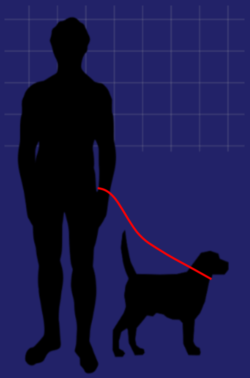
Humanities, Science, Scimat

Chapter 5

History



Lui Lam

History the Word

- In Greek, *Histo*: a learned man who settled legal dispute.
- *Historie*: a search for the rational explanation and understanding of phenomena.
- 5th century B.C.: Herodotus and Thucydides create the writing of history using *historie* techniques.
- *Historiography*: the writing of history.
- *Clio*: Greek muse of history.

Histoire: French word for history

Clio

Why

What History Is About

The system under study:

- A many-body system
- Each "body" is a human being (a "particle" or "agent")
- Each "particle" is a classical object (not quantum mechanical), distinguishable
- A heterogeneous system (different sizes, ages,…)

Interests of historians:

- Anything happened in the past related to these particles (existing now or in the past)

It is a system of material bodies, and hence can be studied scientifically !

But how?

Advocates for History as a Science

Pioneers

• 1743-1794	**Condorcet**	Culture is governed by laws as exact as those of physics, which can be inferred by a study of past history
• 1798-1857	**Comte**	Father of sociology (named "social physics" before)

Historians

• 1821-1862	**Buckle**	Historians must emulate the natural scientists and strive to find laws governing human life
• 1828-1892	**Taine**	Borrowed models and concepts from zoology, physiology, psychology
• 1850-1901	**Adams**	Cofounder of American Historical Association, pushes for "scientific history"
• 1861-1927	**Bury**	History is simply a science, no less and no more
• 1902-1985	**Braudel**	Emphasizes social science in history

They failed to turn history into a science for lack of proper science training and tools.

History: stochastic processes—need statistical physics, etc.

Why history?

- We are curious about (almost) everything.
- We want to know what our parents, and great, great,…grand parents had done.
- We want to know where we came from, and why we end up like this.
- Knowing the past may help us to understand the present and predict the future.

“以铜为鏡，可正衣冠；
以古为鏡，可知兴替。”

《贞观正要．任贤》

Reflection from a mirror
enables us to tidy up ourselves;

Reflection on history
enables us to know the ups and downs of our time.

History Is the Most Important Discipline

History → Theory / Experiment; Basic / Applied — Just like in physics

Applied history (one of many incidents)

1975-1979 → 10^6

2 millions Cambodians killed under the Pol Pot regime

Applied physics (the only one incident)

Little boy (dropped in Hiroshima)

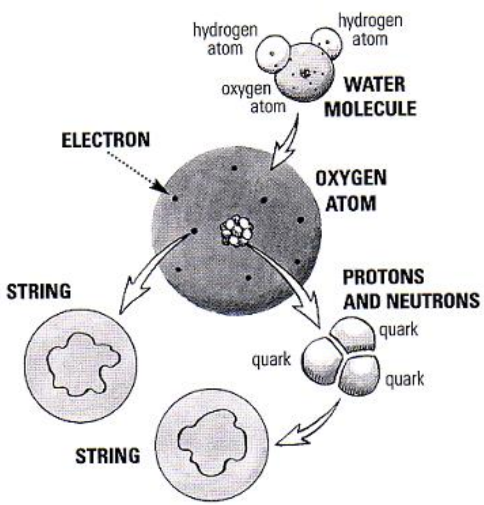
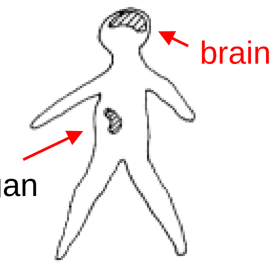
Fat man (dropped in Nagasaki)

1945+ → 10^5

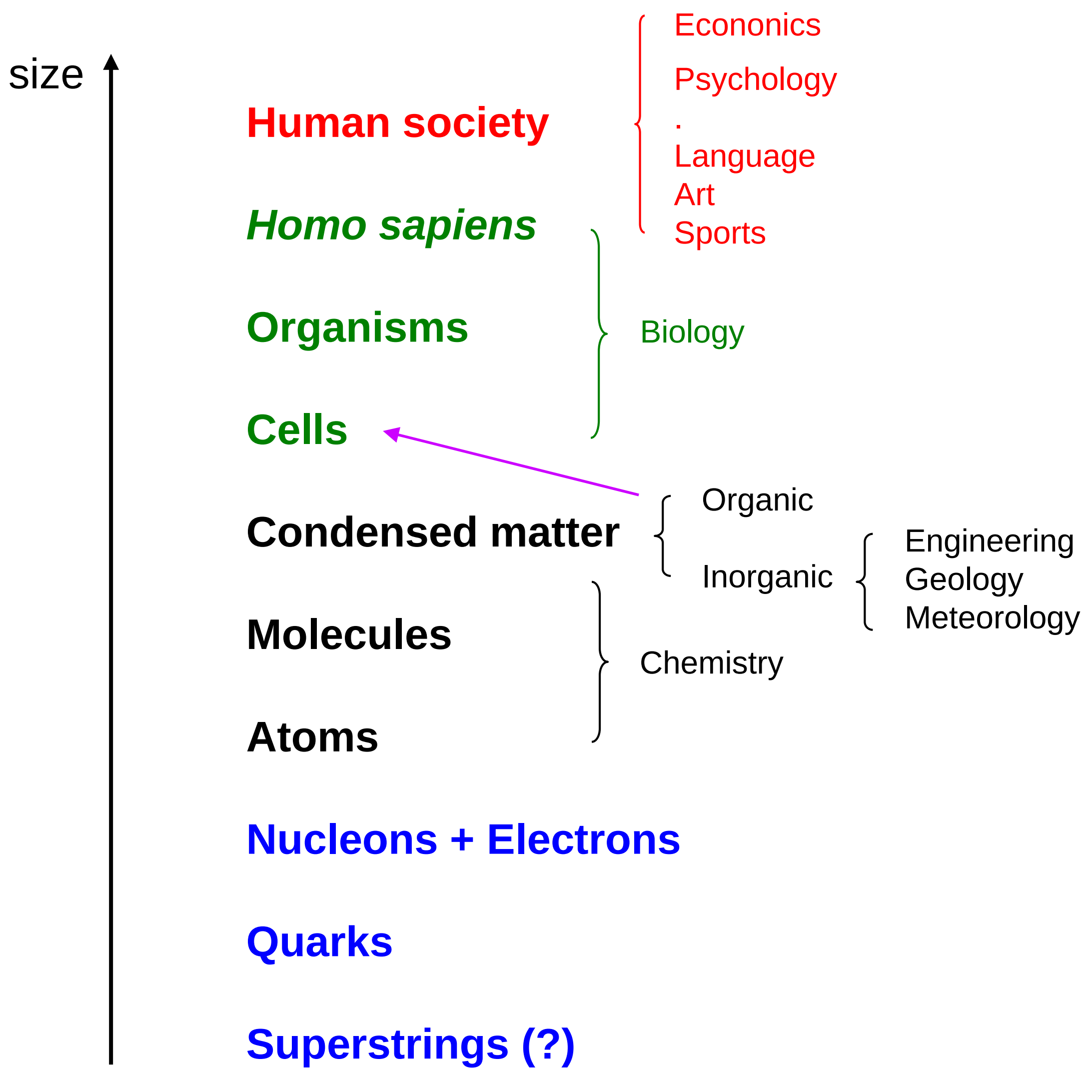
250,000 Japanese died due to 2 atomic bombs (1/2 immediately)

