New book from Robert Marks, William Dembski, and Winston Ewert

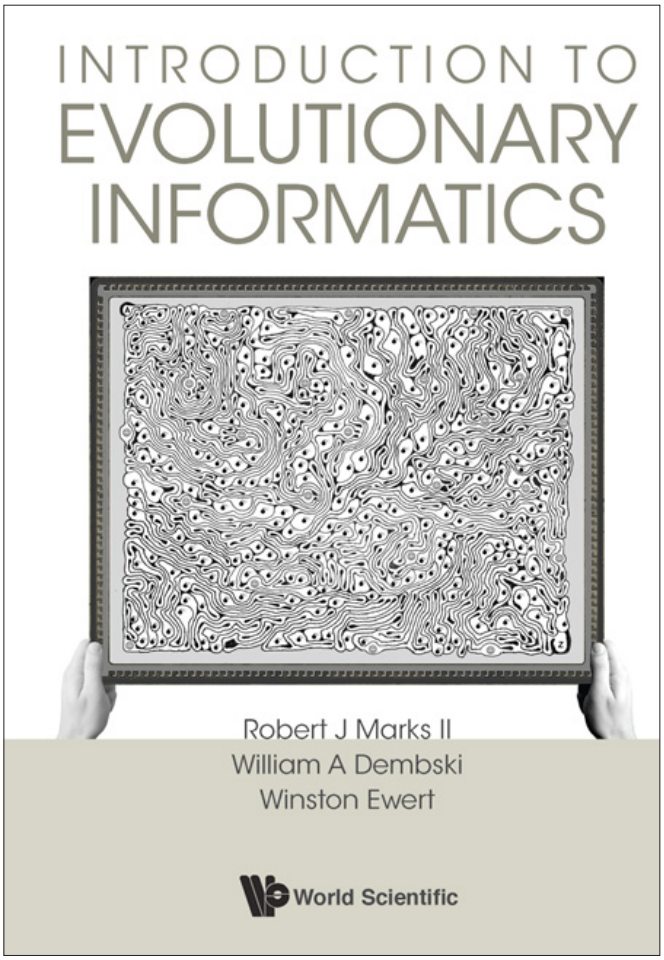
Introduction to Evolutionary Informatics

> ***"An honest attempt to discuss what few people seem to realize is an important problem." Thought provoking!***

Gregory Chaitin, PhD
Professor, Federal University of Rio do Janeiro

> ***"With penetrating brilliance, and with a masterful exercise of pedagogy and wit, the authors take on Chaitin's challenge, that Darwin's theory should be subjectable to a mathematical assessment and either pass or fail. Surveying over seven decades of development in algorithmics and information theory, they make a compelling case that it fails."***

Bijan Nemati, PhD,
Jet Propulsion Laboratory,
California Institute of Technology



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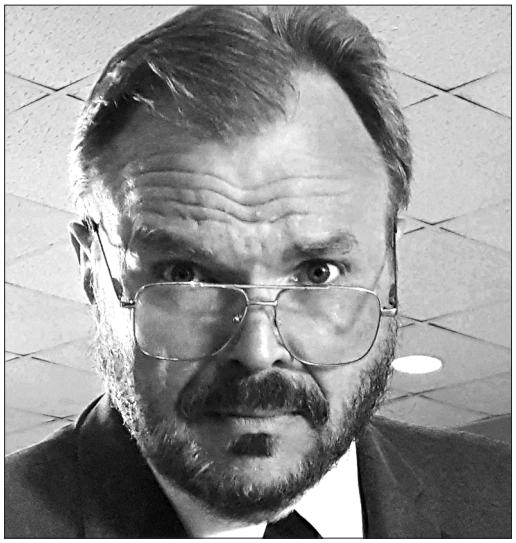
Introduction to Evolutionary Informatics

