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Basic model and logic on interaction and initial intelligence

In sections 1 to 7 of this essay I will present a modelling approach. I start out from physical rules when describing our (economic or social) reality. I have been thinking about this long ago and this essay is summarizing the approach so far. In future I would like to continue to work on this approach and shape it into a useful model, a tool for experimental economics. I cite abstracts from Professor Friston's papers, because I use his work as a 'starting point'. The 'homo oeconomicus' becomes an organism with a 'Bayesian brain'. Interaction of agents creates the 'social field'. I introduce the terms 'inertness', 'adaptation drive' and 'independence drive'. I describe the dynamics within the agent and within the social field. In section 8 I write about inefficient systems, and in section 9 I focus on 'growing inequality'. If the here presented approach will be developed into a model that helps us clearly understanding up-to-date problems (making use of the most advanced information technologies), it would tell us that supporting individual development and monitoring by the social field is a solution.

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The universe is a place of endless possibilities to create energy and matter. Based on our knowledge up to date, everything in the universe is made of 17 elementary particles, some of which mediate interactions, and some of which are subject to interactions. All atoms, molecules, and cells we come across in everyday life consist actually of three particles only. On the nuclear level, the **organization and interaction** of up and down quarks will determine what isotope is formed. The 'cloud' of electrons self-organizing around the nucleus to find a minimum energy state will determine the behaviour in chemical interactions and bonds. Finally, molecules will self-organize to form a cell...

Life, or biological self-organization, is an inevitable and emergent property of any (ergodic) random dynamical system that possesses a Markov blanket. This conclusion is based on the following arguments: if the coupling among an ensemble of dynamical systems is mediated by short-range forces, then the states of remote systems must be conditionally ***independent****. These independencies induce a Markov blanket that separates internal and external states in a statistical sense. The existence of a Markov blanket means that internal states will appear to minimize a free energy functional of the states of their Markov blanket. Crucially, this is the same quantity that is optimized in Bayesian inference. Therefore, the internal states (and their blanket) will appear to engage in active Bayesian inference. In other words, they will appear to model, and act on, their world to preserve their functional and structural integrity, leading to* ***homoeostasis*** *and a simple form of autopoiesis (Friston, 2013a).*

Intelligence is viewed here simply as information present in the interaction and perceived by the agents.

1 Agent

In Friston, 2013b, agency is considered in the setting of embodied or active inference. In brief, we associate a sense of agency with prior beliefs about action and ask ***what sorts of beliefs underlie***

***optimal behaviour**. In particular, we consider prior beliefs that action minimizes the Kullback–Leibler (KL) divergence between desired states and attainable states in the future. This allows one to formulate bounded rationality as approximate Bayesian inference that optimizes a free energy bound on model evidence. We show that constructs like expected utility, exploration bonuses, softmax choice rules and optimism bias emerge as natural consequences of this formulation. Previous accounts of active inference have focused on predictive coding and Bayesian filtering schemes for minimizing free energy. Here, we consider variational Bayes as an alternative scheme that provides formal constraints on the computational anatomy of inference and action—constraints that are remarkably consistent with neuroanatomy. Furthermore, this scheme contextualizes optimal decision theory and economic (utilitarian) formulations as pure inference problems. For example, expected utility theory emerges as a special case of free energy minimization, where the sensitivity or inverse temperature (of softmax functions and quantal response equilibria) has a **unique and Bayes-optimal solution**—that minimizes free energy. This sensitivity corresponds to the precision of beliefs about behaviour, such that attainable goals are afforded a higher precision or confidence. In turn, this means that **optimal behaviour entails a representation of confidence** about outcomes that are under an agent's control.*

2 Agent in environment with more inert agents

An agent is more inert if he has less control in interactions. In a given environment, the outcomes of interactions with more inert agents are more predictable. Therefore, after the human agent goes through a developmental process of accumulating knowledge about his more inert environment, he can feel more confident: his beliefs and actions will result in highly predictable outcomes.

3 Agent in environment with similar agents

If similar agents are present in the same environment, they are likely to develop and learn similarly, since this kind of adaptation is the most efficient. Naturally, homogenous agents can coordinate efficiently.

