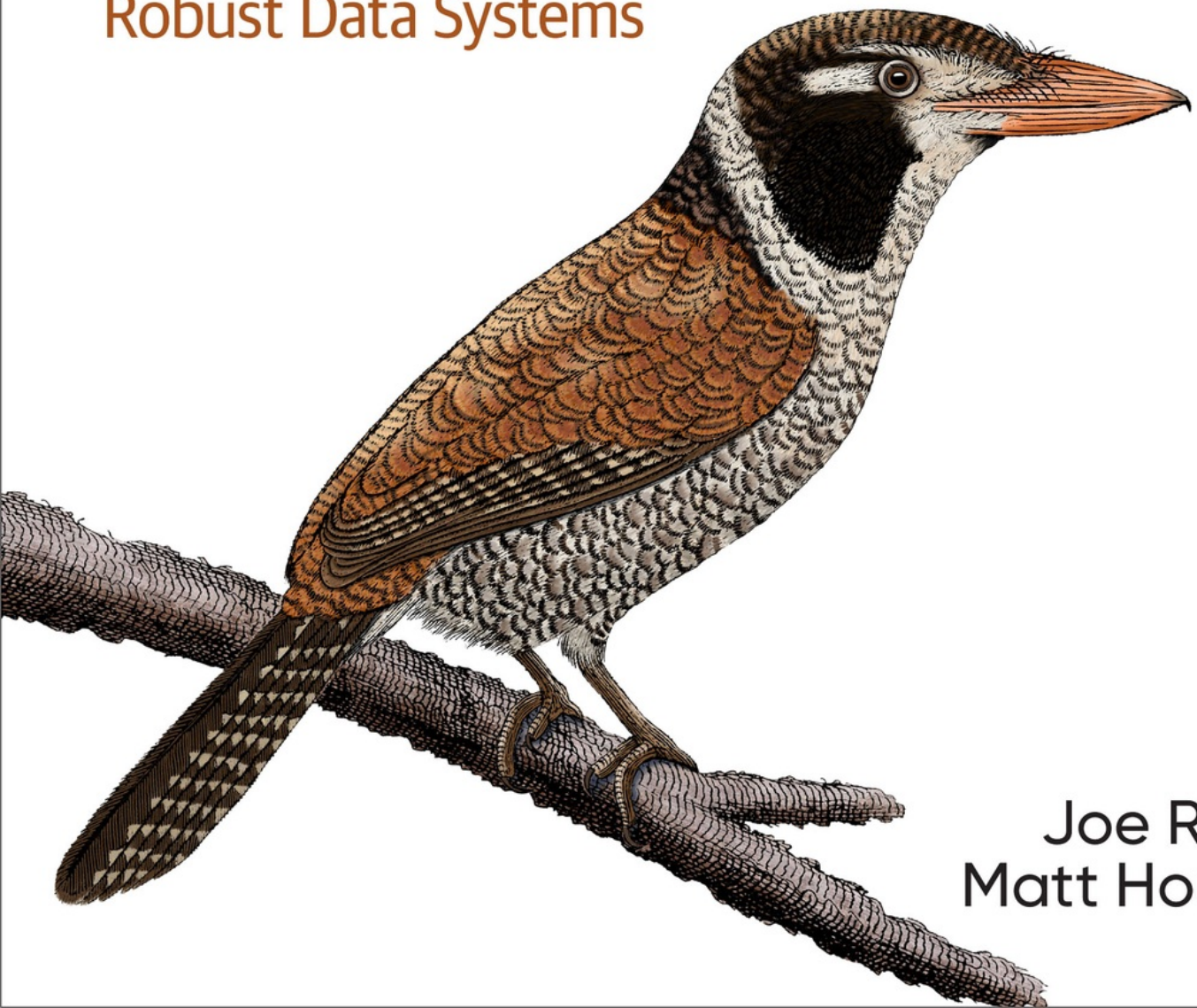
O'REILLY®

Fundamentals of Data Engineering

Plan and Build Robust Data Systems



Joe Reis &
Matt Housley

Fundamentals of Data Engineering

Plan and Build Robust Data Systems

Joe Reis and Matt Housley

Fundamentals of Data Engineering

by Joe Reis and Matt Housley

Printed in the United States of America.

Published by O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472.

O'Reilly books may be purchased for educational, business, or sales promotional use. Online editions are also available for most titles (*http://oreilly.com*). For more information, contact our corporate/institutional sales department: 800-998-9938 or *corporate@oreilly.com*.

Acquisitions Editor: Jessica Haberman

Development Editor: Michele Cronin

Production Editor: Gregory Hyman

Copyeditor: Sharon Wilkey

Proofreader: Amnet Systems, LLC

Indexer: Judith McConville

Interior Designer: David Futato

Cover Designer: Karen Montgomery

Illustrator: Kate Dullea

June 2022: First Edition

Revision History for the First Edition

- 2022-06-22: First Release

See *http://oreilly.com/catalog/errata.csp?isbn=9781098108304* for release details.

