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Excerpt
More Information

Part I

Prevue

1 Making the Improbable Probable

1.1 Generalised Evolution

The amount of attention that academia and popular media have given to evolutionary thought in recent years is unprecedented. More text is being published now on evolution than on theology, signifying a turning point in intellectual history. The mere mention of evolution tends to evoke strong reactions in many of us, ranging from enthusiasm to resistance. This should not come as a surprise. Accepting the evolutionary tale of life and humans has far-reaching implications for how we perceive the biosphere and our place within it. This book exposes the idea that a generalisation and extended application of evolutionary thinking can lead to equally astonishing conclusions. It has the capacity to contribute to a renewed and profound understanding of human cultures, economies, technologies, institutions and even public policies.

Partly triggered by its success in the field of biology, evolutionary thinking has become prevalent in other areas. This is manifest in terms such as non-genetic, social, cultural, symbolic, memetic, exogenetic and exosomatic evolution. These are all instances of what may be called ‘generalised evolution’. It encapsulates the flexible nature of evolutionary features and concepts, which can be recognised in applications to many different phenomena. A related term, ‘generalised Darwinism’, is also appropriate, given that Darwin was writing before the development of genetics, so was not aware of the genetic basis of organic evolution. His ideas about evolution therefore possess a certain level of universality, which enables their transfer to non-genetic realities.

Evolutionary thinking explains things that were hitherto mysterious, or that were explicated in an unsatisfactory way, such as through the infamous design, or watchmaker, argument (Box 1.1). The reason is that evolution is a stunningly effective mechanism for producing dynamic complexity, to begin with in living systems. But we are now able to apply evolutionary principles to solving many other puzzles. This book collects theoretical and empirical insights supporting the idea that evolutionary thinking is our best chance to come to grips with all kinds of real-world complex systems and their dynamics. The fact that evolutionary thought was first fully elaborated theoretically, empirically and experimentally in the domain of biology does not preclude its broader application. One way to regard evolution is as an algorithm or set of general mechanisms that apply to biological and various non-biological phenomena in equal measure (Dennett, 1995). The relevance of such an algorithmic interpretation is supported by the successful formalisation of evolution in mathematics (Nowak, 2006)

Box 1.1 The watchmaker argument double wrong

In 1802, William Paley proposed the famous 'watchmaker argument' in his book *Natural Theology: or, Evidences of the Existence and Attributes of the Deity, Collected from the Appearances of Nature*. Its thesis was that the complexity of living organisms suggests design and therefore a designer, in the same way that a complex clock is designed by a watchmaker. Design arguments had already been proposed by earlier theologians, notably Thomas Aquinas in the thirteenth century. They were considered to be the most important pieces of 'evidence' for the existence of an 'Almighty God'. While, in pre-Darwinian times, the design analogy might have been excused, current evidence for an evolutionary history of life (summarised in Section 3.5) makes the design-of-life-forms a difficult theory to defend. In a creative twist, Richard Dawkins (1986, p. 5) dubbed organic evolution the 'blind watchmaker', to emphasise its unconscious and unplanned character.

What is wrong with the design analogy? For one thing, it reflects a lack of imagination. Living organisms are far more complex than any watch. This is clear when one considers the number of active protein molecules in a single cell of a living organism, which run into the millions (Milo, 2013). By comparison, the most complicated pocket and wristwatches have at most a few thousand components, not all of them even active. But the design analogy is erroneous for another reason. No one single person or firm designed the watches we use or the automobiles we drive from scratch – or any other technology for that matter. Instead, they are the outcomes of an enduring process of cumulative inventions that counted on the participation of numerous individuals and firms. Over time, many ideas arose and either competed or merged. From the diversity of designs at each moment, only a subset carried on to the next phase, not guided by a grand designer but by evolutionary principles of diversity creation, selection and imitation. The proximate explanation for any watch is that it was made, though not designed, by a particular watchmaker. As an ultimate explanation, watch design came about through a long historical process of technological evolution. Section 2.4 considers design versus evolution in more detail, while Chapter 10 elaborates the evolutionary view of technological innovation.

and evolutionary computation (Mitchell and Taylor, 1999; Eiben and Smith, 2003). According to Blackmore (1999, p. 11), 'Algorithms are "substrate-neutral", meaning that they can run on a variety of different materials.'

