The Fabric of History

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Introduction

The Arrow of Time may remain an unsettled question for astronomers and physicists, but not for historians: the progress of time is a given in the history of the universe.

As the universe expanded from the big bang into the current known world, all galaxies, stars, and planets followed their own historical timelines. Most of this history is unknown to us. Because of proximity, we have a better grasp of the history of the sun, its planetary system, and the earth.

Scientific theory, backed up by evidence, tells us how and when earth formed from a gas into a solid planet. From that moment on, every ocean, continent, mountain, valley, lake, and river followed its uncharted path forward in time.

When earth turned from a lifeless rock into a life-sustaining planet, life itself started an evolutionary avalanche that created millions of species and billions of animals and plants. Each of these sprung to life, lived, and died. Some left a fossil record and, with it, evidence for scientific research by humans, themselves products of this evolutionary path.

Humans do not just follow their path, they create it. Together, they created families, tribes, settlements, villages, cities, countries, and civilizations. Every human, every social structure has a timeline. Every building, every street, every infrastructure, every technology, every machine, every gadget, every art form, and every piece of art has a timeline.

Every timeline of every entity tells the story of the origins of the entity, its existence, its demise, and its continuing influence thereafter.

Imagine every timeline to be a thread with knots symbolizing significant events along that timeline. Every event connects entities involved in that event, symbolized by the knot tying together threads. When two people meet at a certain time and place, their timelines and the timeline of that place all connect at that time: three threads knotted together.

History is the multidimensional fabric woven by these threads.

Our goal is to give shape to this intuition. We hope to show that recording history in a formalized manner can reduce the time-consuming complexity of historical research. We hope to develop tools that narrow down ambiguities in the historical record, that find and correct errors, and that assist in evaluating contradictory claims.

What follows is a proposal for an interdisciplinary research program that makes this possible. Every section is a significant project.

Time

Time is a rigid measure in a sea of malleable data. If our goal is to create an accurate historical record and to analyze complex historical questions, we cannot take any shortcuts in the description of time.

A comprehensive system of history must be be able to convert any calendar and any time system every used into the currently accepted de facto standards, the Gregorian calendar and the Coordinated Universal Time (UTC). For most uses, this is adequate.

Sometimes, it is necessary to go back to first principles: astronomy. The rotation of the earth defines the length of a day. The lunar cycle defines months. The solar cycle defines years. When historical texts, illustrations, and art works describe astronomical configurations and phenomena, they give us time. For example, in 1985, Boime was able to compute when Van Gogh painted Starry Night by matching astronomical data to the night sky of the famous painting. Ancient civilizations provide accurate time markers when they leave behind astronomical observations. We should make it easier to use this information by providing access to astronomical data and useful algorithms.

There is also a need for the reverse: Given a location, day, and time, where was the sun, the moon, the planets, the stars? These are the kind of details that false witnesses often get wrong. Easy access to astronomical information can be used to invalidate false and misleading historical accounts.

Finally, astronomy is crucial when recording the history of space exploration. We have had countless space missions, including one outside our solar system (NASA’s Voyager 1).

Location

We also have a de facto international standard to specify the Location of a point on earth: a system of coordinates anchored at Greenwich (longitude 0), the equator (latitude 0), and sea level (altitude 0). We need to make it easy to convert any other Location specification into the standard and vice versa.

Considering that we already witnessed several moon and mars landings, we should be open to non-earth-centric systems of specifying location. We cannot properly record the history of space exploration without the ability to specify the locations of moon and mars landings, and without the ability to describe the trajectory of space ships.

Entities, Events, and Timelines

This section starts the process of defining the Fabric of History. It is tempting to use a notation like BNF [Backus-Naur Form], as if we were describing the syntax of a computer language. While a formal language for recording and analyzing history would be a remarkable achievement, it is not clear that is feasible. For now, we adopt a decidedly informal approach.

Entity

Humans are the primary agents of history. In the Fabric of History, they are described as an Entity of the type Person. In conventional databases, a Person would consist of a set of attributes, like name, birthday, sex, parents,... Here, these data elements and many more are available in a Person's Timeline (see below), which is more comprehensive than any set of attributes. Yet, attributes do allow for quick access to frequently used data without a search through a Timeline. So, we are open to attach a few attributes to any Entity.

People are organized in families, tribes, organizations, and governments, and such groups are agents of history in their own right. Each of these groups may be sufficiently different to need their own specific type of Entity.

A place seems too passive to be an agent of history. However, there are countless examples of places that have influenced history. In a philosophical debate, we might argue that it is the people who changed the history; they just happened to be bound by a place. But this is about the development of a practical framework for recording history. From city halls to the White House and the Kremlin, from the Lincoln reflecting pool to the Taj Mahal, from villages to cities and countries, from rivers to mountains, from lakes to seas, there is no doubt that places can have their own significant story, distinct from the people who built, inhabited, and visited them. It is safe to assume that each kind of place may need its own type.

A Place is more than a Location. A Place, like a city, for example, may grow and shrink, its civic, economic, and entertainment centers may move. We can capture this complexity and dynamism by creating an Entity with a Timeline (see below). We may store some frequently used data in attributes instead of completely relying on the Timeline.

Of course, Place and Location are concepts that are intimately tied. Location is a point defined by a coordinate system, which is precise and amenable to computation. A first draft of a Place Entity might consist of the Location of its center and an approximate size. The precise

boundaries of a Place, say the boundaries of a city or a country, change over time, which can be captured in Events on the TImeline of the Entity (see below).

