

# Computer Compilers Ullman Sethi Aho Solution Exercises

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**High Performance Computing on Vector Systems 2005** Thomas Bönisch 2007-05-31 The book presents the state of the art in high performance computing and simulation on modern supercomputer architectures. It covers trends in hardware and software development in general and specifically the future of vector-based systems and heterogeneous architectures. The application contributions include computational fluid dynamics, physics, chemistry, astrophysics, and biology. Innovative application fields like multiphysics simulations and material science are presented.

*Handbook of Combinatorial Optimization* Ding-Zhu Du 1999-10-31 This volume can be considered as a supplementary volume to the major three-volume Handbook of Combinatorial Optimization published by Kluwer. It can also be regarded as a stand-alone volume which presents chapters dealing with various aspects of the subject including optimization problems and algorithmic approaches for discrete problems. Audience: All those who use combinatorial optimization methods to model and solve problems.

**Generic Programming** Mehdi Jazayeri 2003-06-29 This book constitutes the thoroughly refereed post-proceedings of the International Seminar on Generic Programming held in Dagstuhl Castle, Germany in April/May 1998. The 20 revised full papers were carefully reviewed for inclusion in the book. As the first book entirely devoted to the new paradigm of generic programming, this collection offers topical sections on foundations and methodology comparisons, programming methodology, language design, and applications.

*Compilers: Principles, Techniques, & Tools, 2/E* Aho 2008-09

Visual Language Theory Kim Marriott 2012-12-06 A broad-ranging survey of our current understanding of visual languages and their theoretical foundations. Its main focus is the definition, specification, and structural analysis of visual languages by grammars, logic, and algebraic methods and the use of these techniques in visual language implementation. Researchers in formal language theory, HCI, artificial intelligence, and computational linguistics will all find this an invaluable guide to the current state of research in the field.

Experimental Algorithms Joachim Gudmundsson 2014-06-09 This book constitutes the refereed proceedings of the 13th International Symposium on Experimental Algorithms, SEA 2014, held in Copenhagen, Denmark, in June/July 2014. The 36 revised full papers presented together with 3 invited presentations were carefully reviewed and selected from 81 submissions. The papers are organized in topical sections on combinatorial optimization, data structures, graph drawing, shortest path, strings, graph algorithms and suffix structures.

**Introduction to Automata Theory, Languages, and Computation** John E. Hopcroft 2014

This classic book on formal languages, automata theory, and computational complexity has been updated to present theoretical concepts in a concise and straightforward manner with the increase of hands-on, practical applications. This new edition comes with Gradiance, an online assessment tool developed for computer science. Please note, Gradiance is no longer available with this book, as we no longer support this product.

**ICT Education** Salah Kabanda 2018-12-31 This book constitutes the refereed proceedings of the 47th Annual Conference of the Southern African Computer Lecturers' Association on ICT Education, SACLA 2018, held in Gordon's Bay, South Africa, in June 2018. The 23 revised full papers presented together with an extended abstract of a keynote paper were carefully reviewed and selected from 79 submissions. The papers are organized in topical sections: playfulness, media and classrooms, academia and careers, teaching programming, adaptation and learning, teamwork and projects, learning systems, topic teaching.

**On Macintosh Programming** Daniel K. Allen 1990

**Computer Science** J. Glenn Brookshear 1994 Now in its eighth edition, this book continues to provide a comprehensive, accessible, and up-to-date introduction to the dynamic field of computer science using a breadth-first approach. The table of contents and the text itself have been revised and expanded to reflect changes in the field, including the trend toward using Web and Internet Technology, the evolution of Objects, and the important growth in the field of databases. Specifically, chapter three from the previous edition has been expanded into two chapters. Chapter three will now only cover Operating Systems and the new chapter four will focus on Networks and the Internet. Anyone interested in gaining a thorough introduction to Computer Science.

**Algorithms and Programming** Alexander Shen 2008-01-11 "Primarily intended for a first-year undergraduate course in programming"--Page 4 of cover.

*Languages and Compilers for Parallel Computing* Seventh International Workshop on Languages and Comp 1995-01-26 This volume presents revised versions of the 32 papers accepted for the Seventh Annual Workshop on Languages and Compilers for Parallel Computing, held in Ithaca, NY in August 1994. The 32 papers presented report on the leading research activities in languages and compilers for parallel computing and thus reflect the state of the art in the field. The volume is organized in sections on fine-grain parallelism, alignment and distribution, postlinear loop transformation, parallel structures, program analysis, computer communication, automatic parallelization, languages for parallelism, scheduling and program optimization, and program evaluation.

