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Toward Objectivity in International Criminal Law: Modeling Genocide

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I. Introduction

A. The Paradox of Power and The Need For Objective Standards in ICL

Life's evolution brings about increasing complexity, not only in physical forms but also in functional capabilities, particularly in how life forms interact with energy.[1] This complexity underpins biological systems' ability to store and release energy, crucial from single-celled organisms to complex human societies.[2] For life, energetics is economics. As life evolves, its metabolic and energy storage systems boost its efficiency in energy utilization.[3]

However, this complexity and enhanced ability to manipulate energy entails significant risks, introducing more potential failure points. The advanced energetic capacities enabling species to thrive may also lead to their downfall, presenting a paradox, a double-edged sword, where greater power is coupled with an increased capacity for self-destruction.[4] Humans demonstrate this

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[1] Universal properties of matter, including energy and entropy, drive the evolution of life's functional capabilities, fostering survival and increasing complexity in how life forms interact with energy. Irun R. Cohen & Assaf Marron, *The Evolution of Universal Adaptations of Life is Driven by Universal Properties of Matter: Energy, Entropy, And Interaction*, F1000 RESEARCH 2020 9:626 (published online Sept. 2, 2020), 10.12688/f1000research.24447.3. "A "unit" of evolution "is not a discrete entity, such as a gene, individual, or species; what evolves are *collections of related interactions at multiple scales." Id.* (abstract) (emphasis added).

[2] *See generally* Börje Ekstig, *Biological and Cultural Evolution in a Common Universal Trend of Increasing Complexity*, 66(6) WORLD FUTURES 435-448 (2010) (emphasizes that life's evolution brings about increasing complexity in both physical forms and functional capabilities, particularly in energy interactions); *see also* Börje Ekstig, *Complexity, Natural Selection and the Evolution of Life and Humans*, 20(2) FOUND SCI. 175-187 (2015) (citing president of the International Society for the Systems Sciences, who "in his analysis of the general evolutionary system theory, postulates a universal flow towards ever-increasing complexity, affirming the rate of evolutionary change to be accelerating at the socio-cultural level largely because the motors of memetic change rely on information sharing (rather than energy/matter exchange) and therefore allows for faster rates of change than the biophysical level of genetic change"); Alexander Laszlo, *The Nature of Evolution*, 65(3) WORLD FUTURES 204-221 (2009).

[3] SA Kooijman and TA Troost, *Quantitative Steps in the Evolution of Metabolic Organisation as Specified by the Dynamic Energy Budget Theory,* 82(1) BIOL. REV. CAMB. PHILOS. SOC., 113-142(2007) (elucidates the Dynamic Energy Budget (DEB) theory, describing a transition from simpler systems in prokaryotes to more complex ones in plants and animals); Frank Seebacher & Julian Beaman, *Evolution of Plasticity: Metabolic Compensation for Fluctuating Energy Demands at the Origin of Life*, 225(5) J. EXP. BIOL. (2022) (for argument that Darwinian evolution is contingent upon "metabolic plasticity," a response to fluctuating energy demands at the origin of life).

[4] Various studies illuminate the paradoxical nature of some evolutionary advancements, which provide species the means to survive but also introduce vulnerabilities that can precipitate extinction. *See* Satomi Tsuboko-Ishii & Ronald S Burton, *Prezygotic Reproductive Barriers in Precopulatory Behavior of Tidepool Copepod Species*, 77(10) EVOLUTION 2234–2245 (2023) (prezygotic reproductive barriers in copepod species suggest that complexity in mating behavior can play a role in species downfall due to reproductive isolation, highlighting the intricate balance between evolutionary advantages and vulnerabilities); Anastasia Stefanaki, et al., *Lessons from Red Data Books:*

paradox through technological and political advancements that, while arguably improving quality of life, also create the conditions for global threats like fascism, imperialism, and large-scale warfare.[5] Our societies amplify humanity's creative and destructive capacities and are prone to systemic failures where issues in one area can trigger widespread crises. Addressing the paradox of *social* power involves ethical considerations and responsible governance, to balance the benefits of aggregated and technologically complex social power against its risks.

The development of International Criminal Law (ICL) reflects efforts to manage the paradox of power on a global scale. By establishing norms and rules, ICL seeks to curb the destructive capacities of power, providing a universal framework for accountability.[6] By codifying the prohibition of certain behaviors globally recognized as detrimental to the human species, it aims to mitigate risks associated with power concentration and prevent widespread harm or

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Plant Vulnerability Increases with Floral Complexity, 10(9) PLOS ONE (published online Sept. 21, 2015), https://doi.org/10.1371/journal.pone.0138414 (link floral complexity, particularly floral symmetry, to vulnerability to extinction in plants, suggesting that high complexity scores correlate with vulnerability); David Roy Smith, *The Mutational Hazard Hypothesis of Organelle Genome Evolution: 10 Years On*, 25(16) MOLECULAR ECOLOGY 3769–3775 (2016) (the mutational hazard hypothesis (MHH) holds that 'excess' DNA is a mutational liability, because it increases the potential for harmful mutations); Sergia A. Muñoz-Gómez, *Constructive Neutral Evolution 20 Years Later,* 89(3) J. MOLECULAR EVOLUTION 172-182 (2021) (constructive neutral evolution (CNE) describes how random gene duplications and novel gene interactions can increase complexity, sometimes trapping organisms in states of increased genetic requirements that could potentially lead to vulnerabilities; meaning, "complexity can arise through a series of non-adaptive steps"); Diya Chatterjee & Rishabh Rai, *Choosing Death Over Survival: A Need to Identify Evolutionary Mechanisms Underlying Human Suicid*e, 12 FRONT PSYCHOL. (published online Nov. 2, 2021), https://doi.org/10.3389/fpsyg.2021.689022 (looking for complex evolutionary mechanisms leading up to self-destructive behaviors in humanity like suicide).

[5] Rightfully, much is made of a possible nuclear Armageddon, but it does not take such a rapid scenario for humanity to launch itself (again) into self-destructive feedback loops of ever-larger scales. Cognitive *a prioris* paired with systemic failures and advanced technologies can destroy at world-scale in their own right *and* precipitate nuclear war. *See generally* MAX HORKHEIMER AND THEODOR ADORNO, DIALECTIC OF ENLIGHTENMENT (1956) (the Enlightenment's emphasis on reason and the domination of nature, while initially liberating and empowering, leads to new forms of state oppression, social domination, and large-scale atrocities).

[6] *See generally* Holly Christie, *The Poisoned Chalice: Imperial Justice, Moral Relativism, and the Origins of International Criminal Law*, 72 U. PITT. L. REV. 361, 388 (2010) ("International criminal law offers the world a potential of universal justice. However, if the issues of political influence and historically integrated bias are not addressed as they impact this maturing body of international law, we risk, as an international community, the very result which Justice Jackson foreshadowed in his opening statement for the prosecution of the Nuremberg Trials, 'to pass these defendants a poisoned chalice is to put it to our own lips as well'").

injustice, actualizing the truism that with great power comes great responsibility.[7]

Objective standards in ICL, grounded in a scientific understanding of politics, are crucial for ensuring fairness and legitimacy in global governance. A scientific basis for law aims to transcend subjective biases, promoting laws that are universally applicable and adaptable to changing global dynamics. Mathematical models, including fractal models for capturing multi-scalar, repetitive, recursive social and political patterns, can offer clarity and precision in establishing legal standards.[8] These models provide a universal language for more consistent applications of law and evidence-based decision-making, essential for addressing the challenges of international relations and fostering a just global order.

Exhibiting a fractal structure itself, the paper 'zooms in' on the quest for objectivity in ICL, particularly focusing on the crime of genocide. It aims to elucidate and help specify an objective boundary for this complex legal standard. It does so by offering mathematical models that could aid in predicting, preventing, and consistently adjudicating genocide, arguing fractals are well-suited for this task. It reviews prior work mathematically modeling law and ICL, as well as political science models for predicting genocide and mass atrocities. Building on this, it proposes two new fractal-based indices: 1) A Fractal Genocide Potentiality Index (FGPI) providing data to trigger interventions and assess plausibility, and 2) A Fractal Genocide Actuality Index (FGAI) to serve as evidence in adjudicating genocide guilt. The FGPI incorporates structural risk factors, triggers, existing assessments, and fractal properties like self-similarity and recursion. The FGAI directly aligns with genocide's legal elements, using a recursive function to map protected groups,

[7] The 2005 UN endorsement of Responsibility to Protect principle states that the international community has a responsibility to protect populations from genocide, war crimes, ethnic cleansing, and crimes against humanity, especially when their own state is unwilling or unable to do so. *Responsibility to Protect*, UNITED NATIONS OFFICE ON GENOCIDE PREVENTION AND THE RESPONSIBILITY TO PROTECT (last visited May 5, 2023).

[8] For an explanation of fractals, *see generally* BENOIT MANDELBROT, THE FRACTAL GEOMETRY OF NATURE (1977) (introducing the concept of "fractals" to explain how nature's shapes differ from ordinary geometric shapes).

enumerated acts, indicators of intent, and other factors to a genocide actuality score. By formalizing realizing standards through modeling, these indices can improve objectivity in ICL.

B. The Problem of Hard Power and ICL

Hard Power speaks its own language, distinct from the discourses of diplomacy, morality, and law. Hard Power speaks the language of action, reaction, and leverage; that is, the language of tangible force. The task of reconciling the vernacular of Hard Power, emanating from entities equipped to wield such influence, and the languages of diplomacy, morality, and law, is an undertaking best addressed through the lenses of philosophy, political science, and mathematics.

This article serves as an initial exploration, aiming not to definitively resolve the issue posed but to establish a research agenda for doing so. This agenda is designed with the aim of guiding the standardization and evolution of international legal frameworks and institutions. It proposes a scientific and mathematical approach to the problem, ensuring an objective analysis.

