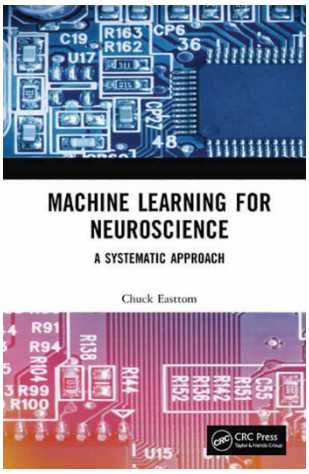

Machine Learning for Neuroscience: A Systematic Approach. Chuck Easttom. CRC Press, Boca Raton, Palm Beach County, Florida, United States, 2023, XV + 306 pages. Price: £ 82.99, ISBN: 9781032136721.

Neuroscience, the intricate study of the nervous system and the brain, has made phenomenal strides in the past decades[1,2]. With the sheer amount of data generated from neuroscientific studies, there is a growing need for sophisticated techniques to analyse, interpret and derive meaningful patterns from them[3]. Machine learning, a subset of artificial intelligence, focuses on developing algorithms and statistical models that allow computers to perform tasks without explicit instructions[4]. The convergence of machine learning and neuroscience promises breakthroughs in our understanding of the brain and its disorders, as well as the development of novel treatments[1,2]. This book is a tour de force in the intersection of two rapidly advancing fields, viz. machine learning and neuroscience. In a landscape where interdisciplinary knowledge is becoming increasingly invaluable, this book seamlessly bridges the chasm between the intricate world of neural systems and the analytical might of machine learning.

In the realm of machine learning for neuroscience, this book is structured into three distinct sections: foundational math and programming, essential neuroscience, and machine learning techniques. It provides a comprehensive journey for the readers, starting from the basics and gradually moving to complex applications of machine learning in neuroscience.

Section I, entitled 'Required math and programming', demystifies the crucial mathematical and programming concepts necessary to delve deep into machine learning. Beginning with linear algebra (chapter 1), the readers are introduced to the world of vectors, matrices and operations, emphasizing their significance in underpinning many machine learning algorithms. The discussion on eigenvectors and eigenvalues particularly sheds light on their criticality in transforming and optimizing data structures. Statistics (chapter 2), the subsequent focal point, underscores its intertwined relationship with machine learning. While one might argue that machine learning is more than just statistics, the undeniable reliance on statistical techniques, especially in clustering algorithms, is evident. A deeper dive into measures of central tendency, correlation tests, and basic probability accentuates the importance of statistical understanding in optimizing and validating machine learning models. Transitioning from the abstract world of math to the more tangible realm of Python programming (chapters 3 and 4), this book makes a convincing case for Python as a pivotal tool in the machine learning toolkit. Starting with rudimentary concepts like variables and control statements, it moves into the intricacies of the program's capabilities, highlighting exception handling, file operations, and the utility of regular expressions in data preprocessing and manipulation.

Section II is entitled 'Required neuroscience'. A neuroscience journey starts with exploring neuroanatomy and physiology (chapter 5). Chapter 5 serves as a foundational pillar, giving readers an understanding of the brain's structure and functions. It brings to light the intricacies of the brain, whether viewed from a developmental lens or an anatomical one, ensuring a holistic perspective. Diving deeper into the cellular realm, the emphasis shifts to neuron activities (chapter 6). Chapter 6 provides insights into the fundamental building blocks of the brain, elucidating electrical activities, neurotransmitter functions and the roles of ion channels. This understanding of cellular neuroscience becomes paramount when considering the modelling of artificial neural networks inspired by these biological systems. In the clinical world, machine learning holds immense promise. The section on neurological disorders bridges the gap between clinical neuroscience and computational models (chapter 7). By reviewing major neurological diseases and then introducing how machine learning can aid in diagnosis and management, this book showcases the transformative potential of machine learning applications in healthcare. The segue into computational neuroscience underscores the seamless integration of machine learning techniques (chapter 8). With a focus on mathematical models of neurons, information theory and tools like graph theory, chapter 8 provides the readers with tools and frameworks to model and understand complex neural systems computationally.

Section III is entitled 'Machine learning'. Starting with a broad overview of machine learning (chapter 9), this section sets the stage for deeper dives into specific algorithms and techniques. The historical context, combined with the introduction to various algorithmic classes, paints a picture of the evolution and capabilities of machine learning. The detailed exploration of artificial neural networks (ANNs) offers theoretical understanding and practical hands-on experience (chapter 10). It not only delves into the foundational concepts but also showcases Python code implementations, bridging theory and practice. Building on this, the variations of ANNs are unpacked, emphasizing their specialization (chapter 11). This comprehensive look ensures that the readers can not only differentiate between these variations but also understand when and how to deploy them effectively in neuroscience contexts. Clustering and classification techniques, such as *k*-means clustering (chapter 12) and *k*-nearest neighbours (*k*-NN; chapter 13), provide insights into data categorization and labelling, underscoring their relevance in identifying patterns and classifying neural data. Concluding the journey is the exploration of self-organizing maps (chapter 14), an unsupervised learning algorithm that showcases the adaptability and learning potential of ANNs.

This book offers an intricate weave of foundational concepts, deep dives into neuroscience and advanced machine learning techniques. It provides the readers with the tools, knowledge and frameworks to harness the power of machine learning in understanding and exploring the vast and complex realm of neuroscience. This book stands as a paragon in interdisciplinary literature, brilliantly interweaving the intricate realms of machine learning, neuroscience, foundational mathematics and programming. Its holistic approach ensures a comprehensive understanding, addressing theoretical and practical necessities. One notable hallmark of this tome is its user-friendly presentation. Despite the inherent complexity of the subjects tackled, the content is meticulously distilled to be

digestible, even for those on the novice end of the spectrum. This ensures a manageable learning curve, making intricate concepts accessible and understandable.

Diving deeper, the pragmatic orientation of this book truly sets it apart. Replete with a fully functional machine learning code, it provides the readers an immersive experience, moving beyond theoretical constructs to real-world applications. The provision of a downloadable code is a testament to its commitment to hands-on learning. Readers are not only encouraged to understand the concepts but are empowered to experiment, modify and apply them, bridging the gap between theory and practice.

Furthermore, this book's structured educational format, adorned with laboratory assignments and quizzes, enhances its utility in academic settings, making it a robust choice for educators and students. Recognizing the diversity of its readership, the content is meticulously tailored. For instance, the book crafts a unique narrative for computer science aficionados, grounding them in neuroscience. Such an approach, which marries varied disciplines, caters to a niche yet growing audience: neuroscience professionals seeking to harness the power of machine learning.

Lastly, the comprehensive scope of this book, spanning from the basics of linear algebra to the nuances of advanced algorithms like ANNs, ensures a complete toolkit for its readers. Whether one is a researcher, a programmer or a student, the book offers invaluable insights, making it an indispensable resource in the ever-evolving landscape of neuroscience and machine learning.

In a nutshell, this book is a must-have for anyone at the intersection of the above-mentioned fields. Whether one is a neuroscience researcher eager to harness the power of machine learning, a programmer venturing into neuroscience-driven projects, or a student exploring the world of computational neuroscience, this book is the beacon to guide us through the confluence of these complex domains. The author, Chuck Easttom, has masterfully demystified two complex subjects, and the result is a book that is both enlightening and eminently practical.

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