

SECOND EDITION

FUNDAMENTALS OF Web Development



Randy Connolly
Ricardo Hoar

Fundamentals of Web Development

Second Edition

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Second Edition

Randy Connolly

Mount Royal University, Calgary

Ricardo Hoar

Sheridan College Institute of Technology and Advanced Learning, Oakville



330 Hudson Street, NY NY 10013

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To the children in my life: Ben, Alex, Hannah, and Mark.

Randy Connolly

To every student working to build a better world

Ricardo Hoar

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Preface

Welcome to the *Fundamentals of Web Development*. This textbook is intended to cover the broad range of topics required for modern web development and is suitable for intermediate to upper-level computing students. A significant percentage of the material in this book has also been used by the authors to teach web development principles to first-year computing students and to non-computing students as well.

One of the difficulties that we faced when planning this book is that web development is taught in a wide variety of ways and to a diverse student audience. Some instructors teach a single course that focuses on server-side programming to third-year students; other instructors teach the full gamut of web development across two or more courses, while others might only teach web development indirectly in the context of a networking, HCI, or capstone project course. We have tried to create a textbook that supports learning outcomes in all of these teaching scenarios.

What is Web Development?

Web development is a term that takes on different meanings depending on the audience and context. In practice, web development requires people with complementary but distinct expertise working together toward a single goal. Whereas a graphic designer might regard web development as the application of good graphic design strategies, a database administrator might regard it as a simple interface to an underlying database. Software engineers and programmers might regard web development as a classic software development task with phases and deliverables, where a systems administrator sees a system that has to be secured from attackers. With so many different classes of user and meanings for the term, it's no wonder that web development is often poorly understood. Too often, in an effort to fully cover one aspect of web development, the other principles are ignored altogether, leaving students without a sense of where their skills fit into the big picture.

A true grasp of web development requires an understanding of multiple perspectives. As you will see, the design and layout of a website are closely related to the code and the database. The quality of the graphics is related to the performance and configuration of the server, and the security of the system spans every aspect of development. All of these seemingly independent perspectives are interrelated and therefore a web developer (of any type) should have a foundational understanding of all aspects, even if they only possess expertise in a handful of areas.

What's New in the Second Edition?

The first edition of this book was mainly written in the first half of 2013 and then published in early 2014. Since that time, web development has simultaneously experienced both constancy and innovation. The new edition tries to capture both of these traits. As well, since publishing the first edition we have received a great deal of useful feedback from instructors and students, which we have incorporated into this version of the book.

The second edition aspires to faithfully cover the most vital trends and innovation in the field since 2013. The book's coverage of JavaScript has been substantially increased from the two chapters in the first edition to the four chapters in this edition. We have also revisited and expanded coverage to reflect changes in HTML, CSS, and PHP over the past three years. We've also added new content in several chapters to address increasingly popular areas like CSS3, version control, NoSQL, new tools, virtualization, and analytics (among others).

On the constancy side, we certainly didn't rewrite everything! This new edition contains plenty of content from the first edition. But even the material that didn't require substantial revisions still went through careful reconsideration and sometimes we restructured or made small improvements (and bug fixes) to existing content.

This version of the book also includes revisions to the overall layout including several new section types that better guide the reader with advice. We've also made some changes to the page layout to help readers distinguish advanced topics from more introductory material, allowing students to focus at a level appropriate for their learning.

Finally, all the end-of-chapter projects, many of the in-chapter exercises and listings, and additional online learning materials have been revisited, enhanced, or created anew to bring them up to date with the changes made throughout the book.

Features of the Book

To help students master the fundamentals of web development, this book has the following features:

- **Covers both the concepts and the practice of the entire scope of web development.** Web development can be a difficult subject to teach because it involves covering a wide range of theoretical material that is technology independent as well as practical material that is very specific to a particular technology. This book comprehensively covers both the conceptual and practical side of the entire gamut of the web development world.