This analysis is to be objective in two distinct senses. First, it is objective in the sense that all law is meant to be, in that it is supposed to be applied universally and neutrally, without differentiation in application based on who is subject to its authority. All rules-based law is an attempt to adjudicate disputes and decide punishments in advance of their occurrence, creating a constantly complexifying *algorithm* in its never-ending "attempt to anticipate everything."[9] This article strives for objectivity in this abstract sense: it aims to establish a *code* whereby the same inputs (circumstances and behaviors) are supposed to consistently correlate with the same outputs

[9] *See* Andrew Stumpff Morrison, *The Law is a Fractal: The Attempt to Anticipate Everything*, 44 LOY. U. CHI. L.J. 649 (2013). Professor Stumph is ultimately skeptical of this development of a rules-based, algorithmic order, criticizing the hyper-specificity of statutory tax law and other attempts "to anticipate everything" in legal regimes. *Id.* at 670, 679-681. Nonetheless, he provides a useful "Brief History of Rules Philosophy" which summarizes well this algorithmic progression of law, along with the co-evolution of its critique based on the notion that the number of "potential hard cases" or "penumbra" cases—which blur boundaries in application—is like a fractal's edges, "infinite." *Id.* at 656-662. Stumph restates the legal maxim, "hard cases make bad law," and argues that is because they are at the fractal's edge and call for "a new wrinkle in a previously smooth section of the border… [and] further wrinkles will ultimately have to be made within that new wrinkle." *Id.* at 661 (n. 35).

(legal outcomes), predictably and necessarily so (if the Rule of Law is to exist in a given legal regime).[10] This principle applies to all codes, including ICL, an evolving body of law and set of institutions meant to address some of the worse "crimes against the peace of the world."[11] As stated forcefully by Justice Jackson to open the Nuremburg Trial: "[t]he wrongs which we seek to condemn and punish have been so calculated, so malignant, and so devastating, that civilization cannot tolerate their being ignored, because it cannot survive their being repeated."[12] The goal of ICL is the worldwide elimination of specific atrocious acts; it threatens punishment to deter humanity from committing them. This *telos* of ICL reaches its apotheosis in the doctrine of "universal jurisdiction," which is a legal exception to the general principle of sovereignty and was requested of states by the Geneva Conventions of 1949,[13] based on the idea that "some crimes are simply too monstrous to go unpunished—regardless of where, when or by whom they were committed," because the perpetrators are "*hostes humani generis*… enemies of all mankind."[14]

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[10] Stumpff, *supra* note 9, at 658 (n. 26) (citing Boscoe Pound for definition of rules as 'precepts attaching a definite legal consequence to a definite detailed state of facts'). According to Stumpff, "the presumed attractiveness of infinite precision may have been stated most extravagantly by law and economics theorists Isaac Ehrlich and Judge Richard Posner: 'A *perfectly detailed and comprehensive* set of rules brings society nearer to its desired allocation of resources by discouraging socially undesirable activities and encouraging socially desirable ones.'" Id. at 666 (n. 54), citing Isaac Ehrlich & Richard Posner, *An Economic Analysis of Legal Rulemaking*, 3 J. LEGAL STUD. 257, 258 (1974).

[11] Robert H. Jackson, Opening Statement before the International Military Tribunal for the United States of America (Nov. 21, 1945), Robert H. Jackson Center, https://www.roberthjackson.org/speech-and-writing/opening-statement-before-the-international-military-tribunal/ (last visited May 5, 2024).

[12] *Id.*

[13] *See* Veronica Diaz-Cerda, *General Pinochet Arrest: 20 Years On, Here's How It Changed Global Justice,* THE CONVERSATION (Oct. 15, 2018), https://theconversation.com/general-pinochet-arrest-20-years-on-heres-how-it-changed-global-justice-104806 (with universal jurisdiction, "the idea that governments are unaccountable to courts located in foreign states for their domestic policies changed, so that all states now became subject to fundamental human rights norms").

[14] This doctrine creates jurisdiction for domestic courts regardless of whether the domestic states are signatories of the ICC; though asserted several times already, the doctrine remains in its nascency. *See* Rick Gladstone, *An Old Legal Doctrine That Puts War Criminals in the Reach of Justice*, N.Y. TIMES (Feb. 28, 2021), https://www.nytimes.com/2021/02/28/world/europe/universal-jurisdiction-war-crimes.html; Sergey Vasiliev, *The Future of Justice for Ukraine is Domestic*, JUSTICEINFO.NET (Mar. 29, 2022), https://www.justiceinfo.net/en/89434-future-justice-for-ukraine-domestic.html (alongside Ukraine and the ICC's investigations, at least eleven European states—Estonia, France, Latvia, Lithuania, Germany, Norway, Poland, Slovakia, Spain, Switzerland and Sweden—have announced investigations into war crimes in Ukraine based on the principle of universal jurisdiction).

ICL has been critiqued, and rightfully so, for its origins in Eurocentric colonialist practices and its present unequal enforcement.[15] But while ICL, like all international law, "is indeed more readily influenced by politics than a national system of criminal law would be, it can be easily differentiated from the famous 'show trials' of history."[16] Despite ICL's historical systemic position and the present reality of its unequal enforcement, a truly objective (universal and neutral) ICL remains the ultimate goal of many of its proponents and this article.

This article aims for objectivity not only by advocating for the universal application of laws but also in a second sense, by developing *objective models* that align legal standards with scientific understandings for the complex crime of genocide. The enforcement of laws against this crime is complex; simplistic, overly individualistic, static, ontologically-flat interpretations of same undermine prevention and fair enforcement. Therefore, a multi-scalar, formally complex objective methodology that aligns with legal standards is necessary. This article is a one small step toward constructing such a methodology, bridging the gap between Hard Power and legal standards, with the hope of restraining excessive uses of the former by way of the latter.[17]

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[15] The critical thought regarding the new bodies of ICL, in the 1940s when they were being introduced, was that they were at their core political bodies rather than true courts. Elizabeth Kopelman, *Ideology and International Law: The Dissent of the Indian Justice at the Tokyo War Crimes Trial*, 23 N.Y.U. J. INT'L L. & POL. 373 (1990). The Dissent of Justice Pal in the Tokyo Trial argued that the lack of prosecutions for Allied crimes damaged the reputation of these international bodies as courts, and exposed their founding/constraining political interests. *Id.* ("the present is much more a political than a legal affair, an essentially political objective having thus been cloaked by a juridical appearance"). This issue repeats itself with the International Criminal Tribunals for the Former Yugoslavia (ICTY), where the prosecutions were disproportionate and NATO bombings were not investigated, and Rwanda (ICTR), where there was no prosecution of the victorious Tutsi forces, the Rwandan Patriotic Front. *Id.* International law in general has been duly critiqued as favoring states within an elite club of 'sovereigns', while dominating others; despite decolonization efforts, the legacy of ICL reflecting Western interests persists. Christie, *supra* note 6, at 367.

[16] Christie, *supra* note 6, at 374.

[17] It's worth contemplating the question, what are the powers of the latter without the use of the former? Does the Law—perhaps exemplified best in its logical appeal to humanity in Immanuel Kant's categorical imperative—as universalist justice have some power in society separate from the Hard Power agencies it has typically been applied through? "The focus on the quality of the law, as opposed to its substance, is by no means new." Leo Park, *The International Court and Rule-Making: Finding Effectiveness,* 39 U. PA. J. INT'L L. 1065, 1084 (2018). Kant, who conceptualized the categorical imperative —act only by universalizable maxims—also "urged for the creation of an international world governed by the rule of law." *Id.*, *citing* Karol Kuźmicz, *The Kantian Model of the State Under the Rule of Law*, 19 STUDS. LOGIC, GRAMMAR & RHETORIC 13, 23 (2009) (summarizing Kant's philosophy and examining his ideals).

II. The Relationship Between Math and Law

A. Objectivity In Law As Formal Realizability

It *seems* there are two possible continuums along which to place rule-styles. One continuum runs from "generality" (standards) to "specificity" (codes/rules), with the border of illegality becoming clearer, and potentially jagged-edged, with each new exception and specification, building a complex algorithm for each law that resembles a fractal.[18] However, there is supposedly a different continuum for rule-styles, from "subjectivity" to "objectivity."[19] One way to think about "objectivity" is the degree to which a law is "formally realizable" or has "symbolic fixity."[20] Professor Stumph gives an easy illustration of the concept:

> For example, a highly formally realizable rule is: "Driving faster than 55 mph is always illegal; and driving less rapidly than 55 mph is always legal." A highly non-formally realizable (or subjective) rule would be: "Driving in a safe manner is always legal, and driving in an unsafe manner is always illegal."[21]

In fact, one can see how this continuum of "formal realizability" can even serve as a critique of the argument that "principles" or "standards" are qualitatively different from "rules."[22] Critiquing Dworkin, Stumpff observes that "a principle is simply a rule that happens to be both general and non-formally realizable."[23] As articulated by Roscoe Pound in 1933, instead of qualitative difference, really there is a hierarchy of types of legal guidelines—based more or less on specificity— "ascending from 'rules' through 'principles,' 'conceptions,' and 'doctrines,' and

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[18] Stumph*, supra* note 9*,* at 662.
[19] *Id.*
[20] Duncan Kennedy, *Form and Substance in Private Law Adjudications*, 89 HARV. L. REV. 1685, 1687-88 (1976); Daniel J. Gifford, *Communication of Legal Standards, Policy Development, and Effective Conduct Regulation*, 56 CORNELL L. REV. 409, (1971).
[21] Stumph*, supra* note 9, at 662.
[22] *See* Ronald M. Dworkin, *The Model of Rules*, 35 U. CHI. L. REV. 14, 22-23 (1967). Stumpff points out that "what Dworkin distinguishes as principles could just as easily be describes as default rules, implicitly preceded by the phrase: 'if no more specific rule applies, then…'" Stumpff, *supra* note 9, at 658 (n. 27). Likewise, Stumpff critiques Justice Posner's jurisprudence, arguing that Posner "struggles objectively" to distinguish rules from standards, having to "define[] a standard incoherently, as both a criterion (e.g., "'efficiency') and as a vague rule." *Id.*, *citing* RICHARD POSNER, THE PROBLEM OF JURISPRUDENCE 239 (1990) (criticizing Dworkin's "arbitrary" distinctions).
[23] Stumpff, *supra* note 9, at 662 (n. 39).

ending with the most general category, 'standards,' the latter of which [Pound] offered the 'reasonable prudent man' as an example.'"[24] Aligning with this article's idea of objective law, "Pound defined rules as 'precepts attaching a definite legal consequence to a definite detailed state of facts.'"[25] The more formally realizable (objective) the law, the more consistent its application.

