What can we learn from history?

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Introduction

"The laws of history are obscured by accidents of history" (attributed to Trotsky).

While everyone knows that the Great World War was caused by the assassination of the Archduke Franz Ferdinand in Sarajevo in June 1914, the details of how the assassination came about are less familiar. The planned assassination by the Black Hand group failed dismally: on seeing a policeman one conspirator lost his nerve, another felt compassion for the Duchess and failed to shoot, and then a bomb thrown by another, Nedelijko Cabrinovic, bounced off the roof of the Archduke's car and missed the target, only having the consequence of causing the Archduke's car to speed away, thereby foiling the attempts of the remaining conspirators. However, one of the members of the gang, Gavrilo Princip, later stopped for a sandwich at Moritz Schiller's delicatessen. Just at the time he was munching away, the Archduke's car happened to appear, having just taken a wrong turn. In attempting to reverse, the car stalled, giving Princip the chance to shoot from just a few feet. Even then he had to rely on a bystander kicking a policeman on the knee as the policeman was attempting to disarm him. The rest is (a very complex, admittedly) history.

Of course the political situation in Europe at the time was tense, but most accounts of the Great War make the assassination of the Archduke the precipitating event of the conflict (e.g. Ponting, 2003; Taylor, 1963). It is therefore interesting to speculate about what would have happened if Princip had been less hungry, and had given the sandwich shop a miss, or more hungry, and sat down for a lengthy lunch in a restaurant. Even if he had still stopped for his sandwich, suppose the driver hadn't taken a wrong turning, or if he hadn't stalled the car, or if the nearby policeman hadn't been kicked on the knee at the vital moment? The assassination would then probably never have happened. Even between the assassination and the outbreak of war there was a complex chain of diplomatic accidents, misunderstandings, blunderings, and interventions, that meant that world war was not the necessary consequence of the assassination (Ponting, 2003; Tuchman, 1962). After the war, analysts recognised the accidental nature of the spark of the "most famous wrong turn in history", and searched for more satisfying accounts, ranging from the train timetables (in Taylor's famous 1963 account of how preparations for militarisation led to an unstoppable chain of events once they were put in motion) to German unification under Bismarck and subsequent militarisation and aggression (Buchanan, 2000), to the recalcitrance of Austria-Hungary and Russia (Ponting, 2003). But would the Great War still have begun, sooner or later? How different would history have been if this chain of accidents had turned out slightly differently? Is it really a case of, as the proverb goes, for the want of a nail, a shoe was lost ... and then the kingdom of Richard III was lost?

The assassination of the Archduke and the origin of the Great War is a particularly clear-cut example of the role of chance in history, but it is by no means an isolated one. A trawl through any history books reveals numerous examples of random small events influencing the greater course of great things: the rashness of the Saxon troops and the subsequent Norman counter-attack at the Battle of Hastings; the weather dispersing the Spanish Armada; the origin and spread of the Black Death; the finely balanced situation of the Cuban missile crisis of October 1962; almost *ad nauseam*. Buchanan (2000), in his masterly account of the physics of history, discusses the collapse of the Soviet Union in a similar vein, as well as financial collapses. The list is lengthy enough, even before we consider the consequences of chance events in prehistory and geological time, such as the impact of the meteorite that almost certainly contributed to the mass extinctions at the Cretaceous-Tertiary boundary. Furthermore, it is well known that major accidents usually result from an unfortunate combination of several factors: among the most studied, the Tenerife air disaster of March 1977, which resulted in 583 deaths following the collision of two Boeing 747s, arose out of a combination of flights being diverted to a small airport following a bomb alert, fog, delays, one flight taking off without clearance, another continuing to the wrong exit, and a simultaneous radio transmission disrupting radio contact, among several other contributing causes (see Brafman & Brafman, 2008).

