

Simplified Complexity Academic PDF

Understanding Simplified Complexity

Simplified complexity is a paradoxical concept that captures the essence of managing intricate systems by reducing their apparent chaos into understandable, manageable components. In an increasingly interconnected and multifaceted world, many disciplines—from science and technology to business and art—struggle with the challenge of making sense of complex phenomena. Simplified complexity offers a pathway: it involves distilling the core elements of complexity into simpler, more accessible representations without losing essential details. This approach not only enhances comprehension but also facilitates decision-making, innovation, and problem-solving. At its core, simplified complexity recognizes that true mastery lies in striking a balance between oversimplification, which risks distortions, and overcomplication, which can paralyze progress.

The Philosophy Behind Simplified Complexity

Balancing Detail and Clarity

The essence of simplified complexity lies in managing the tension between too much detail and too little. While complexity often involves numerous variables, interactions, and unpredictable outcomes, an overly simplified model risks neglecting critical nuances. Conversely, an excessively detailed model can become unwieldy and opaque. The philosophy advocates for creating models and frameworks that are sufficiently detailed to be accurate, yet simple enough to be useful.

Abstraction as a Tool

Abstraction is central to achieving simplified complexity. It involves identifying what elements are critical to the understanding of a system and hiding or omitting less relevant details. For example, when designing a user interface, developers abstract complex back-end processes into simple visual cues, making technology accessible to users who lack technical expertise. This principle applies broadly: by focusing on key variables and relationships, one can simplify complexity without losing the essence of the system.

Methods and Techniques for Achieving Simplified Complexity

Modular Design

- Break down complex systems into modules or components.

- Each module encapsulates a specific function or set of related functions.
- Facilitates understanding, testing, and modification.
- Example: In software engineering, modular programming enhances clarity and maintainability.

Hierarchy and Layering

- Organize components into hierarchical levels.
- Higher levels provide an overview, while lower levels delve into details.
- Enables users to navigate complexity by focusing on the level of interest.
- Example: Organizational charts or network architectures.

Visualization Techniques

- Use diagrams, charts, and models to represent complex data visually.
- Examples include flowcharts, mind maps, and system diagrams.
- Visualizations help identify patterns, relationships, and bottlenecks.

Simplified Models and Simulations

- Develop models that capture essential dynamics of systems.
- Use simulations to test different scenarios quickly.
- Examples: climate models, economic forecasts, or traffic simulations.

Focus on Key Variables

- Identify and prioritize variables with the most significant impact.
- Reduce noise from less influential factors.
- Techniques include sensitivity analysis and principal component analysis.

Applications of Simplified Complexity Across Disciplines

Science and Engineering

- Simplified models help scientists understand phenomena without getting lost in details.
- Example: Newton's laws as simplified representations of motion, ignoring relativistic and quantum effects at small scales.

Business and Economics

- Managers use simplified dashboards to monitor key performance indicators.
- Economic models distill complex markets into primary drivers like supply and demand.

Technology and Software Development

- Agile methodologies promote breaking projects into manageable sprints.
- User experience design simplifies interfaces to enhance usability.

Art and Design

- Minimalist art reduces visual clutter, emphasizing core elements.
- Simplified aesthetics often communicate more profound messages.

Challenges and Limitations of Simplified Complexity

Risk of Oversimplification

- Important nuances might be lost, leading to incorrect conclusions.
- Over-simplified models may not accurately predict real-world behavior.

Dynamic and Evolving Systems

- Systems that change rapidly can outpace simplified representations.
- Models need regular updates to remain relevant.

Subjectivity in What to Simplify

- Deciding which details to omit depends on perspective and purpose.
- Different stakeholders might prioritize different aspects.

Balancing Act

- The art of simplified complexity is in knowing when and what to simplify.
- Requires domain expertise and understanding of the purpose behind simplification.

Strategies for Effective Simplification

Define Clear Objectives

- Understand what you need to achieve with simplification.
- Whether it's education, decision-making, or communication.

Identify Core Elements

- Focus on variables, relationships, and processes that are essential.
- Use tools like mind maps or cause-and-effect diagrams.

Iterative Approach

- Start with a broad simplification.
- Gradually refine models based on feedback and new insights.

Engage Stakeholders

- Incorporate perspectives from different disciplines or user groups.
- Ensures that simplification does not omit critical viewpoints.

