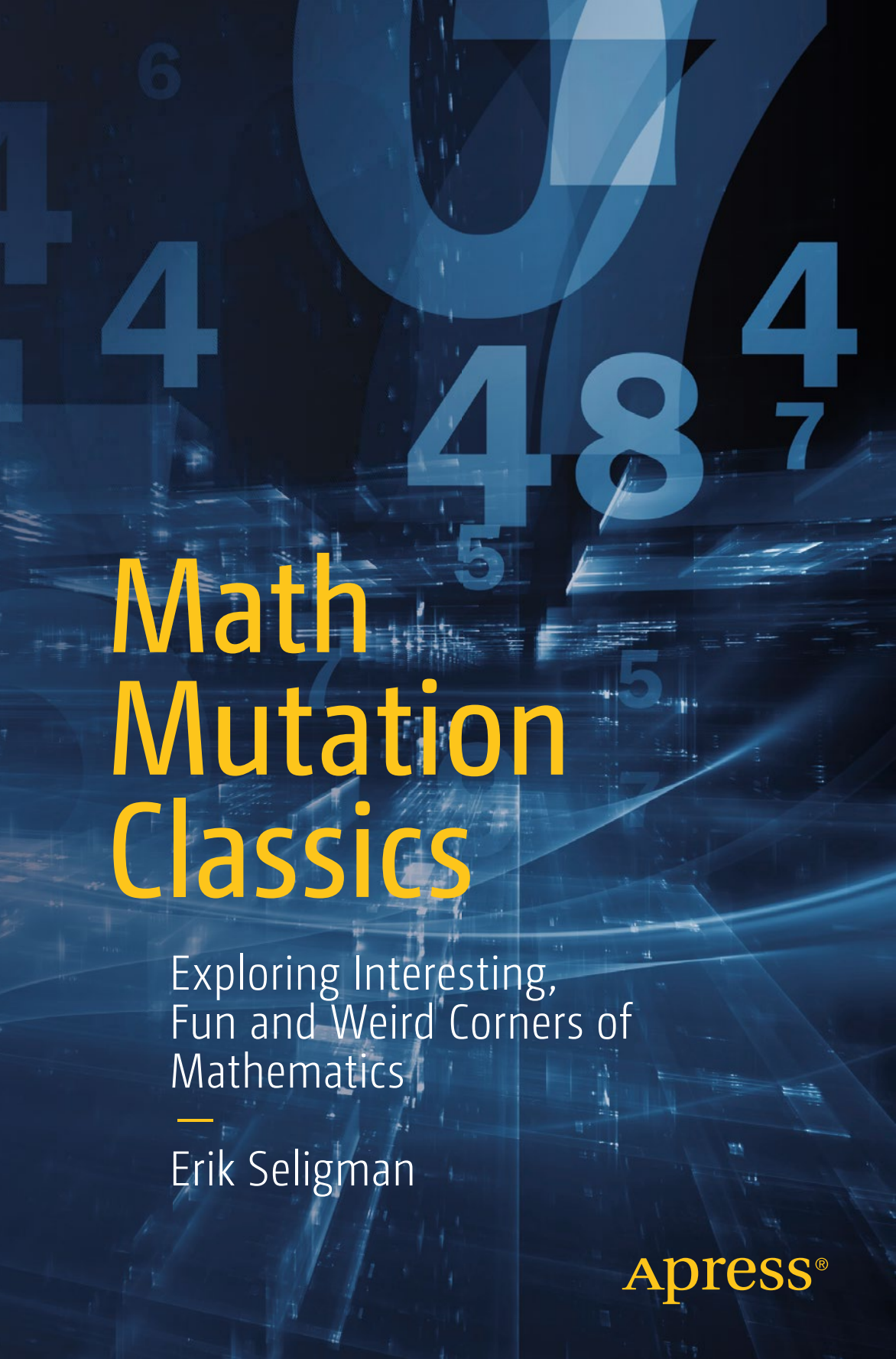




Math Mutation Classics

Exploring Interesting,
Fun and Weird Corners of
Mathematics

Erik Seligman

Apress®

Math Mutation Classics

Exploring Interesting, Fun and
Weird Corners of Mathematics



Erik Seligman

Apress®

Math Mutation Classics: Exploring Interesting, Fun and Weird Corners of Mathematics

