# How to Randomize If You Must:

## Differences in Legal Sortition Processes

**Julio Michael Stern**
IME-USP - Universidade de São Paulo





*http://www.ime.usp.br/∼jstern/miscellanea/jmsslide/ABJ191.pdf*

ABJ - Associação Brasileira de Jurimetria
Bayesian Inference & Maximum Entropy, 01-05/07/19, Max-Planck IPP

# Must (or should) we randomize? - Why? - How?

- I- How to Randomize If You Must:
  Differences in Legal Sortition Processes
- II- Must we randomize? Is it imperative to?
Is there a normative requirement to randomize?
- III- Why should we randomize? What are the reasons
and explanations for making non-deterministic decisions?
- IV- How to randomize? What are the requirements
and desiderata for good randomization procedures?
- Brazilian Supreme Court (STF) case study
- Blockchain implementation using high-entropy bitstreams
- Security by design vs. Security by obscurity and the
Social function of transparancy and understandability
- Motivations: Legal procedures, Clinical trials

# Must (or should) we randomize? - Why? - How?




$\kappa\lambda\eta\rho\omega\ \nu\upsilon\nu\ \pi\epsilon\pi\alpha\lambda\alpha\sigma\theta\epsilon\ \delta\iota\alpha\mu\pi\epsilon\rho\epsilon\varsigma\ \mathbf{o}\varsigma\ \kappa\epsilon\ \lambda\alpha\chi\eta\sigma\iota\nu$:
Let the lot be shaken for all of you, and see who is chosen.
Iliad, VII, 171.

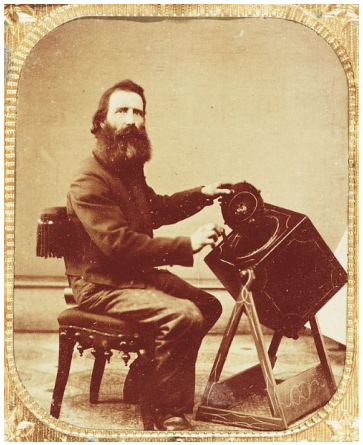
- Must we (is it a Normative Requirement to) randomize?
- Yes! By rituals for supernatural manifestation;
- Yes! By old costumes/ traditions or contemporary laws;
- Yes! By the Golden Standard of Blind & Randomized trials.

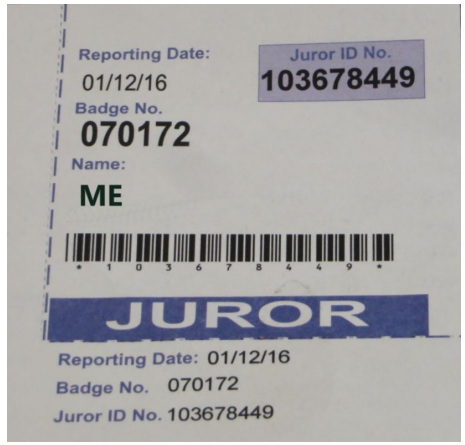
# Randomization in ancient/ traditional rituals


- Orunmilá / Ifá – Yoruba / Brazilian oracle provides:
- Sortition device (buzios game) used for advice, including
- explanations for the game's results/ answerers that are
- embedded in a narrative of the Orixas (Yoruba mitology)

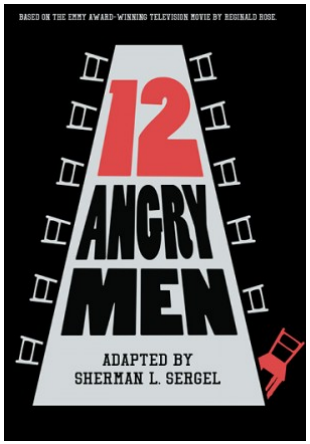
– Ancient Greek divination rituals are lost