But what is evolution, precisely? This question has no adequate brief answer. Moreover, the answer will vary between the contexts to which evolutionary thinking is applied, as later chapters will attest. Following a generalised outline of evolution in Chapter 2, the book delves into evolutionary thought in biology in Chapters 3 and 4. Following on, Chapters 5 to 7 look at evolution as it relates to society and culture, while subsequent chapters will cover the economic, organisational, technological, political and public policy realms. For now, I include some key points about generalised evolution to whet the reader's appetite. 'Generalised evolution' denotes a continuous interaction among three general mechanisms affecting variety in some biological, cultural or technological population: selection, innovation and replication, jointly referred to in this book as the V-S-I-R algorithm. Specific labels differ among disciplines. In biology, selection is also known as differential survival, while innovation is referred to as variety creation, and replication is often referred to as heritability, inheritance or reproduction. In economics and innovation studies, variety creation is commonly called innovation. The interaction of the V-S-I-R mechanisms causes seemingly unlikely constellations and structures to become surprisingly likely. One could say that evolution makes the improbable probable, without any preconceived plan or purpose.

Ostensibly a simple process, the implications of evolution are remarkable. In its entirety, though, the process of evolution is certainly not simple, and definitely more complex than many of its critics can imagine. Interpretations of evolution, such as coincidence, randomness or blind chance, are often misconstrued. The reason is that only one of the three V-S-I-R processes (note that V is a component, not a process), namely innovation (or variety creation), is random. The other two, selection and replication, represent rather deterministic processes, which has been summed up as: 'Mutations propose but selection decides' (Cavalli-Sforza and Cavalli-Sforza, 1995, p. 95). More accurately, even variation creation is not genuinely random. As we will see in Chapter 4, it is better to characterise it as 'undirected' given that it involves many understandable, and even predictable, processes. In the process of evolution as a whole, variety creation then serves as the creative part, environmental selection provides the directive force, and replication or inheritance adds the finishing touch by guaranteeing endurance and stability. The combination of the three processes (S, I and R, working upon V) gives rise to an endless accumulation of adaptations, in biological, cultural or other units, to the respective environment. So, while evolution is unguided by any intermediate or end goals, it would be misleading to describe it as wholly random. If it were, evolution would be unable to produce the unlikely yet functional constellations that it does. Section 2.1 looks more systematically at the specific interaction of the V, S and R factors, including cases in which only one or two of them are present. This helps to better understand their complementarity in generating complexity and diversity.

Evolutionary thinking has two other main features that distinguish it from other approaches found in the natural and social sciences. One is a population approach, which allows for an explicit and comprehensive analysis of variation among agents and changes therein. It provides an alternative to theories that employ average, representative or aggregate agents (Kirman, 1992). A population is a group of individuals or elements generally alike but differing in some subtle ways. In biological contexts, many populations include individuals belonging to the same species and having offspring through sexual intercourse. In social-cultural settings, they consist of similar types of individuals or entities, such as consumers or firms, which interact in terms of imitation, information exchange or competition for customers. The advantage of a population approach is that it offers a suitable foundation for studying distributional or inequity issues, a central concern of many social sciences. In addition, social interactions and networks, common in recent social studies, can be easily integrated into a population approach.

