Data Structures and Algorithms Specialization

Master Algorithmic Programming Techniques. Learn algorithms through programming and advance your software engineering or data science career

4.6 11,147 ratings

Alexander S. Kulikov +4 more instructors

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UNIVERSITY OF CALIFORNIA SAN DIEGO
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Enrolled Already enrolled

235,120 already enrolled

About How It Works Courses Instructors Enrollment Options FAQ

WHAT YOU WILL LEARN

- Apply basic algorithmic techniques such as greedy algorithms, binary search, sorting and dynamic programming to solve programming challenges.
- Apply various data structures such as stack, queue, hash table, priority queue, binary search tree, graph and string to solve programming challenges.
- Apply graph and string algorithms to solve real-world challenges: finding shortest paths on huge maps and assembling genomes from millions of pieces.
- Solve complex programming challenges using advanced techniques: maximum flow, linear programming, approximate algorithms, SAT-solvers, streaming.

SKILLS YOU WILL GAIN

Debugging | Software Testing | Algorithms | Data Structure | Computer Programming | Dynamic Programming | Binary Search Tree | Priority Queue | Hash Table | Stack (Abstract Data Type) | List | Graph Theory

About this Specialization

167,269 recent views

This specialization is a mix of theory and practice: you will learn algorithmic techniques for solving various computational problems and will implement about 100 algorithmic coding problems in a programming language of your choice. No other online course in **Algorithms** even comes close to offering you a wealth of **programming challenges** that you may face at your next job interview. To prepare you, we invested over 3000 hours into designing our challenges as an alternative to multiple choice questions that you usually find in MOOCs. Sorry, we do not believe in multiple choice questions when it comes to learning algorithms...or anything else in computer science! For each algorithm you develop and implement, we designed multiple tests to check its correctness and running time — you will have to debug your programs without even knowing what these tests are! It may sound difficult, but we believe it is the only way to truly understand how the algorithms work and to master the art of programming. The specialization contains two real-world projects: **Big Networks** and **Genome Assembly**. You will analyze both road networks and social networks and will learn how to compute the shortest route between New York and San Francisco (1000 times faster than the standard shortest path algorithms!) Afterwards, you will learn how to assemble genomes from millions of short fragments of DNA and how assembly algorithms fuel recent developments in personalized medicine.

Applied Learning Project

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LEARNER CAREER OUTCOMES

36% Started a new career after completing this specialization.

25% Got a pay increase or promotion.

Shareable Certificate
Earn a Certificate upon completion

100% online courses
Start instantly and learn at your own schedule.

Flexible Schedule
Set and maintain flexible deadlines.

Intermediate Level
Basic knowledge of at least one programming language: C++, Java, Python, C, C#, Javascript, Haskell, Kotlin, Ruby, Rust, Scala. Basic knowledge of discrete

SHOW ALL

Approximately 8 months to complete
Suggested pace of 6 hours/week

English
Subtitles: English, Arabic, French, Portuguese (European), Italian, Vietnamese, German, Russian, Spanish

The courses helped me understand my strengths and weaknesses, and gave me the confidence I needed to quit my job and launch my own startup.

— Zeeshan U.

Learning from leading scientists about what's going on in the field right now is so much different than the experience of reading a textbook.

— Peter W.

Gaining new knowledge and skills throug helped me break out of the mold I'd beer decade. Coursera helped open doors for