The role of chance in history, and in particular how alternative futures hang in a fine balance measured with small events, is not a new topic. John Stuart Mill, in *On Liberty*, can be read as having recognised the issue in his famous discussion of how Protestantism was rooted out in Spain and Italy, and “most likely would have been so in England, had Queen Mary lived or Queen Elizabeth died”. But these famous chance events are just the tip if an iceberg of randomness: we can tunnel back through a network of causal relations and ask specific questions such as what would have happened if Hitler’s mother and father had never met, or if Ghengis Khan had been born with a biological reward system that made him slightly less ambitious? We should also not forget that collective and individual history is made up of countless small events that might have turned out otherwise, each one of which has contributed to the state of the world as it is now. If instead these events had worked out just slightly differently, they could conceivably have led to a very different future.

Alternative histories, exploring these “what if” scenarios, themselves have a long history, both in non-fiction (e.g. Ferguson, 1998 directly, and to a lesser extent, Kershaw, 2008) and, particularly, in fictional literature (not to mention film and television). The earliest known alternative history is Livy’s speculative account of what would have happened had Alexander the Great headed west instead of east. Ferguson presents a collection of several counterfactual histories, answering such questions as what if John Kennedy had lived, what if Nazi Germany had defeated the Soviet Union, and what if Britain had stood aside in 1914? Ferguson’s introduction is interestingly called “Towards a chaotic theory of the past”, suggesting that historical events lie in the balance, with outcomes depending on whether the rider has a nail in his shoe or not.

There are far too many fictional examples of alternative histories to provide a comprehensive listing, although my favourites include Keith Roberts’ *Pavane*, where the Spanish Armada proves successful and England becomes Catholic once again, Ward Moore’s *Bring the Jubilee* (where the American South wins the Civil War), Philip Dick’s *The Man in the High Castle* (where Japan defeats the US in WWII), and more recently, bringing the genre into the literary mainstream, Philip Roth’s *The Plot against America*, where a right-wing Charles Lindbergh defeats Franklin D. Roosevelt in the Presidential election of 1940. There is a famous episode in the Dr Who story Genesis of the Daleks where the Doctor has been tasked with the mission of destroying the Daleks at their inception. He sits outside the breeding chamber, wires ready to connect to destroy the chamber, when he contemplates how the evil of the Daleks has in fact brought a great deal of good to the universe, and how their destruction would probably lead to a worse future. One of the most famous examples of a fictional alternative history is the Ray Bradbury (1952) short story *A sound of thunder,* in which a dinosaur-hunting time traveller accidentally steps on the earth and kills a butterfly. On their return to the present, the travellers find that history has been changed in subtle ways, with words spelled differently and a different President winning the election. That this story hinges on a butterfly is apt, given the argument that follows.

These alternative histories serve as more than entertainment: they address a fundamental issue in the study of history - how *robust* are historical outcomes to variations in the chain of events that lead to them? Could killing a butterfly many millions of years ago *really* change history on the macroscopic level? If Princip had failed to assassinate the Archduke, would the Great War have been averted, or would different events nevertheless soon have led to its outbreak? I want to argue that it depends on the particularities of the situation, a point that some may find obvious, but more originally introduce the notion of a dynamic historical attractor. In doing so I will raise questions about the nature of historical cause and explanation.

We can envisage two very different sorts of possible ways in which history unfurls. The first way is that history has a momentum so that most events won't change the course of history: the eventual outcome will be the same regardless of differences in small events along the way. With this sort of view of history, the Great War would still have begun about the same time had Princip sat down to a hearty Wiener schnitzel and the Archduke not been assassinated that day. On this view, if Hitler's mother and father hadn't met, the conditions were such that some other dictator would have come to the fore in Germany at about the same time. This stance sees history rather as a heavy body moving along a path: you can can perhaps deflect it a little from its course, but it quickly resumes going on as it was before. We can call this the *inertial* view of history. Tolstoy (1868) noted in *War and Peace* how great events (such as Napoleon's march on Moscow) take on an impetus of their own that becomes detached from their leaders and generals.