**Compiler Design: Principles, Techniques and Tools** Terence Halsey 2018-02-13 A computer program that aids the process of transforming a source code language into

another computer language is called compiler. It is used to create executable programs. Compiler design refers to the designing, planning, maintaining, and creating computer languages, by performing run-time organization, verifying code syntax, formatting outputs with respect to linkers and assemblers, and by generating efficient object codes. This book provides comprehensive insights into the field of compiler design. It aims to shed light on some of the unexplored aspects of the subject. The text includes topics which provide in-depth information about its techniques, principles and tools. This textbook is an essential guide for both academicians and those who wish to pursue this discipline further.

**Mathematical Foundations of Computer Science 2002** Krzysztof Diks 2007-10-23 This book constitutes the refereed proceedings of the 27th International Symposium on Mathematical Foundations of Computer Science, MFCS 2002, held in Warsaw, Poland in August 2002. The 48 revised full papers presented together with 5 invited papers were carefully reviewed and selected from 108 submissions. All relevant aspects of theoretical computer science are addressed, ranging from discrete mathematics, combinatorial optimization, graph theory, algorithms, and complexity to programming theory, formal methods, and mathematical logic.

**Model Driven Engineering Languages and Systems** Krzysztof Czarnecki 2008-09-22 This book constitutes the refereed proceedings of the 11th International Conference on Model Driven Engineering Languages and Systems, MoDELS 2008, held in Toulouse, France, during September 28-October 3, 2008. The 58 revised full papers presented were carefully reviewed and selected from 271 submissions. The book also contains three keynote speeches and contributions to workshops, symposia, tutorials and panels at the conference. The papers are organized in topical sections on Model Transformation: Foundations; Requirements Modeling; Domain-Specific Modeling; Model Transformation: Techniques, Composition and Analysis of Behavioral Models; Model Comprehension; Model Management; Behavioral Conformance and Refinement; Metamodeling and Modularity; Constraints; Model Analysis; Service-Oriented Architectures; Adaptive and Autonomic Systems; Empirical Studies; Evolution and Reverse Engineering; Modeling Language Semantics; Dependability Analysis and Testing; Aspect-Oriented Modeling; Structural Modeling; and Embedded Systems.

**Algorithms and Programming** Alexander Shen 2011-03-23 This text is structured in a problem-solution format that requires the student to think through the programming process. New to the second edition are additional chapters on suffix trees, games and strategies, and Huffman coding as well as an Appendix illustrating the ease of conversion from Pascal to C.

**Compilers: Principles, Techniques and Tools (for Anna University), 2/e** Alfred V. Aho 2003

**Engineering a Compiler** Keith Cooper 2011-01-18 This entirely revised second edition of *Engineering a Compiler* is full of technical updates and new material covering the latest developments in compiler technology. In this comprehensive text you will learn important techniques for constructing a modern compiler. Leading educators and researchers Keith Cooper and Linda Torczon combine basic principles with pragmatic insights from their experience building state-of-the-art compilers. They will help you fully understand important techniques such as compilation of imperative and object-oriented languages, construction of static single assignment forms, instruction scheduling, and graph-coloring register allocation. In-depth treatment of algorithms and techniques used in the front end of a modern compiler Focus on code optimization and code generation, the primary areas of recent research and development Improvements in presentation including

conceptual overviews for each chapter, summaries and review questions for sections, and prominent placement of definitions for new terms Examples drawn from several different programming languages

**Convergence and Hybrid Information Technology** Geuk Lee 2011-09-13 This book constitutes the refereed proceedings of the 5th International Conference on Convergence and Hybrid Information Technology, ICHIT 2011, held in Daejeon, Korea, in September 2011. The 94 revised full papers were carefully selected from 323 initial submissions. The papers are organized in topical sections on communications and networking, intelligent systems and applications, sensor network and cloud systems, information retrieval and scheduling, hardware and software engineering, security systems, robotics and RFID Systems, pattern recognition, image processing and clustering, data mining, as well as human computer interaction.

