

Algorithmic Democracy

by
Sam Tenka

Envisioning the Future of Computing Prize
Social and Ethical Responsibilities of Computing
Massachusetts Institute of Technology

Cover Page

SUPERTOPIC: **The Future of our Computational Society**[◦]

← Though the Prize mentions “The Future of Computing”, its prompt makes clear that the Prize more accurately concerns “The Future of (our computational) *Society*”

SUBTOPIC: **Algorithms for Democracy**

FORM: **Informally Chatty but Mathematically Rigorous Persuasive Letter**[◦]

← The Prize prompt allows that the “essay [may] take ... [a] form of your choosing...”

WORD COUNT: ~????[◦]

← My script counts marginnotes but none of: \LaTeX junk, numbers, cover page, end matter.

ESSAY REQUIREMENTS CHECKLIST:

presents computing-related technology: **yes**

details potential benefit of said technology: **yes**

maps social pitfalls/dangers of said technology: **yes** (see passages marked ♣)

envisions how net effect could be positive: **yes** (see passages marked ♣)

ATTESTATION: **I, the author, do attest:**[◦]

← Per <http://computing.mit.edu/cross-cutting/social-and-ethical-responsibilities-of-computing/envisioning-the-future-of-computing-prize/>, accessed 2023-02-04. Text mildly edited e.g. to allow for marginnotes in addition to footnotes and to scope the “insights and ideas” that require citations.

All of the writing here is my own. This means that anything quoted verbatim from another source appears within quotation marks, or in a conspicuously distinct block-quote style, and is accompanied by a footnote — or marginnote — that identifies the source. It means that I have not paraphrased another person’s writing without making it explicit that I am doing so: I recognize that changing the words does not make it my writing. It means that whenever (if at all) I draw text or other content from generative algorithms such as “AI”, I make explicit that I am doing so. And it means that whenever I have drawn substantive insights or ideas from another source (including but not limited to friends and anonymous authors of material on the Internet), I have credited that source in a footnote or marginnote. Background ideas (e.g. the existence of a country called India or the edibility of corn) considered by the author well-known to the author’s intended audience are in-substantive for the purposes of the previous sentence.

submitted 2023-12-04

Algorithms for Uniting States...

...being a Call to employ the creative Methods of Software Defign toward the Refinement of the United States Conftitution by new republican Mechanifms, as illuftrated by sample Amendments to said Conftitution.

Constitutional Infrastructure

EXHORTATION — I admit it: I rarely floss. It prevents gingivitis but feels never urgent. So it is with high hypocrisy that I urge you, O Reader, to incorporate constitutional reform into your civic routine. I don't mean we should amend frequently; I mean we ought to design and debate amendments as regularly and shamelessly as we deliberate over foreign wars or domestic crises. We know how to spend time on politics — how to voice our ideas on such grave and timely issues as Gaza and campus speech. But rarely do we give thought to *meta-politics*, the maintenance of those processes by which we hear and meld our voices. We use our mouths but fail to floss.

Americans red and blue worry for our eroding physical infrastructure; why not also for our *constitutional* infrastructure, that bridge between Governed and Governing, etched with Lincoln's and FDR's desire lines, groaning under 1000 times the foot traffic of 1789, that in our century cracks with broken^o precedents?

What's the opportunity cost? Why let this issue compete with more timely political issues for Congress's attention? Each new issue competes not with the most important item on our legislators' schedules, but with the least important. IF you have a hunch that your Representative each week spends hours signing letters their staff printed, or lingering after a nice dinner celebrating local business, or scrolling through what formerly we knew as Twitter, THEN you might wonder whether they might share that time with constitutional reform.

Some civic religion compels us every other November to the voting booths; this, despite the lottery-scale effect any single vote has on State or Federal governments. I hope and I demand — that this same "super-rationality"^o — this same sacred naivety, this same badge of belonging — inspires in us optimism that we *can* adjust our Constitution after 25 decades of trial and tear.

At their best, constitutions are symbiotes of civic culture: the former provide ingenious mechanisms — *ratchets* to accumulate small acts of courage, *fuses* in case of disaster, *levers* for the outnumbered — that both rely on and fortify the latter. In Obama's choice words,^o the US constitution structures how we "argue about the future" around "analysis [and] argument", "compromise [and] modesty". So precious an inheritance deserves maintenance and repair.

