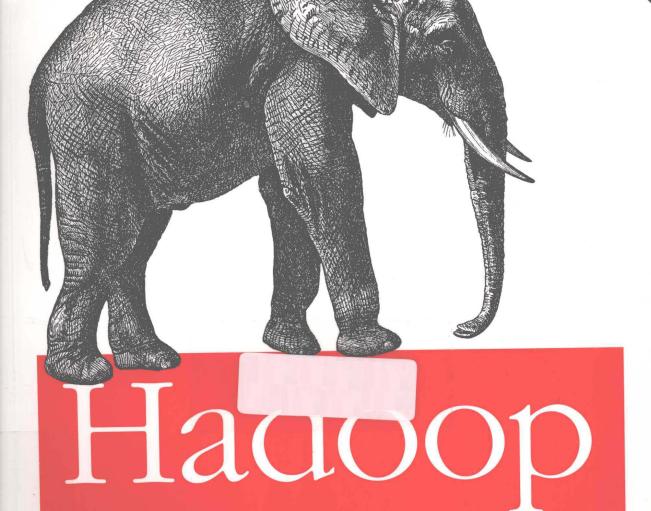
Hadoop权威指南(影印版)

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The Definitive Guide

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Tom White 著

# Hadoop权威指南 (影印版)

**Hadoop: The Definitive Guide** 

Tom White

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## **Foreword**

Hadoop got its start in Nutch. A few of us were attempting to build an open source web search engine and having trouble managing computations running on even a handful of computers. Once Google published its GFS and MapReduce papers, the route became clear. They'd devised systems to solve precisely the problems we were having with Nutch. So we started, two of us, half-time, to try to re-create these systems as a part of Nutch.

We managed to get Nutch limping along on 20 machines, but it soon became clear that to handle the Web's massive scale, we'd need to run it on thousands of machines and, moreover, that the job was bigger than two half-time developers could handle.

Around that time, Yahoo! got interested, and quickly put together a team that I joined. We split off the distributed computing part of Nutch, naming it Hadoop. With the help of Yahoo!, Hadoop soon grew into a technology that could truly scale to the Web.

In 2006, Tom White started contributing to Hadoop. I already knew Tom through an excellent article he'd written about Nutch, so I knew he could present complex ideas in clear prose. I soon learned that he could also develop software that was as pleasant to read as his prose.

From the beginning, Tom's contributions to Hadoop showed his concern for users and for the project. Unlike most open source contributors, Tom is not primarily interested in tweaking the system to better meet his own needs, but rather in making it easier for anyone to use.

Initially, Tom specialized in making Hadoop run well on Amazon's EC2 and S3 services. Then he moved on to tackle a wide variety of problems, including improving the MapReduce APIs, enhancing the website, and devising an object serialization framework. In all cases, Tom presented his ideas precisely. In short order, Tom earned the role of Hadoop committer and soon thereafter became a member of the Hadoop Project Management Committee.

Tom is now a respected senior member of the Hadoop developer community. Though he's an expert in many technical corners of the project, his specialty is making Hadoop easier to use and understand.

Given this, I was very pleased when I learned that Tom intended to write a book about Hadoop. Who could be better qualified? Now you have the opportunity to learn about Hadoop from a master—not only of the technology, but also of common sense and plain talk.

> —Doug Cutting Shed in the Yard, California

## **Preface**

Martin Gardner, the mathematics and science writer, once said in an interview:

Beyond calculus, I am lost. That was the secret of my column's success. It took me so long to understand what I was writing about that I knew how to write in a way most readers would understand. $^{\rm I}$ 

In many ways, this is how I feel about Hadoop. Its inner workings are complex, resting as they do on a mixture of distributed systems theory, practical engineering, and common sense. And to the uninitiated, Hadoop can appear alien.

But it doesn't need to be like this. Stripped to its core, the tools that Hadoop provides for building distributed systems—for data storage, data analysis, and coordination—are simple. If there's a common theme, it is about raising the level of abstraction—to create building blocks for programmers who just happen to have lots of data to store, or lots of data to analyze, or lots of machines to coordinate, and who don't have the time, the skill, or the inclination to become distributed systems experts to build the infrastructure to handle it.

