

Valter Roesler
Eduardo Barrére
Roberto Willrich *Editors*

Special Topics in Multimedia, IoT and Web Technologies



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Valter Roesler • Eduardo Barrére • Roberto Willrich
Editors

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Foreword

I was working with hypertext before the birth¹ of the Web... in fact, I happened to enjoy Sir Tim Berners-Lee demonstration in the Hypertext'91 Conference! *live*, of course... that was 1991! 8-)

This road led me to studying Web/document engineering, human-computer interaction, information retrieval, ubiquitous computing ... and to contributing to many Web-ambient-mobile-collaborative-based interactive multimedia applications... >:)

I was lucky: my work evolved in consonance with the Web, as in the recent paper² “Promoting Social Connection and Deepen Relations in Older People: Design of Media Parcels Towards Facilitating Time-Based Media Sharing”...



We are fortunate: this book brings fundamental and advanced concepts as well as hands-on examples on must-know Web and multimedia topics, from research to

¹Check a little history in <https://www.w3.org/History.html>.

²<http://dx.doi.org/10.2196/14112>.

applications, from data extraction to data analysis, from context awareness to IoT, from modeling to authoring to learning . . . and a lot more as shown by the chapter titles word cloud³ . . . ;-)

Readers will learn a lot from the nine chapters in the book: the 37 contributing authors have in-depth experience in the subject they present. Moreover, I know firsthand how demanding the three editors can be :) and, in this book, you can experience yourself the result of their excellent job in orchestrating the authors' hard work. As a result, we can use the chapters not only as introduction or reference material for classes, but also to solving problems in the wild by taking advantage of Web and multimedia data and infrastructure!

As I say to my students: there are plenty of real life problems to be solved and a lot of opportunities to make the world a better place: with the right tools and learning with each other, we can do a lot (more). . . I am sure you will get inspired by this book. . .

Best

University of São Paulo, São Carlos, Brazil
September 2019

Maria da Graça Pimentel

³Thanks to <https://www.wordclouds.com/>.

Preface

This book presents up-to-date information about a series of hot topics on multimedia and Web. The focus of the book is on practical examples teaching how to use platforms related to these topics. The book has a didactic approach, aiming to show how these concepts relate to solving real problems in computer science, mainly in the area of multimedia and Web.

The main intended audience for this book is students (postgraduates and undergraduates) and lecturers on these specific topics. Professionals can also benefit from the book since some chapters work with practical aspects relevant to the industry. In this context, the book is not a textbook, but can be used as a reference in special topics courses, or parts of disciplines as “Special Topics in multimedia” for example.

Many multimedia applications are already part of life for many of us and will continue to be for generations to come. If we consider the great advance of the Web and the rapid growth of mobile devices, we see that today it is increasingly simple to produce, share, and consume media and multimedia applications. As a consequence, the field of multimedia has encountered new challenges and possibilities in scenarios such as IoT, IPTV, and Web.

The chapters are grouped into three parts: System Architectures and Environment (Chaps. 1 through 4), Tools and Application Development (Chaps. 5 and 6), and Data Collection and Analysis (Chaps. 7 through 9). The chapters in the first part (System Architectures and Environment) aim to introduce Web systems architectures and Fog of Things (FoT) and to discuss the use of deep learning and context-aware computing technologies in the multimedia/hypermedia area, all in a practical and applied way.

Chapter 1 presents the evolution of Web-based software architectures and the current software architectural styles, patterns, and development platforms based on client-side and server-side technologies. In addition, this chapter discusses Web 3.0 requirements such as communication protocols, microservices, MV* browser-based frameworks, boilerplates client-side code, asynchronous programming, and integration with cloud computing infrastructures. Chapter 2 presents the Fog of Things (FoT) paradigm, describing the main characteristics and concepts from the sensor and actuator communication to gateways, local and cloud servers.

Additionally, this chapter presents SOFT-IoT platform as a concrete implementation of FoT, which uses microservice infrastructure distributed along with devices in the IoT system. The final two chapters change the focus to multimedia systems. Chapter 3 aims at presenting main concepts, solutions, and technologies related to the integration of mobile cloud computing (MCC) and context-aware applications, which are research topics with growing interest. MCC seeks to leverage cloud computing features to improve the performance of mobile applications and reduce the energy consumption of mobile devices, while the latter seeks effective ways to build applications that react to changes in its context environment. This chapter presents also a practical guide to the development of a context-aware multimedia Android application using the framework CAOS. Chapter 4 takes into consideration the recent deep learning research that allowed significant advances in several areas of multimedia, especially to build applications that are sensitive to its media content semantics. However, the development of such applications is usually done from scratch, and moreover, the current hypermedia standards do not fully support such kind of development. To support such development, this chapter proposes that a hypermedia language can be extended to support such features. This chapter proposes an extension of the nested context language (NCL) and the model behind it. In the second part of the book (Tools and Application Development), chapters 5 and 6, we introduce selected tools and techniques applied in the development of ubiquitous applications and multimedia learning objects.

