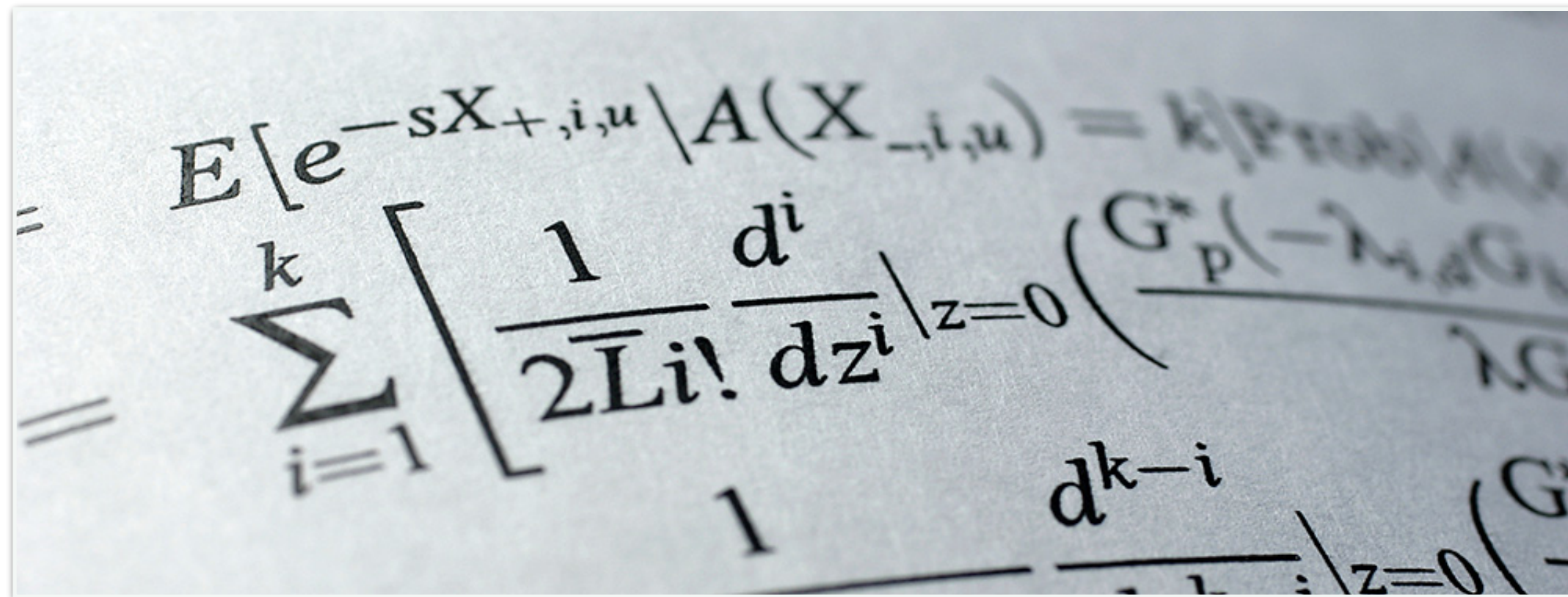


Two Evolutionary Approaches to the Persistence & Change of Rules & Institutions

David Krakauer || SFI

Jessica Flack (SFI), Philip Poon (Madison)

Dan Rockmore (Dartmouth), Tom Ginsburg (Univ Chicago),
Nick Fotie (UW Seattle), Chen Fang (Adobe)



Idealized mathematical models

Simple Principles from non-linear dynamics

low resolution/granularity



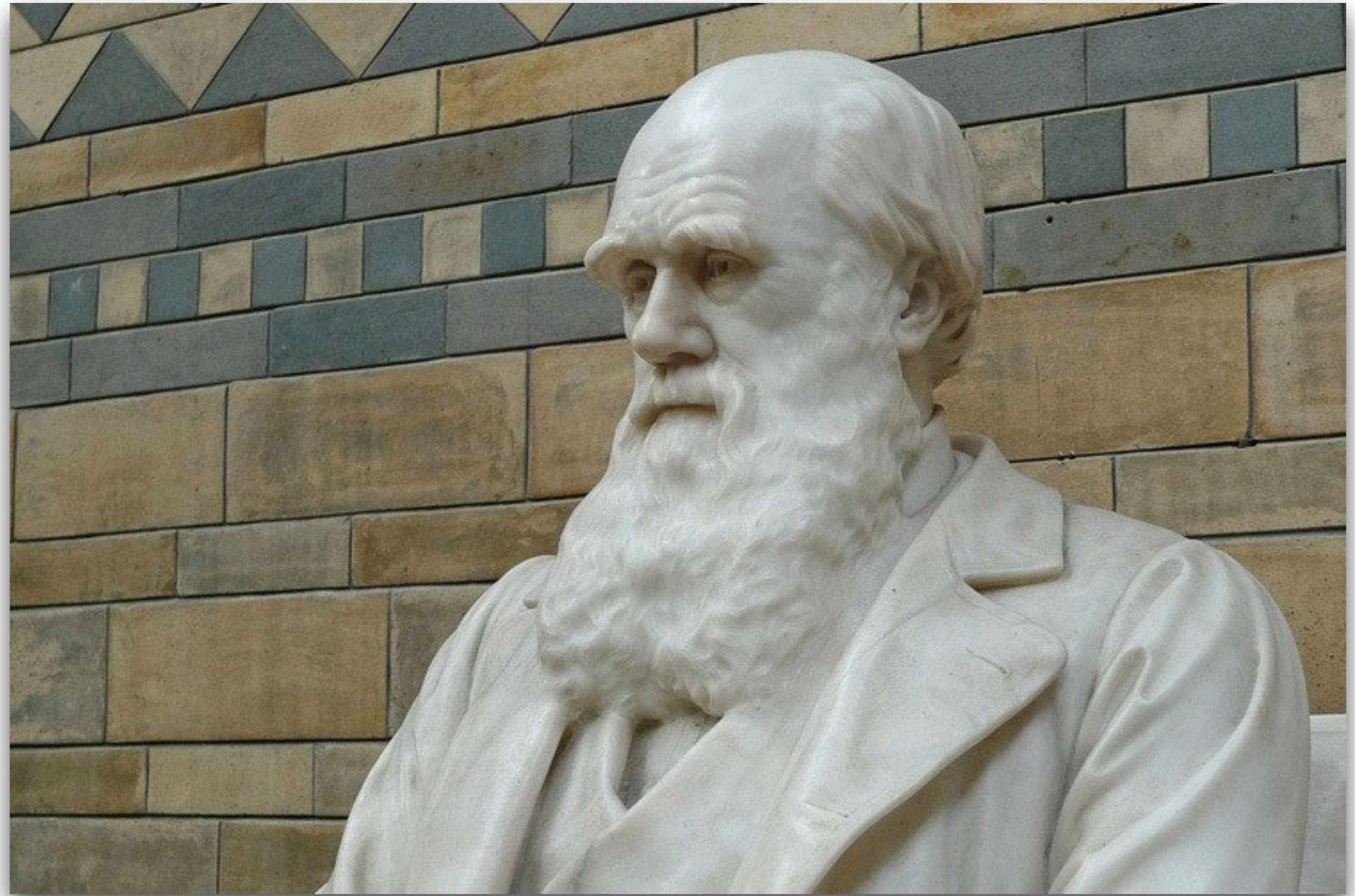
Empirical computational models

Techniques of Bayesian inference

high resolution/granularity

Pioneering theories of Change

$$S = k \cdot \log W$$



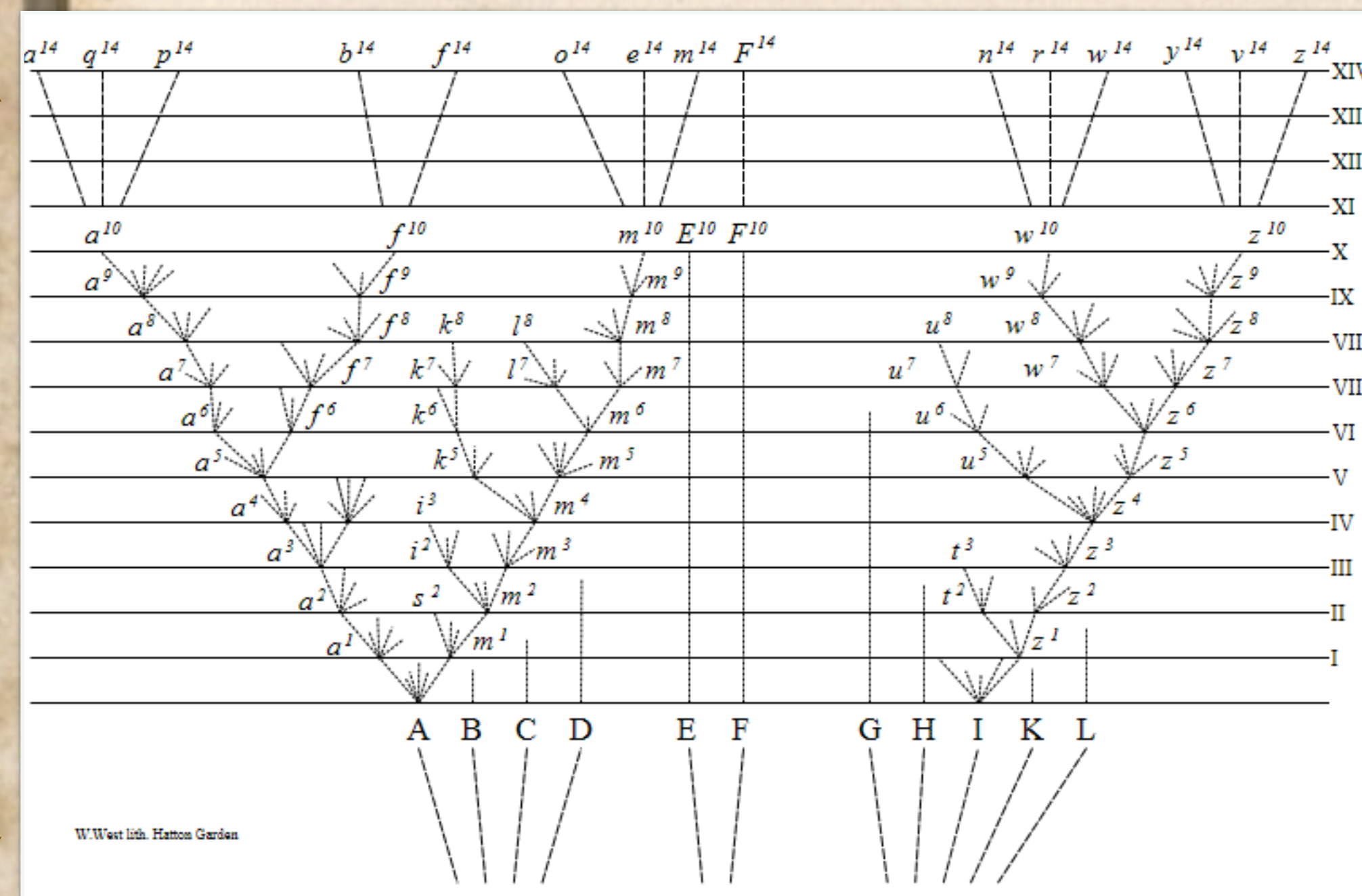


“These laws, taken in the largest sense, being Growth with reproduction; Inheritance which is almost implied by reproduction; Variability from the indirect and direct action of the conditions of life, and from use and disuse; a Ratio of Increase so high as to lead to a Struggle for Life, and as a consequence to Natural Selection, entailing Divergence of Character and the Extinction of less improved forms”

THE ORIGIN OF SPECIES

BY

Diversification through natural selection



CHARLES DARWIN, M.A.,

FELLOW OF THE ROYAL, GEOLOGICAL, LINNEAN, ETC., SOCIETIES ;

AUTHOR OF "JOURNAL OF RESEARCHES DURING H. M. S. BEAGLE'S VOYAGE ROUND THE WORLD."

NEW YORK :

Down, Bromley, Kent,
October 1st, 1859.

The Origin of Selection not the Origin of Species

STRUCTURE AND DISTRIBUTION
OF
CORAL REEFS.

BEING THE FIRST PART OF
THE

"unsung creature which, in its untold millions, transformed the land
as the coral polyps did the tropical sea"

BY
CHARLES **DARWIN**, M.A., F.R.S., F.G.S.,
NATURALIST TO THE EXPEDITION

Published with the Approval of the Lords Commissioners of
Her Majesty's Treasury.

LONDON:
SMITH, ELDER AND CO., 65, CORNHILL.
1842.

THE FORMATION
OF
VEGETABLE MOULD,

THROUGH THE

ACTION OF WORMS

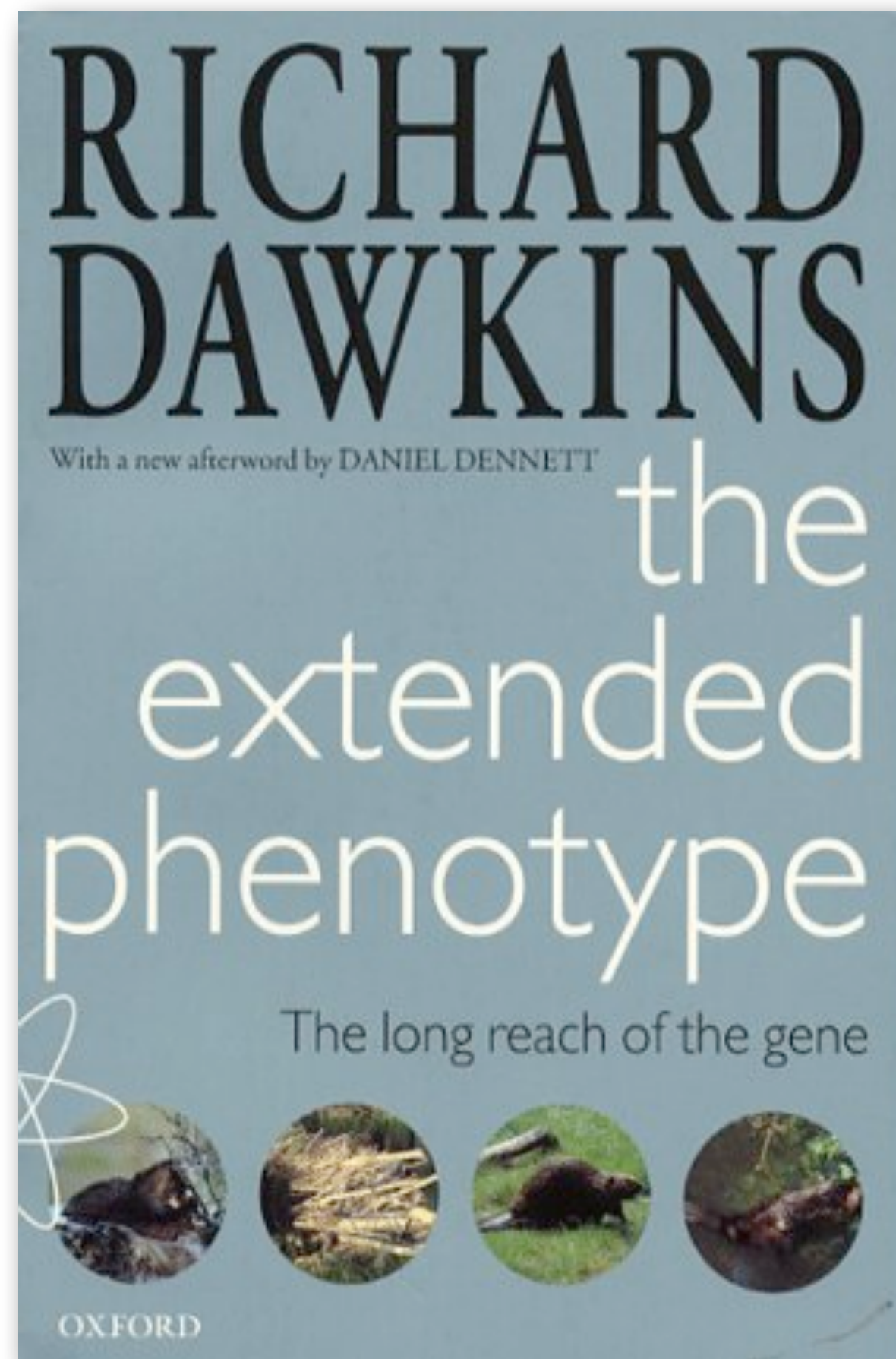
By CHARLES DARWIN, LL.D., F.R.S.

WITH ILLUSTRATIONS.

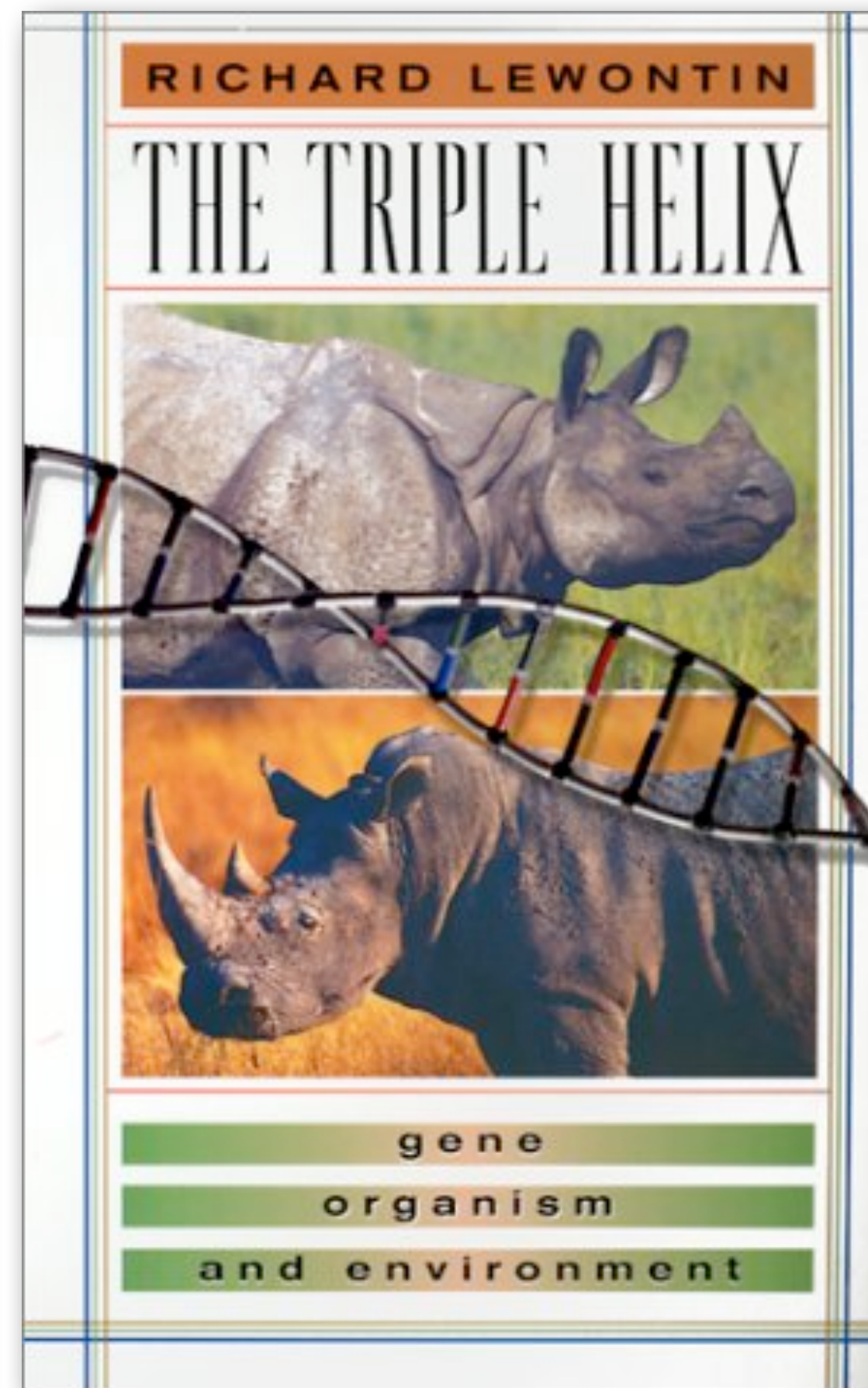
SEVENTH THOUSAND (CORRECTED)

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1882.

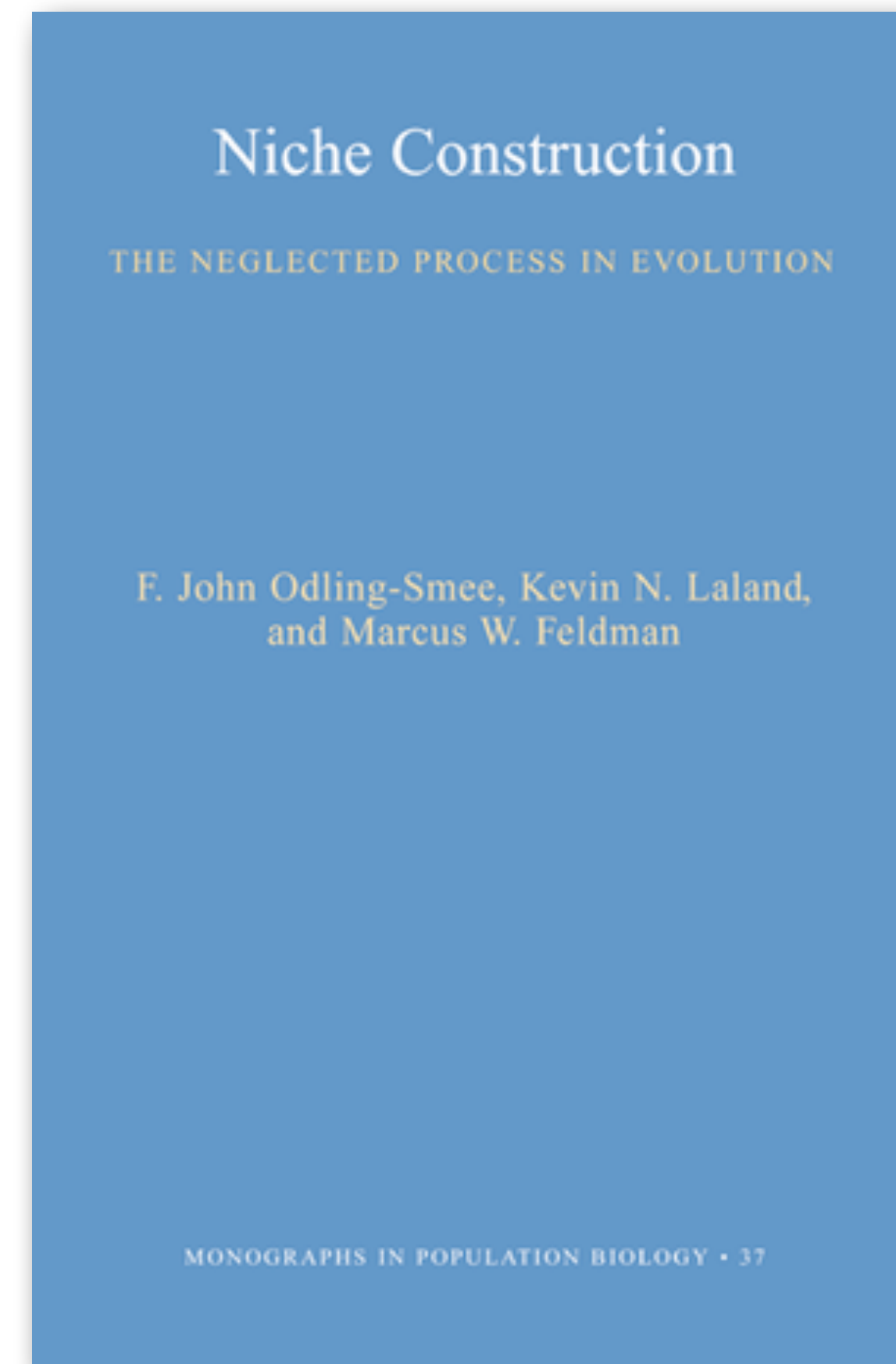
1982



2000



2003



Where the rules (e.g. selection) change as quickly as
the objects that they govern (e.g. genotypes)



Marriage: Attitudes toward Same Sex Marriage

BOTH ARE GUILTY

Oscar Wilde and Alfred Taylor Convicted

OF UNNATURAL CHARGES AND BOTH

Sentenced Each to Two Years in Prison.

LONDON, May 25.---The cases of Oscar Wilde and Alfred Taylor which have stirred up entire England, were settled to-day when the jury in Wilde's case, after having been out two hours, returned a verdict of guilty. In his charge to the jury the judge was decidedly favorable towards Wilde. Both men will be sentenced to prison at hard labor for two years.

