt a non-dominating perspective alongside them (Carter and Charles, 2018). It means acknowledging non-human species as companions in everyday life (Crinall, 2019). But it also means acknowledging their intimately entangled role as co-producers of knowledge in research (Latimer and Gómez, 2019). Life is full of these flowing entanglements, as in Haraway’s example of how sheep-herding dogs follow their trainers, as their trainers follow their dogs, and the sheep follow one another, putting all three entities (dog/sheep/human) into a choreographed dance.

A central drive of much posthumanities literature has been to study the worlds that animals create with their environments and the conditions under which it might be possible to point to distinctions
between the body and the environment. As Cary Wolfe has written in *Ecological Poetics* (2020), the animal has always been, from within ecocriticism, an environmentally situated creature. From a theoretical biological perspective, a favoured frame for Wolfe, it would be impossible to see the lateral line on a trout, for example, and not think it has to do with the body’s embeddedness in its habitat; moreover, the habitat is conditioned by the presence of the body as much as the body is by the habitat. As Dorion Sagan (2010) writes in his introduction to Jakob von Uexküll’s *A Foray into the World of Animals* (2010), if whales can hypothetically garner a sonar image based on their massive echolocation range (1,000+ kms), these images are not representations of space. Instead, he writes that

in their giant Umwelten, [they] have fabulous multisensory pictures of major portions of the ocean, images that, even if we had direct access to them, we couldn’t process, because our brains are too small. They may experience time in a way as extended, as imaging ocean basins suggests superiority in the realm of space. (Sagan, 2010: 18)

John Durham Peters’ (2015) analysis of dolphins is similar in that he points to the fact that dolphins build elaborate social networks with their senses and signals instead of building material infrastructures. We may not know what it means to be an animal. But we may adopt a position wherein being an ally, further widening communities to include non-human animals, would establish better ethical commitments to them.

Media and cultural theorists have argued that non-human formations mediate their worlds and their environments, as bioinformational data networks. Within critical and cultural theory, the concept of data has undergone creative definitions. For instance, ‘data flow’ describes how information leads in and out of individual research projects (Sands et al., 2012); ‘data friction’ accounts for the power dynamics that prohibit and control such flows (Edwards, 2010); Raley (2013) expands on Haggerty and Ericson’s (2000) ‘data double’ as a digital surrogate aggregate (this has also persisted in Gorunova’s, 2019, recent account of the digital subject); ‘data foam’ is Andrews’ (2018) evocative term for describing superfluous data metrics; and ‘data materiality’ has gained attention from Lupton’s (2016) robust research program on the quantified self, which theorizes the prostheticization of embodiment through digital media.
devices. Leonelli’s (2016) ‘data journey’ is an especially interesting concept for following the material openness of data and embodiment, particularly useful for calling up the way contemporary human subjects measure and live their own experiences through digital devices.

Jussi Parikka (2010), in his book *Insect Media*, supplements the Darwinian notion of ‘fit’ with a familiar Deleuzean trope of intensities, to explain the spontaneity and power of collective formation. With persistent reference to insect swarms as the collective intertwining movements between biological and technical bodies, he proposes a ‘need for a cartography of potential forces of inhuman kinds that question evolutionary trees and exhibit alternative logics of thought, organization, and sensation’ (Parikka, 2010: xix). Swarms emerge as ‘super-organisms’, which defy a rational objectified analysis and rely instead on topological understandings of movement. Such swarms, he writes, are bound by a proprioceptive consciousness at the affective level ‘of murmur, whisper, and a refrain that even the bees might not hear but sense in some uncanny way’ (p. 50). We would be amiss to think that the logic of the swarm can be grafted onto the logic of human organization, for the swarm proceeds according to a durational, ongoing and spontaneous movement that Parikka describes as a ‘relationality of microperceptions that work in concert and unfold in time’ (p. 60). However, the swarm’s potential should serve as a philosophical motivation to reimagine what it means to move together as co-emergent entities, to contribute to the individuation of the swarm and to have that individuation inform the continued survival of those it contains. Swarms, therefore, are not objects in space so much as *they are themselves time*, emerging, dancing, moving and resting to move again. A smaller body, the individual within the swarm, brings data from ‘over there’ to ‘over here’; but that ‘over here’ is on its course to becoming an ‘over there’, iterations that repeat again and again.

