AS-74.4192 Elementary Cybernetics

Bonus Lecture "ω+1": **Transfinite Considerations**



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To infinity ... and beyond!

- Infinity 0: Convergence of signals
- Infinity 1: Convergence of models
- ... Convergence of model models ...
- What is there after all the infinities? What is the *transfinite* big picture?







From toy world to real world

Summary: Neocybernetics in Nature's Core

- 1. Everything is a result of (more or less) identical actors
- 2. Actions can be characterized by sets of variables \overline{u}_i (or \overline{x}_i)
- 3. Only statistical net effects remain visible (affect the world)

Central Limit Theorem: the distributions are Gaussian = characterized by only two cumulants, mean + (co)variance:

- 1. $E{\overline{u}_j}$ = averages of variables static world as we see it: matter, abundance, contents within structures (see below)
- 2. $E{\overline{u_j}^2}, E{\overline{u_j}\overline{u_k}} = emformation/emergy world of change: structures as monads = adapted dynamic attractors$

... Or "emtropy pursuit", or "hunger for livelihood", or "being alive" + "World wants to manifest itself" (or "Survival of the fittest")



- Actually, in addition to the chaos, one needs some "axioms":
- The world is fractal = every level is essentially similar = also the induced distributions are Gaussian = couplings linear:

$$\overline{x}_i = \sum_j a_{ij} \overline{u}_j$$

- 2. The world has some basic structure, or *persistence*: there are interactions as shown above with "short-term memories" x_i and "long-term memories" a_{ij}
 - The former only means some kind of *inertia* and the latter can become implemented through physical proximities, etc.
- Thereafter, everything proceeds as presented in "Lec ∞ ".



About "General theory of complex systems"

- Self-organization Kauffman's theory of autocatalytic sets is not enough: mastery of scales (emergence), mathematics (convergence analysis, compression, sparse coding) needed
- Self-regulation only then the "sticky tar" problem can be avoided: competition is the key point – seen as search for one's own room (this is related to evolution!)
- 3. Self-evolution but not with straightforward "survival of the fittest": it is at system-level, symbiotic; the environment is constructed (semiosis + DOE's) applying one's own criteria!

Search of SELF – how to understand + then creatively escape the self-referential loops; how to outperform oneself finding new DOF's. Without this all is too mechanistic!

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These are studied in neocybernetics, the rest are still waiting for a theory!?

Closer analysis of the degrees of freedom

• Remember that in the neocybernetic framework –

In the complex world with many interdependencies, concentrating on the remaining DOF's gives simpler models

- Along a DOF there is still freedom: in a way, the model captures *dynamics* that is invisible in static patterns
- A DOF represents a high-dimensional dependency structure: it can be seen as an *axis of a whirl (monad)*
- The variable x_i that is related to the monad *i* can be seen as the momentary *rotation speed* of the whirl
- More generally (as will be discussed), the employed DOF's characterize the individual.



In a human's world

 The goal of the "system": when the model is ready, the resources are seen as simple degrees of freedom that can be efficiently controlled





DOF's are tools to characterize the world

World

• DOF's are "basis functions" that span the (subjective) world

Distributed model

high-dimensional fitness landscape

set of optimized freedoms spanning the manifold

Philosophies of Leibniz

- Complex objects are based on a fractal structure of dynamic attractors; indeed, in the spirit of Leibniz's monadology, "everything is based on atomic centers of force"
 - Monads are characterized by the degrees of freedom ("rotation axes" of the "whirls") in the neocybernetic setting
- 2. Complex objects can be characterized in terms of more or less dominant features or attributes; indeed, applying the principle of Leibniz, "objects of identical attributes must be the same"
 - Attributes = things that can have different values = degrees of freedom in the neocybernetic setting?
- Can the latter of Leibniz's ideas be exploited further, too?



"Equimonadic" environments

- If the set of DOF's is equal to the (subjective) world itself ...
- Study structured cases of models of surrounding reality.
- 1. Democracy: individuals / representatives (easy case).
 - Individual human with his/her (set of) DOF's characterizes local world and possibilities therein; neocybernetic process (interaction with other people) with sparse coding property extracts from these the most potential DOF's (the representative) to form the next-level model (the parliament). It can be claimed that the parliament is a model of the people's realities.
- 2. Biology: genotype / phenotype (harder case!).
 - It can be assumed (?) that evolution has matched the DOF's among the transcription factors and genes so that the monads in the chemical realm reflect the DOF's in personal outlook. The matching against reality can be carried out on the low level without always having to try it in real life!