The second possibility is that the course of history is very easily changed: small differences in events can lead to very different historical outcomes. It is now common knowledge that some systems are chaotic in that very small differences in their starting state can lead to enormous and unpredictable differences in their later states; the example commonly given is how the flapping of a butterfly's wings in the Amazon can lead to a storm some time later in the northern hemisphere. It's known from economics that small, random differences in starting conditions can build into prolonged and sustained differences in which groups are perceived, and although the initial differences may be random, they nevertheless become reified into systematic biases resembling discrimination (Fryer, Goeree, & Holt, 2005; Harford, 2008). On this account, if Princip had had a mild stomach upset and given his sandwich a miss, WW I might never have begun, the Austrian-Hungarian Empire never collapsed, and England and Germany might have became staunch allies against Russia and France. The future would have been totally different. We can call this the *chaotic* view of history.

The question of whether history is inertial or chaotic is much more than intellectual speculation: it's at the core of what history is about and how it should be studied. The rest of this article considers the alternative views of history, and discusses a complex-systems approach to the subject. Can small chance occurrences really change real-world history-like systems?

Complexity, chaos, and dynamical systems

"Complex systems do not forget their initial conditions; they carry their history on their backs" (Ilya Prigogine).

What is history? A convenient working dictionary definition is that history is the branch of knowledge that summarises and analyses past events, and it's the analysis component that is important for me here. To take one prominent example of what the discipline of history is thought to do, the Wikipedia entry on history emphases that it should investigate the patterns of *causes* and effect that determine events. Within this framework, it is essential to explore the nature of the relationship between cause and event: is it possible to assign systematic, robust causes to events, or are the outcomes the chaotic whim of random circumstances? If history is completely chaotic, so that very small changes along the way lead to very different outcomes in every situation, what sense does it make to talk of searching for patterns of causality? In short, if history is totally chaotic, there's little interest in identifying causes; we can't deduce any generalisations.. Ferguson (1997, p. 89) supports this view: "the search for universal laws of history is futile". I think that this argument is a very depressing one for historians, reducing the subject to an over-intellectualised form of stamp collecting.

It's the patterns of cause and effect with which I am primarily concerned. In doing so, there is no need to become side-tracked with a rigorous philosophical analysis of causality. I believe that the issue of whether history is fully deterministic is to my mind totally irrelevant here. Laplace (1820) famously noted that "we ought to regard the present state of the universe as the effect of its antecedent state and as the cause of the state that is to follow". That is, a suitably omniscient being could, given complete information about the current state of the world, predict what is going to happen next; in other words, history is fully determined by past events. Putting aside issues of quantum effects at the sub-microscopic level, history and the universe run a deterministic course, but this is knowledge that gets us nowhere. We are not omniscient beings. We need to rely on computers for simulations of even moderately complex physical systems. The problem of determining the future from an analysis of past and current conditions would appear to be intractable enough before we start considering chaos theory, which shows that small differences in the starting state can make huge and *effectively* unpredictable differences in subsequent states. My question is to what extent historical macro-outcomes hinge on small events: can tiny differences make a big difference to historical outcomes? Is history a non-linear system?

At this point it is useful to disentangle several related concepts that lie at the core of this examination. As Lewin (1993) points out, "there is tremendous scope for confusion over terms like chaos and complexity".

A dynamical system is one that is time dependent; put a little more formally, we need to include a variable *t* to represent different *states* of the system at different times. The system can be described mathematically so that the state at *t+1* follows from state t according to some equation (or equations). It might seem uncontroversial to the point of banal to say that complex systems are time-dependent, but time is often the forgotten variable in descriptions of complicated systems. Descriptions of psychological processes, for example, are often simplified by omitting time and by treating psychological processes as static systems. It's hard to imagine treating history as a static system, but any account that treats history as a snapshot or even series of unrelated snapshots could be said to be doing so. In history, we can say that the cause is what determines the state of the system at *t+1* given its state at the prior time *t*. We also need to remember that we need to make an arbitrary decision about the size of the time slice captured by *t*, and with historical systems the choice can have important consequences. Clearly the smaller the time slice the more often the system needs to be updated[1]. My first argument is that we can learn important lessons about the nature of patterns of causality in history by conceptualising it as a dynamical system.