- **Focused on the web development reality of today's world and in anticipation of future trends.** The world of web development has changed remarkably in the past decade. For instance, fewer and fewer sites are being created from scratch; instead, a great deal of current web development makes use of existing sophisticated frameworks and environments such as jQuery, WordPress, HTML5, and Facebook. We believe it is important to integrate this new world of web development into any web development textbook.
- **Sophisticated, realistic, and engaging case studies.** Rather than using simplistic “Hello World” style web projects, this book makes extensive use of three case studies: an art store, a travel photo sharing community, and a customer relations management system. For all the case studies, supporting material such as the visual design, images, and databases are included. We have found that students are more enthusiastic and thus work significantly harder with attractive and realistic cases.
- **Comprehensive coverage of a modern Internet development platform.** In order to create any kind of realistic Internet application, readers require detailed knowledge of and practice with a single specific Internet development platform. This book covers HTML5, CSS3, JavaScript, and the LAMP stack (that is, Linux, Apache, MySQL, and PHP). Other important technologies covered include jQuery, JSON, Node.js, MongoDB, AngularJS, XML, WordPress, Bootstrap, and a variety of third-party APIs that include Facebook, Twitter, and Google and Bing Maps.
- **Content presentation suitable for visually oriented learners.** As long-time instructors, the authors are well aware that today's students are often extremely reluctant to read long blocks of text. As a result, we have tried to make the content visually pleasing and to explain complicated ideas not only through text but also through diagrams.
- **Content that is the result of over twenty five years of classroom experience** (in college, university, and adult continuing education settings) teaching web development. The book's content also reflects the authors' deep experience engaging in web development work for a variety of international clients.
- **Tutorial-driven programming content available online.** Rather than using long programming listings to teach ideas and techniques, this book uses a combination of illustrations, short color-coded listings, and separate tutorial exercises. These step-by-step tutorials are not contained within the book, but are available online at www.pearsonhighered.com/cs-resources. Throughout the book you will find frequent links to these tutorial exercises.
- **Complete pedagogical features for the student.** Each chapter includes learning objectives, margin notes, links to step-by-step tutorials, advanced tips, keyword highlights, end-of-chapter review questions, and three different case study exercises.
- **Code listings available online.** Many of the code listings used in the book are publicly available on GitHub (<https://github.com/rconnolly/funwebdev-2nd-codelistings>) and on CodePen (<http://codepen.io/randyc9999/collections/public>).

The chapters in *Fundamentals of Web Development* can be organized into three large sections.

- **Foundational client-side knowledge (Chapters 1–10).** These first chapters cover the foundational knowledge needed by any front-end web developer. This includes a broad introduction to web development (**Chapter 1**), how the web works (**Chapter 2**), HTML (**Chapters 3 and 5**), CSS (**Chapters 4 and 7**), web media (**Chapter 6**), and JavaScript (**Chapters 8–10**).
- **Essential server-side development (Chapters 11–16).** Despite the increasing importance of JavaScript-based development, learning server-side development is still the essential skill taught in most web development courses. The basics of PHP are covered in **Chapters 11 and 12**. Object-oriented PHP is covered in **Chapter 13**. Database-driven web development is covered in **Chapter 14**, while state management and error handling are covered in **Chapters 15 and 16**.
- **Specialized topics (Chapters 17–24).** Contemporary web development has become a very complex field, and different instructors will likely have different interest areas beyond the foundational topics. As such, our book provides specialized chapters that cover a variety of different interest areas. **Chapter 17** covers web application design for those interested more in software engineering and programming design. **Chapter 18** covers the vital topic of web security. **Chapter 19** covers another programming topic: namely, consuming and creating web services. **Chapter 20** covers frameworks in general, and provides an overview of the growing JavaScript-based MEAN (MongoDB, ExpressJS, AngularJS, and Node.js) development stack. **Chapter 21** covers the increasingly important topic of integrating with (and customizing) content management systems. The next two chapters address two important non-development topics: web server administration (**Chapter 22**) and search engines (**Chapter 23**). Finally, **Chapter 24** covers another increasingly important topic: how to integrate third-party social networks and measure your site's success through web analytics.

