

---

# Table of Contents

Preface.....	vii
<b>1. An Introduction to Concurrency.....</b>	<b>1</b>
Moore's Law, Web Scale, and the Mess We're In	2
Why Is Concurrency Hard?	4
Race Conditions	4
Atomicity	6
Memory Access Synchronization	8
Deadlocks, Livelocks, and Starvation	10
Determining Concurrency Safety	18
Simplicity in the Face of Complexity	20
<b>2. Modeling Your Code: Communicating Sequential Processes.....</b>	<b>23</b>
The Difference Between Concurrency and Parallelism	23
What Is CSP?	26
How This Helps You	29
Go's Philosophy on Concurrency	31
<b>3. Go's Concurrency Building Blocks.....</b>	<b>37</b>
Goroutines	37
The sync Package	47
WaitGroup	47
Mutex and RWMutex	49
Cond	52
Once	57
Pool	59
Channels	64
The select Statement	78

The GOMAXPROCS Lever	83
Conclusion	83
<b>4. Concurrency Patterns in Go.....</b>	<b>85</b>
Confinement	85
The for-select Loop	89
Preventing Goroutine Leaks	90
The or-channel	94
Error Handling	97
Pipelines	100
Best Practices for Constructing Pipelines	104
Some Handy Generators	109
Fan-Out, Fan-In	114
The or-done-channel	119
The tee-channel	120
The bridge-channel	122
Queuing	124
The context Package	131
Summary	145
<b>5. Concurrency at Scale.....</b>	<b>147</b>
Error Propagation	147
Timeouts and Cancellation	155
Heartbeats	161
Replicated Requests	172
Rate Limiting	174
Healing Unhealthy Goroutines	188
Summary	194
<b>6. Goroutines and the Go Runtime.....</b>	<b>197</b>
Work Stealing	197
Stealing Tasks or Continuations?	204
Presenting All of This to the Developer	212
Conclusion	212
<b>A. Appendix.....</b>	<b>213</b>
<b>Index.....</b>	<b>219</b>