A non-linear system is one whose output is not proportional to its input. A very simple real-life example of a non-linear system is a pile of sand. We can keep adding single grains of sand and the pile just keeps getting larger and larger; these additions of grains have linear effects. But then one more grain and there's suddenly an avalanche; that grain has had a non-linear effect. The change in state from *t* to *t+1* with this grain is said to be *catastrophic*. Note that although the system is fully deterministic, and we know that at some point adding a further grain of sand will cause the pile to collapse, exactly which grain of sand causes the catastrophe is essentially unpredictable. What's more, the avalanches are of varying sizes, distributed as a power law (Bak, Tang & Wiesen-

[1] I have spent some time worrying about what is meant by time in history. Of course when describing historical systems several different time scales may be applicable. It doesn't make much sense to talk about individual years in geological time, or individual days in prehistory, but when we get to historic time days, hours, minutes, and even seconds can take on a critical aspect. The difference between living and dying, and hence the course of future history, might be a fraction of a second in battle or fleeing a natural disaster.

feld, 1987). The parallels with historical systems here are I think obvious. Buchanan (2000) points to the ubiquity of the power law in natural and historical systems. For example, the distribution of the number of deaths in wars plotted against the number of conflicts fits a near-perfect power law: every time you double the number of deaths in a conflict, wars of that size are four times less common (Buchanan, 2000; Richardson, 1960).

A *complex system* is a system whose properties are not apparent from the properties of its constituent parts; or, as defined by an editorial in *Science* in a special issue in April 1999, "one whose properties are not fully explained by an understanding of it component parts". Complex systems are often said to lie "at the edge of chaos". A *chaotic system* is one where the dynamics of the system are extremely sensitive to the initial conditions, or more generally to the conditions at time *t*. In effect in a chaotic system the behaviour at time *t+1* appears random relative to the state at *t*. (Strictly speaking a function has to meet three conditions to be mathematically chaotic: simplifying somewhat, it has to be sensitive to initial conditions, there has to be a very large number of possible outcomes, and the system cannot become trapped in the same small neighbourhood of outcomes for ever; see Ward, 2002, for a more detailed review). There is then a relation between complexity, chaos, and time, and although we might not agree about how exactly the terms are used, there is some understanding of how these things work.

Note that chaotic systems can arise from deceptively simple conditions. The logistic map function is an example of a recurrence relation where each term of the sequence is defined by the preceding terms, and can be used to model aspects of population growth:

$$X(t+1) = n * x(t) * (1-x(t))$$

The logistic map produces a new output at *t+1* iteratively as a function of *x* at time *t*. The value of n, called the *growth factor*, has curious effects on the value of *x* over time. When *n* is between 0 and 1, the value of *x* declines towards zero (another way of putting it is that the population tends to die out over time). When n is between 1 and 2 the value quickly stabilises on *(n-1)/n*, and when *n* is between 2 and 3 the population also stabilises on *(n-1)/n* but oscillating around that value for some time. When *n* is between 3 and 3.45 (approximately), the population oscillates around two values for ever - these values are called *attractors*. Beyond 3,54, the number of attractors doubles as r increases, with 8, 16, 32 attractors, and so on. Around 3.57 the behaviour starts to become very unpredictable, although with some islands of periodicity and stability. But when $3.86<n<4$, the values of x over time are completely chaotic - although of course they are also completely deterministic. Beyond 4 the values leave the range [0,1] and become divergent (see Spivey, 2007, for more detail). Here very slight differences in the initial value of x lead to large and completely unpredictable differences in subsequent values as the function is iterated over time. It is worth reiterating that this function is however completely deterministic.

