Foundations of Computing Series

Resource Allocation Problems

Algorithmic Approaches

Toshihide Ibaraki and Naoki Katoh

The MIT Press

Resource Allocation Problems Algorithmic Approaches

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Resource Allocation Problems Algorithmic Approaches:

Resource Allocation Problems Toshihide Ibaraki,Naoki Katoh,1988 This book addresses a theoretical problem encountered in a variety of areas in operations research and management science including load distribution production planning computer scheduling portfolio selection and apportionment It is a timely and comprehensive summary of the past thirty years of research on algorithmic aspects of the resource allocation problem and its variants covering Lagrangean multiplier method dynamic programming greedy algorithms and their generalizations Modern data structures are used to analyze the computational complexity of each algorithm The resource allocation problem the authors take up is an optimization problem with a single simple constraint it determines the allocation of a fixed amount of resources to a given number of activities in order to achieve the most effective results It may be viewed as a special case of the nonlinear programming or nonlinear integer programming problem Contents Introduction Resource Allocation with Continuous Variables Resource Allocation with Integer Variables Minimizing a Convex Separable Function Minimax and Maximin Resource Allocation Problems Fair Resource Allocation Problem Apportionment Problem Fundamentals of Submodular Systems Resource Allocation Problems under Submodular Constraints Further Topics on Resource Allocation Problems Appendixes Algorithms and Complexity NP completeness and NP hardness Toshihide lbaraki is Professor in the Department of Applied Mathematics and Physics at Kyoto University and Naoki Katoh is Associate Professor in the Department of Management Science at Kobe University of Commerce Resource Allocation Problemsis included in the Foundations of Computing Series edited by Michael Garey and Albert Meyer **Equitable Resource Allocation** Hanan Luss,2012-09-11 A unique book that specifically addresses equitable resource allocation problems with applications in communication networks manufacturing emergency services and more Resource allocation problems focus on assigning limited resources in an economically beneficial way among competing activities Solutions to such problems affect people and everyday activities with significant impact on the private and public sectors and on society at large Using diverse application areas as examples Equitable Resource Allocation Models Algorithms and Applications provides readers with great insight into a topic that is not widely known in the field Starting with an overview of the topics covered the book presents a large variety of resource allocation models with special mathematical structures and provides elegant efficient algorithms that compute optimal solutions to these models Authored by one of the leading researchers in the field Equitable Resource Allocation Is the only book that provides a comprehensive exposition of equitable resource allocation problems Presents a collection of resource allocation models with applications in communication networks transportation content distribution manufacturing emergency services and more Exhibits practical algorithms for solving a variety of resource allocation models Uses real world applications and examples to explain important concepts Includes end of chapter exercises Bringing together much of the equitable resource allocation research from the past thirty years this book is a valuable reference for anyone interested in

solving diverse optimization problems Algorithmic aspects of resource allocation and multiwinner voting: theory and experiments Kaczmarczyk, Andrzej,2021-12-10 This thesis is concerned with investigating elements of computational social choice in the light of real world applications We contribute to a better understanding of the areas of fair allocation and multiwinner voting For both areas inspired by real world scenarios we propose several new notions and extensions of existing models Then we analyze the complexity of answering the computational questions raised by the introduced concepts To this end we look through the lens of parameterized complexity We identify different parameters which describe natural features specific to the computational problems we investigate Exploiting the parameters we successfully develop efficient algorithms for spe cific cases of the studied problems We complement our analysis by showing which parameters presumably cannot be utilized for seeking efficient algorithms Thereby we provide comprehensive pictures of the computational complexity of the studied problems Specifically we concentrate on four topics that we present below grouped by our two areas of interest For all but one topic we present experimental studies based on implementations of newly developed algorithms We first focus on fair allocation of indivisible resources In this setting we consider a collection of indivisible resources and a group of agents Each agent reports its utility evaluation of every resource and the task is to fairly allocate the resources such that each resource is allocated to at most one agent We concentrate on the two following issues regarding this scenario The social context in fair allocation of indivisible resources In many fair allocation settings it is unlikely that every agent knows all other agents For example consider a scenario where the agents represent employees of a large corporation It is highly unlikely that every employee knows every other employee Motivated by such settings we come up with a new model of graph envy freeness by adapting the classical envy freeness notion to account for social relations of agents modeled as social networks We show that if the given social network of agents is simple for example if it is a directed acyclic graph then indeed we can sometimes find fair allocations efficiently However we contrast tractability results with showing NP hardness for several cases including those in which the given social network has a constant degree Fair allocations among few agents with bounded rationality Bounded rationality is the idea that humans due to cognitive limitations tend to simplify problems that they face One of its emanations is that human agents usually tend to report simple utilities over the resources that they want to allocate for example agents may categorize the available resources only into two groups of desirable and undesirable ones Applying techniques for solving integer linear programs we show that exploiting bounded rationality leads to efficient algorithms for finding envy free and Pareto efficient allocations assuming a small number of agents Further we demonstrate that our result actually forms a framework that can be applied to a number of different fairness concepts like envy freeness up to one good or envy freeness up to any good This way we obtain efficient algorithms for a number of fair allocation problems assuming few agents with bounded rationality We also empirically show that our technique is applicable in practice Further we study multiwinner voting where we are given a collection of voters