Science has made great strides in modeling space, time, mass and energy but is done little to definitively model the obvious meaningful information ubiquitous in the universe. Today, a narrowly focused information theory is used to measure the storage capacity of a DVD or for describing the throughput of a Wi-Fi connection. No consideration is given as to whether the signal described is meaningful or noise. The difficulty associated with the design of the DVD content or the meaning of data transmitted across the Wi-Fi connection are not addressed. New results in information theory now allow meaning and design difficulty to be measured. The theory can be applied to creation including measurement of the design complexity and resident meaning found in biology. For the first time both can be measured in bits. This powerful theory has been developed by the authors in a series of peer reviewed papers published in the literature, but is there written at a level not accessible to those not expert in the fields. Explaining this exciting theory at an accessible and understandable level is a goal of *Evolutionary Informatics.*

About the Authors



Robert J. Marks II is Distinguished Professor of Engineering in the Department of Engineering at Baylor University, USA. Marks's professional awards include a NASA Tech Brief Award and a best paper award from the American Brachytherapy Society for prostate cancer research. He is Fellow of both IEEE and The Optical Society of America. His consulting activities include: Microsoft Corporation, DARPA, and Boeing Computer Services. He is listed as one of the "The 50 Most Influential Scientists in the World Today" By *TheBestSchools.org* (2014). His contributions include: the Zhao-Atlas-Marks (ZAM) time-frequency distribution in the field of signal processing, and the Cheung Marks theorem in Shannon sampling theory.

Marks's research has been funded by organizations such as the National Science Foundation, General Electric, Southern California Edison, the Air Force Office of Scientific Research, the Office of Naval Research, the United States Naval Research Laboratory, the Whitaker Foundation, Boeing Defense, the National Institutes of Health, The Jet Propulsion Lab, Army Research Office, and NASA. He has written or contributed to many books, including *Handbook of Fourier Analysis and Its Applications* (Oxford University Press), *Introduction to Shannon Sampling and Interpolation Theory* (Springer Verlag), and *Neural Smithing: Supervised Learning in Feedforward Artificial Neural Networks* (Rus Reed, MIT Press),

The Handbook of Brain Theory and Neural Networks (Michael Arbib, MIT Press, 1996), and *Evidence for God* (Michael Licona et al., Baker Books, 2010). Marks has edited/co-edited five other volumes in fields such as power engineering, neural networks, and fuzzy logic. He was instrumental in defining the discipline of computational intelligence (CI) and is a co-editor of the first book using CI in the title: *Computational Intelligence: Imitating Life* (IEEE Press, 1994). Marks has also authored/co-authored hundreds of peer-reviewed conference and journal papers.

William A Dembski is Senior Research Scientist at the Evolutionary Informatics Lab in McGregor, Texas. He holds a BA in Psychology, MS in Statistics, PhD in Philosophy, and a PhD in Mathematics from the University of Chicago, and an MDiv degree from Princeton Theological Seminary. Dembski has worked as an Associate Research Professor with the Conceptual Foundations of Science at Baylor University, and taught at Northwestern University, the University of Notre Dame, and the University of Dallas, Irving. He has done postdoctoral work in mathematics with the Massachusetts Institute of Technology, in physics with the University of Chicago, and in computer science with Princeton University. He is a Mathematician and Philosopher. He has held National Science Foundation graduate and postdoctoral fellowships, and has published articles in mathematics, engineering, philosophy, and theology journals and is the author/editor of more than twenty books.

Winston Ewert is a Senior Research Scientist at the Evolutionary Informatics Lab and holds a PhD from Baylor University. He has written a number of papers relating to search, information, and complexity including studies of computer models purporting to describe Darwinian evolution and developing information theoretic models to measure specified complexity. He currently works as a Software Engineer in Vancouver, Canada.

Praise for

Introduction to Evolutionary Informatics

"*Introduction to Evolutionary Informatics* is a lucid, entertaining, even witty discussion of important themes in evolutionary computation, relating them to information theory. It's far more than that, however. It is an assessment of how things might have come to be the way they are, applying an appropriate scientific skepticism to the hypothesis that random processes can explain many observed phenomena. Thus the book is appropriate for the expert and non-expert alike."