978-1-098-10830-4

[LSI]

Preface

How did this book come about? The origin is deeply rooted in our journey from data science into data engineering. We often jokingly refer to ourselves as *recovering data scientists*. We both had the experience of being assigned to data science projects, then struggling to execute these projects due to a lack of proper foundations. Our journey into data engineering began when we undertook data engineering tasks to build foundations and infrastructure.

With the rise of data science, companies splashed out lavishly on data science talent, hoping to reap rich rewards. Very often, data scientists struggled with basic problems that their background and training did not address—data collection, data cleansing, data access, data transformation, and data infrastructure. These are problems that data engineering aims to solve.

What This Book Isn’t

Before we cover what this book is about and what you’ll get out of it, let’s quickly cover what this book *isn’t*. This book isn’t about data engineering using a particular tool, technology, or platform. While many excellent books approach data engineering technologies from this perspective, these books have a short shelf life. Instead, we try to focus on the fundamental concepts behind data engineering.

What This Book Is About

This book aims to fill a gap in current data engineering content and materials. While there's no shortage of technical resources that address specific data engineering tools and technologies, people struggle to understand how to assemble these components into a coherent whole that applies in the real world. This book connects the dots of the end-to-end data lifecycle. It shows you how to stitch together various technologies to serve the needs of downstream data consumers such as analysts, data scientists, and machine learning engineers. This book works as a complement to O'Reilly books that cover the details of particular technologies, platforms and programming languages.

The big idea of this book is the *data engineering lifecycle*: data generation, storage, ingestion, transformation, and serving Since the dawn of data, we've seen the rise and fall of innumerable specific technologies and vendor products, but the data engineering life cycle stages have remained essentially unchanged. With this framework, the reader will come away with a sound understanding for applying technologies to real-world business problems.

Our goal here is to map out principles that reach across two axes. First, we wish to distill data engineering into principles that can encompass *any relevant technology*. Second, we wish to present principles that will stand the test of *time*. We hope that these ideas reflect lessons learned across the data technology upheaval of the last twenty years and that our mental framework will remain useful for a decade or more into the future.

One thing to note: we unapologetically take a cloud-first approach. We view the cloud as a fundamentally transformative development that will endure for decades; most on-premises data systems and workloads will eventually move to cloud hosting. We assume that infrastructure and systems are *ephemeral* and *scalable*, and that data engineers will lean toward deploying managed services in the cloud. That said, most concepts in this book will translate to non-cloud environments.

Who Should Read This Book

Our primary intended audience for this book consists of technical practitioners, mid- to senior-level software engineers, data scientists, or analysts interested in moving into data engineering; or data engineers working in the guts of specific technologies, but wanting to develop a more comprehensive perspective. Our secondary target audience consists of data stakeholders who work adjacent to technical practitioners—e.g., a data team lead with a technical background overseeing a team of data engineers, or a director of data warehousing wanting to migrate from on-premises technology to a cloud-based solution.

Ideally, you're curious and want to learn—why else would you be reading this book? You stay current with data technologies and trends by reading books and articles on data warehousing/data lakes, batch and streaming systems, orchestration, modeling, management, analysis, developments in cloud technologies, etc. This book will help you weave what you've read into a complete picture of data engineering across technologies and paradigms.

Prerequisites

We assume a good deal of familiarity with the types of data systems found in a corporate setting. In addition, we assume that readers have some familiarity with SQL and Python (or some other programming language), and experience with cloud services.

Numerous resources are available for aspiring data engineers to practice Python and SQL. Free online resources abound (blog posts, tutorial sites, YouTube videos), and many new Python books are published every year.

The cloud provides unprecedented opportunities to get hands-on experience with data tools. We suggest that aspiring data engineers set up accounts with cloud services such as AWS, Azure, Google Cloud Platform, Snowflake, Databricks, etc. Note that many of these platforms have *free tier*

options, but readers should keep a close eye on costs, and work with small quantities of data and single node clusters as they study.

Developing familiarity with corporate data systems outside of a corporate environment remains difficult and this creates certain barriers for aspiring data engineers who have yet to land their first data job. This book can help. We suggest that data novices read for high level ideas, and then look at materials in the *additional resources* section at the end of each chapter. On a second read through, note any unfamiliar terms and technologies. You can utilize Google, Wikipedia, blog posts, YouTube videos, and vendor sites to become familiar with new terms and fill gaps in your understanding.

What You'll Learn and How It Will Improve Your Abilities

This book aims to help you build a solid foundation for solving real world data engineering problems.

By the end of this book you will understand:

- How data engineering impacts your current role (data scientist, software engineer, or data team lead).
- How to cut through the marketing hype and choose the right technologies, data architecture, and processes.
- How to use the data engineering lifecycle to design and build a robust architecture.
- Best practices for each stage of the data lifecycle.

And you will be able to:

- Incorporate data engineering principles in your current role (data scientist, analyst, software engineer, data team lead, etc.)
- Stitch together a variety of cloud technologies to serve the needs of downstream data consumers.

- Assess data engineering problems with an end-to-end framework of best practices
- Incorporate data governance and security across the data engineering lifecycle.