and their preferences over a set of candidates The outcome of a multiwinner voting rule is a group or a set of groups in case of ties of candidates that reflect the voters preferences best according to some objective In this context we investigate the following themes The robustness of election outcomes We study how robust outcomes of multiwinner elections are against possible mistakes made by voters Assuming that each voter casts a ballot in a form of a ranking of candidates we represent a mistake by a swap of adjacent candidates in a ballot We find that for rules such as SNTV k Approval and k Borda it is computationally easy to find the minimum number of swaps resulting in a change of an outcome This task is however NP hard for STV and the Chamberlin Courant rule We conclude our study of robustness with experimentally studying the average number of random swaps leading to a change of an outcome for several rules Strategic voting in multiwinner elections We ask whether a given group of cooperating voters can manipulate an election outcome in a favorable way We focus on the k Approval voting rule and we show that the computational complexity of answering the posed question has a rich structure We spot several cases for which our problem is polynomial time solvable However we also identify NP hard cases For several of them we show how to circumvent the hardness by fixed parameter tractability We also present experimental studies indicating that our algorithms are applicable in practice Diese Arbeit befasst sich mit der Untersuchung von Themen des Forschungsgebiets Computational Social Choice im Lichte realer Anwendungen Dabei tr gt sie zu einem besseren Verst ndnis der Bereiche der fairen Zuordnung und der Mehrgewinnerwahlen bei F r beide Konzepte schlagen wir inspiriert von realen Anwendungen verschiedene neue Begriffe und Erweiterungen bestehender Modelle vor Anschlie end analysieren wir die Komplexit t der Beantwortung von Berechnungsfragen die durch die eingef hrten Konzepte aufgeworfen werden Dabei fokussieren wir uns auf die parametrisierte Komplexit t Hierzu identifizieren wir verschiedene Parameter welche nat rliche Merkmale der von uns untersuchten Berechnungsprobleme beschreiben Durch die Nutzung dieser Parameter entwickeln wir erfolgreich effiziente Algorithmen f r Spezialf lle der untersuchten Probleme Wir erg nzen unsere Analyse indem wir zeigen welche Parameter vermutlich nicht verwendet werden k nnen um effiziente Algorithmen zu finden Dabei zeichnen wir ein umfassendes Bild der Berechnungskomplexit t der untersuchten Probleme Insbesondere konzentrieren wir uns auf vier Themen die wir gruppiert nach unseren beiden Schwerpunkten unten vorstellen F r alle Themen bis auf eines pr sentieren wir Experimente die auf Implementierungen der von uns neu entwickelten Algorithmen basieren Wir konzentrieren uns zun chst auf die faire Zuordnung unteilbarer Ressourcen Hier betrachten wir eine Menge unteilbarer Ressourcen und eine Gruppe von Agenten Jeder Agent gibt eine Bewertung des Nutzens jeder Ressource ab und die Aufgabe besteht darin eine faire Zuordnung der Ressourcen zu finden wobei jede Ressource h chstens einem Agenten zugeordnet werden kann Innerhalb dieses Bereiches konzentrieren wir uns auf die beiden folgenden Problemstellungen Der soziale Kontext bei der fairen Zuordnung unteilbarer Ressourcen In vielen Szenarien in denen Ressourcen zugeordnet werden sollen ist es unwahrscheinlich dass jeder Agent alle anderen kennt Vorstellbar ist beispielsweise ein Szenario in dem