The Future of Simplified Complexity

Artificial Intelligence and Data Analytics

- AI can help identify key patterns and variables in vast datasets.
- Automate the process of creating simplified models.

Interdisciplinary Approaches

- Combining insights from diverse fields enhances understanding.

- Promotes holistic yet manageable representations.

Educational Tools and Visualizations

- Interactive visualizations make complex data more accessible.
- Encourage exploration and deeper understanding.

Ethical Considerations

- Responsible simplification ensures that models do not mislead or distort reality.
- Transparency about limitations is essential.

Conclusion: Embracing Simplified Complexity

Simplified complexity is a powerful paradigm for navigating the intricacies of the modern world. It empowers individuals and organizations to understand, communicate, and influence complex systems effectively. By employing abstraction, modular design, visualization, and focusing on key variables, we can achieve clarity without sacrificing essential details. However, this approach requires careful judgment to avoid oversimplification and to adapt to changing realities. As technology advances and interdisciplinary collaborations flourish, the potential for refined, dynamic simplified models will grow, helping us address global challenges with insight and agility. Ultimately, simplified complexity is not about reducing richness but about enhancing our capacity to grasp and harness the richness of complexity itself.

Simplified Complexity is a fascinating concept that challenges the traditional notion that simplicity and complexity are mutually exclusive. In today's fast-paced, information-saturated world, the ability to distill complex ideas into understandable, accessible formats without losing their essence has become a vital skill. This approach's simplified complexity aims to strike a delicate balance, making intricate problems approachable while preserving depth and nuance. It finds applications across various domains, including education, business, technology, and design, offering a powerful framework for effective communication, problem-solving, and innovation. This article explores the multifaceted nature of simplified complexity, its benefits and challenges, and practical strategies for implementing it in real-world scenarios.

Understanding Simplified Complexity

Definition and Core Principles

Simplified complexity refers to the process of making complex ideas, systems, or problems

understandable without oversimplifying or losing critical information. It recognizes that many concepts—be they scientific theories, business models, or technological innovations—are inherently intricate but can be communicated effectively through thoughtful reduction and clarification.

The core principles include:

- Clarity without oversimplification: Removing unnecessary details while maintaining core accuracy.
- Layered understanding: Offering information at multiple levels, catering to both novices and experts.
- Contextual relevance: Presenting information in a manner that aligns with the audience's needs and background.
- Visual and narrative techniques: Using diagrams, stories, and analogies to enhance understanding.

The Difference Between Simplification and Dilution

While simplification aims to clarify, it can sometimes veer into dilution—where essential nuances are lost. Simplified complexity strives to avoid this trap by ensuring that simplification enhances comprehension without sacrificing integrity.

The Importance of Simplified Complexity

Enhancing Communication

In an era where information overload is common, clear communication is crucial. Simplified complexity allows experts to convey sophisticated ideas to broader audiences, fostering better understanding and engagement.

Facilitating Innovation and Problem Solving

Breaking down complicated problems into manageable parts encourages innovative thinking. It enables teams to identify key issues, create targeted solutions, and collaborate effectively across disciplines.

Supporting Education and Learning

Educational methods that leverage simplified complexity make learning accessible. They help students grasp foundational concepts before progressing to advanced topics, promoting lifelong learning.

Driving Business Strategy and Decision-Making

In business contexts, leaders often face complex data and market dynamics. Simplified complexity helps distill this information into actionable insights, improving strategic decision-making.

Challenges and Limitations

Risk of Oversimplification

One major concern is oversimplifying to the point where critical details are lost, leading to misunderstandings or flawed decisions.

Maintaining Accuracy and Depth

Balancing simplicity with depth requires skill; failing to preserve essential nuances can undermine credibility or lead to incomplete solutions.

Audience Diversity

Different audiences have varying backgrounds and needs. Crafting explanations that are both simplified and sufficiently detailed can be challenging.

Resource Intensity

Developing layered explanations, visualizations, and analogies demands time and expertise, which may not always be feasible under tight deadlines.

Strategies for Achieving Simplified Complexity

Know Your Audience

Understanding the audience's knowledge level, interests, and goals is vital. Tailor explanations accordingly, using appropriate language and examples.

