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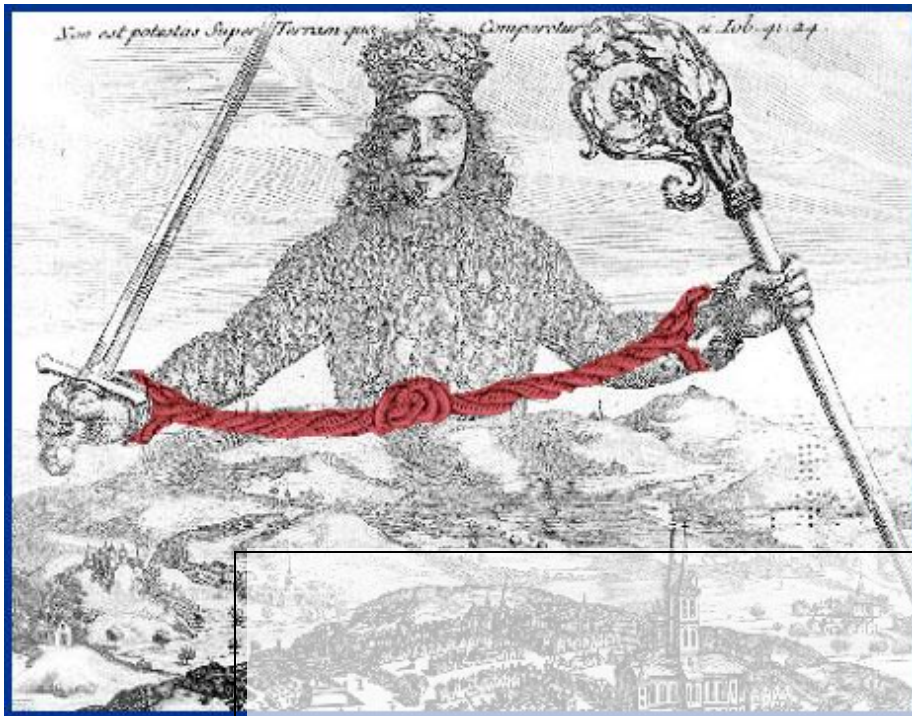
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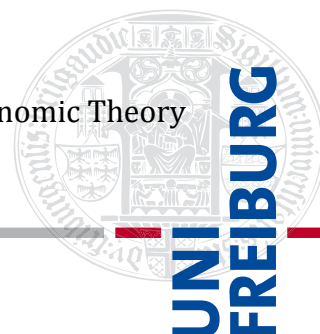
*Von Hayek's Theory of Cultural Evolution in the
Light of a Simplified Model of Kaufmann's
General Biological Evolutionary Theory*

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Abstract

In this paper, Hayek's theory of cultural evolution is compared to a simplified general macro-model of evolution based on Kaufmann (1993). It is shown how under certain conditions evolutionary lock-ins can occur, what consequences this has for the assessment of evolutionary results, and how lock-ins may be overcome. This last issue leads to three interesting results: the interdependency of orders matters, a purely macro-based model of evolution neglects population dynamics, and deliberately designed changes can be an important driving force for evolutionary development. The conclusion is that rule design combined with evolutionary selection may explain how group selection occurs, a point insufficiently addressed in Hayek's theory.

1. Introduction

Taxis versus spontaneous order, constructivism versus evolution—in much of the age old debate whether humans are able to successfully design their institutional environment many take a strong position in favor of one of the two positions. Hayek, on the one hand, is a strong believer in the superiority of evolution and skeptical concerning the abilities of humans to design rules, whereas Buchanan on the other hand can be considered a constitutional constructivist. In this paper it is argued, based on a simple formal model, that both views are not mutually exclusive, but rather need to be integrated in order to understand both the evolutionary limits to design, but also to constructivist driving forces of rule evolution.

