front matter

preface

When we started our career as software developers in 2008, we didn't care about operations. We wrote code, and someone else was responsible for deployment and operations. A huge gap existed between software development and IT operations back then. On top of that, releasing new features was risky because it was impossible to test all the changes to software and infrastructure manually. Every six months, when new features needed to be deployed, we experienced a nightmare.

Then, in 2012, we became responsible for a product: an online banking platform. Our goal was to iterate quickly and to be able to release new features for the product every week. Our software was responsible for managing money, so the quality and security of the software and infrastructure were as important as the ability to innovate. But the inflexible on-premises infrastructure and the outdated process of deploying software made those goals impossible to reach. We started to look for a better way.

Our search led us to Amazon Web Services, which offered a flexible and reliable way to build and operate our applications. The possibility of automating every part of our infrastructure struck us as fascinating and innovative. Step by step, we dove into the different AWS services, from virtual machines to distributed message queues. Being able to outsource tasks like operating an SQL database or a load balancer saved us a lot of time. We invested this time in automating the testing and operations for our entire infrastructure.

The changes that took place during this transformation to the cloud went beyond the technical. After a while, the software architecture changed from a monolithic application to microservices, and the separation between software development and operations got very blurry—and, in some cases, disappeared altogether. Instead, we built our organization around the core principle of DevOps: you build it, you run it.

Since 2015, we have worked as independent consultants, helping our clients get the most out of AWS. We have accompanied startups, midsized companies, and enterprise corporations on their journey to the cloud. Along the way, we have identified—and solved—the common challenges that confront companies of all sizes as they move to the cloud. In fact, we ended up turning some of our solutions into products to sell on the AWS Marketplace.

We enjoyed writing the first edition of our book in 2015. The astonishing support from Manning and our MEAP readers allowed us to finish the whole book in only nine months. Above all, it was a pleasure to observe you—our readers—using our book to get started with AWS or deepen your knowledge with the platform.

AWS is always innovating and constantly releasing new features or whole new services. So, in 2018, we released a second edition of the book, updated and revised based on the feedback of our readers. The second edition added three more chapters to cover newer developments—Lambda, EFS, and ElastiCache—and updated all the previous chapters.

Now, in 2023, it is time to update our book once again. In this third edition, we meticulously reviewed every chapter, updating the text and screenshots so they match the current way things work on the AWS platform. We've also added new content, including a chapter on containerized architectures as well as sections about CodeDeploy, Packer, and more.

We hope you enjoy the third edition of *Amazon Web Services in Action* as much as we do!

acknowledgments

Writing a book is time consuming. We invested our time, and other people did as well. Thank you to everyone involved!

We want to thank all the readers who bought the MEAP edition of this book. Thanks for overlooking the rough edges and focusing on learning about AWS instead. Your feedback helped us polish the final version of the book that you are now reading.

Thank you to all the people who posted comments in the book's liveBook forum and who provided excellent feedback, which improved the book.

Thanks to all the reviewers of the third, second, and first editions who provided detailed comments from the first to the last page. To all the reviewers of this edition: Adrian Rossi, Alessandro Campeis, Amitabh P. Cheekoth, Andres Sacco, Ashley Eatly, Bobby Lin, Brent Honadel, Chris Villanueva, Darnell Gadberry, Edin Kapić, Ernesto Cardenas Cangahuala, Floris Bouchot, Franklin Neves, Frans Oilinki, Ganesh Swaminathan, George Onofrei, Gilberto Taccari, Jeffrey Chu, Jeremy Chen, John Larsen, John Zoetebier, Jorge Bo, Kamesh Ganesan, Kent Spillner, Matteo Battista, Matteo Rossi, Mohammad Shahnawaz Akhter, Philip Patterson, Rahul Modpur, Roman Levchenko, Simeon Leyzerzon, Simone Sguazza, Uziel Linares, Venkatesh Rajagopal, and Vidhya Vinay—your feedback helped shape this book. We hope you like it as much as we do.

Special thanks to Michael Labib for his input and feedback on chapter 11 covering AWS ElastiCache.

Furthermore, we want to thank the technical editors, John Hyaduck and Jonathan Thoms. Your unbiased and technical view on Amazon Web Services helped to perfect our book.

Shawn P. Bolan made sure all the examples in this third edition work as expected. Thanks for proofing the technical parts of our book. Thanks to David Fombella Pombal and Doug Warren for proofing the technical parts in previous editions.

We also want to thank Manning Publications for placing their trust in us. Especially, we want to thank the following staff at Manning for their excellent work:

- Frances Lefkowitz, our development editor, who guided us through the process of writing the second and third editions. Her writing and teaching expertise is noticeable in every part of our book. Thanks for your support.
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Last but not least, we want to thank the significant people in our lives who supported us as we worked on the book.

about this book

Our book guides you from creating an AWS account to building fault-tolerant and autoscaling applications. You will learn about services offering compute, network, and storage capacity. We get you started with everything you need to run web applications on AWS: load balancers, virtual machines, containers, file storage, database systems, and in-memory caches.