die Agenten Mitarbeiter eines gro en Unternehmens repr sentieren Es ist h chst unwahrscheinlich dass jeder Mitarbeiter jeden anderen Mitarbeiter kennt Motiviert durch solche Szenarien entwickeln wir ein neues Modell der graph basierten Neidfreiheit Wir erweitern den klassischen Neidfreiheitsbegriff um die sozialen Beziehungen von Agenten die durch soziale Netzwerke modelliert werden Einerseits zeigen wir dass wenn das soziale Netzwerk der Agenten einfach ist zum Beispiel wenn es sich um einen gerichteten azyklischen Graph handelt in manchen F llen faire Zuordnungen effizient gefunden werden k nnen Andererseits stellen wir diesen algorithmisch positiven Ergebnissen mehrere NP schweren F llen entgegen Ein Beispiel f r einen solchen Fall sind soziale Netzwerke mit einem konstanten Knotengrad Faire Zuteilung an wenige Agenten mit begrenzter Rationalit t Begrenzte Rationalit t beschreibt die Idee dass Menschen aufgrund kognitiver Grenzen dazu neigen Probleme mit denen sie konfrontiert werden zu vereinfachen Eine m gliche Folge dieser Grenzen ist dass menschliche Agenten in der Regel einfache Bewertungen der gew nschten Ressourcen abgeben beispielsweise k nnten Agenten die verf gbaren Ressourcen nur in zwei Gruppen erw nschte und unerw nschte Ressourcen kategorisieren Durch Anwendung von Techniken zum L sen von Ganzzahligen Linearen Programmen zeigen wir dass unter der Annahme einer kleinen Anzahl von Agenten die Ausnutzung begrenzter Rationalit t dabei hilft effiziente Algorithmen zum Finden neidfreier und Pareto effizienter Zuweisungen zu entwickeln Weiterhin zeigen wir dass unser Ergebnis ein allgemeines Verfahren liefert welches auf eine Reihe verschiedener Fairnesskonzepte angewendet werden kann wie zum Beispiel Neidfreiheit bis auf ein Gut oder Neidfreiheit bis auf irgendein Gut Auf diese Weise gewinnen wir effiziente Algorithmen f r eine Reihe fairer Zuordnungsprobleme wenige Agenten mit begrenzter Rationalit t vorausgesetzt Dar ber hinaus zeigen wir empirisch dass unsere Technik in der Praxis anwendbar ist Weiterhin untersuchen wir Mehrgewinnerwahlen bei denen uns eine Menge von W hlern sowie ihre Pr ferenzen ber eine Reihe von Kandidaten gegeben sind Das Ergebnis eines Mehrgewinnerwahlverfahrens ist eine Gruppe oder eine Menge von Gruppen im Falle eines Unentschiedens von Kandidaten welche die Pr ferenzen der W hler am besten einem bestimmten Ziel folgend widerspiegeln In diesem Kontext untersuchen wir die folgenden Themen Die Robustheit von Wahlergebnissen Wir untersuchen wie robust die Ergebnisse von Mehrgewinnerwahlen gegen ber m glicher Fehler der W hler sind Unter der Annahme dass jeder W hler eine Stimme in Form einer Rangliste von Kandidaten abgibt modellieren wir einen Fehler als einen Tausch benachbarter Kandidaten in der Rangliste Wir zeigen dass f r Wahlregeln wie SNTV k Approval und k Borda die minimale Anzahl an Vertauschungen welche zu einer Ergebnis nderung f hrt einfach zu berechnen ist F r STV und die Chamberlin Courant Regel ist diese Aufgabe allerdings NP schwer Wir schlie en unsere Untersuchung der Robustheit unterschiedlicher Wahlregeln ab mit einer experimentellen Evaluierung der durchschnittlichen Anzahl zuf lliger Vertauschungen die zu einer nderung des Ergebnisses f hren Strategische Abstimmung bei Wahlen mit mehreren Gewinnern Wir fragen ob eine bestimmte Gruppe von kooperierenden W hlern ein Wahlergebnis zu ihren Gunsten manipulieren kann Dabei konzentrieren wir uns auf die k

