

The Centralised Mindset and Complexity Science

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Abstract: *Humans tend to explain decentralised phenomena as being caused by a single entity. This way of thinking is often referred to as 'the centralised mindset'. Several authors propose that using programming environments where creation of decentralised agent-based systems is easy can help people to start appreciating dynamics of bottom-up models. However, complexity scientists need to move beyond simple grid worlds with little realism if they are to be taken seriously by others who prefer analytical methods that can predict global behaviours of emergent systems. While responsible complexity science can help us understand and perhaps copy the nature, it is questionable whether we can also use decentralisation as a model of our social, economical or political organisation. Our currently poor understanding of design and evaluation of emergent systems, as well as our egoistic way of living are among things that stand in the way of our species to become more efficient through decentralisation.*

Keywords: centralised mindset, complexity science, decentralisation

1. Introduction

In his book Turtles, Termites and Traffic Jams, Resnick (1997) points out that human thinking is mostly governed by the 'centralised mindset', a conceptual framework that causes the tendency of people to attribute too much responsibility for phenomena that arise from decentralised processes to a single cause. For example, we prefer to blame the government for all our country's problems (Furniss, 1974), we make CEOs overly responsible for a fate of a company (Surowiecki, 2004, p. 219) and some of us still believe that such a complex system as life had to be designed by a single entity (Resnick, 1997, p. 5).

This essay briefly discusses why humans tend to prefer centralised models and mentions two programming environments designed to help young people understand decentralised processes. In Section 3, the role and responsibility of complexity science in creating bottom-up explanations of real-world phenomena is elaborated on. The practicality of using decentralised models outside of science and engineering is questioned in Section 4.

2. The Centralised Mindset

The centralised mindset has its dominant place in many aspects of our society - the economy (Axtell, 1999a), politics (Furniss, 1974), religion (Resnick, 1997, p. 5), warfare (Dekker, 2006) and science. We seem to be attached to the idea of a single 'designer' responsible for patterns occurring as results of decentralised processes - we imagine a bird flock following a leader, or search for a car that caused a traffic jam

(Resnick, 1997, p. 3-4). Strong preference of centralised organisation is evident from both the modern and primitive human societies. For example, hunt tribes use experienced hunt leaders as the only information processing and decision-making nodes. Not only do the leaders tell hunters what to do, they are the only people perceived by their tribe as responsible for outcome of a hunt (Bird et al., 2001).

Resnick (1997) proposes that we should gradually adjust our understanding of the world towards a more decentralised one and that providing programming and visualisation tools for young people can help with such an endeavour. His environment called StarLogo aims to help students develop intuitions about how decentralised agent-based models work. Simple 'turtles' live in a grid world and can be told to behave in certain ways based on locally perceived environments. The advantage of StarLogo is that its scripting language is fairly easy to understand and the user can fully concentrate on creating the desired behaviour, rather than having to program something from scratch.

A similar attempt was made by Vidal and Buhler (2002) who developed Biter, a platform where decentralised solutions could easily be developed for a simulated RoboCup tournament. Observation of how people initially worked with both StarLogo and Biter revealed that there indeed is a certain barrier a human needs to cross in order to start thinking about systems in a non-centralised manner. Some people can switch easier that others, but it seems that one needs to see and more importantly experiment with at least one such system in order to develop a general intuition about decentralised phenomena.

It is intriguing to ask why we cling to our centralised view of the world so tightly. Surely, influence of already existing culture, especially in the young age (Resnick, 1997), is one of the factors. It is also very possible that our species is simply predisposed to seek centralised view of the world. For example it has been argued that the very basic perception of a centralised 'self' in the human brain is only an 'illusion', an emergent property of a decentralised mind (Wegner, 2003; Metzinger, 2006, 2008). The brain might simply be trying to minimise the energy and time it needs to make sense of all that happens within and outside of it - believing that a thunder god is responsible for the rain is much simpler than going into details of the weather dynamics. Similarly, believing that the president is responsible for the fall of economy is easier than attributing small collective responsibilities to seemingly unrelated firms and banks.

