

Algebraic Specification

- An algebra is specified by giving a *sort* (this is the name of a set), and a set of *signatures* (this is a set of function specifications).
- For example, think of a simple algebra for arithmetic with addition and subtraction:
 $\langle S, \{+ : S \times S \rightarrow S, - : S \times S \rightarrow S\} \rangle$
- The specification of an algebra is an abstract entity. We can create and associate a particular algebra with the specification by associating a set (called the *carrier set*) with the sort and a specific function with each operator symbol in the signatures.
- Properties of any particular algebra (or *model* of an algebra) are specified by giving axioms such as
 $-(+(x,y),y)=x$

Algebraic Specification

Michel Bidoit



Algebraic Specification:

Algebraic Specifications in Software Engineering Ivo Van Horebeek, Johan Lewi, 2012-12-06 I prefer to view formal methods as tools the use of which might be helpful E W Dijkstra Algebraic specifications are about to be accepted by industry Many projects in which algebraic specifications have been used as a design tool have been carried out What prevents algebraic specifications from breaking through is the absence of introductory descriptions and tools supporting the construction of algebraic specifications On the one hand interest from industry will stimulate people to make introductions and tools whereas on the other hand the existence of introductions and tools will stimulate industry to use algebraic specifications This book should be seen as a contribution towards creating this virtuous circle The book will be of interest to software designers and programmers It can also be used as material for an introductory course on algebraic specifications and software engineering at undergraduate or graduate level Nowadays there is general agreement that in large software projects appropriate specifications are a must in order to obtain quality software Informal specifications alone are certainly not appropriate because they are incomplete inconsistent inaccurate and ambiguous and they rapidly become bulky and therefore useless The only way to overcome this problem is to use formal specifications An important remark here is that a specification formalism language alone is not sufficient What is also needed is a design method to write specifications in that formalism

Algebraic System Specification and Development Michel Bidoit, 1991-06-26 Methods for the algebraic specification of abstract data types were proposed in the early 1970s in the USA and Canada and became a major research issue in Europe shortly afterwards Since then the algebraic approach has come to play a central role in research on formal specification and development as its range of applications was extended to the specification of complete software systems to the formal description of the program development process and to the uniform definition of syntax and semantics of programming languages Today this approach extends beyond just software to the development of integrated hardware and software systems These flourishing activities in the area of algebraic specifications have led to an abundance of approaches theories and concepts which have universal algebra category theory and logic as a common mathematical basis This volume is an annotated bibliography which provides an up to date overview of past and present work on algebraic specification No attempt is made to provide a coherent introduction to the topic for beginners the intention is rather to provide a guide to the current literature for researchers in algebraic specification and neighboring fields Some indications of how the different approaches are related are included together with some ideas concerning possible future directions

Foundations of Algebraic Specification and Formal Software Development Donald Sannella, Andrzej Tarlecki, 2012-01-05 This book provides foundations for software specification and formal software development from the perspective of work on algebraic specification concentrating on developing basic concepts and studying their fundamental properties These foundations are built on a solid mathematical basis using elements of universal algebra category theory and logic and this mathematical

toolbox provides a convenient language for precisely formulating the concepts involved in software specification and development. Once formally defined, these notions become subject to mathematical investigation, and this interplay between mathematics and software engineering yields results that are mathematically interesting, conceptually revealing, and practically useful. The theory presented by the authors has its origins in work on algebraic specifications that started in the early 1970s, and their treatment is comprehensive. This book contains five kinds of material: the requisite mathematical foundations, traditional algebraic specifications, elements of the theory of institutions, formal specification and development, and proof methods. While the book is self-contained, mathematical maturity and familiarity with the problems of software engineering is required, and in the examples that directly relate to programming, the authors assume acquaintance with the concepts of functional programming. The book will be of value to researchers and advanced graduate students in the areas of programming and theoretical computer science.

Fundamentals of Algebraic Specification 1 Hartmut Ehrig, Bernd Mahr, 2012-12-06. The aim of this book is to present fundamentals of algebraic specifications with respect to the following three aspects: fundamentals in the sense of a carefully motivated introduction to algebraic specifications which is easy to understand for computer scientists and mathematicians; fundamentals in the sense of mathematical theories which are the basis for precise definitions, constructions, results, and correctness proofs; and fundamentals in the sense of concepts which are introduced on a conceptual level and formalized in mathematical terms. The book is equally suitable as a text book for graduate courses and as a reference for researchers and system developers.

