

A Theoretical Computer Science Perspective on Free Will

Lenore Blum¹ and Manuel Blum²

Abstract

We consider the paradoxical concept of free will from the perspective of Theoretical Computer Science (TCS), a branch of mathematics concerned with understanding the underlying principles of computation and complexity, including the implications and surprising consequences of resource limitations.

The concept of **free will** is paradoxical. It puzzled Lucretius (100-50 BCE) [1]:

“If all movement is always interconnected, the new arising from the old in a determinate order – if the atoms never swerve so as to originate some new movement that will snap the bonds of fate, the everlasting sequence of cause and effect - what is the source of the free will possessed by living things throughout the earth?”

It puzzled Samuel Johnson (1709-1784) [2]:

“All science is against the freedom of the will; all experience is for it.”

In our opinion, Dehaene [3] solved the puzzle:

“Our states are clearly not uncaused and do not escape the laws of physics – nothing does. But our decisions are genuinely free whenever they are based on a conscious deliberation that proceeds autonomously, without any impediment, carefully weighing the pros and cons before committing to a course of action. When this occurs, we are correct in speaking of a voluntary decision – even if it is, of course, ultimately caused by our genes [and circumstances].”

Dehaene’s solution would surely have satisfied both Lucretius and Johnson. In what follows, we corroborate Dehaene’s solution with two formal definitions and our own independently-derived solution from the perspective of **Theoretical Computer Science (TCS)**.

The essence of **TCS** is the importance of *resource limitations*. **Computation time** in particular plays a significant role in resolving the paradox of free will. We define a **Conscious Turing Machine (CTM)** [4] that goes through life making choices. During whatever time it evaluates alternatives, before committing to any one of them, it rightly “feels” it has free will about its choices.

Our **TCS** perspective addresses the **paradox of free will** with the following definitions of **free will** and the *feeling of free will* in the **CTM**:

- **Free will** is the ability to violate physics.
As violating physics is impossible¹, no animal, machine, or CTM has free will.

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³ Violating the laws of physics in a deterministic world (like Conway’s Game of Life [11]) is clearly impossible. It is also impossible in the quantum world, where all actions are random selections from precise deterministically-defined (physicists call it calculable) probability distributions.

Perspective In Theoretical Computer Science

R Narasimhan



Perspective In Theoretical Computer Science:

A Perspective in Theoretical Computer Science Raghavan Narasimhan, 1989 **Perspective In Theoretical Computer Science, A: Commemorative Volume For Gift Siromoney** R Narasimhan, 1989-06-01 This volume consists of invited papers written by eminent researchers working in the areas of theoretical computer science The contents of the papers reflect the current trend of research being carried out in each of the areas Some of the areas featured are petri nets distributed systems map generating systems Lindenmayer systems logic cryptography graph grammars probabilistic automata array grammars and pattern recognition Many of these areas contain open problems and it is hoped that younger research workers will be motivated to work on them In addition some of the models designed constructed and presented are suitable for practical applications such as in computer graphics cryptography and distributed computing *Computer Science in Perspective* Rolf Klein, Hans-Werner Six, Lutz Wegner, 2003-07-01 By presenting state of the art aspects of theoretical computer science and practical applications in various fields this book commemorates the 60th birthday of Thomas Ottmann The 26 research papers presented span the whole range of Thomas Ottmann's scientific career from formal languages to algorithms and data structures from topics in practical computer science like software engineering or database systems to applications of Web technology groupware and e learning *Perspectives of Systems Informatics* Andrei Voronkov, Irina Virbitskaite, 2007-08-04 This book constitutes the thoroughly refereed post conference proceedings of the 6th International Andrei Ershov Memorial Conference PSI 2006 held in Akademgorodok Novosibirsk Russia in June 2006 The 30 revised full papers and 10 revised short papers presented together with 5 invited papers address all current aspects of theoretical computer science programming methodology and new information technologies **Perspectives of System Informatics** Dines Bjørner, Manfred Broy, Alexandre Zamulin, 2003-06-30 This book constitutes the thoroughly refereed post proceedings of the 4th International Andrei Ershov Memorial Conference PSI 2001 held in Akademgorodok Novosibirsk Russia in July 2001 The 50 revised papers presented together with 2 invited memorial papers devoted to the work of Andrei Ershov were carefully selected during 2 rounds of reviewing and improvement The book offers topical sections on computing and algorithms logical methods verification program transformation and synthesis semantics and types processes and concurrency UML specification Petri nets testing software construction data and knowledge bases logic programming constraint programming program analysis and language implementation Developments In Language Theory: Foundations, Applications, And Perspectives - Proceedings Of The 4th International Conference Grzegorz Rozenberg, W Thomas, 2000-11-07 The theory of formal languages is one of the oldest branches of theoretical computer science Its original aim in the fifties and sixties was to clarify the laws and algorithms that underlie the definition and compilation of programming languages Since then formal language theory has changed very much Today it includes mathematical topics like combinatorics of words word equations and coding theory but it also covers connections to linguistics for example the