The first part of the book introduces you to the principles of Amazon Web Services and gives you a first impression of the possibilities in the cloud. Next, in part 2, you will learn about fundamental compute and network services. In part 3, we demonstrate six different ways to store your data. Finally, part 4 focuses on architecting on AWS: highly available or even fault-tolerant architectures using load balancers and queues, containerized applications, deployment options, and autoscaling strategies to scale your infrastructure dynamically as well.

Amazon offers a wide variety of services—more than 200 services in 25 categories at last count, with more added regularly. Unfortunately, the number of pages within a book is limited. Therefore, you will not find instructions for all AWS services in this book. What you *will* find is a collection of the most important and universally popular services. We consider

these services the essential toolkit, the ones you need to get up and running and get your business done. You could operate fine with just these services, but once you have mastered them, we hope you will have the confidence and curiosity to explore what else is out there—for instance: Machine Learning as a Service, anyone?

Automation sneaks in throughout the book, so by the end, you'll be comfortable with using AWS CloudFormation, an Infrastructure as Code tool that allows you to manage your cloud infrastructure in an automated way; this will be one of the most important things you will learn from our book.

Most of our examples use popular web applications to demonstrate important points. We use tools offered by AWS instead of third-party tools whenever possible, because we appreciate the quality and support offered by AWS. Our book focuses on the different aspects of security in the cloud, for example, by following the "least-privilege" principle when accessing cloud resources.

We focus on Linux as the operating system for virtual machines. Our examples are based on open source software.

Amazon operates data centers in various geographic regions around the world. To simplify the examples, we use the region US East (N. Virginia). You will also learn how to switch to another region to use resources in the region Asia Pacific (Sydney).

About the third edition

In this third edition, we have revised all of the previous 17 chapters. AWS has made significant progress since the second edition in 2018. As a result, we incorporated countless new features into the third edition. Of course, we also updated all the examples.

The most significant change is the addition of chapter 18, "Building modern architecture for the cloud: ECS, Fargate, and App Runner." The brand-new chapter discusses deploying a web application using containers. We start with a simple example based on App Runner and end the chapter with a cloud-native architecture based on ALB, ECS, Fargate, and S3. We also rewrote chapter 15, "Automating deployment: CloudFormation,

CodeDeploy, and Packer," to provide you the tools to deploy your applications to AWS.

Who should read this book

Amazon Web Services is a toolbox. You can find tools to run a website that can sell goods and services to the general public, but you can also host private applications securely and economically, which a corporation with thousands of customers depends on. Tools are also available to crunch numbers or to train your ML models. The possibilities go on and on. Reading this book should help you get used to the most common tools. Once you are familiar with the common tools, you are equipped to explore the rest of the toolbox on your own.

You don't need much training to read, understand, and adapt the lessons from this book to your own needs. Familiarity with Linux computers, the markup language YAML, and an understanding of basic networking concepts are all you need to get started. You don't even need an AWS account —we'll show you how to sign up for one in chapter 1.

How this book is organized: A road map

Chapter 1 introduces cloud computing and Amazon Web Services. You'll learn about key concepts and basics, and you'll create and set up your AWS account.

Chapter 2 brings Amazon Web Services into action. You'll spin up and dive into a complex cloud infrastructure with ease.

Chapter 3 is about working with a virtual machine. You'll learn about the key concepts of the Elastic Compute Service (EC2) with the help of a handful of practical examples.

Chapter 4 presents different approaches for automating your infrastructure: the AWS Command Line Interface (CLI) from your terminal, the AWS SDKs to program in your favorite language, and AWS CloudFormation, an Infrastructure as Code tool.

Chapter 5 is about security. You'll learn how to secure your networking infrastructure with private networks and firewalls. You'll also learn how to protect your AWS account and your cloud resources.

Chapter 6 is about automating operational tasks with AWS Lambda. You will learn how to execute small code snippets in the cloud without needing to launch a virtual machine.

Chapter 7 introduces the Amazon Simple Storage Service (S3), a service offering object storage, and Amazon Glacier, a service offering long-term storage. You'll learn how to integrate object storage into your applications to implement a stateless server by creating an image gallery.

Chapter 8 is about storing data from your virtual machines on hard drives with Amazon Elastic Block Storage (EBS) and instance storage. To get an idea of the different options available, you'll take some performance measurements.

Chapter 9 explains how to use a networking filesystem to share data among multiple machines. Therefore, we introduce the Amazon Elastic File System (EFS).

Chapter 10 introduces Amazon Relational Database Service (RDS), offering managed relational database systems like MySQL, PostgreSQL, Oracle, and Microsoft SQL Server. You will learn how to connect an application to an RDS database instance, for example.