Inheritance of DOF's in structured models

- General structure of how higher-level models emerge
- Note that it is still the same world (the same attractors) that both models reflect



- It is the DOF's that are the building blocks in genetics, not the individual "genetic alphabets" themselves
- Genetic optimization against the environment takes place only among complete attractors
- This would explain why alterations are reasonable while individual mutations are almost always detrimental
- Low-level matching with environment takes place in the chemical realm
- Survival of the fittest (optimization on the highest level) is carried out only among valid alternatives
- Otherwise feedbacks would be all too slow in biological systems to implement any reasonable evolution!

Convergence – Adaptation – Evolution

 $\overline{\mathcal{X}}_i$

 q_i

 $\mathbb{E}\left\{\overline{x}_{i}\overline{u}\right\}$

 $\overline{\mathcal{U}}$

- Key role of DOF's: developments take place along them.
- Evolutionary goal: acquire more activity!

- Alternatives:
- Adaptation. Apply normal Hebbian learning until negative feedback effects take over
- "Smart evolution". Somehow augment the vector of resources
- 3. "Stupid evolution". Increase the coupling making the system stiffer

"Stupid evolution" goes on: Case of a Human



- There is optimum q_i where emformation transfer between the environment and the system is maximized
- This optimum cannot be seen from inside the system

$$q_i \mathbf{E}\left\{\overline{x}_i^2\right\} = \boldsymbol{\phi}_i^T \boldsymbol{\phi}_i = \sqrt{q_i \lambda_j} - 1$$

Some Moomin Characters

- Ninni, the "invisible child", has been neglected so long that she cannot any more be seen, she has no character
- In the opposite end, there is Haisuli, the rascal: "Then there is those who are so extremely visible but whom nobody still notices!"
- Nuuskamuikkunen is somewhere between the extremes: a hero that does not need to be.







Systemic Narcissism: departure from reality

- If there is no balancing counter-force in the subjective realm, the system can go far beyond the "ecosystem" optimum
- Example from international politics
 - When Soviets collapsed, there was nothing opposing the Western countries. The arrogance of the winners has become overwhelming.
- Example from economics
 - When communism collapsed, there was nothing against capitalism any more. Since then, the finance gurus seem to have become quite outrageous.
- Example from modern science
 - When religious explanations collapsed, scientific world view dominated. Mysteries do not exist, science explains everything, as they say!



Closer look at today's Science

- After the long history of successes in science, the coupling factor *q* is extremely large, and the system is extremely stiff
- Claim: science is *narcissistic*, being superior in its subjective world that does not match the human's world any more
- Science determines its own "interesting" questions, difficult ones that are really *important to humans* are overlooked

Is superiority the same thing as being good?

- Kuhn: First there is the *thesis* then an *antithesis* emerges finally there is *synthesis* (more generally studied in *dialectics*)
- Claim: a top-level scientific revolution (or a new natural philosophy) is needed to regenerate the sciences!



"Emergence Exit" – find new DOF's



Even in mathematics: try to see the freedoms



Now: an attempt towards "smart evolution"

- In macro world and in micro world analyses are too crude due to the observer effect the "wave functions collapse"
- Let us look at the medium-sized system closer the mind



Back to basics: Neurons as centers of inertia Emergence of new DOF's starts from bottom

How can the localized system solve sets of equations like

$$\overline{x} = Q E \left\{ \overline{x} \overline{u}^T \right\} \overline{u} = \phi^T \overline{u} = \phi^T \left(u - \phi \overline{x} \right)$$

Only dynamics and feedback available as a mechanism:

$$\frac{dx_i}{dt / \tau} = -q_i^{-1}x_i + \sum_j \mathbf{E}\left\{\overline{x}_i\overline{u}_j\right\}\widetilde{u}_j$$

or, still simpler for q_{opt}

$$\frac{dx_i}{dt / \tau} = -E\left\{\overline{x}_i \overline{x}_i\right\} x_i + \sum_j E\left\{\overline{x}_i \overline{u}_j\right\} \widetilde{u}_j$$

However – not lossless, not symmetric!