With such a simple and generally applicable feature set, it seemed obvious to me when I started using it that Hadoop deserved to be widely used. However, at the time (in early 2006), setting up, configuring, and writing programs to use Hadoop was an art. Things have certainly improved since then: there is more documentation, there are more examples, and there are thriving mailing lists to go to when you have questions. And yet the biggest hurdle for newcomers is understanding what this technology is capable of, where it excels, and how to use it. That is why I wrote this book.

The Apache Hadoop community has come a long way. Over the course of three years, the Hadoop project has blossomed and spun off half a dozen subprojects. In this time, the software has made great leaps in performance, reliability, scalability, and manageability. To gain even wider adoption, however, I believe we need to make Hadoop even easier to use. This will involve writing more tools; integrating with more systems; and

<sup>1. &</sup>quot;The science of fun," Alex Bellos, The Guardian, May 31, 2008, http://www.guardian.co.uk/science/2008/may/31/maths.science.

writing new, improved APIs. I'm looking forward to being a part of this, and I hope this book will encourage and enable others to do so, too.

#### **Administrative Notes**

During discussion of a particular Java class in the text, I often omit its package name to reduce clutter. If you need to know which package a class is in, you can easily look it up in Hadoop's Java API documentation for the relevant subproject, linked to from the Apache Hadoop home page at <a href="http://hadoop.apache.org/">http://hadoop.apache.org/</a>. Or if you're using an IDE, it can help using its auto-complete mechanism.

Similarly, although it deviates from usual style guidelines, program listings that import multiple classes from the same package may use the asterisk wildcard character to save space (for example, import org.apache.hadoop.io.\*).

The sample programs in this book are available for download from the website that accompanies this book: <a href="http://www.hadoopbook.com/">http://www.hadoopbook.com/</a>. You will also find instructions there for obtaining the datasets that are used in examples throughout the book, as well as further notes for running the programs in the book, and links to updates, additional resources, and my blog.

#### What's in This Book?

The rest of this book is organized as follows. Chapter 1 emphasizes the need for Hadoop and sketches the history of the project. Chapter 2 provides an introduction to MapReduce. Chapter 3 looks at Hadoop filesystems, and in particular HDFS, in depth. Chapter 4 covers the fundamentals of I/O in Hadoop: data integrity, compression, serialization, and file-based data structures.

The next four chapters cover MapReduce in depth. Chapter 5 goes through the practical steps needed to develop a MapReduce application. Chapter 6 looks at how MapReduce is implemented in Hadoop, from the point of view of a user. Chapter 7 is about the MapReduce programming model and the various data formats that MapReduce can work with. Chapter 8 is on advanced MapReduce topics, including sorting and joining data.

Chapters 9 and 10 are for Hadoop administrators and describe how to set up and maintain a Hadoop cluster running HDFS and MapReduce.

Later chapters are dedicated to projects that build on Hadoop or are related to it. Chapters 11 and 12 present Pig and Hive, which are analytics platforms built on HDFS and MapReduce, whereas Chapters 13, 14, and 15 cover HBase, ZooKeeper, and Sqoop, respectively.

Finally, Chapter 16 is a collection of case studies contributed by members of the Apache Hadoop community.

### . What's New in the Second Edition?

The second edition has two new chapters on Hive and Sqoop (Chapters 12 and 15), a new section covering Avro (in Chapter 4), an introduction to the new security features in Hadoop (in Chapter 9), and a new case study on analyzing massive network graphs using Hadoop (in Chapter 16).

This edition continues to describe the 0.20 release series of Apache Hadoop because this was the latest stable release at the time of writing. New features from later releases are occasionally mentioned in the text, however, with reference to the version that they were introduced in.

#### What's New in the Third Edition?

The third edition covers the 1.x (formerly 0.20) release series of Apache Hadoop, as well as the newer 0.22 and 2.x (formerly 0.23) series. With a few exceptions, which are noted in the text, all the examples in this book run against these versions. The features in each release series are described at a high level in "Hadoop Releases" on page 13.

This edition uses the new MapReduce API for most of the examples. Because the old API is still in widespread use, it continues to be discussed in the text alongside the new API, and the equivalent code using the old API can be found on the book's website.