**Principles of Compiler Design** Aho Alfred V 1998

**Computer and Information Sciences -- ISCIS 2003** Adnan Yazici 2003-10-14 This book constitutes the refereed proceedings of the 18th International Symposium on Computer and Information Sciences, ISCIS 2003, held in Antalya, Turkey in November 2003. The 135 revised papers presented together with 2 invited papers were carefully reviewed and selected from over 360 submissions. The papers are organized in topical sections on architectures and systems, theoretical computer science, databases and information retrieval, e-commerce, graphics and computer vision, intelligent systems and robotics, multimedia, networks and security, parallel and distributed computing, soft computing, and software engineering.

**Languages and Compilers for Parallel Computing** 1994

**Advances in Optimization and Approximation** Ding-Zhu Du 2013-12-01 This book is a collection of research papers in optimization and approximation dedicated to Professor Minyi Yue of the Institute of Applied Mathematics, Beijing, China. The papers provide a broad spectrum of research on optimization problems, including scheduling, location, assignment, linear and nonlinear programming problems as well as problems in molecular biology. The emphasis of the book is on algorithmic aspects of research work in optimization. Special attention is paid to approximation algorithms, including heuristics for combinatorial approximation problems, approximation algorithms for global optimization problems, and applications of approximations in real problems. The work provides the state of the art for researchers in mathematical programming, operations research, theoretical computer science and applied mathematics.

**Theory and Practice of Cryptography Solutions for Secure Information Systems** Elçi, Atilla 2013-05-31 Information Systems (IS) are a nearly omnipresent aspect of the modern world, playing crucial roles in the fields of science and engineering, business and law, art and culture, politics and government, and many others. As such, identity theft and unauthorized access to these systems are serious concerns. *Theory and Practice of Cryptography Solutions for Secure Information Systems* explores current trends in IS security technologies, techniques, and concerns, primarily through the use of cryptographic tools to safeguard valuable information resources. This reference book serves the needs of professionals, academics, and students requiring dedicated information systems free from outside interference, as well as developers of secure IS applications. This book is part of the *Advances in Information Security, Privacy, and Ethics* series collection.

**Compiler Construction** William M. Waite 2012-12-06 Compilers and operating systems constitute the basic interfaces between a programmer and the machine for which he is developing software. In this book we are concerned with the construction of the

former. Our intent is to provide the reader with a firm theoretical basis for compiler construction and sound engineering principles for selecting alternate methods, implementing them, and integrating them into a reliable, economically viable product. The emphasis is upon a clean decomposition employing modules that can be re-used for many compilers, separation of concerns to facilitate team programming, and flexibility to accommodate hardware and system constraints. A reader should be able to understand the questions he must ask when designing a compiler for language X on machine Y, what tradeoffs are possible, and what performance might be obtained. He should not feel that any part of the design rests on whim; each decision must be based upon specific, identifiable characteristics of the source and target languages or upon design goals of the compiler. The vast majority of computer professionals will never write a compiler. Nevertheless, study of compiler technology provides important benefits for almost everyone in the field.

- It focuses attention on the basic relationships between languages and machines. Understanding of these relationships eases the inevitable transitions to new hardware and programming languages and improves a person's ability to make appropriate tradeoffs in design and implementation.

AUUGN 1992-02

**Software Verification and Analysis** Janusz Laski 2009-04-29 "The situation is good, but not hopeless" (Polish folk wisdom) The text is devoted to the Software Analysis and Testing (SAT) methods and supporting tools for assessing and, if possible, improving software quality, specifically its correctness. The term quality assurance is avoided for it is this author's firm belief that in the current state of the art that goal is unattainable, a plethora of "guaranteed" solutions to the problem notwithstanding. Therefore, the rather awkward phrase "improving correctness" is to be understood as an effort to minimize the number of residual programming faults ("bugs") and their impact on the software's behavior, that is, to make the faults tolerable. It is clear that such a minimalist approach is a result of frustration. Indeed, having spent years developing software and teaching (preaching?) "How to do it right," I still do not know how to go about it with any degree of certainty! It appears then I probably should stop right now, for who with a modicum of common sense would reach for a text that does not offer salvation but (as will be seen) hard work and misery? If I intend to continue, it is only that I suspect there are many professionals out there who have similar doubts. And they are the intended audience of this project. The philosophical underpinning of the text is the importance of sound engineering practices in software development.

