Annotated Bibliography: Information Theory Today & Tomorrow

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Abstract

Information theory is not a new concept however new perspectives and industry evolution integrates new discoveries into the paradigm world view of information science professionals.

As new history and discoveries are uncovered, information science (IS) professionals must remember the works of the past and integrate them into new "grounded theory building ideas" (Levine, 2021). From computer science to biological regulatory networks, information theory is an inclusive and syncretic collection of theories that continues to evolve and grow as the collective global technological singularity approaches humanity. One belief versus another usually puts both parties in a position of disadvantage and recognizing the commonalities between certain belief systems allows for newer and more evolved beliefs to emerge and/or integrate with others. This reintegration of perspectives contributes to the collective intellectual advancement of consciousness and furthers the expansion of understanding one another, allowing for a more integrative, collaborative, and empathetic comprehension of information and its relation to the individual and society as a whole. As technology advances so must the sciences that incorporate it and the professionals that handle that information alike. Considering the international relationships that have developed and continue to develop with scientists and researchers across the world, information theory presents as a likely primary contributor to collaborative cross-national efforts while increasing world peace. After enough empirical research and experimentation has been concluded in the information theory field, an ontological and more comprehensive understanding could be reached in the not to distant future. Combining the best features of previous beliefs and findings, the collective evolution of information and our relationship with our apprehension of it is a collaborative one that only improves with increased international relations and the decreased entropic nature of ignorance.

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1. Foucault, M. (2008). “Panopticism” from “Discipline & Punish: The Birth of the Prison.” *Race/Ethnicity: Multidisciplinary Global Contexts*, *2*(1), 1–12. http://www.jstor.org/stable/25594995

Foucault discusses the intricate details on what the “Panopticism” is and all of the necessary elements to make it function properly. Prison functions and societal structures are similar in delivery and operation, where “the basic functioning of a society penetrated through and through with disciplinary mechanisms” (Foucault, 2008) is just like the functionality of the panopticon. Centralized institutions function as panopticons’ central towers where “one sees everything without every being seen” (Foucault, 2008). The autonomous structure of the systems in place are sustainable and operable by anybody who steps into the management of the panopticon. Foucault argues that “the panoptic schema” was “destined to spread throughout the social body” in times of plagues and society could even be examined at large through this analytical lens (Foucault, 2008). Observational tyranny ensues when the observers remain disconnected from the observed, and the tower managers deceive themselves when they think they subjects are not observing them (Foucault, 2008).

2. Geroulanos, S. (2024). Code: From information theory to French theory. *Journal of the History of the Behavioral Sciences*, *60*(1), 1–3. https://doi-org.lynx.lib.usm.edu/10.1002/jhbs.22282

This book review of *Code* by Bernard Dionysius Geoghegan discusses cybernetics and how it’s theorists became “servants of ideas about order” that will merge information

theory with cybernetics (Geroulanos, 2024). This merger would be "a technocratic project to encode and enforce social control over mental illness, the family, communication, and colonial subjects" (Geroulanos, 2024). Private foundations' "technoscientific patronage" have exceeded government and academic contributions to discoveries throughout history, as Geroulanos reflects these concepts from the *Code.* The review author discusses on the points he agrees with regarding information theory and structuralism, the foundation *Code* author establishes in his writing. The structuralist concerns and merging of information theory and cybernetics was expressed by the *Code* authors and Geroulanos appreciated this "useful and eminently teachable reframing of early computing and communication theories" (Geroulanos, 2024). Analyzing these concerns of technocratic tyranny is something that remains as long as cybernetic and information theory continues to advance and merge.

3. Levina, N. (2021). All Information Systems Theory Is Grounded Theory. *MIS Quarterly*, *45*(1), 489–494. https://doi-org.lynx.lib.usm.edu/10.25300/MISQ/2021/15434.1.7

