

# Computability

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## ◆ Definition

Function  $f$  is computable if some program  $P$  computes it:  
For any input  $x$ , the computation  $P(x)$  halts with output  $f(x)$

## ◆ Terminology

Partial recursive functions

= partial functions (int to int) that are computable

# Computable Functions

**Richard L. Epstein**



## **Computable Functions:**

**Computable Functions** Nikolai Konstantinovich Vereshchagin, Alexander Shen, 2003 Based on the lectures for undergraduates at Moscow State University this book presents a lively and concise introduction to the central facts and basic notions of the general theory of computation It begins with the definition of a computable function and an algorithm and discusses decidability enumerability universal functions numberings and their properties the fixed point theorem arithmetical hierarchy oracle computations and degrees

*Computability* Richard L. Epstein, Walter A. Carnielli, 2018-10-24 Now in a new edition the classic presentation of the theory of computable functions in the context of the foundations of mathematics Part I motivates the study of computability with discussions and readings about the crisis in the foundations of mathematics in the early 20th century while presenting the basic ideas of whole number function proof and real number Part II starts with readings from Turing and Post leading to the formal theory of recursive functions Part III presents sufficient formal logic to give a full development of Gödel's incompleteness theorems Part IV considers the significance of the technical work with a discussion of Church's Thesis and readings on the foundations of mathematics This new edition contains the timeline

*Computability and Undecidability* as well as the essay *On mathematics*

*Computability* Nigel Cutland, 1980-06-19 What can computers do in principle What are their inherent theoretical limitations These are questions to which computer scientists must address themselves The theoretical framework which enables such questions to be answered has been developed over the last fifty years from the idea of a computable function intuitively a function whose values can be calculated in an effective or automatic way This book is an introduction to computability theory or recursion theory as it is traditionally known to mathematicians Dr Cutland begins with a mathematical characterisation of computable functions using a simple idealised computer a register machine after some comparison with other characterisations he develops the mathematical theory including a full discussion of non computability and undecidability and the theory of recursive and recursively enumerable sets The later chapters provide an introduction to more advanced topics such as Gödel's incompleteness theorem degrees of unsolvability the Recursion theorems and the theory of complexity of computation Computability is thus a branch of mathematics which is of relevance also to computer scientists and philosophers Mathematics students with no prior knowledge of the subject and computer science students who wish to supplement their practical expertise with some theoretical background will find this book of use and interest

**Computability** Douglas S. Bridges, 1994-01-14

*Computability A Mathematical Sketchbook* is a concise rigorous introduction to the theory of computation Using Turing machines as models of computers the author develops major themes of computability theory culminating in a systematic account of Blum's abstract complexity measures One of the book's unique aspects is the inclusion of a chapter on computable real numbers and elementary computable analysis Exercises and solutions form an integral part of the material The book is suitable for self study and provides excellent course materials for senior and graduate level students in mathematics and

computer science     Introduction to Computability Frederick C. Hennie,1977     **Computability and Logic** Daniel E. Cohen,1987     Computability & Unsolvability Martin Davis,1982-01-01 Classic graduate level introduction to theory of computability Discusses general theory of computability computable functions operations on computable functions Turing machines self applied unsolvable decision problems applications of general theory mathematical logic Kleene hierarchy more

**Computability** Klaus Weihrauch,2012-12-06 Intends to lay a common basis for the different branches of recursion theory Leads from the very basic theory to modern concepts of computability Consists of three consecutive parts 1 Basic Concepts of Computability 2 Traditional Recursion Theory 3 Unified Type 2 theory of constructivity and computability on Baire s space including a general theory of representations     *Computability Theory* Rebecca Weber,2012 What can we compute even with unlimited resources Is everything within reach Or are computations necessarily drastically limited not just in practice but theoretically These questions are at the heart of computability theory The goal of this book is to give the reader a firm grounding in the fundamentals of computability theory and an overview of currently active areas of research such as reverse mathematics and algorithmic randomness Turing machines and partial recursive functions are explored in detail and vital tools and concepts including coding uniformity and diagonalization are described explicitly From there the material continues with universal machines the halting problem parametrization and the recursion theorem and thence to computability for sets enumerability and Turing reduction and degrees A few more advanced topics round out the book before the chapter on areas of research The text is designed to be self contained with an entire chapter of preliminary material including relations recursion induction and logical and set notation and operators That background along with ample explanation examples exercises and suggestions for further reading make this book ideal for independent study or courses with few prerequisites     Computability Theory Neil D. Jones,2014-06-20 *Computability Theory An Introduction* provides information pertinent to the major concepts constructions and theorems of the elementary theory of computability of recursive functions This book provides mathematical evidence for the validity of the Church Turing thesis Organized into six chapters this book begins with an overview of the concept of effective process so that a clear understanding of the effective computability of partial and total functions is obtained This text then introduces a formal development of the equivalence of Turing machine computability enumerability and decidability with other formulations Other chapters consider the formulas of the predicate calculus systems of recursion equations and Post s production systems This book discusses as well the fundamental properties of the partial recursive functions and the recursively enumerable sets The final chapter deals with different formulations of the basic ideas of computability that are equivalent to Turing computability This book is a valuable resource for undergraduate or graduate students     **Enumerability, Decidability, Computability** Hans Hermes,2013-03-14 The task of developing algorithms to solve problems has always been considered by mathematicians to be an especially interesting and important one Normally an algorithm is applicable only to a narrowly limited group of