*We suggest that the infinite regress induced by modelling another agent – who is modelling you – can be finessed if you both possess the same model. In other words, the sensations caused by others and oneself are generated by the same process. This leads to a **view of communication** based upon a narrative that is shared by agents who are exchanging sensory signals. Crucially, this narrative **transcends agency** – and simply involves intermittently attending to and attenuating sensory input. Attending to sensations enables the shared narrative to predict the sensations generated by another (i.e. to listen), while attenuating sensory input enables one to articulate the narrative (i.e. to speak). This produces a reciprocal exchange of sensory signals that, formally, induces a **generalised synchrony** between internal (neuronal) brain states generating predictions in both agents. (Friston, 2015, A Duet for one)*

4 Agent in social field: adaptation efficiency

Since it is efficient to store and repeat successful prior developmental sequences, reproduction and accelerated repetition of developmental processes will occur. Genes store reproductive information,

and developmental processes are repeated through childhood, like learning to walk, repeating the understanding of up-to-date physical rules and social skills. Homogenous groups of agents will flourish and grow. Independently evolved groups will differ from each other. Agents of the entire population of the planet are part of a social field. The social field works due to the same basic efficiency principles like on any other level of natural self-organization.

If two individuals of diverse social backgrounds meet, first they will face surprise and uncertainty. To overcome uncertainty and ensure survival, the agents tend to adapt to their neighbours. A stable trend of synchronizing beliefs can be observed. Agents start to adjust their developmental levels and evolve a common language to increase understanding and optimize interaction outcomes. Smaller groups can reach common stages faster, so they can coordinate more efficiently.

Large social fields will have more diverse agents. Agents can already be considered to be different from each other, if they differ in their individual developmental sequences and stages. Thus there will always be uncertainty in social fields. To overcome this uncertainty naturally, the trend of synchronizing beliefs, or the 'regression towards the mean' dynamics got **automated control functions** in social species. The most efficient way to overcome uncertainty is to focus during interactions on the fact that all agents can also be considered to be similar, since they share similar evolutional priors.

On the level of the social field, we can observe similar organizational patterns (like democracy and absolutism), a **social morphogenesis**, which resembles morphogenesis on cellular levels of self-organization.

Understanding how organisms establish their form during embryogenesis and regeneration represents a major knowledge gap in biological pattern formation. It has been recently suggested that morphogenesis could be understood in terms of ***cellular information processing*** *and the* ***ability of cell groups to model shape****. Here, we offer a proof of principle that self-assembly is an emergent property of cells that share a common (genetic and epigenetic) model of organismal form. This behaviour is formulated in terms of variational free-energy minimization—of the sort that has been used to explain action and perception in neuroscience. In brief, casting the minimization of thermodynamic free energy in terms of variational free energy allows one to interpret (the dynamics of) a system as inferring the causes of its inputs—and acting to resolve uncertainty about those causes. This novel perspective on the* ***coordination of migration and differentiation of cells*** *suggests an interpretation of genetic codes as* ***parametrizing a generative model****—predicting the signals sensed by cells in the target morphology—and epigenetic processes as the subsequent inversion of that model. This theoretical formulation may complement* ***bottom-up*** *strategies—that currently focus on molecular pathways—with (constructivist)* ***top-down*** *approaches that have proved themselves in neuroscience and cybernetics. (Friston, 2015, Knowing one's place)*

5 Agent in social field: independence bonus

By independence bonus, the 'novelty' or 'exploration' bonus is meant. Though, 'novelty' itself does not exist. Every idea, **target** and **solution** was already present in the mind in form of memories of prior observations. Pure independent opinion does not exist either. Any change in plasticity depends

on the state of development and continuity of input stimuli (Toyoizumi, 2013). Prior neuronal wiring is a result of inherited information from an interconnected (social) field. Nevertheless, understanding (inferring) causes is a system's ultimate driver, and exploration yields bonuses. And for exploration to take place, the agent has to maintain an independent (questioning) perspective to increase the chances to recognize a given target or solution that was already present in the system as a possibility.

6 Dynamics within the agent

All agents can be modelled to have both an adaptation drive and an independence drive. These drives are inborn intelligence (mechanisms to perceive and utilize information): the adaptation drive is present as initial trust, imitation and memorizing thinking style, and the independence or curiosity drive is present in induced interactions, initiation and experiencing thinking style (Kahneman, 2011).

Agents face restrictions of limited capacity of information processing and limited life time. Adaptation is efficient as it frees up these limited resources and enables individual development. If the agent relies solely on automated adaptation drives, he will experience increased uncertainty when facing relative novelty (cost of excess adaptation, pain of independence (Berns, 2005)). Independence is the prerequisite of individual development, yielding the exploration bonus. If the agent makes a habit of novelty seeking, he will experience a lack of trust (creating uncertainty) and suffering when facing the need to adapt to others and coordinate actions (cost of excess independence).

In this context, homoeostasis within the agent is maintained by an **optimal amount of challenge** (both exploration and adaptation). Otherwise, unused connections in the organism perish, and overloaded connections tire faster. Optimally, the agent has the possibility to receive stimuli for both drives from the system, and the two drives are balanced.