By way of this analysis, these two continuums—general-specific; subjective-objective—are collapsed into one. General law is subjective; specific law is objective. In Stumpff's words, "all in all, then there seems to be just one category—'rules'—of which some are more or less general or subjective than others."[26]

B. The Difficulties in Applying Mathematical Approaches to Rules

Notwithstanding the commonsense in having formally realizable (objective) laws, humans are on unsure footing in getting there. Even apart from subject-centric biases from every angle,[27] legal systems simply are not mathematical systems.[28] Like Stumpff, I note that my article "will not make any sort of general claim that 'the law' is a 'system' in the way that mathematics is an analytic system; instead, it merely observes that certain specific facets of mathematics are conceptually similar to, and therefore potentially illustrative of, certain facets of rulemaking."[29]

However, my article also goes one step further and embraces the fractal structure of

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[24] Stumpff, *supra* note 9, at 658, *citing* Rosco Pound, *Hierarchy of Sources and Forms of Different Systems of Law*, 7 TUL. L. REV. 475, 482-85 (1933). As noted by Stumpff, "for a rulemaker to provide only a nondeterministic, subjective 'standard,' like 'reasonable man,' is to acknowledge the fractal's existence but to leave it to the judges to locate the fractal's edge, as it were, on an as-needed basis." *Supra* note 9, at 668 (n. 65).

[25] Stumpff, *supra* note 9, at 658 (n. 26); *see also* Ehrlich & Posner, *supra* note 10, at 259, 267 (rules are better than standards because rules are better at controlling officials).

[26] Stumpff, *supra* note 9, at 659 (n. 27).

[27] For an understanding of bias based on actual social ontology and phenomenology, *see generally*, Philosophy of Perspectivism and Standpoint Theory.

[28] According to Stumpff, there is actually a "slightly fraught history associated with the invocation of mathematical principles even by analogy to legal scholarship." Stumpff, *supra* note 9, at 650 (n. 1), *citing* David R. Dow, *Gödel and Langdell—A Reply to Brown and Greenberg's Use of Mathematics in Legal Theory*, 44 HASTING L.J. 707, 724 (1993); Jeffrey M. Lipshaw, *The Venn Diagram of Business Lawyering Judgments: Toward a Theory of Practical Metadisciplinarity*, 41 SETON HALL L. REV. 1, 44 (n.169) (2011) and sources cited therein.

[29] Stumpff, *supra* note 9, at 650 (n. 1).

objective rule-making, pushing for its further complexification/specification in the ICL context, as well as for it to be self-conscious of its development as such, taking advantage of all that fractal models have to offer. This is not because I deny Stumpff's contention of the impossibility of "perfect advanced enumeration," or doubt that "persistent attempts to achieve it have imposed enormous, under-recognized costs on regulated populations."[30] It is because the actions, the human behaviors, ICL seeks to police, are in reality complex, *qua* actions, *qua* behaviors, and require complex models to adjudicate in any specific, *objective* sense, which is to say, in a consistent, predictable, and therefore *fair* sense.[31] Furthermore, the creation and clarification of international rules inherently influences state behaviors and attitudes towards legality and compliance, reinforced by behavioral biases and the anchoring effect.[32] The Court's ability to craft influential and legitimate rules, grounded in the quality, clarity, symbolic value, and the conceptual validity of law rather than its mere substance, is key to encouraging state compliance and shaping global legal norms.[33] Ambiguous terms "feed reluctance to act on the part of states."[34] In the ICL context, there is a lack of a "clear, streamlined process for naming crimes, along with weak preventive norms mandating action in the absence of legal certainty."[35] As "competing political and economic

[30] Stumpff, *supra* note 9, at 649-650.
[31] Furthermore, Stumpff's deterministic understanding of science limits his ability to see the real similarities, if not perfect congruences, between legal systems, as systems, and mathematical ones. He writes that "a difference between law and mathematics or the physical sciences is that we will never be able to create definite, determinate formulas, like Newton's laws of motion, for writing and interpreting rules." Stumpff *supra* note 9, at 681. Contemporary approaches to physics, encompassing the irreconcilable frameworks of quantum physics and general relativity, allow for indeterminacy and even contradiction, with the Standard Model being only a temporary workaround until an actually unified theory of everything emerges. Corey S. Powell, *Relativity Versus Quantum Mechanics: The Battle For the Universe,* THE GUARDIAN (Nov. 4, 2015), https://www.theguardian.com/news/2015/nov/04/relativity-quantum-mechanics-universe-physicists.
[32] Leo Park, *supra* note 17, at 1081-83.
[33] *Id.* at 1084–88 ("One scholar summarized the necessary elements for establishing the rule of law as: 1) the rules should be stable; 2) they should apply equally to the governed and the individual; and 3) and they should be applied indiscriminately"). This appeal to the "conceptual validity of law rather than its mere substance" is again reminiscent of Kant. *Supra* note 17.
[34] Katherine Southwick, *Straining to Prevent the Rohingya Genocide: A Sociology of Law Perspective*, 12(3) GENOCIDE STUDIES AND PREVENTION: AN INTERNATIONAL JOURNAL 119-142 (2018).
DOI: https://doi.org/10.5038/1911-9933.12.3.1572
[35] *Id.* (abstract).

considerations obfuscate states' willingness to engage the issue," "these factors combine to portray a weak institutionalization of remedies."[36]

A general-subjective rule like 'reasonably prudent person, under the circumstances' (RPP-UTC) may suffice for common occurrences and claims like general torts involving individuals. But as crimes and claims complexify in their actual dynamics—with relevant events embedded in multiple scales—the law must complexify with them. In an attempt to make ICL more "formally realizable," the remainder of this article proposes a way to do this for one ICL standard in particular, by providing models for the prediction and adjudication of genocide. It discusses first prior attempts to mathematically represent law, then fractal theory, and finally, social science on genocide, atrocities, and aggression, to further lay an epistemological foundation for this task.

C. Prior Attempts to Mathematically Model Law

For some legal scholars, a "scientific approach to legal analysis and jurisprudence," associated in its early days with figures like Christopher Columbus Langdell, is now discredited.[37] Langdell believed "law could be studied and comprehended entirely from within, just as geometry can be."[38] To those critiquing such a notion, law is not mathematics, but something different: "law is norms, and normative advances depend largely on nonmathematical intelligence."[39] However, even these scholars critical of specifically analogizing law and mathematics recognize that "to be sure, normative discussion ought to be as perspicuous and as rigorous as mathematics," even if "it will never *be* math or science."[40] While Stumpff emphasizes the limits of fractals to delineate every border,[41] his own elucidation of the attempt makes a strong case for the use of fractal geometry by

[36] *Id.*
[37] Dow, *supra* note 28, at 708.
[38] *Id.*
[39] *Id.* at 726.
[40] *Id.*
[41] "No precise, definite border can exist between all the possible specific actions microscopically on this side of that which is appropriately legal and all the possible specific actions microscopically on the other side. One can

analogy to understand the actual progression of legal systems.[42] Furthermore, while recognizing at least one "devastating critique" of one attempt to apply the principles of symbolic logic to rule writing, Stumpff opines that the position which certain authors have taken,[43] suggesting it is "illegitimate—somehow off-limits—for legal writers to draw upon science or math, even by way of analogy… seems ridiculous."[44] Along with Stumpff, the paper supports the position that "[A]nalogies… cannot possibly fall within the authority of one discipline or another." [45] Roscoe Pound long-ago "challenge[d]… lawyers… to study the social operation of legislation, the effects it produces, and the means of making it effective."[46] To not utilize the tools of mathematics, systems theory, and social sciences in doing so would be a waste of libraries of scholarship.

Koenig and Mandell persuasively argue that "lawyers should not fear mathematics."[47] Mentioning Lincoln's studies of Euclid, they note that math and law follow a parallel structure.[48] Legal reasoning methods like deductive logic, counterargument, and analogy, correspond to the

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always—forever—find, by adding new facts and circumstances, some new unresolved 'gray area' that exists between the regions of fact-space previously resolved by rules. The law is a fractal." Stumpf, *supra* note 9, at 656 (n. 20); *see also* Frederick Schauer, *Formalism*, 97 YALE L.J. 509, 536 (1988) (the law uses vagueness to avoid incompleteness, which is inherent to fractal rule-making).

[42] *See* Stumpf, *supra* note 9, at 653-656 (II. The Fractal).

[43] *See* Dow, *supra* note 28, at 715

[44] Stumpf, *supra* note 9, at 681 (n. 116).

[45] *Citing* Lipshaw, *supra* note 28, at 43.

[46] Stumpff, *supra* note 9, at 681 (n. 117), *citing* ROSCOE POUND, JURISPRUDENCE 679 (1959). As Pound put it: "[T]he subject of codification is intimately connected with the idea of a written law. It is a form of the demand for a complete, intelligible, authoritative statement of the precepts governing individual relations and individual conduct. It is a phase of the demand that every man shall be assured of knowing what he may do and what he may not do. It is related to the idea behind our Bills of Rights. It is a part of the quest of a government of laws and not of men; it is part of the claim that men be assured that the magistrate shall regulate their conduct and adjust their relations according to preestablished law and not in accordance with his more or less arbitrary will. It has to do with an important aspect of the social interest in the general security in that it is one means of excluding the personal element in the administration of justice and thus of insuring uniformity, equality, and certainty. Indeed, the idea of a written law is urged not only to assure these things, but in order to make the lay public believe that they are assured. For if it is important that justice be done, it is no less important that people feel justice has been done. The stability of the legal ordering of society depends quite as much upon the latter as upon the former." *Id.*

[47] Melissa E. Love Koenig & Colleen Mandell, *A New Metaphor: How Artificial Intelligence Links Legal Reasoning and Mathematical Thinking*, 105 MARQ. L. REV. 559, 573 (2022) ("Despite a storied history of thinkers opposing the idea that mathematics and law are compatible, we posit that mathematical reasoning can inform legal analysis").