Erik Seligman
Hillsboro, Oregon, USA

ISBN-13 (pbk): 978-1-4842-1891-4
DOI 10.1007/978-1-4842-1892-1

ISBN-13 (electronic): 978-1-4842-1892-1

Library of Congress Control Number: 2016937749

Copyright © 2016 by Erik Seligman

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed. Exempted from this legal reservation are brief excerpts in connection with reviews or scholarly analysis or material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work. Duplication of this publication or parts thereof is permitted only under the provisions of the Copyright Law of the Publisher's location, in its current version, and permission for use must always be obtained from Springer. Permissions for use may be obtained through RightsLink at the Copyright Clearance Center. Violations are liable to prosecution under the respective Copyright Law.

Trademarked names, logos, and images may appear in this book. Rather than use a trademark symbol with every occurrence of a trademarked name, logo, or image we use the names, logos, and images only in an editorial fashion and to the benefit of the trademark owner, with no intention of infringement of the trademark.

The use in this publication of trade names, trademarks, service marks, and similar terms, even if they are not identified as such, is not to be taken as an expression of opinion as to whether or not they are subject to proprietary rights.

While the advice and information in this book are believed to be true and accurate at the date of publication, neither the authors nor the editors nor the publisher can accept any legal responsibility for any errors or omissions that may be made. The publisher makes no warranty, express or implied, with respect to the material contained herein.

This book contains personal opinions by Erik Seligman. It does not represent the views of Intel Corporation, the Hillsboro School District, or any other organization of which Erik is a member.

Managing Director: Welmoed Spahr
Lead Editor: Jeffrey Pepper
Technical Reviewer: Barnaby Sheppard
Editorial Board: Steve Anglin, Pramila Balan, Louise Corrigan, Jonathan Gennick,
Robert Hutchinson, Celestin Suresh John, Michelle Lowman, James Markham,
Susan McDermott, Matthew Moodie, Jeffrey Pepper, Douglas Pundick,
Ben Renow-Clarke, Gwenan Spearing
Coordinating Editor: Mark Powers
Compositor: SPi Global
Indexer: SPi Global
Artist: SPi Global

Distributed to the book trade worldwide by Springer Science+Business Media New York, 233 Spring Street, 6th Floor, New York, NY 10013. Phone 1-800-SPRINGER, fax (201) 348-4505, e-mail orders-ny@springer-sbm.com, or visit www.springeronline.com. Apress Media, LLC is a California LLC and the sole member (owner) is Springer Science + Business Media Finance Inc (SSBM Finance Inc). SSBM Finance Inc is a **Delaware** corporation.

For information on translations, please e-mail rights@apress.com, or visit www.apress.com.

Apress and friends of ED books may be purchased in bulk for academic, corporate, or promotional use. eBook versions and licenses are also available for most titles. For more information, reference our Special Bulk Sales-eBook Licensing web page at www.apress.com/bulk-sales.

Any source code or other supplementary materials referenced by the author in this text are available to readers at www.apress.com/9781484218914. For detailed information about how to locate your book's source code, go to www.apress.com/source-code/. Readers can also access source code at SpringerLink in the Supplementary Material section for each chapter.

Printed on acid-free paper

Contents at a Glance

About the Author	xxi
About the Technical Reviewer	xxiii
Acknowledgments	xxv
Playing with Mathematics	xxvii
■ Chapter 1: Simple Surprises	1
■ Chapter 2: Into the Infinite	13
■ Chapter 3: Getting Geometric	25
■ Chapter 4: Deeper Dimensions	41
■ Chapter 5: Understanding the Universe	55
■ Chapter 6: The Mathematical Mind	67
■ Chapter 7: Science and Skepticism	85
■ Chapter 8: Analyzing the Arts	101
■ Chapter 9: Political Ponderings	117
■ Chapter 10: Money Matters	129
■ Chapter 11: Looking at Life	143
■ Chapter 12: Puzzling Paradoxes	159
■ Chapter 13: Rethinking Reality	171
■ Appendix: References and Further Reading	185
Index	211