1895

Composite
75c - NYDailyNews.com
SPORTS FINAL
Chance of T-storms, 83/64, Saturday, June 25, 2011

DAILY NEWS
NEW YORK'S HOMETOWN NEWSPAPER

HISTORY!

JAMES REYFORD/DAILY NEWS

- State OKs gay marriage in groundbreaking 33-29 vote
- Jubilant gov calls it one of New York's 'finest' moments

SEE PAGES 4-6

2011

Laws: Attitudes toward Recreational Drugs



Sensationalism



29 States in USA

Government: Support of Political Parties

[HOME PAGE](#) [TODAY'S PAPER](#) [VIDEO](#) [MOST POPULAR](#) U.S. Edition [TRY TIMES PREMIER](#) dckrakauer... [Help](#)

The New York Times

Politics

Search All NYTimes.com

Go

Capital One

[WORLD](#) [U.S.](#) [N.Y. / REGION](#) [BUSINESS](#) [TECHNOLOGY](#) [SCIENCE](#) [HEALTH](#) [SPORTS](#) [OPINION](#) [ARTS](#) [STYLE](#) [TRAVEL](#) [JOBS](#) [REAL ESTATE](#) [AUTOS](#)

[POLITICS HOME](#) [THE CAUCUS](#) [INSIDE CONGRESS](#) [POLL WATCH](#) [VIDEO](#)

68% OF EXECUTIVES WOULD CONSIDER SWITCHING BANKS FOR BETTER CUSTOMER SERVICE.

G.O.P. Mulls a Strategy From Obama's Playbook

[Life Insurance](#) [BenefitAccess Rider](#)



Newt Gingrich, addressing the Republican National Committee on Thursday.
By JEFF ZELENY
Published: January 24, 2013

CHARLOTTE, N.C. — As Republican leaders gathered Thursday to consider how to rebuild their party, President Obama was at the center of the conversation. But the sharp criticism of him was replaced by something new: envy over his success.

The New York Times

Wednesday, November 5, 2014 | Today's Paper | Video | 64°F | S. & P. 500 +100

World U.S. Politics New York Business Opinion Technology Science Health Sports Arts Style Dining

Senate Map »

DEM.* 44 IND. 1 REP. 52

-7 seats 50 +7 seats

Republicans need +6 for control

House Map »

DEM. 178 REP. 243

-14 seats 218 +14 seats

Democrats need +17 for control

KEY RACES	DEM./IND.	REP.	RPT.
Va. Senate	Warner 49%	Gillespie 48%	99%
N.C. Senate	Hagan 47%	Tillis 49%	100%
Colo. Senate	Udall 45%	Gardner 49%	94%
Iowa Senate	Braley 44%	Ernst 52%	100%
Kan. Senate	Orman 42%	Roberts 53%	100%

Updated 1:24 PM

LEAD WIN RUNOFF

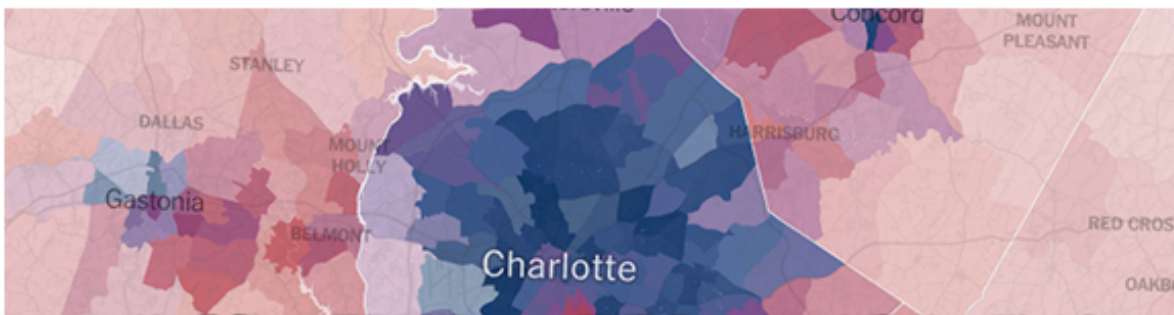
A New Day, and More G.O.P. Victories

Republicans Ride Wave of Anger to Win Senate Majority

By MICHAEL D. SHEAR 12:21 PM ET
The full magnitude of the Republicans' success in reshaping the political landscape at President Obama's expense grew clearer Wednesday morning.
190 Comments

PRECINCT BY PRECINCT

North Carolina Senate Race



The Opinion Pages

Negativity Wins the Senate

By THE EDITORIAL BOARD
Republicans returned to the majority by campaigning on what they called the failure of President Obama.

The Evaporating Democratic Majority

By ROSS DOUTHAT
The G.O.P. fought the future, and the future lost.

The New York Times

Presidential Forecast: Chance of winning »

89% Clinton

11% Trump

YORK TIMES

Late Edition
Today, cloudy, showers midday, high 56. Tonight, stray evening showers, clouds breaking late, colder, low 48. Tomorrow, sunshine, high 56. Weather map appears on Page B11.

VOL. CLXVI ... No. 57,411 * * * © 2016 The New York Times Company NEW YORK, WEDNESDAY, NOVEMBER 9, 2016 \$2.50

TRUMP TRIUMPHS

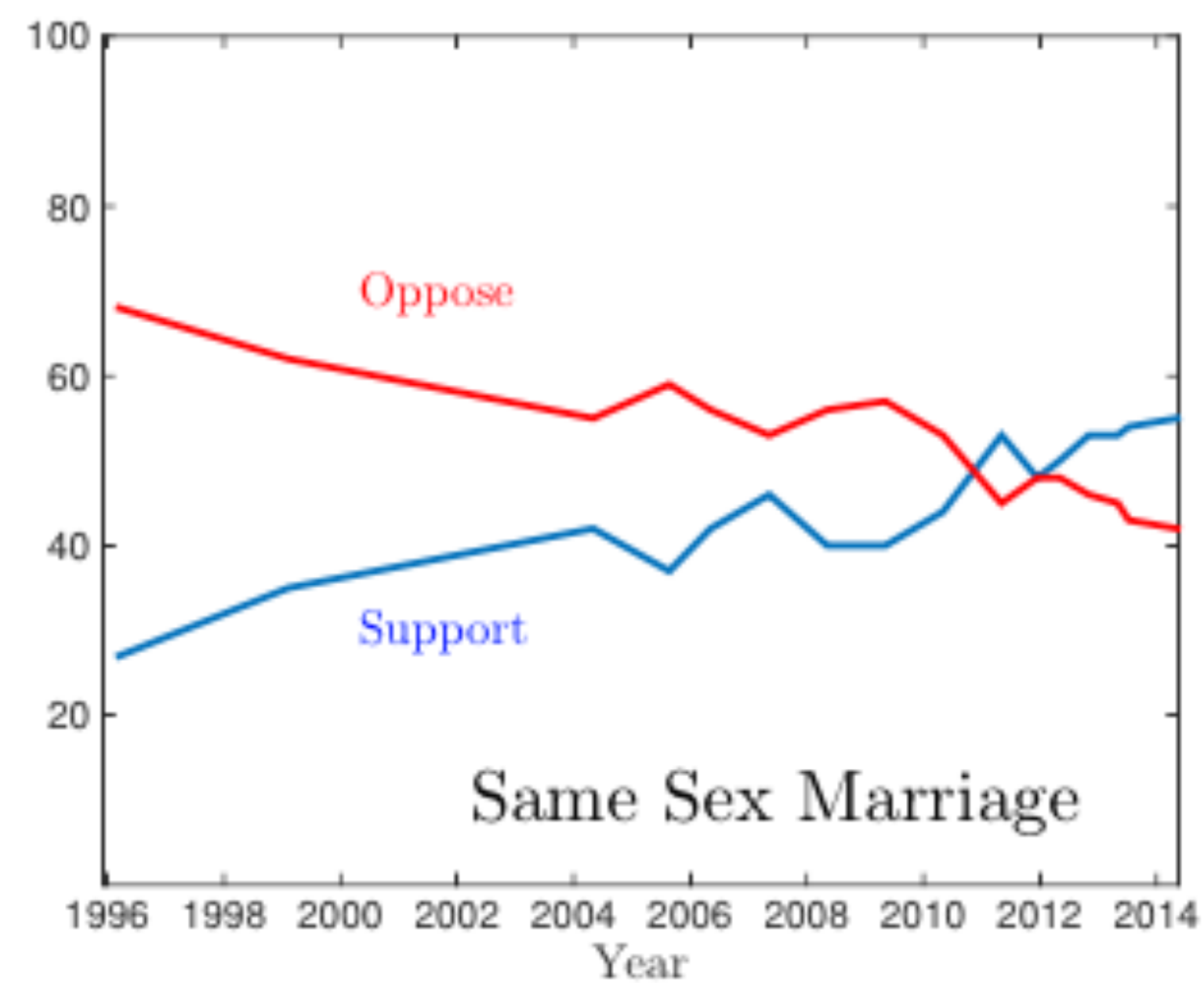
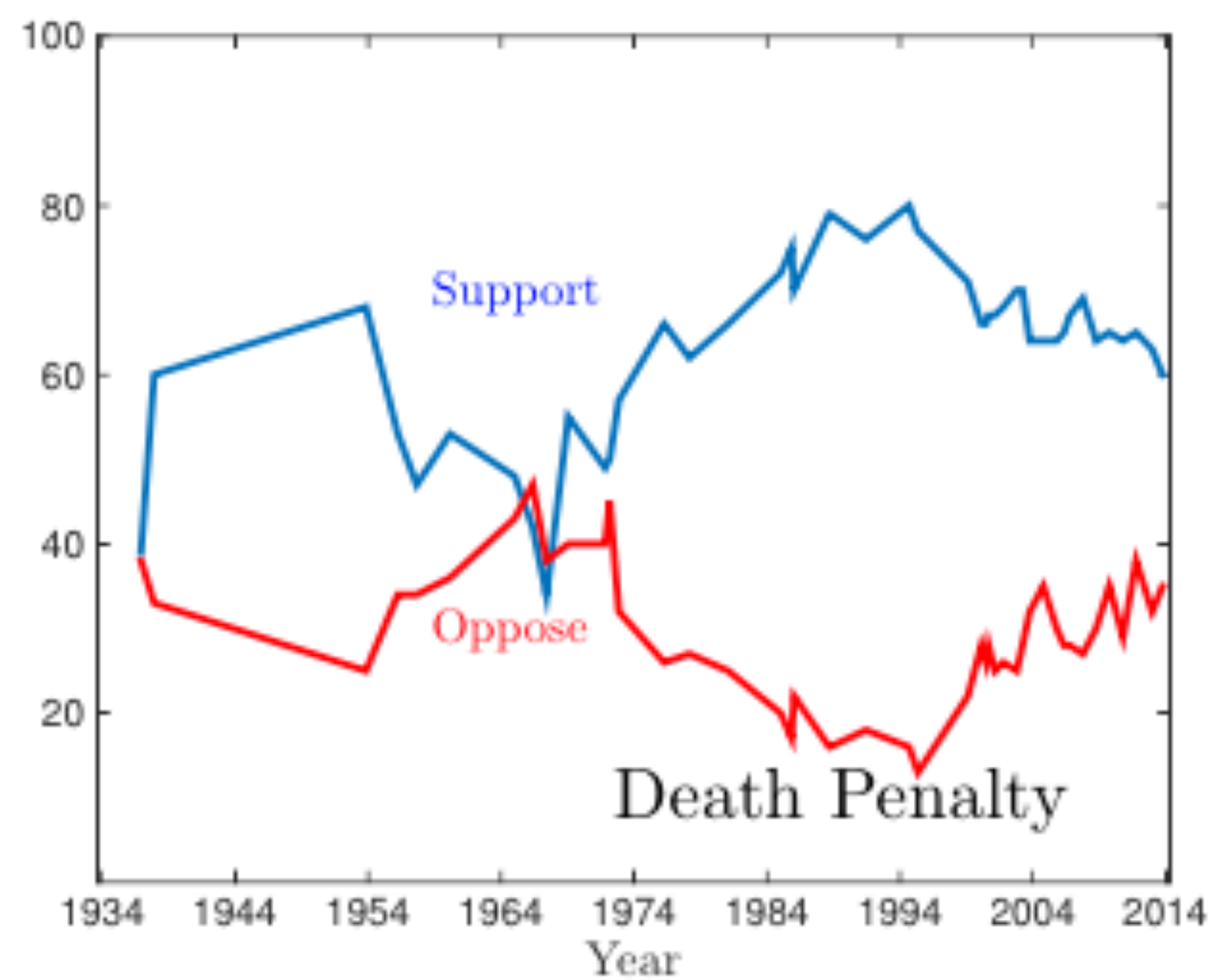
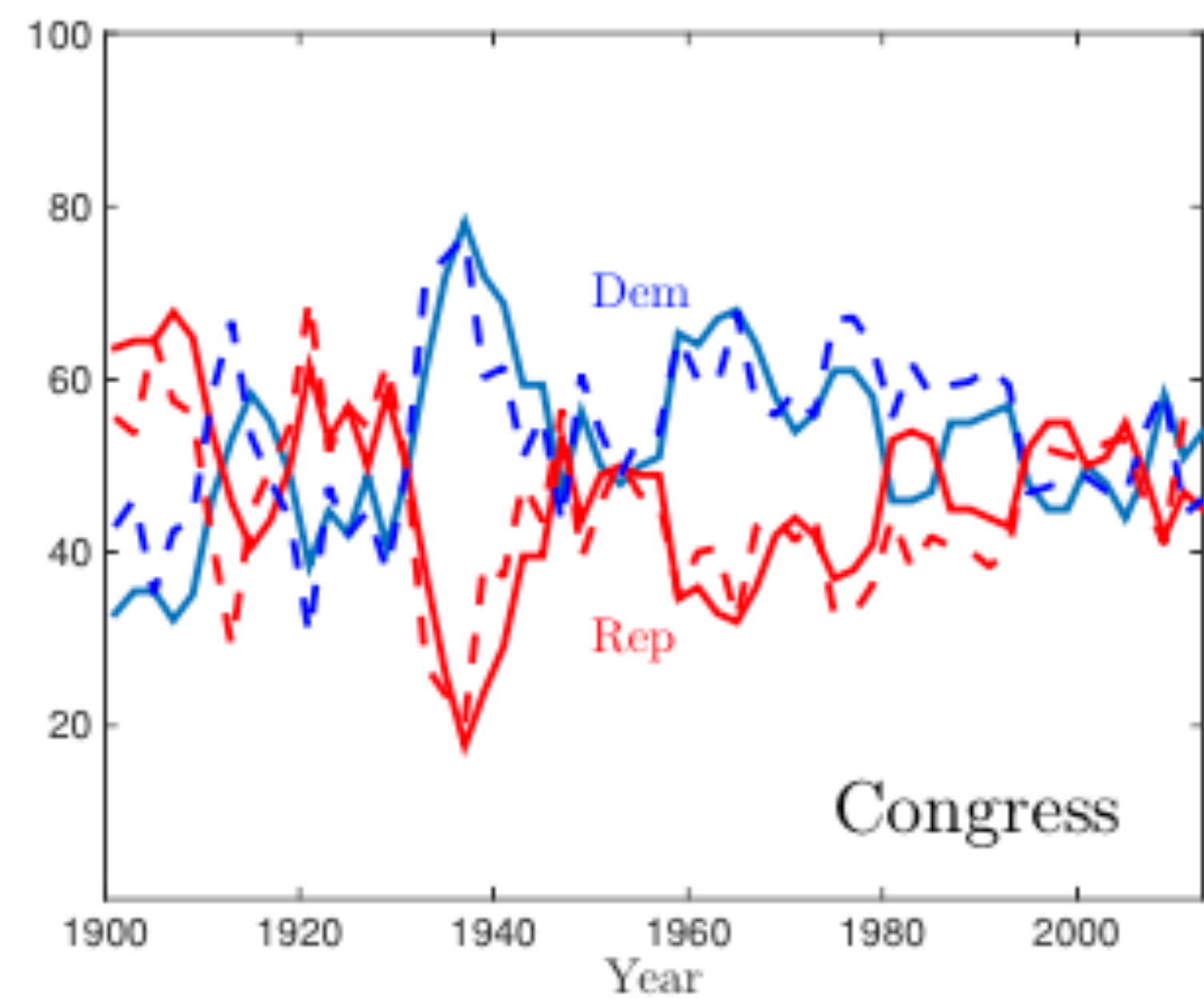
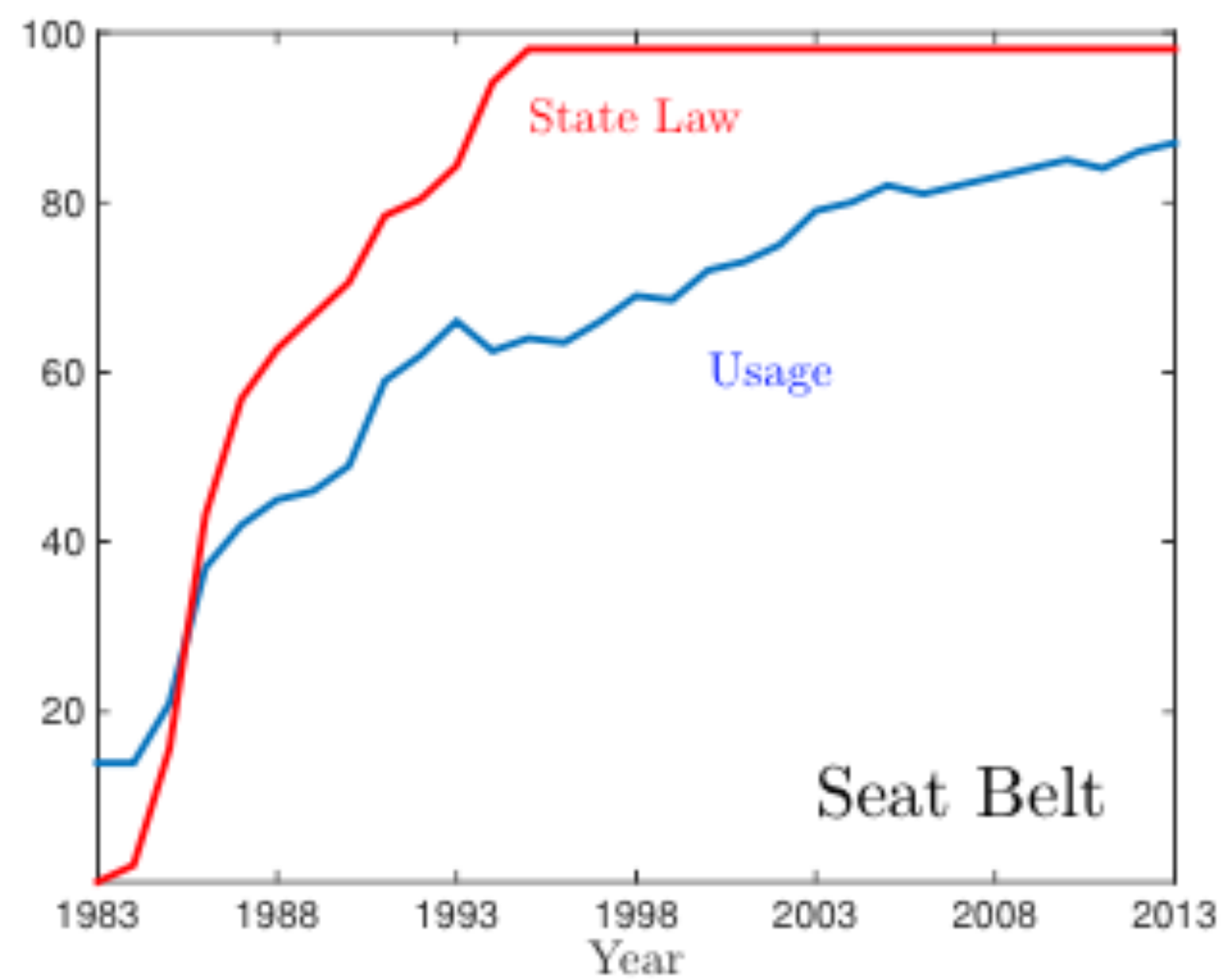
OUTSIDER MOGUL CAPTURES THE PRESIDENCY, STUNNING CLINTON IN BATTLEGROUND STATES



WORKING CLASS SPEAKS

Blue-Collar Whites Give Stinging Rebuke to Democratic Party

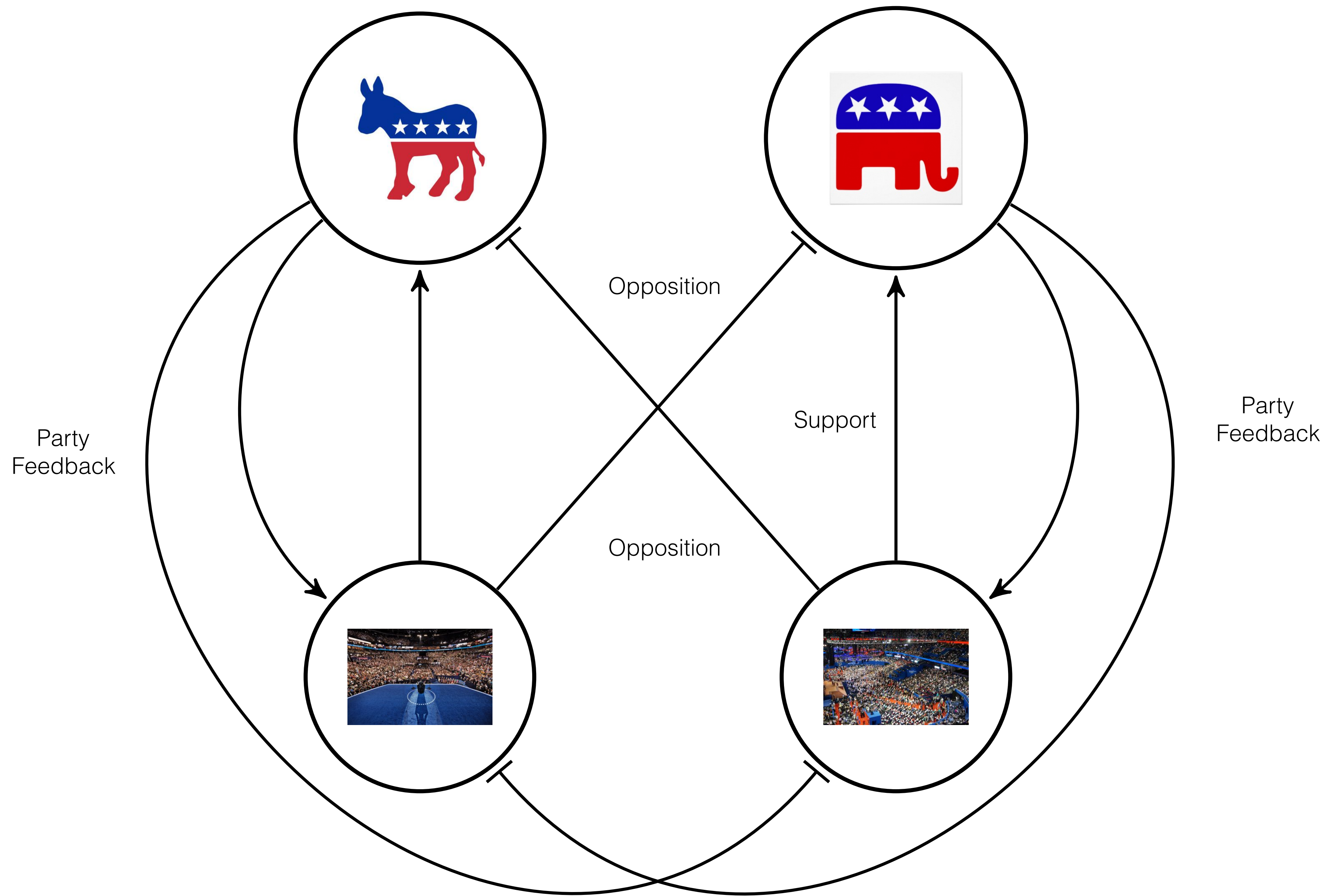
By PATRICK HEALY and JONATHAN MARTIN
Donald John Trump was elected the 45th president of the United States on Tuesday in a stunning culmination of an explosive, populist and polarizing campaign that took relentless aim at the institutions and long-held ideals of American democracy.
The surprise outcome, defying late polls that showed Hillary Clinton with a modest but persistent edge, threatened convulsions throughout the country and the world, where skeptics had



“For most of the interesting issues in political and economic markets uncertainty, not risk, characterizes choice-making. Under conditions of uncertainty, **individuals' interpretation of their environment will reflect the learning that they have undergone. information feedback from their choices is not sufficient to lead to convergence of competing interpretations of reality.** In consequence, as Frank Hahn has pointed out, "there is a continuum of theories that agents can hold and act on without ever encountering events which lead them to change their theories" (Hahn, 1987, p. 324). **In such cases, multiple equilibria will result. ”**