Animal datafication is not an end but the ground for actualizing new potentialities for thought. It is not so much that the measurement of environments or of nature homogenize the perception of the world into an anthropocentric environmental governance. Instead, datafication produces real effects for real experiences and real change in a real world, a world that can be experienced on multiple time scales and from perspectives previously closed to the casing of human
subjectivity. Datafication can offer new potentials for resistance from human and non-human entities and assemblages.

**The Datafication of the Starling: Becoming In-formation**

Ancient and early modern observations of starling murmurations reveal something other-worldly in explanations of how they stay together, reflecting a consistent interest in what keeps the starling in the murmuration. While speculative evidence suggests that ancient Romans observed starling formations as part of a practice of ‘taking the auspices’, at the turn of the 20th century their group behaviour was explained according to an underlying logic. Edmund Selous famously argued, based on years of observing bird flocks (and starling murmurations in particular), that birds undergo a psychic transference, a ‘thought-transference’, that caused them to move together through the sky (Thomas, 1931). He wrote of this: ‘Each mass of them turned, wheeled, reversed the order of their flight, changed in one shimmer from brown to grey, from dark to light, as though all the individuals composing them had been component parts of an individual organism’. Thought-transference reflected understanding of how one actual entity is the data for another actual entity; this notion betrays an interest in the transference of information, how the flock is coded, as well as the subjective experience of the individual entity which absorbs and disseminates data. ‘Thought-transference’ becomes an impersonal bind that dominates the individuals contained beneath or within it. Support for such hypotheses of psychic transference was short-lived in the scientific community. As a founder of the ‘classical ethologist’ perspective, Caroline Hovanec comments on Selous’s work: ‘the classical ethologists’ conclusion that animals’ subjective experiences are “irrelevant” seems to reflect a narrow view of science and an old-fashioned desire for science to be pure, objective, and detached, unsullied by any murky ethical quandaries’ (Hovanec, 2018: 105).

Selous’s work went uncited as a serious scientific contribution for many years to come, with explanations of spontaneous flock movements yielding to definitions built on modelling, technology and algorithms. Certainly, with such explanations, wonder at the events of flocks and flocking was beginning to wane. Ward and Zahavi (1973), for example, had concluded that bird assemblages flocked
together to ease the task of foraging. And while their conclusions were unsentimental, they further theorized that birds in a flock are like nodes in a network that disperse information that the flock follows as one. They surmised that bird in flocks can signal to other related flocks, including signalling the whereabouts of food sources, at a much greater rate than birds that forage alone. Thus, individual birds in bird species with a high communal roost/communal foraging ratio come to recognize the roost as a reliable source of information for feeding locations. The individuals together follow the information that is distributed among the group; the murmuration serves also as a signal to other murmurations that food is nearby. In this way, the group formations distribute information to the individual bodies and to other murmurations, from the outside in.

Conveying the corpus of scientific literature on flocking is outside my scope and purpose here, but I do note that what remains consistent across the literature is a tendency towards information as the key functional heuristic to explain flocking phenomena. Another perspective, consistent with this analogy, concluded that starlings roosted in close groups to keep warm in the winter (Yom-Tov et al., 1977). The roost, within the context of these studies, is a locus for information sharing, but it can also act as a thermodynamic conductor. Yom-Tov et al. (1977) further concluded that large groups, such as starling murmurations that cover the branches of trees and parts of the surrounding grass, also fended off predators in their formations; such information travels virtually instantaneously throughout the flock, causing them to rise in a great storm that shapes and bends through the sky, thus causing confusion and disorientation in the predator.

Information and predation – these two nodes therefore became central in the journey towards datafication of the starling murmuration. Throughout all this, however, materialist questions remained unanswered. For instance, how do the flocks change their shape and how do they merge with other flocks or break off into smaller units (Reynolds, 1987)? No subject/object appears in the body of the starling murmuration. While these are the purely scientific questions, grafting these questions onto the cultural theoretical raises new questions: How is one entity defined temporally, as a body that absorbs and emits data from and towards other entities? A singular body, defined communally, transmits information throughout the network,
but what is the dynamic through which this process of absorption and dissemination occurs? These forms obviously change value as they change historical situations; for example, the starling murmuration finds further significance in the field of computer science and algorithms.