Use Analogies and Metaphors

Analogies bridge unfamiliar concepts with familiar experiences, making abstract ideas more tangible. For example, comparing a blockchain to a shared ledger can clarify its function.

Layered Information Delivery

Present information in layers:

- Start with a high-level overview.
- Provide details progressively for those interested.
- Offer supplementary resources for deep dives.

Employ Visual Aids

Diagrams, infographics, and interactive visuals can often communicate complex relationships more effectively than text alone.

Break Down Complex Systems

Decompose systems into smaller, interconnected parts. Explain each component before illustrating how they work together.

Iterative Refinement

Continuously test and refine explanations based on feedback. Use user testing, peer reviews, and real-world application to improve clarity.

Examples of Simplified Complexity in Action

Technology and Software

Many tech companies have mastered simplified complexity through intuitive user interfaces and onboarding tutorials. For example, Apple's product design emphasizes simplicity, yet the underlying architecture remains sophisticated.

Education

Educational platforms like Khan Academy break complex math and science concepts into digestible videos and exercises, progressively building understanding.

Business and Marketing

Brands often use storytelling and clear messaging to communicate complex value propositions, making their products accessible to a broad audience.

Science Communication

Organizations like NASA and scientific journals utilize visualizations, analogies, and layman summaries to make complex scientific discoveries comprehensible to the public.

Potential Future Directions

AI and Automated Simplification

Emerging AI tools are increasingly capable of analyzing complex data sets and generating simplified summaries, making information more accessible at scale.

Personalized Learning and Communication

Advances in data analytics allow for tailored explanations based on individual knowledge levels, preferences, and goals.

Cross-Disciplinary Collaboration

Simplified complexity can foster better collaboration across disciplines, leading to innovative solutions that integrate diverse perspectives.

Conclusion

Simplified complexity stands as a vital approach in today's interconnected and information-rich environment. It empowers individuals and organizations to communicate and understand intricate ideas without sacrificing accuracy or depth. While it presents challenges such as avoiding oversimplification and maintaining nuance, the benefits in clarity, engagement, and problem-solving are substantial. Success in implementing simplified complexity hinges on understanding the audience, employing effective communication techniques, and iteratively refining explanations. As technology advances and the demand for accessible knowledge grows, mastering the art of simplified complexity will become increasingly essential for educators, innovators, leaders, and communicators alike. Embracing this approach can lead to more informed decisions, better collaboration, and a deeper appreciation of the intricate beauty underlying complex systems.

Question What is meant by 'simplified complexity' in problem-solving? Simplified complexity refers to the process of reducing a complex problem into more manageable, understandable parts while retaining essential features, making it easier to analyze and solve. How can simplifying complexity improve decision-making in business? By breaking down complex data and processes into simpler components, decision-makers can better understand key factors, identify priorities, and make more informed, efficient choices. What are common techniques used to achieve simplified complexity? Techniques include abstraction, modularization, visualization, and using models or frameworks that distill complex information into clearer, more digestible formats. Why is it

important to balance simplification and accuracy? Over-simplification can lead to losing critical details, while excessive complexity can hinder understanding. Balancing the two ensures clarity without sacrificing essential information. Can simplified complexity be applied in technology and software development? Yes, it is fundamental in designing user interfaces, algorithms, and systems that are powerful yet easy to understand and use, improving usability and maintainability. What are some challenges associated with simplifying complexity? Challenges include potential oversimplification, missing nuanced details, and the risk of misinterpretation, which can impact the effectiveness and accuracy of solutions.

Related keywords: minimalism, clarity, elegance, efficiency, straightforwardness, ease, abstraction, zen, streamlined, usability

an introduction to kolmogorov complexity and its a

An introduction to Kolmogorov complexity and its significance in information theory and computer science

Kolmogorov complexity is a fundamental concept in the realms of information theory, computer science, and mathematics. It provides a rigorous way to quantify the amount of information contained within a data object, such as a string of text or a binary sequence. Unlike traditional measures like length or entropy, Kolmogorov complexity focuses on the minimal description length needed to generate a given object, offering profound insights into data randomness, compressibility, and the limits of computation. This article aims to introduce the core ideas behind Kolmogorov complexity, explore its applications, and discuss why it is considered a cornerstone concept in modern theoretical computer science.

What Is Kolmogorov Complexity?