Donald Wunsch, PhD.
Mary K. Finley Missouri Distinguished Professor and Director of the Applied Computational Intelligence Lab, Missouri University of Science & Technology, IEEE Fellow, INNS Fellow, Past President of the International Neural Networks Societ, and author of *Clustering* (with Rui Xu)

"Darwinian pretensions notwithstanding, Marks, Dembski, and Ewert demonstrate rigorously and humorously that no unintelligent process can account for the wonders of life."

Michael J. Behe, Ph.D.
Professor of Biological Sciences, Lehigh University, author of *Darwin's Black Box* and *The Edge of Evolution*

"This is a fine summary of an extremely interesting body of work. It is clear, well-organized, and mathematically sophisticated without being tedious (so many books of this sort have it the other way around). It should be read with profit by biologists, computer scientists, and philosophers."

David Berlinski, Ph.D.
Author of *The Devil's Delusion, The Deniable Darwin and Other Essays, The King of Infinite Space: Euclid and His Elements*, and *Newton's Gift: How Sir Isaac Newton Unlocked System of the World*

"For decades and decades, the ubiquitous cultural lie is that Intelligent Design advocates do nothing but rehash old criticisms of evolutionary theory. They never present fresh, positive research that supports ID theory. Now repeating serious criticisms of evolution is very important, especially since the universities, state school boards, and the ACLU have guaranteed that students must never hear of the problems with evolutionary theory. Still, the ID movement must present positive research for its views, and since this has been done for years through a number of publications, it is now a sign of ignorance, intellectual bigotry and bad faith for people to perpetuate this cultural lie. It is itself a lie. But with the publication of the ground-breaking book, *Introduction to Evolutionary Informatics*, there is now a cutting-edge positive ID research volume that does fresh, here-to-fore unpublished (and un-thought of!) ideas that get to the very deepest bottom of recent science that is not only relevant to the ID/Evolution debate, but actually devastates evolutionary theory at the ground floor. In my view, no one reading this book can continue to adopt Theistic Evolution on philosophical and scientific grounds alone. This is must reading for all believers and unbelievers interested in the debate, and Christians who are scientists have, I believe, a moral and spiritual duty to read this book. Though somewhat difficult, Marks, Dembski and Ewert have done a masterful job of making the book accessible to the engaged and thoughtful layperson. I could not endorse this book more highly."

J.P. Moreland, Ph.D.
Distinguished Professor of Philosophy, Biola University, and author of *The Soul: How We Know It's Real and Why It Matters*

Praise for

Introduction to Evolutionary Informatics

"Dr. Marks has been at the forefront of research on evolutionary algorithms for three decades. However, in 2007 his university removed the website of his Evolutionary Informatics group because his research was a threat to the status quo in evolutionary biology. Nonetheless, Dr. Marks and his colleagues continued to pursue research into the informational requirements of evolutionary algorithms, the result of which is found in this volume. If you want to know what information theory says about evolution, this is the volume to read."

Jonathan Bartlett
Director of The Blythe Institute and author of *Programming from the Ground Up*

"Evolution requires the origin of new information. In this book, information experts Bob Marks, Bill Dembski, and Winston Ewert provide a comprehensive introduction to the models underlying evolution and the science of design. The authors demonstrate clearly that all evolutionary models rely implicitly on information that comes from intelligent design, and that unguided evolution cannot deliver what its promoters advertise. Though mathematically rigorous, the book is written primarily for non-mathematicians. I recommend it highly."

Jonathan Wells, PhD.,
Senior Fellow, Discovery Institute, and author of *Zombie Science*, *Icons of Evolution*, and *The Myth of Junk DNA*

"When biologists finally come to terms with the fact that Darwinism was a long experiment in collective self-deception, the work described in this book will deserve much of the credit for putting things right."

Douglas Axe, PhD.,
Director of Biologic Institute and author of *Undeniable: How Biology Confirms Our Intuition that Life is Designed*

"*Introduction to Evolutionary Informatics* helps the non-expert reader grapple with a fundamental problem in science today: We cannot model information in the same way as we model matter and energy because there is no relationship between the metrics. As a result, much effort goes into attempting to explain information (and intelligence) away. The authors show, using clear and simple illustrations, why that approach not only does not work but cannot work. It impedes understanding of our universe. The picture that emerges from their work is of a universe that is at the same time more mysterious than we had been led to expect and more familiar."