The major change in Hadoop 2.0 is the new MapReduce runtime, MapReduce 2, which is built on a new distributed resource management system called YARN. This edition includes new sections covering MapReduce on YARN: how it works (Chapter 6) and how to run it (Chapter 9).

There is more MapReduce material, too, including development practices such as packaging MapReduce jobs with Maven, setting the user's Java classpath, and writing tests with MRUnit (all in Chapter 5); and more depth on features such as output committers, the distributed cache (both in Chapter 8), and task memory monitoring (Chapter 9). There is a new section on writing MapReduce jobs to process Avro data (Chapter 4), and one on running a simple MapReduce workflow in Oozie (Chapter 5).

The chapter on HDFS (Chapter 3) now has introductions to high availability, federation, and the new WebHDFS and HttpFS filesystems.

The chapters on Pig, Hive, Sqoop, and ZooKeeper have all been expanded to cover the new features and changes in their latest releases.

In addition, numerous corrections and improvements have been made throughout the book.

#### Conventions Used in This Book

The following typographical conventions are used in this book:

Italic

Indicates new terms, URLs, email addresses, filenames, and file extensions.

#### Constant width

Used for program listings, as well as within paragraphs to refer to program elements such as variable or function names, databases, data types, environment variables, statements, and keywords.

#### Constant width bold

Shows commands or other text that should be typed literally by the user.

#### Constant width italic

Shows text that should be replaced with user-supplied values or by values determined by context.



This icon signifies a tip, suggestion, or general note.



This icon indicates a warning or caution.

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# **Table of Contents**

Preface  1. Meet Hadoop  Data!  Data Storage and Analysis  Comparison with Other Systems  Rational Database Management System  Grid Computing  Volunteer Computing  A Brief History of Hadoop  Apache Hadoop and the Hadoop Ecosystem  Hadoop Releases  What's Covered in This Book  Compatibility  2. MapReduce  A Weather Dataset	
Data! Data Storage and Analysis Comparison with Other Systems Rational Database Management System Grid Computing Volunteer Computing A Brief History of Hadoop Apache Hadoop and the Hadoop Ecosystem Hadoop Releases What's Covered in This Book Compatibility  2. MapReduce A Weather Dataset	xvii
Data Storage and Analysis Comparison with Other Systems Rational Database Management System Grid Computing Volunteer Computing A Brief History of Hadoop Apache Hadoop and the Hadoop Ecosystem Hadoop Releases What's Covered in This Book Compatibility  2. MapReduce A Weather Dataset	1
Comparison with Other Systems Rational Database Management System Grid Computing Volunteer Computing A Brief History of Hadoop Apache Hadoop and the Hadoop Ecosystem Hadoop Releases What's Covered in This Book Compatibility  2. MapReduce A Weather Dataset	1
Rational Database Management System Grid Computing Volunteer Computing A Brief History of Hadoop Apache Hadoop and the Hadoop Ecosystem Hadoop Releases What's Covered in This Book Compatibility  2. MapReduce A Weather Dataset	3
Grid Computing Volunteer Computing A Brief History of Hadoop Apache Hadoop and the Hadoop Ecosystem Hadoop Releases What's Covered in This Book Compatibility  2. MapReduce A Weather Dataset	4
Volunteer Computing A Brief History of Hadoop Apache Hadoop and the Hadoop Ecosystem Hadoop Releases What's Covered in This Book Compatibility  2. MapReduce A Weather Dataset	4
A Brief History of Hadoop Apache Hadoop and the Hadoop Ecosystem Hadoop Releases What's Covered in This Book Compatibility  2. MapReduce A Weather Dataset	6
Apache Hadoop and the Hadoop Ecosystem Hadoop Releases What's Covered in This Book Compatibility  2. MapReduce A Weather Dataset	8
Hadoop Releases What's Covered in This Book Compatibility  2. MapReduce A Weather Dataset	9
What's Covered in This Book Compatibility  2. MapReduce	12
Compatibility  2. MapReduce	13
2. MapReduce	15
A Weather Dataset	15
	. 17
Б. П	17
Data Format	17
Analyzing the Data with Unix Tools	19
Analyzing the Data with Hadoop	20
Map and Reduce	20
Java MapReduce	22
Scaling Out	30
Data Flow	30
Combiner Functions	33
Running a Distributed MapReduce Job	36
Hadoop Streaming	36
Ruby	36
Python	39

