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REVIEWS, COMMENTS

Algorithmic Adventures: From Knowledge to Magic

Author: Juraj HROMKOVIČ
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What is an algorithm, what can we compute and what might we compute in the future? These are the questions which underline Hromkovič's book Algorithmic Adventures: From Knowledge to Magic. It covers a relatively broad range of topics, at an introductory overview level, which originated from a public lecture series at ETH Zürich (Swiss Federal Institute of Technology Zürich) in 2005.

Given the general scope of informatics olympiads, it should be pointed out from the beginning that this is in no form an introductory algorithm text, such as Cormen et al [1] or Sedgewick [2]. This is not the place to find a description (or mention) of standard approaches such as dynamic programming or greedy algorithms, standard algorithms or mathematical foundations. Rather it provides an essentially recreational overview of algorithms – a style that introduces some fundamental concepts and glosses-over some technical details.

The chapters within the book fit together well and tell an interesting story. Indeed, the structure of the book and the way in which the story flows between the chapters is one of the book's strengths. The book starts off by discussing scientific discipline, some basic logic and the notion of proof. We then lead in to the standard comparison of an algorithm and a recipe. This discussion is carried on in some depth, including discussions as to specificity of steps and non-termination.

The story then moves to a discussion of the different types of infinity, which is then used to explain why some problems are unsolvable. At this point (almost half way through the book) complexity is introduced, along with a discussion of what is tractable. Randomness is introduced next, along with witnesses and examples of how some hard problems can be solved with such algorithms.

The last third of the book contains two slightly esoteric topics – namely DNA computing and quantum computers, and two more standard topics – cryptography and online algorithms. These latter two topics make good use of the discussions that have preceded them in the book. The DNA and quantum chapters are interesting and different; perhaps a little too brief in both cases, especially when this is material that is not covered nearly as frequently as the other topics in the book. The DNA chapter, for example, lists various operations that can be performed on DNA (such as concatenation and length separation) and gives an example of a problem (on Hamiltonian paths) solved with these operation but makes no attempt to explain why these are sufficient to solve classical computational problems.

The book does not have nearly as many "milestones" and "spectacular facts" as the author may feel it has, but there are some gems within the text. It finishes on a strong note, with an explanation and proof of an online algorithm for a scheduling problem. That algorithm, and the vertex cover one discussed in the chapter on complexity, are perhaps the two instances in the book of problems which might serve as teasers for a starting informatics olympiad student.

Chapters follow a reasonably consistent format, with some background historical detail, discussion on a few parts of the chapter's topic, accompanying exercises and a brief summary. Exercises vary in difficulty although most are easy and mechanical, and some of the exercises are answered at the end of the chapters. The choice of exercises to be answered appears erratic and the more interesting problems are typically unanswered.

The book could have done with better editing. There are numerous mistakes (distracting in general rather than misleading), repetitions, inconsistencies and undefined notations. The index is particularly poor; in almost every case where I went to look something up in the index there was no appropriate entry. The general reader might be excused for being frustrated on reading a sentence like "Remember the travelling salesman problem" but finding no reference to it in the index.

In the book's introduction the author states that "The goal of this book is not typical for popular science writing, which often restricts itself to outlining the importance of a research area. Whenever possible we strive to bring full understanding of the concepts and results presented." Much of the book fails to live up to this promise. Topics are rarely covered in enough depth to provide a full understanding, and a student who stops here is going to be missing much. Conversely, for the student who wants to get a basic understanding of some key concepts – and especially those who are not mathematicians or computer scientists – the book does provide a starting point.

It is difficult however to see the audience that would be best suited to the book[1]. To the mathematician or computer science the book is far too shallow; perhaps suitable as reading for such a student, in their own time, prior to the commencement of a course. To the recreational science reader, quite simply there are far better books in this category out there. Infinity, complexity, randomness, cryptography, etc. . . are all frequently

[1] As discussed in [3] this book has been used as the text in a course for second-year university students on the foundations of informatics as a science. That course, was for students *"from various disciplines, excluding computer science*."

topics, handled well in the recreational mathematics literature. Perhaps the general, non-computer scientist might find parts of the book of interest, if they are able to persist. Unfortunately, the book's attempt to "lure the reader from her or his passive role" and "do some work by solving appropriate exercises" seem more likely to alienate than educate.