How the Specialization Works

Take Courses

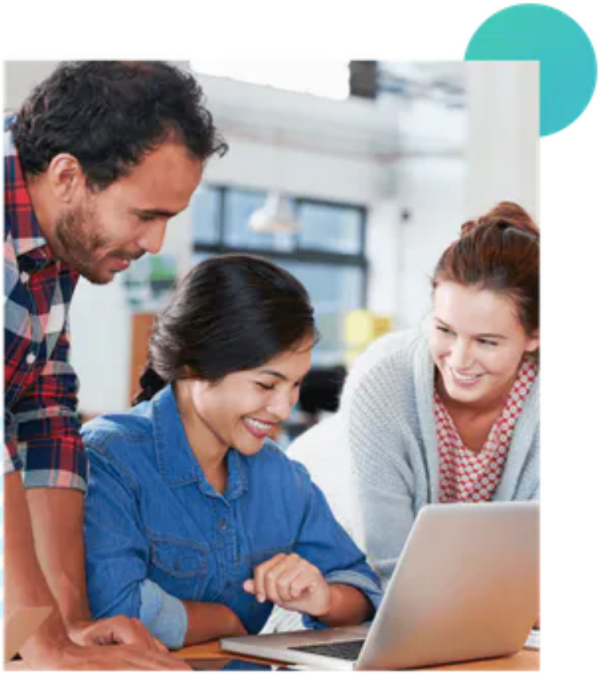
A Coursera Specialization is a series of courses that helps you master a skill. To begin, enroll in the Specialization directly, or review its courses and choose the one you'd like to start with. When you subscribe to a course that is part of a Specialization, you're automatically subscribed to the full Specialization. It's okay to complete just one course — you can pause your learning or end your subscription at any time. Visit your learner dashboard to track your course enrollments and your progress.

Hands-on Project

Every Specialization includes a hands-on project. You'll need to successfully finish the project(s) to complete the Specialization and earn your certificate. If the Specialization includes a separate course for the hands-on project, you'll need to finish each of the other courses before you can start it.

Earn a Certificate

When you finish every course and complete the hands-on project, you'll earn a Certificate that you can share with prospective employers and your professional network.



There are 6 Courses in this Specialization

COURSE 1

Algorithmic Toolbox

4.6 10,778 ratings • 2,270 reviews

The course covers basic algorithmic techniques and ideas for computational problems arising frequently in practical applications: sorting and searching, divide and conquer, greedy algorithms, dynamic programming. We will learn a lot of theory: how to sort data and how it helps for searching; how to break a large problem into pieces and solve them recursively; when it makes sense to proceed greedily; how dynamic programming is used in genomic studies. You will practice solving computational problems, designing new algorithms, and implementing solutions efficiently (so that they run in less than a second).

COURSE 2

Data Structures

4.6 4,279 ratings • 726 reviews

A good algorithm usually comes together with a set of good data structures that allow the algorithm to manipulate the data efficiently. In this course, we consider the common data structures that are used in various computational problems. You will learn how these data structures are implemented in different programming languages and will practice implementing them in our programming assignments. This will help you to understand what is going on inside a particular built-in implementation of a data structure and what to expect from it. You will also learn typical use cases for these data structures.

A few examples of questions that we are going to cover in this class are the following:
1. What is a good strategy of resizing a dynamic array?
2. How priority queues are implemented in C++, Java, and Python?
3. How to implement a hash table so that the amortized running time of all operations is O(1) on average?
4. What are good strategies to keep a binary tree balanced?

You will also learn how services like Dropbox manage to upload some large files instantly and to save a lot of storage space!

COURSE 3

Algorithms on Graphs

4.7 2,002 ratings • 336 reviews

If you have ever used a navigation service to find optimal route and estimate time to destination, you've used algorithms on graphs. Graphs arise in various real-world situations as there are road networks, computer networks and, most recently, social networks! If you're looking for the fastest time to get to work, cheapest way to connect set of computers into a network or efficient algorithm to automatically find communities and opinion leaders in Facebook, you're going to work with graphs and algorithms on graphs.

In this course, you will first learn what a graph is and what are some of the most important properties. Then you'll learn several ways to traverse graphs and how you can do useful

things while traversing the graph in some order. We will then talk about shortest paths algorithms — from the basic ones to those which open door for 1000000 times faster algorithms used in Google Maps and other navigational services. You will use these algorithms if you choose to work on our Fast Shortest Routes industrial capstone project. We will finish with minimum spanning trees which are used to plan road, telephone and computer networks and also find applications in clustering and approximate algorithms.