problems Such is for instance the Euclidean algorithm which determines the greatest common divisor of two numbers or the well known procedure which is used to obtain the square root of a natural number in decimal notation The more important these special algorithms are all the more desirable it seems to have algorithms of a greater range of applicability at one s disposal Throughout the centuries attempts to provide algorithms applicable as widely as possible were rather unsuccessful It was only in the second half of the last century that the first appreciable advance took place Namely an important group of the inferences of the logic of predicates was given in the form of a calculus Here the Boolean algebra played an essential pioneer role One could now perhaps have conjectured that all mathematical problems are solvable by algorithms However well known yet unsolved problems problems like the word problem of group theory or Hilbert s tenth problem which considers the question of solvability of Diophantine equations were warnings to be careful Nevertheless the impulse had been given to search for the essence of algorithms Leibniz already had inquired into this problem but without success

**Theories of Computability** Nicholas Pippenger,1997-05-28 This book gives an introduction to theories of computability from a mathematically sophisticated point of view It treats not only the theory of computability created by Alan Turing and others in the 1930s but also a variety of other theories of Boolean functions automata and formal languages These are addressed from the classical perspective of their generation by grammars and from the modern perspective as rational cones The treatment of the classical theory of computable functions and relations takes the form of a tour through basic recursive function theory starting with an axiomatic foundation and developing the essential methods in order to survey the most memorable results of the field This authoritative account by one of the leading lights of the subject will prove exceptionally useful reading for graduate students and researchers in theoretical computer science and mathematics *Computability : Computable Functions Logic and the Foundations of Math* Richard L. Epstein,1989-11-09 An introduction to recursion theory and particularly to the theory of computing including fourteen readings by Hilbert Godel Turing Post Church and others along with a discussion of issues such as self reference and infinite sets Annotation copyrighted by Book News Inc Portland OR *Computability* George Tourlakis,2022-08-02 This survey of computability theory offers the techniques and tools that computer scientists as well as mathematicians and philosophers studying the mathematical foundations of computing need to mathematically analyze computational processes and investigate the theoretical limitations of computing Beginning with an introduction to the mathematisation of mechanical process using URM programs this textbook explains basic theory such as primitive recursive functions and predicates and sequence coding partial recursive functions and predicates and loop programs Advanced chapters cover the Ackerman function Tarski s theorem on the non representability of truth Goedel s incompleteness and Rosser s incompleteness theorems two short proofs of the incompleteness theorem that are based on Lob s deliverability conditions Church s thesis the second recursion theorem and applications a provably recursive universal function for the primitive recursive functions Oracle computations and various classes of computable functionals the

Arithmetical hierarchy Turing reducibility and Turing degrees and the priority method a thorough exposition of various versions of the first recursive theorem Blum s complexity Hierarchies of primitive recursive functions and a machine independent characterisation of Cobham s feasibly computable functions      **Enumerability · Decidability Computability**