Modelling history

"No snowflake in an avalanche ever feels responsible" (Voltaire).

Well before this point I suspect the average historian will have at best said to themselves "this is all jolly interesting, but what have equations got to do with history?". The behaviour of a historical system is so complex that it would appear to be ridiculous to attempt to reduce the pattern of events over time to any number of equations. At running the risk of stating the obvious, human history is so large, and affected by so many factors, that description in terms of even a tractably moderate number of nonlinear functions is utterly impossible[2]. But another problem with human history is that it involves more than humans: even if we had a way of modelling human history in a tractable way, we would be foolish to restrict ourselves in this way: we would ignore the physical world at our peril. The availability and distribution of natural resources, the climate, and geographical features, have of course all had an enormous influence on our development (see Diamond, 1997, for a detailed discussion), and will continue to do so, particularly with climate change, possible water shortages, and the dwindling of resources, particularly oil. Any comprehensive model of history would need to include a representation of such physical features. Natural disasters have had a profound effect on our history; one only has to think of the effects of the Black Death in the mid-fourteenth century, which, in killing approximately a third of Europe's population, was arguably a prime cause of the collapse of the feudal system. A large meteorite could cause a catastrophe with very little warning; a major earthquake could destroy a major city; a volcanic eruption could cause sudden and profound global cooling; the Cumbre Vieja volcano on La Palma might collapse and send a catastrophic tsunami across the Atlantic; these have all happened before, and are likely to happen again,

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[2] There have of course been some very large-scale simulations, among the best known of which is the study of increasing population and dwindling resources by the Club of Rome, e.g. Meadows, Randers, & Meadows (2004), but these are "toy" simulations - a term not intended to be derogatory - compared with the scale of human history.

eventually on a very large scale indeed. Such events are by their nature rare and largely unpredictable (although disasters follow a power law distribution if their magnitude is plotted against frequency), but could have significant effects on the course of history. And it perhaps goes without saying that we might yet see major conflicts over oil and water.

It is therefore clearly futile to attempt to model history with a view to predicting future events or giving a detailed explanation of why things have happened as they did. Psychologists would flail helplessly around trying to explain or the predict the behaviour of a single individual, and with history we are dealing with a system of billions of individuals. Attempts to predict the future history seem doomed to failure. Individual attempts to forecast the future are generally risible; one only has to consider the failure of most economists to predict the recent “credit crunch”. Books with titles including phrases such as “the end of history” (Fukuyama, 1992) soon met with widespread (but rather unfair) criticism. It’s known that groups of people can fare rather better in detecting patterns and predicting aspects of the future - the *wisdom-of-the-crowd effect* (Surowiecki, 2004). It’s also the case that while we cannot predict with any certainty what an individual might do, we can predict with some confidence the likely average behaviour of a group: for example, the suicide rate remains constant at around 32,000 a year in the USA (Smail, 2008). Nevertheless, such attempts are limited in their success; the mass wisdom of the world’s financial markets completely failed to predict war before or in 1914, showing no anxiety until late July (Ferguson, 2008, p. 298), and statistical averages are the *result* of historical processes, not the cause.

What then could possibly be gained by attempting to model history? My answer is that it provides a clearer understanding of the sorts of processes involved in historic change, and the restrictions (if there are any) on the sorts of causes that lead to different outcomes. Is there any lawfulness in history, or is the unfolding of events completely chaotic? Does it even make sense to talk of searching for causes of how things have come to be? These are the types of profound questions that a dynamical systems approach can illuminate (see also Axelrod & Bennett, 1993; Ball, 2004; Buchanan, 2000).

Properties of chaotic systems

"Hegel was right when he said that we learn from history that man can never learn anything from history" (George Bernard Shaw).

Are there any means of distinguishing inertial from chaotic systems? Are there any reasons to suppose that the sort of thing we call history is sensitive to the initial conditions?