Contents

About the Author xxi

About the Technical Reviewer xxiii

Acknowledgmentsxxv

Playing with Mathematics.....xxvii

■ Chapter 1: Simple Surprises..... 1

 City of Mutants 1

 From Math Mutation podcast 1 1

 Two Plus Two Equals Five..... 2

 From Math Mutation podcast 210 2

 Stupid Number Tricks 4

 From Math Mutation podcast 23 4

 Deceptive Digits 5

 From Math Mutation podcast 206 5

 Nonrandom Randomness 7

 From Math Mutation podcast 193 7

 A True Holiday Celebration 8

 From Math Mutation podcast 50 8

 Forgotten Knowledge 9

 From Math Mutation podcast 151 9

Exponents Squared	10
From Math Mutation podcast 64	10
Giving You the Fingers.....	11
From Math Mutation podcast 75	11
■ Chapter 2: Into the Infinite	13
Too Infinite for Me	13
From Math Mutation podcasts 0 and 5.....	13
Infinitely Ahead of His Time	14
From Math Mutation podcast 116	14
Infinite Infinities	16
From Math Mutation podcast 157	16
Infinity Times Infinity	17
From Math Mutation podcast 184	17
Infinite Perimeter, Finite Area	19
From Math Mutation Podcast 21	19
A Pretty Big Library	20
From Math Mutation podcast 15	20
Someone Knocked My 8 Over	21
From Math Mutation podcast 28	21
Not Quite Infinity.....	22
From Math Mutation podcast 186	22
Big Numbers Upside Down.....	23
From Math Mutation podcast 203	23
■ Chapter 3: Getting Geometric	25
Something Euclid Missed	25
From Math Mutation podcast 171	25
How Not to Decorate Your Bathroom.....	27
From Math Mutation podcast 82	27

Bees Vs Mathematicians	29
From Math Mutation podcast 152	29
A Brush with Evil	30
From Math Mutation podcast 102	30
Twistier Than You Thought.....	31
From Math Mutation podcast 168	31
Squash Those Dice	33
From Math Mutation podcast 18	33
Crazy Dice	35
From Math Mutation podcast 155	35
Wheels That Aren't Round	36
From Math Mutation podcast 209	36
The Future That Never Arrived.....	38
From Math Mutation podcast 73	38
■ Chapter 4: Deeper Dimensions	41
Making Flatland Real.....	41
From Math Mutation episodes 4, 8, 74, and 175	41
Is Flatland Doomed?.....	44
From Math Mutation podcast 53	44
Visitors from the Next Dimension.....	45
From Math Mutation podcast 17	45
Will the Real Fourth Dimension Please Stand Up?	46
From Math Mutation podcast 30	46
A Four-Dimensional House	47
From Math Mutation podcast 111	47
Turning Around in Time	49
From Math Mutation podcast 63	49

11-Dimensional Spaghetti Monsters	50
From Math Mutation podcast 38	50
Your Five-Dimensional Kitchen	51
From Math Mutation podcast 133	51
As Math Goes By	52
From Math Mutation podcast 134	52
Between the Dimensions	53
From Math Mutation podcast 22	53
■ Chapter 5: Understanding the Universe.....	55
The Bogus Bang?	55
From Math Mutation podcast 68	55
The Shape of the Universe	56
From Math Mutation podcast 86	56
Your Size in Space and Time	57
From Math Mutation podcast 148	57
Observing the Universe	58
From Math Mutation podcast 61	58
Alien Algebra	59
From Math Mutation podcast 129	59
Time Reversed Worlds.....	60
From Math Mutation podcast 195	60
A Pear-Shaped Planet.....	62
From Math Mutation podcast 120	62
Where Am I?	63
From Math Mutation podcast 108	63
Putting the Multiverse to Work.....	65
From Math Mutation podcast 31	65