[48] *Id.* at 583.

mathematical concepts of direct proof, contradiction, and induction.[49] Furthermore, desires aside, artificial intelligence using mathematical reasoning is already being utilized in legal practice—for electronic discovery, expertise automation, research, document management, drafting and analytics for contracts and litigation, and prediction—and will only be more so going forward, by both lawyers and judges.[50] Some, including judges, have used math to formulate legal standards themselves, perhaps most famously Learned Hand with his "Burden (B) [> or <] Magnitude of Injury (L) x Probability of Injury (P)" formula for the reasonableness of precautions in the torts context.[51] Others have written on the necessity for mathematical analysis in various legal scenarios, from jury discrimination to antitrust cases, and how courts' reliance on intuition rather than statistical evidence can lead to misguided decisions.[52]

Apart from Stumpff, fractals in particular, as mathematical objects, have been used for diagram/analogy purposes, to understand the development of law, by several legal theorists.[53] Furthermore, there is a wide literature on the study of law as a complex system.[54] That said, there

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[49] *Id.* at 582.
[50] *Id.* at 593-596 (*see* "Section B. The Mathematics of AI" and "Section C. Embracing Mathematics and AI in law").
[51] Kenneth Simons, *Tort Negligence, Cost-Benefit Analysis, and Tradeoffs: A Closer Look At the Controversy*, 41 LOY. L.A. L. REV. 1171 (2008).
[52] See *Book Note: Quantitative Methods in Law: Studies in the Application of Mathematical Probability and Statistics to Legal Problems. by Michael O. Finkelstein. New York: The Free Press. 1978. Pp. Xi, 318. $17.95*, 93 HARV. L. REV. 1398, 1399 (1980) (book demonstrates how courts' reliance on intuition rather than statistical evidence can lead to misguided decisions).
[53] For the first example of such a use, *see* Robert Scott, *Chaos Theory and the Justice Paradox*, 35 WM. & MARY L. REV. 329, 348-49 (1993) (suggesting that the conflict between future justice and present justice produces an inevitable tension in the law that replicates itself over and over, producing a fractal structure); *see also* David G. Post & Michael B. Eisen, *How Long Is the Coastline of the Law? Thoughts on the Fractal Nature of Legal Systems*, 29 J. LEG. STUD. 545, 554 (2000) (described law as a "fractal landscape where rule choices are the branching motif" and the fractal quality of legal citation patterns); Alan L. Durham, *The Fractal Geometry of Invention*, 53 B.C. L. REV. 489 (2012) (contending that the process of invention has a fractal nature); Daniel M. Braun, *Constitutional Fracticality: Structure and Coherence in the Nation's Supreme Law*, 32 ST. LOUIS U. PUB. L. Rev. 389, 409 (2013) (utilizing formalities of fractals like multi-scalar self-similarity, cascade effects, and coherence to understand the U.S. constitution as an integrated whole).
[54] *See*, *e.g.*, David G. Post & David R. Johnson, *"Chaos Prevailing on Every Continent": Towards a New Theory of Decentralized Decision-Making in Complex Systems*, 73 CHI.-KENT L. REV. 1055 (1998); Fried, supra note 2; J. B. Ruhl, The Fitness of Law: Using Complexity Theory to Describe the Evolution of Law and Society and Its Practical Meaning for Democracy, 49 Vand. L. Rev. 1407 (1996); J. B. Ruhl, *Thinking of Environmental Law as a Complex Adaptive System: How to Clean Up the Environment by Making a Mess of Environmental Law*, 34 HOUSTON L. REV.

is little scholarship on the use of fractal modeling to better understand ICL. Additionally, there is a paucity of legal scholarship attempting to use models proactively, in any criminal law context, to *elucidate-specify* legal standards *into* objective rules, as this article attempts to.

III. Fractal Thinking About Conflicts and Conflict-Related Crimes

A. The Need for Fractals in ICL

This article now turns to articulating the objective approach, firstly by describing briefly why fractals, as opposed to other objective models, are best for elucidating legal standards on genocide and war crimes. While mathematical thinking has been used in the ICL context, it has been in a sociological or psychological sense; to better understand, for instance, the movement from quantity to quality in the formation of customary international law,[55] or international compliance with legal standards from a game theory perspective[56]. This article uses fractals to *elucidate* ICL legal standards, to make them "formally realizable."

There is a seemingly endless supply of quantitative political science models for conflict.[57]

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933 (1997); J. B. Ruhl & Harold J. Ruhl, Jr., *The Arrow of the Law in Modern Administrative States: Using Complexity Theory to Reveal the Diminishing Returns and Increasing Risks the Burgeoning of Law Poses to Society*, 30 U.C. DAVIS L. REV. 405 (1997); Mark J. Roe, *Chaos and Evolution in Law and Economics*, 109 HARV. L. REV. 641 (1996); Andrew W. Hayes, *An Introduction to Chaos and Law*, 60 UMKC L. Rev. 751 (1992).

[55] William Thomas Worster, *The Transformation of Quantity into Quality: Critical Mass in the Formation of Customary International Law*, 31(1) B.U. INT'L L.J. 71 (2013) (analyzing the roles of networks and individuals in the system, outlining a program for study, but cautioning on the difficulties of empirical assessment).

[56] Lea Brilmayer & Yunsieg P. Kim, *Model or Muddle? Quantitative Modeling and the Façade of "Modernization" in Law*, 56(1) WASHBURN L.J., 26 (2017).

[57] For an overview of this literature, *see generally* Leiby, Benjamin, and Darryl Ahner, *Datasets and Models for Globally Predicting Country Conflict and Peace: A Survey*, 28(3) MILITARY OPERATIONS RESEARCH 87–112 (2023) (explores the importance of accurately modeling country conflict through the development of an "aspect" construct with underlying "themes" for data consideration, offering a taxonomy of variables, potential datasets, and a survey of modeling and analytical techniques to enhance global conflict prediction efforts); Ana P. Morgenstern, et al., *Resource Letter MPCVW-1: Modeling Political Conflict, Violence, and Wars: A Survey*, 81 AM. J. PHYS. 805-814 (2013); *see also, e.g.,* Neil Johnson, et al, *Simple Mathematical Law Benchmarks Human Confrontations*, 3 SCI. REPORTS 3463 (2013); Vito D'Orazio, et al., *Modeling and Forecasting Armed Conflict: AutoML with Human-Guided Machine Learning*, 2019 IEEE INTERNATIONAL CONFERENCE ON BIG DATA (BIG DATA) 4714-4723 (2019), (discusses the potential of Automated Machine Learning (AutoML) and Human-Guided Machine Learning (HGML) in enhancing predictive models of conflict in political science, highlighting the elevated performance of AutoML implementations in conflict prediction models); Jaime A. Jackson, et al., *International Support Networks and the Calculus of Uprising*, 57(5) JOURNAL OF PEACE RESEARCH 632-647 (2020) (explores how the expectation of external support influences the likelihood and nature of uprisings, affecting the choice between violent and nonviolent actions); Christian Houle,

What is distinctive about this article is its attempt to utilize modeling to *specify rules* for ICL. In other words, this article strives not just to understand these events *qua* events, even less so to survey the literature on the attempt to do so, but to aid in the prevention and prosecution of these events *qua* crimes. For this purpose, choosing one model-shape is efficacious and ultimately necessary. Because these crimes are complex, systemic events, happening on a large scale[58]—or, more accurately, happening on different scales simultaneously—a fractal model is the best possible

Inequality Between Identity Groups and Social Unrest, 19(188) J. R. SOC. INTERFACE (published online Mar. 23, 2022), https://doi.org/10.1098%2Frsif.2021.0725 (models the effects of economic and political inequalities on violent conflicts within societies); Douglas M. Gibler, *Combining Behavioral and Structural Predictors of Violent Civil Conflict: Getting Scholars and Policymakers to Talk to Each Other*, 61(1) INTERNATIONAL STUDIES QUARTERLY 28-37 (2017) (like this article, the authors here emphasize the importance of integrating structural analysis with qualitative assessments for understanding and predicting conflict behaviors globally); Jorge Chica-Olmo, et al., *The Spatial Effects of Violent Political Events on Mortality in Countries of Africa*, 101(3) SOUTH AFRICAN GEOGRAPHICAL JOURNAL 285-306 (2019) (models the impact of different actors on mortality during violent political events in African countries, highlighting the spatial contagion effect).