Chaotic systems are those which are very sensitive to initial conditions such that small differences in the current state can lead to very large differences in subsequent trajectories through state space. As we have seen with the logistic map, chaotic systems can arise from deceptively simple equations, although they must be non-linear. So the question becomes: what characterises stable, inertial systems from chaotic ones? Unfortunately there is no easy answer to this question. In the case of historical systems the situation is complicated further by our great difficulty in conceptualising history mathematically, as I noted above. Simply to reduce historical processes to a position where we can discuss them meaningfully in these sorts of terms simplifies extensively and introduces assumptions that some historians may not find acceptable.

Nevertheless, given the complexity of the historical system, it is clearly partly chaotic. The few examples of personal history (I get killed in that crash) and global history (Princip has a sandwich or doesn't and the Archduke dies or lives) shows that locally the system is at least partly chaotic. Small changes in the current state can lead to unpredictable outcomes later. History is also non-linear: certain small events can have disproportionately large consequences (one mouthful nothing happens, another nothing happens, another ... the Archduke stops in front of you). The interesting question is how chaotic is the system at the macro-level. Do the chaotic effects soon die out, with the inertia of the system taking over? In this case it does make sense to talk about laws and causes in history. Or do they instantly change the future? In which case it makes far less, if any, sense to talk about historical laws and causes.

The "chaotic landscape" view of history

"Men are reluctant to believe that great events have small causes" (A.J.P. Taylor).

Although the Bradbury view of history whereby one dead insect can change history is a charming one, there is something implausible about it. While we could doubtless envisage fantastic scenarios where the future might hinge on such things, almost certainly it won't in fact matter. Indeed, many, probably most, events are not critical in the sense that if they happen or not, the future will soon carry on as it would have done. Whether I have grapes or cherries for breakfast is a local difference, but globally the course of my life resumes, and most of the time for the wider, global system small differences have no consequences at all - most of the time. Sadly, even if I die tomorrow, the course of world history will *probably* continue largely unchanged. Personal and global history is mostly linear.

At first sight there appears to be a paradox here: on the one hand the flap of a butterfly's wings could start a hurricane across the globe, on the other whether I live or die might not matter at all. The key of course are these words "could" and "might". The system might be sensitive to initial conditions, but not always. Clearly then some events are more critical than others. In addition, some outcomes are more likely than others. It is well known that some configurations are more stable than others, and that some patterns of alliance between countries and other groups are more likely (e.g. Axelrod & Bennett, 1993, Ball, 2004).

How can we steer a path between total chaos and total inertia? And how can we begin to formalise the concepts necessary to understand group (and indeed individual) history? I believe the key is to view history as a *temporal dynamics system* and to introduce the notion of a *historical attractor*.

This approach combines two related notions: chaos and attractors. To introduce the overall idea, it's useful to begin with an analogy. Let's think of the space of possible outcome of history, of what's going to happen next, as a landscape, with mountains, hills, valleys, and gorges. Suppose we're parachuted into this landscape from on high. We touch the ground, and start rolling, and let ourselves carry on rolling. (Not recommended practice, I know, and it could be painful, but let's ignore that.) What will happen? We'll roll to the lowest point in our vicinity. If we land near the bottom of a steep valley, it won't take us long at all; if we land near the top of a hill that gently slopes down to a wide, shallow valley, it will take us some considerable time to roll to the bottom. But roll to the bottom of the valley we will. Note that the valley bottom to which we roll will not be the lowest in the landscape (unless by chance we happen to have luckily parachuted onto the slopes of that particular valley); it will be the bottom of our local valley. This idea of a local minimum is an important one (Axelrod & Bennett, 1993).