Better try: Ensemble Kalman Filter

• Find an "ensemble" of simpler data (x) to represent the distribution of the complex data (u), assuming Gaussianity:

$$p(u \mid x) \propto \left(-\frac{1}{2}\left(u - \phi x\right)^T R^{-1}\left(u - \phi x\right)\right)$$

• Solution: update the model from prior to posterior as

$$x^{\text{posterior}} = x^{\text{prior}} + \text{Cov}\left\{x^{\text{prior}}\right\}\phi^{T}\left(\phi\text{Cov}\left\{x^{\text{prior}}\right\}\phi^{T} + R\right)^{-1}\left(u - \phi x^{\text{prior}}\right)$$

• After manipulations, this can be approximated as

$$\frac{dx}{dt / \tau}(t) \approx \phi^T \left(u - \phi x \right) = \phi^T \tilde{u}(t)$$

meaning that the optimal dynamic state update rule is found!



A new view of a cybernetic system ...

 First, the system continually changes; if the internal dynamics is fast enough, one can simplify

$$\mathbf{E}\left\{\overline{x}\overline{u}^{T}\right\} \approx \mathbf{E}\left\{x\widetilde{u}^{T}\right\}$$

- Second, to avoid differential equations, one can apply Laplace transform to the linear models
- All formulas "static" in frequency domain, with complex variables representing amplitudes and phases
- All transpositions change to Hermitean matrices, for example

$$\frac{dx}{dt / \tau_x}(t) = \phi^T \tilde{u}(t) \implies \tau_x s X(s) = \phi^H \tilde{U}(s)$$

• Adaptations, etc., carried out directly in frequency domain!

... is needed in truly large systems ...

- System grows more internal connections than inputs
- The "virtual inputs" are also neurons = dynamic entities:

$$\frac{d\tilde{u}}{dt / \tau_u}(t) = -\phi x(t)$$
 Negative feedback effect

so that, when collected together

$$\frac{d^{2}x}{dt^{2}/\tau_{x}\tau_{u}}(t) = \phi^{H} \frac{d\tilde{u}}{dt/\tau_{u}}(t) = -\phi^{H}\phi x(t) \qquad \text{Just one variable - solvable!}$$
so that
$$x(t) = A \sin\left(\sqrt{\frac{1}{\tau_{x}\tau_{u}}}\phi^{H}\phi t + \psi\right) \qquad \text{Initial values (amplitude, phase)}$$
determined by the input signals

• What one has, is an undamped harmonic oscillator!

... where subsystems are connected

- If there is interaction among neighboring neuron systems, one can assume that it is the *deviations from group average* that drive the dynamics
- Can be modeled by second spatial derivative = diffusion term
- In principle one can then write a partial differential equation

$$\frac{\partial^2 x}{\partial t^2}(t,s) = v^2 \frac{\partial^2 x}{\partial s^2}(t,s)$$

- This is *wave equation* of effects proceeding with velocity *v*
- ... Perhaps the brain waves need to be studied closer!
- This all is purely hypothetic! But let's see consequences ...



Scenario: structured vibration fields

- What kind of "perceptions" are possible in "field models"?
- Inputs initiate frequencies in neuron groups
- These vibrations proceed to neighboring groups
- Neuron groups can participate in various frequencies
- "Chords" activate new frequencies = more complex objects
- Oscillations compete (neocybernetically) for activation there is competition among "perceptions"
- Assume there is a "canvas" of resonators to be awakened …
 As an example, study the process of recognizing a table.



"left-right gradient"



- Recognition starts from elements
- From "below" (eyes), there is information about intensities
- Extract gradients = This is what visual V1 is known to do
- So, there is a local gradient neuron ...
 What might happen after that?

"left-right edge"



- If there is plenty of evidence for drop in intensity, there is an edge
- Another frequency starts in neurons when this is found
- Sum of organized oscillations = wave front is created as in the case of water waves

"pole"



- Two wave edge fronts meet
- pole = meeting of left-right edge + right-left edge
- Self-organization: There are other interpretations, too

 let them compete
- All related neurons start vibrating also this new frequency



"table"



- table = two poles and a slab meet
- From *above* comes supporting evidence about a **room**, etc.
- "Perception chords" get instantiated!



Deep structures – a proposition

- Some kind of "blackboard architecture" being implemented: matching of frequency patterns taking place
- Image recognition: analysis of two-dimensional patterns Language recognition: analysis of one-dimensional patterns
- When there is a balance of chords, "analysis" is complete
- Understanding = Harmony of noospheres





Consciousness: technically acceptable vision?