← §1.2 of A. SCALIA—*The Essential Scalia* (Crown Publishing, 2020) and §II of E. KAGAN *et al.*—*Dissenting Opinion in Dobbs v. Jackson* (597 U.S., 2022) and C. PIPER—*The Broken Senate Confirmation Process* (ourpublicservice.org, 2023) and J. W. PETERS—*Senate Limits Use of Filibuster* (New York Times, 2013)

← pp. 739–796 of D. R. HOFSTADTER—*Metamagical Themas* (Basic Books, 1985)

← pp. 1253–1264 of R. M. SMITH—*The Constitutional Philosophy of Barack Obama* (Social Science Quarterly 93.5, 2012)

PLAN FOR LETTER'S REMAINDER — All this optimism would be nil if no amendments plausibly had sufficient support for ratification. Fortunately, the space of potential constitutional mechanisms is richer than we likely first imagine; it includes many promising mechanisms "orthogonal" to the red-blue axis. Let us explore this

space using the creativity, discipline, and algorithmic thinking we use to craft software. Inventing and weighing such ideas is an activity every computationally literate citizen of a democracy can and should do. The rest of this letter I spend defending these claims by example.

In particular, I show how two concepts in computing theory — *non-linearity* and *distributed systems* — inspire constitutional mechanisms.

Non-linearities and Decisive Consensus

Majorities differ from averages, due to rounding. This difference can accumulate perversely, as in gerrymandering. More subtly, it can distort democratic incentives by which the people may supervise their government. Yet in computer science we are accustomed to molding and harnessing such nonlinearities.^o We now explore two applications of such conceptual technology: one for the Supreme Court, and one for Territorial Application.

← Deep learning's success illustrates this.

SUPREME COURT APPOINTMENTS — Legislators stall in many ways. For example, Senators (perhaps in anticipation of an upcoming presidential election) may reject a technically excellent Supreme Court nominee, causing a long vacancy in that Court. State legislators (perhaps to avoid the acute unpopularity of a “no” vote) may fail ever to schedule a vote on a proposed amendment, leaving the latter’s ratification open for decades.

Such stalling leads to more time to deliberate towards a wise choice but also to irregular disruptions to regular governance and vast power for those who control procedure.

For appointment of Justices, the question our current process answers is **should this particular nominee join the Court?** — but I regard that as an implementation-specific sub-question of this more fundamental question: **who should join the Court?** Majority voting to confirm a particular nominee, even with a time limit, fails to be a decisive procedure, since the Senate might keep rejecting nominees as its members play a game of chicken, each Senator unwilling to budge in the face of the time limit.

Yet, by shifting above from one question to another we have changed the *type signature* we wish to implement and thus permit new algorithmic possibilities. The following procedure guarantees that *someone* will win:

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- (o) The Supreme Court of the United States shall have 9 seats and shall decide cases by strict majority; but the most junior Justice may not vote save to break ties.
- (1) On May 1st of each odd year, the most senior Justice shall retire. These and other vacancies shall be filled as follows within $D = 90$ days, $D/3$ days per step, with the Vice President breaking ties as they arise.
- (A) A list of $K + k$ candidates shall be prepared: $K = 50$ sampled randomly from the judges of the Appellate Courts, then $k = 2$ added by the President.
- (B) The Senate shall select from those candidates $k = 2$ finalists as follows.
- (B.a) The $S = 100$ Senators shall randomly, publicly sequence themselves.
- (B.b) Each Senator in sequence (but skipping absentees) shall publicly mark any one candidate who has fewer than $S/K = 2$ marks.
- (B.c) The finalists shall be the k judges with the *fewest* marks.
- (C) The President shall choose from the k finalists the newest Justice.
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The above procedure is:

ANTIPARTISAN — A Senate with 61 Republicans will lead to a Justice who is ~61st percentile on the "Democrat-Republican" axis. The process favors the broadly inoffensive over the popular-but-polarizing — a boon for the Court's legitimacy.

DECISIVE — Vacancies will be filled without delay. Indeed, the process forces the Senate to choose from a fixed list of candidates rather than to confirm individual nominees. So the Senate has no option to continually reject nominees.

