



## Preface

### About the Book

A recent industry report from Gartner points out that choices related to cloud computing at enterprises have changed from "if" to "how" to build, deploy, consume, manage, secure and integrate cloud services into their operations. The cloud solutions architect is the person who defines the enterprise cloud strategy from a technical point of view and must take responsibility for rolling out these cloud services.

Cloud computing is a transformative paradigm that enables scalable, convenient, on-demand access to a shared pool of configurable computing and networking resources, for efficiently delivering applications and services over the Internet. Amazon Web Services (AWS), a leading provider of cloud platforms and services, defines a cloud solutions architect as one who can provide solution plans for the best architectural practices for cloud applications, can design and deploy highly scalable and fault-tolerant services, can assist in lifting legacy applications and shifting them to the cloud, and can identify and plan for data entry and exit from the cloud platform, choose suitable cloud services based on data, compute, and security requirements. Further, the cloud solutions architect also ensures that enterprise offerings conform to sound principles, such as AWS Well-Architected Framework (WAF) for cloud applications and services.

We have written this textbook, as part of our expanding "A Hands-On Approach"<sup>TM</sup> series, to meet this need at colleges and universities. This book is written as a textbook for training the next generation of cloud solutions architects for educational programs at colleges and universities, and also accompanying cloud certification programs where students would be interested in obtaining valuable hands-on skills on actual cloud platforms to further develop their knowledge and competency base.

The typical reader is expected to have completed a couple of courses in programming using traditional high-level languages at the college level, and is either a senior or a beginning graduate student in one of the science, technology, engineering or mathematics (STEM) fields. The reader is provided the necessary guidance and knowledge to develop working code for

real-world cloud computing applications. Concurrent development of practical applications that accompanies traditional instructional material within the book further enhances the learning process, in our opinion. Furthermore, an accompanying website for this book contains additional support for instruction and learning.

The book is organized into twenty chapters that provide in-depth coverage of concepts, technologies, and architectures related to cloud computing environments and cloud applications. Real-world examples of cloud-based services and their characteristics are described. Reference architectures for different classes of cloud applications, including e-Commerce, Banking, Business-to-Business, Retail, and Social Networking in the context of commonly used design methodologies are examined in detail. The reader is also introduced to specialized aspects of cloud computing, including serverless computing, cloud security, and big data analytics. Case studies on the applications of the cloud in industry, healthcare, transportation systems, smart grids and education are provided.

Through generous use of hundreds of figures and tested code samples, we have attempted to provide a rigorous "no hype" guide to cloud computing. It is expected that diligent readers of this book can use these exercises to develop their own applications on cloud platforms, such as those from Amazon Web Services, Google Cloud, and Microsoft's Windows Azure. We adopted an informal approach to describing well-known concepts primarily because these topics are covered well in existing textbooks, and our focus instead is on getting the reader firmly on track to developing robust cloud computing applications as opposed to more theory.

While we frequently refer to offerings from commercial vendors, this book is not an endorsement of their products or services, nor is any portion of our work supported financially (or otherwise) by these vendors. All trademarks and products belong to their respective owners and the underlying principles and approaches, we believe, are applicable to other vendors as well. The opinions in this book are those of the authors alone.

Please also refer to our books "Cloud Computing: A Hands-On Approach™", "Internet of Things: A Hands-On Approach™", "Big Data Science & Analytics: A Hands-On Approach™" and "Blockchain Applications: A Hands-On Approach™" that provide additional and complementary information on these topics. We are grateful to the Association of Computing Surveys (ACM) for recognizing our book on cloud computing as a "Notable Book of 2014" as part of their annual literature survey. We are also grateful to the universities worldwide that have adopted these textbooks as part of their program offerings for providing us feedback that has helped us in improving our offerings.

## **Book Website**

For more information on the book, the copyrighted source code of all examples in the book, lab exercises, and instructor material visit the book website: [www.hands-on-books-series.com](http://www.hands-on-books-series.com)

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## Preparing for AWS Certified Solutions Architect

This book has been written to assist in providing a solid foundation for the AWS Certified Solutions Architect (Associate) Exam. This book serves as an in-depth study guide for AWS Solutions Architect Certification and a companion to the official study guide for this exam.

As described in the AWS Certified Solutions Architect examination guide, the AWS Certified Solutions Architect (Associate) examination validates an examinee's ability to:

- Define a solution using architectural design principles based on customer requirements.
- Provide implementation guidance based on best practices to the organization throughout the lifecycle of the project.

According to AWS, the main content domains for the AWS Certified Solutions Architect (Associate) Exam are as follows:

### Domain 1: Design Resilient Architectures

- 1.1 Choose reliable/resilient storage.
- 1.2 Determine how to design decoupling mechanisms using AWS services.
- 1.3 Determine how to design a multi-tier architecture solution.
- 1.4 Determine how to design high availability and/or fault-tolerant architectures.

