For a long time, economists have assumed that we were cold, self-centred, rational decision makers – so-called *Homo economicus*; the last few decades have shattered this view. The world we live in and the situations we face are of course rich and complex, revealing puzzling aspects of our behaviour. *Optimally Irrational* argues that our improved understanding of human behaviour shows that apparent ‘biases’ are good solutions to practical problems – that many of the ‘flaws’ identified by behavioural economics are actually adaptive solutions.

Page delivers an ambitious overview of the literature in behavioural economics and, through the exposition of these flaws and their meaning, presents a sort of unified theory of behaviouralism, cognitive psychology and evolutionary biology. He gathers theoretical and empirical evidence about the causes of behavioural ‘biases’ and proposes a big picture of what the discipline means for economics.

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Optimally Irrational

The Good Reasons We Behave the Way We Do

LIONEL PAGE

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Contents

List of Figures vii
List of Tables ix
Preface xi

PART I SETTING THE SCENE
1 The Homo Economicus Model 3
2 The Psychology of Biases in Human Behaviour 12
3 The Logic of a Scientific Revolution in Economics 17
4 Evolution and the Logic of Optimisation 24

PART II INDIVIDUAL DECISIONS
5 Rules of Thumb and Gut Feelings 41
6 Reference Points and Aversion to Losses 62
7 Sensitivity to Probability 87
8 The Randomness of Choices 101
9 Impatience 114

PART III SOCIAL INTERACTIONS
10 Kindness and Reciprocity 129
11 Emotions and Commitment 159
12 Social Identity 174
<table>
<thead>
<tr>
<th>Contents</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>13  Impression Management</td>
<td>205</td>
</tr>
<tr>
<td>14  Selection of Delusion</td>
<td>224</td>
</tr>
<tr>
<td>PART IV  EPILOGUE</td>
<td></td>
</tr>
<tr>
<td>15  Rationality?</td>
<td>247</td>
</tr>
<tr>
<td><em>Bibliography</em></td>
<td>281</td>
</tr>
</tbody>
</table>
Figures

P.1 Hypothetical flowers with petals progressively added following rotations  

P.2 Flower patterns for different rotations close to the golden ratio  

4.1 “Kludged” flat fish. Photo from Tom Nicholson licensed under CC BY-NC 4.0.  

5.1 Ball detection by robots in the Robocup competition. Reproduced from Ashar et al. (2015).  

5.2 The gaze heuristic. Reproduced from Poddiakov (2013).  

5.3 Examples of overfitting and underfitting.  


6.2 Why an S-shape can be an optimal solution to the problem of perception  


7.1 The probability weighting function from prospect theory.  

9.1 Exponential, hyperbolic discounting and quasi-hyperbolic discounting functions. Reproduced from Berns et al. (2007).  

10.1 Prisoner’s dilemma game as a briefcase exchange. Image by Chris Jensen and Greg Riestenberg  

12.1 Stag Hunt Game. Image by Chris Jensen and Greg Riestenberg.  

13.1 Higher-order beliefs in the suitcase game  

13.2 Harry and Sally navigating an ambiguous romantic overture
# Tables

7.1 Allais’ gambles decomposed to reveal the substitution of a common element  

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1</td>
<td>Allais’ gambles decomposed to reveal the substitution of a common element</td>
<td>91</td>
</tr>
<tr>
<td>7.2</td>
<td>A series of gambles to investigate prospect theory’s predictions</td>
<td>94</td>
</tr>
<tr>
<td>11.1</td>
<td>The game of chicken in Rebel without a Cause</td>
<td>163</td>
</tr>
<tr>
<td>14.1</td>
<td>Costs when deciding to protect oneself or not from a danger</td>
<td>227</td>
</tr>
</tbody>
</table>
Preface

There is something oddly satisfying, and mysterious, in the emergence of mathematical patterns in nature. The geometric patterns made by flowers offer vivid examples of this. Flowers have, in particular, one puzzling characteristic: their number of petals tend to land on the Fibonacci sequence. Named after an Italian mathematician from the twelfth century, this sequence starts with the following numbers: 0, 1, 1, 2, 3, 5, 8, 13, 21. In this sequence, each number is the sum of the two previous numbers: 0 + 1 = 1, 1 + 1 = 2, 1 + 2 = 3, ...