What

The Constituents

	Water	Human system
Name	Hydrogen oxide	*Homo sapien*
Symbol	H_2O	☺ (♀, ♂)
Single particle		 Organ ↓ Cells (10^{12} in number) ↓ (organic) Molecules (DNA, …) ↓ Atoms . . .
History	Same particle since formation (Both have history)	Same "particle" (since human nature not change in last 6000 years)
Size	~ 10^{-8} cm (quantum particle)	~ 40 – 200 cm (classical particle)

The Unity of Living and Nonliving Objects



Why Physicists Can Help

- We know how to deal with many-body systems.
  (invented statistical mechanics 100 years ago)

- We have the license to do it.
  "Physics is what physicists do." (*Physics Today*, May 1998, p.24)

- We're urged to do it.
  "The task of physics is not only to understand the hydrogen atom, but to understand the world." (A. Schawlow, Nobel laureate)

- We can read their research journals.
  (but they can't read ours)

- We have a good track record in doing interdisciplinary work.
  (e.g., biophysics, econophysics, histophysics…)

How

Three Levels of Research

		Physics (gas)	History
Empirical level	Collect data	✓	✓
	Summarize data	✓	✓
	→ empirical laws	$PV = kT$	Dynasty lifetimes, etc.
Phenomenological level		Navier-Stokes equation	Active walk, etc.
Bottom-up level		Molecular dynamics	Computer simulation

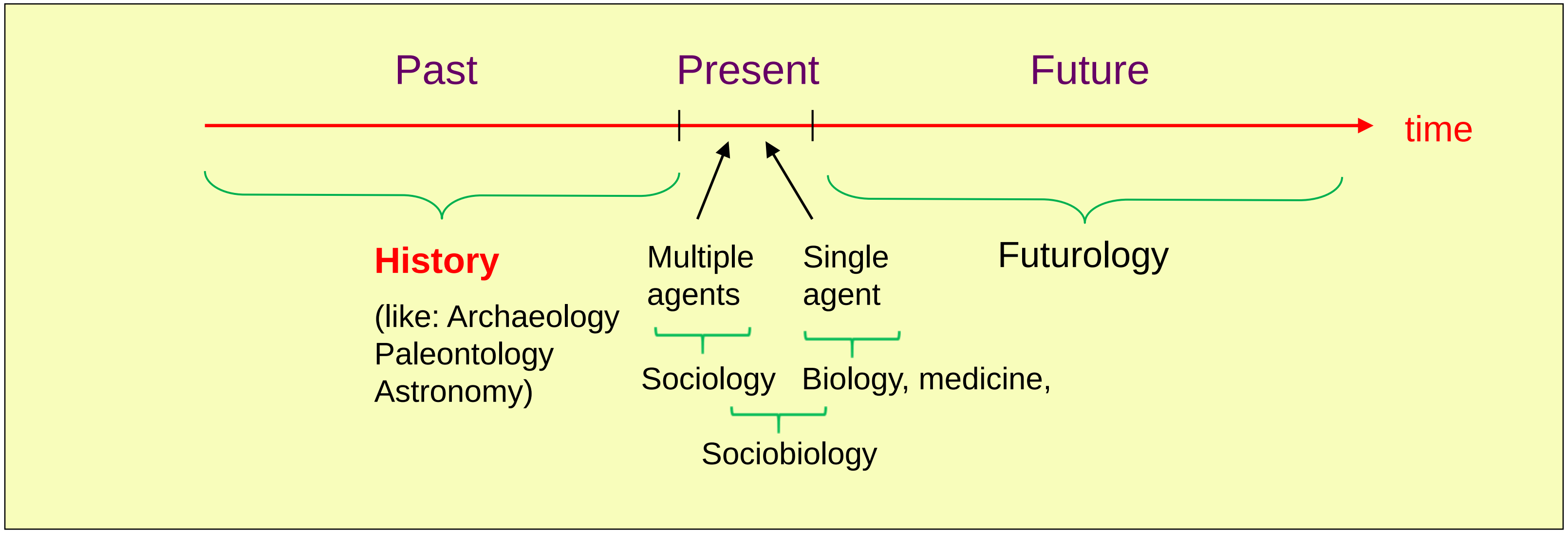
Lessons from physics research

- You don’t have to know things in detail.
- Simplify by keeping only the relevant factors.
- For a stochastic system (like history) one has to ask different questions (i.e., historians have been asking the wrong questions).