Pathways through this Book

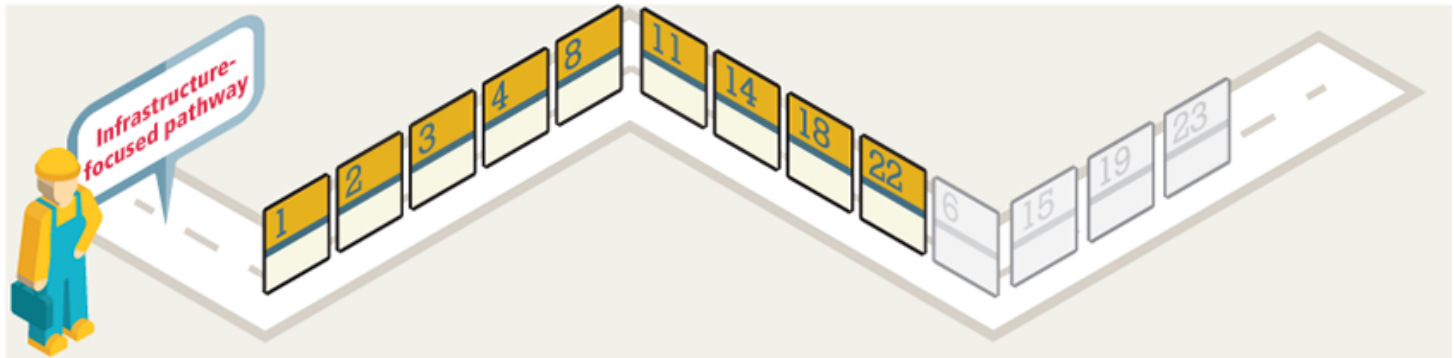
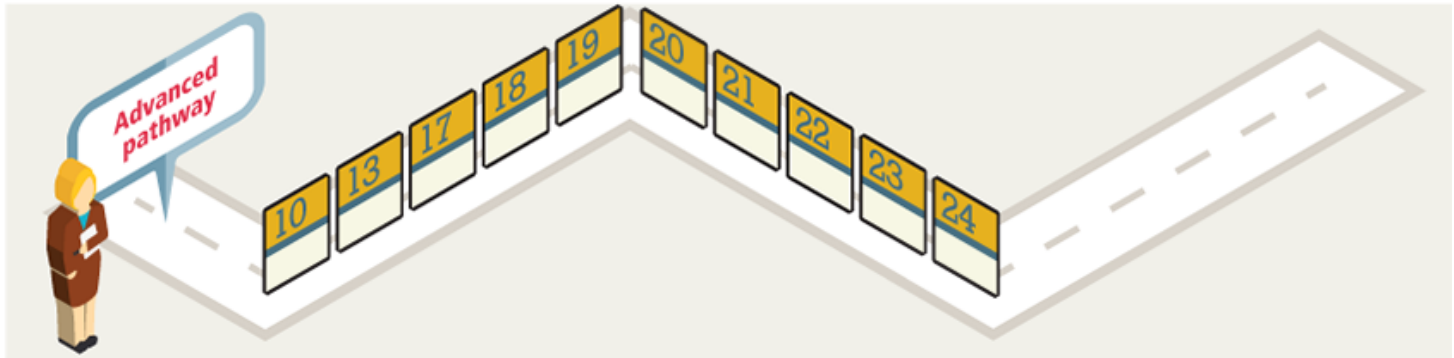
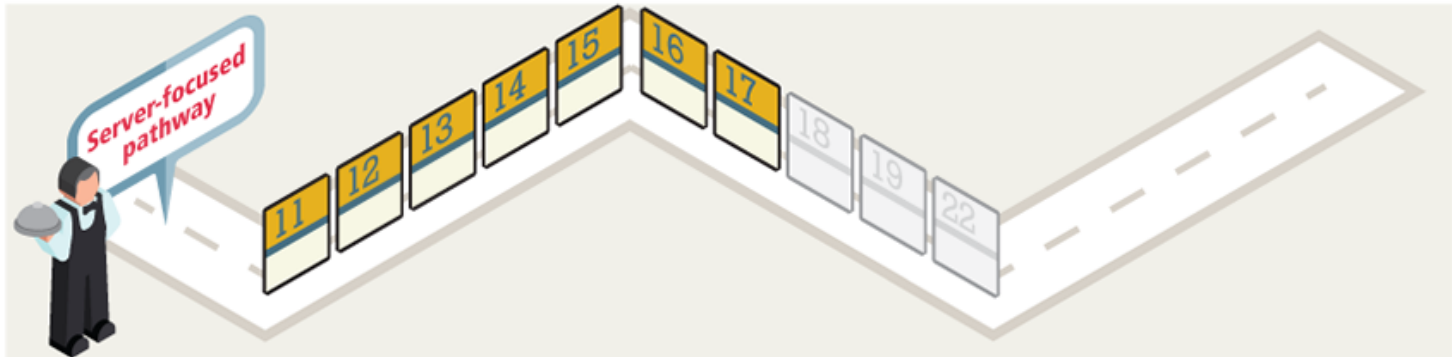
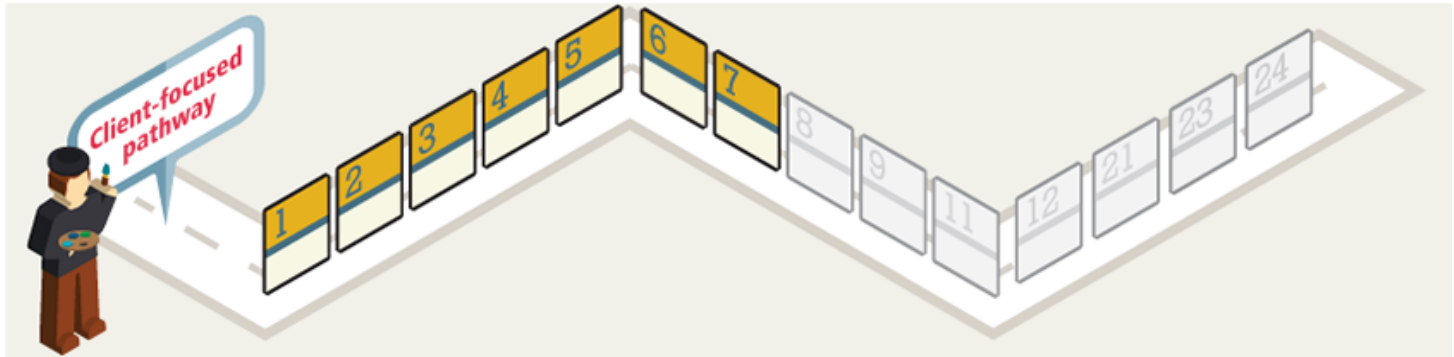
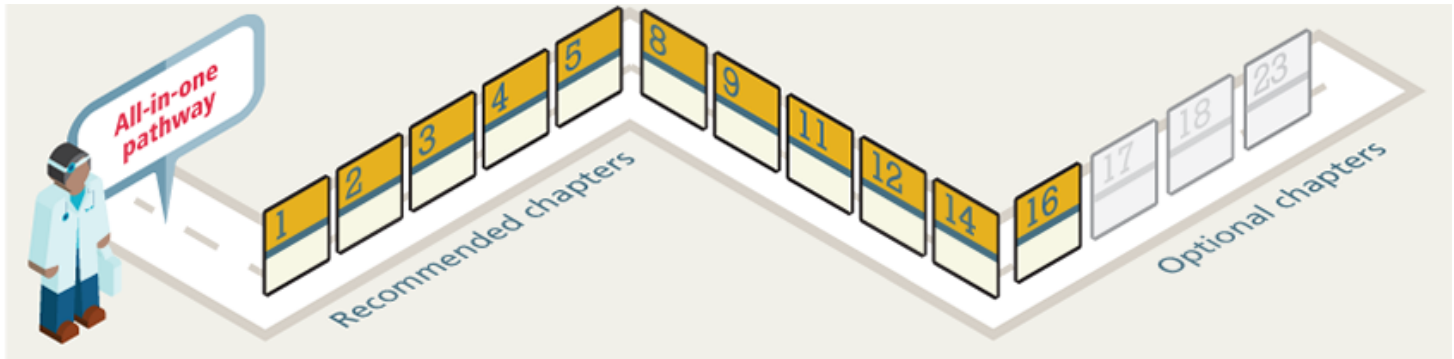
There are many approaches to teach web development and our book is intended to work with most of these approaches. It should be noted that this book has more material than can be plausibly covered in a single semester course. This is by design as it allows different instructors to chart their own unique way through the diverse topics that make up contemporary web development.