study of contextual grammars new computational paradigms like DNA computing and a wide range of applications among them hypertext processing database theory and formal program verification Many of these themes of modern formal language theory are represented in this volume

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People & Ideas in Theoretical Computer Science Cristian Calude, 1999 This book collects personal accounts and reflections of fourteen eminent scientists who have dedicated themselves to the craft of theoretical computer science Contributions focus on the authors specific interests experiences and reminiscences The emerging picture which is just one among many should be a catalyst for further developments and continuations

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Computer Science in Perspective Rolf Klein, Hans-Werner Six, Lutz Wegner, 2003-02-17 By presenting state of the art aspects of theoretical computer science and practical applications in various fields this book commemorates the 60th birthday of Thomas Ottmann The 26 research papers presented span the whole range of Thomas Ottmann s scientific career from formal languages to algorithms and data structures from topics in practical computer science like software engineering or database systems to applications of Web technology groupware and e learning

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Information and Randomness Cristian S. Calude,2013-03-09 The first edition of the monograph *Information and Randomness An Algorithmic Perspective* by Cristian Calude was published in 1994 In my Foreword I said The research in algorithmic information theory is already some 30 years old However only the recent years have witnessed a really vigorous growth in this area The present book by Calude fits very well in our series Much original research is presented making the approach richer in consequences than the classical one Remarkably however the text is so self contained and coherent that the book may also serve as a textbook All proofs are given in the book and thus it is not necessary to consult other sources for classroom instruction The vigorous growth in the study of algorithmic information theory has continued during the past few years which is clearly visible in the present second edition Many new results examples exercises and open problems have been added The additions include two entirely new chapters *Computably Enumerable Random Reals and Randomness and Incompleteness* The really comprehensive new bibliography makes the book very valuable for a researcher The new results about the characterization of computably enumerable random reals as well as the fascinating *Omega Numbers* should contribute much to the value of the book as a textbook The author has been directly involved in these results that have appeared in the prestigious journals *Nature* *New Scientist* and *Pour la Science*

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Table of Contents Perspective In Theoretical Computer Science

1. Understanding the eBook Perspective In Theoretical Computer Science
 - The Rise of Digital Reading Perspective In Theoretical Computer Science
 - Advantages of eBooks Over Traditional Books
2. Identifying Perspective In Theoretical Computer Science
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Perspective In Theoretical Computer Science
 - User-Friendly Interface
4. Exploring eBook Recommendations from Perspective In Theoretical Computer Science
 - Personalized Recommendations
 - Perspective In Theoretical Computer Science User Reviews and Ratings
 - Perspective In Theoretical Computer Science and Bestseller Lists
5. Accessing Perspective In Theoretical Computer Science Free and Paid eBooks
 - Perspective In Theoretical Computer Science Public Domain eBooks
 - Perspective In Theoretical Computer Science eBook Subscription Services
 - Perspective In Theoretical Computer Science Budget-Friendly Options

6. Navigating Perspective In Theoretical Computer Science eBook Formats
 - ePub, PDF, MOBI, and More
 - Perspective In Theoretical Computer Science Compatibility with Devices
 - Perspective In Theoretical Computer Science Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Perspective In Theoretical Computer Science
 - Highlighting and Note-Taking Perspective In Theoretical Computer Science
 - Interactive Elements Perspective In Theoretical Computer Science
8. Staying Engaged with Perspective In Theoretical Computer Science
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Perspective In Theoretical Computer Science
9. Balancing eBooks and Physical Books Perspective In Theoretical Computer Science
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Perspective In Theoretical Computer Science
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Perspective In Theoretical Computer Science
 - Setting Reading Goals Perspective In Theoretical Computer Science
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Perspective In Theoretical Computer Science
 - Fact-Checking eBook Content of Perspective In Theoretical Computer Science
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
 - Integration of Multimedia Elements

- Interactive and Gamified eBooks

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