Denyse O'Leary
Science writer

"Marks, Dembski, and Ewert have written a book summarizing in a very accesible way all of their research at the Evolutionary Informatics Lab for the last decade. If the blind watchmaker says 'me thinks it is like a weasel', they say 'perhaps, but in order to see it you need these active-information glasses.' When the watchmaker is able to see with the glasses (and he needs them to be certain it is a weasel), he is not blind anymore. He is, like the programmer of an evolutionary algorithm, an intelligent designer with a very clear sight of his target. —'Oh, yes, it was a weasel!'"

Daniel Andrés Díaz Pachón, PhD
Research Assistant Professor, Biostatistics, University of Miami

Praise for

Introduction to Evolutionary Informatics

"This is an important and much needed step forward in making powerful concepts available at an accessible level."

Ide Trotter, PhD.
Trotter Capital Management Inc., Founder of *Trotter Prize and Endowment Lecture Series on Information, Complexity, and Inference*, Texas A&M

"Steampunk fiction anachronistically fuses Victorian steam powered technology into the digital age. Darwinism is 'steampunk science.' It is an analog-based Victorian relic trying to make its way in the digital information age. Darwin had no conception of the information problem facing any account of naturalistic evolution. Darwin's 21st century successors certainly know about the problem, but as Marks, Dembski and Ewert demonstrate in *Introduction to Evolutionary Informatics*, in 2017 they are no closer to solving the problem than Darwin was in 1859. This lay-accessible introduction to the information issue and how it remains unsolved is absolutely essential to anyone who wants to understand how all life is fundamentally information-based, and how naturalistic evolutionary science has not come remotely close to solving the problem of how meaningful information can arise in the absence of intelligence."

Barry Arrington, D. Jur.,
Colorado House of Representatives (1997-1998), and Editor-in-Chief of *UncommonDescent.com.*

"One of the things Intelligent Design theorists do is take what is obvious to the layman, that unintelligent forces cannot do intelligent things, and state it in more rigorous, scientific terms, so that highly educated people can understand also. This book makes important contributions to that effort, using results and terminology from information theory."

Granville Sewell, PhD.,
Professor of Mathematics, University of Texas, El Paso, and author of *Computational Methods of Linear Algebra*, *In the Beginning: And Other Essays on Intelligent Design*, and *Christianity for Doubters*

"A very helpful book on this important issue of information, which evolution cannot explain. Information is the jewel of all science and engineering which is assumed but barely recognised in working systems. In this book Marks, Dembski and Ewert show the major principles in understanding what information is and show that it is always associated with design."

Andy C. McIntosh, DSc,
FIMA, C.Math, C.Eng, FInstP, MIGEM, FRAes, and Visiting Professor of Thermodynamics, School of Chemical and Process Engineering, Universitty of Leeds, UK

Preface

Summary: Information remains the most unexplored property of the universe. The goal of *Evolutionary Informatics* is to further explore the science and application of information theory in nature.

A brief discussion of the history of the book is given as is a list of journal and conference papers penned by the authors. The level of required math expected to the reader is discussed as is the role of footnotes and endnotes. Evolutionary Informatics content is built on these publications.

Chapter 1. Introduction

Summary: Rather than placing a theory or ideology on the throne like a Queen as scientists and philosophers often do, engineers make the Queen come down from the throne and scrub the floor. And if she doesn't work, she is fired.

Scientists once thought evolution models running on fast computers would someday confirm evolution. The opposite has happened. Prophets of computer-based demonstration of undirected evolution failed to take into account Borel's law and the Conservation of Information. Borel's Law dictates that events described by a sufficiently small probability are impossible events. There's a small probability that you will experience quantum tunneling through the chair in which you sit. The probability is so small, however, that we can categorize the event as impossible.

Chapter 2: Information. What is It?

Summary: Information is neither matter nor energy. It stands as an independent component of nature.