Computer scientist Craig W. Reynolds (1987), for example, created a model of flocking based on his observations of individuals in flocks. His computer simulation of ‘boid’ formations was based on a three-rule algorithm: individuals (1) avoid collision, (2) match the velocity of their nearest neighbours and (3) simultaneously aim to move to the centre of the flock. The simulated boids provided ways to watch and test murmuration theories. Importantly, the self-organization of Reynolds’s (1987) boids proved useful for thinking through data visualization and data aestheticization, especially live data and the capture of self-organizing motion that, in turn, updates, changes or reconfigures the data.

Research on starling murmurations demonstrated that each individual in a flock was aware that the centre was the safest and most secure from predation. Every element was thus aware of not only its own relation with others but the relations other entities had with itself. Reynolds had constructed his boids with a ‘selfish’ motivation, so that they herded towards the centre of the flock and sought to avoid collisions. In essence, they were conceived as though they possessed an agential power. Rather than being summoned by a psychic transference, the boid algorithm demonstrated that each individual acted in its own best interest of preservation, absorbing the world as information. Because of this simple rule of preservation, as well as individuals’ tendency to flock with their kind, their formation was considered ideal for time-varying data sets that comprised data objects that change over time (Moere, 2004), such as stock prices and the market.

One governance application can be noted in new workplace monitoring techniques that include audio recordings of meetings and the use of the boid algorithm to track which subjects are addressed by which team members and how and whether the rest of the team members follow in formation or deviate towards more mundane discussions. Such strategies are a method to ‘treat the design team as a unit of analysis and a unit of observation’ (Dong and Moere, 2005: 1). These new boid-metric governance machines implement a
neuropower that is solely focused on the act and the movement of labour.

Interdisciplinary research teams, interested in the way individuals converge on certain issues and disagree on others, have themselves become the subject of flocking data analysis. Here, the communicative acts are considered the elements in the flock, which follow and are followed by other such acts. Every member of the team is thus influenced by and influences others, based on the simple rule of following derived from Reynolds’s boids. In the case of high-stakes deliverables in engineering and design, Moere (2004) concluded that the ideas become the actors in a network of other ideas, which can be analysed when teams consist of hundreds or thousands of members. These results can be seen in real time through data visualizations, a real life and real time reification of the dynamic interactions that are ultimately subject to management decisions. Moere has written about this:

A computational approach here implies not looking within the memory and intention of every team member, but using computational programming to analyze digital infrastructures for communicated messages, in order to elucidate the most popular and least popular ideas beheld by team members. (p. 97)

The science of starling murmuration, a sympoietic body of spontaneous collective movements, also has profound implications for coding and transference onto technical forms and various kinds of visualization (Proctor and Winter, 1998). It can help to make sense of big data and to demonstrate the motion of collectives; it can also be programmed as on-screen visualizations that follow hashtags and other live data feeds.

Understanding that animals flock together based on simple local rules they follow is enlightening, but this knowledge is based on assumptions about flight and behaviour (Ballerini et al., 2008). In fact, we still know very little about how those interactions actually work. Do the birds follow their nearest neighbours? How can we measure the significant value of a neighbour or neighbours? What happens when a neighbour exceeds the necessary proximal distance? Some researchers in Rome (Ballerini et al., 2008) used Reynolds’s flocking model, along with observations of starling murmuration, to take up some of these questions. They proposed that birds interact
with one another based on a topological, not a metric, proximity. Specifically, they suggested that birds in a flock will focus on the movements of six to seven adjacent birds of variable distances, despite the opacity or transparency of the flock. The topological distance is what maintains the density of the flock’s aggregate body, despite the variations that occur during stressful periods, such as a predator attack.

