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# Expert MySQL

*Wield tremendous power over MySQL by learning how to create new SQL commands, add user-defined functions, build a pluggable storage engine, and use the embedded engine.*

Charles A. Bell

Apress®

# Expert MySQL



Charles A. Bell

## **Expert MySQL**

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# About the Author



**CHARLES A. BELL** conducts research in emerging technologies. He is an adjunct professor at Virginia Commonwealth University, where he teaches graduate-level computer science courses. He recently joined MySQL AB as a senior software developer. He lives in a small town in rural Virginia with his loving wife. Chuck received his Doctor of Philosophy in Engineering from Virginia Commonwealth University in 2005. His research interests include database systems, versioning systems, semantic web, and agile software development.

Chuck's research projects and development of an advanced database versioning system make him uniquely qualified to author this book. He is an expert in the database field and has extensive knowledge and experience in modifying the MySQL source code. With over 25 years' experience in enterprise development and systems architecture, Chuck is well qualified to create a book that gives excellent insight into developing and modifying open source systems.



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# Introduction

**M**ySQL has been identified as the world's most popular open source database and the fastest-growing database system in the industry. MySQL AB is reporting over 8 million active installations and nearly 50,000 downloads per day. MySQL is rapidly becoming the database system of choice for system integrators. According to an article in the *SD Times*, MySQL is now the number three "Top Deployed Database" in a recent survey of over 900 readers ([www.mysql.com/why-mysql/marketshare/](http://www.mysql.com/why-mysql/marketshare/)).

This book presents some advanced database system topics, examines the MySQL architecture, and provides an expert's workbook for examining, integrating, and modifying the MySQL source code for use in enterprise environments. The book provides insight into how to modify the MySQL system to meet the unique needs of system integrators and educators alike.

## How This Book Is Organized

The material is divided into three parts. Each part is designed to present a set of topics ranging from introductory material on MySQL and the open source revolution to extending and customizing the MySQL system and even how to build an experimental query optimizer and execution engine as an alternative to the MySQL query engine.

### Part 1

The first part of the book, "Getting Started with MySQL Development," is used to introduce concepts in developing and modifying open source systems. Part 1 provides you with the tools and resources necessary to begin exploring the more advanced database concepts presented in the rest of the book.

Chapter 1, "MySQL and the Open Source Revolution," is less technical and contains more narration than the rest of the book. It guides you through the benefits and responsibilities of an open source system integrator. It highlights the rapid growth of MySQL and its importance in the open source and database system markets. Additionally, it provides a clear perspective of the open source revolution.

Chapter 2, "The Anatomy of a Database System," covers the basics of what a database system is and how it is constructed. The anatomy of the MySQL system is used to illustrate the key components of modern relational database systems.

Chapter 3, "A Tour of the MySQL Source Code," presents a complete introduction to the MySQL source along with how to obtain and build the system. You are introduced to the mechanics of the source code along with coding guidelines and best practices for how the code is maintained.

Chapter 4, "Test-Driven MySQL Development," introduces a key element in generating high-quality extensions to the MySQL system. Software testing is presented along with the

common practices of how to test large systems. Specific examples are used to illustrate the accepted practices of testing the MySQL system.

## Part 2

Part 2, “Extending MySQL,” uses a hands-on approach to investigate the MySQL system. It introduces you to how the MySQL code can be modified and how the system can be used as an embedded database system. Examples and projects are used to illustrate how to debug the source code, how to modify the SQL commands to extend the language, and how to build a custom storage engine.

Chapter 5, “Debugging,” examines debugging skills and techniques that help make development easier and less prone to failure. Several debugging techniques are presented, along with the pros and cons of each.

Chapter 6, “Embedded MySQL,” provides a tutorial on embedding the MySQL system in enterprise applications. Example projects assist you in applying the skills you’ll learn to your own integration needs.

Chapter 7, “Building Your Own Storage Engine,” is the first of the MySQL modification chapters. It demonstrates techniques that require the least amount of modifications to the MySQL code. The MySQL pluggable storage engine capability is explored, using examples and projects that permit you to build a sample storage engine.

Chapter 8, “Adding Functions and Commands to MySQL,” presents the most popular modification to the MySQL code. You are shown how to modify the SQL commands and how to build custom SQL commands. The chapter includes examples of how to modify SQL commands to add new parameters, functions, and new commands.

## Part 3

Part 3, “Advanced Database Internals,” takes a deeper look into the MySQL system and provides you with an insider’s look at what makes the system work. The part begins with an introduction to the advanced database technologies. Theory and practices are presented in a no-nonsense manner to enable you to apply the knowledge gained to tackle the more complex topics of database systems. This part also presents examples of how to implement an internal query representation, an alternative query optimizer, and an alternative query execution mechanism. Examples and projects are discussed in detail. Chapters 10 through 12 show you how to alter the internal structure of the MySQL system to implement an alternative query processing mechanism. These chapters provide you with a unique insight into how large systems can be built and modified.

Chapter 9, “Database Systems Internals,” presents advanced database techniques and examines the MySQL architecture. Topics include query execution, multiuser concerns, and programmatic considerations.

Chapter 10, “Internal Query Representation,” discusses the MySQL internal query representation. You are provided with an example alternative query representation. A discussion is included of how to alter the MySQL source code to implement an alternative query representation.

Chapter 11, “Query Optimization,” presents the MySQL internal query optimizer. The chapter includes an example alternative query optimizer that uses the alternative query representation from the previous chapter. You’ll learn how to alter the MySQL source code to implement the alternative query optimizer.

Chapter 12, “Query Execution,” combines the techniques from the previous chapters to provide you with instructions on how to modify the MySQL system to implement alternative query processing engine techniques.

## Appendix

The appendix provides a list of resources on MySQL, database systems, and open source software.

# Using the Book for Teaching Database Systems Internals

Many excellent database texts are available that offer coverage of relational theory and practice. However, few offer material suitable for a classroom or lab environment. Even fewer resources are available for students to explore the inner workings of database systems. This book offers an opportunity for instructors to augment their database classes with hands-on labs. There are three ways that this text can be used in a classroom setting.

The text can be used to add depth to an introductory undergraduate or graduate database course. Parts 1 and 2 can be used to provide in-depth coverage of special topics in database systems. Suggested topics for lectures include those presented in Chapters 2, 3, 4, and 6. These topics can be used in addition to more traditional database theory or systems texts. Hands-on exercises or class projects can be drawn from Chapters 6 and 8.

An advanced database course for undergraduate or graduate students can be based on Parts 1 and 2, where each chapter can be presented over the course of 8 to 12 weeks. The remainder of the lectures can be spent on discussing the implementation of physical storage layers and the notion of storage engines. Semester projects can be based on Chapter 7 and allow students to build their own storage engines.

A special-topics course on database systems internals for the senior undergraduate or graduate students can be based on the entire text, with lectures based on the first nine chapters. Semester projects can be derived from Part 3 and allow students to implement the remaining features of the database experimental platform. These features include applications of language theory, query optimizers, and query execution algorithms.

## Let's Get Started!

I have written this book with a wide variety of readers in mind. Whether you have been working in database systems for years, or maybe have taken an introductory database theory class, or even read a good Apress book on MySQL, you will get a lot out of this book. Best of all, if you ever wanted to know what makes a database system like MySQL tick, you can even get your hands on the source code!