The agent can either initiate a higher level organization, or adapt to an existing organization. If the agent refuses to adapt, he preserves a higher degree of independence. So, agency itself could be seen as a product of independence (like a force), and willingly occurred adaptation could be seen as inhibition of the independence drive (like a counterforce). In interactions, agents have the ability to willingly take part in maintaining **homoeostasis** of the organization.

7 Dynamics within the social field

The social field has a trend towards homogeneity. The independent individual has an opposing trend towards diversity. Similarly, as agents increase their welfare from adaptation, the social field increases common welfare of all from independent agents contributing exploration bonuses, and thus shifting the aggregate developmental stage upwards. So both dynamics increase welfare in the social field, however, only, if the social field reached a developmental stage that understands these dynamics and provides the agents with the necessary possibilities to maintain their homoeostasis and to contribute their part to the system homoeostasis. **In other words, successful organizations emerge naturally, are decentralized, interconnected, homogenous and unbounded in the common developmental stage and its agents maintain self-agency in diverse and independent ways**.

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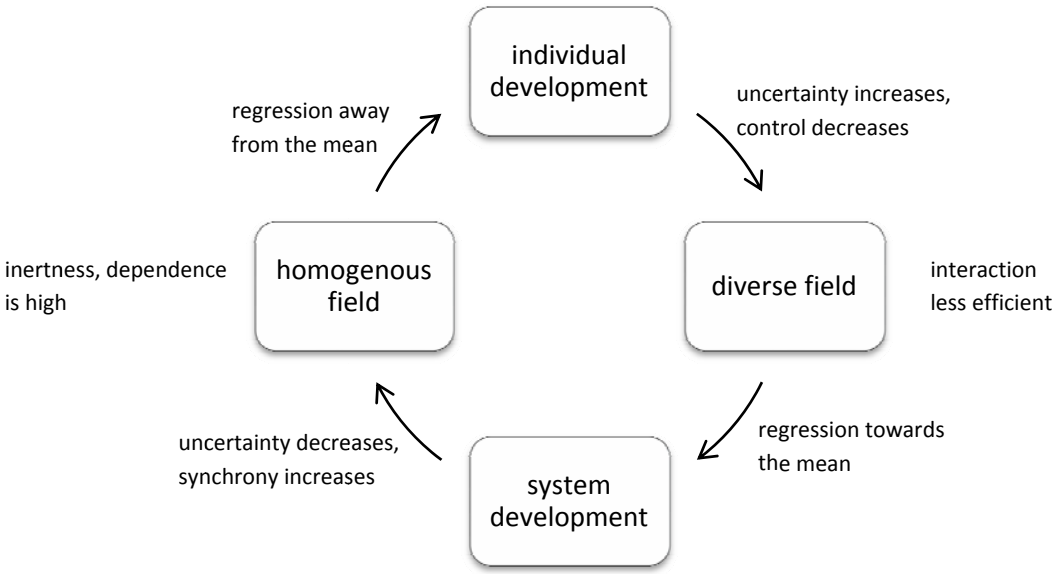

Suppose all agents in a society have the same beliefs and act on the same model. In this state the social field is highly predictable, and coordination between agents is efficient (synchrony), which frees up limited capacities of information processing and limited time of the single agent to explore his environment further. Migration and differentiation of agents occurs. New insights are collected on the edges of the social field (tails of any population distribution), and individual development contributes to the system's intelligence, reducing inefficiencies and systemic biases. Agents will more easily and willingly adapt to an improved system, which in turn facilitates individual optimization problems.

Such cyclic development can also be observed on the agent level. First, the target of morphogenesis is creation of an independent organism, and after reaching this target, the same cellular system begins a new morphogenesis (aging) with the target of melting back into a more homogenous field. Reproduction of agents assures that the social field as a target is kept alive, and that intelligence (information and efficient processing of information) accumulated **over time** and generations, is stored in the system.

Another way of accumulating knowledge is **over space**: through the communication and coordination mechanisms of regression away from the mean and regression towards the mean agents can easily adapt to development trends.

The whole system underlies continuous change in a field of endless possibilities. Oscillating development (cyclic rise and fall) is due to failures and learning with respect to a certain target. A stable and sustainable trend of development is due to **smoother, more conscious transition** processes.

Since processes are irreversible, life-cycles assure **self-healing processes** within the organization (survival of the fittest). The reformation and repetition of self-emerged processes (like regeneration, reproduction) are repeated coordination and repeated interactions towards a specific arrangement, and repetition offers the possibility of improvement. Whenever the system drives towards a dead-

end path, or where failure is experienced, more agents will shift their capacities and time towards finding the solution to that specific problem.