Kolmogorov complexity, also known as algorithmic complexity, was independently developed by Andrey Kolmogorov, Ray Solomonoff, and Gregory Chaitin in the 1960s. It formalizes the intuitive notion that some strings or data are simple and highly compressible, while others are complex and appear random.

Definition of Kolmogorov Complexity

At its core, Kolmogorov complexity measures the length of the shortest possible program that can produce a particular string when run on a universal computer (such as a Turing machine). Formally, for a string (s) , the Kolmogorov complexity $(K(s))$ is defined as:

$$\{$$

$$K(s) = \min_{\{p\}} \{ |p| : U(p) = s \}$$

$$\}$$

where:

- (p) is a program (a string of bits),
- $(|p|)$ is the length of the program in bits,
- (U) is a universal Turing machine,
- $(U(p) = s)$ means that running program (p) produces the string (s) .

In essence, $(K(s))$ is the length of the shortest description (program) that outputs (s) . The smaller the $(K(s))$, the more compressible or simple the string is; the larger the $(K(s))$, the more complex or random it appears.

Key Concepts in Kolmogorov Complexity

Understanding Kolmogorov complexity involves grasping several foundational ideas:

Incompressibility

A string is considered incompressible if its Kolmogorov complexity is close to its length. Such strings lack patterns or structure that could be exploited for compression. Random strings are typically incompressible because no shorter program can generate them other than explicitly listing the string itself.

Key points about incompressibility:

- Almost all strings of a given length are incompressible.
- Incompressible strings serve as models of randomness in computational terms.
- They are useful in defining algorithmic randomness.

Invariance Theorem

The invariance theorem states that the Kolmogorov complexity depends on the choice of the universal Turing machine only up to an additive constant. Formally:

$$\lfloor$$

$$K_U(s) \leq K_{U'}(s) + c$$

$$\rfloor$$

for some constant $\lfloor c \rfloor$, where $\lfloor U \rfloor$ and $\lfloor U' \rfloor$ are two universal Turing machines. This means that the complexity measure is robust and does not depend heavily on the specific computational model used.

Applications of Kolmogorov Complexity

Kolmogorov complexity has a wide array of applications across various fields:

Data Compression

- It provides a theoretical foundation for understanding the limits of data compression.
- The minimal program length $\lfloor K(s) \rfloor$ serves as an idealized measure of the best possible compression for data.

Randomness and Algorithmic Information Theory

- It helps formalize the concept of randomness by identifying strings that have no shorter description than listing themselves.
- In this context, a string is considered random if its Kolmogorov complexity is close to its length.

Complexity and Pattern Recognition

- By measuring the complexity of data, algorithms can distinguish between structured (low complexity) and unstructured (high complexity) data.
- This has implications in machine learning, pattern detection, and anomaly identification.

Mathematical Foundations and Theoretical Computer Science

- It provides insights into the limits of computation and decidability.
- Helps in understanding the nature of formal systems and the boundaries of what can be known or proven.

Challenges and Limitations

While Kolmogorov complexity offers a powerful theoretical framework, it also presents certain challenges:

Uncomputability

- One of the most significant issues is that Kolmogorov complexity is uncomputable in general.
- There is no algorithm that can, in all cases, compute $K(s)$ exactly, due to the halting problem.

Approximation and Practical Use

- Since exact calculation is impossible, researchers often rely on approximations or heuristics.
- Compression algorithms (like ZIP, LZ77, etc.) can provide upper bounds on $K(s)$, but they are not perfect measures.

Relation to Other Measures of Complexity

Kolmogorov complexity is often contrasted with other measures:

Shannon Entropy

- Shannon entropy quantifies the average information content of a source based on probability distributions.
- Kolmogorov complexity focuses on individual objects rather than statistical ensembles.

Logical Complexity and Computational Depth

- Logical complexity considers the depth or difficulty of proving properties about data.
- Computational depth looks at the resources needed to generate data from simpler representations.

Despite differences, these measures are interconnected and contribute to a comprehensive understanding of information and complexity.

Why Is Kolmogorov Complexity Important?

Understanding Kolmogorov complexity is vital because it:

- Offers a theoretical limit on data compression.
- Provides a rigorous definition of randomness.
- Deepens our understanding of the nature of information.
- Contributes to fields like cryptography, machine learning, data science, and theoretical computer science.