Empirical Level 1: Narrative

- The "internal state" of the brain are emphasized by Collingwood (1946, "reenacting the thoughts of historical players").

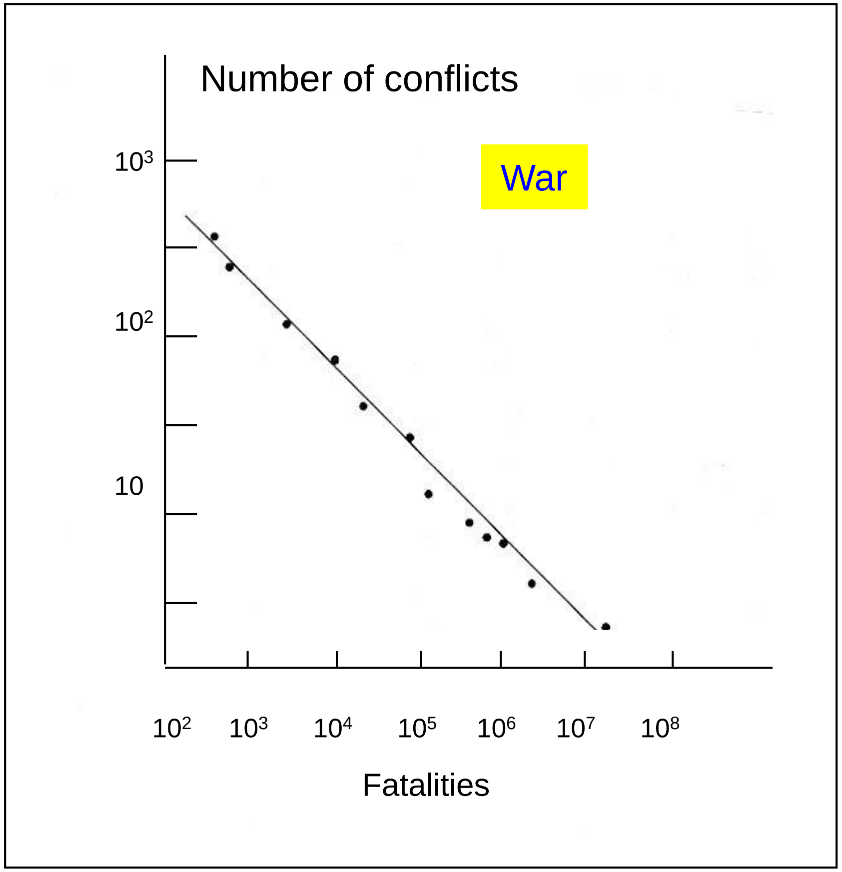
- The importance of Social Science in history is emphasized by the Annales school in France

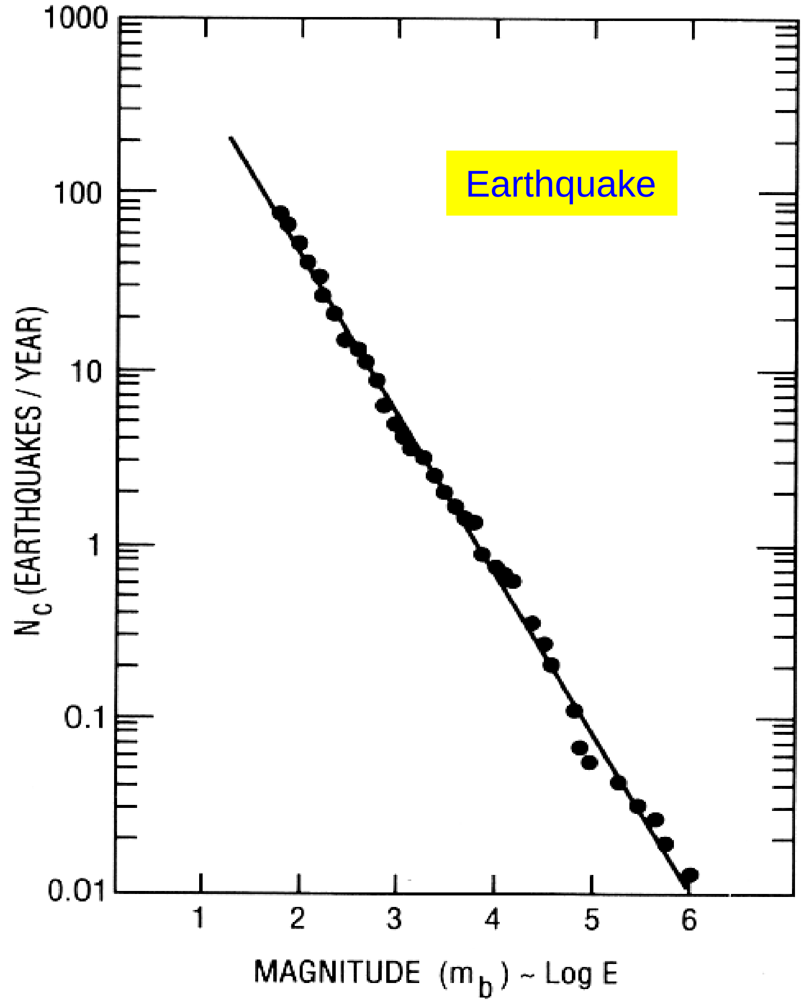


- The objectivity (in reaching the "truth") of history narratives is ruled out by White and Derrida (deconstruction → meaning of writings can't be decided).

Most are narratives, at the empirical level.