2. Hayek's theory of cultural evolution

According to Hayek (1988), cultural evolution can be understood as a process in which individuals experiment with different rules as “problem solving tools”. Over time, only the most adequate problem solving rules survive. On the one hand, better problem solving skills give a survival advantage to those having successfully improved their rule repertoire. On the other hand, less successful individuals copy the behavior of the more successful ones. Both mechanisms lead to the spreading of more adequate problem solving strategies. The main distinction between cultural and biological evolution is that the latter rests on selection of genetically stored programs, which are subject to mutations and recombination. Cultural evolution mainly comprises inheriting information on the collective level (“collective learning” (ibid.)), i.e. experiences gathered by individuals and groups having experimented over long periods of time. The rules for individual and collective problem solving comprised in a certain culture therefore represent the knowledge gathered by numerous individuals and generations before.

The crucial point is—drawing on Hayek's theory of dispersed knowledge—that the evolution of superior problem solving programs is not the result of deliberate design antic-

ipating all results, but rather a process of trial and error in which the consequences of a specific “rule as a tool” decide on success and spreading of the rule via the mechanisms described above. The emergence and use of the market as one very general rule for solving economic problems in the end has not been the result of one ingenious act of design, but rather the result of slow changes from early hunter-gather-groups to modern industrialized societies with intensive division of labor.

One mayor problem in Hayek’s theory is that it explains the success of one culture relatively to another by referring to a process of group-selection.¹ This is at odds with his general work, which is based on pure individual interaction. The introduction of collective bodies called “groups” is therefore inconsistent, because he does not resolve the puzzle of why self-interested individuals experimenting with rules should implicitly agree on rules which solve prisoners’ dilemma (PD) like conflicts. Even though on the collective level, a group benefits from individual cooperation in a PD game, for single individuals there is no incentive to sacrifice benefits for the sake of collective success. In purely individualistic interaction, everyone has the incentive to free-ride. This circumvents the spontaneous emergence of collective cooperation. Hayek was aware of the problem that group selection remained a puzzle in (biological) evolution, but simply declared this point being irrelevant for his work. This “weaseling out” makes his theory of cultural evolution partially unsatisfactory. Below, I give arguments how nevertheless we may observe group selection if we allow for elements of rule design.

3. A Macro-Model of Evolution, based on Kaufmann (1993)

3.1. Sluggish evolution, outpacing constructivism

One classical dispute in Western philosophy is between constructivist rationalism and evolutionary empiricism. Constructivist rationalists argue that all it takes to create a successful society is to design adequate rules, taking into consideration the relevant inte-

¹ The inconsistent use of “individual” and “group” in this chapter roots in Hayek’s lack of clarity when he speaks of individual or group selection with respect to evolution of rules.

reactions of different rules and anticipating different outcomes implied by different rules. Evolutionary empiricists on the other hand point—like Hayek—to limits of rationality and lack of sufficient knowledge to successfully plan a society. One argument for the superiority of planning versus evolution is that evolution is a very slow process, thus improvements may occur only after a long trial and error process—whereas many problems in society are so pressing that they need immediate action, a case for deliberate rule design. A simple example shows that this argument is not a solid one.

Imagine a system made of 10 elements, each can take 2 different states of nature. If we have a computer that can access the performance of one specific configuration within 0.001 seconds, then it will take $10^2 \cdot 0.001 \text{ s} = 0.1 \text{ s}$ to calculate the best configuration. If we have a similar system of again 10 elements, but which can take 20 instead of 2 states, to find the best solution it takes $10^{20} \cdot 0.001 \text{ s} = 10^{17} \text{ s}$, or 3.2 billion years—which is about one fifth of the universe's age. Apart from the mere time problem, there is also the problem of lack of exact knowledge concerning the different performance levels of a system. So evolution not only may be quicker, but due to the impossibility of gathering complete knowledge by a central planner, it simply may be the only option to achieve an optimum.

3.2. Mutations without inter-linkages

This paragraph shows how a system with independently mutating elements will achieve over time its performance optimum. Assume—for the sake of graphical representability—a system consisting of 3 elements. Each element can take two different states (0 and 1), with a respective performance level. The overall performance (which means reproductive fitness) is calculated as the sum of the fitness values of all single elements. The fitness-levels of the single elements are drawn randomly from a uniform distribution between 0 and 1. Higher levels mean better reproductive success.

