Preface

This book is intended to serve two purposes: one to introduce students in nuclear and radiological engineering to Python and to use Python as a pedagogical tool for numerical methods relevant to their studies. The audience for this book is intended to be junior and senior undergraduate students. Most of the material is, however, suitable for sophomore students if appropriate background is provided for the nuclear reactor and radiation physics. The book arose out of a set of lecture notes for a course at Texas A&M University that was for juniors who had previously taken a course in nuclear reactor theory.

The first part of the book serves as the introduction to Python 3 and the relevant libraries for scientific computing (namely NumPy and Matplotlib). The use of the library SciPy is scrupulously minimized. This is not because the library is not useful (I find it particularly useful). Rather, learning the numerical methods needed for engineering problems would be minimized if students had such methods delivered on an Argentine platter. Additionally, this book does not cover object-oriented programming with Python. While this will be a useful skill for those students that will develop engineering software as a career, there is simply not room to do it justice in a single text.

The second part of the text introduces traditional engineering numerical methods and applies them to engineering problems relevant to the audience. On the whole, the applications do not assume a great deal of nuclear or radiological engineering background. The exception is chapters 18–20, where some knowledge of diffusion theory for neutral particles is assumed. Nevertheless, references to the relevant background are given.

The final part of the text covers the important topic of Monte Carlo methods for particle transport, in particular neutron transport. The discussion mentions neutrons specifically, but of the techniques directly apply to gamma or x-ray transport, the eigenvalue discussion in Chapter 23 notwithstanding. For the Monte Carlo chapters, the discussion walks a fine line between demonstrating the full power of Monte Carlo methods and minimizing the length of code listings. The idea is to show the reader how complications could be added to Monte Carlo codes, without having each code have the totality of the functionality discussed.

This book adopts the philosophy that all the elements of the text should, where possible, be included in the flow of the discussion and not to treat figures and code listings as floating objects that can appear far from where they are mentioned. Additionally, in the early chapters, the code to generate the figures is included to demonstrate how one makes such figures using Python.

The exercises in this book have been chosen to demonstrate the features of the numerical methods or Python code features discussed. The solutions are intended to include a large amount of discussion and critical analysis of the results. This is especially true for the programming projects. Ideally, the solutions provided by students for these problems are mini-lab reports, because in these problems, the students are performing numerical experiments.

Finally, this book seeks to serve the needs of students by making Python a tool for them to use to solve engineering problems. Many of problems are designed to teach a student how to set up a problem and then solve it with a known algorithm. The primary goal is to know how to apply the method. My view is that a deep understanding of numerical techniques is preferable, but not *de rigeur* for contemporary students. Those students who do go on to be computational scientists will deepen their understanding in additional courses and reading. I fully realize that this point of view is not universally adopted. I only point out that using calculators without understanding the circuit boards inside did not make previous generations of students lesser scientists.

My ultimate goal is that this book generates excitement in students for computational science.

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