WORLD SYSTEM PROCESSES: AN EVOLUTIONARY APPROACH

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Contents:

Summary

World system history might be understood as a detailed description of the cascade of evolutionary processes that are multi-level, co-evolving, nested, and self-similar. World system organization, the product of these processes, is a work-in-progress, precariously poised on the boundary between order and chaos, that allows however for flexibility that is a necessary condition for evolution and learning. Collective learning in turn accounts for the major transitions marking world history, and also serves as framework for long-range forecasting as in respect of globalization. A literature review confirms the close affinity between evolution and learning, and empirical evidence supports the concept of a cascade. The general equation describing world system emergence suggests it to be a project whose current period is now about 80 pc complete, with its major features now in place.

1. World System Evolution

The social system of humanity or, for short, the **world system**, may be approached from two different, if complementary, perspectives: structural, or process-oriented. The structural perspective offers insights in such areas as the division of labor in the world economy, power distribution in the world political system, core-periphery relations in world society, or the role of world media. The focus is on shorter-term arrangements in-being, and the attention tends toward description. The process-oriented or time-sensitive perspective focuses on longer-term change and, while requiring reliable description, privileges processes that account for what the economy, polity, society, and culture have become and are becoming in world-wide proportions. While the study of world system **processes** is the theoretical backbone of the history of the world system, it also needs stressing that, since evolution manifestly is a process, **evolutionary** concepts, accounting for change over time, are the meat of that discourse.

The premise that humanity constitutes a complex adaptive system makes it possible to envisage it as evolving, and by looking at it holistically, it is possible to uncover common patterns and features that may be invisible or unpredictable in the short-run but tractable in the long term. Since world system structures emerge, endure, decline, and recede into the past in a number of forms, regular and recurrent behavior is to be expected, and needs to be explained. World history highlights and encompasses social processes marked by transitions powered by innovations. These processes constitute world system evolution.

The following is the discussion, first, of social evolution, and second, of the processes to which it gives rise.

1.1. Biological and Social Evolution

World system processes are processes of social evolution. Basic to this discussion is the need for drawing a clear line between biological and social evolution, to skirt the dangers of biological determinism, and to establish the distinctiveness of social evolution.

Evolutionary processes are often thought of as purely biological, concerning 'descent with modifications' of organisms transferring information via genetic mechanisms (and humans are, of course, among such organisms). That is the problem biologists have studied at least since Charles Darwin, such that to-day all of biology is pervaded by evolutionary theorizing and its implications. Biological evolution can now be mapped as extending more than three billion years of the existence of life on earth. J.M. Smith and E. Szathmary (1995) depict evolution as inter-generational information transfer that lies at the base of the seven 'major' transitions that have marked the emergence of new levels of biological organization.

Social evolution, too, is based on the transfer of information but primarily via the transmission of culture between and among generations. The mechanisms of that transmission include language, are part of social organization, and include the family, peer groups, and educational and media systems. That means that humans, and the human species, have been subject to two types of information transmission. As organisms, hominids have been evolving, albeit slowly, from mammals with a lineage extending for several dozen million years, including changes that have affected not just their genetic make-up but also their behavioral characteristics, such as bipedalism, the use of fire, or the family. More recent developments have been marked by the rising and increasingly dominant role of cultural transmission,

The focus of this chapter is 'world system history', that is those more recent processes of social evolution that initiated the possibility of a common organization for the entire human species, and maintaining that project over an extended period of several millennia. Table 1 summarizes the principal differences between biological and social evolution.

Characteristics	Biological evolution	Social evolution
Time horizon	Longer (billions of years)	Shorter (a few millions of years), 5 millennia in present analysis
Focus of inquiry	Inter-species	Intra-species
Master questions	Origin of species, tree of life	(Human) social change
Information transfer Mode Rapidity Route	 Genetic (Mendelian) Slow Vertical (parental only)	 Cultural (Lamarckian) Fast Vertical (parental and non-parental) and Horizontal.
Trend (toward complexity)	Random (passive trend)	Both directed and random (active trend)

Table 1. Biological and social evolution compared

1.2. The Comparison

A systematic comparison yields the following observations:

The time horizon of biological evolution is unimaginably long, extending over billions of years. In that time, innumerable number of species has had the time and the opportunity to have come and be gone. Social evolution here analyzed concerns an obviously shorter time span but also allows for sharper definition. It is shorter because it is dwarfed by the sweep of biological processes even though it is still impressive by the standards of the social sciences that tend to concentrate on the immediate and the contemporary.