Chapter 11 is about adding a cache to your infrastructure to speed up your application and save costs due to minimizing load on the database layer. Specifically, you will learn about Amazon ElastiCache, which provides Redis or Memcached as a service, as well as Amazon MemoryDB for Redis.

Chapter 12 introduces Amazon DynamoDB, a NoSQL database offered by AWS. DynamoDB is typically not compatible with legacy applications. You need to rework your applications to use DynamoDB. You'll implement a to-do application in this chapter.

Chapter 13 explains what's needed to make your infrastructure highly available. You'll learn how to recover automatically from a failed virtual machine or even a whole data center.

Chapter 14 introduces the concept of decoupling your system to increase reliability. You'll learn how to use synchronous decoupling with the help

of Elastic Load Balancing (ELB). Asynchronous decoupling is also part of this chapter; we explain how to use the Amazon Simple Queue Service (SQS), a distributed queuing service, to build a fault-tolerant system.

Chapter 15 introduces three different ways to deploy software to AWS. You'll use each of the tools to deploy an application to AWS in an automated fashion.

Chapter 16 dives into building fault-tolerant applications based on the concepts explained in chapters 13 and 14. You'll create a fault-tolerant image-processing web service within this chapter.

Chapter 17 is all about flexibility. You'll learn how to scale the capacity of your infrastructure based on a schedule or based on the current load of your system.

Chapter 18 explains ways to deploy containers on AWS. You'll learn to use ECS with Fargate and App Runner to run your containerized application.

AWS costs

AWS offers a Free Tier, which allows you to experiment with a number of services for at least a full year at no charge. Most of the projects we walk you through in this book can be done within the Free Tier. For the few processes we teach that do go beyond the Free Tier, we provide a clear warning for you, so you can opt out if you do not want to incur charges. In chapter 1, you'll learn much more about how AWS charges for services, what's covered in the Free Tier, and how to set budgets and alerts so you don't receive any unexpected bills from AWS.

About the code

You'll find four types of code listings in this book: bash, YAML, Python, and Node.js/JavaScript. We use bash to create tiny scripts to interact with AWS in an automated way. YAML is used to describe infrastructure in a way that AWS CloudFormation can understand. In addition, we use Python to manage our cloud infrastructure. Also, we use the Node.js platform to create small applications in JavaScript to build cloud-native applications.

All source code in listings or in text is in `a fixed-width font like this` to separate it from ordinary text. Code annotations accompany many of the listings, highlighting important concepts. In some cases, numbered bullets link to explanations that follow the listing, and sometimes we needed to break a line into two or more to fit on the page. In our bash code, we used the continuation backslash. The $ at the beginning indicates that the following line was an input. If you are using Windows, you have to make the following adjustments: the leading $ can be ignored. In PowerShell: replace the continuation backslash \ with a `. At the command prompt: replace \ with a ^. An artificial line break is indicated by this symbol: ➥.

You can get executable snippets of code from the liveBook (online) version of this book at **https://livebook.manning.com/book/amazon-web-services-in-action-third-edition**. The complete code for the examples in the book is available for download from the Manning website at **https://www.manning.com/books/amazon-web-services-in-action-third-edition**, and from GitHub at **https://github.com/AWSinAction/code3/**.

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Manning's commitment to our readers is to provide a venue where a meaningful dialogue between individual readers and between readers and the author can take place. It is not a commitment to any specific amount of participation on the part of the authors, whose contribution to the forum remains voluntary (and unpaid). We suggest you try asking them some challenging questions lest their interest stray! The forum and the archives of previous discussions will be accessible from the publisher's website as long as the book is in print.

about the authors

Andreas Wittig and **Michael Wittig** are software engineers and consultants, focusing on Amazon Web Services. The brothers started building on AWS in 2013 when migrating the IT infrastructure of a German bank to AWS—the first bank in Germany to do so. Since 2015, Andreas and Michael have worked as consultants, helping their clients migrate and run their workloads on AWS. They focus on Infrastructure as Code, continuous deployment, serverless applications based on AWS Lambda, containers, and security. Andreas and Michael are building SaaS products on top of Amazon's cloud as well. On top of that, Andreas and Michael love to share their knowledge and teach others how to use Amazon Web Services through their book, *Amazon Web Services in Action*, as well as their blog, podcast, and YouTube channel at **cloudonaut.io**.

about the cover illustration

The figure on the cover of *Amazon Web Services in Action, Third Edition*, is "Paysan du Canton de Lucerne," or "A Peasant from the Canton of Lucerne," taken from a collection by Jacques Grasset de Saint-Sauveur, published in 1797. Each illustration is finely drawn and colored by hand.

In those days, it was easy to identify where people lived and what their trade or station in life was just by their dress. Manning celebrates the inventiveness and initiative of the computer business with book covers based on the rich diversity of regional culture centuries ago, brought back to life by pictures from collections such as this one.