Approval Wahlregel Wir zeigen dass die Berechnungskomplexit t der besagten Manipulation eine reiche Struktur besitzt Auf der einen Seite identifizieren wir mehrere F lle in denen das Problem in Polynomzeit l sbar ist Auf der anderen Seite identifizieren wir jedoch auch NP schwere F lle F r einige von ihnen zeigen wir wie die Berechnungsschwere durch parametrisierte Algorithmen umgangen werden kann Wir pr sentieren zudem experimentelle Untersuchungen welche darauf hindeuten dass unsere Algorithmen in der Praxis anwendbar sind *Resource Allocation Problems* Toshihide Ibaraki,Naoki Katoh,1988 This book addresses a theoretical problem encountered in a variety of areas in operations research and management science including load distribution production planning computer scheduling portfolio selection and apportionment It is a timely and comprehensive summary of the past thirty years of research on algorithmic aspects of the resource allocation problem and its variants covering Lagrangean multiplier method dynamic programming greedy algorithms and their generalizations Modern data structures are used to analyze the computational complexity of each algorithm The resource allocation problem the authors take up is an optimization problem with a single simple constraint it determines the allocation of a fixed amount of resources to a given number of activities in order to achieve the most effective results It may be viewed as a special case of the nonlinear programming or nonlinear integer programming problem Contents Introduction Resource Allocation with Continuous Variables Resource Allocation with Integer Variables Minimizing a Convex Separable Function Minimax and Maximin Resource Allocation Problems Fair Resource Allocation Problem Apportionment Problem Fundamentals of Submodular Systems Resource Allocation Problems under Submodular Constraints Further Topics on Resource Allocation Problems Appendixes Algorithms and Complexity NP completeness and NP hardness Toshihide lbaraki is Professor in the Department of Applied Mathematics and Physics at Kyoto University and Naoki Katoh is Associate Professor in the Department of Management Science at Kobe University of Commerce Resource Allocation Problemsis included in the Foundations of Computing Series edited by Michael Garey and Albert Meyer *Effective Resource Management in Manufacturing Systems* Massimiliano Caramia,Paolo Dell'Olmo,2006-01-09 Manufacturing systems regardless of their size have to work with scarce resources in dynamic environments Effective Resource Management in Manufacturing Systems aims to provide methods for achieving effective resource allocation and to solve related problems that occur daily and often generate cost overruns This book will be bought by postgraduate students of business engineering and computer science as well as researchers in these fields It will also be of interest to practitioners in manufacturing systems and operations managers in industry Algorithmic Number Theory: Efficient algorithms Eric Bach,Jeffrey Outlaw Shallit,1996 Volume 1 **Algorithm Engineering** Gerth Stølting Brodal,Daniele Frigioni,Alberto Marchetti-Spaccamela,2001-08-15 Compact DFA representation for fast regular expression search Gonzalo Navarro The Max Shift algorithm for approximate string matching Costas S Iliopoulos Fractal matrix multiplication a case study on portability of cache performance Gianfranco Bilardi Experiences with the design and implementation of space efficient deques Jyrki