In dynamical systems theories these valley bottoms, the points to which things in local space will gravitate, are called *attractors*. Attractors are in fact defined in multi-dimensional space, with the dimensions of the space defined by the number of units at that level of representation, a point to which I shall return, but for historical systems the number of dimensions will be enormous. The space can have one or many attractors: it can be described as one large valley, or two or more valleys. In every case the attractor to which you're attracted depends on the current configuration of the state space. It's important to note that attractors can vary in size: some might be very large, covering a relatively large area of the landscape, or very small. We can think of these as corresponding to a very large valley having a large drainage basin, or smaller ones which cover a smaller area. Obviously if you're parachuted at random into a landscape with many attractors, you're more likely to end up in the larger basin, but not necessarily so. More strictly, the probability of to which attractor you fall is a function of the relative sizes of the attractors in that landscape. Different attractors can have walls of different slopes, too, just as in a real landscape some valleys are shallow and some steep. The steepness of the attractor wall defines how quickly you as parachutist will reach the bottom of the valley (the attractor); you'll roll more steeply down a steep mountain slope than down a gentle broad hill.

In terms of historical systems, attractors are historical outcomes. The Great War was an attractor, and probably one with a very large valley; many but not necessary all events would have taken us to the attractor of devastating global conflict and what followed. The Great War with Britain standing against Germany was one attractor; the Great War with Britain standing aside another. Certain outcomes may be very likely whatever the starting conditions. The War was very likely, or at least probable at that time, but not a certainty.

The next step involves deviating from the comfortable reality of our landscape analogy. Or rather, while the geographical landscapes with which we are familiar are relatively stable, changing mostly imperceptibly in geological time, the topography of the historical attractor landscape is rapidly changing, perhaps chaotically so, evolving from time slice to time slice. We have landscape in rapid and constant motion - sometimes. Even the rate of change of our landscape between time steps is unpredictable: sometimes it is as though we're moving in geological time and the landscape hardly changes at all, but at other times as though there's tectonic upheaval replete with earthquakes and massive volcanoes appearing each moment. It seems unlikely that whether you or I have a sandwich now or in five minutes is going to make much difference to anything, particularly global events (although in Princip's case it of course did). Both some events and some time periods are more critical than others. And some events are clearly going to have large effects. Most local effects don't perturb the landscape too much, but some might. So while there is persistence in the historical landscape, it can change dramatically from time to time.

So we conceptualise history as an ever-changing attractor landscape. As events unfurl, the historical state space changes. Events move us stochastically through the changing landscape: even the chaos isn't stable. Nevertheless, there are attractors, but their size and stability vary and change, sometimes rapidly.

It is likely that in common with many other phenomena the frequency of occurrence of events of different magnitude is not random, but can be described by a power law, so that there is a linear relationship between the logarithm of the frequency and the logarithm of the magnitude of the event. The power-law relationship says far more than events with big consequences happen less often than events with small consequences; the relation is far more precise, so that, for example, events that are twice as big happen a quarter as many times as the smaller event (depending on the slope of the line). Power laws characterise many physical and biological systems with properties similar to those of the historical system in the way I have been describing it - self-organising systems.

It should be noted that the landscape analogy involves a three-dimensional space that evolves through time, both with the changing of the landscape and the movement of things through it. The historical system is multi-dimensional; staggeringly so. Indeed, one of the challenges of this approach is to decide what are the appropriate units that describe the multi-dimensional space that in turn captures the system. What are the basic units of history? Events? Time slices? Properties of humanity? There are no obvious answers to this problem. As I have mentioned, even trying to characterise time in a historical context is difficult, and the same difficulty is apparent in trying to define an event.

Experiments in history

"I've never tried to block out the memories of the past … everything you live through helps to make you the person you are now" (Sophia Loren).

Unfortunately we can't experiment directly with history. We can't rerun events and see what happens if Princip sits down for his hearty Wiener Schnitzel, or if Operation Sea Lion had proceeded and Hitler had tried to invade Britain in the autumn of 1940. In consequence it is impossible to distinguish between the chaotic and inertial views of history experimentally. Nevertheless we might be able to obtain some insight into the robustness of historical unfolding using computational modelling. We might not be able to experiment with history, but we can model it.