Empirical Level 2: Statistical

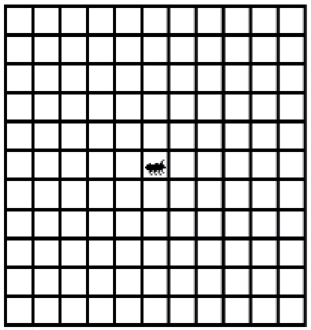


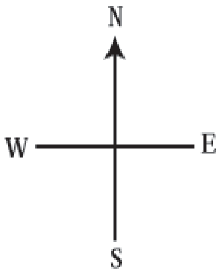


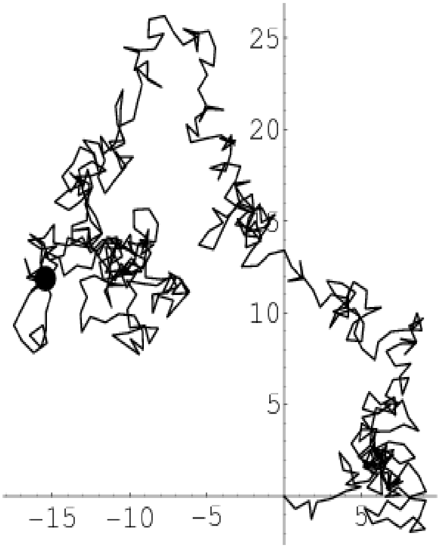
- Similar power laws found in earthquake and city populations.
- → Some human affairs share characteristics of other complex systems.

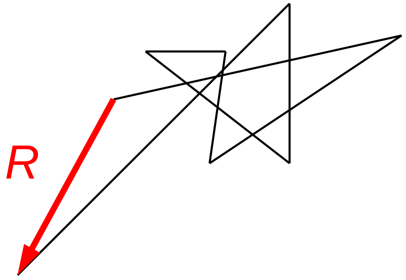
Power law: $y = A x^{b}$

Stochastic System 1: Random Walk









Louis Bachelier

Ph.D. thesis in economics (1900)

Einstein

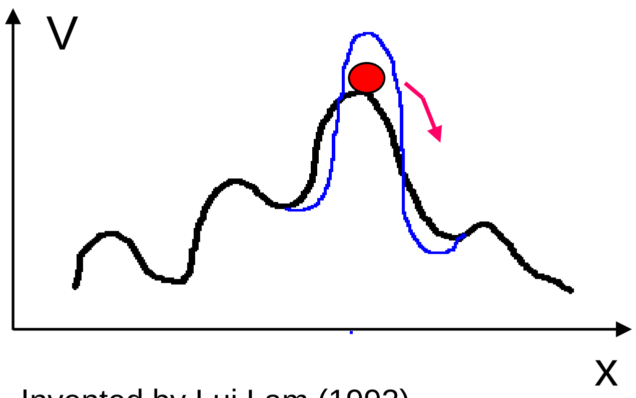
Brownian motion paper (1905)

Cannot predict actual path

But can ask, e.g.:

- What is the morphology ?
- Is it self-similar (a fractal) ?
- If yes, what is the fractal dimension ?
- How does *R* depend on time ? (Ans: $R \sim t^{1/2}$)

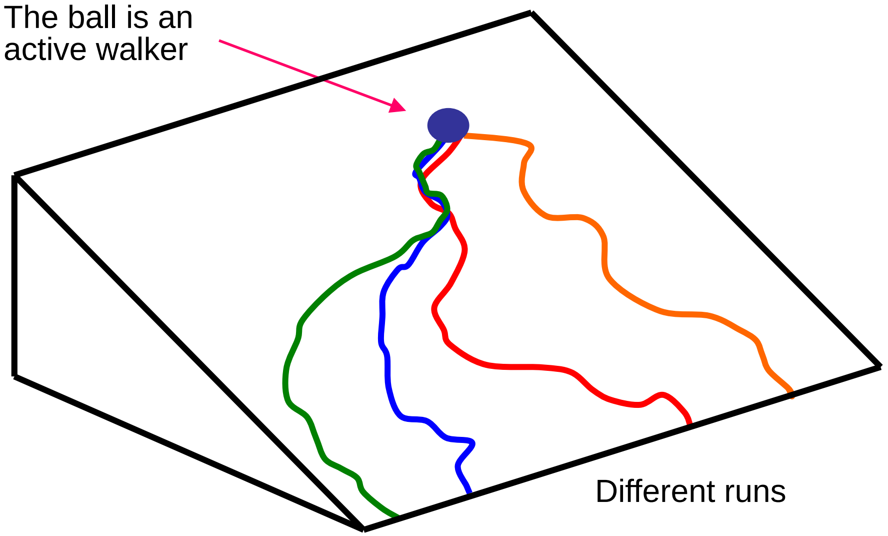
Stochastic System 2: Active Walk



Invented by Lui Lam (1992)