■ Chapter 6: The Mathematical Mind	67
What Color is this Podcast?.....	67
From Math Mutation podcast 6	67
Computers on the Brain	68
From Math Mutation podcast 48	68
The Rain Man's Secret	69
From Math Mutation podcast 10	69
Look Him in the Eye.....	70
From Math Mutation podcast 119	70
Savants Are People Too	71
From Math Mutation podcast 97	71
The Uninhibited Brain	72
From Math Mutation podcast 99	72
A Logical Language	73
From Math Mutation podcast 192	73
When 'Is' Isn't.....	75
From Math Mutation podcast 196	75
De-Abstracting Your Life.....	77
From Math Mutation podcast 212	77
Your Kids Are Smarter Than You	78
From Math Mutation podcast 208	78
My Brain Hurts.....	80
From Math Mutation podcast 56	80
Psychochronometry.....	81
From Math Mutation podcast 202	81

■ Chapter 7: Science and Skepticism.....	85
Why Statisticians Stink at Statistics.....	85
From Math Mutation podcast 163	85
On Average, Things Are Average	86
From Math Mutation podcast 58	86
Don't Panic	88
From Math Mutation podcast 101	88
It Must Be True, There's an Equation	88
From Math Mutation podcast 132	88
A Twisted Take on Turing	90
From Math Mutation podcast 107	90
I Want My Molecule	91
From Math Mutation podcast 7	91
The Gullible Ratio	92
From Math Mutation podcast 185	92
Monkeying Around with Probability.....	94
From Math Mutation podcast 118	94
Solving Burma's Problems	96
From Math Mutation podcast 42	96
A New Numerology.....	97
From Math Mutation podcast 128	97
One Intestinal Worm Per Child.....	98
From Math Mutation podcast 110	98
■ Chapter 8: Analyzing the Arts.....	101
Discovering the Third Dimension.....	101
From Math Mutation podcast 135	101
A New Perspective on Perspective.....	104
From Math Mutation podcast 154	104

Hippasus's Revenge	105
From Math Mutation podcast 142	105
Unlistenable But Fun	106
From Math Mutation podcast 87	106
What a Planet Sounds Like.....	107
From Math Mutation podcast 29	107
Mozart Rolls the Dice	108
From Math Mutation podcast 54	108
Candide's Calculus	109
From Math Mutation podcast 83	109
Fractals in the Hat.....	110
From Math Mutation podcast 91	110
Math or Not Math?	112
From Math Mutation podcast 125	112
Gnarly Gnoveles.....	114
From Math Mutation podcast 170	114
■ Chapter 9: Political Ponderings	117
A Founding Theorem	117
From Math Mutation podcast 183	117
More Than a Cartoon Cat.....	119
From Math Mutation podcast 88	119
The Round Road to Damnation.....	120
From Math Mutation podcast 20	120
A Math Teacher to Remember	121
From Math Mutation podcast 93	121
Election Solutions.....	122
From Math Mutation podcast 172	122

Democracy Doesn't Work	124
From Math Mutation podcast 188	124
Drop That Number or We'll Shoot.....	126
From Math Mutation podcast 60	126
That's How We Do It In Government	127
From Math Mutation podcast 158	127
■ Chapter 10: Money Matters	129
Tally Folly.....	129
From Math Mutation podcast 96	129
How to Bankrupt Your Boss and Get Rich.....	130
From Math Mutation podcast 84	130
What Color Is Your Swan?	131
From Math Mutation podcast 164	131
Comparative Disadvantage	133
From Math Mutation podcast 165	133
Money for Math	134
From Math Mutation podcast 182	134
Liking the Lottery	136
From Math Mutation podcast 191	136
Number Nonsense.....	137
From Math Mutation podcast 70	137
Does the House Always Win?	138
From Math Mutation podcast 140	138
Mutating Up the Corporate Ladder	140
From Math Mutation podcast 146	140
The Converse of a CEO	141
From Math Mutation podcast 205	141