Satisfiability Problem Dingzhu Du 1997-01-01 The satisfiability (SAT) problem is central in mathematical logic, computing theory, and many industrial applications. There has been a strong relationship between the theory, the algorithms, and the applications of the SAT problem. This book aims to bring together work by the best theorists, algorithmists, and practitioners working on the sat problem and on industrial applications, as well as to enhance the interaction between the three research groups. The book features the applications of theoretical/algorithmic results to practical problems and presents practical examples for theoretical/algorithmic study. Major topics covered in the book include practical and industrial SAT problems and benchmarks, significant case studies and applications of the SAT problem and SAT algorithms, new algorithms and improved techniques for satisfiability testing, specific data structures and implementation details of the SAT algorithms, and the theoretical study of the SAT problem and SAT algorithms.

Programming Languages and Systems David Sands 2003-06-29 ETAPS 2001 was the fourth instance of the European Joint Conferences on Theory and Practice of Software. ETAPS is an annual federated conference that was established in 1998 by combining a number of existing and new conferences. This year it comprised several conferences (FOSSACS, FASE, ESOP, CC, TACAS), ten satellite workshops (CMCS, ETI Day, JOSES, LDTA, MMAABS, PFM, ReMiS, UNIGRA, WADT, WTUML), seven invited lectures, a debate, and ten tutorials. The events that comprise ETAPS address various aspects of the system development process, including specification, design, implementation, analysis, and improvement. The languages, methodologies, and tools which support these activities are all well within its scope. Different blends of theory and practice are represented, with an inclination towards theory with a practical motivation on one hand and soundly-based practice on the other. Many of the issues involved in software design apply to systems in general, including hardware systems, and the emphasis on software is not intended to be exclusive.

**Introduction to Compiler Design** Torben Ægidius Mogensen 2017-10-29 The second edition of this textbook has been fully revised and adds material about loop optimisation, function call optimisation and dataflow analysis. It presents techniques for making realistic compilers for simple programming languages, using techniques that are close to those used in "real" compilers, albeit in places slightly simplified for presentation purposes. All phases required for translating a high-level language to symbolic machine language are covered, including lexing, parsing, type checking, intermediate-code generation, machine-code generation, register allocation and optimisation, interpretation is covered briefly. Aiming to be neutral with respect to implementation languages, algorithms are presented in pseudo-code rather than in any specific programming language, but suggestions are in many cases given for how these can be realised in different language flavours. Introduction to Compiler Design is intended for an introductory course in compiler design, suitable for both undergraduate and graduate courses depending on which chapters are used.

*Code Nation* Michael J. Halvorson 2020-04-22 Code Nation explores the rise of software development as a social, cultural, and technical phenomenon in American history. The movement germinated in government and university labs during the 1950s, gained momentum through corporate and counterculture experiments in the 1960s and 1970s, and became a broad-based computer literacy movement in the 1980s. As personal computing came to the fore, learning to program was transformed by a groundswell of popular enthusiasm, exciting new platforms, and an array of commercial practices that have been further amplified by distributed computing and the Internet. The resulting society can be depicted as a "Code Nation"—a globally-connected world that is saturated with computer technology and enchanted by software and its creation. Code Nation is a new history of personal computing that emphasizes the technical and business challenges that software developers faced when building applications for CP/M, MS-DOS, UNIX, Microsoft Windows, the Apple Macintosh, and other emerging platforms. It is a popular history of computing that explores the experiences of novice computer users, tinkerers, hackers, and power users, as well as the ideals and aspirations of leading computer scientists, engineers, educators, and entrepreneurs. Computer book and magazine publishers also played important, if overlooked, roles in the diffusion of new technical skills, and this book highlights their creative work and influence. Code Nation offers a "behind-the-scenes" look at application and operating-system programming practices, the diversity of historic computer languages, the rise of user communities, early attempts to market PC software, and the origins of "enterprise"

computing systems. Code samples and over 80 historic photographs support the text. The book concludes with an assessment of contemporary efforts to teach computational thinking to young people.

Programming Languages: Concepts & Constructs, 2/E Sethi 2007-09

**Modern Compiler Design** Dick Grune 2000-10-11 While focusing on the essential techniques common to all language paradigms, this book provides readers with the skills required for modern compiler construction. All the major programming types (imperative, object-oriented, functional, logic, and distributed) are covered. Practical emphasis is placed on implementation and optimization techniques, which includes tools for automating compiler design.