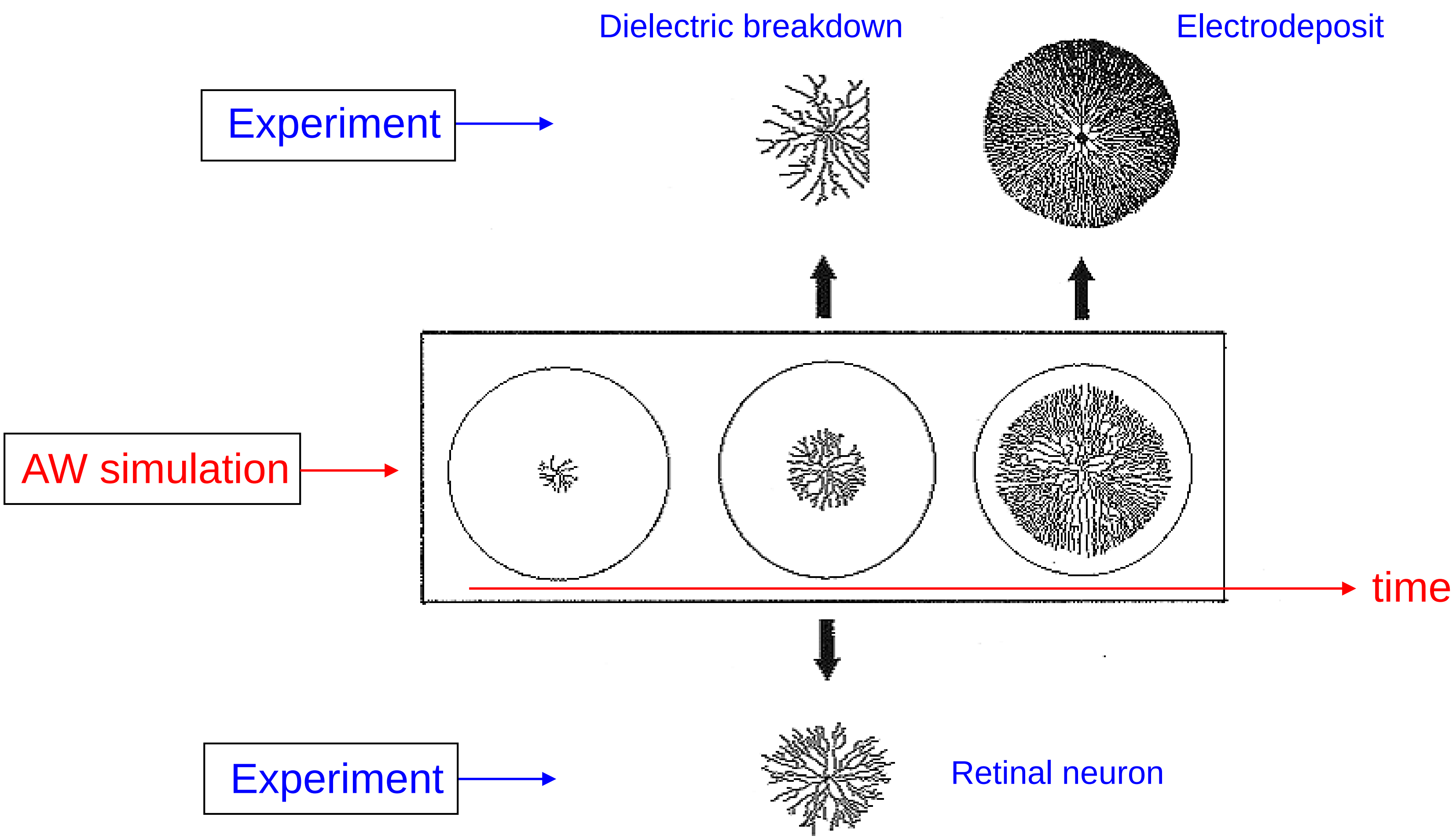
1. Landscaping rule: how the walker modifies the landscape as it walks.
2. Stepping rule: how the walker chooses its next step (which could be probabilistic).
3. Landscape's self-evolving rule: change of landscape not due to walker (e.g. external factors).

A ball running dow a deformable inclined plane



- Track of walker forms a filamentary pattern.
- (Probabilistic) AW is a history-dependent, stochastic process, so is history.
- Probability of track (scenario in history) could be predictable.
- History, resulting from a combination of chance and necessity, is best understood as active walks.

AW: Simulations vs Experiments



Histophysics

Bottom-Up Level: Simulation of Village Growth

Population growth and collapse in a multiagent model of the Kayenta Anasazi in Long House Valley

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Long House Valley in the Black Mesa area of northeastern Arizona (U.S.) was inhabited by the Kayenta Anasazi from about 1800 before Christ to about anno *Domini* 1300. These people were prehistoric ancestors of the modern Pueblo cultures of the Colorado Plateau. Paleoenvironmental research based on alluvial geomorphology, palynology, and dendroclimatology permits accurate quantitative reconstruction of annual fluctuations in potential agricultural production (kg of maize per hectare). The archaeological record of Anasazi farming groups from anno *Domini* 200-1300 provides information on a millennium of sociocultural stasis, variability, change, and adaptation. We report on a multiagent computational model of this society that closely reproduces the main features of its actual history, including population ebb and flow, changing spatial settlement patterns, and eventual rapid decline. The agents in the model are monoagriculturalists, who decide both where to situate their fields as well as the location of their settlements. Nutritional needs constrain fertility. Agent heterogeneity, difficult to model mathematically, is demonstrated to be crucial to the high fidelity of the model.

patterns and demographic behavior among subsistence-level agricultural societies in marginal habitats. Between roughly 7000 and 1000 years before Christ (B.C.), the valley was sparsely occupied, first by Paleo-Indian big game hunters and second by Archaic hunters and gatherers. The introduction of maize around 1800 B.C. initiated a long transition to a food producing economy and began the Anasazi cultural tradition (7), which persisted until the abandonment of the region around *anno Domini* (A.D.) 1300 (9). Anasazi is the term applied to a distinctive archaeological pattern and sequence that is confined to the southern Colorado Plateau and that has given rise to the cultural configurations that characterize the modern Pueblo people of the Southwest. The Anasazi pattern is defined by an emphasis on black-on-white painted ceramics, plain and textured gray cooking pottery, the development from pithouses to stone masonry and adobe pueblos, and the kiva as the principal ceremonial structure. Considerable spatial variability within the general pattern has led to the recognition of several geographic variants of Anasazi. Long House Valley falls within one of the

Fig. 1. Long House Valley, looking to the South.

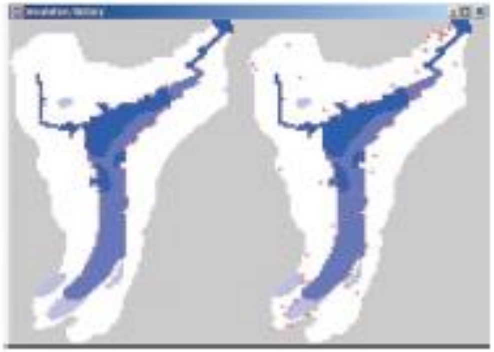


Fig. 3. Simulated and historical settlement patterns, in red, for Long House Valley in A.D. 1125. North is to the top of the page.