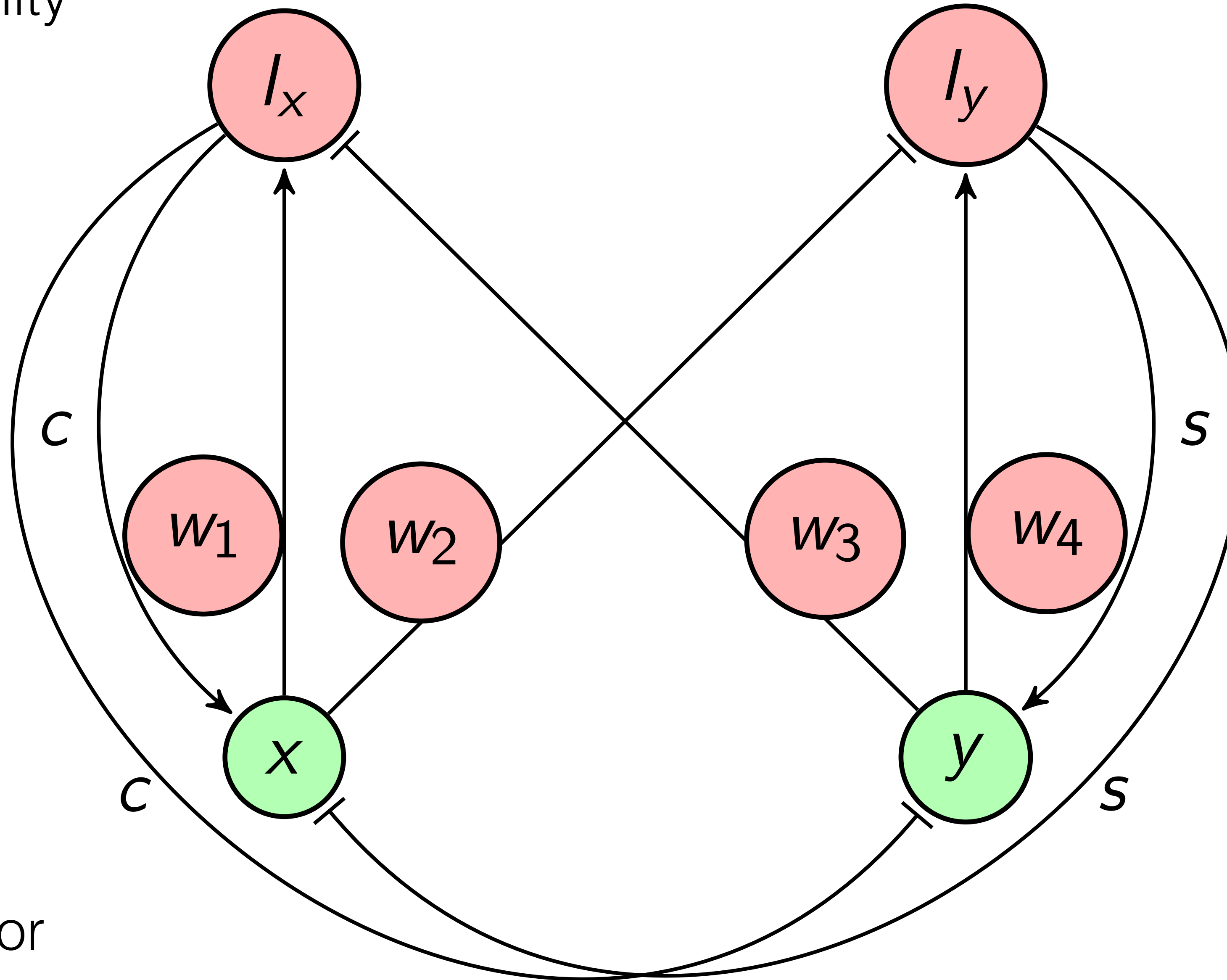


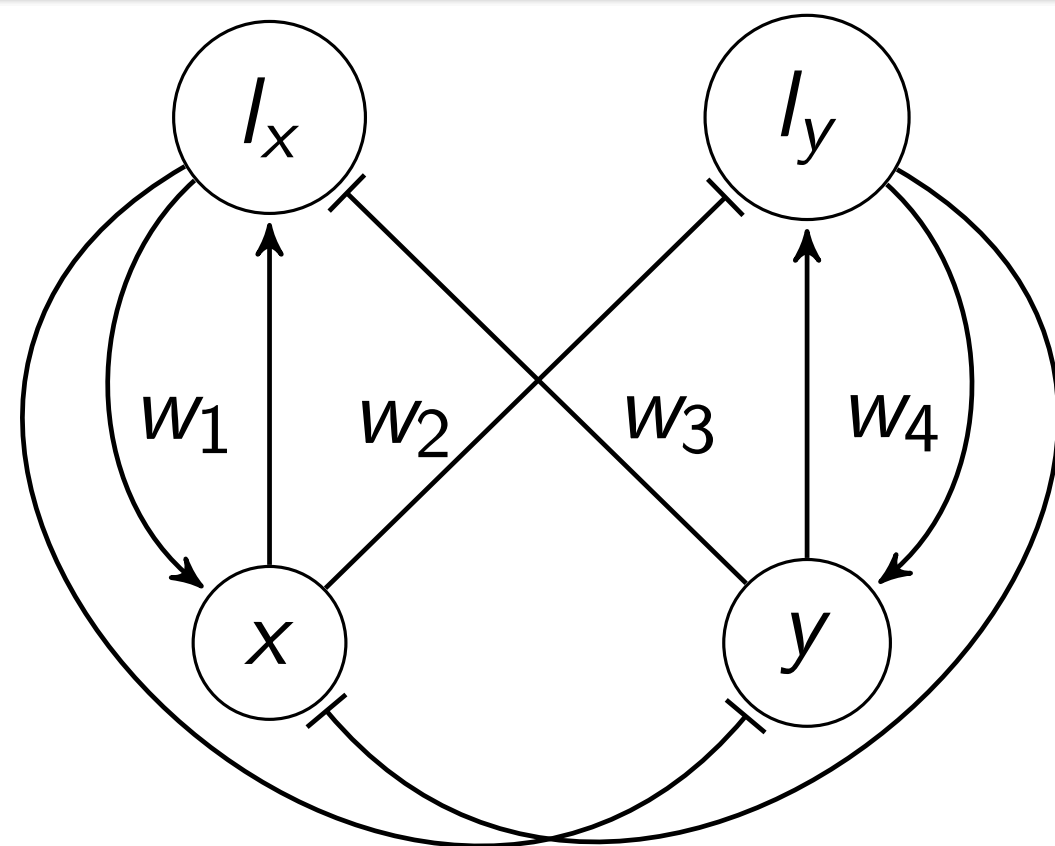
“Shared Mental Models: Ideologies and Institutions.”
Arthur Denzau and Douglas North (Kyklos: 1994)



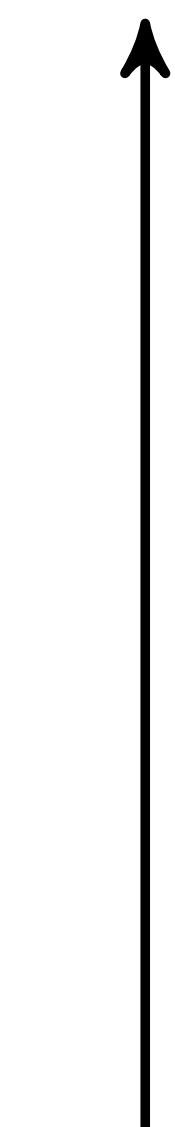
institutional stability

learning
Slow
↑
Fast
opinion
individual behavior





Slow



Fast

Intermediate

Slow

Fast

$$I_x = \phi(z_{I_x}) = \phi(w_1 x - w_3 y) ;$$

$$I_y = \phi(z_{I_y}) = \phi(w_4 y - w_2 x) ,$$

Hebbian Rule

$$\frac{1}{\varepsilon} \frac{dw_1}{dt} = x I_x - w_1$$

Compensation Rule

$$\frac{1}{\varepsilon} \frac{dw_1}{dt} = y I_y - w_1$$

$$\frac{dx}{dt} = r - s(I_y + q)xy - \lambda_x x + c I_x y ;$$

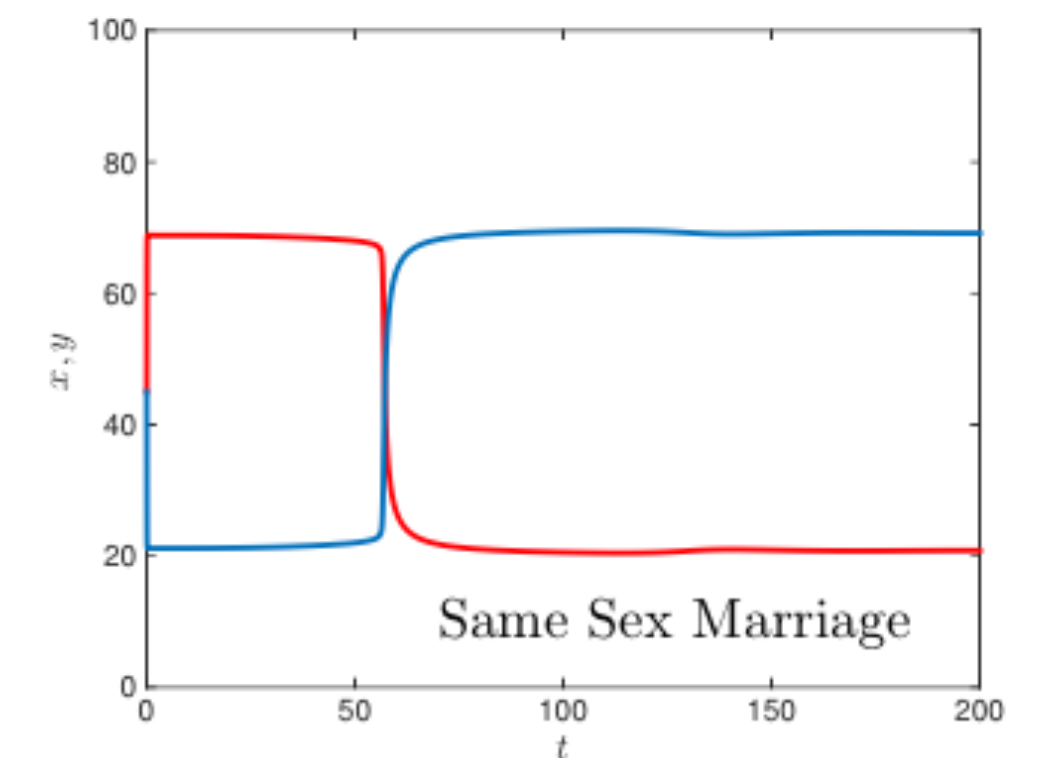
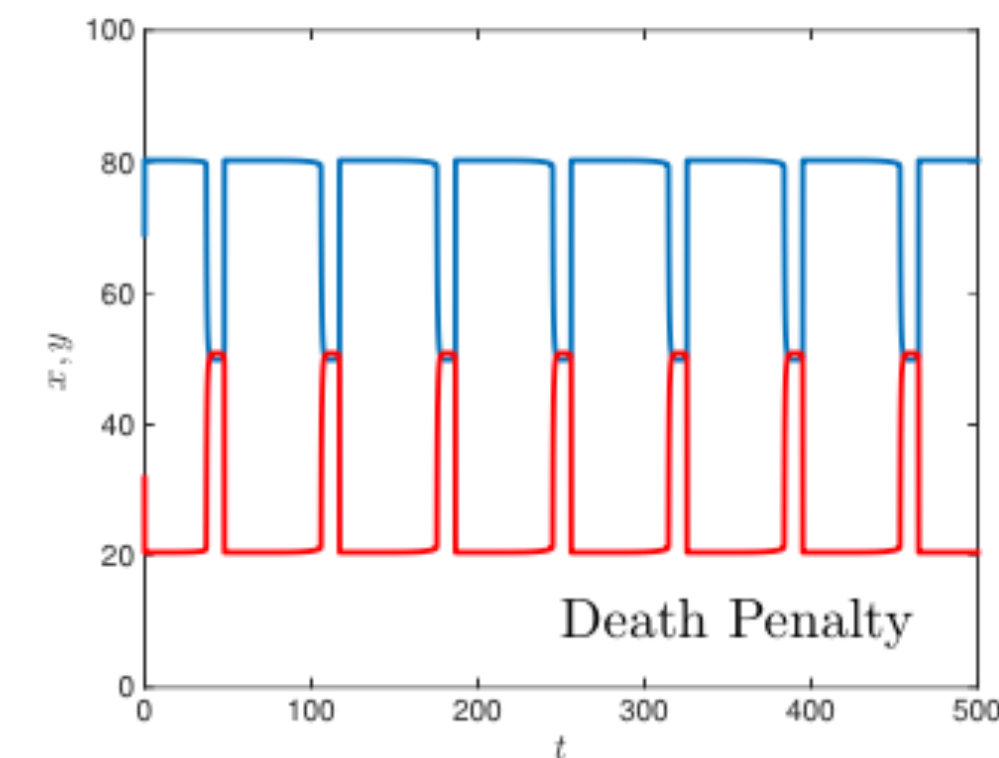
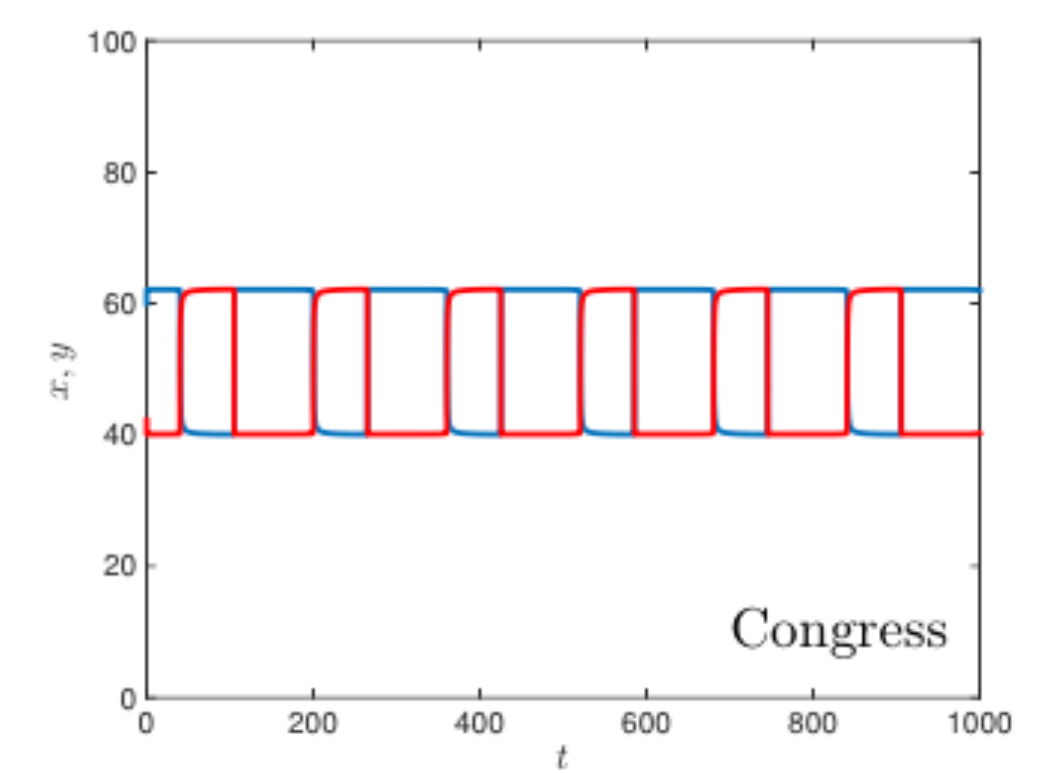
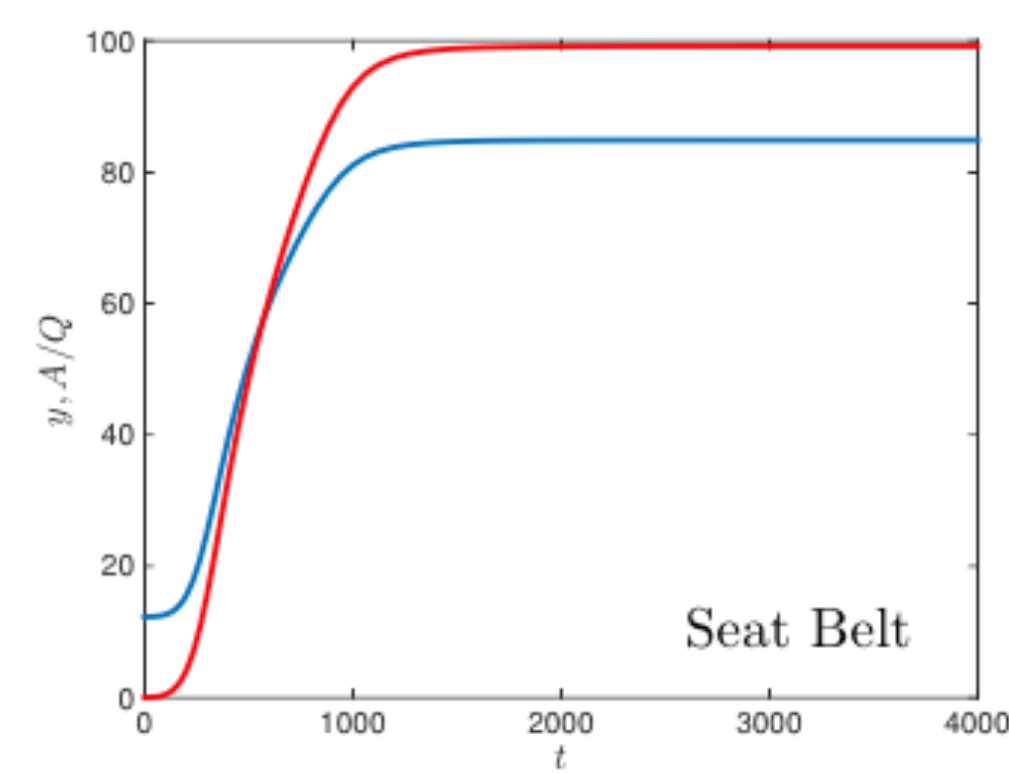
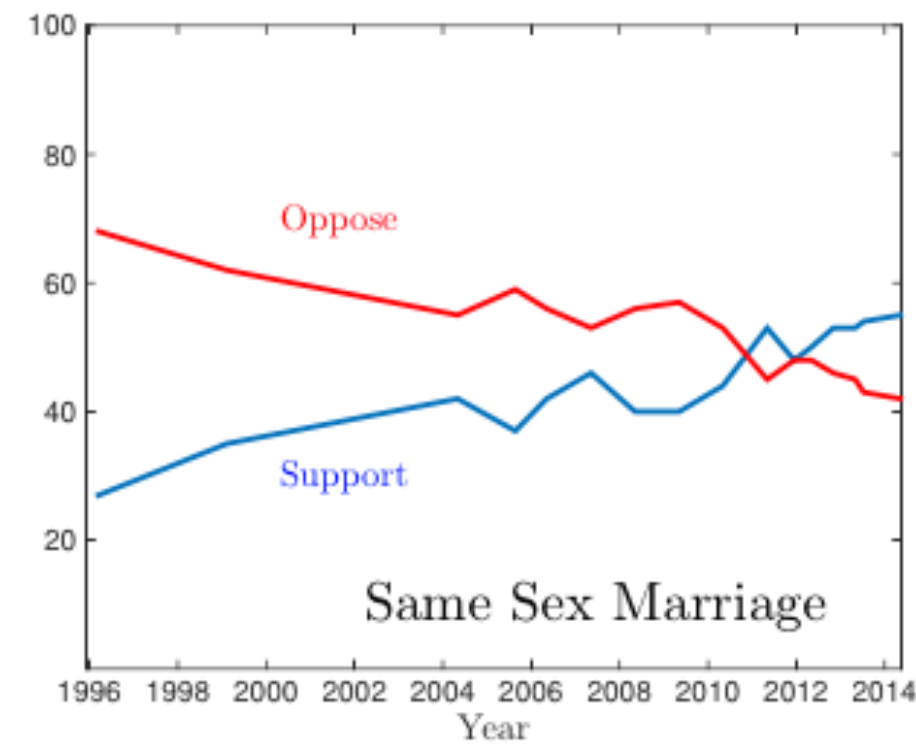
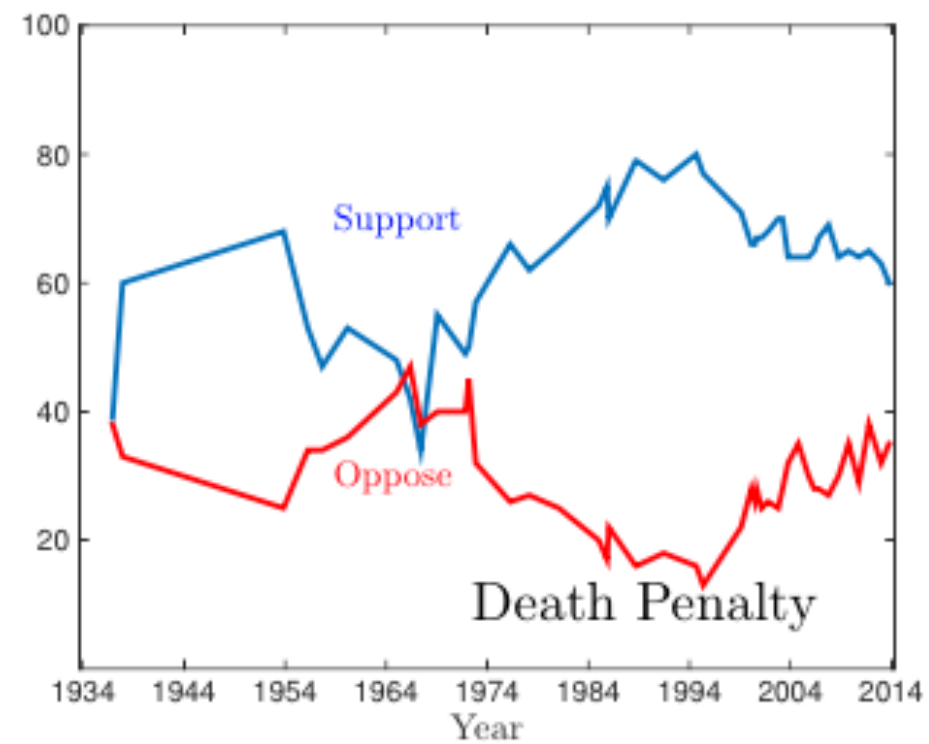
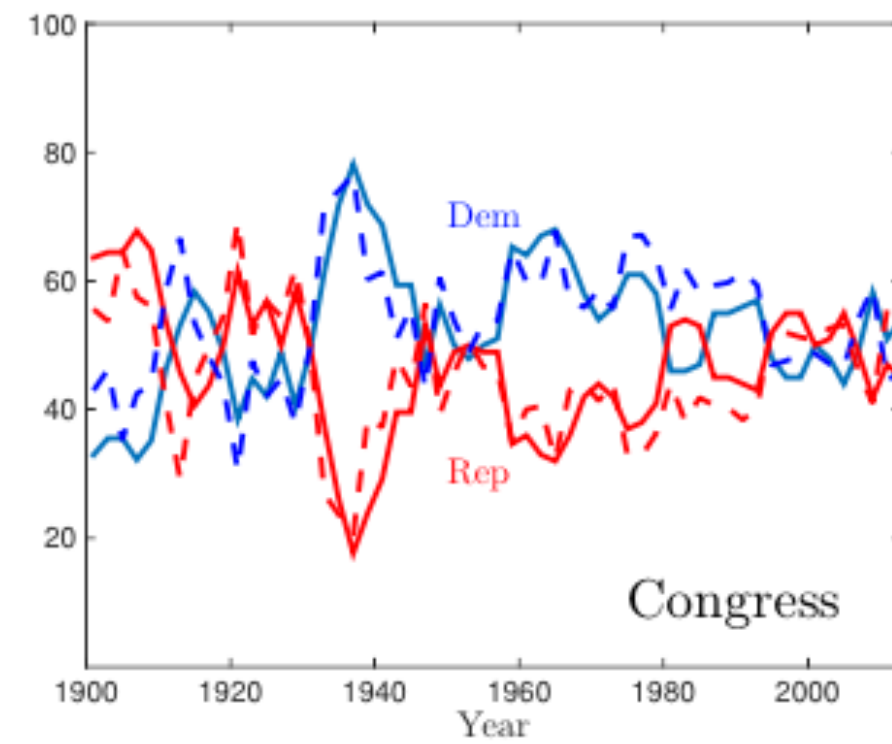
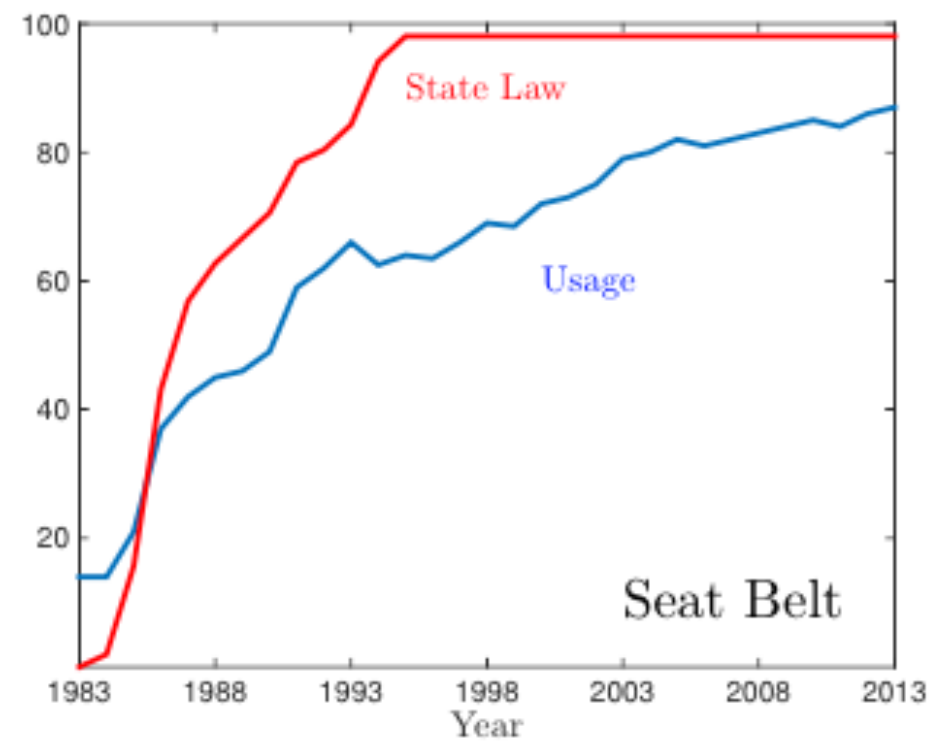
$$\frac{dy}{dt} = s(I_y + q)xy - \lambda_y y - c I_x y .$$