The term information is typically not well defined whether used in casual conversation or in a journal article. Shannon information theory is perhaps the best-known mathematical model of information. Shannon noted the obvious: his model of information is narrow and not applicable to the broad range of possible definitions of information.

Kolmogorov-Chaitin-Solomonov (KCS) information theory, also known as algorithmic information theory, is another popular information model. Both Shannon and KCS models fail to model information in the sense of measuring the meaning or the design difficulty associated with an object.

Chapter 3: Design Search in Evolution and the Requirement of Intelligence

Summary: Engineering design is invariably an iterative search guided by domain expertise of the designer. WD-40 took 40 trials to design and Formula 409 required 409 tries. That's how these products got the numerical part of their names.

The anatomy of a search is illustrated by a chef's design of a good pancake recipe. The important components of design are identified, including the role of domain expertise and the curse of dimensionality that can quickly makes uninformed designs impossible.

Analysis of NASA's design of an antenna using evolutionary search shows that the design domain expertise is evolutionary design is rich and the search problem was not that difficult.

Trade-offs are necessary in design. Designing a car that is both inexpensive and safe requires one criterion to be traded off with the other. Cheap cars aren't safe and safe cars aren't cheap. More than not, global optimality necessitates component suboptimality. Ill-informed critical claims of suboptimal design in biological systems is clarified with a discussion of the trade-offs inherent in any multi-objective design.

Chapter 4: Determinism in Randomness

Summary: It may sound like an oxymoron, but there are elements of determinism in randomness. If, for example, a fair coin is repeatedly flipped thousands of times, the proportion of heads will always approach the deterministic value of one half. In a similar manner, many programs purporting to demonstrate Darwinian evolution are invariably written to converge to a specific deterministic outcome most of the time. Like the steel ball in a pinball machine, different paths can be taken in every trial, but the steel ball always ends up going down the little hole underneath the flippers.

Bernoulli's Principle of Insufficient Reason (PrOIR), although fancy sounding, simply says that the chance of winning a lottery with 1000 tickets sold is one chance in 1000 if you have purchased only one ticket. Equal probability is assigned to every possible outcome in the drawing. Bernoulli's PrOIR is important in the modeling of random blind search.

Basener's Ceiling imposes a severe restriction on any evolutionary process. It demands that any evolutionary computer search will reach a point where further improvement is not possible. It is common sense that an evolutionary program written to design an antenna will not continue to evolve to the point where, for example, the program learns to play chess. The theory behind this limitation of evolutionary processes is firmly established by Basener's Ceiling.

Chapter 5: Conservation of Information in Evolutionary Processes

Summary: We now have the tools needed to present the Law of Conservation of Information as illustrated by the No Free Lunch Theorem. The No Free Lunch theorem dictates that when seeking to iteratively design an object, one procedure is as good on the average as any other procedure if the designer has absolutely no domain expertise. The No Free Lunch Theorem published in 1997 by Wolpert and Macready raised the eyebrows of the machine intelligence community who often placed one search algorithm against another to see which was best. The results of that competition, it turns out, said nothing about the effectiveness of one search algorithm over another. It only said that one search algorithm was better on the problem being examined. The performance ranking was not necessarily valid for other problems.

The No Free Lunch Theorem was also the inspiration behind Bill Dembski's book with a similar title.

If no domain expertise is available, we expect a random search to work as well as any other. The problem is that random searches quickly exhaust the probabilistic resources in the universe. Even the probability resources of a multiverse are insufficient to generate the table of contents for the first chapter of this book by blind chance. Design requires intelligence.

An evolutionary search can be made better than average by use of domain expertise. Fewer iterations are required to achieve a successful design. Active information measures the degree to which domain expertise has helped in a search. Active information is illustrated using easily understood examples such as the Cracker Barrel Puzzle and the game show Let's Make a Deal.

The No Free Lunch Theorem has been claimed to be violated by the so-called process of co-evolution. We straightforwardly show this not to be the case.

Lastly we broach the topic of a search – for – a – search. If all search procedures work the same on average, could not we have the computer search for a good search that works better than average? The answer turns out to be an emphatic NO! A search – for – a – search is shown to be exponentially more difficult than the search itself.