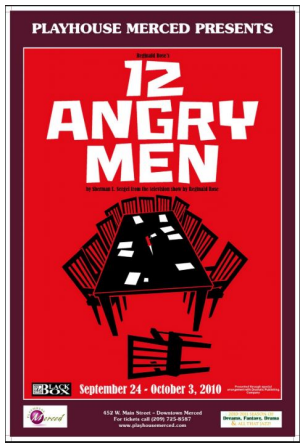
# Randomization in contemporary law

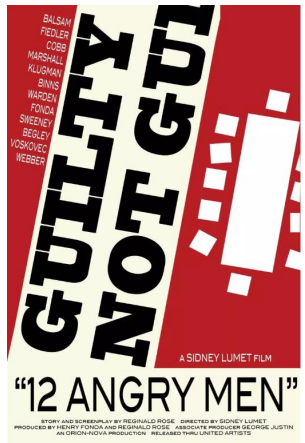


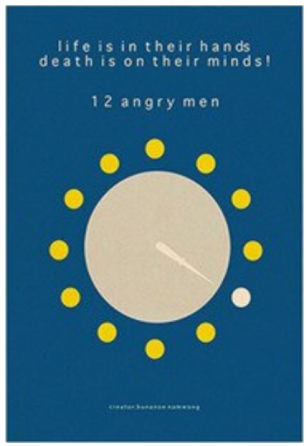




- Military draft lottery in the USA at the civil war / Vietnam war;
- Jury duty (1957) must provide verdict + crime narrative;

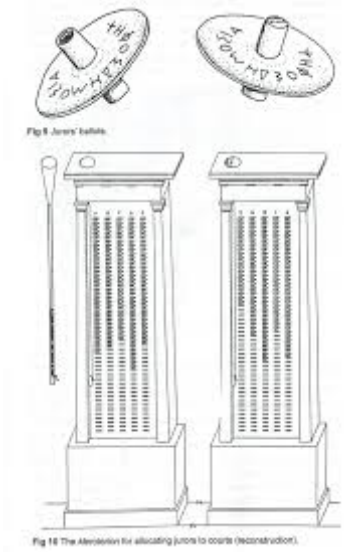


# Randomization in Athenian Democracy




- $\kappa\lambda\eta\rho o\varsigma$ (lot, chance) + Heliastic oath = Athenian democracy
- Each Dikasterion had from 501 to 2501 jurors,
  that should *not* deliberate their vote, rather,
- Each Dikastes (juror; $\Delta\iota\kappa\eta$, fair justice) swore to cast his vote independently according to his best knowledge of law & facts

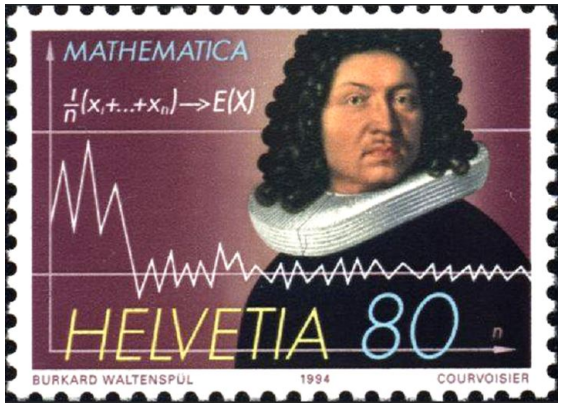
# Randomization in Athenian Democracy



- Heliastic oath: $\eta\lambda\iota\alpha\iota\alpha, \grave{\alpha}\lambda\iota\zeta o$, assembly, to assemble

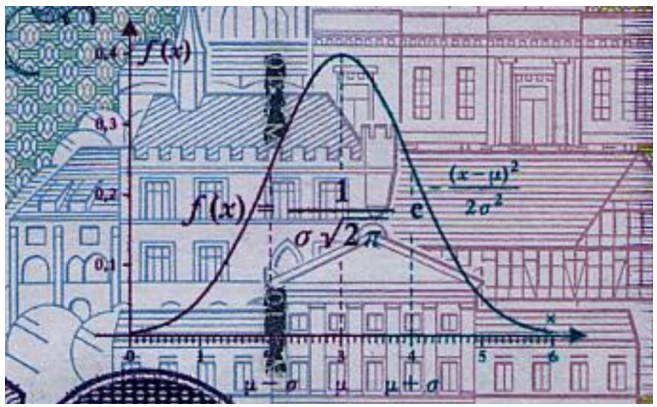
*I will cast my vote in consonance with the laws and with the decrees passed by the assembly and by the Council, but, if there is no law, in consonance with my own sense of what is most jutst, without favour or enmity. I will vote only on matters raised in the charge, and I will listen impartially to accusers and defenders alike*.
Hansen (1999, p.182).