It is important to note that one element's state can change via mutation from 0 to 1 or vice versa without affecting the performance level of the other elements. They are purely independent from each other. Drawing random fitness levels, the described entire system can take 8 states with corresponding overall fitness levels shown in table 1:

Elements and performance states			Fitness contributions			Total Fitness
1	2	3	f1	f2	f3	Summe
0	0	0	0.2	0.8	0.3	1.3
0	0	1	0.2	0.8	0.4	1.4
0	1	0	0.2	0.5	0.3	1.0
0	1	1	0.2	0.5	0.4	1.1
1	0	0	0.7	0.8	0.3	1.8
1	0	1	0.7	0.8	0.4	1.9
1	1	0	0.7	0.5	0.3	1.5
1	1	1	0.7	0.5	0.4	1.6

Table 1: Fitness levels of different configuration (author's compilation).

Mutation from one state to another occurs by allowing the change of one element at a time. The result is that independently at which configuration from (0,0,0) to (1,1,1) the process starts, it will always end up at the optimum, in our case (1,0,1). This happens because a mutation leading to a higher performance level by a change of one single element, e.g. from (0,1,1) to (0,0,1), means that the more successful configuration outperforms the initial one. The system switches to a new equilibrium. Logically, only mutations to more successful configurations survive, and by trial and error finally the optimum is selected. This process is shown in figure 1, where the arrows indicate how mutation leads from one equilibrium to the next, better one (but never in reverse direction).

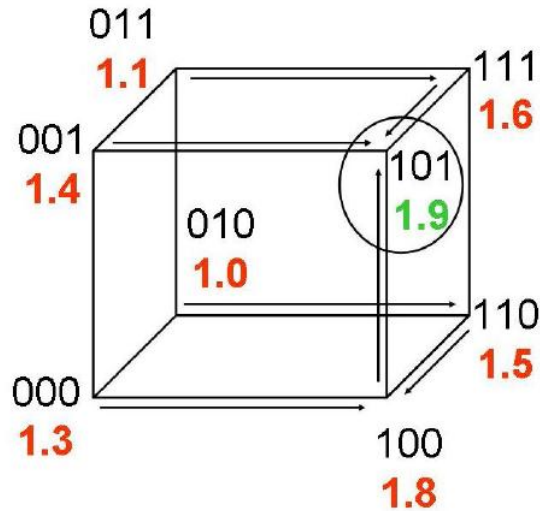


Figure 1: Stepwise mutation to the highest fitness level (author's compilation).

3.3. Mutations with inter-linkages (epistasis)

Kaufmann (1993) highlights that in reality we often observe a process called epistasis in the context of evolving systems. This means that the change of the fitness contribution of one element has an effect also on the contributions of others elements. In biochemistry, one may think of one amino acid pair being exchanged by another one leads to different levels of enzyme production, which affects the performance of other genetic sequences. In other words, apart from a direct effect on evolutionary fitness, we observe as well indirect effects. For example, instead of the system above, there is now one in which a mutation of the first element triggers a change of the performance level of the third one. A random assignment of fitness contributions therefore may look like the one in table 2:

Elements and performance states			Fitness contributions			Total Fitness
1	2	3	f1	f2	f3	Sum
0	0	0	0.2	0.8	0.3	1.3
0	0	1	0.5	0.8	0.6	1.9
0	1	0	0.2	0.5	0.3	1.0
0	1	1	0.5	0.5	0.6	1.6
1	0	0	0.1	0.8	0.8	1.7
1	0	1	0.4	0.8	0.2	1.4
1	1	0	0.1	0.5	0.8	1.4
1	1	1	0.4	0.5	0.2	1.1

Table 2: Fitness levels in case of epistasis between element 1 and 3 (yellow) (author's compilation).

The corresponding graph (figure 2) contains a remarkable difference compared to the first one: instead of one optimum, we get two local optima. Due to the mutation rule of only one change a time, it now is possible to get locked in at (1,0,0), even though the global optimum is at (0,0,1). The emergence of lock-ins is a general feature of systems in which epistasis takes place (Kaufmann 1993).