Regardless of the size of the flock, the formation is kept intact through its topological relations. If the flock was measured using a metric analysis of pure distance, it would be unstable because the range would be too variable. Birds can keep track of only a limited number of objects, so their world within the flock consists of the information gathered from the bodies of their proximal neighbours. Ballerini and colleagues (2008) described this information as a ‘prenumeric’ relation, a ‘subtizing’ capacity to retain and maintain the six- to seven-neighbour relation, since this is the maximum number of others from which the individual can gather information. They surmised that the individual garners accurate enough information about the direction of a predatory attack from these limited number of neighbours. They considered three to five neighbours a weak threshold, unable to carry the appropriate information, while eight or more neighbours would produce noise. In other words, the direction of the flock and its inevitable destruction could be guided by misinformed nodes (see also Cavagna et al., 2010).

The topological model offers greater explanatory power because it shows that the form of the flock maintains its structure despite the variable changes in the distances between neighbours. The flock can perform all sorts of tactics in its dances, but the form comfortably maintains itself. Ballerini and colleagues (2008) also write that a topological interaction is very robust, because its strength is the same at different densities. By interacting within a fixed number of individuals, the aggregation can be either dense or sparse, change shape, fluctuate and even split, yet maintain the same degree of cohesion.

But, why the variation? Why the dance? Scientists still had to grapple with the great variabilities and sensitivity among the starling murmuration (Hildebrandt et al., 2010). With the topological character no longer in question, the focus shifts to the methods
starlings used to maintain the flock cohesion. Storms and colleagues (2019) have identified that starlings employ several strategies to avoid predation:

- **Wave event**: One or more pulses of optically darkened bands propagate through the flock
- **Blackening**: The flock, or part of it, darkens
- **Flash expansion**: Starlings suddenly move radially outwards from the flock
- **Vacuole**: A hole appears for a certain period in the flock, where flock members are aligned
- **Split**: A single flock splits into multiple subflocks
- **Merge**: Multiple subflocks merge together
- **Cordon**: Two relatively large parts of the flock are interconnected by a thin string of individuals
- **Flock dilution**: A flock spreads out and becomes lighter in colour, indicating larger distances between individuals

(Storms et al., 2019: 3)

Recent evidence does suggest, however, that the murmuration holds together by an oscillating code of light and dark, with a flickering dynamic that helps the starling perceive its own place within the murmuration itself. As an individual starling follows the movements of its neighbours, light signifies an opening to the outside, with dark expressing the cloak of neighbouring bodies. This is a phenomenon that Pearce and colleagues term a ‘hybrid projection’ (Pearce et al., 2014: 10423). Every starling is tasked with dutifully maintaining a balance of light and dark, flying closer to their neighbours for safety, away from them to maintain awareness of their direction and their surroundings. Together, the oscillation of light and dark, like the flicker of a movie projector, allows the birds to experience their own movement in their environment, including the passage of time and space. In this context, light and dark constitute a binary code of information: light is the sky, dark is a neighbouring body that casts a shadow. Together, they allow a view of the entire flock’s movement as well as participation in and experience of that movement, which enables the individual to extract information quickly about that movement. If cloaked in darkness, the individual bird’s movements are inhibited; in light, it is outside the formation and vulnerable to predators. This rather simple coding makes for quick
context-based decisions in movement (Pearce et al., 2014). About this, Pearce and colleagues write the following:

This information is all that would be available to an agent, regardless of the behavioral model that might be chosen.... Individuals in a flock that is sparse enough for them to typically see a complex projected pattern of dark and light have more information about the global state of the flock. Such sparse flocks also allow an individual to see out in a significant fraction of all directions, which would allow the approach of a predator, or at least the response of distant individuals to the approach of a predator, to be registered. Conversely, a dense, completely opaque flock would offer little information about either the global state of the flock or the approach of predators.

(p. 10422)

The dynamic we can glean from this perspective on the murmuration is that the birds individually gather information from the oscillation of light and dark, produced through the movements within the murmuration. This flickering is not a mediation but something broader. It is a vibration, an asymmetrical synthesis, a process without a goal or an aim; it is a site that underlies the necessity for further movement.

