Prolog and Artificial Intelligence in Chemical Engineering

By T. E. Quantrille and Y. A. Liu, Academic Press, New York, 609 pp.

Among the programming languages used in the field of artificial intelligence (AI), LISP has been the language of choice in the United States, while Prolog has been used mostly in Europe. The book by Quantrille and Liu is the first to introduce Prolog and its artificial intelligence context to chemical engineers, and one of very few Prolog books that would be suitable for any engineers; the book thus represents a valuable addition to the literature. A clear advantage of Prolog is that it is easy to learn, even for people with little or no computer programming experience.

This book wisely begins with an introduction to programming with Prolog, rather than abstract AI concepts that might be difficult to grasp and of little use to the uninitiated reader. The pace of this 200-page part is quite relaxed, and a reader could learn Prolog through the detailed explanations of the book even without access to actual programming facilities; readers who practice Prolog programming as they study these chapters will find that they can adopt a quicker pace through this part.

The principles of AI are the second part of the book where the practical side of the concepts is illustrated with concrete examples, using Prolog. This part successfully captures and condenses the important and practical aspects of AI. The third part of the book is devoted to a case study from the authors' research, the EXSEP expert system for the synthesis of separations. This case study is very instructive. The context of the problem is stated in terms every chemical engineer can understand, and the AI concepts involved are shown in action, raising the reader's confidence about the value of AI for chemical engineering. The complete Prolog source code for this case study is included in the book. Finally, in its fourth part, the book focuses on the two most extensively used portions of AI; it provides an overview of chemical engineering applications of knowledge-based systems and an introduction to artificial neural networks. The discussion of the scope and potential of neural networks is refreshingly fair and balanced in assessing the role of this technology, its advantages, its limitations, and the best ways to go about investigating and applying the technology.

In all its chapters, particularly in the fourth part, the book includes a large number of references so that the reader may study particular applications or advanced topics in more detail. Another nice feature of the book is the provision of a glossary of AI and Prolog terms in an Appendix.

My only criticism of the book might be that it is somewhat long—over 600 large-size pages. The book's modular structure, however, makes it easy for readers to skim or skip sections, according to their backgrounds and needs. For example, the first three chapters (pages 1-86) cover basic aspects of Prolog which can be read and learned quickly by those readers who have extensive programming experience (especially if they have worked with expert system shells or LISP). The two chapters in Part IV (pages 396-487) reviewing knowledge-based applications and neural networks are self-standing and can be omitted or studied on their own. Finally, pages 488 to 609 consist of the index and Appendices, and approximately one half of this portion is the complete program listing for the EXSEP system for the synthesis of separations (pages 493-541). Thus, the length of the book is a result of the breadth of the material it covers and the inclusion of thorough reviews, explanations and documentation. The result of organizing this broad and thorough coverage in a modular fashion is a versatile book which can serve readers with different backgrounds and goals.

The authors obviously understand the subject matter very well. This well written book will be enjoyed by any chemical engineer that wants to become familiar with Prolog, the basic concepts of AI, and the full spectrum of AI applications in chemical engineering.

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Continuous Flow Methods In Organic Synthesis

By P. Tundo, Ellis Horwood Ltd., 310 pp., 3 Appendices, hardback, 1991.

This book is a comprehensive up-to-date survey of organic syntheses that are conducted by continuous-flow methods. The emphasis is on the production of fine chemicals, and the text is well-referenced (over 3,000 literature references). The presentation is a departure from the typical discussions of organic synthesis that normally involve batch processing. The book will be useful for researchers in such areas as polymer science, heterogeneous catalysis, and reaction engineering, because it covers reactions important to the production of polymers, pharmaceuticals and fine chemicals.

Chapter 1 involves the preparation and properties of heterogeneous and heterogenized catalysts. Emphasis is given to immobilization methods for gas-liquid (such as supported liquid-phase catalysis) and liquid-solid (such as metal complexes on inorganic and polymeric supports) reaction systems. (For a more exhaustive presentation of this topic, the reader is referred to *Supported Metal Complexes* by F. R. Hartley and D. Reidel, 1985).

Chapter 2 gives a brief overview of characterization methods used for studying heterogeneous catalysis. Techniques to measure physical properties (such as surface area, pore size and distribution) and chemical properties (such as chemisorption and photoemission) are discussed, but not covered in sufficient rigor for any real understanding. This, however, is not the main point of the book and does not detract from the following chapters.

Chapters 3, 4 and 5 provide an extremely nice survey of reactions carried out in the gas phase, in a gas phase over a liquid film, and in the liquid phase, respectively, using continuous-flow reactors. Chapter 3 contains well-documented sections on gas-phase reactions catalyzed by Nafion and zeolites and closes with a discussion of supported basic and superbasic catalysts. Chapter 4 mainly involves supported liquid-phase and phase transfer catalysis. Although a commercial supported liquid-phase catalyst does not exist as yet, the potential for future use in the synthesis of fine chemicals appears high. Chapter 5 describes continuous-flow systems for liquid-phase reactions using immobilized reagents (in solid-phase synthesis of peptides) and catalysts (strongly acidic ion exchange resins, supported aqueous-phase catalysts, phase transfer catalysts, and enzymes). The chapter includes an interesting mix of reactions and processes that illustrate the diversity of chemical reactions that employ the types of catalysts mentioned above.