Modelling has the great virtue that it forces us to be completely explicit about our assumptions. Many of the ideas I've described above should be clear when we create models. Of course it is impossible to model history, but we can play with toy worlds to get a feel for the robustness of historical attractor landscapes. Let me reiterate that I am aware that any attempt to model real-world historical systems will involve an enormous degree of simplification. My claim though is that this simplification will not cause us to lose any of the principles of interest.

The problem with modelling history is that it is modelling in a vacuum. Unlike psychological phenomena, where we can test our models against rich data sets and make predictions about future behaviour, history is nor amenable to this sort of reductionist approach. The first problem lies in the difficulty of reducing the complexity of the historical system in any lawful way in terms of the length of time and the number of variables in the system. The second problem is that even if we could reduce the complexity lawfully we would be very circumscribed in the sorts of predictions we could make. History is a one off. The Great War either started in August 1914 or it didn't. We can't try different configurations and see what happens; history is what we see. We can't in reality go back and start again with slightly different starting conditions and see what happens; but we could get some idea of what might happen with a suitable mode,

These limitations unfortunately imposed by reality lead to a lack of verifiability and falsifiability, the consequence of which is that History is not, and never can be, a science, even though modelling might cast brilliant light on the sorts of mechanisms operative as events unfurl. This statement is not to say that history is inferior to science, or that academics who pursue history are in some way inferior to scientists! However, the types of approach open to historians are circumscribed - not just in practice, but in principle.

Conclusion

"No one in the history of the world ever washed a rented car" (Laurence Summers).

Would the Great War have still happened if Gustav Princip hadn't stopped outside Moritz Schiller's delicatessen just as the Archduke's car happened to reverse in front of him, or if any of the diplomatic and communication blunders detailed by Ponting (2003) had been avoided? Probably, yes, because the circumstances at the time - the ethnic tensions, the large militarised states engaged in an arms race, the lack of efficient diplomatic channels, and the legacy of recent conflicts had led to an unstable system where European conflict was a massive attractor. But events might have led to the attractor being avoided in 1914, only for a different attractor (a Russian attack on Germany perhaps) to develop a few years later.

Are there "laws of history"? If a system is truly chaotic does it make sense to talk of causes? As ever the truth lies between the ends of a false dichotomy. I have argued that the dynamic attractor landscape model suggests that history is a blend of chaos and inertia, so it does indeed make sense to talk of historical laws - not just accidents. A law is a configuration of events that leads to a relatively stable, large attractor over time. So the configuration that led to the Great War is amenable to a lawful analysis.

What do dynamic attractors buy us? Are they anything more than a trivial redescription of the data? Yes, they are much more. First, they give us a vocabulary to describe unfolding history in terms of probability and causes. We can talk in terms of causes and probabilities. Second, they are amenable to a mathematical and computational analysis. We can really see what would have happened.

Finally, what applies on the world stage, macrohistory, also applies on the individual, microhistory. How affected are we by the past? Would we have been totally different people if we had had baked beans instead of Brussel sprouts on our fifth birthday? The same concepts apply when thinking about microhistory. Although the scale is smaller, the complexity is still staggering. We have bifurcation points, where chaos reigns; slight changes in what happens lead to enormous changes in one's life. Half a second earlier or later and that fatal crash would never have happened. If I had not gone to a particular place at a particular time, I would not have met my wife. We can see these personal events stretching before us as a moment by moment, ever-changing chaotic landscape. On the other hand, it is likely that regardless of the many possible trajectories, I would still have become a scientist of some sort, and with lower but nevertheless still high probability, still become a psychologist, along many of them. Hence these outcomes are attractors for me. As with history, attractors change as we move along the bifurcating paths of the dynamic chaotic landscape, but some loom large and remain relatively stable over time. Dynamic attractors are an exceptional useful tool for thinking about historical processes, and the study of history could learn much from the study of the psychology of the individual.

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