# Must (or should) we randomize? - Why? - How?





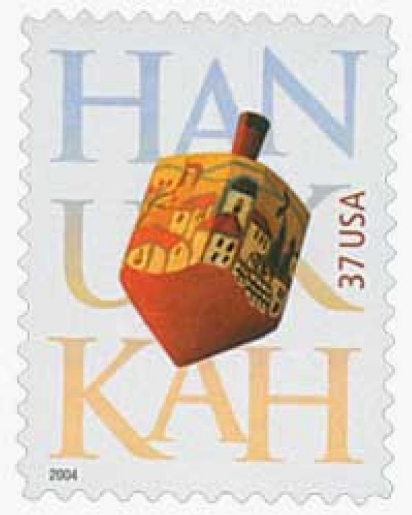

- J.Bernoulli (1655-1705) – Poisson(1781-1840) – Chebyshev (1821-1894) Law of Large Numbers, $\sum_{i=1}^{n} x_i \to E(x)$ requires *independent and identically distributed* variables

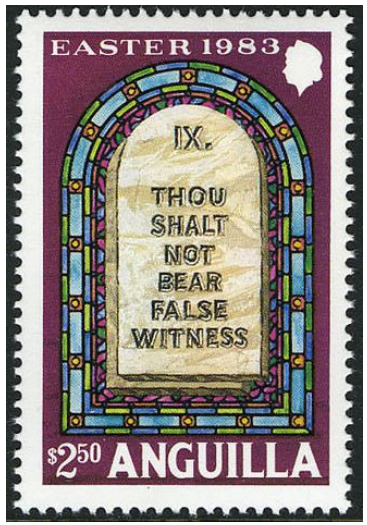




– *nunc pro tunc*, yes, I know

# Randomization in the Hebrew Bible



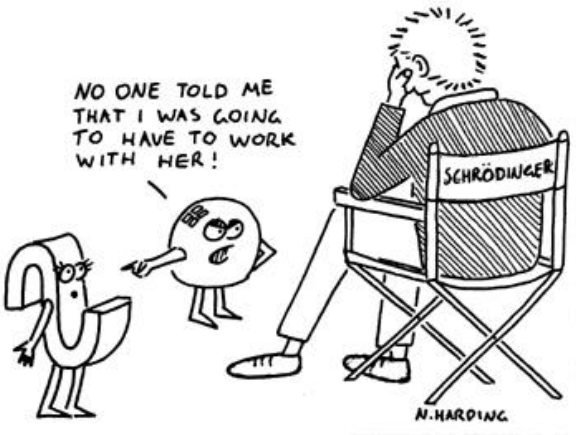


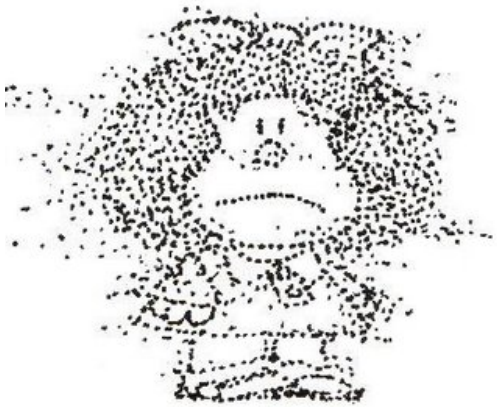

מְדָנִים יַשְׁבִּית הַגּוֹרָל וּבֵין עֲצוּמִים יַפְרִיד

Casting the dice puts judgment quarrels to rest and keeps essential powers separated. Proverbs 18:18.

- Rare example of ancient (before probability and statistics) explanation for the use of randomization procedures using rational arguments

# Convexification / Discretization Operator



מְדָנִים יַשְׁבִּית הַגּוֹרָל...

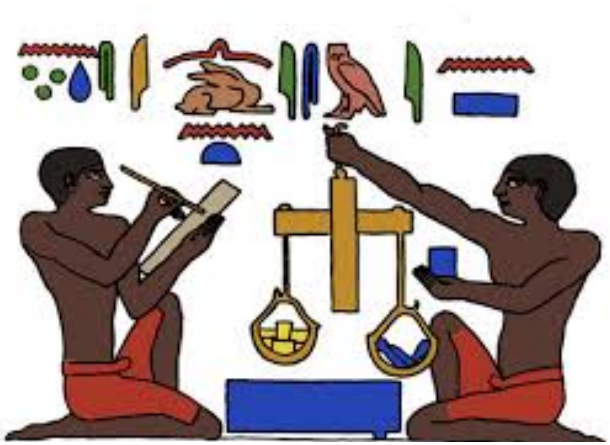
Casting the dice puts disputes to rest...