We must be prepared for significant ambiguity in the data. For example, a city may be surrounded by a large metropolitan area. “Los Angeles” may refer to the city itself, to the county, or to a geographical area. We must also be prepared for inconsistency. Different historical sources adhere to different definitions, conventions, standards.

There is no hard limit to the number of Entity types we might consider. For example, buildings, books, works of art, and technology all have changed the world and are worthy of their own Entity types.

Event

An Event has a Start and End Time, a list of relevant Entities, and a Description of the Event.

For example, when two people meet at a coffee shop, the Event is described by its Start and End Times, three Entities (2 Persons, 1 Place), and a Description of what took place (“they had a coffee and talked”).

To manage the vast amount of data, we need tools that automate the process of extracting Events from books, papers, and other historical material. These tools should use the larger context of the source material to uniquely identify Persons and Places. Times and Locations should include an indication of their uncertainty (error bars/intervals).

The Description of the Event should point to the original source of the information, the original text supplemented with any additional analysis and insight. The Description may also include visual information, videos, photos, paintings, maps, etc.

Timeline

A Timeline is a time-ordered sequence of Events related to one Entity.

The Timeline of an Entity is its history, a sequence of Events involving that Entity. For Persons, it is their personal history from birth to death. For a Group, it is the history of its growth and demise, its gains and loss of power, its membership, etc.

When an Event is added to Fabric, it affects the Timeline of all Entities involved in the Event. For every such Entity, we insert the Event at the appropriate time in the Timeline. When adding an Event, we may discover new inconsistencies and/or contradictions, which need to be flagged or, preferably, resolved.

Filtering Information

Historical research is stressed by two competing forces. On the one hand, we must gather as much historical information as possible. On the other, we need to filter out false information. Here, we examine two methods to filter information.

Constraints

Every Entity and its Timeline is subject to constraints, and the constraints depend on the type of Entity.

For example, a Person involved in two Events at two different Places needs time to travel. Travel time is subject to high uncertainty. Yet, it is possible to make reasonable estimates about the minimum time required to travel from A to B. This time depends on the transportation available in the area at that point in history, on the wealth of the Person, and on the age and health of the Person. If records are available, even the weather at the time might be a consideration.

A Person is born, lives, and dies. As a Person grows up, they evolve from total dependence on others, to independence, and perhaps back to dependence. Each stage of life comes with its own constraints. A Person's Timeline may even continue after death, as their body may be subject to investigation as a result of crime, controversy, and/or reverence.

Constraints are a tool to discover inaccuracies, contradictions, errors, and lies. We must develop constraints for every type of Entity and apply them to the historical record. This requires developing an effective representation of constraints.

Bad Actors

Any crowd-sourced system is vulnerable to incompetence and vandalism. The historical record is also target of people who want to manipulate it in furtherance of political goals. Submitted content must should pass several levels of quality control, from automated screening to crowd-sourced refereeing. All content should contain identifying information of the user and/or organization that submitted it. When bad actors are identified, appropriate action must be taken, from walling off their information to banning them from the system and removing all the information they submitted. The quality-control processes are also targets for manipulation and vandalism.

Using the Fabric of History

Fabric is not just storage of historical information. It is meant to be used.

Custom Filtering

History is not science. The evaluation of information is subject to judgment. Users should be able to filter information according to their subjective judgment. They might filter out Events extracted from particular sources or submitted by particular users.

This would be useful for testing hypotheses. For example, if filtering out a historical source clears up a disproportionate number of contradictions, it might be a suspect source or it might be a source suppressed by the established power structures of the era. (A test can help inform a historian, it cannot replace a historian's judgment.)

Private Information

When discovering a potential new source, a historian (or group of historians) should be able to submit the information from this source to Fabric without having to share it with the world. This feature can be used to conduct initial analysis and to assess its value.

Reverse Engineering an Event

Any important Event is preceded by many other Events. To reverse engineer an Event, we would travel backwards in time on the Timelines of all Entities directly involved in the Event. As we identify key preceding Events, we recursively reverse engineer those Events as well. In doing so, we can map a comprehensive history of all Entities and all Events that contributed essential elements.

Visualizing History

Fabric is complex, because history is complex. We need tools to visualize Fabric and to help us find relevant information in the morass of complexity.

Zooming in on Individual Timelines draws attention to every detail. Zooming out lets us connect Events and Entities separated in time and space. We may map how a Person moves from Event to Event, from Place to Place, throughout their life. We may sit at the corner of a street and watch the world evolve over centuries.

Other visualization tools may compare and contrast the Timelines of two or more Entities.

Telling the Story

Historians are storytellers. Stories make historical facts and figures come alive. They provide context and interpretation. They make history relevant to current readers.

Fabric provides the infrastructure to assemble and analyze historical facts. Fabric also provides the infrastructure to construct stories. Think of the storyteller as a drone hovering over Fabric's Timelines. The drone can fly high and report on major movements. It can fly low and observe up close the Events on the Timeline of one Entity. It can switch from one Timeline to another when the action demands it. This is the story editor at work.

Conclusion

History is complex. With Fabric, we recognize that this complexity is built from elementary, less complex, building blocks: Timelines consisting of Events. These structure can collect a massive amount of unstructured data. As data technology evolves, Fabric's data will get increasingly more useful.

Each of sections and subsections above is a challenging research project. When researching these projects, it is important to keep this in mind: To be useful, Fabric must be used by many people who are willing to contribute time and effort to contribute data. We know people will do this if the system solves hard problems. Fabric must go beyond current requirements and provide what current infrastructure cannot.