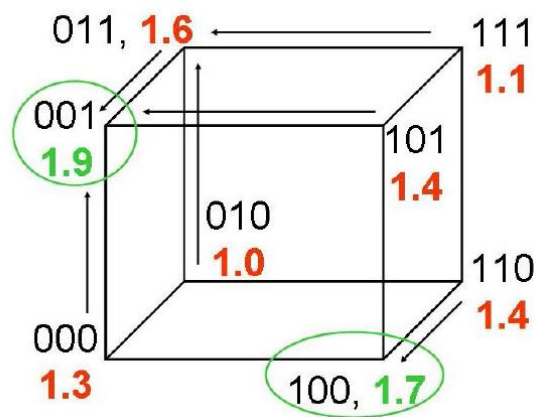


Figure 2: Two local optima due to epistasis can lead to a lock-in (author's compilation)

3.4. Inter-linkage between systems: co-evolution

In fact, such lock-ins pose a crucial problem for evolution. They show that evolution not necessarily leads to a global optimum, but only to a local one. Thus, evolution does not mean “survival of the fittest”, but rather “survival of sufficiently adapted ones”. Hayek was aware of this fact, and consequently did not speak of the survival of the fittest, but of more and less successful groups. For example, in *The Fatal Conceit* (Hayek 1988: 16), he states that “those groups practicing the most advantageous customs will have an advantage in the constant struggle between adjacent groups over those that practice less advantageous customs” (Hayek 1988: 16). Nevertheless, I want to emphasize the issue of lock-ins, as it will later be of consequence when discussing the role of population dynamics

in evolution, as well as the role of rule design. One way out of a lock-in can be driven by co-evolution between two or more coupled systems. Again, like in the epistasis case, we observe coupling of fitness levels among elements. The difference now is that coupling not only occurs among elements within a system, but also between systems. For example, imagine a system 1 whose third element is coupled with the first one of a system 2. As well, just like in chapter 3.3, in our second system there is a coupling between the first and the third element. Assigning as always some corresponding random fitness levels, we get two different situations: one in which the third element of system 1 is in state “0”, and another one for state “1”. In other words, depending on the state of the third element of system 1, system 2 changes its overall performance level. This is summarized in table 3:

System 2, when in system 1 the third element is in state “0”

Elements and performance states			Fitness contributions			Total Fitness
1	2	3	f1	f2	f3	Sum
0	0	0	0.2	0.8	0.3	1.3
0	0	1	0.8	0.8	0.2	1.8
0	1	0	0.2	0.5	0.3	1.0
0	1	1	0.8	0.5	0.2	1.5
1	0	0	0.1	0.8	0.8	1.7
1	0	1	0.3	0.8	0.9	2.0
1	1	0	0.1	0.5	0.8	1.4
1	1	1	0.3	0.5	0.9	1.7

System 2, when in system 1 the third element is in state “1”

Elements and performance states			Fitness contributions			Total Fitness
1	2	3	f1	f2	f3	Sum
0	0	0	0.2	0.8	0.3	1.3
0	0	1	0.5	0.8	0.6	1.9
0	1	0	0.2	0.5	0.3	1.0
0	1	1	0.5	0.5	0.6	1.6
1	0	0	0.1	0.8	0.8	1.7
1	0	1	0.4	0.8	0.2	1.4
1	1	0	0.1	0.5	0.8	1.4
1	1	1	0.4	0.5	0.2	1.1

Table 3: *Different fitness levels of system 2, depending on the state of element 3 in system 1 (author’s compilation).*

Note that the fitness performance of system 1 shall not be of interest here. Of course, one could imagine also a circular feedback from system 2 to system 1, but we

want to abstract from this possibility to focus on the main effect of co-evolution. Figure 3 shows how the coevolutionary case looks like using the cube diagrams.