### Domain 2: Define Performant Architectures

- 2.1 Choose performant storage and databases.
- 2.2 Apply caching to improve performance.
- 2.3 Design solutions for elasticity and scalability.

### Domain 3: Specify Secure Applications and Architectures

- 3.1 Determine how to secure application tiers.
- 3.2 Determine how to secure data.
- 3.3 Define the networking infrastructure for a single VPC application.

### Domain 4: Design Cost-Optimized Architectures

- 4.1 Determine how to design cost-optimized storage.
- 4.2 Determine how to design cost-optimized compute.

### Domain 5: Define Operationally-Excellent Architectures

- 5.1 Choose design features in solutions that enable operational excellence.

In this book, we cover each of the above content domains through case studies and tested code samples.

In addition to the topics covered in this book, we recommend the readers to study the following AWS whitepapers and FAQs:

### Whitepaper: Architecting for the Cloud: AWS Best Practices

[https://d1.awsstatic.com/whitepapers/AWS\\_Cloud\\_Best\\_Practices.pdf](https://d1.awsstatic.com/whitepapers/AWS_Cloud_Best_Practices.pdf)

## Whitepaper: AWS Well-Architected webpage

<https://aws.amazon.com/architecture/well-architected/>

### Amazon EC2 FAQs

<https://aws.amazon.com/ec2/faqs/>

### Amazon S3 FAQs

<https://aws.amazon.com/s3/faqs/>

### Amazon VPC FAQs

<https://aws.amazon.com/vpc/faqs/>

### Amazon Route 53 FAQs

<https://aws.amazon.com/route53/faqs/>

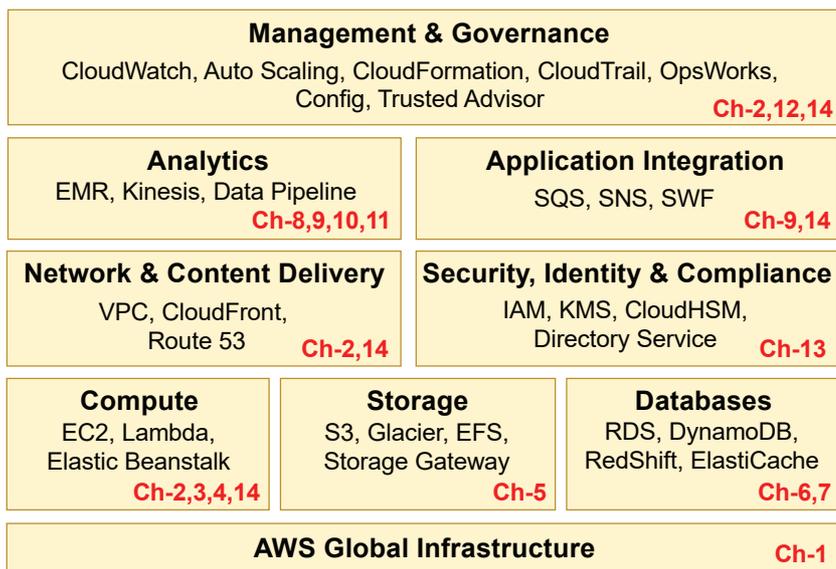
### Amazon RDS FAQs

<https://aws.amazon.com/rds/faqs/>

### Amazon SQS FAQs

<https://aws.amazon.com/sqs/faqs/>

The key AWS services which you must know for the AWS Certified Solutions Architect exam are shown in the figure below:



Key AWS services to learn for AWS Certified Solutions Architect exam and mapping to chapters in this book

## Acknowledgments

### *From Arshdeep Bahga*

I would like to thank my father, Sarbjit Bahga, for inspiring me to write books and sharing his valuable insights and experiences on authoring books. This book could not have been completed without the support of my mother Gurdeep Kaur, wife Navsangeet Kaur, son Navroz Bahga and brother Supreet Bahga, who have always motivated me and encouraged me to explore my interests.

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### *From the Authors*

We would like to acknowledge the instructors who have adopted our earlier books in the "A Hands-On Approach"<sup>TM</sup> series, for their constructive feedback.