[58] The scale and systematicity of alleged war crimes, and alleged genocide in particular, makes understanding, prevention, and prosecution in this context qualitatively different from criminal law in the domestic context, which understands and prosecute crimes *qua* individual behavior, punishing on the level of the soul or psyche, not the system or government policy. *See generally* Michel Foucault, DISCIPLINE AND PUNISH: THE BIRTH OF THE PRISON (1975) (modernization in penal systems meant going from punishing the rebellious body via torture to disciplining the individual soul via the prison and homologous institutions). In the War Crimes context, the opportunistic, though perhaps just, prosecution of a single individual, juxtaposed against a systemic, large-scale crime like extra-territorial aggression, seems woefully inadequate and almost ironic. *See* Sergei Kuznetsov, *Russian Soldier Sentenced to Life In Prison for Killing Ukrainian Civilian*, POLITICO (May 23, 2022), https://www.politico.eu/article/russian-soldier-sentenced-to-life-in-prison-for-killing-ukrainian-civilian (twenty-one year old Russian tank commander pleads guilty to war crimes in Ukraine court, the first to do so; just three months after the February 2022 invasion, Kyiv's prosecutor general's office registered over 12,000 suspected war crimes and 6,000 crimes against national security committed by Russian troops); *Id.* (just one month after the February 2022 invasion, "abhorrent images and footages recorded by the authorities, civil society actors, reporters, and eyewitnesses on the ground and circulating widely on social media attest to an unimaginable *scale* of destruction and human suffering") (emphasis added). Scale-analysis is inescapable when trying to understand, explain, or prevent conflict and destruction in the Palestine-Israel context. Daniele Palumbo, et al., *At Least Half of Gaza's Buildings Damaged or Destroyed, New Analysis Shows*, BBC (Jan 30, 2024) https://www.bbc.com/news/world-middle-east-68006607 (BBC Verify's analysis shows "*scale* of destruction of farmland" and "*scale* of damage"; 50-61 percent of buildings in the Gaza strip were damaged as of January 2024) (emphasis added); Secretary-General of the UN, Antonio Guterres, *Scale of Death & Destruction in Gaza Result of Wide-Area Explosives in Populated Areas*, GLOBAL ISSUES (Thur. Nov. 2023), https://www.globalissues.org/news/2023/11/30/35424; Courtney McBride & Gwen Ackerman, *US Says Israel Must Not Repeat Scale of North Gaza Damage*, BLOOMBERG (Nov. 30, 2023), https://www.bloomberg.com/news/articles/2023-11-30/us-says-israel-must-not-repeat-scale-of-north-gaza-destruction; United Nations Office for the Coordination of Humanitarian Affairs (OCHA), *"Essential Supplies Must Enter Gaza at the Scale Needed," Senior UN Official Tells Security Council*, OCHA (Oct. 24, 2023), https://www.unocha.org/news/essential-supplies-must-enter-gaza-scale-needed-senior-un-official-tells-security-council; Human Rights Watch, *Israel/Palestine: Unprecedented Killings, Repression*, HRW.ORG (Jan. 11, 2024) (report states that civilians in Gaza have been "targeted, attacked, abused, and killed over the past year at a *scale* unprecedented in the recent history of Israel and Palestine," with 23,469 Palestinians killed and 59,604 injured in Gaza alone between October 7, 2023 and January 11, 2024) (emphasis added).

fit for the complex and fraught task of specifying, or *formally realizing*, ICL.[59]

B. Fractals in Nonequilibrium Systems Theory and Political Science

"Whatever the discipline, there is an emerging perception that in our cosmos empirical data frequently demonstrate certain universal patterns of behavior."[60] The mathematical and epistemological principles of complexity science, particularly in regard to non-equilibrium systems, "can be applied to systems with natural hazards, and also human social and economic systems."[61] Importantly for ICL, "disruptive, extreme events result from the emergent properties of complex, nonequilibrium systems that consist of interdependent components whose interactions result in a competition between organized, interaction-dominated behavior and irregular or stochastic, fluctuation-dominated behavior."[62] Applied to ICL, there is a "competition" between social order (including order within warfare) and social chaos (including disorder within warfare). Importantly for this article's purpose, "the use of fractal analysis allows insights into the origin and development of such extreme events, and provides limits for theoretical models."[63] The need to pair non-equilibrium systems theory with ICL is crucial because "the tools of chaos, nonlinear dynamics, and statistical mechanics," in other words, "fractal methods," can "improve the assessment and analysis of risks associated with systems that exhibit extreme events," the exact kind of events ICL seeks to police.[64]

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[59] Alongside aiding our understanding of *events* and *laws* themselves, scale should be considered when thinking through *investigations* and *prosecutions.* Arguably, a benefit of the ICC is that in some contexts it can offer both an economy of scale in investigations and prosecutions as well as unmatched impartiality. *See* Kevin Jon Heller, *The Best Option: An Extraordinary Ukrainian Chamber for Aggression*, OPINIOJURIS (Mar. 16, 2022), https://opiniojuris.org/2022/03/16/the-best-option-an-extraordinary-ukrainian-chamber-for-aggression (arguing the "ICC would offer economy of scale" and would "lessen (though not eliminate) selectivity problems, as it would be able to investigation other acts of aggression, as well").

[60] James Wanliss, *Fractal Methods in Nonequilibrium Systems*, FRACTAL ANALYSIS – APPLICATIONS AND UPDATES (published online July 13, 2023), https://www.intechopen.com/chapters/1137664.

[61] *Id.* (abstract)

[62] *Id.*

[63] *Id.*

[64] *Id.* Specific fractal methods analyzed in the article include range scaling (R/S) analysis, spectral analysis, the Higuchi method, structure function analysis, and detrended fluctuation analysis (DFA).

Some political scientists have begun applying fractal models to social conflicts, validating a theory regarding their applicability to such. Blau and Paxton's recent work providing "a fractal analysis of four levels of human aggression," for example, uses the concept of "scale-independence" to explore the event of aggression "across all feasible temporal scales of human activity."[65] The authors attempt to demonstrate repetitive, temporally overlapping patterns of aggression from the "very microlevel" (body movements during arguments), "microlevel" (violent crimes), "macrolevel" (riots), and "very macrolevel" (wars).[66] Their data found empirical support for a scale-independence hypothesis regarding all scales *except* the "microlevel" (violent crimes).[67] The study's "findings support the validity of using fractal analyses on human behavior to understand these phenomena across multiple scales" while also "rais[ing] important questions about the impact of data quality on such analyses."[68] It notes that it examined only one type of human behavior—aggression—and that "future work should target other kinds of human activities that are well-documented across temporal or spatial scales to continue testing the scale-independence hypothesis in human dynamics."[69]

Not only to test such a hypothesis, but to objectively specify an international legal standard, using scale-independence and other fractal properties, for the well-documented, spatially and temporally-scaled human activity of *genocide* is the purpose of the remainder of this article. To do so, it discusses the standard and the rules of evidence in ICL, reviews literature providing risk-

[65] Julia J. Blau and Alexandra Paxton, *Scale-Independent Aggression: A Fractal Analysis of Four Levels of Human Aggression*, 1 COMPLEXITY 1-8 (2020).
[66] *Id.* at 2
[67] *Id.* at 4. The study speculates on various reasons why crime might be temporally distinct from the other levels: late reporting, non-reporting, source skewing, and perhaps it just does not hold at this level. Though the authors find the possibility that it "simply does not hold at this level of analysis… to be the least compelling possibility," I am not as sure. It can be argued that violent crime within a given society may decrease as intra-society or inter-society political violence increases, as solidarity-effects and channeling-effects occur. This would help explain the study's results.
[68] *Id.* at 6.
[69] *Id.*

assessment heuristics for genocide, proposes fractal principles to conceptualize the crime's complexity, and suggests formulas for mathematically modeling the legal standard objectively.

IV. Modeling the Legal Standard for Genocide Using Fractals and Chaos Theory

A. The Standard for Genocide and Admissibility of Evidence in ICL

Genocide is one of, if not *the*, most prohibited crime within ICL,[70] in that it is prohibited by the UN Convention on the Prevention of the Crime of Genocide ("Genocide Convention")[71] and the Rome Statute of the International Criminal Court,[72] and is widely recognized as a crime falling within the category of those punishable under "universal jurisdiction."[73] Furthermore, Article I of the UN Convention on Genocide explicitly requires not just punishment, but "prevention" of genocide by contracting parties.[74] Therefore, predictive modeling is not just a political science endeavor, it is a legal obligation for parties seeking to fulfill their duties under the Convention, as prevention must in some sense include prediction. The ICC adjudicates Rome Statute violations by individuals; the ICJ adjudicates Genocide Convention violations by states.[75] While a scaled, mathematical approach could be useful for either adjudication, it is arguably most apropos for the complex task of determining the legal culpability of states in the ICJ context, as establishing what it means for a *state* to act genocidally, and with genocidal intent, requires rational extrapolations and inferences based on the state's actions *qua* system-of-violence, a complex analysis less necessary for prosecuting individuals *qua* single-actors.

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[70] *See generally* WILLIAM A. SCHABAS, GENOCIDE IN INTERNATIONAL LAW: THE CRIME OF CRIMES (2004).
[71] Convention on the Prevention and Punishment of the Crime of Genocide, opened for signature Dec. 9, 1948, 102 Stat. 3045, 78 U.N.T.S. 277 [hereinafter Genocide Convention).
[72] Rome Statute of the International Criminal Court, July 17, 1998, 2187 U.N.T.S. 90. [hereinafter Rome Statute]
[73] *Genocide: The Legal Basis for Universal Jurisdiction*, AMNESTY INTERNATIONAL (published 2001), https://www.amnesty.org/en/wp-content/uploads/2021/06/ior530102001en.pdf.
[74] Genocide Convention, Art. IV, *supra* note 71.
[75] Philippa Webb, *Binocular Vision: State Responsibility and Individual Criminal Responsibility for Genocide*, in L. van den Herik, & C. Stahn (Eds.), THE DIVERSIFICATION AND FRAGMENTATION OF INTERNATIONAL CRIMINAL LAW (2012) highlights the complementary roles of the ICC and ICJ, where the ICC addresses individual criminal responsibility for genocide and the ICJ focuses on state responsibility).

As the UN notes, the popular understanding of what constitutes genocide tends to be broader than the content of the crime under ICL.[76] The Genocide Convention defines the crime somewhat narrowly, including two requisite elements.[77] The "physical element," or *actus reus*, includes the following five acts, enumerated exhaustively: (a) Killing members of the group; (b) Causing serious bodily or mental harm to members of the group; (c) Deliberately inflicting on the group conditions of life calculated to bring about its physical destruction in whole or in part; (d) Imposing measures intended to prevent births within the group; and (e) Forcibly transferring children of the group to another group. The "mental element," or *mens rea*, of genocide is the "intent to destroy, in whole or in part, a national, ethnical, racial or religious group, as such."