• From modeling of closed loop to modeling of open loop parts





Consciousness: intuitively acceptable vision?!

New view:

- Holograph intuition
- Pervasive fields and vibrations
- "Feeling" of being alive





... This reminds of something ...

- Compare to neocybernetic molecule orbitals in Lec. 11!
- Electrons find their locations around nuclei, pushing each other farther, balancing and self-organizing the system in the neocybernetic sense
- "Electronical lockers" determine the number of electrons and energies in each orbital, and thus their vibration frequencies
- Vibration patterns characteristic to each atom in a molecule; molecules act as "directional antennas"
- Only identical frequencies among molecules can interact, resulting in automatic "electric pattern matching" in solutions
- Technical note: to model spatial and temporal phenomena simultaneously, *quaternions* can be employed?



- How molecules experience their environment —
- Static fields cannot explain the pattern matching functions among molecules, but the structured field model can!?
- ... Are there lessons to be learned?





View into Future: Fields are Fundamental

- Hypothesis: a general theory of complex systems is possible, and it is based on neocybernetics
- Hypothesis 2: a general theory of second level cybernetics is possible, and it is based on neocybernetic fields
- Some principles:
 - First level models employ physical variables, but second level models employ frequencies; because of emergy pursuit, algorithms are still the same
 - Again, constraints are given from outside, whereas degrees of freedom (oscillation amplitudes) better characterize the true nature of the system
 - Because of sparse coding, some kind of higher-level patterns emerge from the frequency realm
 - First-level models are complicated by the spatial & temporal structure of the data – now these axes are abstracted away!



Overall View of Cybernetics: Domains of Fields

 "Neocyberspaces" are domains, where individual systems of comparable temporal and spatial scales become unified, no matter what the individual systems are composed of

"World"	Operational fields	Attractor granules
<i>Cosmic</i> Subatomic level	Bohm's pilot waves?	Elementary particles
Material Microscopic	Molecular orbitals??	Physical matter
Mental Mind	Brain waves?	Thoughts
 ↓ Complex □□ Macroscopic 	Morphic fields ??	Kami ??



dow

"Morphic Fields"?

- Assumption: complex systems are characterized by cycles Where do the "vibrations" come from now?
- In systems there is a (fractal) succession of catastrophes:
 birth growth decay death (also in cultures + economies)
- Seasons, for example, can synchronize the catastrophes in natural systems





"Stupid evolution", too: spectra emerging



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Own spectrum for all DOF's = all life forms!

Human's Role: Consciousness of Nature?

- However, there are no concrete force fields to implement the high-level pattern matching (as compared to the molecular orbitals, or the mind, where there are the electrical fields)
- An external mental machinery is needed to "see" spatial and temporal fields frequencies are abstractions over the axes
- The model has to be reconstructed in the mind the nature of unity and continuity among systems has to be seen
- Human's role: nature needs humans to act as the mediating "aether" for the complex systems to become "unified"
- In the Hegelian spirit: nature and history can become conscious of themselves but only with the help of a human!



- What does the "abstraction over time axis" mean in practice?
- You have to live in time but you have to think in terms of frequencies (generations as cycles)
- You are the link between the past and the future, without you (and your appropriate actions) there is no continuum
- You have to pass the cycles of your family, your culture, your profession, your environment, etc., undisturbed (enhanced!) into the future (understand where and when to make impact!)
- There are many simultaneous chains, a full fabric of systems passing through you
- You are necessary as the center of your subjective world!



- "Look at the birds in the forest!"
- Experience the fields and participate in them
- Play your own chord!
- Become a "laulaja"!



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Cybernetic Imperatives

- "Science should not say anything about morals or values"
- Why not there is (should be) the best understanding?
- Neocybernetic values:
 - Should be centered on *life*: how many living monads the thing hosts?
 - There is a continuum from less valuable to more valuable life forms
 - Landmarks of cybernetic life processes: fractality, symmetry, *beauty*
- Neocybernetic ethics:
 - You cannot affect their morals
 No Kantian/Christian imperatives; do not reflect your behaviors against others
 - Rather, reflect yourself against the continuum: keep your forefathers happy
 - Iterated prisoners dilemma this means that altruism, etc., can be explained
 - Apathy and anarchy can be avoided, system remains stable but can evolve



"Absolute Ethics" Revised



- Remember: Osiris asked two questions
 - 1. Did you find **joy** in your earthly life?
 - 2. Did you bring **joy to others** in your earthly life?
- Now, Antero Vipunen asks:

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External view
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- 1. Did you become a full flourishing system?
- 2. Did you promote other systems to flourish?
- For the more advanced: unity

Internal view

- 1. Did you see environment as integrated whole?
- 2. Did you become "emmersed" in your world?