Information Science (IS) is an integral aspect of information theory. Information theory should be grounded "in between," where parts of the theory are drawn from prior theories and parts from data" (Levina, 2021). Levina argues how "IS theory should be of this 'in between' variety and should be developed through a particular process, namely, through grounded theorizing" (Levina, 2021). The author of this article reviews Glaser and Strauss' grounded the theory method (GTM), which is an instructional "guide on how to go about conducting qualitative research using both data and extant theory" (Levina, 2021). The technology acceptance model (TAM), "which appears to have been built deductively based on *priori* theory in psychology" and "has its roots in an inductive

qualitative research project," and GTM were developed by following "principles of grounded theory" (Levina, 2021). Just as TAM emerged by "bringing an existing theory to formalize grounded emergent theoretical themes," emerging theories should provide "a promising way of building theory of contemporary phenomena for long-lasting impact" (Levina, 2021). The author clearly recognizes the importance of syncretism and building upon the hard work and diligent efforts of IS professionals from times past to present and future days to come. This inclusive perspective allows for IS professionals to develop innovative new discoveries incorporating previous concepts in a non-dogmatic or fundamentalist way. Grounded theory evolves with information theory and combine so that "we will all benefit if we embrace this logic in our work and publications" (Levina, 2021).

4. Pan, C., & Chen, Y. (2024). Informeasure: an R/bioconductor package for quantifying nonlinear dependence between variables in biological networks from an information theory perspective. *BMC Bioinformatics*, *25*(1), 1–8. https://doi-org.lynx.lib.usm.edu/10.1186/s12859-024-05996-z

Information measures commonly used and discussed in this article include "mutual information (MI), conditional mutual information (CMI), interaction information (II), partial information decomposition (PID), and part mutual information (PMI)" (Pan & Chen, 2024). Information measures in this article specifies "using information measures to infer biological regulatory networks" that "can capture nonlinear relationships between variables" (Pan & Chen, 2024). Pan and Chen aim to develop and "provide researchers with a comprehensive toolkit of information measures" and "the developed tool, Informeasure, is an R/ Bioconductor package with well-documented functions" (Pan &

Chen, 2024). IS could intersect with a broad spectrum of other fields, biotechnology and biological networks included. R package, which is “designed to quantify nonlinear dependencies in biological regulatory networks from an information theory perspective” (Pan & Chen, 2024), is another example of how an evolving syncretic IS theory integrates a modality of systems, from the microcosm to the macrocosm.

5. Lazarou, Lazarou, M., Atito, S., Awais, M., & Kittler, J. (2025). Which images can be effectively learnt from self-supervised learning? *Pattern Recognition Letters.*, *198*, 8–13. https://doi.org/10.1016/j.patrec.2025.09.003

This article “investigate models trained using this family of self-supervised methods and reveal certain properties about them” (Lazarou et al., 2025). Considering “access to large datasets” for “deep learning,” which has “revolutionized Computer Vision,” has enabled “semantic segmentation, object detection, and depth estimation” (Lazarou et al., 2025). This article discusses Self-supervised learning, which “focuses on learning representations from unlabeled data, enabling strong performance in downstream tasks after fine-tuning” (Lazarou et al., 2025). Self-supervised learning combines iBOT and DINO by “incorporating masked image modeling along with loss function forms” and could also “help train models to learn discriminative features using unlabeled data” and (Lazarou et al., 2025). The authors of this article “propose to use Signature entropy as a way to understand which images are learnt during the self-supervised pre-training stage” (Lazarou et al., 2025). Whether its computer science, programming, or understanding complicated systems to simplify it for other, IS continues to evolve along all other science fields. IS professionals continue to integrate previous findings to further the evolution of understanding and sharing information as a scientific field.

6. Wing, S., & Balasis, G. (2024). Preface: Information theory and machine learning for geospace research. *Advances in Space Research*, *74*(12), 6249–6251. https://doi-org.lynx.lib.usm.edu/10.1016/j.asr.2024.09.007

Machine learning paradigms continue to evolve at an accelerated rate and "advances in machine learning go hand in hand with advances in computing power" (Wing & Balasis, 2024). This article outlines how "information theory can be integrated with machine learning to achieve greater insights and performance," even in areas "including geospace research" (Wing & Balasis, 2024). This application of "machine learning is a versatile tool capable of addressing a wide ranging problems," such as "solar energetic particles, radiation belts, Pc5 waves, geomagnetic storms, terrestrial and Martian ionospheres, satellite navigation, land use detection based on satellite imagery, and extraterrestrial mineral extraction" (Wing & Balasis, 2024). The authors of this article clearly demonstrate the depths of IS and how information theory is strengthened with the expansion of scientific discoveries. While machine learning controversies continue to perpetuate in fear of job or career losses, information theory integrates these processes with it's own evolution and syncretic theoretical understanding of the world and our collective place(s) within it.