An example for systems with a homogenous field are highly developed Asian countries with very competitive societies. Agents orient on the stereotype winner, and are rather inert to turn deviations from the average expectation into possibilities of new developmental paths. Deviations and failures are experienced as detrimental, which is mirrored in life satisfaction surveys. Other examples for systems with a homogenous field, but lower inertness are Nordic countries in Europe. Their societies leave more room for independent individual development, and they also believe that this will drive their system development. Integration and communication is facilitated much, and also interactions with countries of similar developmental stages improve a lot. Since social comparison with respect to individual development is less important, their societies are less competitive, less corrupt, and the birth rate and life satisfaction measures are higher.

8 Inefficient systems

An inefficient system works against its agents. Even if we observe growth and development on the aggregate level, we might observe inefficiencies on the agent level. This also implies that there is more growth potential than what is realized. Agents are not only contributors to aggregate development, but they also **monitor** this development. If a bias is present in the system, agents can either resist adaptation (if agents understand the bias) or adapt and contribute to the increase of the bias (if agents are unaware of the bias) until the system finally breaks down. In both cases agents will experience unnecessary stress and suffering. Even if it is impossible to reduce exploration failures and uncertainties, systemic bias can be reduced, and should be reduced to increase wellbeing both on the individual and aggregate level.

Free flow of information and feedback information on both successes and failures are necessary for the proper functioning of any immune system. For example, governments and social media would be the most useful as **coordination devices**, but only if information is collected and processed as correctly (i.e. scientifically) as possible.

The cornerstone in reducing biases is the **educated agent**. And since the agent is also a pioneer to the development on the system level, education and improvement of understanding is where most of our capacities and time should be invested, especially if the target is a very simple form of physical efficiency.

9 Thoughts to growing inequality

Above I presented an approach how economic modelling could be reconstructed using latest neuroscience insights about physical interactions underlying human decision making. Next I would like to catch up with the debate on growing inequality in welfare, living standards and opportunities. To do so, I will refer to a talk of Professor Stiglitz on May 13, 2015 at the Columbia Faculty House, on which I was present.

9.1 Understanding the causes: endogenous change

In his talk, Prof. Stiglitz pointed out the importance of a proper diagnosis before any reform could efficiently take place.

According to the above presented model, **any elite is a product of the social field (the followers)**. Any goal of any **ruling elite** will naturally prevent change, since goals and values will be fixed by either rules or declaration of ownership. Ruling in this context is control over other agents, resulting in a decrease of individual agency. Ruling enables elites to extract rents (lifetime and capacities), and by reducing others' opportunities to develop it leads to a suboptimal outcome in a dynamic view. Declaration of ownership is control over more inert systems, like land, ideas or slaves. Any idea and solution was already present in the system, since it emerges physically from priors in the brain, therefore any patent is stealing. The under-pricing of nature also roots in the declaration of ownership on land, since any owner has only a limited lifetime to use nature, therefore only those reproduction processes and consequences are accounted for, which affect the owner, regardless of future generations (time) and those agents (even other species) who are excluded from ownership although they belong to the same system (space). **Only the system has unlimited time and capacity to realize any possibility**. For example, flying is such an endeavour reaching from Icarus in Ancient Greece into the future where we might have the choice to physically grow wings and not just to use an airplane. May it be ruling or ownership, any **control over less developed systems** is a boundary to possible change towards a more sustainable development.

In order to reach more sustainable solutions, the **coordinating elite** has to extract as much available **information from the system** as possible. The information is present, and as science improves, extracting this information develops, like the use of social media, observation of other species, or understanding of complex systems. The individual agent is the only source of reliable information, and the more information can be aggregated, the more can collective decision making improve. This is in line with the above presented modelling approach. Individual development will further improve system development, and system development will contribute to individual development.

Optimization was originally dynamic when life emerged. Only abused control over less developed systems and agents created static optimization and cyclic repetition of similar failures in human history. The need for ownership and ruling is inherited. This implies that the root of the problem of growing inequality lies in individual behaviour, therefore the solution has to involve also a continuous **bottom-up reform**, a smooth and inherited transition.

9.2 Supporting individual development

Naturally, development is inherited through free education to our own offspring. But it becomes a trading good towards others, for a simple reason: developmental advantage can be abused to win a competition. Sellers abuse their timely advantage in developmental processes (often simply the fact that they were born earlier). **Buyers are always less developed groups**. Instead of developing independently, they will use capacities and time to pay for past development, and to avoid an even more unfair competition.