Compensation Rule Results

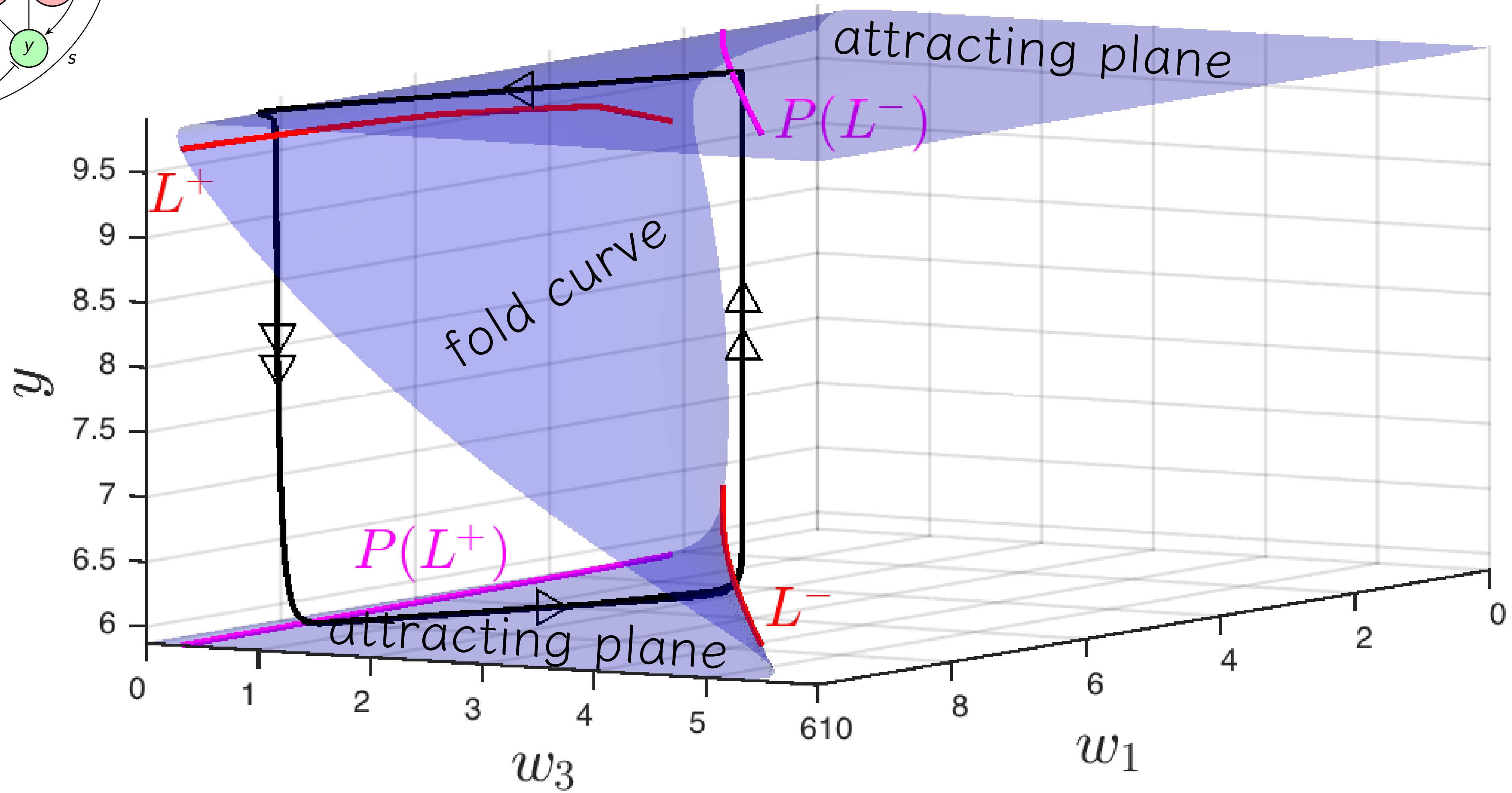
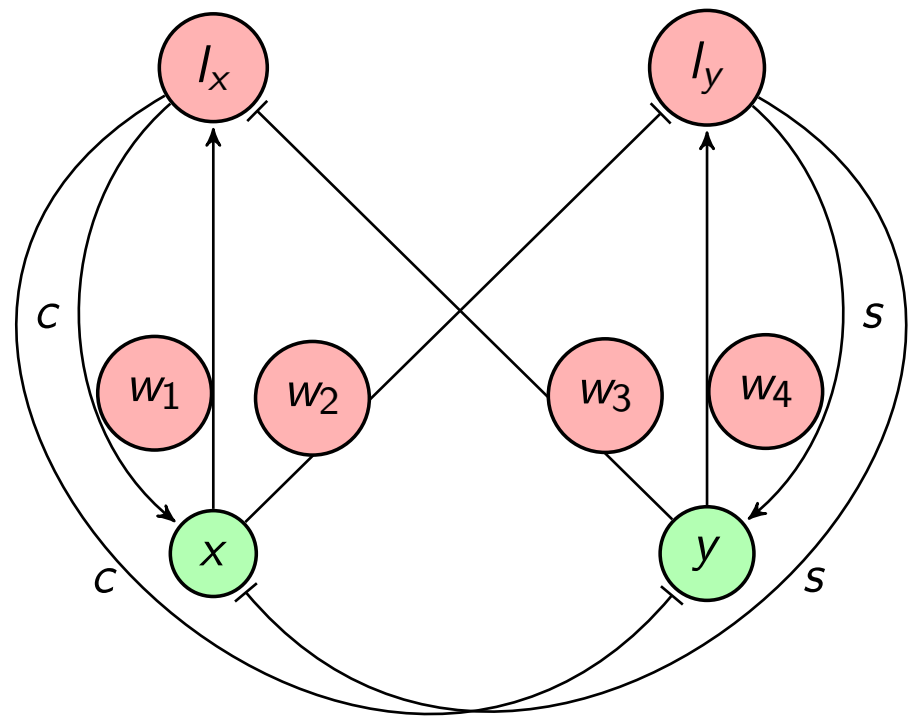
$$\frac{1}{\varepsilon} \frac{dw_1}{dt} = y l_y - w_1$$

Empirical time series

Analytical time series

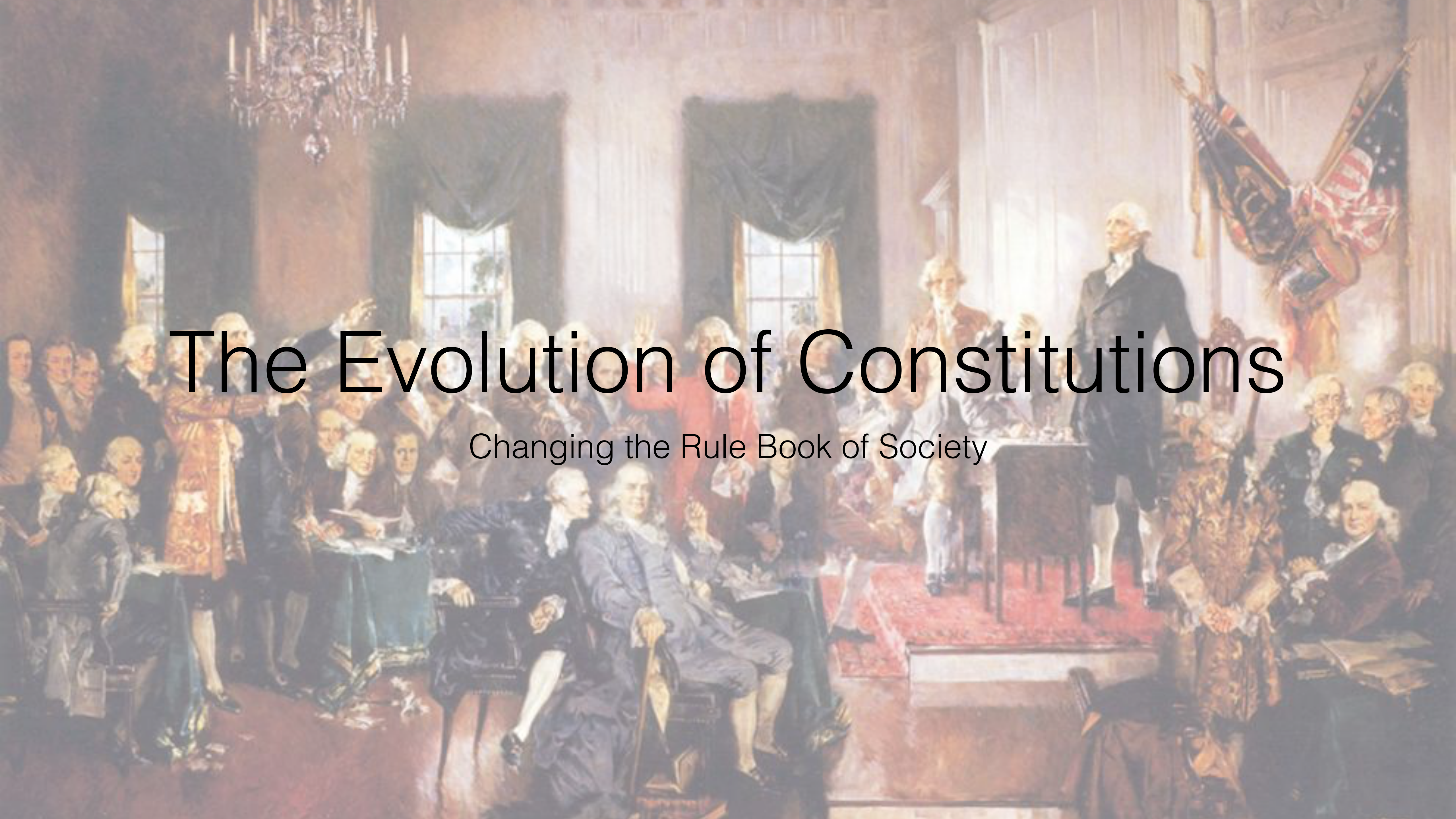


The Critical Manifold - *not heteroclinic orbits*



Insights for Institutional Switching:

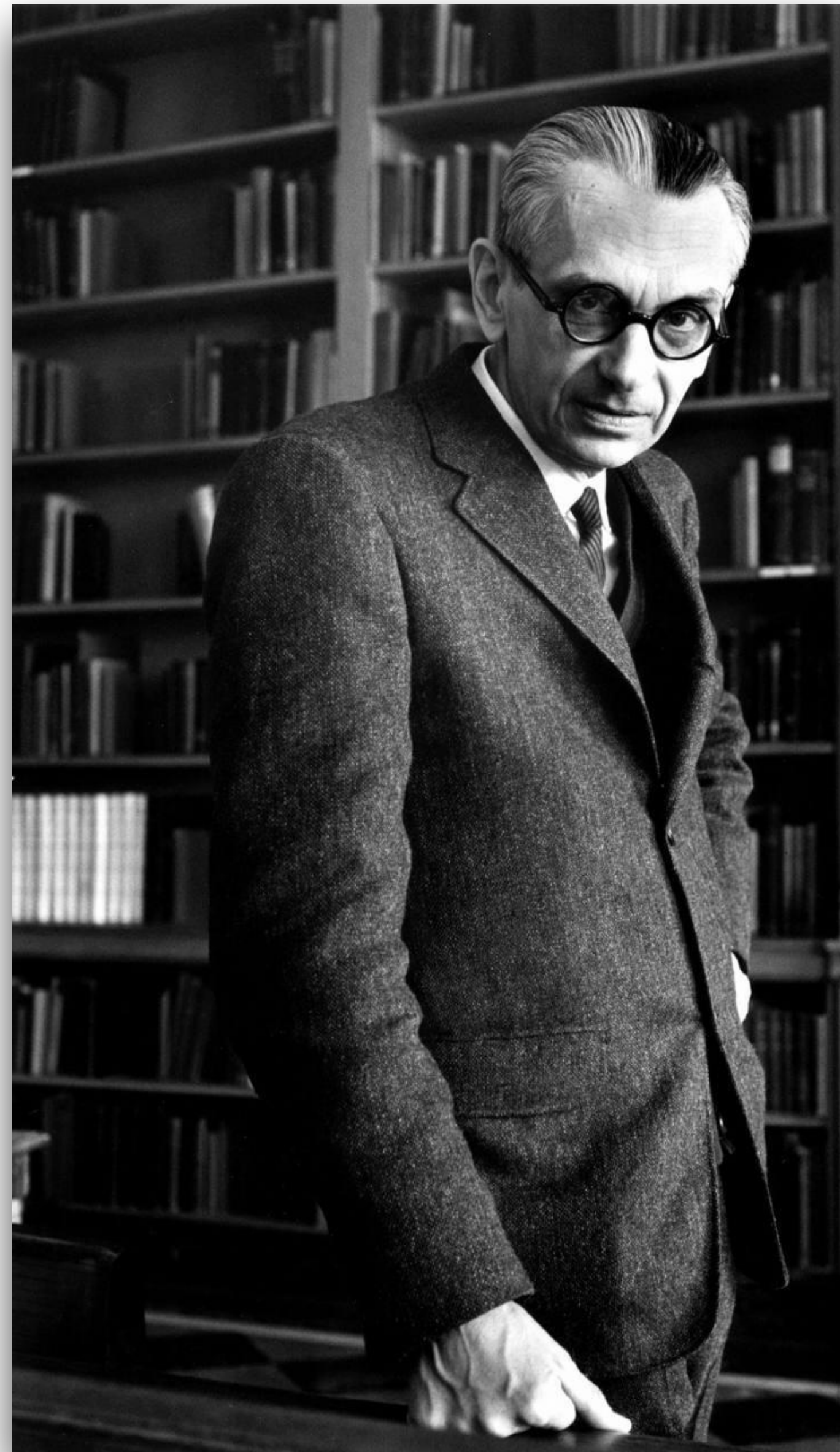
- Institutional switching emerges from a variety of short term selfish and “invisible” slow learning processes - *e.g. scientific institutions/revolutions*
- Institutional cycles emerge from compensation like-learning (“effort minimization”/“resource scarcity”) - *e.g. political/private institutions*
- Institutional Memory - Persistence (hysteresis) arises from institutional feedback in bistable regimes - *e.g. losing a habit is harder than acquiring it (systemic endowment effect)*



The Evolution of Constitutions

Changing the Rule Book of Society

When Godel visited Trenton, NJ - 5th Dec, 1947
(with Einstein and Morgenstern)



DRAFT

MEMORANDUM from MATHEMATICA

To:

Date: September 13, 1971

From: O. Morgenstern

Subject: History of the Naturalization of Kurt Gödel

The following is dictated on the basis of memory only without consultation of my notes and diaries. The concrete dates and other details will be filled in at another opportunity.

It was in 1946 that Gödel was to become an American citizen. He asked me to be his witness and as the other witness, he proposed Albert Einstein who also gladly consented. Einstein and I occasionally met and were full of anticipation^{as} to what would happen during this time prior to the naturalization proceedings themselves and even during those.

Gödel whom I have seen of course time and again in the months before this event began to go in a thorough manner to prepare himself properly. Since he is a very thorough man, he started informing himself about the history of the settlement of North America by human beings. That led gradually to the study of the History of American Indians, their various tribes, etc. He called me many times on the phone to get literature which he diligently perused. There were many questions raised gradually and of course many doubts brought forth as to whether these histories really were correct and what peculiar

circumstances were revealed in them. From that, Gödel gradually over the next weeks proceeded to study American history, concentrating in particular on matters of constitutional law. That also led him into the study of Princeton, and he wanted to know from me in particular where the borderline was between the borough and the township. I *tried* to explain that all this was totally unnecessary, of course, but with no avail. He persisted in finding out all the facts he wanted to know about and so I provided him with the proper information, also about Princeton.

Then he wanted to know how the Borough Council was elected, the Township Council, and who the Mayor was, and how the Township Council

Now came an interesting development. He rather excitedly told me that in looking at the Constitution, ^{how} he had found some inner contradictions to his distress, and that he could show ⁱⁿ a perfectly legal manner it would be possible for somebody to become a dictator and set up a Fascist regime, never intended by those who drew up the Constitution. I told him that it was most unlikely that such events would ever occur, even assuming that he was right, which of course I doubted. But he was persistent and so we had many talks about this particular point. I tried to persuade him that he should avoid bringing up such matters at the examination before the court in Trenton, and I also told Einstein about it: he was horrified that such an idea had occurred to Gödel, and he also told him he should not worry about these things nor discuss that matter.



Gödel: "It was a republic, but the constitution was such that it finally was changed into a dictatorship."

The Examiner: "Oh! This is very bad. This could not happen in this country."

Gödel: "Oh, yes, I can prove it."

So of all the possible questions, just that critical one was asked by the Examiner. Einstein and I were horrified during this exchange; the Examiner was intelligent enough to quickly quieten Gödel and say "Oh God, let's not go into this" and broke off the examination at this point, greatly to our relief. We finally left, and as we were walking out towards the elevators, a man came running after us with a piece of paper and a pen and approached Einstein and asked him for his autograph. Einstein obliged. When we went down in the elevator, I turned to Einstein and said, "It must be dreadful to be persecuted in this fashion by so many people." Einstein said to me, "You know, this is just the last remnants of cannibalism." I was puzzled and said, "How is that?" He said: "Yes, formerly they wanted your blood, now they want your ink."

we

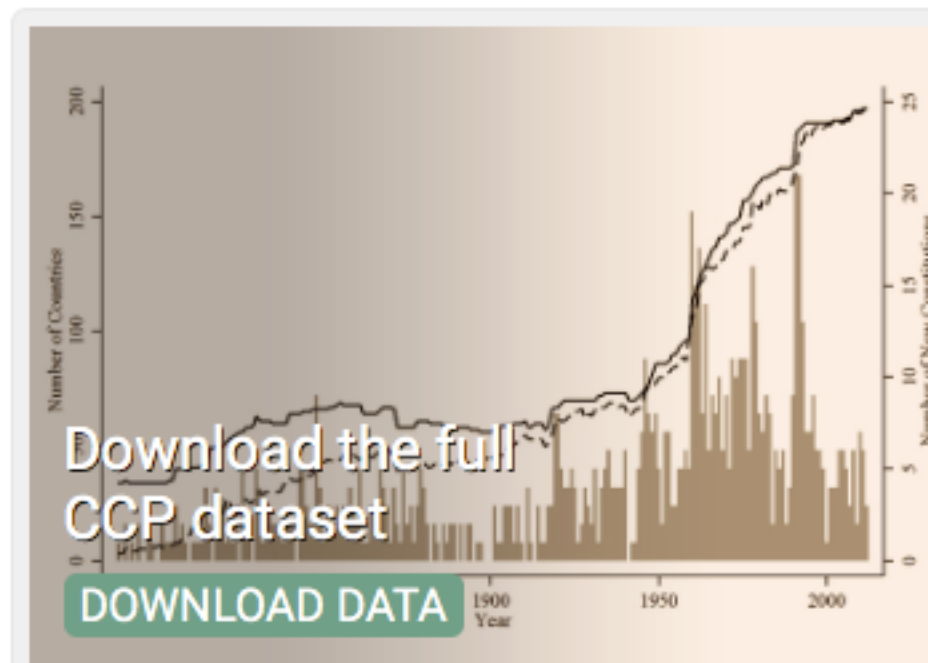
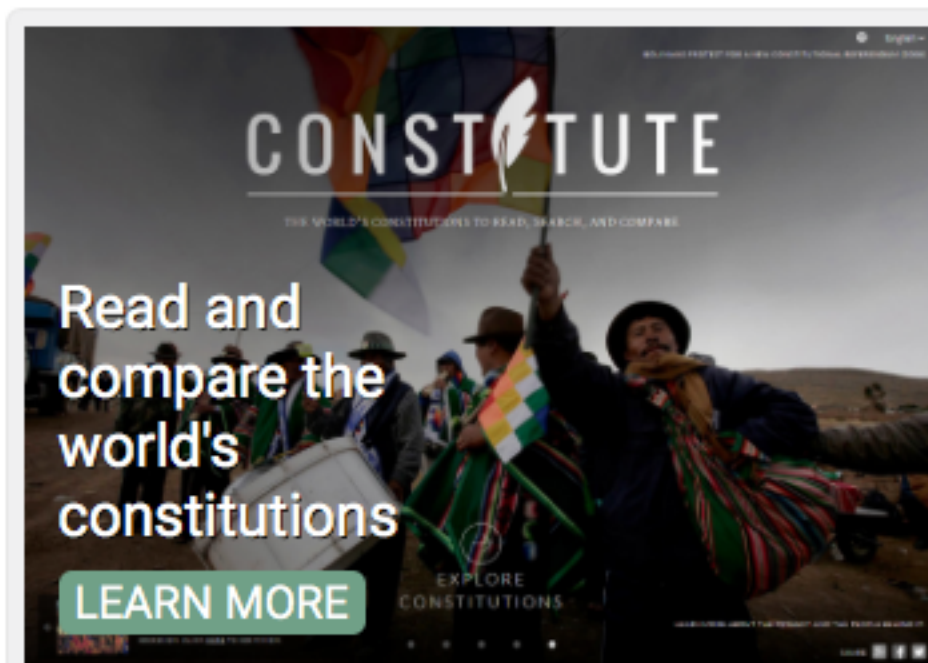


Signs urge Moroccans to vote on a constitutional referendum. Image by Christopher Rose.

Informing constitutional design

We are scholars who produce comprehensive data about the world's constitutions to promote peace, justice, and human development through the constitution making process. [Learn more >](#)

DONATE NOW



We the People

of the United States, in Order to form a more perfect Union, establish Justice, insure domestic Tranquillity, provide for the common defence, promote the general Welfare, and secure the Blessings of Liberty to ourselves and our Posterity, do ordain and establish this Constitution for the United States of America.

Article. 1.

Section. 1. All legislative Powers herein granted shall be vested in a Congress of the United States, which shall consist of a Senate and House of Representatives.

Section. 2. The House of Representatives shall be composed of Members chosen every second Year by the People of the several States, and the Electors in each State shall have Qualifications requisite for Electors of the most numerous Branch of the State Legislature.

No Person shall be a Representative who shall not have attained to the age of thirty five Years, and seven Years a Citizen of the United States, and who shall not, when elected, be an Inhabitant of that State in which he shall be chosen.