Katajainen Designing and implementing a general purpose halfedge data structure Herv Br nnimann Optimised predecessor data structures for internal memory Naila Rahman An adaptable and expensible geometry kernel Susan Hert Efficient resource allocation with noisy functions Arne Andersson Improving the efficiency of branch and bound algorithms for the simple plant location problem Boris Goldengorin Exploiting partial knowledge of satisfying assignments Kazuo Iwama Using PRAM algorithms on a uniform memory access shared memory architecture David A Bader An experimental study of basic communicat Algorithmic Aspects in Information and Management Ming-Yang Kao,Xiang-Yang Li,2007-06-26 This book constitutes the refereed proceedings of the Third International Conference on Algorithmic Aspects in Information and Management AAIM 2007 held in Portland OR USA in June 2007 It covers graph algorithms combinatorics scheduling graph theory network algorithms game theory option theory computational geometry graph theory and combinatorics as well as networks and data **Modeling and Optimization: Theory and Applications** János D. Pintér,Tamás Terlaky,2019-02-14 This book features a selection of contributions that were presented at the Modeling and Optimization Theory and Applications Conference MOPTA held at Lehigh University in B ethlehem Pennsylvania USA between August 16 18 2017 The conference brought together a diverse group of researchers and practitioners working on both theoretical and practical aspects of continuous and discrete optimization Topics covered include algorithms for solving convex network mixed integer nonlinear and global optimization problems and address the application of deterministic andstochastic optimization techniques in energy finance logistics analytics health and other important fields The selected contributions in this book illustrate the broad diversity of ideas discussed at the meeting **Approximation Algorithms for Combinatorial Optimization** Klaus Jansen,Samir Khuller,2003-07-31 This book constitutes the refereed proceedings of the Third International Workshop on Approximation Algorithms for Combinatorial Optimization Problems APPROX 2000 held in Saarbrcken Germany in September 2000 The 22 revised full papers presented together with four invited contributions were carefully reviewed and selected from 68 submissions The topics dealt with include design and analysis of approximation algorithms inapproximibility results on line problems randomization techniques average case analysis approximation classes scheduling problems routing and flow problems coloring and partitioning cuts and connectivity packing and covering geometric problems network design and various applications *Practical Handbook of Genetic Algorithms* Lance D. Chambers,2019-09-17 Practical Handbook of Genetic Algorithms Volume 3 Complex Coding Systems contains computer code examples for the development of genetic algorithm systems compiling them from an array of practitioners in the field Each contribution of this singular resource includes unique code segments documentation descripti **Computing Handbook** Allen Tucker,Teofilo Gonzalez,Heikki Topi,Jorge Diaz-Herrera,2022-05-29 This two volume set of the Computing Handbook Third Edition previously theComputer Science Handbook provides up to date information on a wide range of topics in computer science information systems IS information technology IT and software engineering The third edition of this

popular handbook addresses not only the dramatic growth of computing as a discipline but also the relatively new delineation of computing as a family of separate disciplines as described by the Association for Computing Machinery ACM the IEEE Computer Society IEEE CS and the Association for Information Systems AIS Both volumes in the set describe what occurs in research laboratories educational institutions and public and private organizations to advance the effective development and use of computers and computing in today s world Research level survey articles provide deep insights into the computing discipline enabling readers to understand the principles and practices that drive computing education research and development in the twenty first century Chapters are organized with minimal interdependence so that they can be read in any order and each volume contains a table of contents and subject index offering easy access to specific topics The first volume of this popular handbook mirrors the modern taxonomy of computer science and software engineering as described by the Association for Computing Machinery ACM and the IEEE Computer Society IEEE CS Written by established leading experts and influential young researchers it examines the elements involved in designing and implementing software new areas in which computers are being used and ways to solve computing problems The book also explores our current understanding of software engineering and its effect on the practice of software development and the education of software professionals The second volume of this popular handbook demonstrates the richness and breadth of the IS and IT disciplines The book explores their close links to the practice of using managing and developing IT based solutions to advance the goals of modern organizational environments Established leading experts and influential young researchers present introductions to the current status and future directions of research and give in depth perspectives on the contributions of academic research to the practice of IS and IT development use and management **Computing Handbook, Third Edition** Teofilo Gonzalez,Jorge Diaz-Herrera,Allen Tucker,2014-05-07 Computing Handbook Third Edition Computer Science and Software Engineering mirrors the modern taxonomy of computer science and software engineering as described by the Association for Computing Machinery ACM and the IEEE Computer Society IEEE CS Written by established leading experts and influential young researchers the first volume of this popular handbook examines the elements involved in designing and implementing software new areas in which computers are being used and ways to solve computing problems The book also explores our current understanding of software engineering and its effect on the practice of software development and the education of software professionals Like the second volume this first volume describes what occurs in research laboratories educational institutions and public and private organizations to advance the effective development and use of computers and computing in today s world Research level survey articles provide deep insights into the computing discipline enabling readers to understand the principles and practices that drive computing education research and development in the twenty first century