3. Complexity Science

Luckily, we no longer believe that gods cause bad weather and hopefully one day we will also be able to realise and fully understand all complexities of the world. Today, simple programs and grid worlds can help children and undergraduates to start thinking in this new way. But is it enough?

Too many scientists seem to use grid worlds and very simple models of what they consider decentralised systems, including using of StarLogo or other Logo instances. How can these models be taken seriously by people who prefer analytical but fairly robust methods to predict global behaviours of decentralised systems? More importantly, how can simulations where agents have perfect information and noiseless movement made up of discrete steps be taken seriously by people who are predisposed to reject such models? There is a great danger that simple grid-world models could be perceived as environments in their own respect, with almost no relation to the real world. On the other hand, continuous models with realistic physics and/or behaviours can make the gap between the reality and the simulation smaller. Such models remind us that there are bigger parameter spaces to be explored. How can we know what parameters are important in the real systems if we completely omit them in our simulations?

Franks et al. (1992) implemented an agent-based model to mimmic how ants build a circular nest around themselves. The author observed real ants that brought stones to the nest and bulldozed them against other stones, gradually creating thick walls around the brood. In his computer simulation, ants could observe the number of stones already in the area and had a high probability of dropping a carried stone where wall density was high. The resulting structures were fairly similar to the real nests, but the

mechanism that produced them was very different. Firstly, Franks claimed that real ants were blind and walking randomly during the construction, yet in his model they somehow knew the concentration of the stones around. Secondly, physics of the model were practically non-existent. The author of this essay is currently working on a more realistic model where ants cannot look around and have to bulldoze stones that have a certain weight rather than simply dropping platonic stones that have no cost of carrying. It turns out that weight is one of the important parameters of building by bulldozing - generally speaking, walls become less regular when stones are heavier as it is more difficult to push multiple stones together. It is more than probable that there are other crucial parameters that play role in the real ant behaviour, waiting to be explored.

While dynamics of simple models are interesting, looking at them more closely often reveals that they have little use in the real world. It should be a scientist's responsibility to think about real-world parameters before creating their models and trying to persuade others to believe their explanatory power. Reasoning and careful experiments are amongst the greatest challenges complexity science and agent-based modeling face. While some idealisation is necessary in order to build any models at all, perfect and rational agents placed in noiseless environments will not do. For instance, Axtell (1999a) argued that explanatory power of neoclassical economical agent-based models was very low because of the lack of detail, as well as frequent idealisation. Going slightly further and introducing bounded rationality and heterogeneity to agents, Axtell could develop simulations of how firms emerge, producing data similar to real-world observations.

By using computers, we can create richer models than we would normally be able to conceive of. Object-oriented, functional and parallel programming let us concentrate on isolated problems and the job of putting the final behaviour together is left to the computer. Therefore, good programming skills and working knowledge of software design patters should ideally be on the repertoire of every complexity scientist who seeks to move beyond simple toy worlds. Or, at least good care should be taken when choosing pre-programmed scripting environments to work with.

4. The Age of Decentralisation?

It is doubtless that science needs to embrace decentralised understanding in order to explain complexities of the world. Should decentralisation be taught in schools? Possibly so, otherwise no one will completely understand what complexity scientists talk about. Will it help people to live fuller lives? Can decentralised thinking be applied anywhere else than for describing the world and perhaps for biologically-inspired engineering?

It has been recognised for some time that decisions of a well-diverse group where opinions of people are pooled together are almost always better than decisions of single individuals (Surowiecki, 2004, p. 5). It may therefore seem like we should organise ourselves in a way that would utilise such decision making, especially as our society is becoming increasingly complex (Furniss, 1974). There are certain companies like Zara in the United States that can effectively use bottom-up organisation and frequent on-demand production in order to quickly adapt to needs of its customers, gaining advantage over its competitors (Surowiecki, 2004, p. 192-193).

When questioned about whether firms should move away from centralised organisations, some believe that people will behave responsibly when given the responsibility (Furniss, 1974) and that more responsibility means more engagement from workers who feel 'empowered' and simply enjoy their day-to-day jobs more (Surowiecki, 2004, p. 212). Furthermore, decentralisation often results in better coordination (Surowiecki, 2004, p. 213) as less information needs to travel between people. Finally, an architecture that does not rely on a single centralised controller is also more fault-tolerant (Dekker, 2006).