Representatives and direct Taxes shall be apportioned among the several States which may be included within this Union, according to their respective Numbers, which shall be determined by adding to the whole Number of free Persons, including those bound to Service for a Term of Years, and including Indians not taxed, three fifths of all other Persons. The actual Enumeration shall be made within three Years after the first Meeting of the Congress of the United States, and within every subsequent Term of ten Years, in such Manner as they shall by Law direct. The Number of Representatives shall not exceed one for every thirty thousand, but each State shall have at least one Representative; and until such Enumeration shall be made, the State of New Hampshire shall be entitled to choose three, Massachusetts eight, Rhode Island and Providence Plantations one, Connecticut five, New York six, Pennsylvania eight, Delaware one, Maryland one, Virginia ten, North Carolina five, South Carolina five, and Georgia three.

When vacancies happen in the Representation from any State, the Executive Authority thereof shall fill the Writs of Election to fill such Vacancies.

The House of Representatives shall choose their Speaker and other Officers; and shall have the sole Power of Impeachment.

Section. 3. The Senate of the United States shall be composed of two Senators from each State, chosen by the Legislature thereof, for six Years, and each Senator shall have one Vote.

Immediately after they shall be assembled in Consequence of the first Election, they shall be divided as equally as may be into three Clases. The Seats of the Senators of the first Class shall be vacated at the Expiration of the second Year, of the second Class at the Expiration of the fourth Year, and of the third Class at the Expiration of the sixth Year, so that one third may be chosen every second Year; and if Vacancies happen by Resignation, or otherwise, during the Course of the Session of any State, the Executive thereof may make temporary Appointments until the next Meeting of the Legislature, which shall then fill such Vacancies.

No Person shall be a Senator who shall not have attained to the Age of thirty Years, and been seven Years a Citizen of the United States, and who shall not, when elected, be an Inhabitant of that State for which he shall be chosen.

The Vice President of the United States shall be President of the Senate, but shall have no Vote, unless they be equally divided.

The Senate shall choose their other Officers, and also a President pro tempore, in the Absence of the Vice President, or when he shall exercise the Office of President of the United States.

The Senate shall have the sole Power to try all Impeachments. When sitting for that Purpose, they shall be on Oath or Affirmation. When the President of the United States is tried, the Chief Justice shall preside. And no Person shall be convicted without the Concurrence of two thirds of the Members present.

Judgment in Cases of Impeachment shall not extend further than to removal from Office, and disqualification to hold and enjoy any Office of honor, Trust, or Profit under the United States; but the Party convicted shall nevertheless be liable and subject to Indictment, Trial, Judgment, and Punishment, according to Law.

Section. 4. The Times, Places and Manner of holding Elections for Senators and Representatives, shall be prescribed in each State by the Legislature thereof; but the Congress may at any time by Law make or alter such Regulations, except as to the Places of choosing Senators.

The Congress shall assemble at least once in every Year, and such Meetings shall be on the first Monday in December, unless they shall by Law appoint a different Day.

Section. 5. Each House shall be the Judge of the Elections, Returns and Qualifications of its own Members, and a Majority of each shall constitute a Quorum to do Business, but a smaller Number may adjourn from day to day, and may be authorized to compel the Attendance of absent Members, in such Manner, and under such Penalties as each House may provide.

Each House may determine the Rules of its Proceedings, punish its Members for disorderly Behavior, and, with the Concurrence of two thirds, expel a Member.

Each House shall keep a Journal of its Proceedings, and from time to time publish the same, excepting such Parts as in their Judgment require Secrecy; and the Yeas and Nays of the Members of either House on any question shall not be Recorded, unless by yeas and Nays of two thirds of the Members of that House.

Neither House, during the Session of Congress, shall, without the Consent of the other, adjourn for more than three Days, nor hold any Session at a Place other than that in which the last Session shall be holding.

Section. 6. The Senators and Representatives shall receive a Compensation for their Services, to be ascertained by Law, and paid out of the Treasury of the United States. They shall in all Cases, except Treason, Felony, and Breach of the Peace, be privileged from Arrest during their Attendance at the Session of their respective Houses, and in going to and returning from the same, and for any Speech or Debate in either House, they shall not be questioned in any other Place.

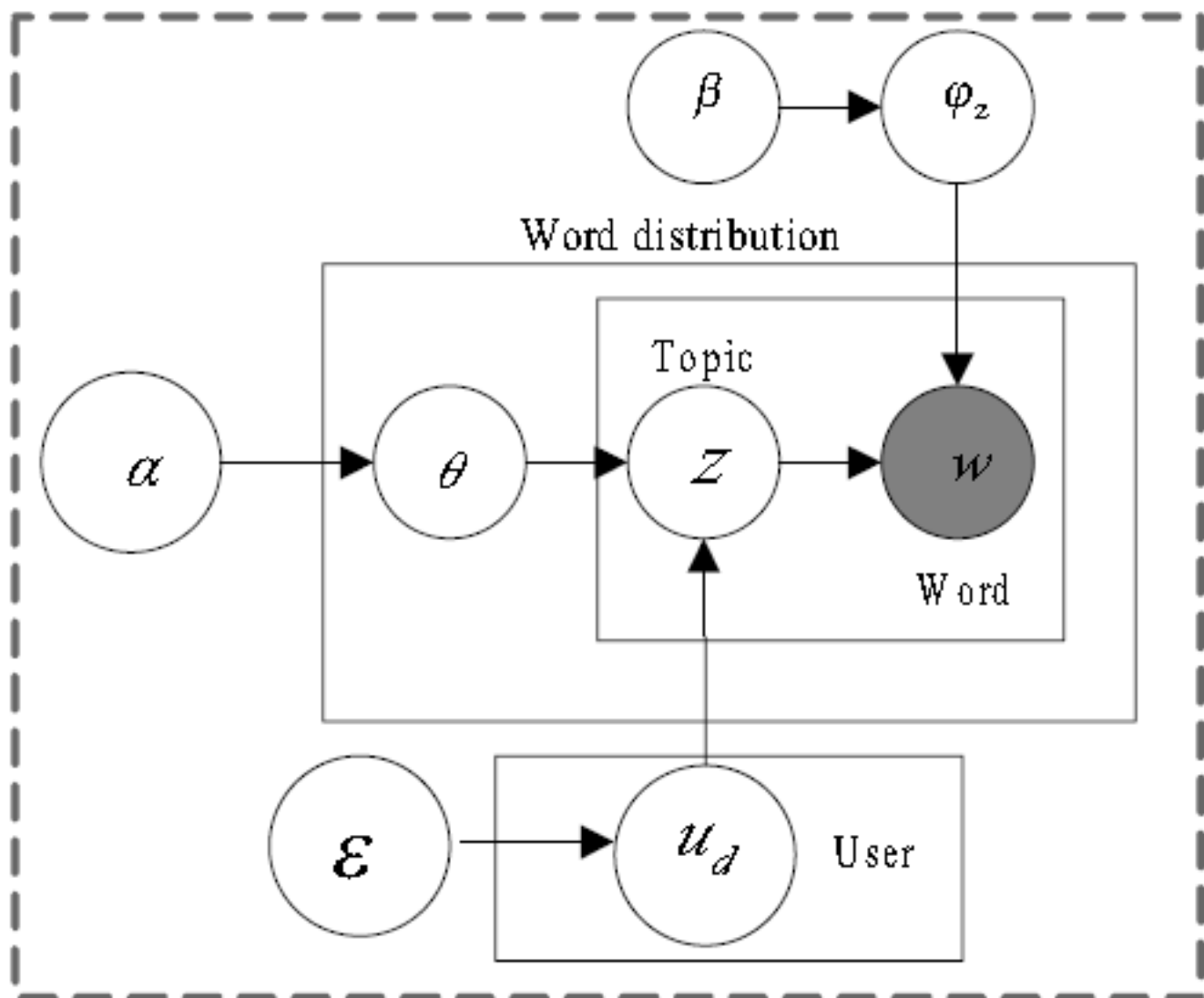
No Senator or Representative shall, during the Term for which he was elected, be appointed to any civil Office under the Authority of the United States which shall have been created, or the Emoluments whereof shall have been increased during such Term; and no Person holding any Office under the United States shall be a Member of either House during the Continuance in Office.

Section. 7. All Bills for raising Revenue shall originate in the House of Representatives; but the Senate may propose or concur with Amendments as to the Matter of such Bills. Every Bill which shall have passed by yeas and Nays of a majority of both Houses, shall before it become a Law, be presented to the President of the United States; and if he approve, he shall sign it, and it shall become a Law; or if he disapprove it, he shall return it with his Objections to the House of Representatives, in which it shall be recorded, and the House may reconsider it. If after such Reconsideration two thirds of the House shall agree to pass the Bill, he shall sign it, and it shall become a Law. If the Senate concur with the House, after such Reconsideration, two thirds of that Body shall pass the Bill, he shall sign it, and it shall become a Law.



Topic Modeling

Breaking a Document into Lexical Units



music band songs rock album jazz pop song singer night	book life novel story books man stories love children family	art museum show exhibition artist jazz paintings painting century works	game knicks nets points team season play games night coach	show film television movie series says life man character know
theater play production show stage street broadway director musical directed	clinton bush campaign gore political republican dole presidential senator house	stock market percent fund investors funds companies stocks investment trading	restaurant sauce menu food dishes street dining dinner chicken served	budget tax governor county mayor billion taxes plan legislature fiscal



$$p(Z, \theta_{1:N}, \beta_{1:K} | W, \alpha, \eta) = \frac{p(W | Z, \theta_{1:N}, \beta_{1:K}) p(Z, \theta_{1:N}, \beta_{1:K} | \alpha, \eta)}{p(W | \alpha, \eta)}$$



JOSHUA THOMPSON with his sons, Wyatt and Jordan, after his diagnosis, above, and before, with his wife, Joy, and Wyatt.

Fighting for a Last Chance at Life

One Family's Tenacious Campaign for Access to an Unproven Drug

By AMY HARMON
VIRGINIA BEACH — As Lou Gehrig's disease sapped Joshua Thompson of his ability to move and speak last fall, he consistently summoned one question from within the prison of his own body. "I hope,"



cells and genetics generate greater hope for experimental therapies, there is little consensus on how and when to provide them to dying patients whose lives could be prolonged, or shortened, by trying them.

From a Theory To a Consensus On Emissions

Permits Gain Political Edge Over Taxation

By JOHN M. BRODER

WASHINGTON — As Congress weighs imposing a mandatory limit on climate-altering gases — an outcome still far from certain — it is likely to turn to a system that sets a government ceiling on total emissions and allows polluting industries to buy and sell permits to meet it.

That approach, known as cap and trade, has been embraced by President Obama, Democratic leaders in Congress, mainstream environmental groups and a growing number of business interests, including energy-consuming industries like autos, steel and aluminum.

But not long ago, many of today's supporters dismissed the idea of tradable emissions permits as an industry-inspired Republican scheme to avoid the real costs of cutting air pollution. The right answer, they said, was strict government regulation, state-of-the-art technology and a federal tax on every ton of harmful emissions.

How did cap and trade, hatched as an academic theory in obscure economic journals half a century ago, become the policy of choice in the debate over how to slow the heating of the planet?

And how did it come to eclipse the idea of simply slapping a tax on energy consumption that defouls the public square or leaves the nation hesitant to forgo oil

CONSERVATIVES MAP STRATEGIES ON COURT FIGHT

MEMOS OUTLINE ATTACKS

Hoping to Re-Energize G.O.P. by Opposing Obama's Choice

By CHARLIE SAVAGE

WASHINGTON — If President Obama nominates Judge Diane P. Wood to the Supreme Court, conservatives plan to attack her as an "outsider" supporter of abortion, including partial-birth abortion.

If he nominates Judge Sonia Sotomayor, they plan to accuse her of being "willing to expand constitutional rights beyond the text of the Constitution."

And if he nominates Kathleen M. Sullivan, a law professor at Stanford, they plan to denounce her as a "prominent supporter of homosexual marriage."

Preparing to oppose the confirmation of Mr. Obama's eventual choice to succeed Justice David H. Souter, who is retiring, conservative groups are working together to stockpile ammunition. Ten memorandums summarizing their research, obtained by The New York Times, provide a window onto how they hope to frame the coming debate.

The memorandums dissect possible nominees' records, noting statements the groups find objectionable on issues like abortion, economic stimulus, the

Expert Semantic Enrichment...(Tom's Job)

Topic name	Top words in topic
Monarchy	king royal kingdom state estates storting general throne
Organizational structure	article chapter law manner must following articles established
General rights	article right rights citizens everyone state established freedoms
Sovereignty	state people constitution democratic national political sovereignty
Judiciary	court courts supreme judges judicial justice law office
Executive branch	article executive chapter branch general case ministers law
Misc 1	legislative public title order rights civil body citizens
Socio-economic rights	right education social work health protection children conditions
Electoral process	elected election president term office elections votes candidate
Cabinet formation	government minister prime ministers confidence vote president
Criminal Procedure	right law one person cases criminal personal liberty
Amendment process	constitution force law provisions amended date day amendment
Foreign Policy	president state appoint war laws supreme foreign ministers
Lawmaking process	majority vote referendum members draft law number adopted
Legislative powers	congress states nation power laws foreign case made
Civil liberties (freedoms)	freedom right public religious religion law information order
Lawmaking authority	article bodies constitution procedure constitutional laws acts law
Legislative formation	deputies chamber session deputy senate chambers sessions term
Term length	years one senate two three members number first
Republic of Croatia	republic president present croatian laws referendum powers
Economic System	economic social development policy resources promote property
Regulate	article provisions accordance well regulated first second
constitutional adjudication	constitutional court law article decision constitution legal decide
Misc 2	organic constitutional case exercise conditions government
Committee structure	committee committees members parliamentary standing rules
Presidential responsibilities	president office vice functions elected hold duties term
Separation of powers	power laws law constitution executive provisions powers
Socialism	people state socialist work working prescribed power economic
Budget and Finance	budget financial public audit bank year fiscal funds
Local governance	local municipal government municipalities municipality units
Cabinet structure	council members member elected two following one among
Commissions	office commission public person member appointed functions
Establishment of national power	national established establish accordance pass country elect
International agreements	international treaties agreements treaty european government
Human rights	rights human right persons language freedoms respect
Legislative procedure	bill passed assent bills senate president presented referred
Prime Minister	minister prime office accordance person functions appointment
House of Representatives	house representatives houses members constitution senate states
Legislative representation	people state article congress saeima organs ethnic standing
Legislative assembly	assembly members legislative vote majority three days provided
Internal Organization of legislature	speaker member person deputy members sitting time chairman
Public power	public law accordance established organization general organs
Misc 3	state provide law affairs determined institution whole certain

The World

The World

The World

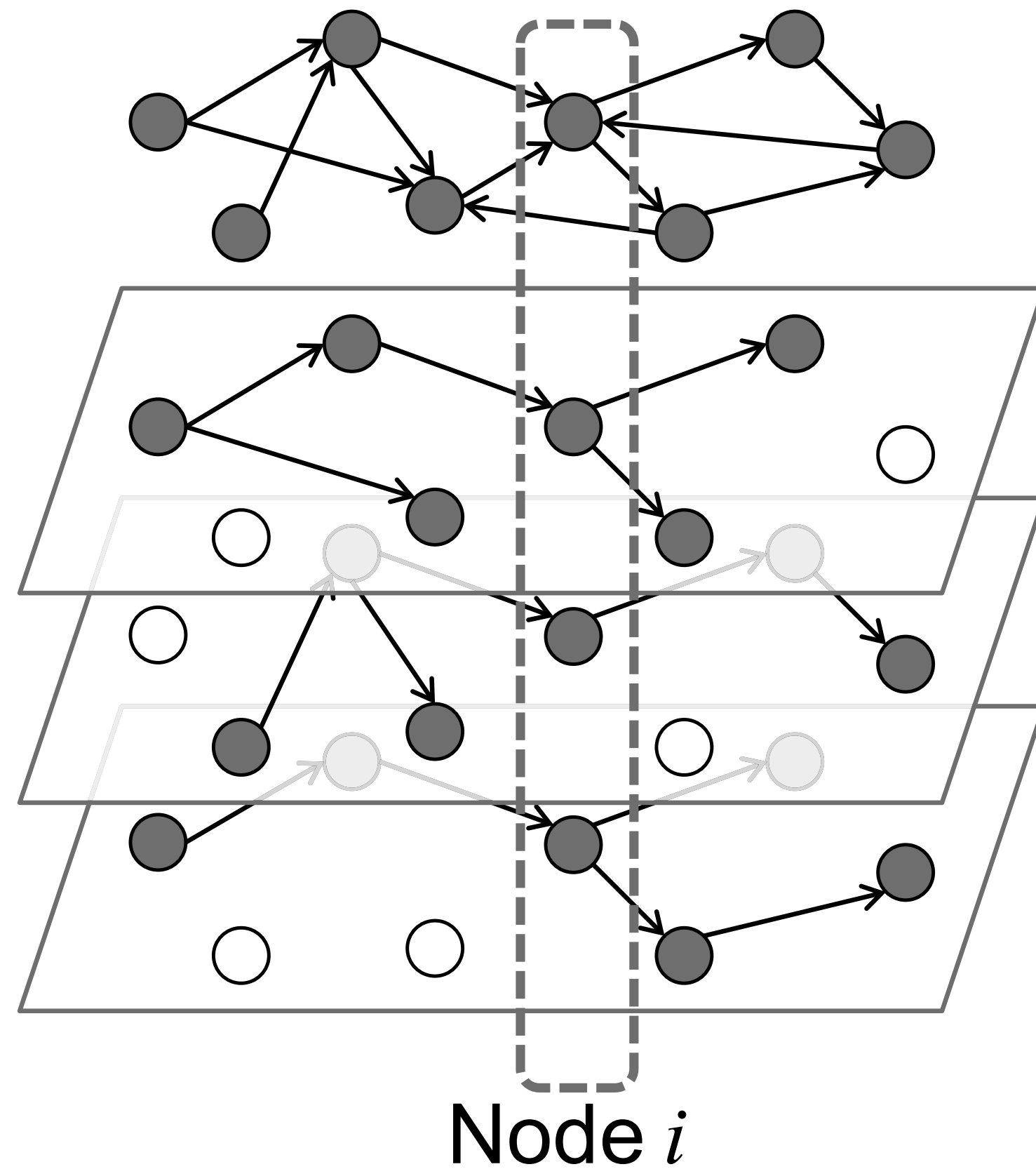
The World

Time



Observed: time of topic appearance in node $v \{v, t(v)\}$

M. Gomez-Rodriguez et al. 2012



Network $G^* \{u, v, t(v)\}$

Cascade c_1

Cascade c_2

Cascade c_3

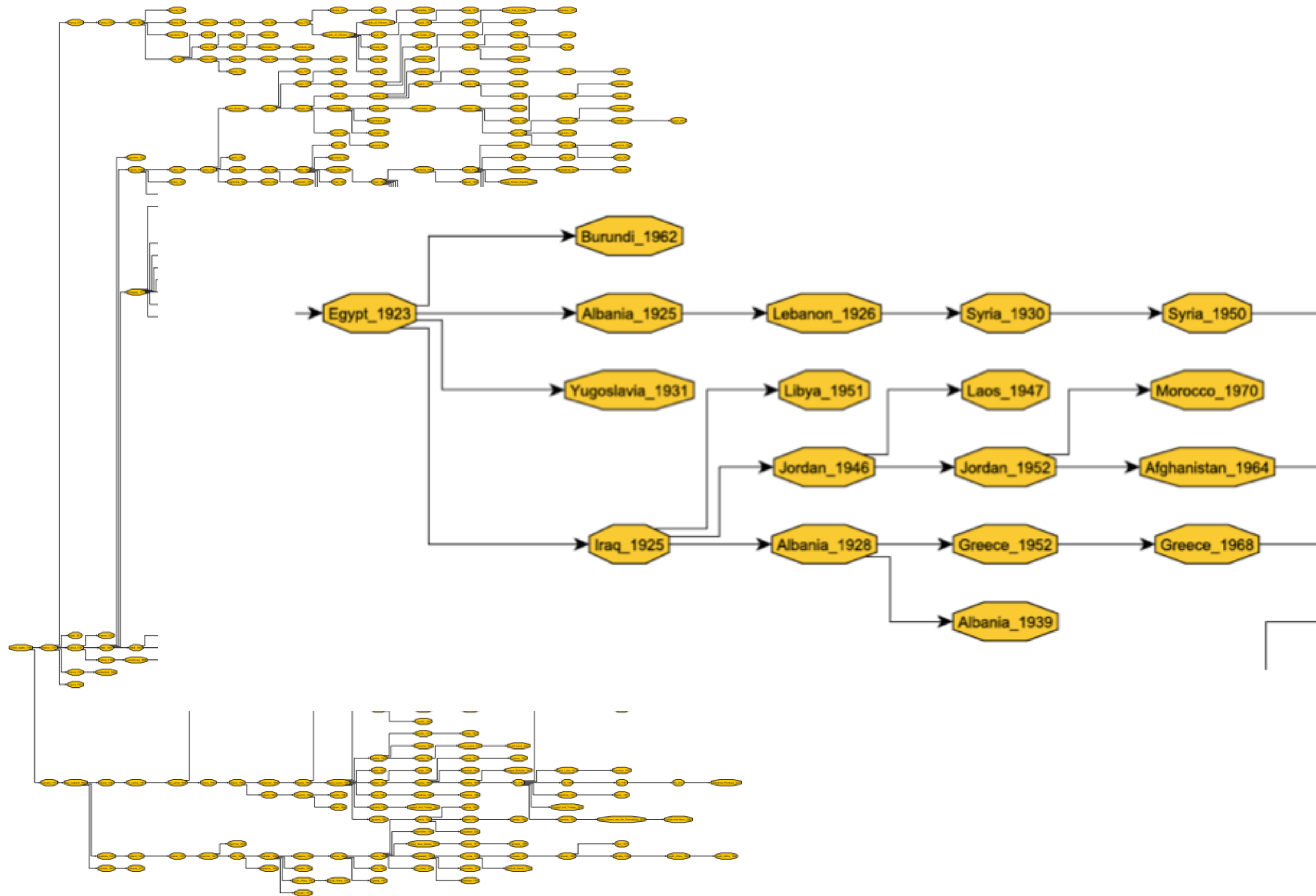
cascade = single parent

$$P_c(u, v) = P_c(\Delta_{u,v}) \propto e^{-\frac{\Delta_{u,v}}{\alpha}} \text{ and } P_c(u, v) = P_c(\Delta_{u,v}) \propto \frac{1}{\Delta_{u,v}^\alpha}.$$