A second important feature of evolutionary thinking is that it enables researchers to identify ultimate causes, next to proximate ones. These refer to why things exist and how they work, respectively. Proximate causes involve physiological, behavioural-psychological, economic, institutional or technical factors. Ultimate causes relate to evolutionary processes, whether they are of a biological, cultural, economic or technological nature. These processes help to explain how the proximate factors came about. Ultimate causes can be seen as a subcategory of a wider class of long-term, historical causes. The latter include geographical and climatological factors, which tend to change little over prolonged periods. Proximate and ultimate causes are complementary and need to be studied in tandem to achieve a comprehensive understanding of complex systems. Evolution is perfectly capable of describing the mechanisms through which ultimate causes give rise to proximate causes. This explains why biology has a solid grasp of ultimate causes, unlike the social sciences, which tend to focus on proximate ones (Scott-Phillips et al., 2011). Linking the two types of causes through evolutionary thinking could enrich the social sciences. In turn, this would enable policy studies, as part of the wider social sciences, to design more effective solutions for social and economic problems, namely through a profound understanding of ultimate causes and consequences.

This volume zooms in on the social sciences, setting it apart from other treatises of universal evolution. It covers sociology, anthropology, political science, economics, organisational science, innovation studies, history, policy studies, environmental science and climate studies. In other words, it applies an evolutionary approach to social, environmental and policy sciences. While it would be too ambitious to claim that the full spectrum of possible evolutionary applications is covered, it is fair to say that a broad set of topics will receive attention – including those at the boundary between the natural and social sciences. Examples are evolutionary medicine, evolutionary criminal law, evolutionary mineralogy, the role of sex and gender in society, and the evolution of language, science, religion, music and humour.

Four specific goals motivate this book: (1) to inform the general, well-educated reader about evolutionary thinking in a variety of areas; (2) to convince social scientists that evolutionary approaches deserve our serious attention and that they already exist in productive forms within various social science fields; (3) to inform biologists that evolutionary concepts and methods serve a useful role in fields outside of biology, from which they can possibly learn or to which they can contribute original thoughts; and (4) to show that biological concepts and theories can be fruitfully transferred to the evolutionary social, environmental and policy sciences, enriching their scope and explanatory power.

1.2 Human Evolution Beyond Biology

The notion of evolution is one of the most impactful ideas that science has ever generated. It represents what philosopher Thomas Kuhn called a paradigm shift or what another philosopher described as ‘Darwin’s dangerous idea’ and ‘a universal acid’ that destroys old ideas (Dennett, 1995). This is because evolutionary explanations encapsulate cause–effect mechanisms that can be applied to all kinds of structural change phenomena. Darwinism has already moved beyond well-trodden paths to advance new ideas on such diverse issues as language, medicine, knowledge formation, ethics, religion, computation and Darwin machines, such as the immune system and the brain (Buskes, 2006). Evolutionary approaches can also be found in the majority of social sciences (White, 1998). Indeed, it is undeniable that human cultures, economies, organisations, institutions and technologies are related through historical descent. This validates efforts to use evolutionary thinking to better understand them.

The transition from biological to cultural evolution occurred through various stages of social evolution, i.e. evolution of social behaviours, in primates and humans. Chapter 5 clarifies the origin, functions and dynamics of social behaviour and groups, while providing some detail on social insects and primates. During the 1970s, sociology and anthropology were conquered by the fear that invoking evolutionary arguments implies some form of biological determinism. This was largely an emotional response to an emerging biological area of research baptised as sociobiology (E.O. Wilson, 1975). The ensuing debate was complicated by politically sensitive societal topics, such as racism, sexism, homosexuality, aggression and crime (Ruse, 1979; Nielsen, 1994). Over time, the research continued, wisely adopting new names, such as behavioural ecology and evolutionary psychology. Nowadays, evolutionary thinking is widely accepted in the fields of anthropology and psychology. It partly denotes a revival of the old ideas, and partly an integration of previously separate fields. For example, evolutionary anthropology integrates insights from comparative analysis of primates and humans, behavioural ecology and ethology, human evolutionary biology and genetics, palaeontology and archaeology, evolutionary psychology and linguistics, and broader cognitive science. This practice of collecting many distinct, mutually consistent insights to reach unequivocal ultimate explanations is common in evolutionary studies. Indeed, it already characterised Darwin's way of working (see Section 3.2).