1. Cormen, T., Leiserson, C., Rivest, R., Stein, C. (??? year). *Introduction to Algorithmics*, MIT Press.
2. Sedgewick, R. (??? year). *Algorithms in C*, Addison Wesley.
3. Verhoeff, T. (2010). An enticing environment for programming. *Olympiads in Informatics*, 4, 134–141.

Richard Forster

Methods of Tasks Solving in Informatics. International Olympiads

Authors: Vladimir M. KIRYUKHIN
and Stanislav M. OKULOV
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An important place in preparing for the International Olympiad in Informatics is the methodical and informational support of all kinds and forms of work with gifted students. Since the olympiads themselves are just an evaluation of the preparatory process results, the systematic work with gifted students on development of their abilities is a key to the olympiad movement in informatics. And here there are a lot of questions such as – How to analyze complex and competition tasks in Informatics? How to explain their solution to students?

Traditional publications on this subject are usually based on the principle: do thus and thus and you'll get the result. What preceded this "doing so" is usually not disclosed by the authors of publications; this remains in the shadows. Moreover, in this case the students do not get the return of obtaining of correct solutions by themselves because all is explained about it to them. In this book, on examples of the tasks which were offered at the IOI between 1989–2006, the authors have attempted to show the problem-solving process from beginning to end. This proved to be much more complicated than simply

describing a solution in the form of algorithm description or program code (even with the proofs of mathematical facts, if they lie at the basis of the solution).

There is a viewpoint that the ordinary informatics teacher is not under force to prepare students for IOI, that this work is a lot of ”elite”. The book's authors disagree with this position, since they proceed from the fact that the main thing in working with gifted children is to establish a creative environment. Of course, a teacher or coach must be purposefully working on these problems, but to be ”Guru” in tasks solving is not necessarily! Surprising but at the basis of almost any complexity is simplicity. To see and find this simplicity, to go from this simplicity to complete solution of the task in the process of joint activity with the students – this is the basis of work of teacher or coach. To learn how to do it, the authors have tried to write in this book, choosing the IOI competition tasks for this purpose.

In preparation for the IOI an informatics teacher still faces the same problem: What to teach? How to teach? What books and information resources to use? In spite of the increased capabilities of information technology, these problems have remained, as it remains an unchanged mission for the teacher – to develop the creative abilities of student in informatics. It has remained unchanged and a criterion for evaluating the work of the teacher as the successful performance of his students on the IOI.

Since the IOI is a very popular olympiad among students of many countries, in the book authors are talking about the solution of the IOI competition tasks, more precisely, the method of analysis of complex tasks in informatics, because on the status the IOI offers just such competition tasks. The tasks statements in this book are as close as possible to the original versions proposed at the IOI. Cuts and changes are minimal, which enables them to represent both the development contents and requirements for students.

The book provides analysis of all the IOI competition tasks from 1989 to 2006. Where there is enough material for a lesson, the authors discuss its analysis. In other words, using this material the teacher can ”construct” a lesson. Otherwise, if the information is insufficient or the theory is too complicated for a student to understanding, the authors just talk about the ideas for solving it. The book ends with ”a guide to tasks”, which provides a classification of tasks both by complexity and topics.

It is clear that for full preparation for the IOI it is necessary to organize a creative environment and to use modern methods for the development of gifted students, but this problem is beyond the scope of this book. In this book the authors are talking about the contents aspect of teaching and methods of teaching. Importantly, this is considered not in separate chapters, not as common considerations about ”what is good and what is bad”, but presented with the concrete material during the discussion of each task. Instead of the traditional parsing of tasks or a general description of the algorithm to solve them the authors have tried to give a summary of studies with gifted students to teacher or coach and have tried to show the features of teaching during lessons, because all this laid down in the very structure of the discussion of each task.

Coming back to contents of teaching process, one can say that analysis of each task leads to the need to study these, or other topics in informatics, in more detail. But it is not possible to indefinitely extend the number of these topics in this part of working with

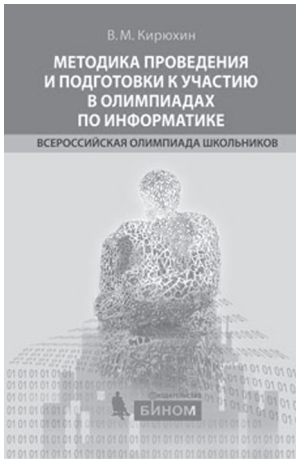
the students, because it is the problem of universities. In the book there are highlighted only those topics that are fundamental in informatics, and the material for learning them is sufficient in the scientific literature. In particular, such topics are:

- combinatorial calculus;
- sorting and search;
- algorithmic strategies;
- algorithms for graphs;
- string processing;
- dynamic programming;
- algorithms of computing geometry.