REGULAR — New justices periodically replace old justices, leading in effect to 18-year term limits. Due to the most junior Justice, these transitions do not threaten to evenly divide and thus impair the Court.

Setting $k = 2$ allows the President to closely interview and decide between multiple finalists, thus allowing recovery even if one totally unqualified candidate slips through.°



Reviewing $K + k = 52$ candidates may seem a great burden. But recall for scale that Senators in principle read tens of thousands of pages per year in close detail — in practice, of course, their aids, party organs, and allied think-tanks share this burden. I regard compiling and contemplating dossiers on the characters, experiences, and jurisprudential philosophies of each 52 candidates to be a lesser burden.

← It could be that both finalists are totally unqualified; but if these finalists — the least objectionable 4% ($\approx 2/52$) of a representative sample of the highest ranking 21% ($\approx 179/861$) of the country's non-Justice judges — harbor multiple incompetent judges, then we have bigger problems to worry about.

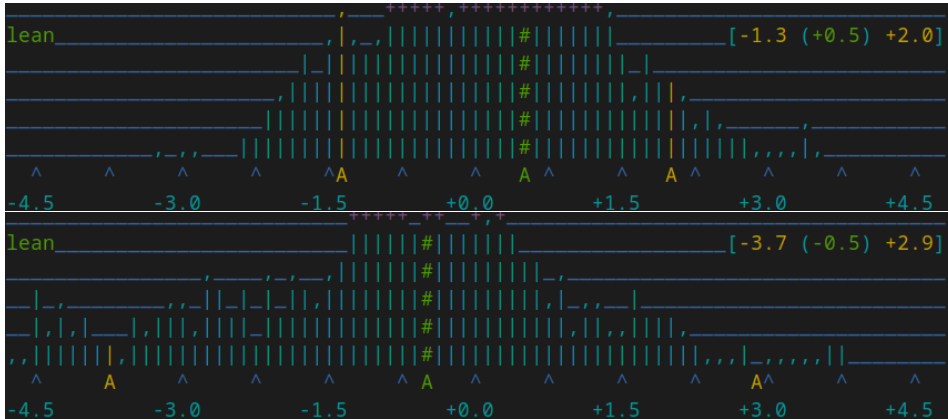


Figure 1: **Partisan leans of judges on superior courts. (Histograms)** Farther from 0 is more partisan. Units are natural log-probabilities, so each step of ± 1.0 multiplies or divides the chance of concurring with “the opposite side” by $\approx \exp(1) \approx 2.7$. **Top:** the US Supreme Court. **Bottom:** the US Appellate Courts. (Raw data drawn from supremecourt.gov and links therefrom. Analyzed using hierarchical Bayesian methods (MCMC with custom time-series proposals) using code — available upon request — written for this Prize Essay.

- (2) The Appellate Courts of the United States shall have $N = 179$ seats, or a number as the Chief Justice may request and the Congress by a three-fifths majority in each chamber may confirm. But each added seat shall belong to §(1.A)'s sampling pool only $W = 12$ years after its addition. No Act of Congress shall remove seats earlier than W years after Act's passage.
- (3) Judges of the Appellate Courts shall be appointed by the President, with the consent of a simple majority of the Senate, to fill vacancies as they arise. No person shall serve more than $T = 20$ years as a judge of the Appellate Courts; and before that time, no judge under the age of $A = 65$ shall, except by Impeachment, be compelled to retire.
- (4) §(2, 3) shall take effect immediately upon Ratification of this Amendment. §(0, 1) shall take effect exactly 8 years after Ratification. §(3)'s limit on term length shall be understood not to count years served before Ratification.

POPULATION-SUMMARIZING DELEGATIONS — Note that the Territories on whole lean blue, so red politicians do not want to grant statehood for fear of losing ground in the Senate (or, analogously, the House). A suitable non-linearity provides a workaround.

- (0) These Territories of the United States shall as a whole be entitled to two seats in the Senate. The Congress shall by law determine a list of these Territories; these must include the Commonwealth of Puerto Rico and the District of Columbia, unless and until they become States or parts thereof.
- (1) The Territorial Senators shall be elected in the same year once every six years, as follows. Each voter shall vote for at most one candidate, and any candidate receiving strictly more than one third of the vote shall become a Senator. The President shall fill vacancies as they arise, including when fewer than two candidates exceed the stated threshold.

