

Preface to the second edition

Since the publication of the book, I have had the opportunity to run further courses at Queen's University Belfast, Western Sydney University and training courses at the Reserve Bank of Australia. I also received valuable input from the readers in the last 6 years. The second edition takes all of this into account. We have updated the materials, added many more examples and problems and have added a new chapter "Projects" which demonstrates how to use *Mathematica* to explore mathematics. Some of these projects were given as assignments to the students in the courses mentioned above.

Most of the work on the second edition was done during the ferry rides Manly-Circular Quay-Parramatta to work. I would like to thank Sydney Ferries for running such a smooth service.

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Teaching the mechanical performance of routine mathematical operations and nothing else is well under the level of the cookbook because kitchen recipes do leave something to the imagination and judgment of the cook but the mathematical recipes do not.

G. Pólya

This book grew out of a course I gave at Queen's University Belfast during the period 2004 to 2009. Although there are many books already written on how to use Wolfram *Mathematica*[®], I noticed that they fall into two categories: either they provide an explanation of how to use the commands, in the style of: enter the command, push the button and see the result; or they study some problems and write several-paragraph codes in *Mathematica*. The books in the first category did not inspire me (or my imagination) and those in the second category were too difficult to understand and were not suitable for learning (or teaching) *Mathematica*'s abilities to do programming and solve problems.

I could not find a book that I could follow to teach this module. In class one cannot go on forever showing students just how commands in *Mathematica* work; on the other hand it is very difficult to follow raw codes having more than five lines (especially as *Mathematica*'s style of programming provides a condensed code). Thus this book.

This book promotes *Mathematica*'s style of programming. I tried to show when we adopt this approach, then how naturally one can solve (nice) problems with (*Mathematica*) style.

Here is an example: Does the Euler formula $n^2 + n + 41$ produce prime numbers for $n = 1$ to 39?

```
(#^2 + # + 41) & /@ Range[39] ∈ Primes  
True
```

In another problem, for example, we try to show how one can effectively use pattern matching to check that for two matrices A and B , $(ABA^{-1})^5 =$

AB^5A^{-1} . One only needs to introduce the fact that $A^{-1}A = 1$ and then *Mathematica* will verify the result by cancelling the inverse elements instead of by direct calculation.

Although the meaning of the code above may not be clear yet, the reader will observe as we proceed how the codes start to make sense, as if this is the most natural way to approach the problems. (People who approach problems with a procedural style of programming (such as C++) will experience that this style replaces their way of thinking!) We have tried to let the reader learn from the codes and avoid long and exhausting explanations, as the codes will speak for themselves. Also we have tried to show that in *Mathematica* (as in the real world) there are many ways to approach a problem and solve it. We have tried to inspire the imagination!

Someone once rightly said that the *Mathematica* programming language is rather like a “Swiss army knife” containing a vast array of features. *Mathematica* provides us with powerful mathematical functions. Along with this, one can freely mix different styles of programming, functional, list-based and procedural, to achieve a lot. This mélange of programming styles is what we promote in this volume.

Thus this book could be considered for a course in *Mathematica*, or for self study. It mainly concentrates on programming and problem solving in *Mathematica*. I have mostly chosen problems having something to do with natural numbers as they do not need any particular background. Many of these problems were taken from or inspired by those collected in [4].

I would like to thank Ilan Vardi for answering my emails and Brian McMaster and Judith Millar for polishing the English.

Naoko Morita encouraged me to turn my notes into this book. I thank her for this and for always smiling and having a little Geschichte zu erzählen.

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