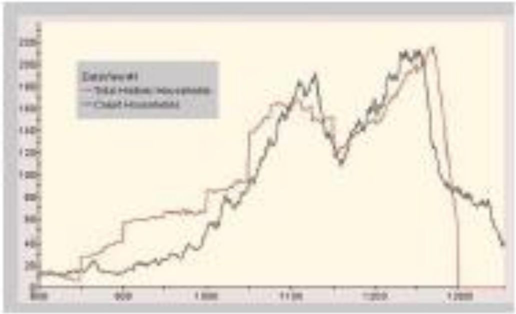
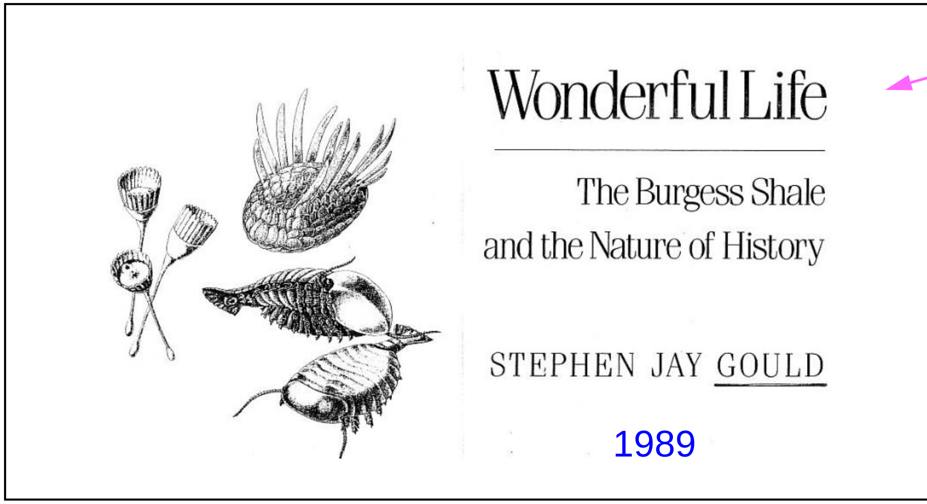


Fig. 2. Best single run of the model according to the L^1 norm. Other best runs based on other norms yield very similar trajectories. The average run, produced by averaging over 15 distinct runs, looks quite similar to this one as well.

Phenomenological Level: How Important Is Chance in Survival ?



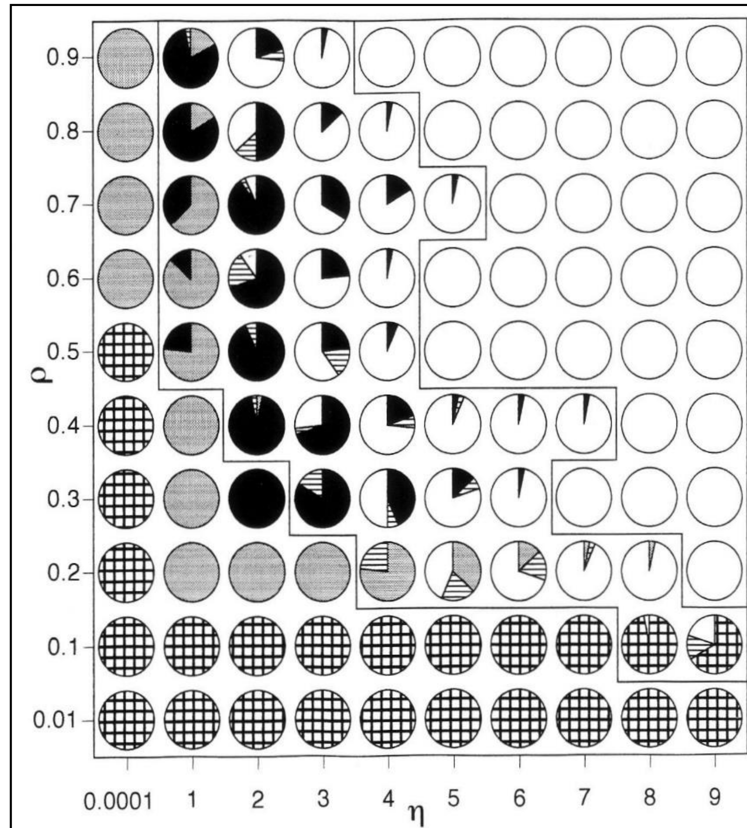
One data point: From the fossil record, some "advanced" organisms (with many legs, e.g.) that should survive are extinguished now.

Gould asked: If life's "tape" is replayed, will humans still be here?

Gould's answer: Humans won't be here!
(i.e., contingency is all important)

Gould concluded that chance is extremely important in evolutionary history (i.e., not "the fittest survive" according to Darwin).

Our answer: It depends !