As will be discussed extensively in Chapter 7, once culture emerged in human groups, due to the unusual ability of humans for social learning and imitation, a combination of natural and cultural selection started to direct human evolution. Here culture should be broadly interpreted, comprising language, cooperation with non-kin, redistribution and sharing, exchange and trade, invention and perfection of tools, specialisation and division of labour, and institutions such as rules, norms, law and religion. For example, in Section 4.8, we will consider the role of economic processes in shaping human evolution, while in Section 11.2 the role of cooking will receive attention. The presence of cultural selection or evolution that affects human behaviour, brain–mind and even physiology, undercuts the common idea that genetic evolution caused or shaped culture. Instead, a two-way process of mutual influences of genetic and cultural evolution, or gene–culture coevolution, is a more apt characterisation of human evolution since the first appearance of cultural elements in human groups. Moreover, it also holds the key to adequately explaining current and future human evolution (Chapter 16). Hence, the study of human evolution is not the sole domain of biology, but requires a synthesis of human evolutionary biology with insights about culture and cultural dynamics from the various social sciences.

Biologist E.O. Wilson (1998) has suggested that the social sciences can achieve greater progress by striving for consilience. By this, he means that results from the social sciences should be consistent with relevant and widely accepted insights from other disciplines, notably the natural sciences. This view is supported by many scientists today, notably behavioural ecologists, ethologists, primatologists and psychologists (de Waal, 1996). As stressed by Wilson (1998), the boundary between, on the one hand, the natural sciences and, on the other, the social sciences is very incompletely studied, and to make progress, both need to be involved and even cooperate. According to Richard Nelson (2007), 'universal Darwinism' is dominated by contemporary biological evolutionary theory, which contributes to evolution in the social sciences being seen as analogous to biological evolution. He considers Dawkins (1976), notably his proposed meme thinking (addressed in Section 7.6), and Daniel Dennett (1995) as the principal representatives of this so-called 'biological imperialism'. His preferred alternative is a specific social science approach to evolution, such as associated with the ideas of the philosopher David Hull (1988) and the anthropologists Boyd and Richerson (1985). Nelson claims that a generalised formulation of evolution in the social sciences has to be unbiased towards biology. I personally believe that fear of biological imperialism is unwarranted. In various places in this book, I will argue why biology-inspired notions can sometimes offer fresh angles and deserve to be given a fair chance in the social sciences.

As later chapters testify, evolutionary social sciences encompass both genetic and non-genetic evolution. Genetic evolution applies to the living world, including humans, also those living in cultural settings. Non-genetic evolution applies mainly to humans and their cultural, social, economic and technological realities. The study of human genetics includes the disciplines of evolutionary psychology (Barkow et al., 1992) and genetics (Carey, 2002). The first combines evidence from genetics, physiology, human palaeontology and primatology to understand the evolutionary history of human behaviour. The second synthesises human evolutionary theory and behavioural experiments to understand how the mind, brain and human culture have co-adapted. It also looks at how humans are currently maladapted to their environment. Evolutionary analysis in anthropology, sociology, economics and technology studies focuses on non-genetic evolution, even though sometimes genetics is included, such as when studying the evolution of pest resistance due to agricultural practices. Some studies move one step further by assessing the dual influence of genetic and non-genetic factors and associated gene–culture coevolution (Sections 7.3 and 7.4).