Data Clustering Guojun Gan,Chaoqun Ma,Jianhong Wu,2007-01-01 Cluster analysis is an unsupervised process that divides a set of objects into homogeneous groups This book starts with basic information on cluster analysis including the

classification of data and the corresponding similarity measures followed by the presentation of over 50 clustering algorithms in groups according to some specific baseline methodologies such as hierarchical center based and search based methods As a result readers and users can easily identify an appropriate algorithm for their applications and compare novel ideas with existing results The book also provides examples of clustering applications to illustrate the advantages and shortcomings of different clustering architectures and algorithms Application areas include pattern recognition artificial intelligence information technology image processing biology psychology and marketing Readers also learn how to perform cluster analysis with the C C and MATLAB programming languages **Clustering Challenges in Biological Networks** Sergiy Butenko,2009 This text offers introductory knowledge of a wide range of clustering and other quantitative techniques used to solve biological problems **Exploring Interior-point Linear Programming** Ami Arbel,1993 This book provides practitioners as well as students of this general methodology with an easily accessible introduction to the new class of algorithms known as interior point methods for linear programming **Handbook of Integrated Risk Management for E-Business** Abderrahim Labbi,2005-11-09 This book provides a recipe for the practical application of technology and is one of the first instances where the tools and technologies that allow for the implementation of solutions to solve specific problems are actually outlined Dr Krishna Nathan Vice President IBM Research This ground breaking book integrates converging views of e business processes and offers ways to manage their inherent risks with advanced modeling techniques Contributors from leading academic and business organizations explore state of the art adaptive risk analysis systems that support business processes in project portfolio management operations management supply chain management inventory control data mining for customer relationship management information technology security finance e banking and more Today s new business environments are characterized by increasing sources of uncertainty and variability which challenge current decision making processes Handbook of Integrated Risk Management for E Business Measuring Modeling and Managing Risk provides a roadmap for identifying and mitigating the primary risks associated with each critical e business process It also shows you how to transform your processes by empowering your decision making systems and how to design appropriate risk management systems for decision support **Broadband Communications, Networks and Systems** Ioannis Tomkos,Georgios Ellinas,Prasun Sinha,2012-05-01 This book constitutes the thoroughly refereed post conference proceedings of the 7th International ICST Conference on Broadband Communications Networks and Systems BROADNETS 2010 held in October 2010 in Athens Greece The 39 revised full papers were carefully selected from numerous submissions The conference was divided in 3 tracks Optical Wireless and Internet The optical track covers topics such as optical switch architectures reliable optical networking routing wavelength assignment and traffic grooming network control and management The wireless track highlights MIMO and OFDM techniques mobility management routing protocols hybrid networks and the internet track covers routing scheduling security trust semantic technologies and social networks

Proportional Optimization and Fairness Wieslaw Kubiak,2008-11-16 Proportional Optimization and Fairness is a long needed attempt to reconcile optimization with apportionment in just in time JIT sequences and find the common ground in solving problems ranging from sequencing mixed model just in time assembly lines through just in time batch production balancing workloads in event graphs to bandwidth allocation internet gateways and resource allocation in computer operating systems The book argues that apportionment theory and optimization based on deviation functions provide natural benchmarks for a process and then looks at the recent research and developments in the field Individual chapters look at the theory of apportionment and just in time sequences minimization of just in time sequence deviation optimality of cyclic sequences and the oneness bottleneck minimization competition free instances Fraenkel s Conjecture and optimal admission sequences response time variability applications to the Liu Layland Problem and pinwheel scheduling temporal capacity constraints and supply chain balancing fair queuing and stride scheduling and smoothing and batching City Evacuations: An Interdisciplinary Approach John Preston,Jane M Binner,Layla Branicki,Tobias Galla,Nick Jones,James King,Magdalini Kolokitha,Michalis Smyrnakis,2014-08-01 Evacuating a city is a complex problem that involves issues of governance preparedness education warning information sharing population dynamics resilience and recovery As natural and anthropogenic threats to cities grow it is an increasingly pressing problem for policy makers and practitioners The book is the result of a unique interdisciplinary collaboration between researchers in the physical and social sciences to consider how an interdisciplinary approach can help plan for large scale evacuations It draws on perspectives from physics mathematics organisation theory economics sociology and education Importantly it goes beyond disciplinary boundaries and considers how interdisciplinary methods are necessary to approach a complex problem involving human actors and increasingly complex communications and transportation infrastructures Using real world case studies and modelling the book considers new approaches to evacuation dynamics It addresses questions of complexity not only in terms of theory but examining the latest challenges for cities and emergency responders Factors such as social media information quality and visualisation techniques are examined to consider the new dynamics of warning and informing evacuation and recovery

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