	Hadoop Pipes	40
	Compiling and Running	41
3.	The Hadoop Distributed Filesystem	. 43
	The Design of HDFS	43
	HDFS Concepts	45
	Blocks	45
	Namenodes and Datanodes	46
	HDFS Federation	47
	HDFS High-Availability	48
	The Command-Line Interface	49
	Basic Filesystem Operations	50
	Hadoop Filesystems	52
	Interfaces	53
	The Java Interface	55
	Reading Data from a Hadoop URL	55
	Reading Data Using the FileSystem API	57
	Writing Data	60
	Directories	62
	Querying the Filesystem	62
	Deleting Data	67
	Data Flow	67
	Anatomy of a File Read	67
	Anatomy of a File Write	70
	Coherency Model	72
	Data Ingest with Flume and Sqoop	74
	Parallel Copying with distop	75
	Keeping an HDFS Cluster Balanced	76
	Hadoop Archives	77
	Using Hadoop Archives Limitations	77
	Limitations	79
4.	Hadoop I/O	81
	Data Integrity	81
	Data Integrity in HDFS	81
	LocalFileSystem	82
	ChecksumFileSystem	83
	Compression	83
	Codecs	85
	Compression and Input Splits	89
	Using Compression in MapReduce	90
	Serialization The Weigeble Leaves are	93
	The Writable Interface	94

	Writable Classes	96
	Implementing a Custom Writable	103
	Serialization Frameworks	108
	Avro	110
	Avro Data Types and Schemas	111
	In-Memory Serialization and Deserialization	114
	Avro Datafiles	117
	Interoperability	118
	Schema Resolution	121
	Sort Order	123
	Avro MapReduce	124
	Sorting Using Avro MapReduce	128
	Avro MapReduce in Other Languages	130
	File-Based Data Structures	130
	SequenceFile	130
	MapFile	137
_	Davidsoin - Man Dadosa Annii satism	143
5.	Developing a MapReduce Application	143
	The Configuration API	144
	Combining Resources	145
	Variable Expansion	146
	Setting Up the Development Environment	146
	Managing Configuration	148
	GenericOptionsParser, Tool, and ToolRunner	150
	Writing a Unit Test with MRUnit	154
	Mapper	154
	Reducer	156
	Running Locally on Test Data	157
	Running a Job in a Local Job Runner	157
	Testing the Driver	160
	Running on a Cluster	161
	Packaging a Job	162
	Launching a Job	163
	The MapReduce Web UI	165
	Retrieving the Results	168
	Debugging a Job	170
	Hadoop Logs	175
	Remote Debugging	177
	Tuning a Job	178
	Profiling Tasks	179
	MapReduce Workflows	181
	Decomposing a Problem into MapReduce Jobs	181
	JohControl	193

	Apache Oozie	183
6.	How MapReduce Works	. 189
	Anatomy of a MapReduce Job Run	189
	Classic MapReduce (MapReduce 1)	190
	YARN (MapReduce 2)	196
	Failures	202
	Failures in Classic MapReduce	202
	Failures in YARN	204
	Job Scheduling	206
	The Fair Scheduler	207
	The Capacity Scheduler	207
	Shuffle and Sort	208
	The Map Side	208
	The Reduce Side	210
	Configuration Tuning	211
	Task Execution	214
	The Task Execution Environment	215
	Speculative Execution	215
	Output Committers	217
	Task JVM Reuse	219
	Skipping Bad Records	220
7.	MapReduce Types and Formats	. 223
	MapReduce Types	223
	The Default MapReduce Job	227
	Input Formats	234
	Input Splits and Records	234
	Text Input	245
	Binary Input	249
	Multiple Inputs	250
	Database Input (and Output)	251
	Output Formats	251
	Text Output	252
	Binary Output	253
	Multiple Outputs	253
	Lazy Output	257
	Database Output	258
8.	MapReduce Features	259
	Counters	259
	Built-in Counters	259
	User-Defined Java Counters	264
	· • · · · · · · · · · · · · · · · · · ·	∠∪T

viii | Table of Contents