Chapter 5 presents the theoretical and practical basics of model-driven engineering (MDE) aiming at the construction of ubiquitous applications. MDE is an approach that considers models as the main artifacts in software development. These models are generally built using domain-specific languages, such as UML and XML, which are defined by their own metamodel. In this context, this chapter presents some key frameworks and languages available to assist in building models in accordance with a particular metamodel. Models built in this environment can then be used to document and maintain systems from different domains. Chapter 6 discusses both the pedagogical and technological recommendations involved in the authoring of multimedia learning objects (LOs). LOs are entities that can be used, reused, or referred during the teaching process, allowing students to individualize their learning experience with nonlinear browsing mechanisms and content adaptation.

Finally, in the third and last part of the book (Data Collection and Analysis), chapters 7 to 9, we aim to deliver a comprehensive view to collect data from different sources and present different approaches for extracting and processing information.

Chapter 7 presents different approaches for extracting and processing information from Twitter using Natural Language Processing and Machine Learning techniques, examining tools and methods to collect and analyze semantic information from tweets. Understanding these approaches is worthwhile because Twitter emerges as a valuable data source to get information about what people think and feel about the most different subjects. Chapter 8 presents three important issues to deal with data from multiple sources with a focus on practical strategies and research questions. These issues are considered important because data from the

Web are increasingly heterogeneous and unstructured, representing challenges for data crawling, integration, and preprocessing. There are studies that are “data-oriented,” i.e., based on the available data, but their results are restricted to the respective data. In contrast, there are various problems prior to identifying what data is needed to solve them, and often multiple data sources are needed. Finally, Chap. 9 aims to discuss game development for researchers who wish analyze game user experience. In the first part of chapter 9 the authors introduce the theory of game design, highlighting definitions and examples about data collection involving guidelines and usability. The second part discusses multimedia data collection and variable analysis.

The organization of the book in three parts allows a formative and at the same time punctual study on each theme. This division assists teachers to organize their disciplines, focusing only on one, two, or even three parts. Students can use the book to gain a broad understanding of multimedia architectures and environments, tools and techniques for application development, or even how to collect and analyze data from the Web or multimedia applications.

Postgraduate students, professionals, and other researchers can read the book to treat a specific topic (chapter), or even know/update one of the three parts of the book.

This book was originated from the short courses of the Brazilian Symposium on Multimedia and Web (WebMedia). Promoted by the Brazilian Computer Society (SBC), WebMedia is the main event of the theme in Brazil and an excellent opportunity for scientific and technical exchange among students, researchers, and professionals in the areas of multimedia, hypermedia, and Web. Briefly, there were 36 proposals submitted for short-course chapters in 2017 and 2018. Of these, 12 were selected to be presented during both symposia. Of these 12 short courses accepted, 9 themes were selected to be extended in order to compose this book.

Porto Alegre, Brazil
Juiz de Fora, Brazil
Florianopolis, Brazil
September 2019

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Acronyms

6LOWPAN	IPv6 over Low power Wireless Personal Area Networks
AJAX	Asynchronous Javascript and XML
AMQP	OASIS Advanced Message Queuing Protocol
API	Application Program Interface
ARM	Architectural Reference Model
ASD	Autism Spectrum Disorders
BFS	Breadth-First Search
CAC	Context Acquisition Component
CAM	Context Acquisition Middleware
CAMCS	Context Aware Mobile Cloud Services
CAOS	CAD as an Adaptive Open Platform Services
CARMiCLOC	Context Awareness in Reflective Middleware Cloud Computing
CGI	Common Gateway Interface
CNN	Convolutional Neural Network
CoAP	Constrained Application Protocol
CPA	Cloud Personal Assistant
CRUD	Create/Read/Update/Delete
CSS	Cascading Style Sheets
CSV	Comma-Separated Values
DFS	Depth-First Search
DITV	Digital TV
DOM	Document Object Model
DSML	Domain-Specific Modeling Language
DTLS	Datagram Transport Layer Security
EE	Entity Extraction
EMF	Eclipse Modeling Framework
EOL	Epsilon Object Language
ESB	Enterprise Service Bus
ETL	Extract, Transform, Load
EVL	Epsilon Validation Language
FOAF	Friend of a Friend