**Stochastic Algorithms: Foundations and Applications** Kathleen Steinhöfel 2003-07-31 SAGA 2001, the first Symposium on Stochastic Algorithms, Foundations and Applications, took place on December 13–14, 2001 in Berlin, Germany. The present volume comprises contributed papers and four invited talks that were included in the final program of the symposium. Stochastic algorithms constitute a general approach to finding approximate solutions to a wide variety of problems. Although there is no formal proof that stochastic algorithms perform better than deterministic ones, there is evidence by empirical observations that stochastic algorithms produce for a broad range of applications near-optimal solutions in a reasonable run-time. The symposium aims to provide a forum for presentation of original research in the design and analysis, experimental evaluation, and real-world application of stochastic algorithms. It focuses, in particular, on new algorithmic ideas involving stochastic decisions and exploiting probabilistic properties of the underlying problem domain. The program of the symposium reflects the effort to promote cooperation among practitioners and theoreticians and among algorithmic and complexity researchers of the field. In this context, we would like to express our special gratitude to DaimlerChrysler AG for supporting SAGA 2001. The contributed papers included in the proceedings present results in the following areas: Network and distributed algorithms; local search methods for combinatorial optimization with application to constraint satisfaction problems, manufacturing systems, motor control unit calibration, and packing flexible objects; and computational learning theory.

**The Foundations of Computability Theory** Borut Robič 2020-11-13 This book offers an original and informative view of the development of fundamental concepts of computability theory. The treatment is put into historical context, emphasizing the motivation for ideas as well as their logical and formal development. In Part I the author introduces computability theory, with chapters on the foundational crisis of mathematics in the early twentieth century, and formalism. In Part II he explains classical computability theory, with chapters on the quest for formalization, the Turing Machine, and early successes such as defining incomputable problems, c.e. (computably enumerable) sets, and developing methods for proving incomputability. In Part III he explains relative computability, with chapters on computation with external help, degrees of unsolvability, the Turing hierarchy of unsolvability, the class of degrees of unsolvability, c.e. degrees and the priority method, and the arithmetical hierarchy. Finally, in the new Part IV the author revisits the computability (Church-Turing) thesis in greater detail. He offers a systematic and detailed account of its origins, evolution, and meaning, he describes more powerful, modern versions of the thesis, and he discusses recent speculative proposals for new computing paradigms such as hypercomputing. This is a gentle introduction from the origins of computability theory up to current research, and it will be of value as a textbook and guide for

advanced undergraduate and graduate students and researchers in the domains of computability theory and theoretical computer science. This new edition is completely revised, with almost one hundred pages of new material. In particular the author applied more up-to-date, more consistent terminology, and he addressed some notational redundancies and minor errors. He developed a glossary relating to computability theory, expanded the bibliographic references with new entries, and added the new part described above and other new sections.

**Embedded Computing** Joseph A. Fisher 2005 The fact that there are more embedded computers than general-purpose computers and that we are impacted by hundreds of them every day is no longer news. What is news is that their increasing performance requirements, complexity and capabilities demand a new approach to their design. Fisher, Faraboschi, and Young describe a new age of embedded computing design, in which the processor is central, making the approach radically distinct from contemporary practices of embedded systems design. They demonstrate why it is essential to take a computing-centric and system-design approach to the traditional elements of nonprogrammable components, peripherals, interconnects and buses. These elements must be unified in a system design with high-performance processor architectures, microarchitectures and compilers, and with the compilation tools, debuggers and simulators needed for application development. In this landmark text, the authors apply their expertise in highly interdisciplinary hardware/software development and VLIW processors to illustrate this change in embedded computing. VLIW architectures have long been a popular choice in embedded systems design, and while VLIW is a running theme throughout the book, embedded computing is the core topic. Embedded Computing examines both in a book filled with fact and opinion based on the authors many years of R&D experience. · Complemented by a unique, professional-quality embedded tool-chain on the authors' website, <http://www.vliw.org/book> · Combines technical depth with real-world experience · Comprehensively explains the differences between general purpose computing systems and embedded systems at the hardware, software, tools and operating system levels. · Uses concrete examples to explain and motivate the trade-offs.