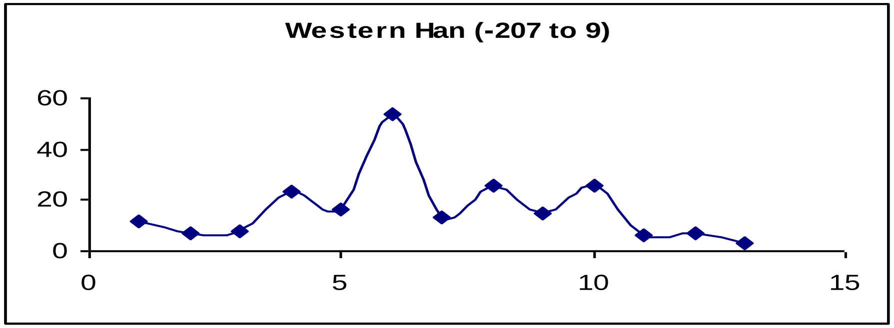


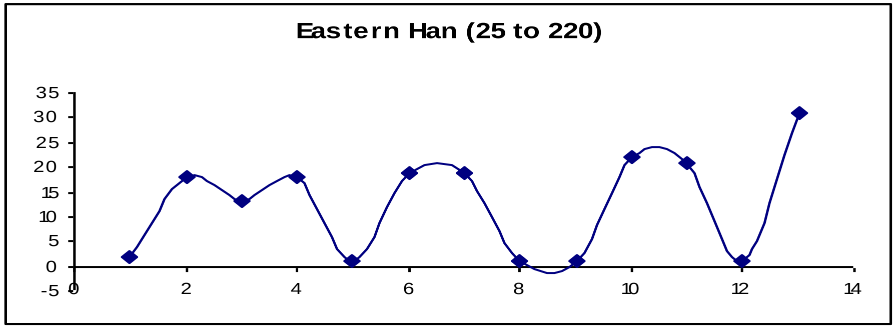
AW modeling

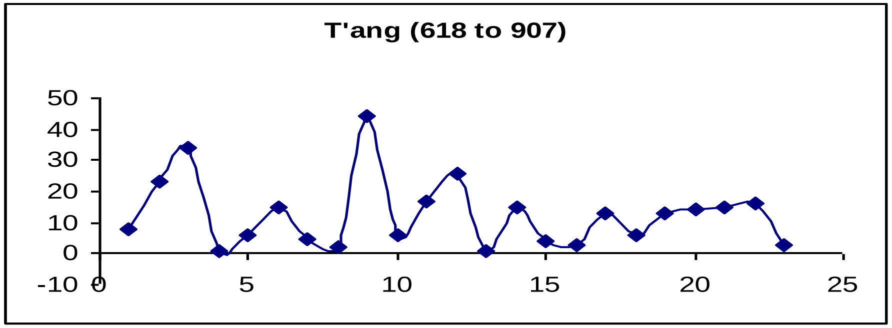
Empirical Level: How Long Can a Chinese Dynasty Last ?

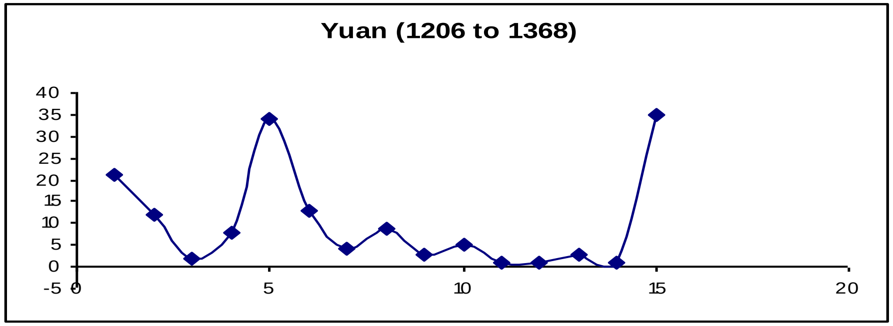
Regime lifetime (τ_R) of each emperor in same dynasty (China)

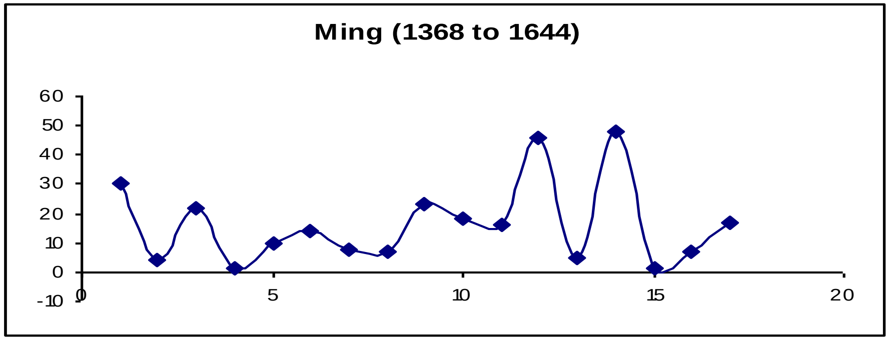
No trend !