Imitation involves a natural lag, evolving a leader-follower hierarchy (Bostian, 2015). If imitation is used in a smart way, it can contribute to individual development (for example, South Korean miracle of hard work). However, it requires hard work to overcome the natural lag, especially if old debts have to be repaid (for example, loan for education). Another problem emerges if agents start to rely solely on imitation. The lack of **learning from exploration** and novel experiences can create a lack of understanding of some of the developmental processes by not going through them, and also not repeating them. This can even lead to biases like lack of confidence and uncertainty aversion. For example, if children miss to repeat the successful evolutional process of crawling before walking, prior information will be missing for further development. If toys (like the baby walker) are used to prevent them from failing, a later failure will be experienced as much more severe.

Therefore to sell past development to next generations and/or less developed groups has a high possibility to turn into a net loss for the whole system. It could be compared to selling meals to children until they learn how to feed themselves (get mature), which process will take longer if they skip school to work (inefficiently) to pay for nutrition. It does not matter whether it is ethical or not: it is simply evolutionary inefficient.

Another source of inefficiency can be observed when optimizing processing capacity and time: it seems rational to divide labour to tasks where each party has a comparative advantage. The information about comparative advantage is based on past experiences. We cannot know (ex ante) what else we are good at and motivated at, if we do not get the chance to try it out. Individual developmental processes are similar to the system development: they require free capacities and time to be invested in **exploring (sampling)**.

To assure individual development the agent has to reach a developmental stage where he recognizes that he has to invest into individual development to improve his decision making. This is more likely to happen naturally in more developed systems, where information and education is made accessible to every individual on any developmental stage, ideally without competition in the quality of education. **A cellular student-teacher ratio of 'few to one' is the most efficient**.

9.3 Consciousness and monitoring

As productivity grew more than demand, developed economies shifted to the service sector. The main drivers of the service sector are creation of addictive demand (excess consumption, returning customers, loyalty programs and any kind of self-sustaining rent extracting mechanisms) and creation of contagion (trend creation, social media pressure etc.). Such market equilibriums do not take into account whether the agent's life improves or not. Valuable resources, human capital and time are used to pay for excess consumption (and debts) and at the same time these resources are wasted.

Only agents who reached a certain individual development stage understand these mechanisms and are able to improve their **self-control** ('learn to like'). For example, in developed countries agents switch back to use the bicycle instead of the car, not simply to avoid crowding costs and taxes, but to increase the time spent in nature and spent living healthier (increasing own resources of lifetime and fitness). In developed societies, agents also switch back to consume fewer goods, produce less waste

and use social media to share goods (cars, sports equipment, flats, open source solutions etc. Even small jobs can be traded in the neighbourhood.).

Agents have similar lifetime, so that there is less need for hourly wages to differ by huge multipliers, supposing that every agent does his job with the highest available productivity. For example, streets have to be cleaned to avoid spreading epidemics, and this task, as any other task, should be done with the latest available technology and know-how. Teaching can be part of any job, as can be exchange of information with colleagues all over the world.

Increasing productivity makes it possible to shift time to individual development (learning and teaching). **The agent could become more conscious** and a global society of conscious agents could coordinate and communicate more efficiently.

The society would always be diverse in consciousness and development stages. However, no agent would be excluded from development and communication. Less developed agents would have the time to follow their individual developmental pace. Coordination between agents of different developmental stages would be based on a mutual respect of agency and the right to learn and teach each other.

Monitoring would improve naturally in an open global society. Diverse agents would continuously question and monitor processes. The free flow of information is the best prevention against any form of manipulation or abuse. Failures and inefficiencies would be reported and analyzed. Instead of imitation of a certain innovator and ruler, it would be the system again that naturally leads its discoverer-agents. Once understood, these are physical realities that can be trusted and followed, and used as a solid scientific basis to establish **global interest homogeneity** for efficient coordination: a common goal (understanding interconnectedness and the need for individual development), a common language or availability of translation and time for a lot of communication.

The advantage of such reform goals is that they can be **tested in the field**, since applying the reforms in smaller groups can provide fast data for analysis and further improvement. Experimental results can be a clear evidence for welfare improvement. Taking part in experimental work is where I could be useful as a researcher, and I hope I will find many **engaged collaborators and senior supporters**.

Acknowledgements

I would like to thank all my teachers for guiding me and encouraging me to stay critical and curious. I would also like to gratefully acknowledge the contributions of Wikipedia in assembling answers to puzzling complex questions. None of the insights presented here are genuine, since they are a product of the social field that shaped me.

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