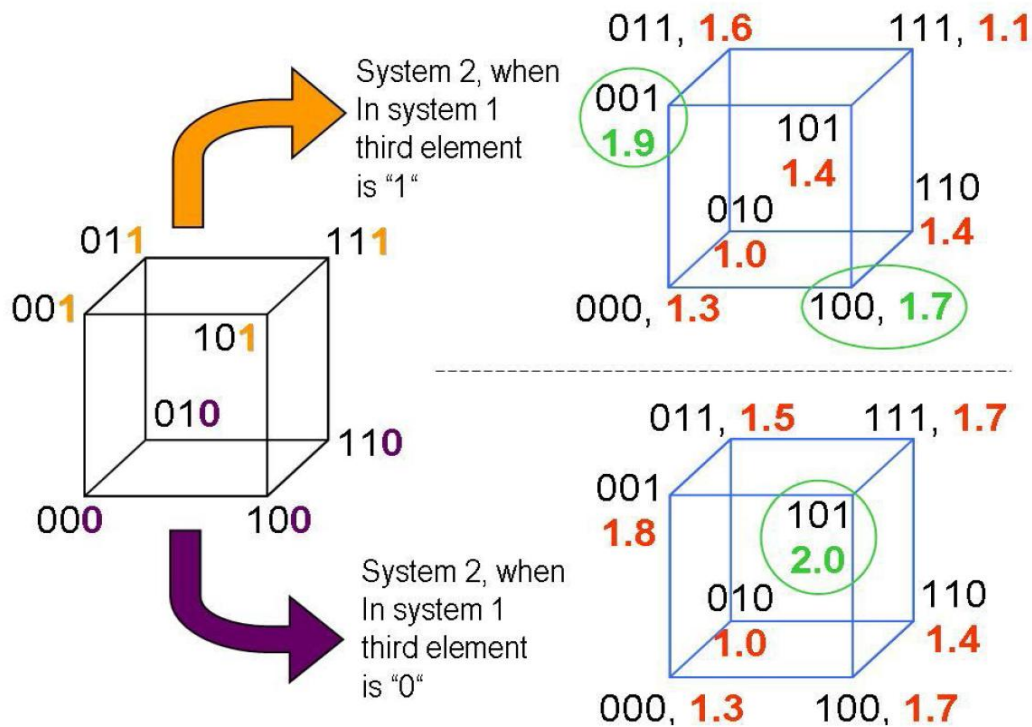


Figure 3: Co-evolution leading system 2 switching its fitness level (author's compilation)

We observe that a switch from $(x,y,0)$ to $(x,y,1)$ of the first system may alter the fitness structure of the second system such that suddenly a former lock in (e.g. $(x,y,0)$ and $(1,0,0)$) switches to a state where the former configuration $(1,0,0)$ can successfully mutate to a global optimum $((1,0,1)$ in the lower case). To sum up: in co-evolution, a mutation in one system may trigger a mutation in another one, such that an initial lock-in is overcome.

4. Hayek's theory and evolutionary macro-models

In chapter 2, it was argued that the main weakness of Hayek's theory is its reliance on group selection, even though it does not explain how such selection would occur. Apart from this, the Kaufmann model has shown that on a macro-level, evolutionary lock-ins may be the result. This therefore could also be the case in Hayek's cultural evolution model.

The outcomes observed not necessarily are the optimal ones, but simply good enough to have survived. Of course, there is still the case of co-evolution. Unfortunately, Kaufmann (1993) has shown that the more linkages there are, the more oscillation between different fitness levels occurs, and the more similar the fitness levels of different states become. In other words: the more coevolution we observe, the easier systems may get out of lock-ins, but at the expense of more and more alike, close to average performance states. The Kaufmann model in its macro-interpretation of course neglects population dynamics, an aspect Hayek's theory provides. If we introduce population dynamics, the following may occur. Several different fitness level configurations—or mutants—coexist, as they all fulfill the requirement of minimum fitness. An initially less fit configuration, e.g. (1,0,0) in figure 2, may mutate to a configuration like (1,1,0), which is initially even less fit, but sufficiently quickly mutates to a new form like (1,1,1). This form in the end may mutate to the globally optimal fitness level (0,0,1), having overcome the initial lock-in path. How realistic such a break of path-dependent development in the end is depends on the relevant parameters like minimum fitness and speed of mutation. But it shows that in principle population dynamics can relax some of the dead-end characteristics of evolution.