Article 69 of the Rome Statute, which covers evidence, gives broad allowance to parties and the ICC itself to submit evidence considered necessary for the determination of the truth, as long as the evidence is relevant and its probative value outweighs its prejudicial effect.[78] The ICJ likewise gives parties "wide scope to determine what to produce, often leading to massive filings containing much of doubtful relevance."[79] With regard to the use of evidence, "laissez-faire largely prevails… there [being] no rules requiring 'best evidence' or excluding hearsay."[80] Meaning, "parties are essentially free to put in what they will."[81] Although the ICJ has broad powers to request additional evidence, to call and question witnesses, to conduct site visits, and to appoint its own experts, "these powers are rarely used."[82] With "growing caseloads and limited resources,"

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[76] United Nations, *Definitions: Genocide*, UN.ORG (last visited May 5, 2024), https://www.un.org/en/genocideprevention/genocide.shtml
[77] Genocide Convention, Art. II, *supra* note 71.
[78] Rome Statute, Art. 69, § 4.
[79] John R. Crook, *Evidence Before the International Court of Justice. by Anna Riddell and Brendan Plant. London: British Institute of International and Comparative Law, 2009. Pp. Xxvii, 420. $130*, 107 AM. J. INT'L L. 259, 261 (2013).
[80] *Id.* at 262.
[81] *Id.*
[82] *Id.* at 261.

the ICJ "sometimes finds that it has access to insufficient information on central questions of fact, while ... being overloaded with superfluous evidence relating to less significant questions."[83] This article contends the ICJ should use its power "to appoint its own experts"—which they used to but declined to continue doing[84]— to apply scientific models, including precedential comparisons, for the purpose of presenting objective evidence to the Court, to determine preventative choke-points, thresholds for plausibility in pleadings, adjudications, and punishments. Regardless of whether the Court exercises this prerogative at their disposal, given ICL's "laissez faire" rules of evidence, the parties themselves have considerable discretion to use mathematical models to make their cases.

B. Genocide's Formal Complexity and Specific Intent Requirement

The legal standard for genocide is textually complex for several reasons. First, the *actus reus* is measured on a five-dimensional axis.[85] Second, the standard includes a handful of facially ambiguous terms within it, including but not limited to: "serious bodily or mental harm," "conditions of life," "deliberately…calculated," "physical destruction," "in whole or in part," "measures…to prevent births," and "forcibly transferring."[86] Third, and perhaps most vexingly, the *mens rea* of specific intent is notoriously difficult to conceptualize and prove.[87]

There is a rich body of literature examining specific intent. Some of it discusses the challenges of determining the accused's mindset without direct evidence, emphasizing the lack of precedent consistency and varying legal outcomes due to "the freedom of assessment" by

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[83] *Id.*
[84] *Id.* at 263 (referencing the "good result" in Corfu Channel (UK v. Alb.), 1949 ICJ REP. 4 (Apr. 9)).
[85] This axis is *only* five-dimensional if one only includes Article II acts and *excludes* Article III (b)-(e) criminal acts, which also include conspiracy, incitement, attempt, and complicity, in relation to the penta-dimensional conceptualization of the "physical element" (*actus reus*) of genocide. *See* Genocide Convention, Arts. II-III.
[86] Genocide Convention, Art. II. For analysis of the ambiguity of Genocide's terms, *see* Southwick, *supra* note 34.
[87] "Specific intent requires that it be shown that an act is motivated by a prohibited motive." Jay Gordon, *When Intent Makes All the Difference in the World: Economic Sanctions and the Accusation of Genocide*, 5 YALE HUM. RTS. & DEV. L.J. 57 (2002).

international courts.[88] Some authors take a historical-comparative approach to analyzing specific intent.[89] Some discuss the "contextual elements"[90] involved or the "motivations" behind intent.[91] Related to same, some focus on the "emergence of a new type of evidence: a cognitive, linguistic, culturally determined plural of genocidal *mens rea*."[92] Others attempt to shed light on the psychological steps, highlighting the role of abstraction in lowering inhibitions for potential perpetrators and fostering indifference in bystanders.[93] Critics of the intent requirement argue it may over-exculpate actors for acts of massive human destruction.[94] What these works share in common is their call for more clarity in ICL to better prevent and prosecute "the crime of crimes."[95]

This article relies on an understanding of genocide as a *process* that escalates from discrimination and dehumanization to systematic extermination, involving feedback loops that allow genocidal ideologies to take hold and spread, such as propaganda, political manipulation, and the erosion of checks and balances. One recognized framework for understanding the progression towards genocide is Gregory Stanton's "10 Stages of Genocide."[96] These stages—Classification, Symbolization, Discrimination, Dehumanization, Organization, Polarization,

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[88] Paul Behrens, *Assessment of International Criminal Evidence: The Case of the Unpredictable Génocidaire*, 71(4) ZEITSCHRIFT FÜR AUSLÄNDISCHES ÖFFENTLICHES RECHT UND VÖLKERRECHT 662-89 (2011).
[89] Myroslava Antonovych, *Specific Intent (dolus specialis) in the Armenian Genocide, the Holodomor and the Holocaust: Comparative Analysis*, 3 NAUKMA RESEARCH PAPERS LAW 19-25 (2019) (comparing the three genocides, concluding a key common element in genocides examined to be state organization being replaced by the hegemony of a ruling party).
[90] *See generally* NASOUR KOURSAMI, THE 'CONTEXTUAL ELEMENTS' OF THE CRIME OF GENOCIDE (2017).
[91] *See* JOHN B QUIGLEY, THE GENOCIDE CONVENTION : AN INTERNATIONAL LAW ANALYSIS (2006) (chapter titled, "Intent Without Intent").
[92] Dojcinovic, Predrag, *The Chameleon of Mens Rea and the Shifting Guises of Culture-Specific Genocidal Intent in International Criminal Proceedings* 15(4) JOURNAL OF HUMAN RIGHTS (published online Feb. 1, 2014), https://ssrn.com/abstract=2843475 (arguing for an "advanced forensic approach to the language used by the network of genocidaires" to determine intent).
[93] Paul Behrens, *From Abstraction to Intent: The Law of Genocide and Its Insights into the Genocidal Mindset*, EDINBURGH SCHOOL OF LAW RESEARCH PAPER NO. 2017/01 (published online Jan. 30, 2017), https://ssrn.com/abstract=2908073 or http://dx.doi.org/10.2139/ssrn.2908073
[94] *See* Gordon, *supra* note 87.
[95] See Schabas, *supra* note 70.
[96] Dr. Gregory Stanton, *The Ten Stages of Genocide*, GENOCIDE WATCH, http://genocidewatch.net/genocide-2/8-stages-of-genocide (last visited May 5, 2024) (map pinpointing currently existing stages of genocide worldwide).

Preparation, Persecution, Extermination, and Denial—are not linear and may occur simultaneously.[97] While this framework does provide a general understanding, it does not provide a quantitative measure, instead highlighting qualitative warning signs and processes.

This article argues that this processual pattern of behavior resembles a *fractal*, in that it is a repetition of certain self-similar genocidal actions—including institutions like the camp—across different spatiotemporal scales within a conflict. Not only does a fractal model provide courts an objective multi-scalar understanding of the complex self-similar phenomenon of genocide, but it can also provide early warning signs, conceptualize recursion (larger scales incorporating information from smaller scales, leading to cascade effects) and chaos (underlying patterns among seeming disorder; sensitivity to initial conditions and perturbations), and incorporate new data as the situation evolves. Because genocidal intent, the *mens rea*, can be inferred from factual circumstances,[98] modeling and indexing the multi-scalar factual circumstances, the process of genocide, from potentiality to actuality, is essential for adjudicating *both* elements of the crime.

C. Prior Attempts to Model and Predict Genocide

This article is certainly not the first attempt to model genocide, for purposes of prevention and objective assessment. Most notably, a collaboration between the Simon-Skjodt Center for the Prevention of Genocide at the United States Holocaust Memorial Museum (USHMM) and the Dickey Center for International Understanding at Dartmouth College has produced the Early Warning Project.[99] The Project puts out a regular "Mass Killing Risk Assessment Report,"

[97] *Id.; see also* Dr. Gregory Stanton, *The Ten Stages of Genocide,* HOLOCAUST MEMORIAL DAY TRUST, https://www.hmd.org.uk/learn-about-the-holocaust-and-genocides/what-is-genocide/the-ten-stages-of-genocide/ (last visited May 5, 2024) (for an infographic of the stages).
[98] International Criminal Court, *Elements of Crimes*, ICC-CPI.INT, https://www.icc-cpi.int/sites/default/files/Publications/Elements-of-Crimes.pdf (last visited May. 5, 2024).
[99] EARLY WARNING PROJECT, https://earlywarningproject.ushmm.org (last visited May. 5, 2024).

highlighting countries at risk of such.[100] Though one explicit goal of this project is "to prevent future genocides" by understanding how they occur—the warning signs and human behaviors—what it actually measures is not genocide *per se*, but "mass killings," defined as "deliberate actions of armed groups in a particular country (including but not limited to state security forces, rebel armies, and other military) resulting in the deaths of at least 1,000 noncombatant civilians."[101] While perhaps useful for general forecasting on that specific fact pattern, the project's approach to genocide has *no* relation to either element of the legal standard. Furthermore, the project's model relies on the selection of 30 variables, or "risk factors," going back to 1960, as input for a logistic regression analysis that algorithmically identifies predictive relationships in the data, resulting in an estimation model.[102] This model is not useful for modeling genocide in any particular case, nor for modeling it as a process. Indeed, the project admits that its "variables" may not be "drivers," and may serve as "useful predictors, not because they cause mass killings to be more likely, but because they indirectly serve as proxies for other factors that do."[103] While this article appreciates the project's contributions and intent, its approach contrasts markedly.