A study looking at 650 species of plants found that the Fibonacci numbers were present in more than 92% of them (Jean 2009). For example, lily and iris have 3 petals; columbine, delphinium and gilliflower, 5; buttercup and delphinium, 8; garden mum, 13; astra, 21; daisy, 34, 55, 89. How could such patterns emerge in organisms a priori unable to engage in fancy mathematical calculations? The seemingly impossible emergence of mathematical regularities such as the Fibonacci sequence in the random natural world is fascinating and puzzling. It is easy to understand that it has fostered many theories on divine or magic meanings.

To try to understand how such a pattern can emerge, let's imagine for a minute that you are a flower. You have to decide where to place the petals growing around your centre (pistil). For your first petal, it is an easy job. Any location around the centre will do. Let's consider the clock position and let's say that you place your petal at 3. If you want to add more petals, the problem becomes a bit more difficult. Where should you put each additional petal relative to the position of the previous ones? Suppose you opt for a simple solution: to rotate around your pistil with a given angle and place a new petal. Then you can repeat this action once more, using the same angle and place another petal, and so on. In other words, you are considering a simple rule to place your petals: repeatedly rotate around the flower's centre with the same angle and place a new petal each time. Once you have adopted such a rule, your
problem is now quite simple: to grow petals, you need to find a good angle, or even better the *best angle* to determine the location of new petals.

What should this angle be? If the angle is half a circle, the second petal is on the other side of the centre. That is good, but the third petal goes on top of the first one, and the fourth petal goes on top of the second, and so on. This rule would not create a balanced flower, but a flower with two “arms”, one at the clock position 3 and one at the clock position 9. If the angle is a third of a circle, you will have three “arms” of petals instead of two. The first petal is again on clock position 3, the second is on clock position 7, the third is on clock position 11 and the fourth falls back on position 3, restarting the cycle. Indeed, for any rational number (a number that is the ratio of two natural numbers, e.g., 1/4 or 3/8) the petals will grow in a limited number of arms. Figure P.1 illustrates this fact for rotations of 1/3, 1/4 and 1/8 of a circle.

For irrational numbers (numbers that cannot be written as the ratio of two natural numbers), something interesting happens. The petals grow in arms that are not straight, but form spirals. Intuitively, the number of arms depends on the rational number that best approximates this irrational number.

Let’s then ask our question: Among all the possible angles, what is the one that would optimise the location of your petals? Suppose that you want to leave the least space as possible between petals. In other words, you want to pack as many petals as possible in a given amount of space. What rotation should you follow to achieve this goal? Given that rational numbers and approximations of rational numbers create arms, what about a number that is not easily approximated by a rational number, or perhaps even the number that is the least easily approximated by a rational number? One such number exists, it is the *Golden ratio*, which is approximately equal to 0.618. This number has been dubbed “the most irrational of the irrational numbers” (Tung 2007, p. 9). Being the hardest to approximate with a rational number, the Golden ratio allows an *optimal* spread of petals around the flower’s circle.¹

¹ The optimality of the Golden ratio to pack petals was demonstrated by Ridley (1982).
Preface

There is a deep connection between the Golden ratio and the Fibonacci sequence: the ratio between two consecutive numbers in the Fibonacci sequence is roughly equal to this ratio: \( \frac{2}{3} \approx \frac{5}{8} \approx \frac{8}{13} \) and this approximation grows closer as we go higher in the sequence. As a consequence, a plant’s approximation of the Golden ratio angle will determine the number of arms of petals its flower has and leads this number to be one of the numbers of the Fibonacci sequence (Okabe et al. 2019). The beautiful geometric patterns of flowers that follow the Fibonacci sequence are therefore optimally irrational.