ALGORITHM FOR POLITICALLY BALANCED SENATE REPRESENTATION FOR THE TERRITORIES

Thus, unless there is overwhelming ($\geq 67\%$) blue or red support (as occurs in DC but not in the overwhelmingly more populous Puerto Rico), there will be both a blue and a red Senator. This maintains the red-blue balance in the Senate

while giving voice to non-(red-blue) axis issues of importance — for example, the US trade laws that capriciously disadvantage Puerto Rico, or struggles for further representation in the Federal government.

Independence and Turn-Taking

RANDOMNESS AGAINST GERRYMANDERING — Imagine that within a district over time, population “takes turns”: e.g. a stably 60%-red 40%-blue district would in our current system elect 10 red representatives in a row; we shall describe a system wherein that district would elect about 6 red representatives and 4 blue representatives across that same timespan. Moreover, House at each time-slice more faithful snapshot of the populace.

Horrible folks will occasionally get elected. But that’s democracy. It is exceedingly improbable that a 10%-popular movement of, say, paperclip fanatics, would win anything close to a House majority, no matter how their support concentrates or scatters among districts; but the few seats they may earn would enrich debate and nudge compromise lines. When we celebrate our grand forum of deliberative democracy, we celebrate our chance to say our crazy ideas and through consensus pick which ones to implement. Indeed, several constitutional provisions enforce this consensus: the House is limited by the Senate, by the Presidential veto, and to an explicit list of (mainly Article I) powers.

- (o) Each voter in each district shall vote for at most one candidate for Representative. Should multiple candidates receive a fraction of votes greater than $f = 1/3$, one of those candidates shall be randomly selected to win the race, each with probability in proportion their share of votes. Otherwise, the candidate with most votes shall win the race.

MEMORYLESS TURN-TAKING ALGORITHM TO COMBAT GERRYMANDERING FOR MORE FAITHFUL REPRESENTATION

At first, it may seem that “whoever rolls the dice holds the power”. But the technological idea of *hash-based commitment schemes*^o undermines that objection: a community may by such schemes agree on a random value not just fairly but *visibly fairly* (unless literally all candidates conspire). We have more reason to trust such a scheme than we have to trust the cryptography that secures our bank accounts and military plans.

← pp. 278–293 of O. GOLDREICH—*Foundations of Cryptography* (Springer-Verlag, 1999)

Gerrymandering is now impossible

- (1) The aforementioned quantity f shall at a constant rate decrease from $1/2$ through $1/3$ over the span of $W = 12$ years beginning with the first Presidential Election after ratification of this Amendment.

SUPPLEMENTARY AMENDMENT FOR SMOOTH INTERPOLATION

INSULATED DEPARTMENTS — State legislatures prescribe the procedure for state-level and national-level elections within their borders. Thus, they have historically have levied poll taxes (prohibited now by Amendment XXIV) and gerrymandered (still allowed).

One might turn to the federal government to reduce such pathologies. But national oversight has serious drawbacks. We in our federal system enjoy the blessings of decorrelation gotten through partial sovereignty of the several states:

we accept some bias to decrease variance. If a national elections board could draw district lines, they could do so to favor one party in ALL states. So I prefer the current way, where gerrymandering benefits a given party in some states and costs them in others. Intrinsic bias remains, favoring whichever parties folks in rural areas tend in a given era to support.

Yet there is a third way: mandate an “independent” election oversight board in each state. Scare quotes are intentional but not at fullest force: I do think another layer of indirection would contribute against gerrymandering.

Here’s what that might look like.

ELECTIONS BOARD ALGORITHM

- (o) The Elections Board of each State shall determine the manner of and districts for the State and Federal elections within that State and shall guarantee a proportional, republican form of Government to the People of the State.
- (1) The Elections Board shall seat 8 Members; but the most Junior Member shall have no vote, save to break ties. In May of each odd year the most Senior Member shall resign. Such and other vacancies shall within 90 days be filled by the State’s Chief Executive with the advice and consent of its Legislature.
- (2) The work of the Board shall be subject to judicial review by the State courts. Moreover, State Constitutions may explicitly provide for the removal, for unfitness or for cause, of Members of the Board.