There was also the Political Instability Task Force (PITF), a U.S. government sponsored project aiming to study and build a database on major political conflicts that lead to state failures.[104] The PITF identified over 100 "problem cases" worldwide from 1955 to 2011, focusing on four

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[100] Naomi Kikoler (Director), *Countries at Risk for Mass Killing 2023-24: Early Warning Project Statistical Risk Assessment Results*, EARLY WARNING PROJECT, https://earlywarningproject.ushmm.org/reports/countries-at-risk-for-mass-killing-2023-24-early-warning-project-statistical-risk-assessment-results (last visited May. 5, 2024) (pdf).
[101] *Id.* at 4.
[102] *Id.* at 5-6 (Data and Modeling Approach).
[103] *Id.* at 6.
[104] Jack Goldstone, et al., *Political Instability Task Force: New Findings*, WILSON CENTER AT PRINCETON UNIVERSITY, https://www.wilsoncenter.org/event/political-instability-task-force-new-findings (last visited May. 5, 2024); *see also Political Instability Task Consolidated Problem Set: Historical State Armed Conflicts and Regime Crises 1955-2018,* SYSTEMICPEACE.ORG, https://www.systemicpeace.org/inscr/PITF%20Consolidated%20Case%20List%202018.pdf (last visited May. 5, 2024)

types of state failure events: revolutionary wars, ethnic wars, adverse regime changes, and genocides/politicides.[105] Their findings highlight the significant role of a country's political institutions in determining vulnerability to state failure, using "statistical logistic regression analysis" and "neural network analysis" to identify risk factors for instability.[106] PITF's dataset and findings are valuable, but like the Early Warning Project, pay no mind to the legal standard for genocide (going by its own definition and considering it but one form of "state failure") and do little to map the complexity of the process constituting such. Likewise, the U.S. State Department's Atrocity Risk Assessment Framework (ARAF), useful for its own purpose of helping "decision makers and country watchers understand atrocity risk and where atrocities are underway," has no relation to the legal standard for genocide, instead dealing with the rather nebulous term, "atrocities," and is indeed not a quantitative model at all but a qualitative "framework."[107]

Some political scientists have had moderate success in predicting "genocide," and continue to refine their models over time. For example, in their attempt to produce a prototype for a real-time model capable of forecasting one year into the future, Goldsmith, et al., implement a two-stage approach that considers both the likelihood of instability and the likelihood of genocide in a single estimate.[108] Their goal is to "produce annual lists of at-risk states in a format that should be

[105] The dataset includes detailed information for each case, such as country, the onset and ending dates, type of case, and annual codes on magnitude variables, among others.
[106] Jack Goldstone, et al., *State Failure Task Force Report: Phase II Findings*, 5 ENVIRONMENTAL CHANGE & SECURITY PROJECT REPORT 49 (1999).
[107]U.S. Atrocity Risk Assessment Framework, U.S. DEPARTMENT OF STATE, https://www.state.gov/u-s-atrocity-risk-assessment-framework (last visited May 5, 2024); for a similar framework and understanding of the issue, *see also*, Fund for Peace, *Measuring Fragility*, FRAGILE STATES INDEX, https://fragilestatesindex.org/ (last visited May 5, 2024).
[108] Benjamin E. Goldsmith, et al., *Forecasting the Onset of Genocide and Politicide: Annual Out-of-sample Forecasts on a Global Dataset, 1988–2003*, 50(4) JOURNAL OF PEACE RESEARCH 437-452 (2013); *see also*, Benjamin E. Goldsmith, et al., *A Two-Stage Approach to Predicting Genocide and Politicide Onset in a Global Dataset*, SSRN ELECTRONIC JOURNAL (published online March 20, 2012), https://ssrn.com/abstract=2027396 (out-of-sample forecasts for 1988-2003 predict 81.8% of genocide onsets correctly while also predicting 78.7% of non-onset years correctly).

of use to policy makers seeking to prevent such mass atrocities."[109] The study's "out-of-sample forecasts for 1988–2003 predict 90.9% of genocide onsets correctly while also predicting 79.2% of non-onset years correctly, an improvement over a previous study using a case-control in-sample approach."[110] This study shows predictive promise but like others mentioned, its process-ontology is oversimplistic and it does not even mention the legal standard for "genocide," let alone model it. Instead, it relies upon the PITF's definition of genocide *and politicide*, subsuming the two.[111]

Ernesto Verdeja has "canvassed contemporary risk assessment and early warning approaches in contemporary conflict prevention," including the above studies and others, finding "impressive advances in identifying the main indicators of mass violence in its many forms for policy purposes."[112] Verdeja's study has the benefit of articulating common risk-indicators in the literature predicting genocide and mass atrocities,[113] and common early warning signs,[114] admitting "there is no hard line between risk assessment and early warning," other than the fact

[109] Goldsmith (2012), *supra* note 108 (abstract).
[110] Goldsmith (2013), *supra* note 108, at 450.
[111] "Genocide and politicide events involve the promotion, execution, and/or implied consent of sustained policies by governing elites or their agents - or in the case of civil war, either of the contending authorities - that result in the deaths of a substantial portion of a communal group or politicized non-communal group. In genocides the victimized groups are defined primarily in terms of their communal (ethnolinguistic, religious) characteristics. In politicides, by contrast, groups are defined primarily in terms of their political opposition to the regime and dominant groups." Goldsmith (2012), *supra* note 108, at 14; *citing* Jack Goldstone, et al., *A Global Forecasting Model of Political Instability*, 54(1) AMERICAN JOURNAL OF POLITICAL SCIENCE 190-208 (2010).
[112] Ernesto Verdeja, *Predicting Genocide and Mass Atrocities*, 9(3) GENOCIDE STUDIES AND PREVENTION: AN INTERNATIONAL JOURNAL 13-31 (2016).
[113] Verdeja, *supra* note 112, at 21 (mentioning seven (7): history of prior genocide or mass atrocities; regime type; state-led discrimination; political instability; ongoing domestic armed conflict; and economic factors)
[114] Verdeja, *supra* note 112, at 27 (mentioning fifteen (15): increased hate media; public rallies and popular mobilization against vulnerable groups; upcoming elections; public commemorations of past crimes or contentious historical events; rapid change in government leadership, such as through assassination or coup; natural disasters; sharp increase in repressive state practices, including removal of political, religious, civil and economic rights, stripping of citizenship; arrest, torture, disappearance or killing of political, religious, or economic leaders; physical segregation or separation of the targeted group, including forced removal or settlement of populations; increase in weapons transfers to security forces or rebels; rapid increase *or* decrease in opposition capacity; deployment of security forces against previously targeted civilian groups; commencement/resumption of armed conflict between government forces and rebels; spillover of armed conflict from neighboring countries; nowhere for targeted civilian groups).

that "early warning models tend to focus on short- and midterm predictions."[115] Scholars like Goldsmith, et al., note that while there is a "growing promise for prediction of armed conflict and political violence…prediction of rare events like genocide is among the most challenging tasks in social science."[116] Verdeja "advised realistic expectations about what degree of predictive accuracy we should expect," acknowledging that "[o]f course, the ultimate challenge concerns whether political leaders will take these warnings seriously."[117] This article contends that one way to get warnings taken more seriously is to lodge them firmly within the legal standard, which political leaders are *obligated* to take seriously.

D. Constructing a Fractal Genocide Potentiality Index (FGPI)

Based on the preceding analysis, this article now turns to its proposal for a Fractal Genocide Potentiality Index (FGPI), a metric that could provide data—*qua* evidence and for the elucidation and future creation of precedential benchmarks—to international courts and other international actors. Such an index could both trigger preemptive international interventions and aid pleading-stage judicial determinations on the plausibility of genocide in any given case.

i. Step 1: Defining the Index Structure

1. *Structural Risk Factors and Triggers Integration*: Incorporate and scale Verdeja's long-term structural risk factors and fifteen short-term specific triggers as foundational elements. Each factor and trigger should be assigned a weight based on empirical data and theoretical insights.

2. *Predictive Assessments*: Utilize assessments from existing models like the Early Warning Project and the Goldsmith two-stage model to provide dynamic input into the FGPI. These assessments offer two more well-researched data-points to enhance the index's predictivity.

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[115] Verdeja, *supra* note 112, at 23.
[116] Benjamin E. Goldsmith & Charles Butcher, *Genocide Forecasting: Past Accuracy and New Forecasts to 2020*, 20(1) JOURNAL OF GENOCIDE RESEARCH 90, 106 (2018).
[117] Verdeja, *supra* note 112, at 28.

3. *Fractal Model Properties*: Self-similarity (ensure the model accounts for patterns of genocide risk that recur at various scales, to identify patterns that echo across contexts); threshold triggers and cascade effects (define specific thresholds for each risk factor and trigger that, when exceeded, significantly increase the risk score within the model, accounting for the nonlinear relationship between risk factors and the potential for genocide); recursion (incorporate scaled feedback loops within the model to reflect how past and present instances of genocide contribute to current risk assessments); chaos (allow sensitivity to perturbations and small differences in initial conditions, highlighting the need for continuous data updating and the value of engagement).

4. *Dynamic Updating and Real-Time Analysis*: Design the FGPI to be adaptable and responsive to new information. This includes establishing protocols for the regular updating of data inputs and model parameters to reflect the latest developments.

ii. Step 2: Producing the Index

1. *Outline a formula that incorporates the defined components*:

$FGPI=W\times(PEWP+PGSM)+S+T+R+C+Q+L+U$[118]

2. *Refine the outline into a model*: Given the components—Structural Risk Factors (*SRF*) and Triggers (*T*)[119]; Predictive Assessments (*PA*)[120]; Fractal Adjustment (*F*)[121]— FGPI could be:

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[118] Where: *W* is the weight assigned to the predictive scores from existing models; *PEWP* is the predictive score from the Early Warning Project; *PGSM* is the predictive score from the Goldsmith two-stage model; *S* represents the self-similarity component; *T* accounts for threshold triggers and cascade effects; *R* includes recursion, reflecting the influence of past events; *C* covers the chaos component, emphasizing the sensitivity to initial conditions; *Q* represents the integration of quantitative data; *L* is the integration of qualitative assessments; *U* stands for the dynamic updating and real-time analysis component.