Fundamentals of Algebraic Specification 2 Hartmut Ehrig, Bernd Mahr, 1989-12-28. Since the early seventies, concepts of specification have become central in the whole area of computer science. Especially algebraic specification techniques for abstract data types and software systems have gained considerable importance in recent years. They have not only played a central role in the theory of data type specification but meanwhile have had a remarkable influence on programming language design, system architectures, and software tools and environments. The fundamentals of algebraic specification lay a basis for teaching, research, and development in all those fields of computer science where algebraic techniques are the subject or are used with advantage on a conceptual level. Such a basis, however, we do not regard to be a synopsis of all the different approaches and achievements but rather a consistently developed theory. Such a theory should mainly emphasize elaboration of basic concepts from one point of view and in a rigorous way reach the state of the art in the field. We understand fundamentals in this context as:

1. Fundamentals in the sense of a carefully motivated introduction to algebraic specification which is understandable for computer scientists and mathematicians.
2. Fundamentals in the sense of mathematical theories which are the basis for precise definitions, constructions, results, and correctness proofs.
3. Fundamentals in the sense of concepts from computer science which are introduced on a conceptual level and formalized in mathematical terms.

Algebraic Specification Techniques and Tools for Software Development Ingo Classen, Hartmut Ehrig, Dietmar Wolz, 1993. The

intention of this book is to show how algebraic specification methods can be used for software development to support reliability modifiability and reusability These methods are introduced by parameterized and module specifications through practical examples and case studies using algebraic specification languages and tools developed at TU Berlin

Fundamentals of Algebraic Specification 1 Hartmut Ehrig, Bernd Mahr, 1985-03-01 The aim of this book is to present fundamentals of algebraic specifications with respect to the following three aspects fundamentals in the sense of a carefully motivated introduction to algebraic specifications which is easy to understand for computer scientists and mathematicians fundamentals in the sense of mathematical theories which are the basis for precise definitions constructions results and correctness proofs and fundamentals in the sense of concepts which are introduced on a conceptual level and formalized in mathematical terms The book is equally suitable as a text book for graduate courses and as a reference for researchers and system developers

Algebraic Foundations of Systems Specification Egidio Astesiano, Hans-Jörg Kreowski, Bernd Krieg-Brückner, 2012-12-06 The aim of software engineering is the provision and investigation of methods for the development of software systems of high quality with correctness as a key issue A system is called correct if it does what one wants if it meets the requirements To achieve and to guarantee correct systems the need of formal methods with rigorous semantics and the possibility of verification is widely accepted Algebraic specification is a software engineering approach of this perspective When Liskov and Zilles Guttag and the ADJ group with Goguen Thatcher Wagner and Wright introduced the basic ideas of algebraic specification in the mid seventies in the U S A and Canada they initiated a very successful and still flourishing new area In the late seventies algebraic specification became a major research topic also in many European countries Originally the algebraic framework was intended for the mathematical foundation of abstract data types and the formal development of first order applicative programs Meanwhile the range of applications has been extended to the precise specification of complete software systems the uniform definition of syntax and semantics of programming languages and to the stepwise development of correct systems from the requirement definitions to the running programs The activities in the last 25 years have led to an abundance of concepts methods approaches theories languages and tools which are mathematically founded in universal algebra category theory and logic

Algebraic Specification J. A. Bergstra, J. Heering, Paul Klint, 1989 This book brings together recent research work on algebraic specification AS which aims to provide formal techniques for the specification and prototyping of software

Algebraic Specification J. A. Bergstra, J. Heering, Paul Klint, 1989 This book brings together recent research work on algebraic specification AS which aims to provide formal techniques for the specification and prototyping of software

Algebraic Specification of Information Systems Erkki Karimaa, 1995 Finnish summary

The Construction of Formal Specifications John G. Turner, T. Lee McCluskey, 1994 Introducing two widely used approaches to the formal specification of software systems this book considers VDM and the algebraic approach In each case the emphasis is intuitive rather than mathematical and shows the reader how to construct a

formal specification from the first principles by using general procedures that can be followed each time Familiar applications are referred to throughout and examples small case studies and problems accompany each chapter The two approaches are brought together in one large joint case study at the end of the book as well as a section comparing and contrasting them *Machine Support for Behavioral Algebraic Specification and Verification* Kai Lin,2003