■ Chapter 11: Looking at Life	143
Florence Nightingale, Math Geek	143
From Math Mutation podcast 85	143
The Genius Who Cheated.....	144
From Math Mutation podcast 112	144
Shuttle Butt	146
From Math Mutation podcast 72	146
Booms and Busts	147
From Math Mutation podcasts 14 and 159.....	147
The Boids and Bees of Leadership.....	148
From Math Mutation podcast 160	148
A New Kind of Decade.....	150
From Math Mutation podcast 166	150
Basic Bugs	152
From Math Mutation podcast 167	152
Bugged by Math	153
From Math Mutation podcast 179	153
Voyages Through Animalspace.....	154
From Math Mutation podcast 194	154
A Heap of Seagulls	156
From Math Mutation podcast 201	156
■ Chapter 12: Puzzling Paradoxes.....	159
You Can Cross the Road	159
From Math Mutation podcast 94	159
Four-Dimensional Greek Warships	160
From Math Mutation podcast 197	160
A Christmas Surprise.....	162
From Math Mutation podcast 139	162

Resolving the Grandfather Paradox.....	163
From Math Mutation podcast 122	163
A Million Dollar Choice	164
From Math Mutation podcast 123	164
The Painter's Paradox	166
From Math Mutation podcast 55	166
The Monty Hall Paradox	167
From Math Mutation podcasts 3 and 109.....	167
A Mathematical Nuclear Bomb.....	168
From Math Mutation podcast 24	168
■ Chapter 13: Rethinking Reality.....	171
Answering All Possible Questions	171
From Math Mutation podcast 207	171
Sacrificing a Goat to Calculus	173
From Math Mutation podcast 65	173
Grue and Bleen.....	174
From Math Mutation podcast 76	174
Hippos in my Basement	175
From Math Mutation podcast 113	175
Is There a Hippopotamus in this Podcast?	176
From Math Mutation podcast 144	176
I Have Lied to You	178
From Math Mutation podcast 115	178
Does This Podcast Exist?.....	179
From Math Mutation podcast 177	179

A Universe Made of Math	181
From Math Mutation podcast 105	181
Mathematical Immortality	182
From Math Mutation podcast 178	182
■ Appendix: References and Further Reading	185
Chapter 1: Simple Surprises	185
City of Mutants	185
Two Plus Two Equals Five	185
Stupid Number Tricks	186
Deceptive Digits	186
Nonrandom Randomness	186
A True Holiday Celebration	186
Forgotten Knowledge	186
Exponents Squared	186
Giving You The Fingers	187
Chapter 2: Into Infinity	187
Too Infinite For Me	187
Infinitely Ahead of His Time	187
Infinite Infinities	187
Infinity Times Infinity	187
Infinite Perimeter, Finite Area	188
A Pretty Big Library	188
Someone Knocked My 8 Over	188
Not Quite Infinity	188
Big Numbers Upside Down	188
Chapter 3: Getting Geometric	189
Something Euclid Missed	189
How Not To Decorate Your Bathroom	189
Bees Vs Mathematicians	189

A Brush With Evil	189
Twistier Than You Thought.....	190
Squash Those Dice	190
Crazy Dice.....	190
Wheels That Aren't Round	190
The Future That Never Arrived	191
Chapter 4: Deeper Dimensions.....	191
Making Flatland Real.....	191
Is Flatland Doomed?	191
Visitors From The Next Dimension.....	191
Will The Real Fourth Dimension Please Stand Up?.....	191
A Four Dimensional House.....	192
Turning Around In Time.....	192
11-Dimensional Spaghetti Monsters	192
Your Five Dimensional Kitchen	192
As Math Goes By.....	192
Between The Dimensions	192
Chapter 5: Understanding The Universe	193
The Bogus Bang?.....	193
The Shape of the Universe.....	193
Your Size in Space and Time	193
Observing the Universe	193
Alien Algebra.....	193
Time Reversed Worlds	193
A Pear Shaped Planet.....	194
Where Am I?	194
Putting the Multiverse to Work	194