## About the Authors

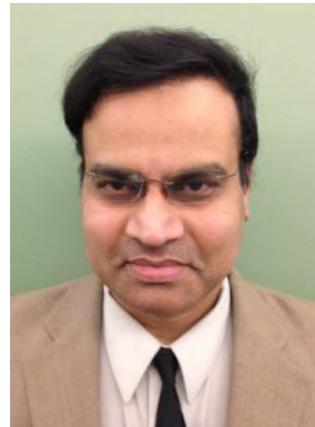
### **Arshdeep Bahga**

Arshdeep Bahga is a computer science researcher noted for his research work and textbooks in the areas of Blockchain, Internet of Things, Cloud Computing and Big Data. Arshdeep completed Masters degree in Electrical & Computer Engineering from Georgia Institute of Technology in 2010. He worked as Research Scientist with Georgia Tech from 2010-2016. Arshdeep has to his credit several scientific publications in peer-reviewed journals and technology patents. Arshdeep received the 2014 Roger P. Webb - Research Spotlight Award from the School of Electrical and Computer Engineering, Georgia Tech.



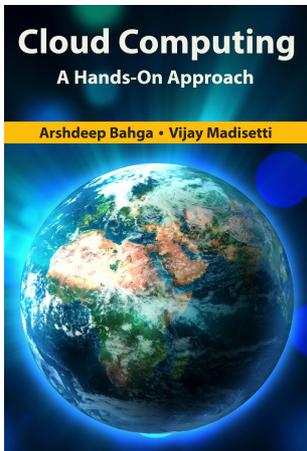
### **Vijay Madisetti**

Vijay Madisetti is a Professor of Electrical and Computer Engineering at Georgia Institute of Technology. Vijay is a Fellow of the IEEE, and received the 2006 Terman Medal from the American Society of Engineering Education and HP Corporation.



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## Companion Books from the Authors



### Cloud Computing: A Hands-On Approach

Recent industry surveys expect the cloud computing services market to be in excess of \$20 billion and cloud computing jobs to be in excess of 10 million worldwide in 2014 alone. In addition, since a majority of existing information technology (IT) jobs are focused on maintaining legacy in-house systems, the demand for these kinds of jobs is likely to drop rapidly if cloud computing continues to take hold of the industry. However, there are very few educational options available in the area of cloud computing beyond vendor-specific training by cloud providers themselves. Cloud computing courses have not found their way (yet) into mainstream college curricula. This book is written as a textbook on cloud computing for educational programs at colleges. It can also be used by cloud service providers who may be interested in offering a broader perspective of cloud computing to accompany their customer and employee training programs.



### Internet of Things: A Hands-On Approach

Internet of Things (IoT) refers to physical and virtual objects that have unique identities and are connected to the Internet to facilitate intelligent applications that make energy, logistics, industrial control, retail, agriculture, and many other domains "smarter". Internet of Things is a new revolution of the Internet that is rapidly gathering momentum driven by the advancements in sensor networks, mobile devices, wireless communications, networking, and cloud technologies. Experts forecast that by the year 2020 there will be a total of 50 billion devices/things connected to the Internet. This book is written as a textbook on the Internet of Things for educational programs at colleges and universities, and also for IoT vendors and service providers who may be interested in offering a broader perspective of Internet of Things to accompany their customer and developer training programs.

## Big Data Science & Analytics: A Hands-On Approach

Big data is defined as collections of datasets whose volume, velocity or variety is so large that it is difficult to store, manage, process, and analyze the data using traditional databases and data processing tools. Big data science and analytics deal with the collection, storage, processing, and analysis of massive-scale data. We have written this textbook to meet this need at colleges and universities, and also for big data service providers who may be interested in offering a broader perspective of this emerging field to accompany their customer and developer training programs.

The book is organized into three main parts, comprising a total of twelve chapters. Part I provides an introduction to big data, applications of big data, and big data science and analytics patterns and architectures. Part II introduces the reader to various tools and frameworks for big data analytics, and the architectural and programming aspects of these frameworks, with examples in Python. Part III introduces the reader to various machine learning algorithms with examples using the Spark MLlib and H2O frameworks, and visualizations using frameworks such as Lightning, Pygal, and Seaborn.

## Blockchain Applications: A Hands-On Approach

Blockchain is a distributed and public ledger that maintains records of all the transactions on a blockchain network comprising suppliers of products and services and consumers. With the blockchain's ability to establish trust in a peer-to-peer network through a distributed consensus mechanism rather than relying on a powerful centralized authority, the technology is being seen by the industry experts as one of the greatest innovations since the invention of the Internet.

The book is organized into three main parts, comprising a total of ten chapters. Part I provides an introduction to blockchain concepts, design patterns, and architectures for blockchain applications. A blockchain stack comprising a decentralized computation platform, a decentralized messaging platform, and a decentralized storage platform is described. Part II introduces the readers to tools and platforms for blockchain. Implementation examples of various smart contracts and decentralized applications (Dapps) are provided. The reader is introduced to the Whisper decentralized messaging platform and Swarm decentralized storage platform. Part III focuses on advanced topics such as the security and scalability related challenges for the blockchain platforms.