WHY?



Goal of Life

- Purpose of life = find the model of one's own life to implement more efficient control (management) of the world!
- The task of all living things generally: increase entropy

• Quantitative effect

By maximizing interaction (optimal coupling), exploitation and *emergy dispersal* becomes maximized

• Qualitative effect

By increasing the number of freedoms, there is possibility to reach new levels of entropy production (higher-level controls)

And there are always still higher-level controls possible!
 But do not waste before the highest-level controls are done

Levels of seeing the World

Before Zen: "What mom said"

During Level 1 Zen: What you experience

After Level 1: What you perceive

During Level 2 Zen: What you understand

After Zen: What you believe





Back to animism

• The fields, too, become cybernetically modeled, assumedly resulting again in a sparse coded structure – what are the "granules" that emerge from the morphic fields, then?

Appropriate connotations are captured in the idea of *spirits*

- To bring philosophies to everyday life without collapsing the "wave functions", it is not just thinking; one has to *live it*, become part of that world, *emmerse* in it
- One just has to *believe* in the immaterial spirits
- Those tribes who lived thousands of years amongst nature should they not know better than the alienated modern man?
 - What then are the modern hierarchies of cybernetic spirits?



Deities and Daisies





If you do not understand this, do not worry: in that case this does not apply in your world, the hierarchy does not exist!

More freedoms?

- Humor is a "meme collider", testing traditional ways of thinking ...?
- Arthur Schopenhauer said that arts can (momentarily) free us, giving new views (freedoms) ...
- Let us see examples.





1. Charles Sandison's Installations





2. Eino Leino's Poetry

- "... sointua pelkkää" = "to me everything is mere chords"
- Traditional view: life is hard and gets much harder "Höyhensaaret" and "Ja vuodet ne käy yhä vaikeammiks"
- Human development is possible however: From "Tumma" to "Hymyilevä Apollo" ("Aurinkolaulu") In any case, "Hyvä on hiihtäjän hiihdellä" So that finally perhaps "Väinämöisen laulu" Still, do not worry ... "Laulajan laulu"
- Conclusion in "Minä"
- The role of freedoms (attractors): "Se kuitenkin liikkuu"
- In English: http://www.youtube.com/watch?v=3KdDCT56NgQ



3. "Spirited Away" the Movie

 The director Hayao Miyazaki was obsessed by the "Always with me" ending song (find it in YouTube)





Tribute to the Japanese

- There is no more connection to the ancient Finnish animism, but there are other examples
- In Japanese Shintoism, animism seems to still live strong and there is no problem connecting it to modern world
- Also there, ancestors are being worshipped, as well as other "fathers" (emperors)
- In both countries, nature is admired, etc. but there are striking differences, too:
 - In Japan, customs are very rigid not in Finland
 - In Japanese, writing system is very different from that of Finnish
- In Japan, they have the *Torii* gates between the profane and the sacred showing where the spirits live ...

Spirits in the Backyard





Finnish-like places for such "blue thoughts"



"Cybernetism": Granules as Signs







Tunnenpa systeemin synnyn.

Oleva tiedosta tehty / mielestä on ja mallista Elävä luonnon muodosta / tahtojen tasapainossa Ajatus aineesta tehty / mitattavasta datasta Ymmärrys yhteenmenosta / rakenteella ja runolla.

Tunnenpa myöskin sen soinnun.

Tietoisuus koostuu kaiuista / minun ja muiden mallissa Kuoja on malli minusta / ylimmäksi soittajaksi Kulttuuri tästä kaikesta / kokoon kootuista säkeistä Suomen laulu sydämestä / sitkeydestä ja sisusta.





Vladimir Fomin:

Hello! I wrote the first picture.Birth of the Sampo (Ouroboros). Runa 10. A series of "Kalevala", x., M, 74h05. 2011 The second picture - July, August, when the first love. Your opinion?