Why are then so few of today's firms like Zara? Firstly, people often get decentralised architectures wrong, blindly insisting on some form of centralised element that slows decision-making down. This was the case with General Motors during the seventies

or many Silicon Valley companies in the eighties (Surowiecki, 2004, p. 201-207). Secondly, it might be the case that we fail to critically compare centralised and decentralised organisations because of statistics that only look at short-term advantages, overrating centralised solutions (Furniss, 1974). Thirdly, there is a cost to understanding, implementing and maintaining bottom-up organisations (Furniss, 1974). Bottom-up designs are messy. It is hard to imagine how they will work until they are run and observed for some time (Axtell, 1999b).

The idea of everybody having more equal amount of responsibility is often tempting when it comes to one's work place, but arguably more so when political power is in question. In representative democracy, people are often frustrated with their country's leaders and would prefer (or at least think they would prefer) to contribute to the decisions. However, polls suggest that an average person does not know much about the political situation (Surowiecki, 2004, p. 266), questioning how capable a crowd would be in deciding what should be counted as a crime or whether to go to war. Dekker (2006) showed that when it comes to strategic cognitive decisions, a centralised architecture actually outperforms a decentralised one. On the other hand, what a crowd is good at is collectively picking a leader who will be able to make such decisions, especially as a leader who wants to be re-elected needs to specialise and is constantly watched and evaluated by the citizens (Surowiecki, 2004, p. 266).

While a state leader or a company manager can abuse their power, a decentralised system is generally not better in many cases and balance between these two mindsets needs to be sought. Decentralisation means less control over the general picture, which is something not everybody might accept (Furniss, 1974). Furniss argued that when it comes to political or commercial organisations, the problem is not centralised versus decentralised process, but the substrate of a state itself.

The problem is people. Getting rid of strict organisational hierarchies in companies often ends in a disaster because of lack of responsible workers (Furniss, 1974) and poor honesty about performance (Surowiecki, 2004, p. 207-208). Both are crucial factors in a design where a lot of nodes should process information and cooperatively solve problems. More importantly, it takes a shift in the egoistic perception of ourselves to accept people with a less significant career negotiating about our decisions (Dekker, 2006). A similar problem of cooperation versus individualism is faced by other species. Ward et al. (2012) argued that the reason why insects can always cooperatively forage, whereas other animals like fish and birds only do so when they cannot obtain food as individuals is the threat of stealing from one another. Such a defection is not an issue in an insect colony because of a very specific social structure that is in place. Similarly, humans often put their egoistic goals before the collective good. It is without doubt that we simply evolved to be so. Must we evolve further in order to harness the power of decentralisation for our social organisation?

5. Conclusion

What Resnick calls a 'centralised mindset' is the predisposition of people to look for single decision-making components when it comes to explaining complex phenomena. People tend to blame politicians, CEO's and even gods for things that really are results of much bigger processes, processes that happen gradually, on many places and are not easily tractable.

While simple toy worlds can help children and adults who never heard of decentralisation understand mechanisms like positive feedback and emergence, much more needs to be done in complexity science if it is to lead us to the 'Century of Complexity' as envisioned by Stephen Hawking (ComplexityDigest). Hidden parameters that we take for granted in the real world and do not pay attention to in our models have the potential to significantly affect outcomes and explanatory power of our computer simulations. In order for complexity science to be useful and respected, it needs to pay a lot of attention to the detail and provide models that are believable.

In the world outside of science, usefulness of the decentralised mindset is more questionable. While in some instances we may benefit from bottom-up

approaches, reorganising a company or a state to get rid of centralised control often meets with a lot of problems. Lack of responsibility and honesty, as well as preference of personal goals before the common good stand in our way to become a more effective society.

Can complexity science free us from the centralised mindset? Absolutely, provided that it is responsible in the assumptions it makes. Can we use the decentralised mindset for anything else than understanding and copying the nature? Perhaps we are not ready for it as a species yet.

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