Spontaneous organization around information is thus a defining feature of the starling murmuration (Webster et al., 2018), keeping it versatile enough to respond to different threat levels through various escape patterns. If it is a medium-level threat, the formation would blacken then wave—the thereby creating indeterminate patterns, in variation. In high threat, the murmuration would expand then split. When not sensing an attack, the individuals maintain a good deal of distance between one another (flock dilution), but when an attack is imminent, the murmuration provides one of the flock’s powerful displays of surging movement. These variations speak not only to the spontaneity of the topological deformation but to the topological precondition that activates the dynamic of the databodiment entanglement.

The datafied object of analysis—here, the dynamic of following and being followed—continues to amaze and delight, demonstrating in some cases that data, design and nature can fuse and become one with the flock. ‘Franchise Freedom’ is a flying sculpture designed by artists and designers at Studio Drift (studiodrift.com), who used the principle that ‘no bird works alone’ for three performances—Miami,
Amsterdam and the Burning Man Festival – embodying this maxim to great effect. They programmed 700 lighted drones to individually obey the rules of starling murmurations as outlined by Reynolds (1987). ‘Franchise Freedom’ was released for a brief air display in a fully autonomous cloud formation, making use not only of the formation but of the intensity of light shining from each individual drone according to its proximity to its neighbours. The nature/technology/art entanglement changes shape on its own, but under the watchful gaze of the festivalgoers where it is installed; the murmuration also changes shape depending on the position of the individual spectators. Thus, it offers a topology that is not simply based on the natural formation but depends too on the way in which spectators position themselves and move around social spaces. The sculpture thus speaks doubly to the freedom of the murmuration as well as to the spectators. The boid algorithm is repurposed as the datum that underlies further experience: drone murmurations and light displays, flocking information in formation of starling clouds, a sculptural topology.

A data doubleness emerges as the becoming information becomes in-formation. This art piece is a moment of singularity among multiple multiplicities, bound between two embodiments of the same data. As the swarm of drones swells like fireflies in the dark, human spectators are called into a state of collective intimacy, a gathering of contemplation where the determinants of code and natural laws are suspended under the principle of a self-governing system. The murmuration appears to emulate a natural formation in an unnatural form. And although the flock is stable through its individuated, self-sensing bodies, it is a collective body of sense and self-sense. The formation is not sensing its environment so much as it is sensing its own sensation of the environment through singular nodes (a multiplicity of a multiple).

On 9 May 2020, amid the COVID-19 lockdown in Rotterdam in the Netherlands, Studio Drift illuminated the sky again with 300 drones to form shapes of hands and masks in praise of frontline workers. Described as a way of ‘managing uncertainty and maintaining consensus’ (qtd. in Miller, 2020), the purpose was not necessarily for onlookers to marvel at the formation, but rather to observe and experience how the drones’ movements instantiate the elastic dynamic of the formation rules. The dynamic was not hidden in the
form, but instead *was* the form. But the movement into those forms also spoke on another level: to emphasize that we need to manage our uncertainty by maintaining our consensus, which is exemplified in the ethos of not working alone. Thus, the communal line of the starling murmuration was woven through the computational logic of the boid, the formation of the drone swarm and the contingency of the COVID-19 pandemic – where we are also called to manage uncertainty by reaching common understandings.

The question arises of whether starling murmurations are defined by their pure function of evading predators. Each starling’s *logos* is informed by the pure fact of following, not evading. This pure fact of following becomes the dynamic of their communities. It imposes a limited epistemological *knowing* in each body in the murmuration, to become information to become in-formation. As each entity is bound by the dynamic of following, this dynamic is activated by the actions of its (six to seven) closest neighbours, who are activated by *their* seven closest neighbours and so on and so forth. I close this article with some thoughts on the implications of this communal thread of information.

**Conclusion**

The murmuration is a closure to the extent that it constitutes a world. To return to Cary Wolfe’s (2020) point, it makes little sense to consider animals apart from their situatedness in an environment. A murmuration does not unfold *in an* environment; rather, its tactics demonstrate that it folds *into* it, making it material, a space for unfolding and folding into, a bird in a flock in a dance in the air. Every actual starling is an active recipient of and transmitter of data, every actual starling’s body programmed into the body of every other starling. Equally so, because each starling is part of another starling’s environment, that which it follows, so that it is making and being made by and through environments and by other organisms who are experiencing their own worlds. Through these interactions, the environment and the organism are in constant flux.