Focus of inquiry in biology refers to developmental patterns in what are millions of surviving species, thought to be only a small fraction of all species that have ever existed. That is, its empirical domain is immensely large. Social evolution could, in principle, refer to the social organization of a variety of social species, such as ants, but the knowledge of that domain is quite limited and the principal focus on this occasion is

the trajectory of the of the world system in its emergence. One important consequence of it is that biological evolution primarily concerns inter-species interactions (as in 'the struggle for survival') while social evolution deals primarily with intra-species developments, that is with relations among members of the same species, hence also with greater opportunities for cooperation. That is why it privileges forms of social cooperation such as families, cities, nations, trading systems, information networks, alliances and international institutions, just as much if not more than as it pays what are often regarded as classically Darwinian situations that are involved in selection mechanisms such as markets, wars, and elections.
The master questions of biological evolution, as formulated by Darwin, and not really changed since, remain the origin of species and the morphology of the tree of life. The mechanisms are genetic, and environmental variability, as well as natural selection as manifested in pressures of the environment and interspecies competition. Social evolution concerns social organization and, in the present analysis, changes in programs, strategies and institutions that have enabled the interrelationships of humans over the past five millennia.

Information transfer between generations is the characteristic of all evolution. In biology, its principal form is genetic (Mendelian). DNA is the code of life for all organisms. In human society, the main mechanisms of transmission are social and cultural, as in child training (involving the family), imitation (involving social interaction), or education and science (in schools and professions), and calls for symbolic communication. Learning is the principal motor of social evolution. But while in genetic inheritance the information transfer is largely vertical, that is from one generation to the next, and basically parental (between genetically related individuals), in cultural transmission, the transfer of information is not only from parents to children but can take place between unrelated individuals (non-parental) and across communities. Added to that vertical route there is a horizontal route among individuals of the same generation, uninfluenced by age differential between transmitter and transmittee. Both routes, vertical and horizontal, and the weakening of the parental role give to cultural transmission the diffusion characteristic of collective learning, responsible for the explosive rapidity and cumulative directionality characteristic of social evolution. The way information is transmitted makes social evolution more Lamarckian than Darwinian, such that the inheritance of acquired behavioral traits becomes a reality.

Trend toward complexity has sometimes been equated with biological evolution, seen as the consequence of Darwinian natural selection (blind selection). This constitutes a passive trend toward greater complexity. Social evolution may also be equated with similar, Darwinian-type mechanisms leading to increasing complexity, but the addition of Lamarckian-type characteristics just noted gives to it a more active trend for directionality and speed.

Social evolution operates then by mechanisms that can validate a general and driven trend toward increasingly complex social structures, quite different from the passive trend of Darwinian processes. Biological evolution is too slow to keep up with changes in society. That is the most striking conclusion resulting from the comparison just undertaken, a characteristic that is a consequence of learning-related mechanisms found in cultural transmission. Yet it is worth noting that, among the different routes, it is the slower (vertical) one that times the social evolutionary process, for *it is the generational turnover that is the pacemaker of change in the social realm*.

1.3. Social Evolutionary Explanations

The question of social evolutionary explanations did suggest itself as soon as human consciousness emerged in the 19th century from the intellectual confinement of traditional time horizons, and when natural scientists paved the way toward understanding biological change. Important thinkers launched into such explanations, and propounded schemes of stages of human history. August Comte and Herbert Spencer both argued for social evolution even before Darwin launched his own conceptions. Karl Marx and Friedrich Engels produced a scheme of world historical transitions whereby mankind moved from primitive communism, through several stages to capitalism, and socialism. Yet such overly grand schemes gradually lost traction, and by the mid-20th century the term social evolution came to denote the evolution of particular societies (as in 'specific' evolution), and attempts to model 'general' evolution had all but been abandoned.