Scientific Computing and Differential Equations Gene H. Golub 2014-06-28

**Scientific Computing and Differential Equations: An Introduction to Numerical Methods**, is an excellent complement to Introduction to Numerical Methods by Ortega and Poole. The book emphasizes the importance of solving differential equations on a computer, which comprises a large part of what has come to be called scientific computing. It reviews modern scientific computing, outlines its applications, and places the subject in a larger context. This book is appropriate for upper undergraduate courses in mathematics, electrical engineering, and computer science; it is also well-suited to serve as a textbook for numerical differential equations courses at the graduate level. An introductory chapter gives an overview of scientific computing, indicating its important role in solving differential equations, and placing the subject in the larger environment. Contains an introduction to numerical methods for both ordinary and partial differential equations. Concentrates on ordinary differential equations, especially boundary-value problems. Contains most of the main topics for a first course in numerical methods, and can serve as a text for this course. Uses material for junior/senior level undergraduate courses in math and computer science plus material for numerical differential equations courses for engineering/science students at the graduate level.

**Problems and New Solutions in the Boolean Domain** Bernd Steinbach 2016-04-26 The

Internet of Things is a great new challenge for the development of digital systems. In addition to the increasing number of classical unconnected digital systems, more people are regularly using new electronic devices and software that are controllable and usable by means of the internet. All such systems utilize the elementariness of Boolean values. A Boolean variable can carry only two different Boolean values: FALSE or TRUE (0 or 1), and has the best interference resistance in technical systems. However, a Boolean function exponentially depends on the number of its variables. This exponential complexity is the cause of major problems in the process of design and realization of circuits. According to Moore's Law, the complexity of digital systems approximately doubles every 18 months. This requires comprehensive knowledge and techniques to solve complex Boolean problems. This book summarizes both new problems and solutions in the Boolean domain in solving such issues. Part 1 describes powerful new approaches in solving exceptionally complex Boolean problems. Efficient methods contribute to solving problems of extreme complexity. New algorithms and programs utilize the huge number of computing cores of the Graphical Processing Unit and improve the performance of calculations by several orders of magnitude. Part 2 represents several applications of digital systems. Due to the crucial role of the internet, both solutions and open problems regarding the security of these systems are discussed. The exploration of certain properties of such systems leads to a number of efficient solutions, which can be reused in a wide field of applications. Part 3 discusses the scientific basis of future circuit technologies, investigating the need for completely new design methods for the atomic level of quantum computers. This part also concerns itself with reversible circuits as the basis for quantum circuits and specifies important issues regarding future improvements.

*Matrix Algorithms* G. W. Stewart 1998-08-01 This volume is the first in a self-contained five-volume series devoted to matrix algorithms. It focuses on the

computation of matrix decompositions--that is, the factorization of matrices into products of similar ones. The first two chapters provide the required background from mathematics and computer science needed to work effectively in matrix computations. The remaining chapters are devoted to the LU and QR decompositions--their computation and applications. The singular value decomposition is also treated, although algorithms for its computation will appear in the second volume of the series. The present volume contains 65 algorithms formally presented in pseudocode. Other volumes in the series will treat eigensystems, iterative methods, sparse matrices, and structured problems. The series is aimed at the nonspecialist who needs more than black-box proficiency with matrix computations. To give the series focus, the emphasis is on algorithms, their derivation, and their analysis. The reader is assumed to have a knowledge of elementary analysis and linear algebra and a reasonable amount of programming experience, typically that of the beginning graduate engineer or the undergraduate in an honors program. Strictly speaking, the individual volumes are not textbooks, although they are intended to teach, the guiding principle being that if something is worth explaining, it is worth explaining fully. This has necessarily restricted the scope of the series, but the selection of topics should give the reader a sound basis for further study.

**Modern Compiler Design** Dick Grune 2012-07-20 "Modern Compiler Design" makes the topic of compiler design more accessible by focusing on principles and techniques of wide application. By carefully distinguishing between the essential (material that has a high chance of being useful) and the incidental (material that will be of benefit only in exceptional cases) much useful information was packed in this comprehensive volume. The student who has finished this book can expect to understand the workings of and add to a language processor for each of the modern paradigms, and be able to read the literature on how to proceed. The first provides a firm basis, the second potential for growth.