Flowers are the way they are for a good reason: the rule they follow, even though puzzling, at first sight, is a good answer to the problem they face in nature. Aeons of evolution have found a way for flowers to approximate this optimal solution, to our amazement (Okabe 2015).

The optimal irrationality of flowers is a great metaphor for this book. I will look here at many quirky patterns in human behaviour that may seem mysterious and have often been dubbed “irrational” because it seems hard to find good reasons to explain them. This word does not refer to the same thing for numbers and behaviour. But, in each case, the irrationality sounds like an oddity. The fact that an irrational number like the Golden ratio is found frequently in the natural world seems, at first sight, intriguing and mysterious. In the same way, irrationalities found in human behaviour can seem puzzling and unexplainable. In both cases, though, there is generally a good explanation: plants and humans are the product of evolution. When they do something systematically, the reason is usually that it made them more efficient at solving the problems they faced in their environment.

This is, in a nutshell, the story of this book. I present both a broad overview of the widely discussed “irrational patterns” in human behaviour and how they exist for a good reason. Many economists and psychologists cited in this book have made a similar argument. This book integrates their insights and the work of many other behavioural scientists.

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\(^2\) This figure is reproduced from Prusinkiewicz and Lindenmayer (2012).
Preface

The intended audience is anyone with a deep interest in understanding human behaviour. This book should be easy to read for economists. I hope it will be of interest to them by bringing a rich set of empirical and theoretical works together with a different perspective than what is usually presented in texts on *behavioural economics* (the study of human behaviour using insights from economics and psychology). This book should also be accessible to any social scientist interested in thinking about the deep roots of human behaviour. Finally, this book should be of interest to any person (scientist or not) interested in deciphering the puzzling aspects of human behaviour. I have kept the technicality of the discussions to a minimum.

The literature I cover in this book is vast. My intention is in no way to give an exhaustive presentation of each topic I discuss. Instead, for readers unfamiliar with some of the topics, this book can serve as an introduction, with a specific angle: discussing how we can make sense of the main findings about human decision-making, with an evolutionary perspective. Each chapter contains references to go further into the specific topics. For readers well versed in the topics covered, I hope that I have done justice to the subtlety of the research findings, while at the same time often providing novel insights about the reasons people behave the way they do.

In the process of writing this book, I have benefitted from discussions with many people. Particular thanks go to Jason Collins, David Hirshleifer, Joshua Miller, Moshe Hoffman, Peter Wakker, Itzhak Gilboa, Ken Binmore, Peter Bossaerts, Luis Rayo, two different reading groups at the University of Queensland and at the University of Technology Sydney gathering Vera te Velde, Alice Solda, Matt Peddie, Alex Karakostas, David Smerdon, Bill von Hippel, Changxia Ke, Greg Kubitz, Zachary Breig, Xiqian, Stephanie Tobin, David Butler, Kenan Kaylaci, Ozan, David Goldbaum, Jingjing Zhang, Elif Incekara-Hafalir, Hanlin Lou, Adrian Camilleri, Ben Young, Alexander Caminer and Stephen Cheung. The book is much clearer and richer thanks to their suggestions and comments. Finally, I thank my wife Katie for her understanding, support and encouragements throughout the process of writing this book.

I start the book, in Part I, with a broad introduction on how economists and psychologists have looked at the rationality of human behaviour. After this introduction, I review a broad range of behaviours that have been cast as puzzling or irrational. I gather types of behaviour in two broad categories. In Part II, I look situations where decisions are made in isolation (e.g., taking a risky gamble). In Part III, I look at situations where decisions involve interactions with other people (e.g., cooperation). I cover a wide range of behaviours throughout. My aim is to get you to see the underlying meaning to the often mysterious ways we seem to live our lives.