COURSE 4

Algorithms on Strings

4.5 959 ratings • 167 reviews

World and internet is full of textual information. We search for information using textual queries, we read websites, books, e-mails. All those are strings from the point of view of computer science. To make sense of all that information and make search efficient, search engines use many string algorithms. Moreover, the emerging field of personalized medicine uses many search algorithms to find disease-causing mutations in the human genome.

COURSE 5

Advanced Algorithms and Complexity

4.6 601 ratings • 116 reviews

You've learned the basic algorithms now and are ready to step into the area of more complex problems and algorithms to solve them. Advanced algorithms build upon basic ones and use new ideas. We will start with networks flows which are used in more typical applications such as optimal matchings, finding disjoint paths and flight scheduling as well as more surprising ones like image segmentation in computer vision. We then proceed to linear programming with applications in optimizing budget allocation, portfolio optimization, finding the cheapest diet satisfying all requirements and many others. Next we discuss inherently hard problems for which no exact good solutions are known (and not likely to be found) and how to solve them in practice. We finish with a soft introduction to streaming algorithms that are heavily used in Big Data processing. Such algorithms are usually designed to be able to process huge datasets without being able even to store a dataset.

COURSE 6

Genome Assembly Programming Challenge

4.5 291 ratings • 54 reviews

In Spring 2011, thousands of people in Germany were hospitalized with a deadly disease that started as food poisoning with bloody diarrhea and often led to kidney failure. It was the beginning of the deadliest outbreak in recent history, caused by a mysterious bacterial strain that we will refer to as E. coli X. Soon, German officials linked the outbreak to a restaurant in Lübeck, where nearly 20% of the patrons had developed bloody diarrhea in a single week. At this point, biologists knew that they were facing a previously unknown pathogen and that traditional methods would not suffice – computational biologists would be needed to assemble and analyze the genome of the newly emerged pathogen.

To investigate the evolutionary origin and pathogenic potential of the outbreak strain, researchers started a crowdsourced research program. They released bacterial DNA sequencing data from one of a patient, which elicited a burst of analyses carried out by computational biologists on four continents. They even used GitHub for the project: https://github.com/ehec-outbreak-crowdsourced/BGI-data-analysis/wiki

The 2011 German outbreak represented an early example of epidemiologists collaborating with computational biologists to stop an outbreak. In this Genome Assembly Programming Challenge, you will follow in the footsteps of the bioinformaticians investigating the outbreak by developing a program to assemble the genome of the E. coli X from millions of overlapping substrings of the E.coli X genome.

Show Less

Instructors

Alexander S. Kulikov
Visiting Professor
Department of Computer Science and Engineering
602,495 Learners
14 Courses

Michael Levin
Lecturer
Computer Science
554,075 Learners
9 Courses

Neil Rhodes
Adjunct Faculty
Computer Science and Engineering
496,855 Learners
7 Courses

Pavel Pevzner
Professor
Department of Computer Science and Engineering
569,867 Learners
14 Courses

Daniel M Kane
Assistant Professor
Department of Computer Science and Engineering / Department of Mathematics
487,528 Learners
5 Courses

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Frequently Asked Questions

- What is the refund policy?
- Can I just enroll in a single course?
- Is financial aid available?
- Can I take the course for free?
- Is this course really 100% online? Do I need to attend any classes in person?
- What will I be able to do upon completing the Specialization?
- What background knowledge is necessary?
- What is the difference between this course and other courses covering algorithms?
- How long does it take to complete the Specialization?
- How often is each course in the Specialization offered?

What background knowledge is necessary?

Do I need to take the courses in a specific order?

Will I earn university credit for completing the Specialization?

Do I need to buy a textbook for this specialization?

More questions? Visit the **Learner Help Center**.