Viewing the constitution of the humanity as a complex system moves the explanation of large-scale change in the human story to a new level. World system history is not world history; it is an explanation of the propensity of human organization to move towards the new states of world organization via a series of major transitions embodying significant innovations. Transitions punctuate world history, but there is of course much more to history than accounts, and explanations of major social change. One such major transition is that toward what has classically been called civilization, over 5,000 years ago, toward urban living (civilization stems etymologically from the same root as city), ordered by calendars, writing, and sowing the seeds of states and organized religion. If laying the foundations of cultural reproduction was the hallmark of the **ancient** era of world system evolution then the **classical** civilizations saw a population surge based on agricultural expansion through Eurasia, and the rise of historical religions as foundation of wider social cooperation. The **modern** world era gave birth to nation-states and is now seeing the emergence of global organization.

World system history, viewed as world system evolution, covers only a minute portion of the timeline occupied by biological evolution, but does so in similar vein and at a higher resolution, much higher speed, and yields more accurate data on systemic transitions. As it seems unlikely that such transitions can be purely random, and innovations just manna from heaven, it is reasonable to suppose that social evolutionary processes are at work, whose distinguishing driver is learning.

2. Learning Drives Social Evolution

2.1. Learning and Evolution

The mechanism of world social evolution is learning. That is shown by how learning affects biological evolution, how it affects populations, and how it organizes the analysis of social evolutionary processes.

Evolutionary theorists have argued for more than a century about how the blind mechanism of selection acting on random mutations can give rise to such a variety of individual organisms. For long, the battle has gone strongly in favor of geneticists, and the Lamarckian idea that acquired adaptations are passed on to offspring by learning adaptations was routinely dismissed. More recent research has yielded new insights that tend to favor some aspects of the Lamarckian hypothesis. J.M Smith (1987). described what is now known as the “Baldwin effect”, the conjecture that individuals who vary genetically in their capacity to learn, will leave more descendants because of their higher ability to adapt, Computer simulations of the “Baldwin effect such as those of Hinton and Nowlan (1987) and Belew (1990) show that creatures that are genetically predisposed to learn are, on the average, more fit than those who cannot find the solution to an environmental obstacle.

Learning tends to affect populations via culture. Studies by Ackley and Littman (1981) have shown that the presence of cultural factors may create a selective pressure for the ability to learn. Thus the rise of agriculture has given rise to pressures leading to swift genetic changes, such as allowing the introduction of milk into adult diets as the result of the spread of cattle raising, as documented by Feldman et al. (1994). Learning can guide evolution because the results of one system of adaptive search (an individual’s learning) can be capitalized by another system (the evolution of a population). When culture is interposed as an adaptive system, it allows the hard-won knowledge gained by individuals to improve the fitness of other conspecifics (members of the same species) via non-genetic information pathways. In models of gene-culture evolution, a purely cultural transmission system may arise from an initial state of purely genetic co-transmission. Both in molecular biology, and in agent-based modeling, a bias can be found for adaptation, and then learning, at the boundary between order and disorder, commonly referred to as the edge of chaos.

The concept of learning has also recently entered the historians’ domain. David Christian views collective learning as “the single most important distinguishing feature of human history”, and he uses it as an organizing idea for his “big history” project, maintaining that “collective learning is so powerful an adaptive mechanism that one might argue that it plays a role in human history analogous to that of natural selection in the histories of other organisms”. Human evolution began when symbolic language enabled collective learning. Christian explains major transitions made possible by accelerated learning in increasingly large networks, but does not identify distinct evolutionary processes for the modern world. In his preface to Christian’s *Maps of Time* (2004), William McNeill, the dean of world historians, strongly endorsed his use of ‘collective learning’.

