

## Beautiful Networks TDS

### NOTES WEEK 2

At every level of complexity “emergent properties” exhibit qualities not found at the lower levels (Capra, p. 28)

Emergent properties emerge out of the whole but do not necessarily exist at the lower levels

“Swarm intelligence” means the whole can do things the individuals cannot. The individuals do not need to be aware of emergence for emergence to occur!

Local level activity consists of ants paying attention to their neighbors through pheromone trails and their antennae. Simple rules govern local interaction. For example, the decision to move or not move, change direction or work together all depends on the simple ways each agent interacts with its neighbor. There is no need for each ant to be directed by a central leader or know anything about the larger organization of the colony or know of the different stages of development of the colony.

Only colonies make more colonies!

This local level activity over time creates a larger entity or “emergent property” like the collective “swarm intelligence” of the colony itself. Each agent is relatively simple but it is their interaction over time that allows complex relationships to emerge: the creation of the colony itself.

It’s this “swarm intelligence” that cannot be explained by any one ant or even all the ants combined. Rather it comes about because of the *INTERACTION* they have which means it is the whole and not only the parts that allow emergence to come about. The organization is truly decentralized.

Think of Interaction as qualitative change in the whole. Interaction is more intensive (action; expression) and less extensive (spatial; scalar). Nevertheless the two embody the same living organism.

Systems thinking: connectedness, relationships and context (Capra, p. 29)

Properties of the whole emerge from the interaction *between* parts and not just from the parts themselves

“Whole is more than the sum of its parts”

Intensive qualitative changes expressed by the whole through interaction of the parts results in the whole as more than the sum of its parts!

Analysis means taking something apart in order to understand it; systems thinking means putting it into the context of a larger whole (Capra, p. 30)

Time in analysis is reversible while in systems thinking time is irreversible!

No two moments are the same!

Each living system operates according to the network model

As matter-energy flows through the system “patterns in time” are created thus making a network of nonlinear relationships

The whole is dynamic and not static, instead of strict “command and control” hierarchies we have webbed patterns or relationships

In nature there are only networks nesting within other networks (Capra, p. 35)

Living systems are then integrated wholes whose properties cannot be reduced to those of the smaller parts (Capra, p. 36)

The “systemic properties” are literally of the whole

The whole arises by way of “systemic properties” which come from the *INTERACTION* or “organizing relations” of the parts themselves

The Cartesian model is only in relation to discrete parts (“coordinate space” from a fixed position). Because order is fixed then one missing piece can cause the whole to not function. Order here is linear and requires each part to remain the same. Any serious deviation from the initial plan will cause everything else to breakdown. The clock only keeps time if all its parts are working in unison and remain in their fixed positions. Motion here is “mechanically self-

perpetuating” and thus requires energy or a force from outside to run and maintain it.

Matter is inert in the Cartesian model while in systems thinking matter-energy is active or self-organizing. In the Cartesian model material is solid and stable like bronze or clay while in systems thinking material is dynamic and elastic like living cells or organic material.

The Cartesian model molds matter at will: shaping it by external force

Again, with systems thinking matter-energy is active or dynamic and more a process than just inert “stuff”

*Dynamism is immanent to matter!*

Since Cartesian thought viewed matter as inert it sought to find immutable laws that would explain order and predictability in nature as integral to a mechanistic and deterministic view of the universe (“clockwork universe”)

In systems thinking the parts are contextual and change *in* time

The “parts” in context are always the larger whole!

Systems thinking is “contextual thinking” (Capra, p. 37)

The part in systems thinking is “a pattern in an inseparable web of relationships” (Capra, p. 37)

In the mechanistic order these parts are distinct and act like a collection of separate objects

Our new model of knowledge is not a hierarchical building or “tree of knowledge” but a network of interaction, creating “mutually cooperative relationships” that give feedback and create a self-sustaining process or loop

Descartes and his “clockwork universe” (Read Capra, p.67)

This explains why the “parts” were privileged because the parts and the way they moved were so beautiful and enjoyable! The clockworks revealed human mastery and control. They also

suggested the presence of immutable laws in nature.

Parts to our machines are no longer visible!

We live in a world of surfaces!

Concealment is used in devices like the computer and cell phone

Today since we do not see the parts we privilege the whole!

Wholeness and integration lead to a world in flux: a world constantly in motion. A world that does not repeat itself without the whole changing! Nothing is reversible. Everything changes through transformation and creation: growth is morphogenetic.

Our enjoyment and pleasure now comes from seeing the larger pattern!

For example, in the Photosynth demo we experience a physical sensation to the flowing movement as it “flocks” and spontaneously reorganizes itself!

## **Summary:**

Networks unlike Descartes’ clockwork model are nonlinear (web of connection)

Instead of there just being extensive points in space (“fixed points”) we see in networks that the points are intensive or changing (“nodes”)

The points themselves are not as important as the *interaction* between them

The network is more a qualitative intensive model and the clockwork is more a quantitative extensive model

From mechanism to holism!

Because networks consist of intensive connections those interactions between “nodes” in the system continually change thus the connections are the whole

It also means that for us using the Internet the network does not exist somewhere out in front of us like an object

In the Cartesian model the subject doing the analysis always stands apart from the object being measured

“I think therefore I am” is one way of putting all this since in the analytic tradition mental activity lords over both body and world

### ***The Internet and the network model:***

The Internet is not an object nor does it merely exist outside us

As users we are the network!