- מָדוֹן, quarrel, contention, dispute; דִּין, judge.
- שָׁבַת, cease, desist, rest.
- גּוֹרָל, to cast lots, dice; Arab: *jaral*, pebble.

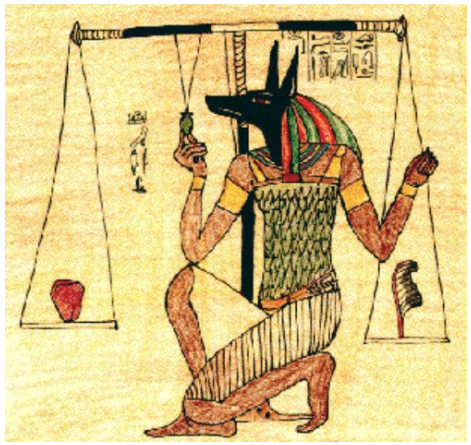
- Randomization provides a Tie or Symmetry-Breaker, it allows a discrete choice (instead of a convex combination) to be made

ex: distribution of land lots, order of service, etc.

# Decoupling of Functionally Differentiated Systems



Egyptian merchants ∼2400BC;

Maat scale, Hunefer papyrus ∼1275BC

וּבֵין עָצוּמִים יַפְרִד...

...and keeps essential powers separated.

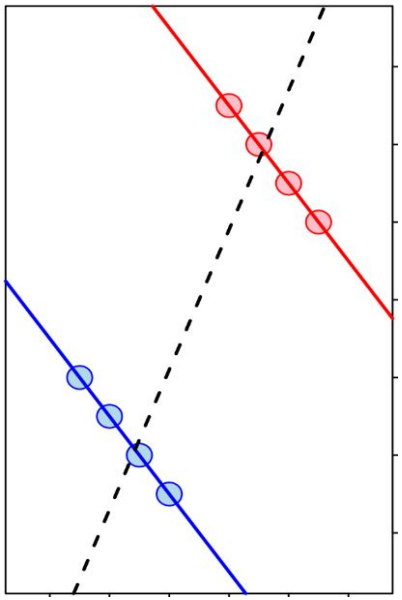
- עָצוּם, powerful; עֶצֶם, bone, power, *e(t)sem* - essence; עַצְמוּת, essential quality, characteristic; עַצְמָאוּת, independce;
- פָּרַד, to separate, divide, scatter.

- Randomization yields a verifiable pathway to Haphazardness, the key for Decoupling/ Separating (functionally) distinct powers (systems) and avoiding spurious influences between them (Niklas Luhmann's dedifferentiation).

# Clinical Trails - Confounding Effects

Table: Lindley/ Simpson Paradox

| Sex | T | R | NR | Total | R% |
|---|---|---|---|---|---|
| All | T | 20 | 20 | 40 | 50% |
| All | NT | 16 | 24 | 40 | 40% |
| Male | T | 18 | 12 | 30 | 60% |
| Male | NT | 7 | 3 | 10 | 70% |
| Fem. | T | 2 | 8 | 10 | 20% |
| Fem. | NT | 9 | 21 | 30 | 30% |



Lindley (1991): From 80 patients, 40 were Treated (T), & 40 did Not (NT). Some patients Recovered (R), others did Not (NR). Table of Recovery rates (R%), for All and disagregated by sex.
$\Rightarrow$ Treatment is Godd for All, but Bad for both Male & Female!

# Haphazard assignment vs. Spurious associations

Lindley (1991, p.47-48), Pearl (2000):
Responsible physician did not trust the treatment, moreover, he knew the disease affects Female patients more severely.

Hence, in order to avoid any harm to Female, he decided to give Treatment preferentially to Male (would recover anyway)

In so doing, the physician generated a Spurious Association between explained variable R% and explaining variab. Sex.

- Medical ethics: Help or do no harm to the patients!
- Scientific ethics: Search for the truth! (about the treatment)
- Ethics can and do collide (Hell is paved by good intentions)

In a medical trial, neither the physician nor the patients can choose their preferred treatment. Instead, a "Haphazard" assignment is used to break spurious associations. How?

- Dice are blind to & unaffected by any variable of interest:
- Randomness $\Rightarrow$ Haphazardness

# Must (or should) we randomize? - Why? - How?


*Meos tam suspicione quam crimine iudico carere oportere*.
My people should be free from either crime or suspicion.
Julius Caesar (62BC), in Suetonius (119CE, Sec.I.74.2).