Bibliography on Abstract Data Types B. Kutzler,F. Lichtenberger,2012-12-06 Sponsored by the sterr Fonds zur Förderung der Wissenschaftlichen Forschung project nr P4567 *Algebraic Foundations of Systems Specification* Hans-Jörg Kreowski,1999-08-19 This IFIP report is a collection of fundamental high quality contributions on the algebraic foundations of system specification The contributions cover and survey active topics and recent advances and address such subjects as the role of formal specification algebraic preliminaries partiality institutions specification semantics structuring refinement specification languages term rewriting deduction and proof systems object specification concurrency and the development process The authors are well known experts in the field and the book is the result of IFIP WG 1.3 in cooperation with Esprit Basic Research WG COMPASS and provides the foundations of the algebraic specification language CASL designed in the CoFI project For students researchers and system developers *Fundamentals of Algebraic Specification* Hartmut Ehrig,Bernd Mahr,1985 *Software Engineering with OBJ* Joseph A. Goguen,Grant Malcolm,2013-11-11 Software Engineering with OBJ Algebraic Specification in Action is a comprehensive introduction to OBJ the most widely used algebraic specification system As a formal specification language OBJ makes specifications and designs more precise and easier to read as well as making maintenance easier and more accurate OBJ differs from most other specification languages not just in having a formal semantics but in being executable either through symbolic execution with term rewriting or more generally through theorem proving One problem with specifications is that they are often wrong OBJ can help validate specifications by executing test cases and by proving properties As well as providing a detailed introduction to the language and the OBJ system that implements it Software Engineering with OBJ Algebraic Specification in Action provides case studies by leading practitioners in the field in areas such as computer graphics standards hardware design and parallel computation The case studies demonstrate that OBJ can be used in a wide variety of ways to achieve a wide variety of practical aims in the system development process The papers on various OBJ systems also demonstrate that the language is relatively easy to understand implement and use and that it supports formal reasoning in a straightforward but powerful way Software Engineering with OBJ Algebraic Specification in Action will be of interest to students and teachers in the areas of data types programming languages semantics theorem proving and algebra as well as to researchers and practitioners in software engineering **Nondeterminism in Algebraic Specifications and Algebraic Programs** Hussmann,2013-03-08 Algebraic specification nondeterminism and term rewriting are three active research areas aiming at concepts for the abstract description of software systems Algebraic specifications are well suited for describing data structures and sequential

software systems in an abstract way Term rewriting methods are used in many prototyping systems and form the basis for executing specifications Nondeterminism plays a major role in formal language theory in programming it serves for delaying design decisions in program development and occurs in a natural way in formalisations of distributed processes Heinrich Hussmann presents an elegant extension of equational specification and term rewriting to include nondeterminism Based on a clean modeltheoretic semantics he considers term rewriting systems without confluence restrictions as a specification language and shows that fundamental properties such as the existence of initial models or the soundness and completeness of narrowing the basic mechanism for executing equational specifications can be extended to nondeterministic computations The work of Heinrich Hussmann is an excellent contribution to Algebraic Programming it gives a framework that admits a direct approach to program verification is suitable for describing concurrent and distributed processes and it can be executed as fast as Prolog

Algebraic Specification Techniques in Object Oriented Programming Environments Ruth Breu,1991-12-04 The main aim of this monograph is to provide a framework for the integrated design of object oriented programs with algebraic specification techniques The design method pursued relies fundamentally on the structuring of systems based on the notion of data types Depending on the level of abstraction data types are described in an object oriented way by algebraic specifications or by machine executable object oriented programs The treatment involves two main aspects First object oriented programs have to be related by a notion of correctness that models the transition from specifications to program implementations The author presents a notion of correctness which relies on the idea of abstraction functions Second in order to obtain an integrated design environment a uniform structuring concept for object oriented programs and algebraic specifications has to be provided Inheritance subtyping and clientship are three central notions of object oriented structuring Theauthor uses them to develop the kernel of a typed object oriented programming language The monograph provides the formal foundation for a unified framework of algebraic specifications and object oriented programs A major guideline is the development of a design method supporting the structured design and reuse of software in this environment

Algebraic Specification Yellamraju Venkata Srinivas,1990

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