Thus we do not stand apart from it but are embodied by it

The Internet changes because of how those nodes communicate or how we use it

By using it we have no final idea of the complexity it creates

Like all networks it is not centralized but decentralized

No one person controls it and no one group keeps it running

The network organizes itself by the way we actually interact in it!

Like all networks it is never the same network twice!

Because the Internet is a network it behaves like other networks in biology etc.

The “World Wide Web” may in fact be an “emergent property” of the network not unlike other forms of emergence

With self-regulating feedback loops and an Autopoietic (“self-making”) nature it may be like other nonhuman networks despite the fact it is collectively created by humans

All networks have a resilient structure

What makes networks robust is that no one node or point in the system is holding everything together

If there is damage in one area energy can be redirected to create new connections thus keeping the flow of information or energy moving

In clockworks no fundamental changes in the “parts” can be tolerated

Because clocks are “mechanically fixed” I know from the blueprint what the clock is doing and what it is going to do in the future

Because networks run in parallel and it’s the whole of all those interactions and not the parts themselves that express change in the system then it is very easy for information to be retrieved since in nonlinear systems distance is collapsed

For example, in the clockwork we see a fixed linear order (sequencing)

If that order changes then the clock will not work properly

In networks order is nonlinear and not fixed (webbing)

In fact we might say order only emerges in networks because of how the connections change over time and how those connections follow a nonlinear pattern of movement

If change is not allowed to occur in networks then those networks cease being relevant

All nodes in the network share and replicate the same information while their interaction also changes the information being shared

It is a self-organizing but also self-creating system where novelty, change and stability go hand in hand!

Thus if all nodes are a part of the whole then to retrieve information does not mean one signal travels from point A to point B in a linear fashion

Rather, signals are multiple and all those nodes in the network already have the information one is seeking.

***In every node we have expression of the whole!***

So in networks it's not distance that matters but moments in time!

***Networks are temporal while ironically clockworks are not!***

***1) A network changes in time. The network's medium is time! No two moments are the same. In networks time is durational and intensive. Time in the network model is nonlinear and embodies a multiplicity of changing states. Finally, time in networks is more about quality than quantity! We could say that the whole is all the interaction in the system and the way networks endure in time is partly representative of their robust and constantly changing relationship to the irreversible flow of time. But remember in networks the whole is not external to the nodes themselves. In fact each node embodies the whole as it changes because the whole is the interaction of nodes. Each node is a multiplicity of forces. Like our body each node is really a concentration of movement or action! Making the network truly nonlinear. Embodied in time is the network's "multiple unity of duration." Expressing how it then changes and endures through time.***

***2) In clockworks time is frozen and fixed from moment to moment! Clockworks do not change their organization thus they are temporally fixed. According to the clockwork time is something quantifiable. Each so called moment the clockwork measures is momentarily fixed. There is nothing durational about clockworks. Duration is measured by clockworks as entropy. Their parts measure time by the use of spatial symbols like numbers or fixed points. All clockworks analyze time by way of incremental change. Each moment in time is fixed and is relative to the parts and not the whole. In other words, clockworks see time as a progression of separate instants (not continuous change or movement) that are theoretically the same. The passage of time is not only linear but hits upon one fixed moment after another!***

Again, networks exist directly in time since they are changing constantly

This does not mean they are chaotic all the time but because of the way they change they then create stability

Change is continuous in networks while change is made of static parts in the Cartesian model

Bergson would be proud of the Internet because of the “multiple unity of duration” it embodies! The fact that the continuity of time is expressed as multiple states all enduring in time.

*The network embodies Time.*

*Thus the network embodies real change.*

This stability comes from how each node is continuous with its neighbor

*Each node is not fixed in a relative position to its neighbor because the whole of their interaction is expressed in the totality of the nodes themselves! In fact each node embodies the whole as a constantly evolving interaction.*

Thus each node changes just as the connections change between them change. Thus the totality of nodes is Open and not closed

Remember, like self-organization in ants each local level activity pays attention to its neighbor and through those local interactions a global pattern is created. Or in the case of ants their “swarm intelligence” emerges as no one ant is capable of retaining this intelligence by itself

We could also apply this to brain science where the interaction of neurons leads to the Mind as an emergent property of the brain. Like all so called emergent properties we cannot reduce the phenomena to say a fixed understanding of physical causes. We also cannot say that the smaller agents directly created the emergent property. This would be like saying all we have to do to understand complex systems is simply add up all the parts. All we can say is that a certain kind of interaction made the emergent property possible. And by its very nature as an emergent property it cannot be reduced to the parts themselves. Again the *interaction* is the significant aspect here and not just the number of agents involved. Temporality has as much to do with emergence as the agents themselves. Everything is embodied in time!

***Again, Interaction is qualitative change in the whole!***

*So where does the “swarm intelligence” come from? It comes about in the interaction of agents!*

Again, the World Wide Web may be considered an “emergent property” of the Internet. As a meshwork the Web embodies the nonlinear network and hierarchical structures like institutions etc.

The Web is not necessarily planned nor is it the result of one person. Rather human evolution through technological expression created it: culture is the way nature evolved in humans!

*We should also remind ourselves that for the majority of organisms in the world learning and communication do not require a complex nervous system or brain.*