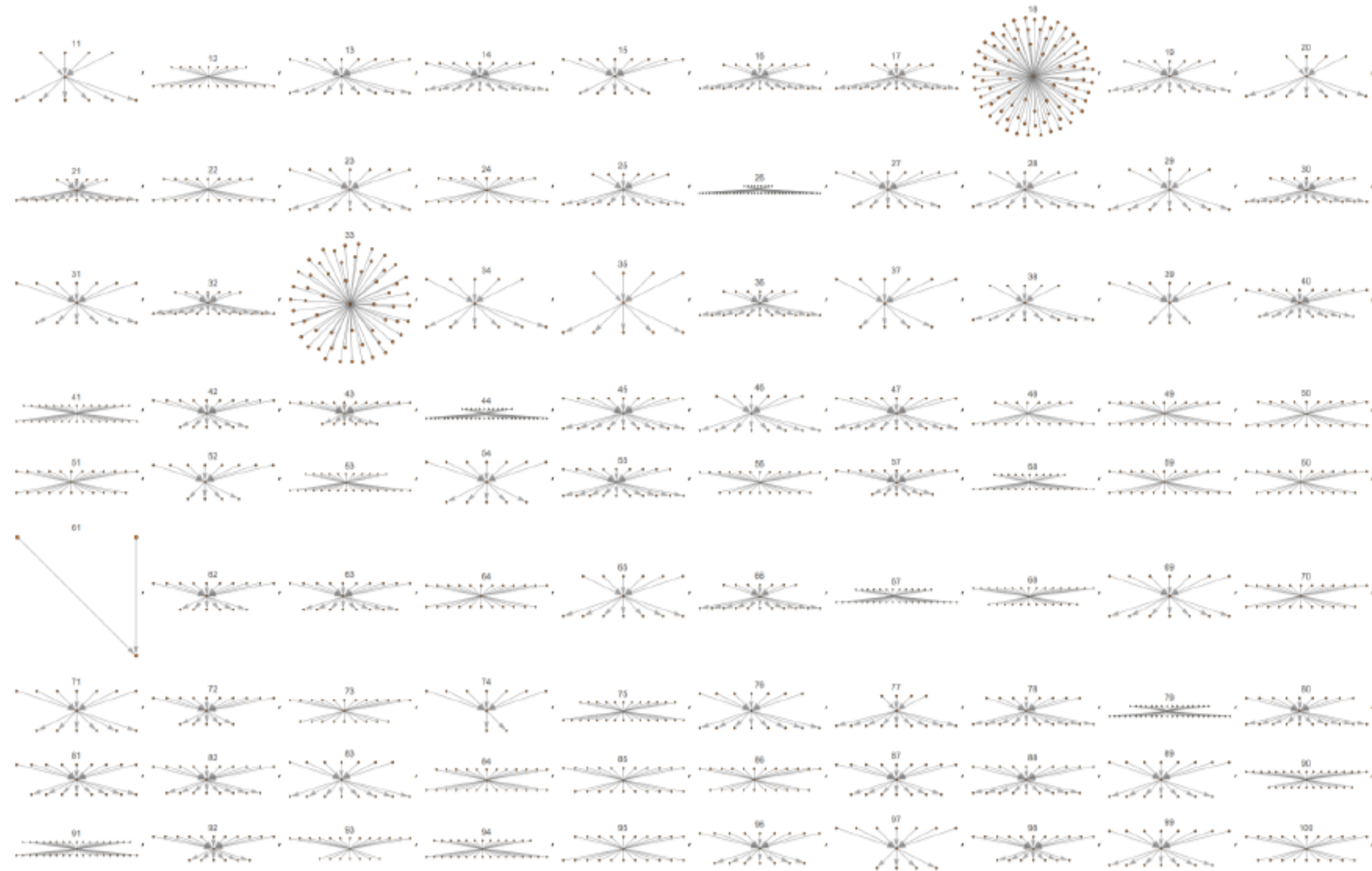
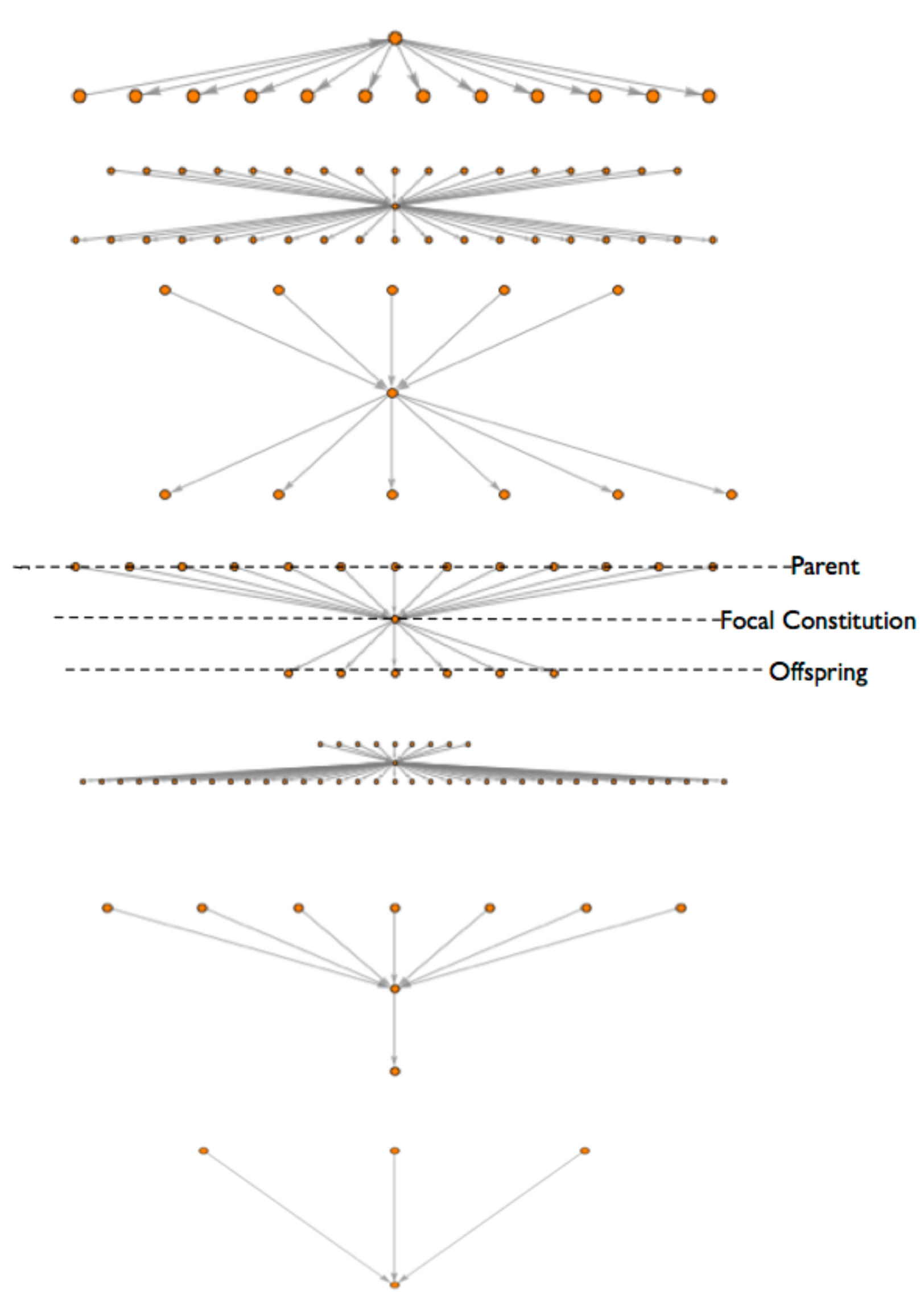
$$P(c|T) = \beta^q (1 - \beta)^r \prod_{(u,v) \in E_T} P_c(u, v),$$

$$P(c|G) = \sum_{T \in \mathcal{T}_c(G)} P(c|T) P(T|G), \quad P(C|G) = \prod_{c \in C} P(c|G),$$

$$\hat{G} = \operatorname{argmax}_{|G| \leq k} P(C|G),$$



The “Geometry” of Influence & transformation



Canada, 1791



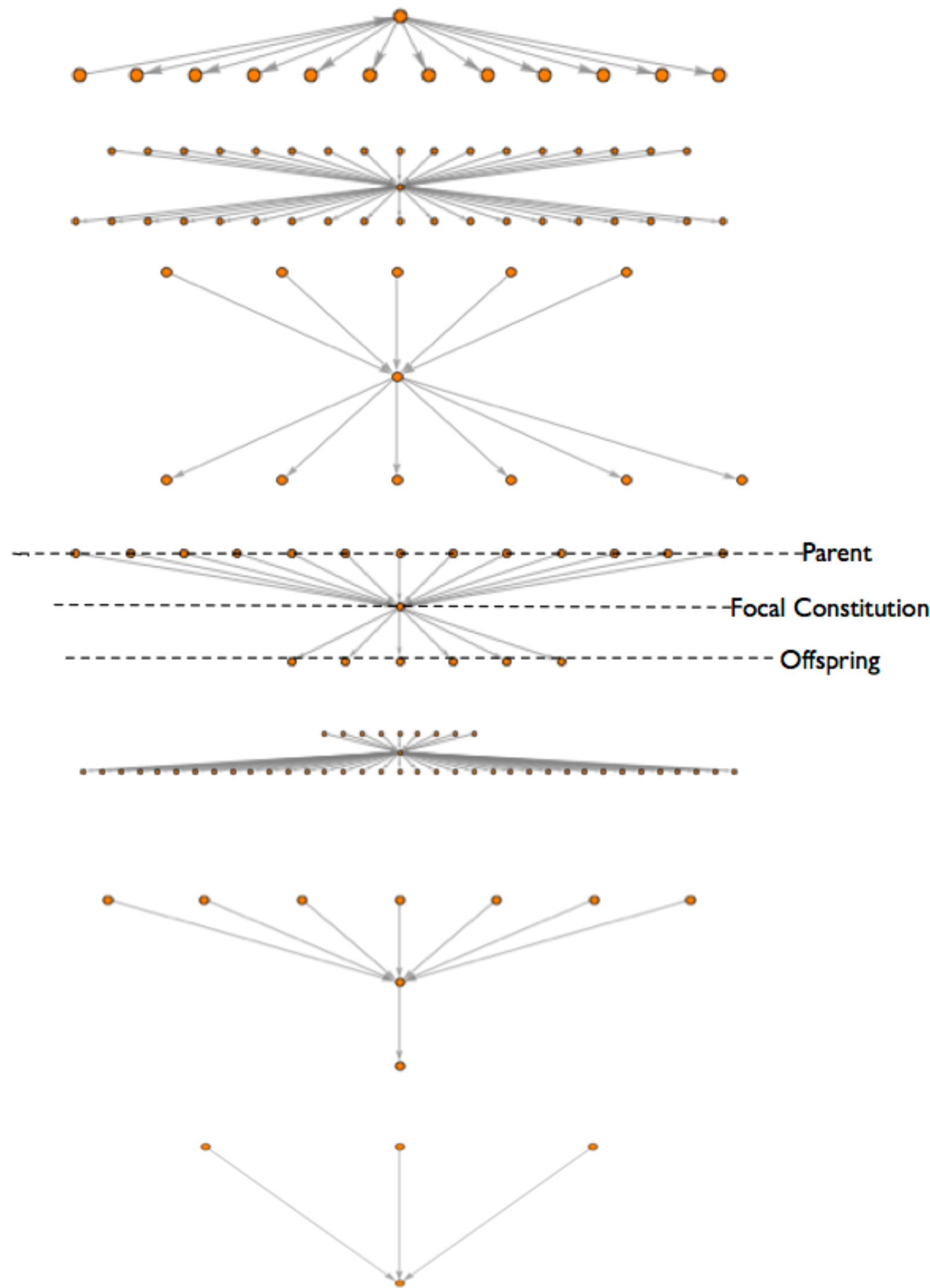
Bolivia, 1826



South Korea, 1948



Montenegro, 1992



Iceland, 1874



Venezuela, 1830



Albania, 1976



Yule Process

$$P\{N(t) = n\} = P_n(t)$$

$$\text{Prob. of birth in } (t, t + h) \text{ if } \{N(t) = n\} = n\lambda h + o(h)$$

$$\begin{aligned} P_n(t + h) &= P_n(t)(1 - n\lambda h + o(h)) \\ &\quad + P_{n-1}(t)((n - 1)\lambda h + o(h)) \end{aligned}$$

$$P_n(t + h) - P_n(t) = -n\lambda h P_n(t) + P_{n-1}(t)(n - 1)\lambda h + o(h)$$

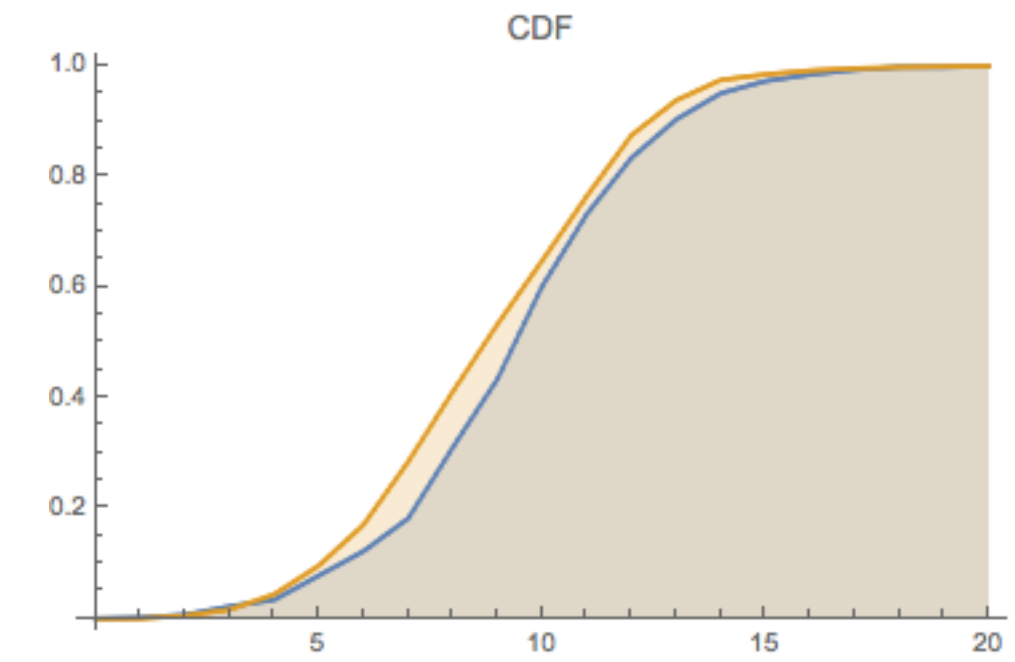
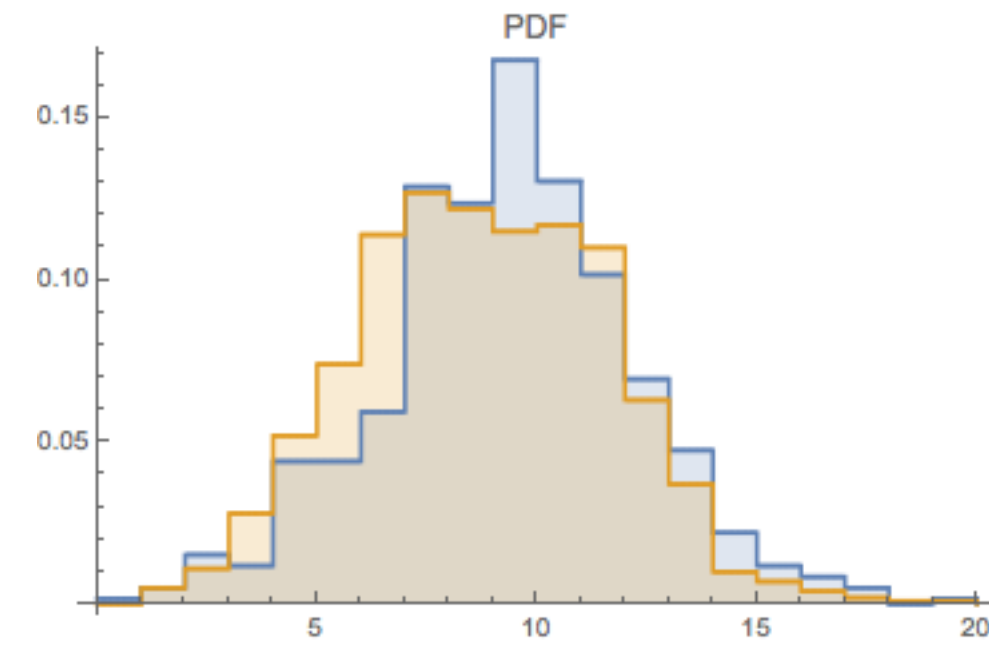
$$\frac{P_n(t + h) - P_n(t)}{h} = -n\lambda P_n(t) + P_{n-1}(t)(n - 1)\lambda + o(h) \text{ as } h \rightarrow 0$$

$$\boxed{P'_n(t) = -n\lambda P_n(t) + (n - 1)\lambda P_{n-1}(t)}$$

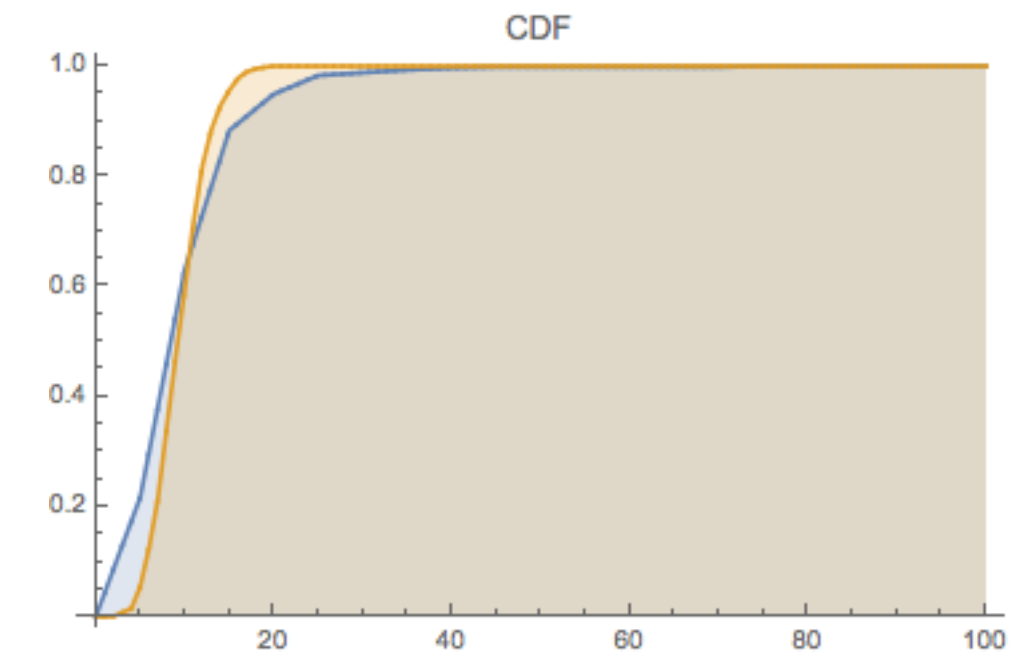
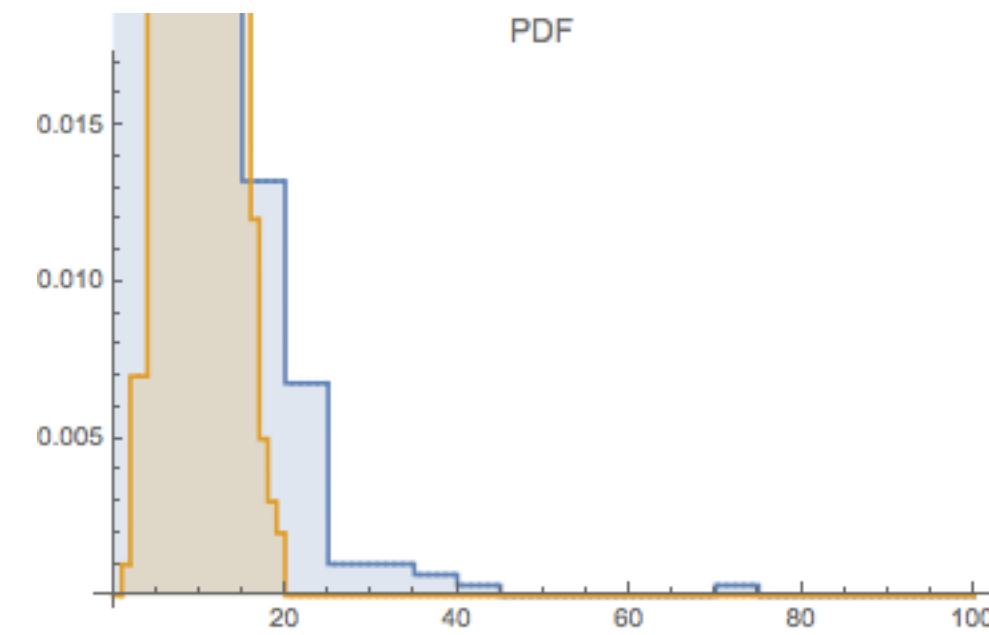
$$\text{Initial condition } P_{n_0}(0) = P\{N(0) = n_0\} = 1$$

$$P_n(t) = \binom{n-1}{n-n_0} e^{-\lambda n_0 t} (1 - e^{-\lambda t})^{n-n_0} \quad \text{Negative Binomial}$$

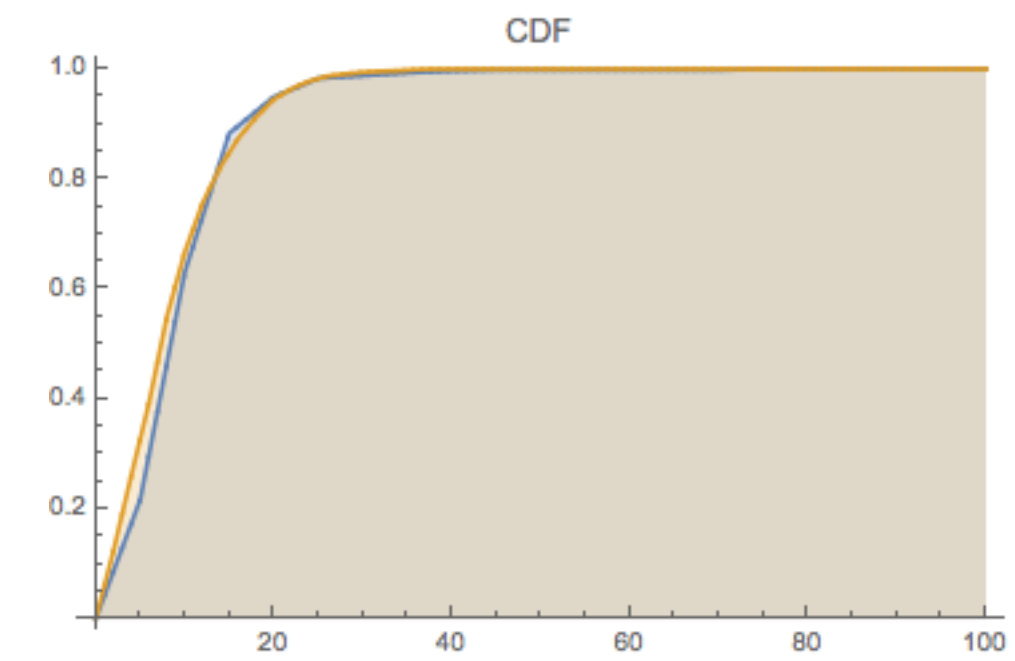
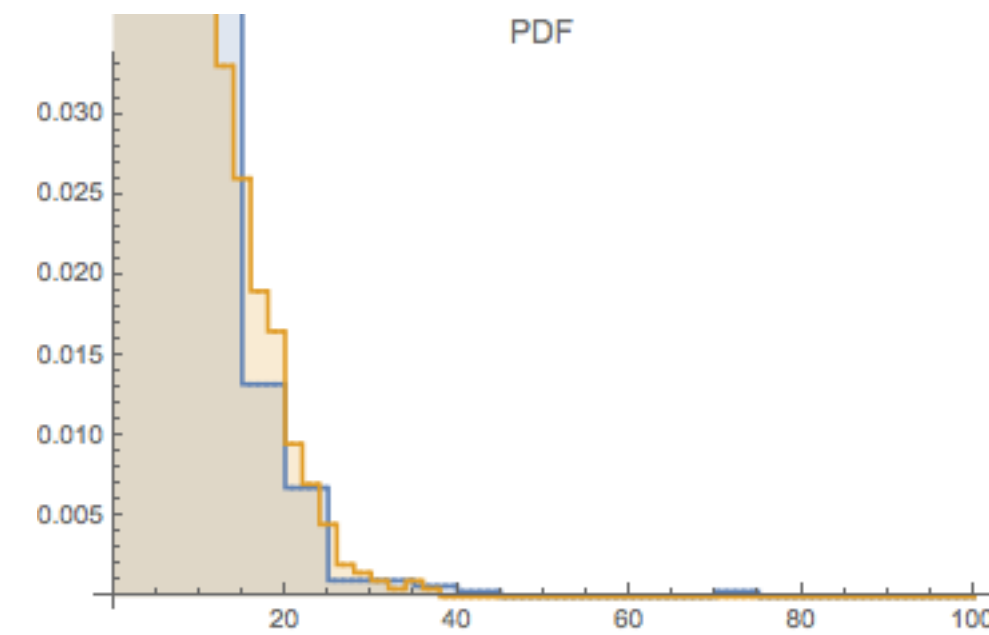
{in-degree, gaussian}