The book closes with three appendices that deal with membranes, monoliths, and reactors. These three short presentations provide brief introductions to continuous-flow devices. There is nothing new in these sections that have not been presented in detail in many texts on reaction engineering.

Overall, I find this book to be a useful source of information concerning heterogeneous catalysis for fine chemicals. The presentation by Prof. Tundo is timely, since the number and complexity of reactions peformed by heterogeneous catalysts is burgeoning, and it concisely organizes many useful organic syntheses into a single reference.

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Advances in Heat Transfer: Bioengineering Heat Transfer

Edited By Y. I. Chao, J. P. Hartnett, and T. F. Irvine, Jr., Academic Press, 443 pp., 1992

The stated intent of this monograph, published as Volume 22 in the well-known Advances in Heat Transfer series, is "to present the fundamentals and applications of heat and mass transfer in biomedical systems." This is a broad and ambitious undertaking, and it is not surprising that the editors have decided to limit the work to an in-depth and detailed treatment of the analysis, description, and measurement of temperature distributions in biological tissue. The result is an excellent review of a narrow part of the wide spectrum of heat-transfer topics one encounters in biomedical systems and certainly among biological heat-transfer problems amenable to an engineering approach. The absence of any significant consideration of mass-transfer effects, surface convection transfer, radiative heat exchange mechanisms, or regulatory phenomena may disappoint readers expecting a fuller treatment as the title and intent would imply. For researchers desiring an exhaustive treatment of the range of techniques used in developing microscopic temperature distributions in tissue, it is an excellent summary.

The volume consists of four chapters, each written by a recognized authority on the subject. The first is an interesting and concise history by Professor John Chato of the University of Illinois of the major developments in the aspects of bioheat transfer in tissues, covering the period from the contemporaries of Galileo to the present. The second chapter, by Professor Caleb Charny of the Cooper Union, summarizes the development of the microscopic thermal energy balance in tissue (the bioheat equation) and its various solution techniques, beginning with a lucid description of the pioneering work of Pennes in 1948. Successive advances and modifications discussed include the Wulff continuum model, which added an anisotropic blood flow term to the existing perfusion and conduction models, the Klinger continuum model in 1974 which introduced spatial averaging techniques, and the Chen and Holmes contribution in 1980, which used two conduction and two convection terms in the energy balance. Countercurrent treatments, notably those of Keller and Seiler and of Mitchell and Myers, are discussed. A recent work by Weinbaum and Jiji which introduces morphological detail in the intermediate tissue layer is also presented.

The longest chapter, (190 pages with 231 references) by Professor Kenneth Diller of the University of Texas at Austin, is devoted to the application of the bioheat equation to describe effects arising at low and high temperatures, such as found in cryosurgery, tumor hyperthermia therapy, laser surgery, freezing of tissue for preservation, cryoinjury, and burns. This is an excellent chapter with many examples of how classical mathematical analysis techniques can be employed along with various forms of the microscopic thermal energy balance to produce useful results concerning local heat fluxes and temperature distributions in a wide variety of geometries.

The last section, prepared by Professor Jonathan Valvano of the University of Texas at Austin, is perhaps the most generally useful for researchers, including those needing to employ temperature measurement techniques in other applications. Dr. Valvano presents the theory, mechanisms, a discussion of instrumentation techniques, and error analysis for the most significant technologies used in bioheat transfer, including thermistors, thermocouples, and thermal imaging techniques.

In summary, this volume is an excellent resource for those with an interest in the measurement and characterization of temperature distributions and heat fluxes in biological tissue. Those interested in bioengineering heat-transfer subjects such as environmental exchange, artificial organ design, thermoregulation, and macroscopic problems still await a definitive work.

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Fluidization Engineering

By Kaizo Kunii and Octave Levenspiel, Butterworth-Heinemann Publisher, 491 pp., 2nd. Ed., $145 (hard cover), 1991

Fluidization in a broad sense covers a variety of fluid-particle systems in which the particles are in a moving state. It is an important operation in industry encompassing many chemical, petrochemical, metallurgical, energy and environmental process systems. For example, in the chemical industry today, significant amounts of products or intermediate products are in granular form. These products routinely undergo a variety of fluid-particle interactions, chemically or nonchemically, in the transport processes. Thus, an understanding of fluidization phenomena is essential to the successful operation of these systems.

Since its first edition in 1968, Kunii and Levenspiel's *Fluidization Engineering* has been widely adopted as the principal textbook for classroom teaching of fluidization throughout the world. It has also become a standard, important reference book for experienced practitioners in their research. It highlighted the major breakthrough by several pioneers in the 1960s on the flow structure around the bubble culminating in the authors' bubbling bed model and fluidized bed reactor analyses. Despite the notoriously complex flow structure in fluidized beds, the approach adopted in their book describing fluidization behavior was uniquely simple; yet it contained inherent concepts of this complexity, essential to characterizing the fluid and particle flows