Chapter 6: Analysis of Some Evolutionary Models

Summary: There are a number of computer programs that purport to demonstrate undirected Darwinian evolution. The most celebrated is the Avida evolution program whose performance was louted by evolution proponents at the 2004-05 Kitzmiller v. Dover Area School District trial testing a public school district policy concerning the teaching of intelligent design. Conservation of information, discovered and published five years later, soundly discredits Avida.

Since Avida is attempting to solve a moderately hard problem, the writer of the program must have infused domain expertise into the code. We identify the sources and measure the resulting infused active information. Avida is shown to contain a lot of clutter used to slow down its performance. When the clutter is removed the program converges to the solution more quickly.

Another evolutionary program discredited through the identification and measurement of active information is dubbed EV.

Once a source of knowledge is identified in an evolutionary program, active information can be mined in different ways by using other search programs. For both Avida and EV, alternate search programs are shown to generate the same results as the evolutionary search. The computational burden of the evolutionary approach in both cases is significantly higher.

On EvoInfo.org, we have developed online GUIs (graphical user interfaces) to illustrate the performance of both Avida and EV. There is also a GUI that allows experimental exploration of Richard Dawkins's famous Weasel search algorithm. The performance and use of these GUIs is sufficiently explained so that the reader, if so motivated, can go online and the experiment themselves.

Lastly, a model proposed by Gregory Chaitin (the C in KCS) in his 2013 book Proving Darwin: Making Biology Mathematical is analyzed. Chaitin's model, built in the beautiful and surrealistic world of algorithmic information theory, is shown to be overflowing with active information. Like other computer programs written to demonstrate undirected Darwinian evolution, it works only because it was designed to work.

Chapter 7: The Meaning of Meaning: Algorithmic Specified Complexity

Summary: Specified complexity has been proposed in the intelligent design literature as a method of assessing the degree to which an object is designed or has meaning. Algorithmic specified complexity measures this property in bits.

Algorithmic specified complexity (ASC) assumes that meaning is based on context. A picture of my family has more meaning to me than to someone who has never met my family. A page of kanji characters has more meaning to a Japanese reader than to someone who doesn't know Japanese.

Winning hands in the game of poker is an example. For a deck of 52 distinct cards, there are 2,869,682 possible five card hands. Some hands, like a royal flush are more meaningful than others, e.g. a pair of twos. We show that the ASC of a royal flush is a hefty 16 bits where as that of a hand with one pair is zero.

Another illustrative example deals with snowflakes. Although a single individual snowflake displays a high degree of complexity, high complexity events happen all the time. We show that the ASC of two different snowflakes is near zero. But two identical snowflakes has a very large ASC.

Lastly, the ASC of objects in Conway's cellular automata Game - of -Life is calculated. Invented in 1970, interest in the GoL continues to grow. Today there are online user groups where intricate and complicated objects are constructed using Conway's four simple rules. As expected, large complex objects are assigned high values of ASC were as simple objects that have a high chance of being produced randomly have low values of ASC.

Chapter 8. Intelligent Design & Artificial Intelligence

The fields of artificial intelligence (AI) and intelligent design (ID) both share a variation of the word "intelligent." There is a deeper relationship. Strong AI using computers has been largely dethroned. Roger Penrose argues convincingly that human intelligence will never be achieved by a Turing machine, i.e. a computer. His argument, backed by the astonishing incompleteness theorem of Kurt Gödel, is based on the inability of computers to be creative beyond what they are told.

We see the same thing in models that purport to demonstrate Darwinian evolution. Again and again such models have been shown to work only because the programmer has infused information into the process. And, of course, these models of Darwinian evolution are run on a Turing machine.

Darwinian evolution can't create information. Neither can a computer. For humans, Penrose believes the answer might lie in quantum phenomena resident in our neurons. Alternately, in both AI and ID, creation of information can be explained by externally applied intelligence

Chapter 9. Appendices

9. Appendices
   - 9.1 Acronym List
   - 9.2 Variables
   - 9.3 Notation