By quantifying the minimal description length of data, Kolmogorov complexity bridges the gap between computability, information theory, and algorithm design.

Conclusion

In summary, Kolmogorov complexity presents a powerful and elegant way to measure the intrinsic information content of data objects. Its core idea—assessing the shortest program that can produce a string—captures notions of randomness, compressibility, and structural complexity. While it faces challenges due to its uncomputability, the concept remains a cornerstone of theoretical computer science, influencing research in data compression, randomness, and the foundations of mathematics. Whether used as a theoretical tool or approximated in practical applications, Kolmogorov complexity continues to shape our understanding of information in the digital age.

Keywords for SEO optimization:

- Kolmogorov complexity
- algorithmic complexity
- data compression
- information theory
- randomness
- computational complexity
- uncomputability
- minimal description length
- data analysis
- theoretical computer science

An Introduction to Kolmogorov Complexity and Its Applications

An introduction to Kolmogorov complexity and its significance

In the vast landscape of computer science and information theory, few concepts are as profound

and as intellectually stimulating as Kolmogorov complexity. This measure, named after the Soviet mathematician Andrey Kolmogorov, offers a way to quantify the simplicity or complexity of a data object—in particular, a string of characters—by considering the shortest possible description or program that can generate it. As we delve into this fascinating topic, we uncover not only a new lens through which to view data but also insights into the nature of randomness, information, and computation itself.

What is Kolmogorov Complexity?

The Core Idea

At its core, Kolmogorov complexity seeks to answer a fundamental question: How simple or complex is a given piece of data? More precisely, given a string of data—such as a sequence of bits—Kolmogorov complexity measures the length of the shortest computer program (in a fixed universal programming language) that can produce that string as output and then halt.

For example, consider the following two strings:

- String A: `1010101010101010`
- String B: `1100100101110110`

Intuitively, String A exhibits a clear pattern: it's a repeated sequence of `10`. As a result, a relatively short program that outputs "repeat '10' five times" can generate it. Conversely, String B appears more random and lacks an obvious pattern, likely requiring a longer program—possibly one that explicitly encodes the entire sequence.

Kolmogorov complexity (K) of a string `s` is formally defined as:

> The length of the shortest binary program, running on a fixed universal Turing machine, that outputs `s` and halts.

This measure is invariant up to a fixed additive constant, meaning that the choice of programming language or universal Turing machine influences the complexity only marginally.

Formal Definition

Let's formalize the concept:

- Universal Turing Machine (U): An abstract computational model capable of simulating any other

Turing machine.

- Program p : A finite binary string that encodes instructions for U .
- Output s : The string produced when U runs p .

The Kolmogorov complexity of s , denoted as $K(s)$, is:

$$K(s) = \min\{|p| : U(p) = s\}$$

where $|p|$ is the length of program p in bits.

Properties of Kolmogorov Complexity

- Incompressibility: Most strings of a given length are incompressible; that is, their Kolmogorov complexity is close to the length of the string itself. These are considered random strings.
- Non-computability: Kolmogorov complexity is not a computable function. There is no algorithm that can, in general, determine the shortest program for an arbitrary string, due to fundamental limits established by the halting problem.
- Invariance theorem: The specific choice of universal Turing machine affects the complexity only by a fixed constant, ensuring that the measure is robust.

Why Does Kolmogorov Complexity Matter?

Measuring Randomness

One of the key applications of Kolmogorov complexity lies in the quantification of randomness. A string with high Kolmogorov complexity is essentially incompressible, reflecting high randomness or unpredictability. Conversely, strings with low complexity are highly structured and predictable.

This idea underpins the notion of algorithmic randomness, where a string is considered random if its Kolmogorov complexity is close to its length. For example:

- A string like `"1111111111"` has low complexity, as it can be described as "ten ones."
- A string like `"010011010110"` with no discernible pattern likely has high complexity.

Foundations for Data Compression

In practical terms, Kolmogorov complexity offers a theoretical underpinning for data compression. The best possible compression of a string cannot be shorter than its Kolmogorov complexity. While actual compression algorithms (like ZIP or JPEG) are heuristic and cannot reach the theoretical limit

due to computational constraints, understanding Kolmogorov complexity helps delineate what is theoretically achievable.