The novelty of this proposed amendment, separate from meddling with State Governments, is (o)’s word “proportional”. This clarifies Article IV’s guarantee of “*a republican Form of [state-level] Government*”.

Amending Article V

DISCUSSION AND TEXT — Our constitutional amendment process begins with country-wide proposals followed by state-wise ratification. It can be Congress that proposes, or instead a “national convention” called by the State Legislatures; then each State, either by law or by a “state convention” per Congress, ratifies or rejects.

Yet this procedure is prone to stalling, and worse, is vague.

I propose a new Amendment Process. The main changes are three: we set a deadline by which each State must ratify or reject a proposal; States ratify by popular Referendum; we diminish the Legislature’s role to optionally modifying a success-threshold for a popular referendum; we clarify the procedure for Article V’s “*Convention[s] for proposing Amendments*”.

A META-AMENDMENT

- (o) This Amendment shall hold no force if not ratified, within seven years since passage in Congress, by three fourths of the Legislatures of the several States. If and when it is so ratified, parts 1, 2, 3, 4 shall replace the text of Article V.
- (1) The Congress, whenever two thirds of both Chambers shall deem it necessary, shall propose Amendments to this Constitution.
- (2) The States, whenever two thirds shall deem it necessary, shall by the procedure below call a Convention for proposing Amendments.
- (3) An Amendment proposed by either Congress or Convention^o shall be valid to all Intents and Purposes as Part of this Constitution when ratified within

← maintains independence of States

seven years^o of proposal by three fourths of the several States. Each State shall within said time hold one popular Referendum, of whose votes two thirds — or, as the State’s Legislature may before the Referendum establish by law, one half — shall be necessary and sufficient for ratification. ← timing mechanism

(4) No State shall be deprived without its Consent of its equal Suffrage in the Senate.^o

← for backward compatibility

CONVENTION DETAILS

(2') The Chief Executives of two thirds of the Several States may, by submitting a jointly signed Petition to the President, call a Convention for proposing Amendments. Thereupon each State shall hold an election wherein each voter may select one or more Candidates, and shall send as Delegates that pair of Candidates that intersects with the selections of the greatest number of voters, with the State’s Chief Executive filling vacancies as they arise. The Delegates shall not propose an Amendment without two thirds approval in each of two Votes: the first, counting Delegates simply; the second, entitling each Delegate to as many votes as their State is entitled Representatives. The Delegates shall be entitled the same constitutional Privileges and Immunities as Senators, but they shall conclude their Convention within 12 months.

SUMMARY — Through five analyzed examples, we have demonstrated and advocated an *engineering approach to constitutional refinement*. Creative importing of concrete algorithmic concepts (such as *non-linearity* and *distributed systems*) enlarges the space of conceivable Visions of the Good, enriches constitutional discourse, and uncovers democratic refinements orthogonal to current partisan gridlock. In fact, careful design — employing ideas such as algorithmic influence bounds and verifiably fair randomness — can yield subroutines *anti-partisan by construction*. Ordinary citizens, armed with algorithmic literacy, may design and debate novel constitutional subroutines in the same manner as we do political policy; to do so is to affirm the same civic optimism that compels us to vote for President.

It is time to liberate our algorithmic inheritance from its silicon nursery. Ours is a society now literate in the *conceptual technology* of sophisticated algorithmic design; to employ this success only in FPGAs and GPUs, rather than also in our democratic fabric and in our non-electronic lives, is to swim only the great oceans, though it is in smaller creeks that freshwater lies. To envision Computing in the Society of the Future, we should look beyond the glittering glamor of mere metal — even if that metal can run large language models and thus predict the next word in a TV script — and at ourselves.

Let us floss.

Endmatter

METHODOLOGY DISCLAIMER — All numerical experiments and results are preliminary.[◦]

← The reason for this is that the author re-learned of the Prize mere hours before the submission due date. Thus, the computer code in this project — especially the data-visualization code — was written in haste. Data and code available upon request.

REFERENCES — Starred (★) are references that (contain ideas that) more heavily influence the author. The author by personal judgement classifies (the cited passages of) references as conservative (◊) or liberal (◻) in the colloquial American political sense.

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