FoT	Fog of Things
GMF	Graphical Modeling Framework
HCI	Human–Computer Interface
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
ICIDH	International Classification of Impairments, Disabilities, and Handicaps
ICT	Information and Communication Technologies
IDE	Integrated Development Environment
IGDA	Independent Game Developers Association
IIC	Industrial Internet Consortium
IIoT	Industrial Internet of Things
IIRA	Industrial IoT Reference Architecture
IISF	Industrial Internet Security Framework
IM	Identity Management
IoT	Internet of Things
IP	Internet Protocol
JCoAP	Java Constrained Application Protocol
JEE	Java Enterprise Edition
JSON	JavaScript Object Notation
JSON-LD	JSON-Linked Data
JSX	JavaScript Syntax eXtension
KEM	Key Exchange and Management
K-NCM	Knowledge-Based Nested Context Model
LCDS	Microsoft Learning Content Development System
LMS	Learning Management Systems
LO	Learning Object
LoCCAM	Loosely Coupled Context Acquisition Middleware
LOD	Linked Open Data
M2M	Model-to-Model
M2T	Model-to-Text
MCC	Mobile Cloud Computing
MDE	Model-Driven Engineering
ML	Machine Learning
MOF	Meta-Object Facility
MpOS	Multiplatform Offloading System
MQTT	Message Queuing Telemetry Transport
MVC	Model–View–Controller
MVP	Model–View–Presenter
MVVM	Model–View–Viewmodel
NCL	Nested Context Language
NCM	Nested Context Model
NER	Named Entity Recognition
NFC	Near Field Communication

NLP	Natural Language Processing
NLTK	Natural Language Toolkit
OCL	Object Constraint Language
OGC	Open Geospatial Consortium
OKF	Open Knowledge Foundation
OMG	Object Management Group
openHAB	open Home Automation Bus
OSGi	Open Services Gateway initiative
PD	Participatory Design
PERSIST	Personal Self-Improving Smart Spaces
PGASS	Brazilian General Program of Health Actions and Services
PHP	Hypertext Preprocessor language
PLC	Programmable Logic Controller
PSS	Personal Smart Space
RA	IoT Reference Architecture
RDF	Resource Description Framework
REE	Remote Execution Environment
REST	Representational State Transfer
RFID	Radio-Frequency Identification
RM	IoT Reference Model
RNN	Recurrent Neural Network
SBC	Brazilian Computer Society
SCORM	Shareable Content Object Reference Model
SDI	Spatial Data Infrastructure
SDK	Software Development Kit
SMIL	Synchronized Multimedia Integration Language
SMQTT	Secure Message Queue Telemetry Transport
SMS	Short Message Service
SOA	Service-Oriented Architecture
SOAP	Simple Object Access Protocol
SPA	Single Page Application
SPO	Subject-Predicate-Object
SQL	Structured Query Language
SSL	Secure Sockets Layer
SSM	SceneSync Model
SUS	Brazilian Health System
SVM	Support Vector Machine
TATU	The Accessible Thing Universe
TF-IDF	Term Frequency-Inverse Document Frequency
TLS	Transport Layer Security
TPI	Thing Protocol for Internet
TRA	Trust and Reputation Architecture
UI	User Interface
UML	Unified Modeling Language
URI	Uniform Resource Identifier

URL	Uniform Resource Locator
VDOM	Virtual Document Object Model
VM	Virtual Machine
VNC	Virtual Network Computing
W3C	World Wide Web Consortium
WAI	Web Accessibility Initiative
WCAG	Web Content Accessibility Guidelines
WHO	World Health Organization
WLAN	Wireless Local Area Network
WoT	Web of Things
WPAN	Wireless Personal Area Network
WWW	World Wide Web
WYSIWYG	What You See Is What You Get
XML	Extensible Markup Language
XMPP	Extensible Messaging and Presence Protocol

Part I
System Architectures and Environment

Chapter 1

Evolution of Web Systems Architectures: A Roadmap



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1.1 Introduction

Web systems have become popular because of the Web browsers ubiquity. This characteristic allows us to conveniently install and maintain software systems on a server without changing client-side software, even if it is accessed by millions of browsers [15]. Currently, Web systems are used for all kinds of applications, such as e-commerce, audiovisual content access, email, social networks, searches, corporate portals, etc. [13].

Web systems can be considered a kind of client–server architecture model. In this scenario, the Web browser represents the client that interprets HTML, CSS, and JavaScript code. Besides, it communicates with the server using a URL and the HTTP protocol [7]. In the beginning, each Web page was delivered to the browsers as static documents and the server’s responsibility was only to receive requests for locating and sending files. However, servers can now generate a dynamic page for each request by running software, accessing the database, or integrating with other systems. In addition, a Web page can also execute code on the client-side. These characteristics led to the creation of different software development platforms

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