- Random source must have good Statistical & Cryptographic (predictibility) properties, be Understandable and Auditable.
- Leadership requires public trust and confidence!
- Security by Design vs. by Obscurity - Kerckhoffs' principles;
- Protocol that is simple to implement, easy to use, traceable, flexible, efficient and verifiably secure.

# How to Randomize, (mostly) Legal Applications

- Julio Michael Stern (2018).
Verstehen (causal/interpretative understanding), Erklären (law-governed description/prediction), and Empirical Legal Studies. Journal of Institutional and Theoretical Economics (JITE) 174 (1), 105-114.

- Diego Marcondes, Cláudia Peixoto, Julio M. Stern (2019)
Assessing randomness in case assignment:
the case study of the Brazilian Supreme Court.
Law, Probability and Risk, mgz006,
https://doi.org/10.1093/lpr/mgz006

- Olivia Terence Saa, Julio Michael Stern (2019).
Auditable Blockchain Randomization Tool
arXiv preprint arXiv:1904.09500

# What can we learn from *post hoc* Analyses?

- Diego Marcondes, Cláudia Peixoto, Julio M. Stern (2019)

*The statistical analyses in the preceding sections give us a global assessment of the allocation process.*
*Although we detect deviations from expected statistics, indicating the existence of systematic biases on the random allocation of judicial cases, we cannot make any conclusions about the fairness or appropriate randomization process of any individual judicial case. Such a conclusion cannot be reached by post-hoc statistical analysis of historical data.*
*Furthermore, the systematic biases may be created by sources that, though unknown on the dataset at hand, are known to the court (as for example, the cases that fit the related-case rule and the caseloads of each chair).*

# Recommendations and Protocol Implementation

- Olivia Terence Saa, Julio Michael Stern (2019):
- Blockchain randomization using high-entropy bitstreams

*Finally, given the juridical and social importance of the themata under scrutiny, we believe that it is important to develop randomization procedures fully compliant w.the following desiderata:*

*(a) Statistical soundness (Hammersley & Handscomb, 1964);*
*(b) Procedural, cryptographical and computational security (Boyar, 1989; L'Ecuyer, 2012; Wattenhofer, 2017);*
*(c) Complete auditability (Haber & Stornetta, 1991);*
*(d) Open-source programming;*
*(e) Multiple hardware platform and operating system;*
*(f) User friendliness and transparency (Parikh & Pauly, 2012; Stern, 2018);*
*(g) Flexibility and adaptability for the needs and requirements of multiple application areas (ex: clinical trials, selection of jurors, judges or courts, and draft lotteries).*

# Security by Design vs. Security by Obscurity

- Auguste Kerckhoffs (1883) principles:

(1) Cryptographic systems must be substantially, if not mathematically, undecipherable, i.e. – Secure by design;

(2) The system design must not require secrecy and it can be stolen by the enemy without causing troubles, i.e.,
– No reliance on security by obscurity.

- Linus' law: Transparency enhances security.

- Developer / attacker non-separability: Courtois (2009):

*We must realize that the secrecy of a product specification poses a threat of a very large scale electronic subversion. We need to have the courage to examine these questions and stop pretending that research in security is about discovering vulnerabilities that are always not intentional. ... Developers are also potential attackers for all such systems and trade/ industrial secrets should always be regarded as, potentially, a very major security breach.*

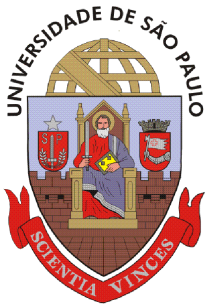
# Social Function of Transparency and Understanding

- Niklas Luhmann (1927-1998) Sociological Theory of Law
- Luhmann (1985, pp.77,82): *the function of the legal system is congruent generalization of normative behavior expectations*.

- Julio Michael Stern (JITE, 2018):

In Luhmann's theoretical framework, the legal system can only achieve its goal of congruent generalization of normative expectations – as they are coded in specific laws – if individuals (and other participating agents) comply; and compliance involves knowledge, understanding, and acceptance of the same laws. Moreover, social harmony depends on the establishment of reliable, stable, and sustainable forms of interaction. Consequently, legislators should pay close attention to how laws and legal procedures are known, perceived, and understood by the participating agents of this society.

# Acknowledgements


IME - Instituto de
Matemática e Estatística

associação
brasileira de
jurimetria

abj

CeMEAI
CEPID - Centro de Ciências
Matemáticas Aplicadas à Indústria

entropy

IPP
Max Planck Institute
for Plasma Physics