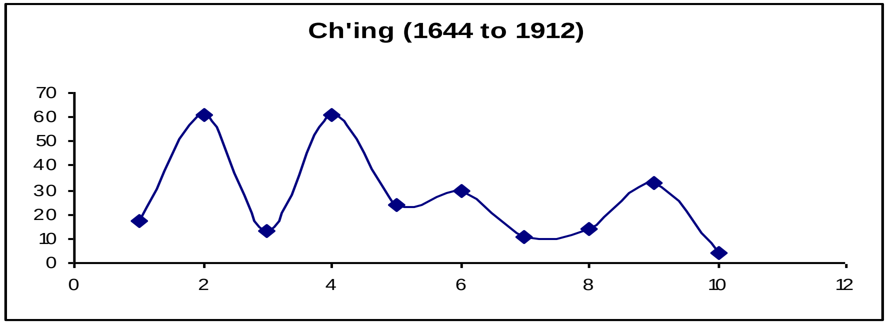




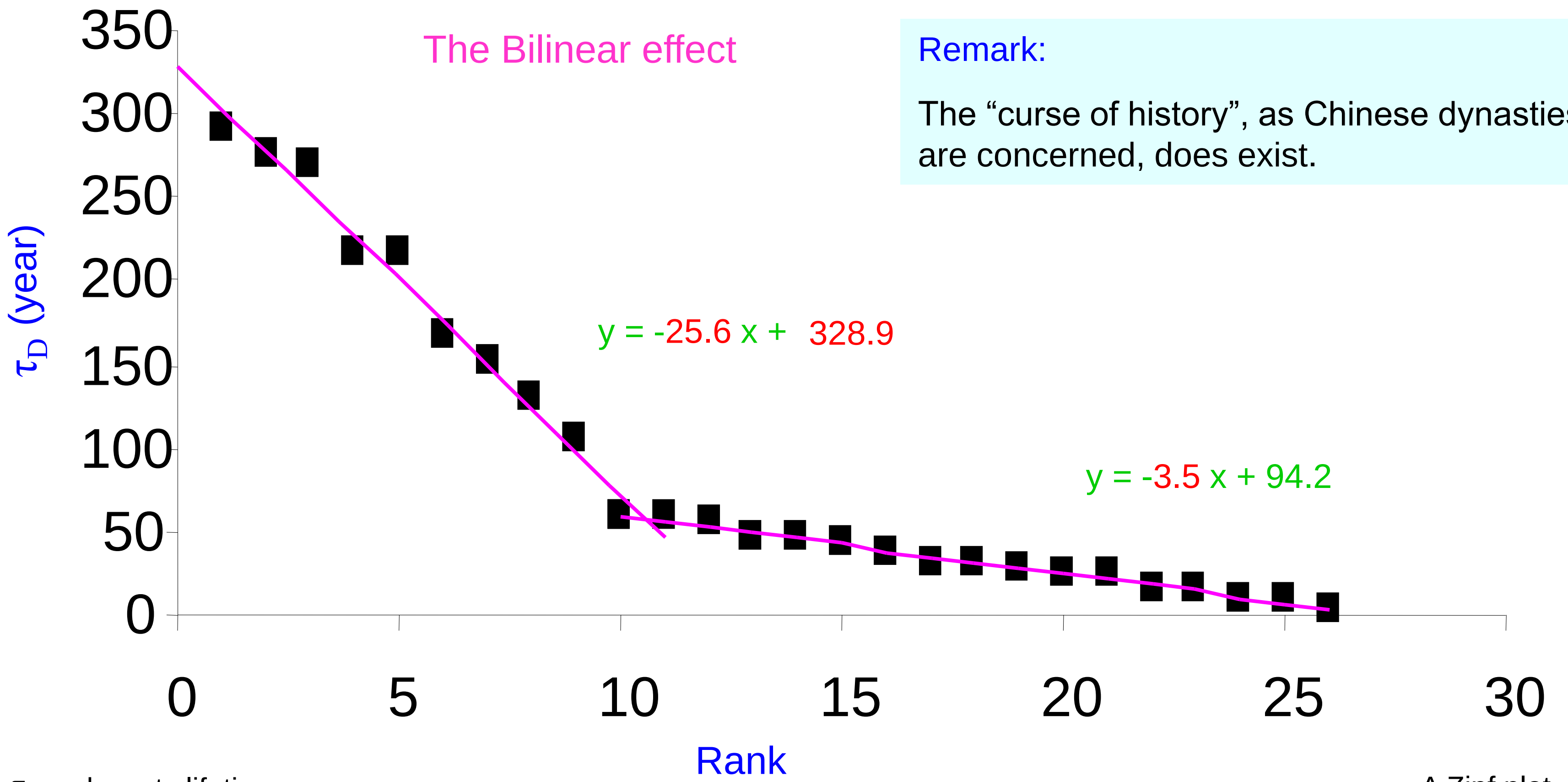








A Quantitative Law: A Chinese dynasty can survive every 3.5 years if it lasts less than 57 years; beyond that, every 25.6 years (i.e., dynasty lifetime is discrete, or "quantized").



Remark:

The "curse of history", as Chinese dynasties are concerned, does exist.

τ_D = dynasty lifetime

A Zipf plot

A quantitative prediction (assuming dynasties fall into the bilinear type):

Any dynasty after Qing, if exists, will either

1. last 290 years or less and fall on the two lines, or
2. end definitely and exactly in its year 329.

Bilinear Effect in Complex Systems

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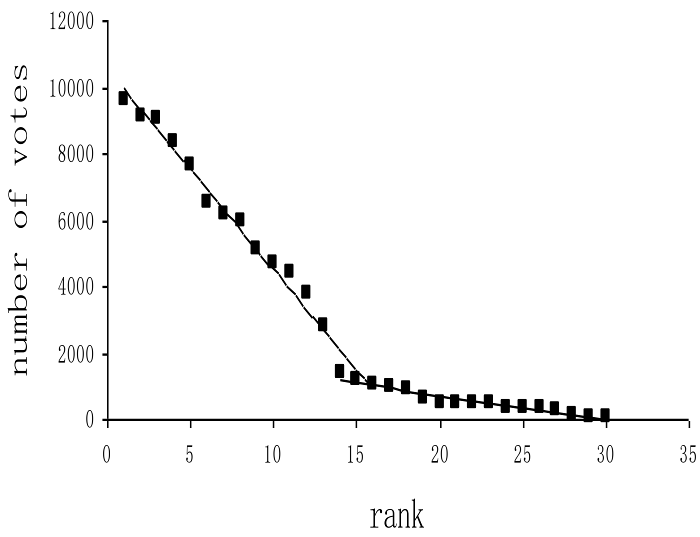
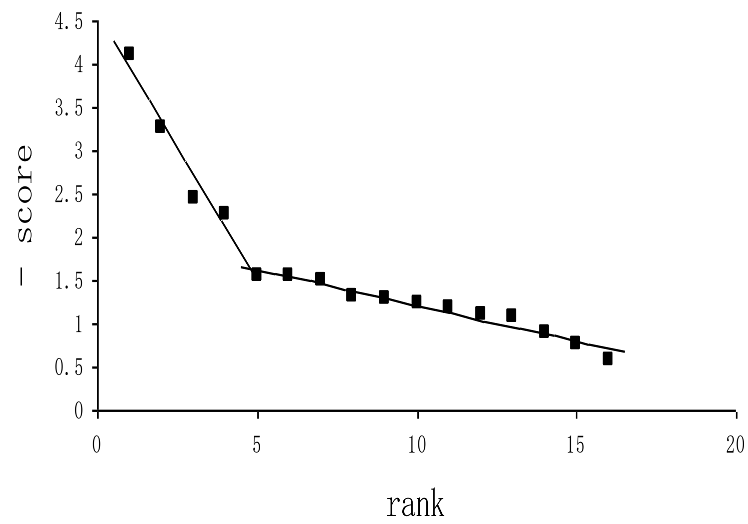


Popular votes for *xiaopin* actors



Airline quality data

Conclusion

- There is much more in history than pure narratives (i.e., story telling).
- Through the methods borrowed from physics, complex systems, DNA studies and so on, many historical phenomena could be explained and understood, and hidden historical laws could be unearthed.
- Sometimes, the study of individual historical examples could lead to the discovery of a general phenomenon in nature (such as the Bilinear Effect).
- Conventional methods (mainly narratives) used by historians should be continued, but collaborations between historians and “natural scientists” are strongly encouraged.
- Quantitative training (such as use of Excel) should be taught to humanities students, including those in history.