This book aims to offer a fair and balanced account of the main evolutionary ideas and theories in the social sciences, including those that cross the natural–social science divide. This complements other publications on social, cultural or economic evolution, which often emphasise or promote one particular theory. At best, these mention alternatives in a tangential and superficial way, or provide disproportionate criticism to sweep aside competing approaches. While certainly not eschewing critiques, the treatment here will consist of constructive accounts and comparisons of all relevant theories. This starts in Chapter 5 with approaches to clarify social behaviour from an evolutionary angle. The various evolutionary perspectives on the role of groups in evolution, a much-debated topic, are considered in Chapter 6. This is complemented in Chapter 7 with a broad range of evolutionary theories proposed in sociology and anthropology, covering themes such as dual inheritance, gene–culture coevolution, learning, religion, music and humour. In Section 7.10, we will systematically and critically compare the different evolutionary approaches used to study social-cultural systems, that is, sociobiology, evolutionary psychology, dual inheritance (including gene–culture coevolution) and memetic thinking. Next, Chapters 8 to 10 extend the cultural evolutionary palette by addressing evolutionary economics, organisational evolution and innovation studies. These integrate insights from behavioural economics, consumer analysis, firm organisational studies, financial economics and recently also macroeconomics. Evolutionary approaches are further encountered in geography and political science; these receive attention in Chapters 8 and 15. Chapters 11 and 12 present an evolutionary angle on long-term history, focusing on the evolution of *Homo sapiens*, the emergence of agriculture, and the rise of modern science and industry.

1.3 Practical Values of Evolutionary Reasoning

Evolution as a mode of thinking has begun to enter disciplines that aim to improve the human world. We will consider this in more detail in Chapters 13 and 14, where environmental and climate policies are examined from the angles of evolutionary biology, economics and technology, and in Chapter 15, which scrutinises more generally the design of public policies and the dynamics of political processes. The notion of evolutionary or Darwinian policy draws attention to the relevance of distinguishing between proximate and ultimate causes of human problems. In addition, it brings to light questions as to what are relevant evolutionary criteria for public policy design, and raises the much-debated issue of evolutionary progress, including in socioeconomic and technological contexts. Incidentally, the policy-related term ‘policing’ is used in evolutionary biology to refer to detection and punishment mechanisms in groups of genetically weak or unrelated organisms.

The practical value of evolutionary thinking is clear in the realm of the biomedical sciences. This is particularly evident in evolutionary medicine and clinical evolutionary psychology and psychiatry (Nesse and Williams, 1994). The traditional approaches in these fields focus on the direct or proximate reasons for, and physiological processes underlying, human sickness and disease. Evolutionary approaches add insights about ultimate factors behind human diseases as well as about the nature of defence mechanisms in the human body. Explanations include imperfections arising from trade-offs among adaptation to different selection conditions, maladaptation to cultural environments, and relationships between genes and molecular processes underlying diseases. In particular, our understanding of cancer and HIV/AIDS has improved considerably thanks to evolutionary analysis. The recognition that these diseases are effectively a battle against evolution has given rise to more effective cures. Box 1.2 explains this in some detail.

Box 1.2 Cancer and HIV/AIDS infection as evolutionary processes

Cancer can be regarded as an undesirable outcome of an evolutionary process internal to a multicellular organism. It occurs when a population of mutant cells competes with healthy cells for scarce space and resources. Mutant cells are selected as they are better adapted to the micro-ecological environment. Martin Nowak (2006, Chapter 12, p. 209) states that cancer is typical for multicellular organisms, since it means the ‘evolution of defection’ and a ‘breakdown of cellular cooperation’. He notes that while computers are sensitive to viral infections, they are immune to cancer. The micro-selection environment of cancer cells varies between cells, even within a small region. In particular, proximity to blood vessels influences how cells are affected by chemotherapy. For example, more distant cells can escape the strong effects of cancer treatment. The connection between evolution and cancer is further strengthened by the fact that most, if not all, cancers have genetic causes. Activation of ‘oncogenes’, often transferred by viruses, triggers cell proliferation and deactivates tumour-suppressing genes. Attempts to cure cancer can avoid the process of selection for resistance by taking heed of underlying evolutionary processes. Treatments following this approach have become more effective over the last decade in controlling certain types of cancer. Techniques include multi-drug therapies that alter the level of competition between mutant and benign cells so as to improve the strength of the latter (Merlo et al., 2006). From an evolutionary perspective, so-called ‘targeted therapies’ that help to obstruct the proliferation of tumour cells, appear to be an effective and less damaging alternative to standard chemotherapy. The latter aims to kill cancerous cells, but with significant collateral damage to the human body. Considering tumours from the angle of selection points to novel remedies such as blocking the growth of new blood vessels to tumours. Another idea is to treat a tumour only when it is growing and leaving it alone when it is not, as this might be selecting for cells that have a slow life-history strategy (Aktipis et al., 2013). We can learn more about combating tumours by studying the mechanisms that the body uses to defend itself against them. In addition, one can derive insights from comparing animal species that are more and less prone to cancer.