Chapter 6: The Mathematical Mind	195
What Color Is This Podcast?	195
Computers On The Brain.....	195
The Rain Man's Secret.....	195
Look Him In The Eye	195
Savants Are People Too.....	195
The Uninhibited Brain	195
A Logical Language	196
When 'Is' Isn't	196
De-Abstracting Your Life.....	196
Your Kids Are Smarter Than You	196
My Brain Hurts.....	197
Psychochronometry.....	197
Chapter 7: Science and Skepticism.....	197
Why Statisticians Stink at Statistics.....	197
On Average, Things Are Average	197
Don't Panic	197
It Must Be True, There's An Equation	198
A Twisted Take on Turing	198
I Want My Molecule	198
The Gullible Ratio.....	198
Monkeying Around With Probability.....	198
Solving Burma's Problems.....	199
A New Numerology	199
One Intestinal Worm Per Child	199
Chapter 8: Analyzing The Arts.....	199
Discovering the Third Dimension.....	199
A New Perspective on Perspective	199
Hippasus's Revenge	200

Unlistenable But Fun	200
What a Planet Sounds Like	200
Mozart Rolls the Dice.....	200
Candide's Calculus	200
Fractals in the Hat	201
Math or Not Math?.....	201
Gnarly Gnoveles.....	201
Chapter 9: Political Ponderings	201
A Founding Theorem.....	201
More Than a Cartoon Cat	201
The Round Road to Damnation	201
A Math Teacher to Remember	202
Election Solutions	202
Democracy Doesn't Work.....	202
Drop That Number or We'll Shoot	202
That's How We Do It In Government	202
Chapter 10: Money Matters	202
Tally Folly	202
How to Bankrupt Your Boss and Get Rich	203
What Color Is Your Swan?	203
Comparative Disadvantage.....	203
Money for Math	203
Liking the Lottery.....	203
Number Nonsense	204
Does The House Always Win?	204
Mutating Up the Corporate Ladder	204
The Converse of a CEO	204

Chapter 11: Looking at Life	204
Florence Nightingale, Math Geek.....	204
The Genius Who Cheated	205
Shuttle Butt.....	205
Booms and Busts.....	205
The Boids and Bees of Leadership	205
A New Kind of Decade	205
Basic Bugs.....	206
Bugged By Math	206
Voyages Through Animalspace.....	206
A Heap of Seagulls	206
Chapter 12: Puzzling Paradoxes	206
You Can Cross the Road.....	206
Four Dimensional Greek Warships.....	206
A Christmas Surprise.....	207
Resolving the Grandfather Paradox	207
A Million Dollar Choice.....	207
The Painter's Paradox.....	207
The Monty Haul Paradox.....	207
A Mathematical Nuclear Bomb.....	207
Chapter 13: Rethinking Reality	208
Answering All Possible Questions.....	208
Sacrificing a Goat to Calculus.....	208
Grue and Bleen	208
Hippos in My Basement.....	208
Is There a Hippopotamus In This Podcast?.....	208

■ CONTENTS

I Have Lied to You	209
Does This Podcast Exist?	209
A Universe Made of Math	209
Mathematical Immortality.....	209
Index.....	211

About the Author

Erik Seligman is a Formal Verification Architect at Intel Corporation, where he has been an engineer for over two decades. Erik has hosted the *Math Mutation* podcast since 2007. He was recently lead author of the well-received technical book, *Formal Verification: An Essential Toolkit for Modern VLSI Design* (Morgan Kaufmann, 2015). He earned a M.S. in computer science from Carnegie Mellon and a B.A. in mathematics at Princeton. He also has served since 2013 as an elected director on the board of the Hillsboro School District, the 4th largest K-12 school district in Oregon.

About the Technical Reviewer

Barnaby Sheppard is a mathematics writer and editor based in London, UK. Formerly a lecturer and researcher in pure mathematics (University College Dublin, Durham University, Lancaster University), he continues to pursue the subject, now branching out from the functional analytic and operator algebraic roots of his PhD and subsequent early research. He is the author of *The Logic of Infinity* (Cambridge University Press), an introduction to axiomatic set theory and related mathematical/philosophical matters, and is currently working on a number of other long-term writing projects. He is also interested in certain theoretical aspects of music and is a keen guitarist. He can be contacted via his book's website: <https://thelogicofinfinity.wordpress.com>.