In the presented book "Guide" each task is classified to the one of these topics. In addition, a number of other topics are identified: "tasks on the idea", tasks on the programming techniques, "task without continuing". Due to this a teacher or coach has the opportunity to select a task, necessary for him to carry out lessons, and a student can select the task for his preparation, depending on the topic and the level of his development (the "Guide" provides an assessment of the complexity of each task). Thus, the "Guide" allows readers to organize the work with the book not on the level of easy familiarity and sequential read, but permanent use in preparation for the IOI.

It should be noted that in working with this book the process of considering tasks is not confined to the reading of their discussions. Readers are also required to analyze different approaches to solving tasks and use algorithms, the development of software code, testing of solution program and study the complexity of the solution. All this determines all the necessary conditions for fruitful preparation of students for the IOI and successful performance at it.

Sergey A. Beshenkov



Method of Carrying out and Preparation for Participation in the Olympiad in Informatics: All-Russian Olympiad

Author: Vladimir M. KIRYUKHIN
Publishing house: BINOM. Knowledge Lab (LBZ)
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Russia has carried out many different olympiads and contests in informatics and information technology for students of secondary and high school. Among them the Russian Olympiad in Informatics (RusOI) has a special place, both in the number of participants, and by its influence on the development of their intellectual potential. For many years, this olympiad has implemented and improved innovative methods of search and supporting gifted students, regardless of where they live and study.

The RusOI has been held by the Ministry of Education and Science of Russia every year since 1988 in four stages: school, municipal, regional and final. The school stage involves all interested 5–11th grade students from all schools in the country (there is an eleven-year secondary education system in Russia). Only the winners and prize winners of previous stages participate in subsequent stages. Up to the final stage only about 200 students from the 9–11th grades are allowed, who demonstrated the best results among all the participants of the regional stage, which takes place simultaneously in all regions of Russia; using the same sets competition tasks for all participants of the regional stage.

This book presented the long experience of organizing and holding the RusOI, from school stage and ending with the final stage. The organization of each stage, their technical and technological equipment, formation of sets of competition tasks for participants of all ages are discussed in detail.

Particular attention in this book is paid to how to prepare for different kind of olympiads in informatics. Methods of preparation are considered that are not based on solving largest possible number competition tasks, but on developmental teaching, on forming individual trajectories of learning using modern techniques of developing the creative capacity of students. An important place is occupied here by the content of competition tasks as well as the use of modern information technology.

The book consists of five chapters. The first chapter describes the main features of the organization and holding for all stages the RusOI. There are considered in detail issues concerning the composition of participants, dates, forms and procedure of competition, as

well as the order of summarizing of each stage. Particular attention is paid to the school stage, because how this stage was organized and held depends in many respects on the success of further development of the olympiad movement in informatics.

The second chapter is dedicated to the organizational and technical support of all stages the RusOI. All the governing bodies of the RusOI and the basic functions they perform are considered. It also discusses in detail the requirements for the hardware and software of each stage.

The third chapter deals with the system of competition tasks. There are considered in detail methodological principles and characteristics of competition tasks, especially tasks for school, municipal, regional and final stages, formation of sets of tasks, as well as communication competition tasks with the Russian State School Educational Standard and a guide to competition tasks.

The fourth chapter contains a description of testing techniques and systems for evaluation of competition tasks solutions common to all stages of the RusOI. Particular attention is paid to methods of evaluation of participants solutions, including methods for determining violations of time and memory limits for testing programs. There are also considered features of evaluation of participants solutions in the final stage, since the process at this stage is the most established, and the organizers of other stages the RusOI should be familiar with the experience of its implementation and using this experience in their work.

The fifth chapter is devoted to consideration of most important issues related to preparations for olympiads in informatics, which are useful as participants of various stages of the RusOI, and their teachers and coaches. Particular attention is paid to developing teaching system as the basis for olympiad preparation and individual forms of preparation and self-preparation of students. The book also contains useful Internet resources for olympiad preparation that can be successfully used in various forms of preparation for olympiads in informatics.

The book will be very useful as organizers of competitions in informatics, and students who are interested in olympiads in informatics, as well as their parents, school teachers and coaches working with talented students. It will undoubtedly contribute to further development of the International Olympiad in Informatics and involvement for new students and countries.

Sergey A. Beshenkov