Hans Hermes,2012-12-06 Once we have accepted a precise replacement of the concept of algorithm it becomes possible to attempt the problem whether there exist well defined collections of problems which cannot be handled by algorithms and if that is the case to give concrete cases of this kind Many such investigations were carried out during the last few decades The undecidability of arithmetic and other mathematical theories was shown further the unsolvability of the word problem of group theory Many mathematicians consider these results and the theory on which they are based to be the most characteristic achievements of mathematics in the first half of the twentieth century If we grant the legitimacy of the suggested precise replacements of the concept of algorithm and related concepts then we can say that the mathematicians have shown by strictly mathematical methods that there exist mathematical problems which cannot be dealt with by the methods of calculating mathematics In view of the important role which mathematics plays today in our conception of the world this fact is of great philosophical interest Post speaks of a natural law about the limitations of the mathematicizing power of Homo Sapiens Here we also find a starting point for the discussion of the question what the actual creative activity of the mathematician consists in In this book we shall give an introduction to the theory of algorithms      *Handbook of Computability and Complexity in Analysis* Vasco Brattka,Peter Hertling,2021-06-04 Computable analysis is the modern theory of computability and complexity in analysis that arose out of Turing s seminal work in the 1930s This was motivated by questions such as which real numbers and real number functions are computable and which mathematical tasks in analysis can be solved by algorithmic means Nowadays this theory has many different facets that embrace topics from computability theory algorithmic randomness computational complexity dynamical systems fractals and analog computers up to logic descriptive set theory constructivism and reverse mathematics In recent decades computable analysis has invaded many branches of analysis and researchers have studied computability and complexity questions arising from real and complex analysis functional analysis and the theory of differential equations up to geometric measure theory and topology This handbook represents the first coherent cross section through most active research topics on the more theoretical side of the field It contains 11 chapters grouped into parts on computability in analysis complexity dynamics and randomness and constructivity logic and descriptive complexity All chapters are written by leading experts working at the cutting edge of the respective topic Researchers and graduate students in the areas of theoretical computer science and mathematical logic will find systematic introductions into many branches of computable analysis and a wealth of information and references that will help them to navigate the modern research literature in this field      Computability and Complexity in Analysis Jens Blanck,Vasco Brattka,Peter Hertling,2003-06-29 The workshop on Computability and Complexity in Analysis CCA 2000 was

hosted by the Department of Computer Science of the University of Wales Swansea September 17 19 2000 It was the fourth workshop in a successful series of workshops CCA 95 in Hagen Germany CCA 96 in Trier Germany and CCA 98 in Brno Czech Republic About 40 participants from the countries United Kingdom Germany Japan Italy Russia France Denmark Greece and Ireland contributed to the success of this meeting Altogether 28 talks were presented in Swansea These proceedings include 23 papers which represent a cross section through recent research on computability and complexity in analysis The workshop succeeded in bringing together people interested in computability and complexity aspects of analysis and in exploring connections with numerical methods physics and of course computer science It was rounded off by a number of talks and papers on exact computer arithmetic and by a competition of various implemented systems A report on this competition has been included in these proceedings We would like to thank the authors for their contributions and the referees for their careful work and we hope for further inspiring and constructive meetings of the same kind April 2001 Jens Blanck Vasco Brattka Peter Hertling Organization CCA2000 was hosted by the Department of Computer Science of the University of Wales Swansea and took place on September 17 19 2000

**Provability, Computability and Reflection** Lev D. Beklemishev, 2000-04-01 Provability Computability and Reflection Turing Computability Robert I. Soare, 2016-06-20 Turing's famous 1936 paper introduced a formal definition of a computing machine a Turing machine This model led to both the development of actual computers and to computability theory the study of what machines can and cannot compute This book presents classical computability theory from Turing and Post to current results and methods and their use in studying the information content of algebraic structures models and their relation to Peano arithmetic The author presents the subject as an art to be practiced and an art in the aesthetic sense of inherent beauty which all mathematicians recognize in their subject Part I gives a thorough development of the foundations of computability from the definition of Turing machines up to finite injury priority arguments Key topics include relative computability and computably enumerable sets those which can be effectively listed but not necessarily effectively decided such as the theorems of Peano arithmetic Part II includes the study of computably open and closed sets of reals and basis and nonbasis theorems for effectively closed sets Part III covers minimal Turing degrees Part IV is an introduction to games and their use in proving theorems Finally Part V offers a short history of computability theory The author has honed the content over decades according to feedback from students lecturers and researchers around the world Most chapters include exercises and the material is carefully structured according to importance and difficulty The book is suitable for advanced undergraduate and graduate students in computer science and mathematics and researchers engaged with computability and mathematical logic Extending and Refining Hierarchies of Computable Functions Robert L. Constable, 1968

Embark on a transformative journey with Written by is captivating work, **Computable Functions** . This enlightening ebook, available for download in a convenient PDF format PDF Size: , invites you to explore a world of boundless knowledge. Unleash your intellectual curiosity and discover the power of words as you dive into this riveting creation. Download now and elevate your reading experience to new heights .

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