

Computer Communications and Networks

Muthu Ramachandran  
Zaigham Mahmood *Editors*

# Software Engineering in the Era of Cloud Computing

 Springer

Muthu Ramachandran · Zaigham Mahmood  
Editors

# Software Engineering in the Era of Cloud Computing

 Springer

*Editors*

Muthu Ramachandran  
School of Built Environment, Engineering,  
and Computing  
Leeds Beckett University  
Leeds, UK

Zaigham Mahmood  
Debasis Education  
Derby, UK  
Northampton University  
Northampton, UK  
Shijiazhuang Tiedao University  
Hebei, China

ISSN 1617-7975                      ISSN 2197-8433 (electronic)  
Computer Communications and Networks  
ISBN 978-3-030-33623-3              ISBN 978-3-030-33624-0 (eBook)  
<https://doi.org/10.1007/978-3-030-33624-0>

© Springer Nature Switzerland AG 2020

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG  
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

# Contents

|   |            |
|---|------------|
| <b>Part I Cloud Requirements Engineering and Domain Modelling</b>   |            |
| <b>1 Requirements Engineering Framework for Service and Cloud Computing (REF-SCC) . . . . .</b>                               | <b>3</b>   |
| Krishan Chand and Muthu Ramachandran  |            |
| <b>2 Toward an Effective Requirement Engineering Approach for Cloud Applications . . . . .</b>                                | <b>29</b>  |
| Abdullah Abuhussein, Faisal Alsubaei and Sajjan Shiva   |            |
| <b>3 Requirements Engineering for Large-Scale Big Data Applications . . . . .</b>   | <b>51</b>  |
| Thalita Vergilio, Muthu Ramachandran and Duncan Mullier   |            |
| <b>4 Migrating from Monoliths to Cloud-Based Microservices: A Banking Industry Example . . . . .</b>                          | <b>85</b>  |
| Alan Megargel, Venky Shankararaman and David K. Walker  |            |
| <b>5 Cloud-Enabled Domain-Based Software Development . . . . .</b>  | <b>109</b> |
| Selma Suloglu, M. Cagri Kaya, Anil Cetinkaya, Alper Karamanlioglu and Ali H. Dogru  |            |
| <b>6 Security Challenges in Software Engineering for the Cloud: A Systematic Review . . . . .</b>                             | <b>131</b> |
| Mohamed Alloghani and Mohammed M. Alani   |            |
| <b>Part II Cloud Design and Software Engineering Analytics with Machine Learning Approaches</b>                               |            |
| <b>7 Software Engineering Framework for Software Defect Management Using Machine Learning Techniques with Azure . . . . .</b> | <b>155</b> |
| Uma Subbiah, Muthu Ramachandran and Zaigham Mahmood   |            |

|   |   |            |
|---|---|------------|
| <b>8</b>  | <b>Sentiment Analysis of Twitter Data Through Machine Learning Techniques</b> .....                                     | <b>185</b> |
|   | Asdrúbal López-Chau, David Valle-Cruz<br>and Rodrigo Sandoval-Almazán   |            |
| <b>9</b>  | <b>Connection Handler: A Design Pattern for Recovery from Connection Crashes</b> .....                                  | <b>211</b> |
|   | Naghmeh Ivaki, Nuno Laranjeiro, Fernando Barros and Filipe Araújo   |            |
| <b>Part III Cloud Testing and Software Process Improvement as a Service</b> |   |            |
| <b>10</b>   | <b>A Modern Perspective on Cloud Testing Ecosystems</b> .....   | <b>255</b> |
|   | V. Vijayaraghavan, Akanksha Rajendra Singh and Swati Sucharita  |            |
| <b>11</b>   | <b>Towards Green Software Testing in Agile and DevOps Using Cloud Virtualization for Environmental Protection</b> ..... | <b>277</b> |
|   | D. Jeya Mala and A. Pradeep Reynold   |            |
| <b>12</b>   | <b>Machine Learning as a Service for Software Process Improvement</b> .....   | <b>299</b> |
|   | Supun Dissanayake and Muthu Ramachandran  |            |
| <b>13</b>   | <b>Comparison of Data Mining Techniques in the Cloud for Software Engineering</b> .....                                 | <b>327</b> |
|   | Kokten Ulas Birant and Derya Birant   |            |
|   | <b>Index</b> .....  | <b>351</b> |

# Chapter 8

## Sentiment Analysis of Twitter Data Through Machine Learning Techniques



Asdrúbal López-Chau, David Valle-Cruz  
and Rodrigo Sandoval-Almazán

**Abstract** Cloud computing is a revolutionary technology for businesses, governments, and citizens. Some examples of Software-as-a-Services (SaaS) of cloud computing are banking apps, e-mail, blog, online news, and social networks. In this chapter, we analyze data sets generated by trending topics on Twitter that emerged from Mexican citizens that interacted during the earthquake of September 19, 2017, using sentiment analysis and supervised learning, based on the Ekman's six emotional model. We built three classifiers to determine the emotions of tweets that belong to the same topic. The classifiers with the best accuracy for predicting emotions were Naive Bayes and support vector machine. We found that the most frequent predicted emotions were happiness, anger, and sadness; also, that 6.5% of predicted tweets were irrelevant. We provide some recommendations about the use of machine learning techniques in sentiment analysis. Our contribution is the expansion of the emotions range, from three (negative, neutral, positive) to six in order to provide more elements to understand how users interact with social media platforms. Future research will include validation of the method with different data sets and emotions, and the addition of new artificial intelligence techniques to improve accuracy.

**Keywords** Cloud computing · Sentiment analysis · Machine learning · ML · Twitter · Naive Bayes · Ekman's model

---

A. López-Chau  
Autonomous University of the State of Mexico, 55600 Valle Hermoso, Zumpango,  
Estado de México, Mexico  
e-mail: [alchau@uaemex.mx](mailto:alchau@uaemex.mx)

D. Valle-Cruz (✉) · R. Sandoval-Almazán  
Autonomous University of the State of Mexico, Instituto Literario # 100, Toluca,  
Mexico  
e-mail: [davacr@uaemex.mx](mailto:davacr@uaemex.mx)

R. Sandoval-Almazán  
e-mail: [rsandovala@uaemex.mx](mailto:rsandovala@uaemex.mx)