Insights into Computational Theory

Kolmogorov complexity bridges the realms of information theory and computability, providing a framework to understand the limits of data description and the inherent complexity of objects. It has implications for:

- Algorithmic information theory: Combining information theory with computation.
- Computability theory: Demonstrating that certain measures, like Kolmogorov complexity, are non-computable, highlighting fundamental limits in algorithmic analysis.

Deep Dive into Applications and Implications

- Randomness Testing

While traditional statistical tests evaluate the randomness of data by looking for statistical anomalies, Kolmogorov complexity offers a more rigorous, algorithmic perspective. If a string can be generated by a short program, it is considered non-random; if it requires a long program, it approaches randomness.

Limitations: Since Kolmogorov complexity is uncomputable, practical randomness tests rely on approximations, such as compression algorithms, to estimate the complexity.

- Complexity and Data Analysis

In fields like bioinformatics or machine learning, understanding the complexity of data can inform models and hypotheses. For example:

- DNA sequences with low Kolmogorov complexity may indicate repetitive or conserved regions.
- High complexity might suggest regions with high variability or mutations.

- Theoretical Limits in Data Compression

Kolmogorov complexity sets an ideal benchmark: no compression method can produce a code

shorter than the string's Kolmogorov complexity. This principle underscores the importance of finding efficient algorithms that approach this theoretical limit, even if reaching it exactly is impossible.

Challenges and Criticisms

Despite its conceptual elegance, Kolmogorov complexity faces practical barriers:

- Non-computability: No general algorithm exists to compute the Kolmogorov complexity for arbitrary data, limiting its direct application in real-world scenarios.
- Dependence on the Universal Machine: Although invariant up to a constant, the choice of the universal Turing machine can influence the complexity measure, especially for short strings.
- Approximation Difficulties: Estimating Kolmogorov complexity often involves compression algorithms, which are heuristic and may not reflect the true minimal description length.

Future Directions and Research

Researchers continue to explore how Kolmogorov complexity can inform various domains:

- Algorithmic Information Theory: Developing more refined measures and understanding their implications for randomness and complexity.
- Machine Learning: Using concepts of complexity to evaluate models, detect anomalies, or measure data regularity.
- Quantum Computing: Extending ideas of complexity into quantum information theory, potentially leading to quantum analogs of Kolmogorov complexity.

Conclusion

Kolmogorov complexity offers a profound lens through which to understand the essence of data, randomness, and computational limits. While its non-computability presents challenges, the concept remains a cornerstone of theoretical computer science, inspiring ongoing research and providing foundational insights into the nature of information. Whether in analyzing biological data, optimizing compression algorithms, or probing the boundaries of computation, Kolmogorov complexity continues to illuminate the intricate relationship between data and the algorithms that describe it.

Question What is Kolmogorov complexity and how is it defined? Kolmogorov complexity of a string is the length of the shortest possible computer program that can produce that string as output. It measures the information content or randomness of the string based on its minimal description. **Why is Kolmogorov complexity considered a foundational concept in algorithmic**

information theory? Because it provides a formal way to quantify the amount of information in a data object, bridging the gap between computational complexity and information theory, and enabling analysis of randomness and compressibility. How does Kolmogorov complexity relate to data compression? Kolmogorov complexity essentially reflects the best possible compression of data; a string with low complexity can be compressed significantly, whereas a random string with high complexity cannot be compressed much shorter than its original length. What is the significance of the 'invariance theorem' in Kolmogorov complexity? The invariance theorem states that the Kolmogorov complexity is invariant up to an additive constant regardless of the choice of universal Turing machine, ensuring the measure's robustness and universality. Can Kolmogorov complexity be computed exactly for arbitrary strings? No, Kolmogorov complexity is uncomputable in general due to the halting problem; we cannot algorithmically determine the shortest program for arbitrary strings, but we can estimate or bound it. What are some practical applications of Kolmogorov complexity? Applications include randomness testing, data compression, pattern detection, complexity analysis in machine learning, and understanding the intrinsic complexity of biological data. How does the concept of Kolmogorov complexity relate to the idea of randomness? A string with high Kolmogorov complexity is considered random because it lacks a shorter description than itself; conversely, highly compressible strings are considered less random.

Related keywords: Kolmogorov complexity, algorithmic information theory, descriptive complexity, computational complexity, information content, minimal description, Kolmogorov randomness, universal Turing machine, compressibility, algorithmic entropy

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