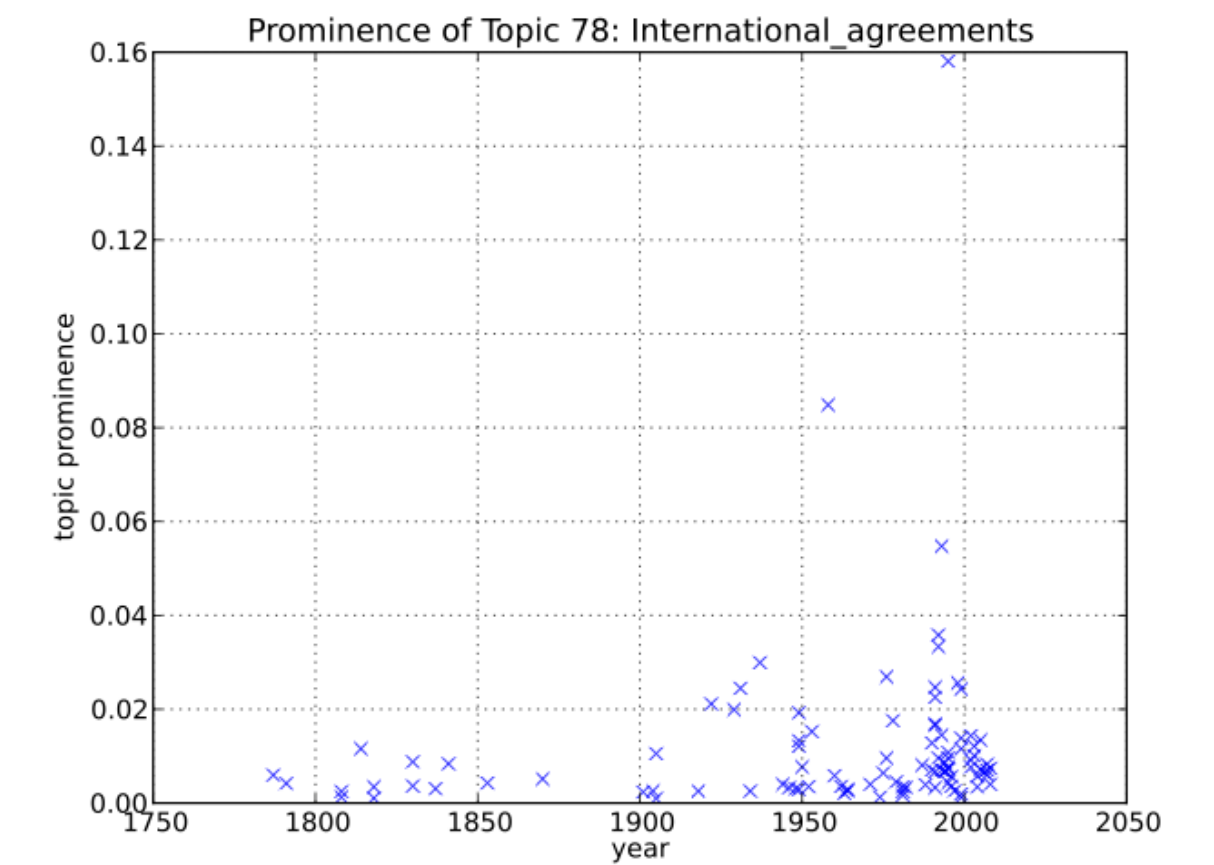
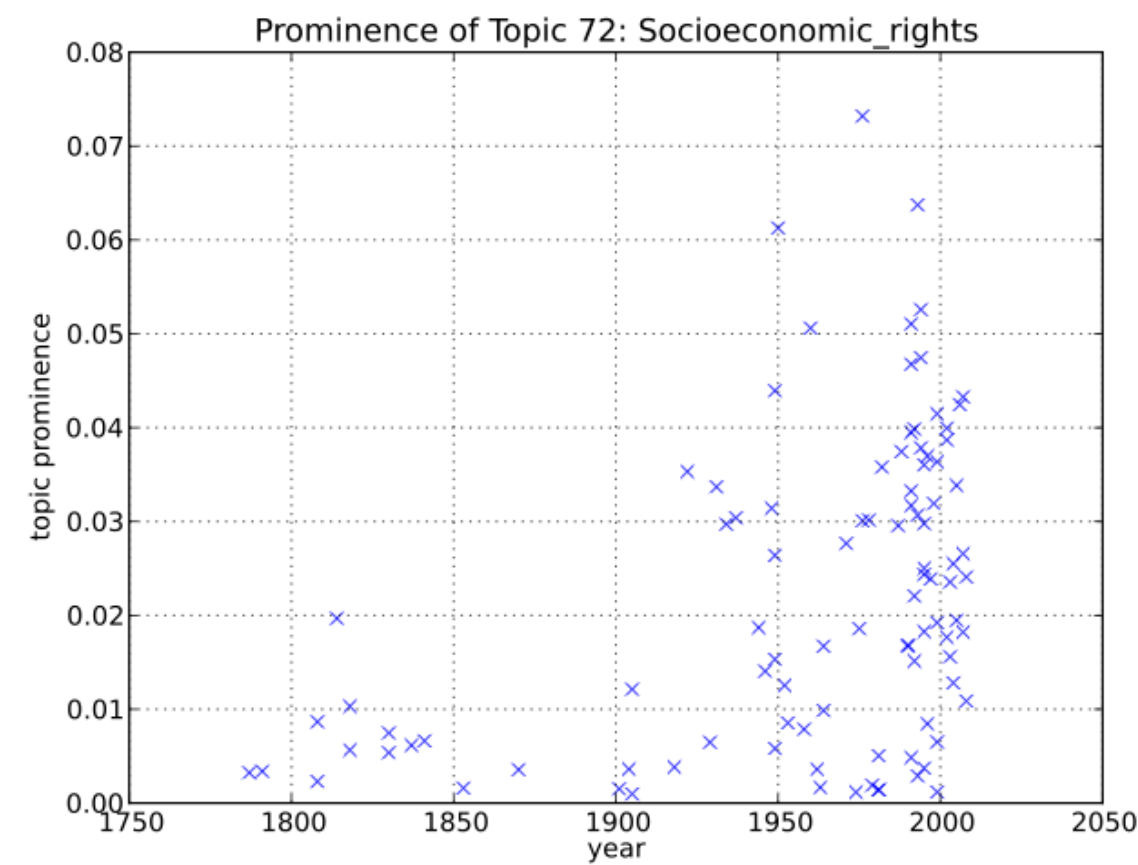
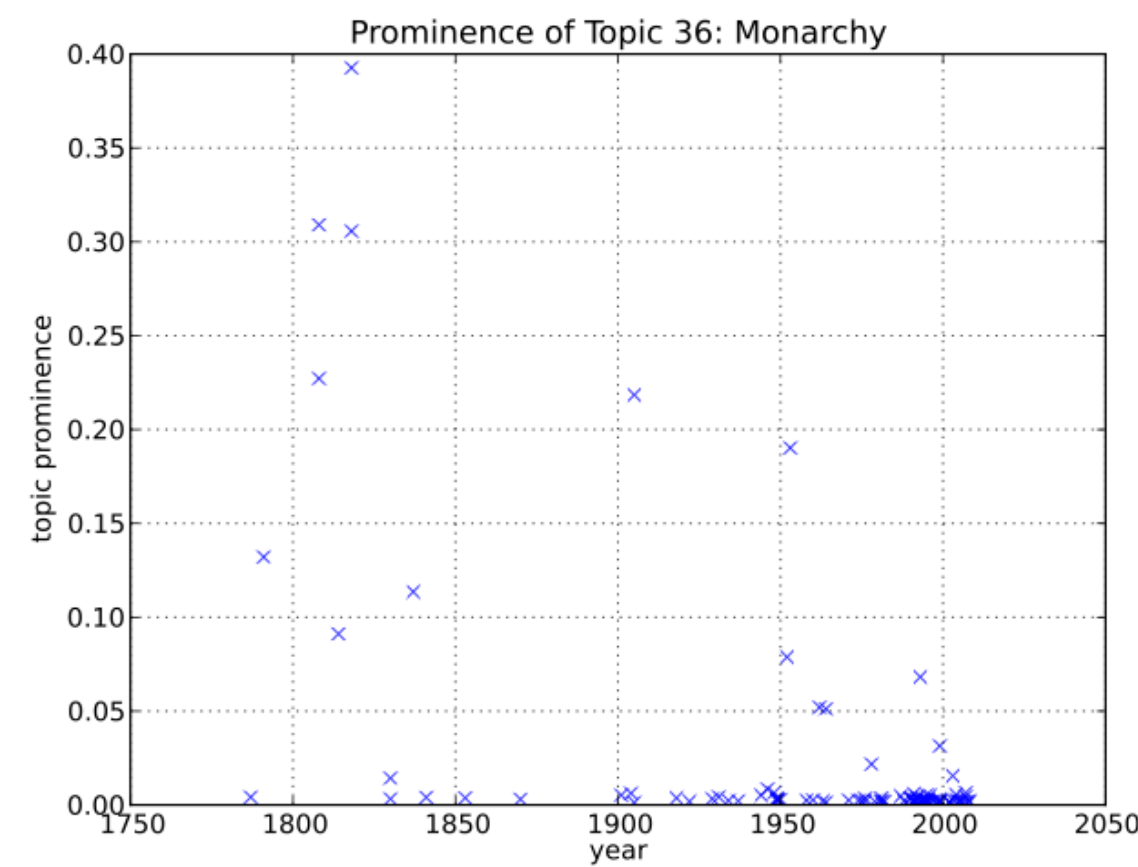
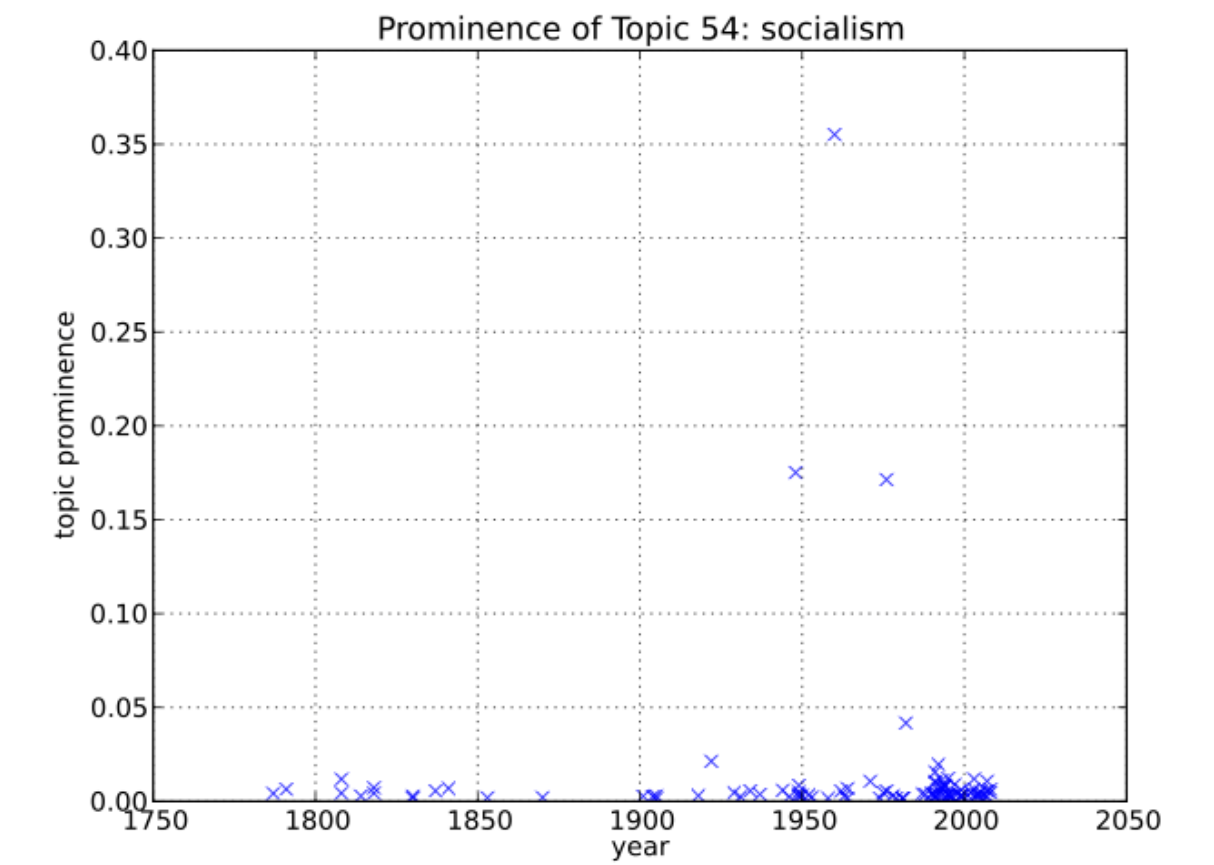
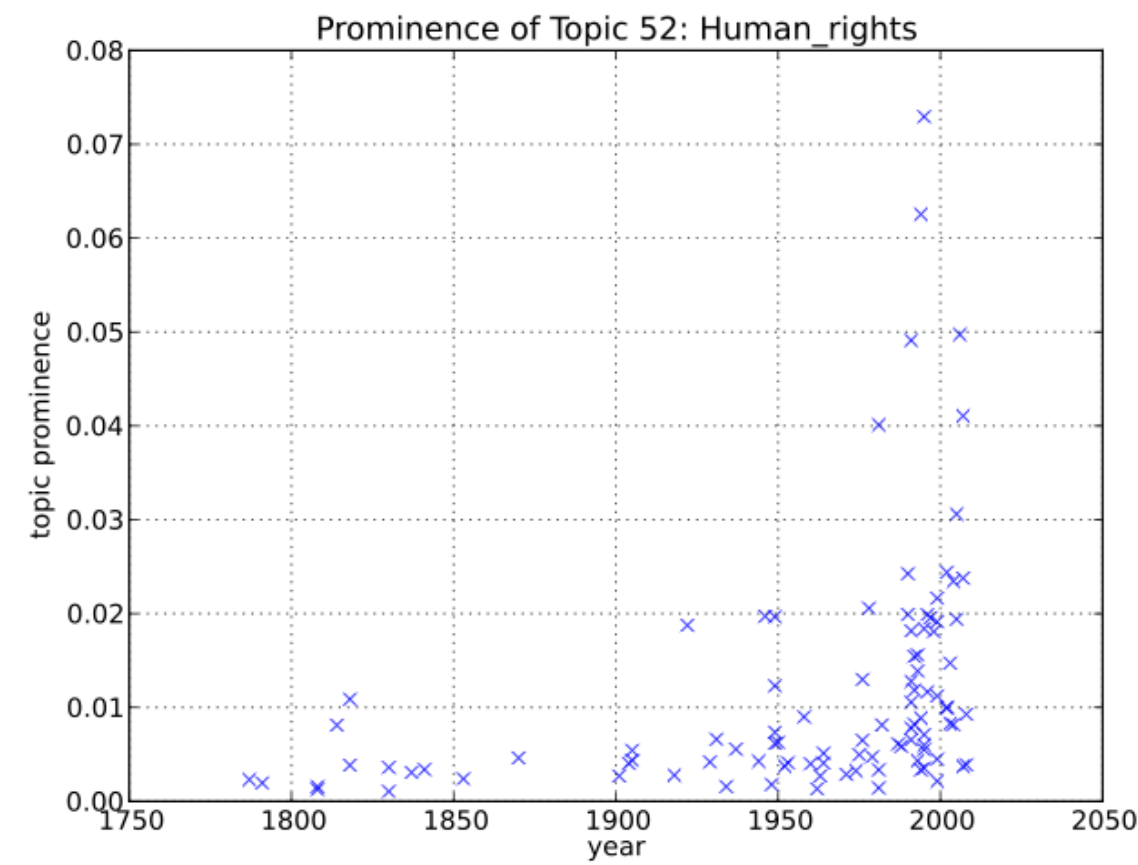
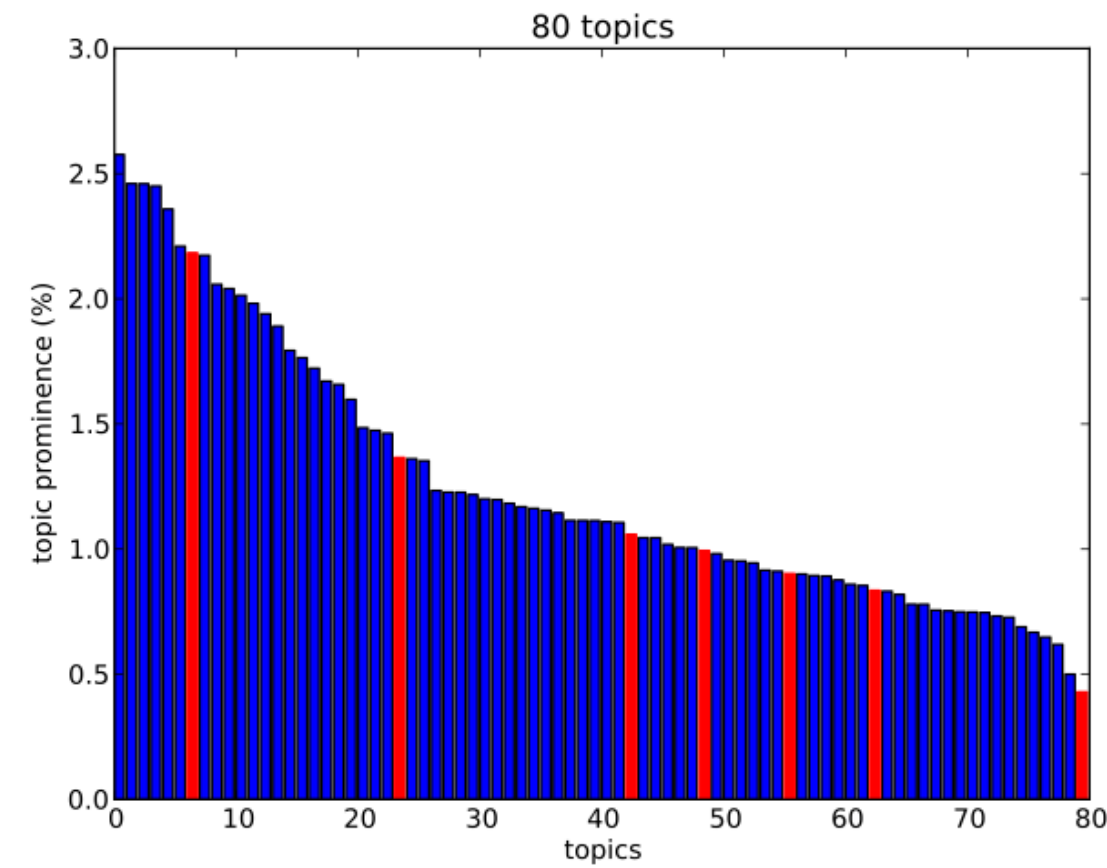
{out-degree, poisson}



{out-degree, negative binomial}



How do the topics diffuse in time?



Decline

Growth

Transients

USA

Canada

French Revolution



1789

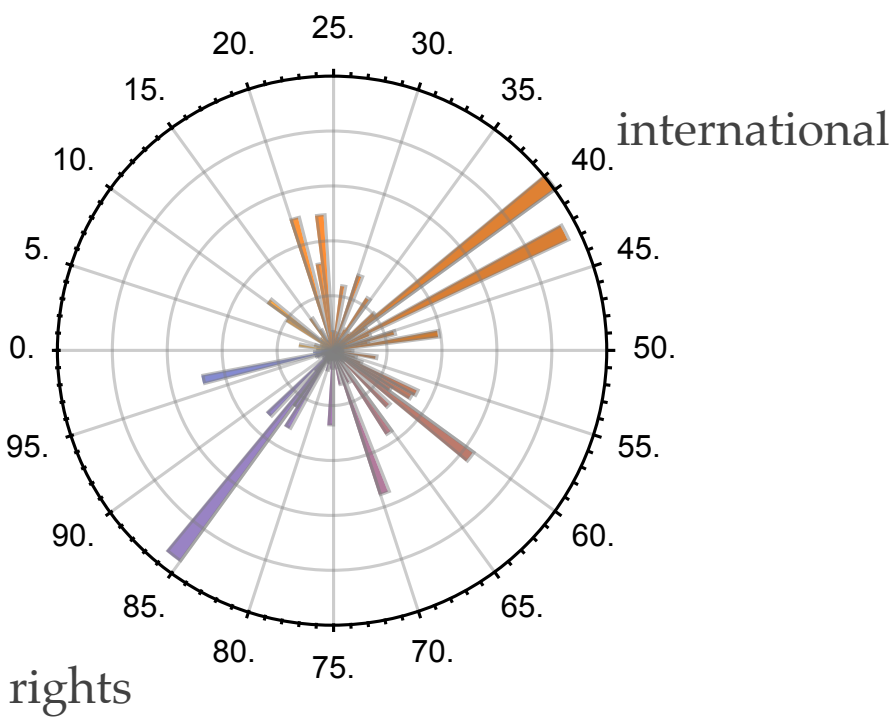
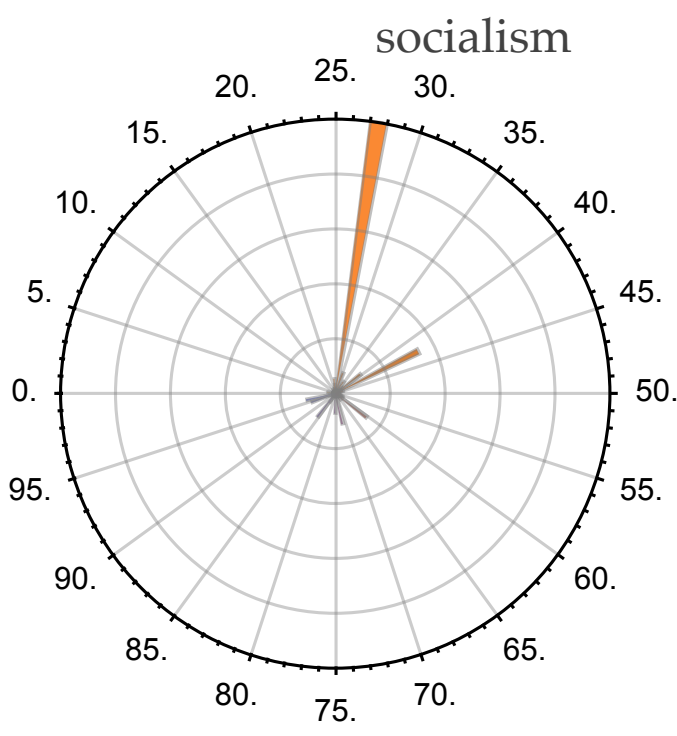
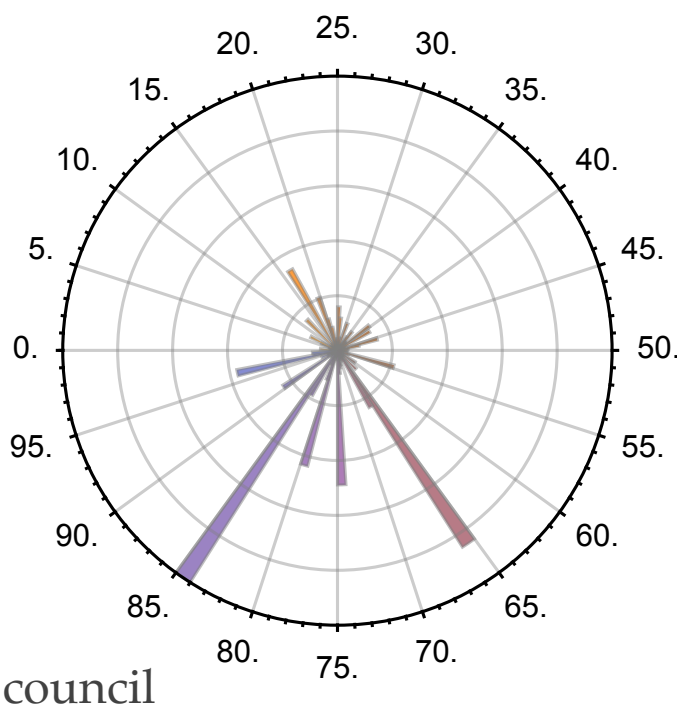
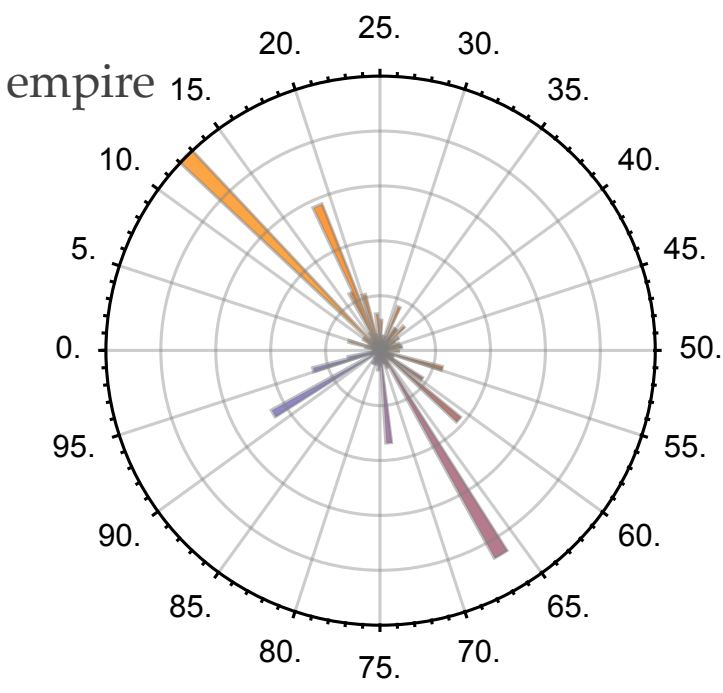
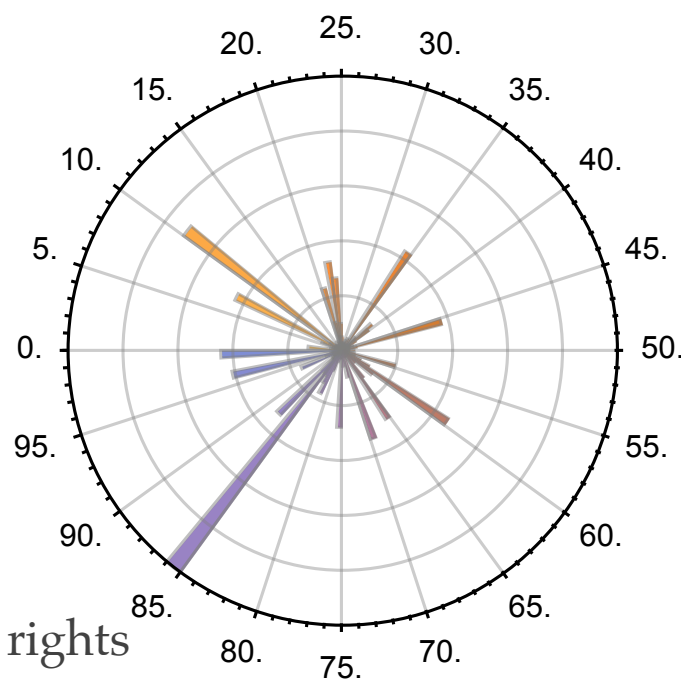
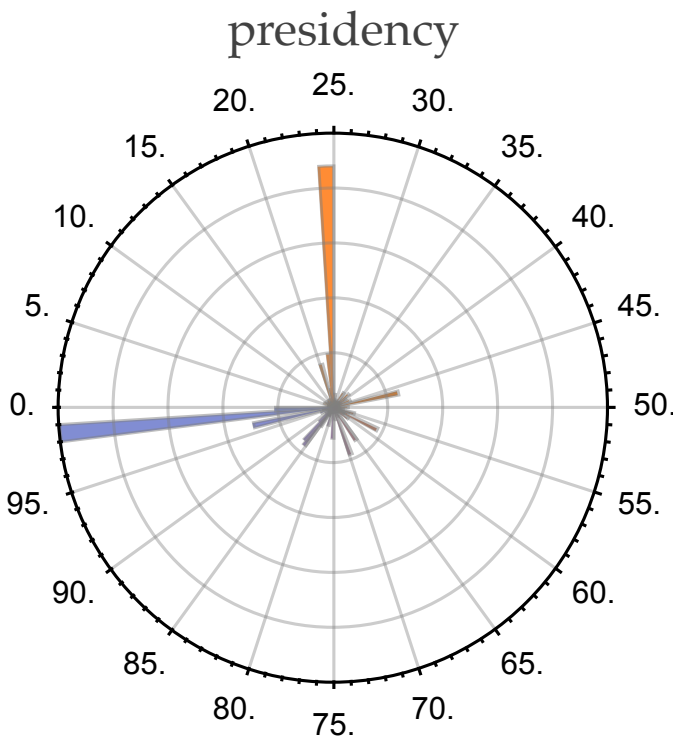
1791