Under the current COVID-19 pandemic, the logic of the starling murmuration has been grafted onto the social imaginary of our new collective becomings. Examples abound. In the first few weeks of the pandemic, a murmuration of starlings was captured on video amidst...
the silent streets of Ahmedabad, a teeming Indian city with cars and carts and bulls and kittens and camels and people, all on the same roads. The video was shared via social media as a visualization of peace within the context of a serious threat to human existence. The tweet that was retweeted many times read as follows:

Today at Ahmedabad Riverfront... See how nature is celebrating the peaceful coexistence of Human and Non-human beings in Corona regime 😊

However, fact-checking by the independent website *Boom* revealed that the video was filmed *well before* the COVID-19 pandemic (Badiruddin, 2020). But notably, humans and non-humans were not in proximity, as is usual. Instead, what was special about the video was the fact that people were paying more attention to nature. The din of modern traffic was absent. The busyness of the crowds was gone. Nature was on full display – by using the dynamic of starling murmurations, the video suggested a desire to become *with* nature, a desire that pervades observations of the murmurations, as the tweet cited above demonstrates (in spite of the video not being filmed during the pandemic).

Popular business websites have also used starling murmurations as directives for how to lead during a pandemic. Business blogs like *The Partnering Initiative* and business magazines such as *Forbes* have published articles arguing that we should ‘bottle the essence of collaboration’ that occurs during a crisis, in the same way a starling murmuration moves through space (Benjamin and Komlos, 2020; Prescott, 2020). This natural form is not being admired for its beauty; instead, the animal formation is a consultant for ethical action. The difference here is between a gaze and a consultation.

Murmurations are similarly resonant with current creative productions, such as poetry. During the coronavirus pandemic, Newcastle University encouraged people around the world to contribute to a poem that celebrates the natural world. The project, *Murmuration*, by British poet Linda France, brought people together in a mass online collaboration, much like other living archive and massive online archive projects:

The concept is inspired by murmurations, the astonishing displays of aerial acrobatics we see in the air in autumn and winter, when great flocks of starlings gather. Flying together, but never colliding,
starlings know there is safety in numbers. In a murmuration the birds are protected from predators and cooling temperatures, while they share news and information and enjoy each other’s company, arcing, folding and singing together. (Newcastle University Press Office, 2020)

In other words, the starling murmurations, as with other animal behaviours, are emerging as an assemblage that we think with, instead of think about.

Adhering to the datafication of nature is, paradoxically, a way of resisting the datafication of nature. Data entities were presented as relational entities, which are subject to the change and will of research agendas. Despite the violence of datafication involved in reducing a natural formation to a formulation of pure facts – here, the pure facts of following information – the datafied object still contains the potential for a renewed experiential life. One outcome of this renewed experience could be the resuscitation of awe and wonder at the mystery of the flock (contained in the drone assemblages). However, another more radical insight persists in the realization that something that was once beautiful can become disorienting. The drones used in the compelling Studio Drift exhibits find their shadow in the militaristic predator drones, which are invoked for a far different purpose than aesthetic wonder and joy. The disorientation and alien phenomenology that attends that type of utilization echoes the current global crisis of the COVID-19 pandemic as well as future crises that have yet to unfold.

A case study like the starling murmuration problematizes the ease with which we warn against the datafication of nature and the equal ease with which we seek to reclaim experience from nature – as if scientific pursuits have not already altered nature. It also challenges the overly simplistic goal of denying the life that data give to objects. We are in a fortunate position to study the datafication of nature, as the planet has become consumed by practices of environmental monitoring and governmentality, which use environmental sensors and various intimate ways of accruing the collective behaviour of animals. More importantly, we have the opportunity to study nature’s resistance to its datafication through a new phenomenological position of databodiment, a touching of data and body, one that shows how radically opposed and resistant nature is to the anthropocentric gaze.
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