Table of Contents

About the Authors xv

About the Contributors xvii

About the Technical Reviewer xix

Acknowledgments xxi

Introduction xxiii

Chapter 1: Fundamentals of a Computer System 1

von Neumann Architecture 1

CPU: Fetch, Decode, Execute, and Store 3

Fetch 4

Decode, Execute, and Store 10

Controlling the Flow 13

The Stack 15

Instruction Pipeline 21

Flynn's Taxonomy 22

Main Memory and Secondary Storage 24

Input and Output (I/O) 26

Summary 27

References and Further Reading 28

Copyright © 2021. Apress L. P.. All rights reserved.

Crutcher, Paul D., et al. Essential Computer Science : A Programmer's Guide to Foundational Concepts, Apress L. P., 2021.
ProQuest Ebook Central, http://ebookcentral.proquest.com/lib/th-deggendorf/detail.action?docID=6640815.
Created from th-deggendorf on 2022-03-05 07:00:30.

Chapter 2: Programming 29

Programming Language Fundamentals 30

Hello, World! 31

Compile, Link, and Load 32

High-Level Languages 35

Programming Paradigms 38

Imperative Programming 39

Declarative Programming 40

Object-Oriented Programming 42

Interpreted Programming 45

Parallel Programming 47

Machine Learning 49

Summary 50

References and Further Reading 50

Chapter 3: Algorithm and Data Structure 53

What Is an Algorithm 53

Good and *Not So Good* Algorithm 54

Time/Space Complexity 54

Asymptotic Notation 55

Fundamental Data Structures and Algorithms 57

Store (Data Structure) 57

Problem Solving Techniques 66

Recursion 67

Divide and Conquer 68

Brute Force 70

Greedy Algorithms 70

Class of Problems 71

NP-Complete and NP-Hard Problems 71

Copyright © 2021. Apress L. P.. All rights reserved.

Crutcher, Paul D., et al. Essential Computer Science : A Programmer's Guide to Foundational Concepts, Apress L. P., 2021.
ProQuest Ebook Central, http://ebookcentral.proquest.com/lib/th-deggendorf/detail.action?docID=6640815.
Created from th-deggendorf on 2022-03-05 07:00:30.

Databases 72
Persistence and Volume 72
Fundamental Requirements: ACID 72
Brief History of Database System Evolution 74
Most Prominent Current Database Systems 74
Relational Data and SQL 74
NoSQL 77
Summary 78
References and Further Reading 78

Chapter 4: Operating System 81

What Is an Operating System 81
OS Categories 84
Why We Need an OS 85
Purpose of an OS 87
Complex and Multiprocessor Systems 88
Multitasking and Multifunction Software 88
Multiuser Systems 89
Why Is It Important to Know About the OS? 90
Responsibilities of an OS 92
Scheduling 93
Program and Process Basics 94
Process States 94
Process Control Block (PCB) 95
Context Switching 97
Scheduling 98
Scheduling Criteria 100
Thread Concepts 101

Copyright © 2021. Apress L. P.. All rights reserved.

Crutcher, Paul D., et al. Essential Computer Science : A Programmer's Guide to Foundational Concepts, Apress L. P., 2021.
ProQuest Ebook Central, http://ebookcentral.proquest.com/lib/th-deggendorf/detail.action?docID=6640815.
Created from th-deggendorf on 2022-03-05 07:00:30.

Memory Management 102
Address Binding 103
Logical vs. Physical Address 105
Inter-process Communication 107
I/O Management 109
I/O Subsystem 110
Polled vs. Interrupt I/Os 114
I/O and Performance 115
Synchronization Concepts 116
File Systems 122
File Concepts 123
Directory Namespace 124
Access and Protection 126
Rings: User Mode and Kernel Mode 126
Virtualization 127
Protection 128
User Interface and Shell 128
Some OS Specifics 129
Summary 130
References and Further Reading 131

Chapter 5: Computer Networks and Distributed Systems 133

History and Evolution of Networks and the Internet 133
Protocols: Stateful and Stateless 139
Internet Protocol (IP): TCP and UDP 139
Host, IP Address, MAC Address, Port, Socket 143
DNS and DHCP 145
Proxy, Firewall, Routing 147

Copyright © 2021. Apress L. P.. All rights reserved.

Crutcher, Paul D., et al. Essential Computer Science : A Programmer's Guide to Foundational Concepts, Apress L. P., 2021.
ProQuest Ebook Central, http://ebookcentral.proquest.com/lib/th-deggendorf/detail.action?docID=6640815.
Created from th-deggendorf on 2022-03-05 07:00:30.

Distributed Systems: Prominent Architectures 150
Client Server 150
Peer to Peer 151
N-Tiered 152
Distributed System Examples 153
FTP 153
The World Wide Web 155
Case Study: Web Application 158
System Architecture 158
HTML, CSS, and JavaScript 159
Front End 160
Back End 162
Summary 163
References and Further Reading 164

Chapter 6: Computer Security 165

Access Control 166
Confidentiality 167
Integrity 169
Availability 170
Symmetric Key Cryptography 170
Asymmetric Key Cryptography 171
Digital Signatures 172
Digital Certificates 172
Certificate Chains 173
Salts and Nonces 173
Random Numbers 174
Security in Client Computing Systems 175

Copyright © 2021. Apress L. P.. All rights reserved.