1791

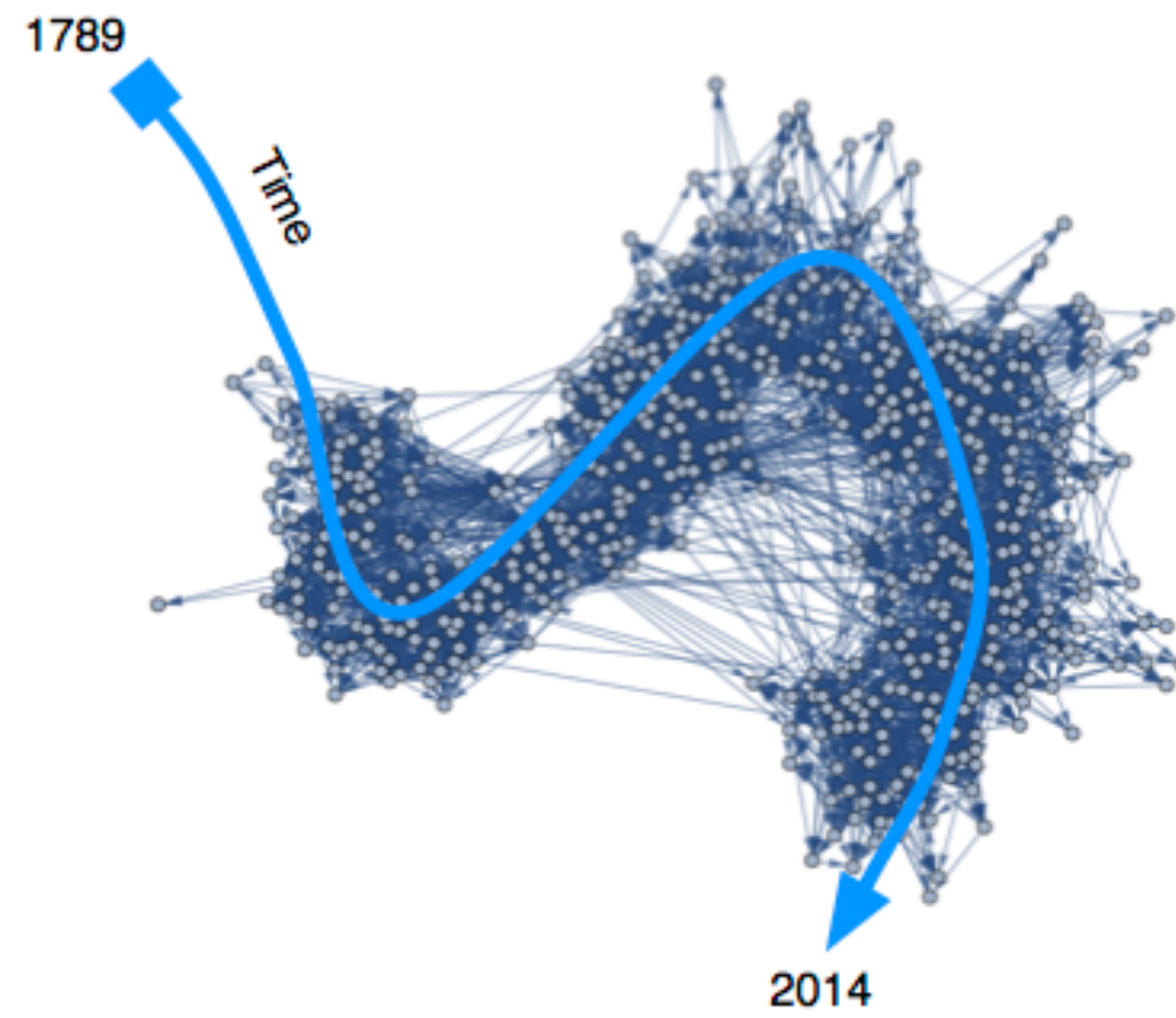
1793

1795

1799

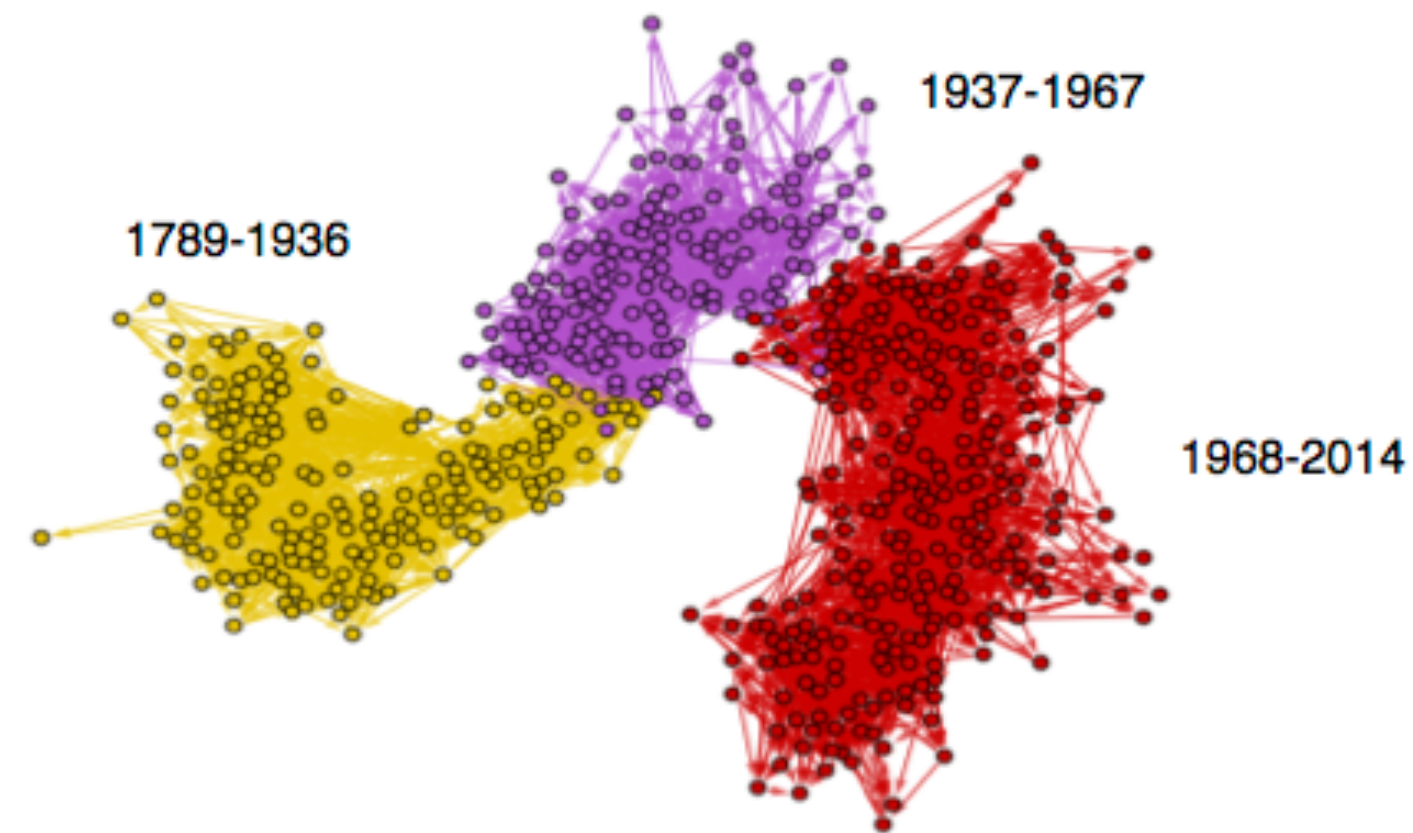


A



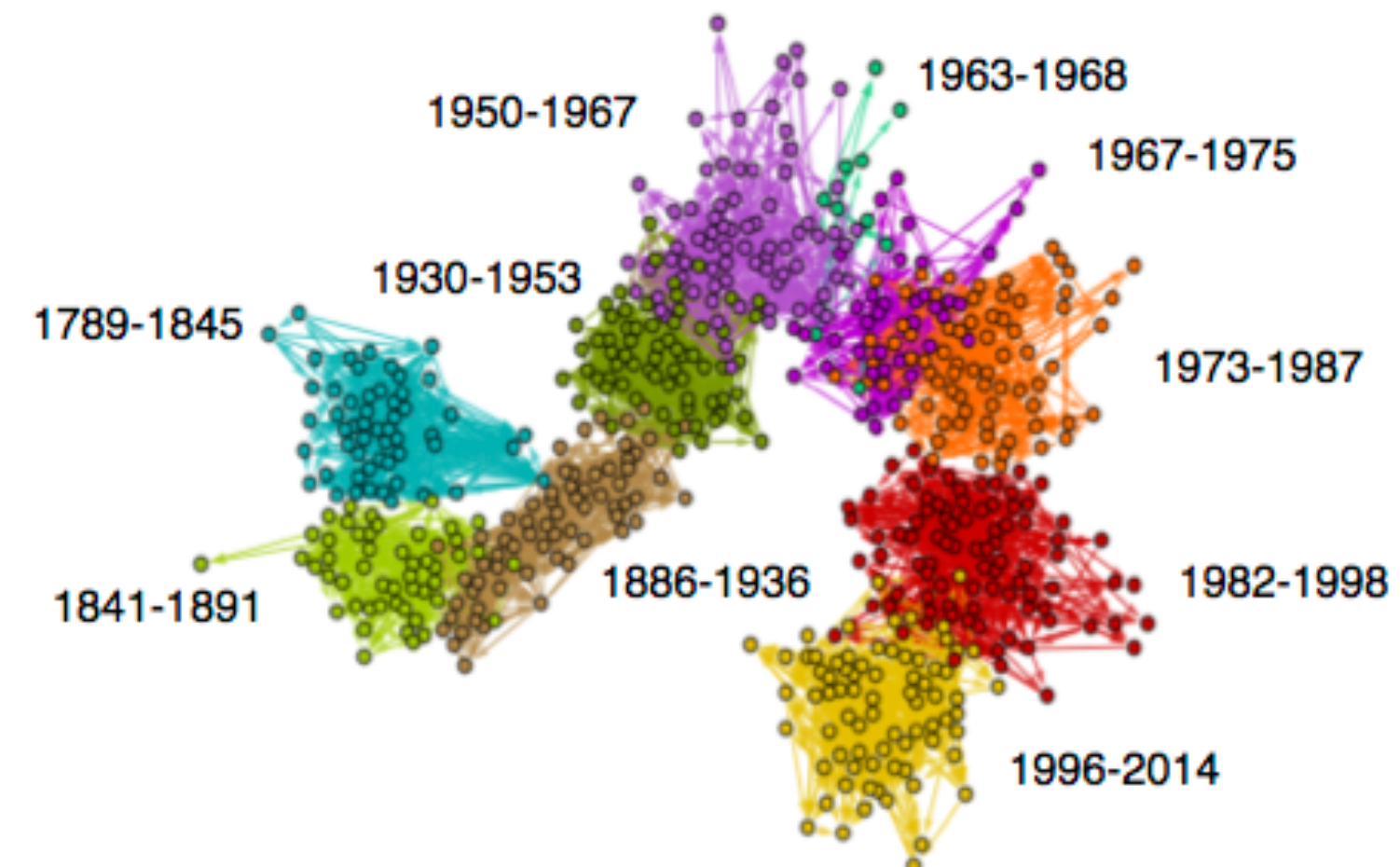
The Chronological backbone

B



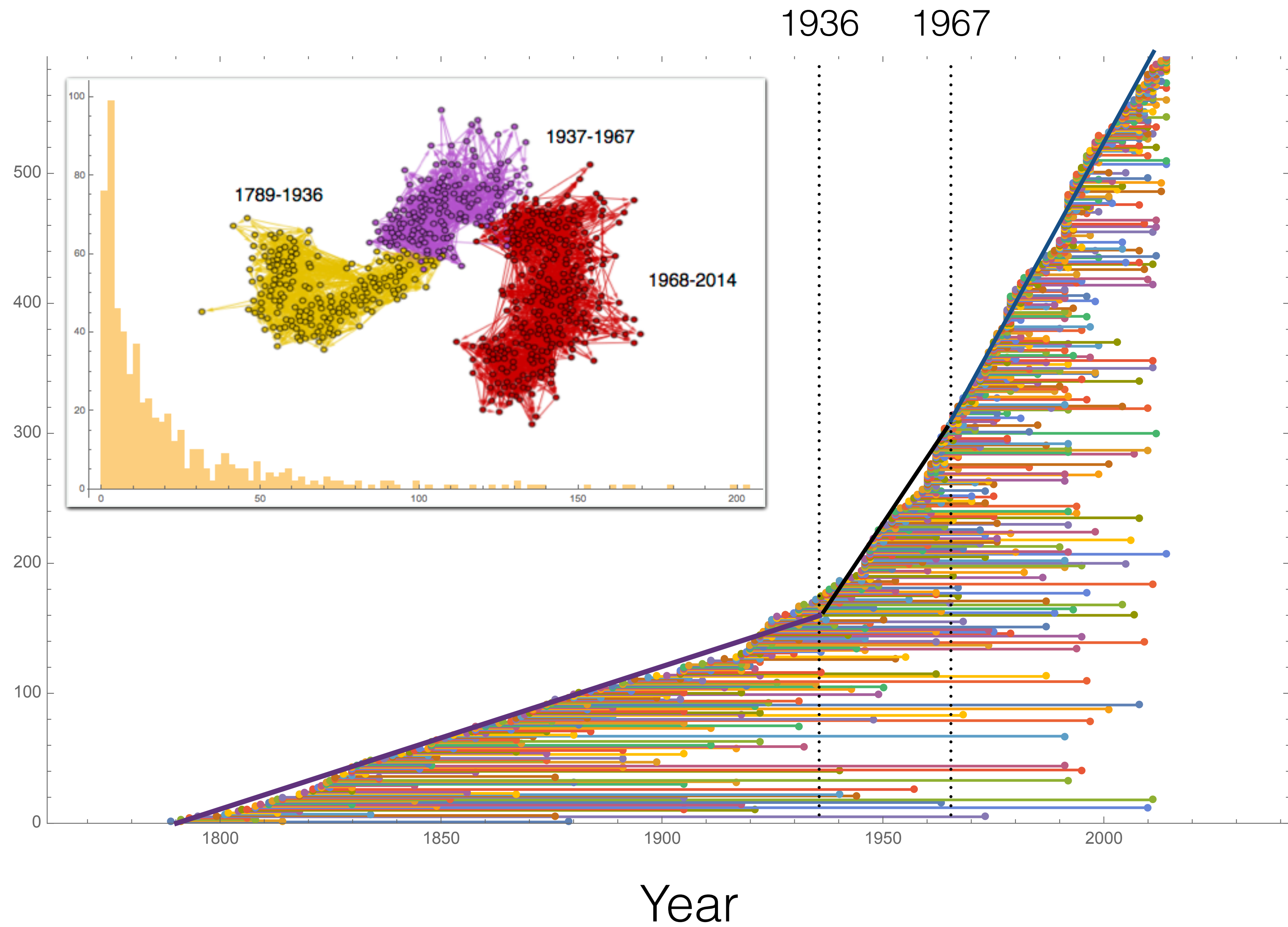
Course-grained clusters

C

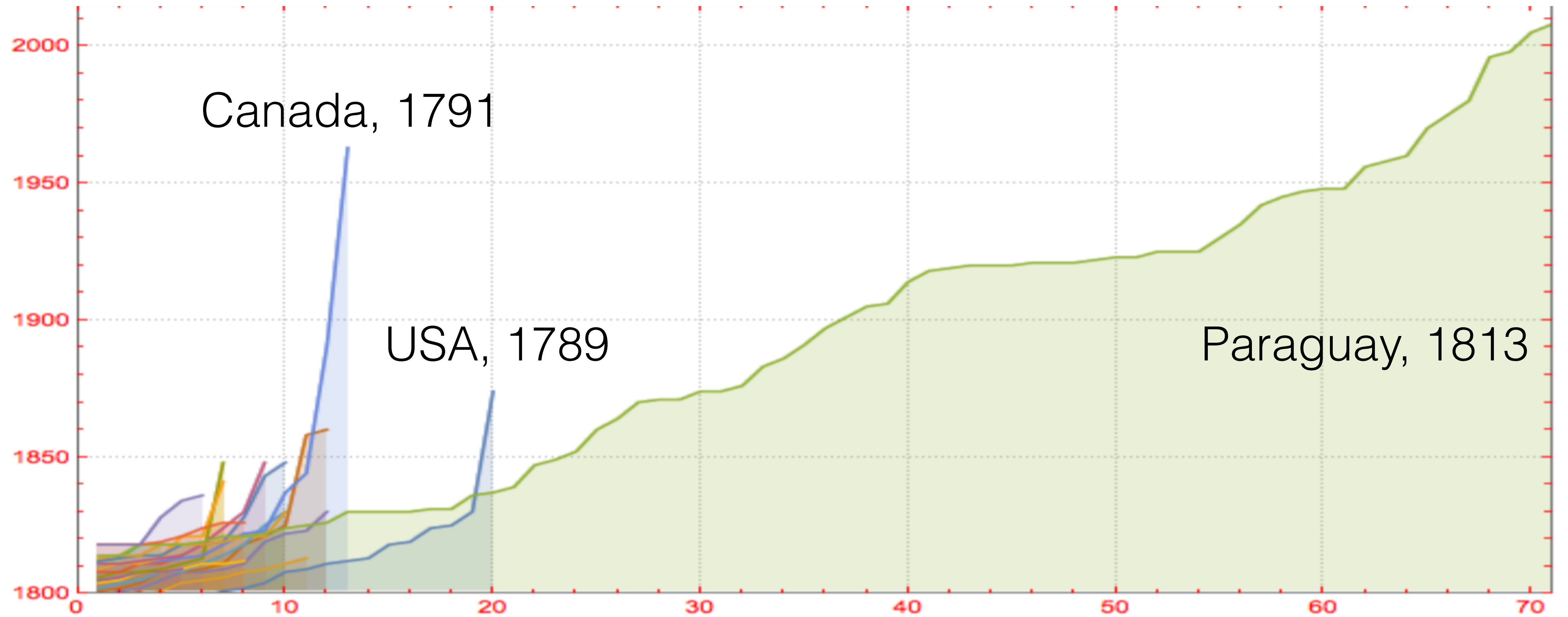


Granular clusters

Constitution
(birth-death)



Year Descendant Constitution
was Written

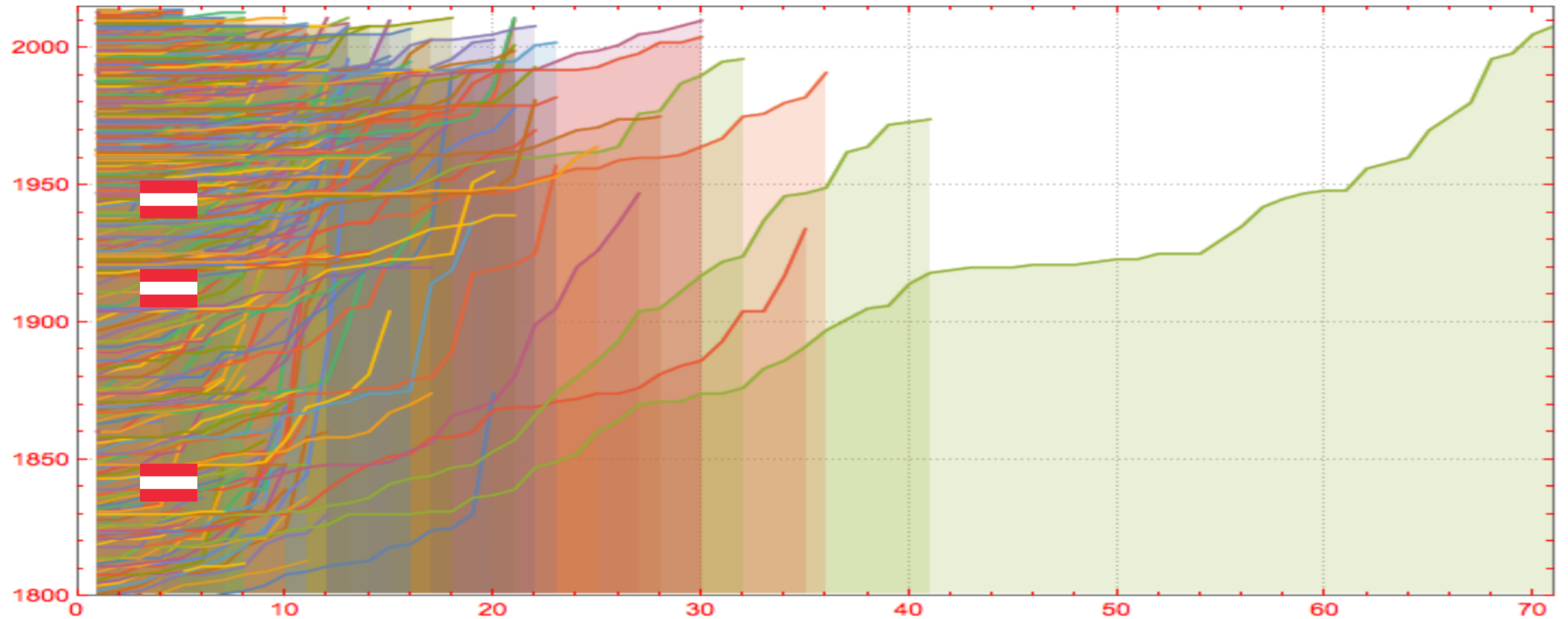


Number of Descendant Constitutions in Chronological order

Limited Influence
& short lived

Large Influence
& long lived

Year Descendant Constitution
was Written



Number of Descendant Constitutions

Insights into Change

- Want to understand mechanisms for the **collective** construction and modification of rule systems
- Appreciate the crucial role of **learning** - imitation/borrowing and consideration of learning costs and constraints
- Recognize that **dynamics** impose strong long-term regularities beyond short-term individual preferences & awareness