[119] Each factor and trigger are assigned weights based on empirical evidence; *wi* to denote the set of weight for SRFs and *vj* to denote the set of weights for Ts. Let *n* be the number of structural risk factors, and *m* be the number of triggers. Each factor or trigger's impact is scored on a scale (for simplicity, let's say 0 to 1), and these scores are multiplied by their respective weights and then summed.

[120] This includes scores from the Early Warning Project (*EWP*) and the Goldsmith two-stage model (*GSM*). Let's assign weights to these assessments (*wEWP*·and *wGSM*) and integrate them into the index.

[121] Incorporate fractal properties through a recursive function that adjusts the total risk score based on the interconnectedness of scales. This could be represented by a factor (*F*) that modifies the score based on the level of risk interaction across scales.

$FGPI=(\sum i=1nwi\cdot SRFi+\sum j=1mvj\cdot Tj)\cdot F+wEWP\cdot PAEWP+wGSM\cdot PAGSM$[122]

3. *Further refine the fractal element*: The fractal adjustment factor (*F*) could be designed to increase the FGPI score as interactions between scales indicate a higher risk of cascading effects. It could be modeled using a logistic function, which is commonly used to represent growth processes and can simulate the saturation effect of risk factors as they approach a critical threshold. This is due to a logistic function's properties, which include a rapid increase past a certain point, mimicking the cascade effects seen in fractal systems. Defining *F* as:

$$F = 1\frac{\square}{\square}\left(1 + e^{-k*(x-x_0)}\right)$$[123]

Integrating *F* into the *FGPI* formula allows the index to dynamically reflect how close the current situation is to a critical threshold that could lead to cascade effects, based on the interaction and accumulation of risk factors and triggers. This calculation should fit with historical data.

4. *Bringing it all together:* The final FGPI formula captures the complex dynamics of fractal systems to finely tune genocide risk assessments. Its complexity mirrors the intricate nature of the phenomena it aims to model and prevent, much like a sophisticated drug designed for a complex disease, where its value lies not in simplicity but in efficacy. FGPI =

$$(\sum i=1nwi\cdot SRFi+\sum j=1mwj\cdot Tj)\cdot 1\frac{\square}{\square}\left(1 + e^{-k*(x-x_0)}\right)+wEWP\cdot PAEWP+wGSM\cdot PAGSM$$

E. Constructing a Fractal Genocide Actuality Index (FGAI)

Finally, Based on the preceding analysis, this article now turns to its proposal for a Fractal Genocide Actuality Index (FGAI), another metric that could provide data—*qua* evidence and for

[122] Where: *SRFi* and *Tj* are the scores for the *i-th* structural risk factor and *j-th* trigger, respectively; *F* represents the fractal adjustment factor; and weights are finely-tuned according to precedent and principle (*wi, vj, wEWP, wGSM*).
[123] Where: *e* is the base of the natural logarithm; *k* is a steepness parameter of the curve; *x* represents the aggregated risk score from structural risk factors and triggers before fractal adjustment; *x0* is the midpoint of the logistic function, representing the critical threshold at which the risk of genocide increases significantly. The aggregated risk score (*x*) can be calculated as $x=\sum i=1nwi\cdot SRFi+\sum j=1mwj\cdot Tj$.

the elucidation and future creation of precedential benchmarks—to international courts and other international actors. In addition to these utilities, an FGAI could be considered legitimate evidence to adjudicate *final* determinations of guilt, not just preliminary determinations of plausibility.

i. Step 1: Methodology – Align Model to Legal and Fractal Principles

1. *Identify Protected Groups and Enumerated Acts*: Define sets G and A to encapsulate the legal requirements of genocide concerning who is protected and what acts constitute genocide.

2. *Define a Recursive Fractal Function*: Establish $f:G\times(a)A\times X\rightarrow[0,1]$, mapping combinations of groups, acts, and factors to a genocide actuality score. The output is a value between 0 and 1, representing the degree to which the combination of group G (binary score: protected *qua* group *or* not), committed acts a (subset of all *potential* genocidal acts (A)), and parameters X satisfy the legal definition of genocide.

3. *Incorporate Legal Elements*: Integrate the *actus reus* elements by detailing specific acts *(a)* within A and linking them to the protected groups in G.

4. *Model Intent*: Create $f1(g,a,X)$ to quantitatively assess genocidal intent through a weighted formula reflecting stated intent, the nature of acts, and circumstances implying intent.

5. *Expand Fractal Levels*: Develop further fk levels to incorporate *scales* of genocidal acts.

6. *Use Max Function*: Apply the max function across all fractal levels to capture the most significant evidence of genocide.

7. *Dynamic Parameter Vector*: Allow X to evolve, reflecting changes over time and the impact of interventions, thereby introducing adaptability and responsiveness to the model.

This methodology ensures our model aligns with legal standards and fractal principles.

ii. Step 2: Producing the Model

$$FGAI(g,a,X) = \backslash max\left(f_{k(g,a,X)_{\{k=0\}}^{\{6\}}}\right)$$

Where:

- $g \in G$ represents the protected groups.
- $a \in A$ represents the enumerated acts of genocide.
- X is a vector of any other relevant factors, according to ICL.
- $f0(g,a,X)$ represents the base level assessment, considering if g and a fall within the protected groups and enumerated acts, respectively.[124]
- $f1(g,a,X) = w1 \cdot p(i,X) + w2 \cdot i(a,g,X) + w3 \cdot c(a,g,X)$ evaluates *intent* with weights $w1$, $w2$, $w3$ reflecting the relative importance of stated intent, the indiscriminate nature of acts, and objective circumstances implying intent.[125]
- Subsequent fk levels account for the impact of specific genocidal acts (a1 to a5), each building upon the previous level's assessment.[126]
- The final FGAI value is determined by the maximum of all fk levels, capturing the most significant aspects of genocide actuality as defined legally and enhanced by fractal modeling.

This formula encapsulates the complex, multi-layered approach required to quantitatively assess genocide actuality against legal standards, incorporating fractal principles to address the scale-invariant and recursive nature of genocidal processes.

V. Conclusion

[124] $f0(g, a, X) = s(a, X)$ *if* $g \in G$ *and* $a \in A$, *else* 0. Thus, there is no genocide if the targeted group is not protected.
[125] Where: $p(i, X)$ = **Stated/expressed intent level modulated by parameters**—*this itself could be a scaled-recursive model wherein statements are hierarchically weighted* (cabinet members, military officers, military personnel, civilian mass media, civilian social media; respectively); $i(a, g, X)$ = **"Indiscriminate index"** quantifying indiscriminate nature of acts—*increases proportionately the more casualties from attacks demographically resemble the population as a whole*; $c(a, g, X)$ = **Physical destruction**/circumstances objectively implying intent—*A score*.
[126] **Digging deeper into genocidal acts *a1* through *a5*,** which produce the *A score*:

$F2(g, a, X) = f1(g, a, X) * k(a, X)$
$k(a, X)$ analyzes the specifics of killing acts *a1*

$f3(g, a, X) = f2(g, a, X) * h(a, g, X)$
$h(a, g, X)$ assesses harm/injury acts *a2*

$f4(g, a, X) = f3(g, a, X) * l(a, g, X)$
$l(a, g, X)$ models destructive conditions/deprivations *a3*

$f5(g, a, X) = f4(g, a, X) * b(a, g, X)$
$b(a, g, X)$ handles birth prevention acts *a4*

$f6(g, a, X) = f5(g, a, X) * t(a, g, X)$
$t(a, g, X)$ covers child transfer acts *a5*

Higher levels $fk+1$ can extend by multiplying by additional legal considerations $qk+1(g, a, X)$.

The next steps in specifying and applying these models involve software development,[127] validation and calibration,[128] and educational and policy outreach, in particular to relevant courts.[129] Additionally, a discussion of how to collect objective *data* is worthy of its own paper. On that question, for now, it can only be acknowledged that beyond the normal biases and difficulties inherent in any data collection, there is the *fog of war* often surrounding crimes, *qua* events, like genocide.[130]

In an ideal world, the criminal laws governing all the world would be created and applied objectively, and the paradox of social power would be mitigated accordingly. This paper offers formulas that could serve as starting points toward putting objectively determined numbers to allegations of genocide, producing a "score" for each, for courts and other international bodies to consider in making their crucial determinations. What better way to *formally realize*—to specify—complex standards in ICL than through *real formulas*?

[127] International courts and other international bodies could develop software that implements the FGPI and FGAI, allowing users to input current data on structural risk factors, triggers, and genocidal actions and statements to receive updated genocide potentiality and genocide actuality scores. This tool could be user-friendly and accessible to policymakers, jurists, and researchers.

[128] *Before adoption*, FGPI must be validated against historical cases of genocide to calibrate its predictive accuracy and ensure consistency with precedents. This may involve back-testing the FGPI model using historical data to see how well it would have predicted past genocides. With regard to the FGAI, it is vital to fill the model with valid *empirical data* and even more *legal analysis*. This calibration would involve setting the weights (*w1, w2, w3*), to reflect the importance of different factors accurately, and defining the functional forms, specifying how these factors are mathematically related to the outcome, based on real-world cases and accepted legal interpretations. *After adoption*, the model's effectiveness in capturing the actuality of genocide would significantly benefit from iterative testing in different circumstances.

[129] Create educational materials and training programs for potential FGPI users to ensure they understand how to interpret its outputs. Engage with international courts like the ICJ and ICC, governments, and NGOs in the process.

[130] The fog of war seems to stem from two main sources: deliberate "misinformation" being utilized as part of war efforts and a proliferation of "incomplete information" games due to heightened systemic chaos. Both processes combine exponentially to create evermore chaos *qua* unpredictably, in a feedback loop with cascade effects scaling the phenomenon upward.