We do have some suggested pathways through the materials (though you are welcome to chart your own course), which you can see illustrated in the pathway diagrams.

- **All the web in a single course.** Many computing programs only have space for a single course on web development. This is typically an intermediate or upper-level course in which students will be expected to do a certain amount of learning on their own. In this case, we recommend covering

Chapters 1–5, 8, 9, 11, 12, 14, and 16. Other complimentary chapters include **17, 18, and 23.**

- **Client-focused course for introductory students.** Some computing programs have a web course with minimal programming that may be open to non-major students or which acts as an introductory course to web development for major students. For such a course, we recommend covering **Chapters 1–7.** You can use **Chapters 8 and 9** to introduce client-side scripting if desired. If some server-side web programming is going to be introduced, you can also cover **Chapters 11 and 12.** If no programming is going to be covered, you might consider adding some parts of **Chapters 21, 23, and 24.**
- **Server-focused course for intermediate students.** If students have already taken a client-focused course (or you want the students to learn the client content quickly on their own), then **Chapters 11–17** and perhaps **Chapters 18, 19 and 22** would provide the students with a very solid foundation in server-side development.
- **Advanced web development course.** Some programs offer a web development course for upper-level students in which it is assumed that the students already know the foundational topics and are also experienced with the basics of server-side development. Such courses probably have the widest range of possible topics. One example of such a course might include advanced client and server **Chapters 10, 13 and 20** alongside a selection of the advanced topics from **Chapter 17–24.**
- **Infrastructure-focused course.** In some computing programs the emphasis is less on the particulars of web programming and more on integrating web technologies into the overall computing infrastructure within an organization. Such a course might cover **Chapters 1, 2, 3, 4, 8, 11, 14, 18, and 22** with an option to include some topics from **Chapters 6, 15, 19, and 23.**



For the Instructor

Web development courses have been called “unteachable” and indeed teaching web development has many challenges. We believe that using our book will make teaching web development significantly less