5. Evolutionary development and the role of constructivism

One last aspect must not be forgotten: in biological evolution, the drivers of different fitness configurations are spontaneous mutations as well as sexual reproduction. Both forces to a large extent are driven by unconscious experiments respectively recombinations. In cultural evolution, to some extent people can make deliberate choices to experiment. For sure, the overall development path of a society is not subject to a general design approach, but within limits bounded rational agents deliberately alter their behavioral repertoire if they can make a fair guess that some conscious change has potential for improvement. This does not only hold for individual experiments, but especially for collective decision making. In all societies, there exist mechanisms for collective decision making, where decision are not taken randomly, but formulating expectation about the outcome of

a certain decision. Such deliberate design of rules is not mutually exclusive with evolutionary development, but rather a complement. In cultural evolution, apart from spontaneous evolution due to “mistakes” that turned out to lead to more successful rules, a large part of change is driven by constructivist measures. These measures for sure *must not* and usually *do not* comprise a change of the entire socio-economic system, but rather a small change in one parameter. In the long run, the more successful experiments then have more reproductive success, just according to Hayek’s initial theory. Elinor Ostrom (1990) showed in her empirical studies how groups manage by successful design as well as corresponding trial and error processes to overcome collective action problems, like for example the tragedy of the commons in many situations of joint resource utilization. Seen in the light of group selection, one then could argue that the Swiss farmers who successfully managed to maintain their common resources showed cultural survival fitness, while the Mayan culture did not survive the selection of sufficiently adapted cultures, if the story that resource over-exploitation in their empire really is the root of the decline of the Mayan system. Last, often the quality of the development of evolving systems is assessed in a tautological way: what survives is good, and only the good survive. A way out is to accept some external criteria of moral quality, which allow to judge the systems which survived from a standpoint different than a purely evolutionary one. Like in the market, where it is not competition per se, but only of some quality (“*Leistungswettbewerb*”), it is not evolution per se which leads to satisfactory outcomes, but *constrained* evolution (Vanberg 1994). A system in which human rights are violated constantly does not become a good one just because it was evolutionary successful.

6. Summary and Conclusion

Evolution may outperform constructivism on two grounds: design may simply take too long if all potential situations are taken into account, but more realistically, designers may simply lack sufficient information and therefore not be able to construct an optimal solution. Evolution, on the other hand, may via elimination of the less successful over time

lead to more adapted systems. Nevertheless, evolutionary lock-ins cannot be ruled out. But even in this case, co-evolution may provide a way out. One could for example think of the interdependence of the economic and the political order, as Eucken (1952) highlighted. A change in one of the two systems may trigger relevant changes in the other system. This means that we not only may not simply get out of lock-ins by co-evolution, but that intervention in one system may lead to unexpected changes in another coupled system. Even though the macro-model based on Kaufmann gives interesting insights into evolutionary processes, its neglect of population dynamics is a considerable disadvantage. Introducing competition among different configurations at a micro-level, the lock-in consequences appear less dramatic. A last important element is the introduction of deliberate design of rules, at least to a limited extent. If we interpret Ostrom's (1990) findings as a way in which deliberate experiments not only drive changes—which are crucial for evolution as without mutation, there is no competition—but also lead to the selection of more adequate rules to overcome collective action problems, a driver of group selection can be identified.

This last hypothesis may help to close a gap left by Hayek's theory, the issue of group selection. To sum up: in cultural development, for sure both evolutionary selection as well as rule design plays a role—the latter one especially if we think of constrained evolution. Via deliberate collective decision making, groups may experiment with different ways of solving PD structures or commons problems. Even though there is no full knowledge about all potential changes and all consequences, bounded rational individuals, being equipped with a collective decision making mechanism and a certain moral value system, can engage in constructivist rule design within a certain environment around the current state of nature. Whether or not a group made a correct guess will be shown by evolutionary selection over time.

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