Acquired immunodeficiency syndrome or AIDS is the expression of the HIV retrovirus that can infect and kill so-called CD4 cells of the immune system. Vaccines have so far proven ineffective, as the virus quickly responds by mutating to escape their selective pressures (Nowak, 2006, Chapter 10). The evolutionary origins of these viruses are simian immunodeficiency viruses (SIV) that infect many primate species, without leading to a disease. When they jump to other species, however, they can induce AIDS. Probably the most viral HIV virus, HIV-1, crossed the species barrier from the chimpanzee and gorilla to humans multiple times, giving rise to four groups of the virus (M, N, O and P). The first transmission occurred around 1910, and may have been related to ‘bushmeat activities’ combined with the emergence of larger, colonial African cities that brought with them higher levels of promiscuity and prostitution, increasing the risk of HIV transmission. It has further been suggested that railways have played a role in wider diffusion of AIDS (Cohen, 2014). The

Box 1.2 (*cont.*)

evolution of HIV in the body creates a diversity of antigens over time. An antigen is the part of the virus that causes the immune system to generate antibodies. HIV is unique in that it has an unusually fast replication cycle and high mutation rate. This results in a high diversity of HIV antigens over time, causing the immune system to become overloaded and, also because of losing CD4 cells, incapable of controlling the virus. Although there is no definite cure for HIV/AIDS, effective antiretroviral therapies exist. One combines various medicines from six drug classes to create a complex selection environment that controls the virus for a long time, thus both extending patients' lives and improving their quality of life. In the short run, HIV quickly evolves in individual humans during infections, that is, in the absence of antiviral treatment. Its long-run fate is yet uncertain. In fact, a remarkable 8% of our human genome is accounted for by inactive remnants of ancient retroviral infections. For a highly pathogenic retrovirus, such as HIV-1, evolution towards a less virulent state would likely take a long time – probably at least several millennia. This suggests a high death toll before HIV turns into a silent passenger in our genome or the HIV-host becomes resistant. HIV may, though, not follow the same evolutionary pattern as other retroviral infections, given that it moves through a global population and is subject to anti-retroviral control. Effectiveness of such control over a long time period, especially reducing transmissibility of the virus, is essential to making HIV less destructive.

The policy sciences can likewise benefit from evolutionary angles, not only regarding genetic evolution, such as that associated with the occurrence of pesticide resistance in modern agriculture, but also with respect to non-genetic evolution, such as in the areas of technological innovation (Chapter 10), environmental regulation (Chapter 13) or inequality and poverty (Chapter 15). Since climate change ties many of these issues together, evolutionary thinking can help in guiding a sociotechnical transition to a sustainable and low-carbon economy (Chapters 13 and 14). Incidentally, natural history abounds with transitions, which have received much attention in evolutionary biology (Section 3.6). One can thus expect rewarding cross-disciplinary spillovers in this respect.

Evolutionary medicine and evolutionary environmental policy share several themes. Foremost, that humans are in some ways maladapted to the current environment, also known as 'evolutionary mismatch'. In this respect, an improper diet and lack of exercise are often mentioned as the consequence of Pleistocene humans living in a modern technology-driven world. According to evolutionary approaches to environmental science, humans are maladapted even as a species, since environmentally damaging technologies, overconsumption and a large population push them to live beyond the material and energy limits of local and global environments. As a result, humans are altering basic environmental conditions, in turn worsening the degree of their maladaptation. Both evolutionary medicine and policy analysis recognise that an understanding of proximate causes of problems is insufficient for identifying effective solutions to relevant health or environmental problems. One has to understand their ultimate causes.