Crutcher, Paul D., et al. Essential Computer Science : A Programmer's Guide to Foundational Concepts, Apress L. P., 2021.
ProQuest Ebook Central, http://ebookcentral.proquest.com/lib/th-deggendorf/detail.action?docID=6640815.
Created from th-deggendorf on 2022-03-05 07:00:30.

Malware, the Bad Apples of Software....175
Trusted Execution Environments and Virtual Machines....181
Communication Security: Security of Data in Motion....185
Transport Layer Security....186
Virtual Private Network....188
IP Security....189
Writing Secure Programs: Where Do We Start?....189
Summary....192
References and Further Reading....192

Chapter 7: Cloud Computing....195

Cloud Computing Models....196
IaaS....197
PaaS....198
Serverless....199
SaaS....200
Comparison of Cloud Computing Models....200
Benefits of Cloud Computing....201
Cost....201
Scalability....202
Velocity....203
Reliability and Availability....203
Productivity....203
Performance....204
Ease of Use and Maintenance....204
Cloud Deployment Configurations....204
Private Cloud....205
Public Cloud....205

Copyright © 2021. Apress L. P.. All rights reserved.

Crutcher, Paul D., et al. Essential Computer Science : A Programmer's Guide to Foundational Concepts, Apress L. P., 2021.
ProQuest Ebook Central, http://ebookcentral.proquest.com/lib/th-deggendorf/detail.action?docID=6640815.
Created from th-deggendorf on 2022-03-05 07:00:30.

Hybrid Cloud 206
Ideal Cloud Deployment Configuration 206
Cloud Configuration Interface/Mechanism 207
Cloud Service Providers 209
Considerations in Choosing a CSP 209
Motivation for Switching CSPs 210
Considerations for Developing Portable and Interoperable Cloud Solutions 212
Interoperability vs. Portability 213
Containers, Docker, and Kubernetes 216
The Way Forward 221
Recommendations 222
Summary 223
References and Further Reading 223

Chapter 8: Machine Learning 225

Brief History of Machine Learning 226
Artificial Intelligence, Machine Learning, and Deep Learning 228
Fundamental Tenets of Machine Learning 229
Models 230
Training 231
Prediction (Inference) 232
Categories of Machine learning 232
Supervised Learning 232
Unsupervised Learning 234
Semi-supervised Learning 234
Reinforcement Learning 234
Machine Learning in Practice 235
Leading Machine Learning Frameworks 235

Copyright © 2021. Apress L. P.. All rights reserved.

Crutcher, Paul D., et al. Essential Computer Science : A Programmer's Guide to Foundational Concepts, Apress L. P., 2021.
ProQuest Ebook Central, http://ebookcentral.proquest.com/lib/th-deggendorf/detail.action?docID=6640815.
Created from th-deggendorf on 2022-03-05 07:00:30.

Machine Learning and Cloud Computing 236
The Way Forward 237
Summary 239
References 240

Appendix A: Software Development Lifecycle 241

Planning 242
Analysis 243
Architecture and Design 244
Implementation 244
Test 245
Deploy 246
Maintenance 247

Appendix B: Software Engineering Practices 249

Planning and Management Practices: Agile 249
Scrum 249
Kanban 251
Analysis and Design 252
Scaling Agile Practices 252
Documentation 253
Requirements, Design, and Architecture 253
Comments and Code 254
User 254
Testing 254
Phases and Categories of Testing and Goals 255
Test-Driven Development 256

Copyright © 2021. Apress L. P.. All rights reserved.

Crutcher, Paul D., et al. Essential Computer Science : A Programmer's Guide to Foundational Concepts, Apress L. P., 2021.
ProQuest Ebook Central, http://ebookcentral.proquest.com/lib/th-deggendorf/detail.action?docID=6640815.
Created from th-deggendorf on 2022-03-05 07:00:30.

Developing for Debug....256
Asserts and Exceptions....257
Logging and Tracing....257
Source Control Management....258
Purpose and Mechanism....258
Tools....260
Build Optimizations and Tools....261
Purpose and Mechanism....261
Tools....262
Continuous Integration and Continuous Delivery....264
Purpose and Mechanism....264
Tools....266

Appendix C: ACPI System States....269

Global and System States....270
Device States....273
Processor States....274

Appendix D: System Boot Flow....277

Index....281

Copyright © 2021. Apress L. P.. All rights reserved.

Crutcher, Paul D., et al. Essential Computer Science : A Programmer's Guide to Foundational Concepts, Apress L. P., 2021.
ProQuest Ebook Central, http://ebookcentral.proquest.com/lib/th-deggendorf/detail.action?docID=6640815.
Created from th-deggendorf on 2022-03-05 07:00:30.