In the context of the social sciences, the concept of learning is central to the study of worldwide evolutionary processes. For one, the rise and decline of leading powers may be modeled as a learning process that co-evolved with the rise of leading industrial sectors (K-waves). The evolution of global politics might be seen as the successive adaptations of a complex system poised on the boundary between order and chaos, countering conventional thinking that regards it as tending either toward a balance-of-power (strongly ordered),or an anarchical (chaotic) state. G. Modelski’s “world system evolution" is a project for modeling the trajectory of the human species over the past five millennia.

2.2. The Pace of Evolutionary Change

Cumulative learning following the pattern of logistic curves can be found in individual behavior, or in a group of people following a common goal, be that of making products, living together, or pursuing exploration. Learning curves appear in the literature in two forms. The first one, regarding individual learning is the classical example of the growth of an infant's vocabulary; the second one concerns returns to scale, by which performance and productivity typically increase as individuals and organizations gain experience, 'learning by doing'. In the first case, the process is adequately described by a Verhulst differential equation, whose integral is the logistic, or an S-shaped curve. The second case, calls for a power law function where unit costs depend on cumulative experience. But the two cases are mathematically equivalent in that in both the S-shaped curves, and the industrial curves, the fundamental process involved is learning. This demonstrates the universality of the phenomenon, one that is not restricted to individuals, and is also encountered in an enterprise, a country, or a species.

Against this background, T. Devezas and J. Corredine (2001) have proposed a model of "Generational Learning" that conceives of the techno-economic system that gives rise to K-waves as an 'evolving learning dissipative structure" (dissipative structures are open systems far from equilibrium that exchange energy and matter with their environments). The waves are subject to two constraints: a biological one that is generational, and a cognitive one, that resides in a limit to the rate at which learning grows. An analysis of the mathematical relationship between the differential (continuous) and discrete logistic equations shows that the learning rate parameter (δ) of the logistic equation and the gain-determining constant (k) of the recursive discrete logistic equation are closely related through the expression $k = \delta t_{\mathrm{G}}$. In this equation, δ expresses the cognitive determinant, the rate at which humankind learns to deal with radical innovations, and t_{G}, known as the characteristic time of the logistic function, stands for the effective generational determinant, corresponding to the time span of the generational turnover.

Viewing K-waves as a collective learning process following the path of simple logistic curves, a review of possible values of k, aids in the search for an explanation of these phenomena. In the light of deterministic chaos theory, for $k < 1$, there is no growth; for $1 < k < 3$, a non-zero equilibrium value is achieved, and with $3 < k < 4$, there is the onset of bifurcation, in a bounded limit-cycle regime. As k (the gain-determining constant) becomes larger, and approaches 4, true chaos follows. Thus the range of $1 < k < 3$ stands for endurance, and stable equilibrium, and $k > 4$ means breakdown. By contrast, $3 < k < 4$ represents chaotic behavior that is deterministic. That is why sustainable growth requires $3 < \delta t_{\mathrm{G}} < 4$, that is a diffusion learning rate δ of about 12% to 16%/ year with a typical duration of generational turnover at 25-30 years [yielding a range 0.12 x 25 = 3, and 0.16 x 25 = 4, or 0.13 x 30 = 3.9]. That is how [δt_{G}] acts as the control parameters of K-wave behavior, determining the basic rate of change and acting as the pacemakers of social change. This implies that the social process of aggregate learning within a generation operates near the threshold limit between (frozen) order and chaos.

The time-evolution of an economic sector experiencing rapid change may be described discretely as a logistically growing number of 'interactors' adopting an emerging set of basic social and technological innovations. By using two successive logistic functions as the probabilistic distribution of individuals exchanging and processing information in a finite niche of available information, Devezas and Corredine (2002) demonstrated that the rate of information entropy change (Kolmogorov entropy) exhibits a 'wavy' aspect evidenced by a four-phased behavior denoting the unfolding a K-wave. The system exhibits a limit-cycle behavior whose basic mechanism is the periodic deployment and filling of information in a 'leeway' field of active information.

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