7. Zhang, J., Ji, L., Gao, F., Li, M., Zhang, C., & Cui, Y. (2025). An information-theoretic learning model based on importance sampling with application in face verification. *Pattern Recognition Letters*, *188*, 81–87. https://doi-org.lynx.lib.usm.edu/10.1016/j.patrec.2024.11.033

In this paper the authors "develop a learning model based on principles of information theory by minimizing the worst case loss at prescribed levels of uncertainty" (Zhang et

al., 2025). This work, which is supported by the National Natural Science Foundation of China, "develop an information-theoretic learning model derived from importance sampling to deal with the problem of data distribution deviation between current training data and future test data" (Zhang et al., 2025). Considering the global political climate with the United States and China, developments in information science and theories could continue to unite researchers and scientists, which would contribute to more peaceful international relations. In this way, as research and experimentation increase, information theory could be a leading contributing factor in contemporary and future global peace negotiations.

8. Gecow, A. (2025). Two coherent definitions of the life process derived from the half-chaos theory and the (unintentional) purposeful information theory. *Biosystems*, *256*, N.PAG. https://doi-org.lynx.lib.usm.edu/10.1016/j.biosystems.2025.105533

Bringing order out of chaos is a concept that has formed the global network of international relations as we know it today. Defining life as a process and not an object allows for the "process of life," where "a sufficient speed of reproduction allows for compensating for the increase in entropy" (Gecow, 2025). When a "positive feedback loop" appears with "the speed of reproduction," which leads to "a quantitative explosion, in which the effectiveness of purposeful information increases," and increase in "amount (uniqueness of structure) and length of record (complexity)" occurs with the decrease of "limited resources" (Gecow, 2025). The "collection of purposeful information," respectively "is mainly the exchange of purposeful information creating population mechanisms and memory creating a non-lethal test and memes, which can also be exchanged, thus creating cultures and civilizations" (Gecow, 2025). The collective global

society as we know it is a combination of other systems, beliefs, and evolving theories intersecting with one another. As entropy increases every passing moment, the collective evolution of information and its integration into our fundamental understanding of ourselves as a whole decreases the entropic devolution of our lesser halves.

9. Shim, J. W. (2024). Enhancing cross entropy with a linearly adaptive loss function for optimized classification performance. *Scientific Reports*, 1–6. https://doi-org.lynx.lib.usm.edu/10.1038/s41598-024-78858-6

This article covers "cross entropy, which is an asymmetric quantity, is a measure of the dissimilarity between two probability distributions, typically one true distribution and one estimated distribution and indicates how well the estimated distribution approximates the true distribution" (Shim, 2024). The authors discuss "linearly adaptive cross entropy loss function' is proposed, which is a novel loss function designed to enhance the optimization process in machine learning classification tasks," which could be "potentially improving overall classification performance" (Shim, 2024). The authors of this article even identify that "potential future work could involve a detailed theoretical analysis of the convergence properties of our linearly adaptive loss function" (Shim, 2024), which pave the way for future researchers to build upon. Machine learning could evolve parallel to our understanding of it, and as we continue to learn and build upon the findings of others we strengthen our understanding of information science, information theory, and our role in the comprehensive advancement of humanity as a collective.

10. Friedgut, E. (2024). An Information-Theoretic Proof of a Hypercontractive Inequality. *Entropy*, *26*(11), 966. https://doi-org.lynx.lib.usm.edu/10.3390/e26110966

The authors of this paper “apply an information-theoretic approach to proving for Boolean functions, trying to analyze the pair (X,Y) as the coordinates of X and Y are revealed to us one by one” (Friedgut, 2024). They “use the chain rule of entropy, exposing the bits of the vectors in question one by one and comparing the amount of information about their joint distribution with the information captured by their marginal distributions” (Friedgut, 2024). While this paper calculates entropic values in mathematical terms, this demonstrates the degree to which entropy and information theory have with one another. The correlation between information science and entropy are beyond scientific reasoning and stretch beyond the physical into the metaphysical comprehension of our collective relationship with information. While ontological calculations have not been empirically introduced or understood yet, scientific and mathematical approaches only contribute to our eventual development of a theory of everything. Such a theory will likely be grounded or even built around, or upon, information theory and the professionals who continue to contribute to this scientific field.