

# *C++ Allocators for the Working Programmer*

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# *C++ Allocators for the Working Programmer*

*John Lakos*

*Joshua Berne*

◆◆Addison-Wesley

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This is John’s dedication to Josh for being so great and  
writing this book so well.

JL

This is Josh’s dedication to his wife, child,  
and mother-in-law for being all supportive and  
wonderful. And to steak. Steak is great.

JMB



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# Foreword

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# Preface

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# Acknowledgements

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## About the Authors

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John Lakos, author of *Large-Scale C++ Software Design* [Pearson, 1996] and *Large-Scale C++ — Volume I: Process and Architecture* [Pearson, 2019], serves at Bloomberg in New York City as a senior architect and mentor for C++ software development worldwide. He is also an active voting member of the C++ Standards Committee’s Evolution Working Group. From 1997 to 2001, Dr. Lakos directed the design and development of infrastructure libraries for proprietary analytic financial applications at Bear Stearns. From 1983 to 1997, Dr. Lakos was employed at Mentor Graphics, where he developed large frameworks and advanced ICCAD applications for which he holds multiple software patents. His academic credentials include a Ph.D.

in Computer Science (1997) and an Sc.D. in Electrical Engineering (1989) from Columbia University. Dr. Lakos received his undergraduate degrees from MIT in Mathematics (1982) and Computer Science (1981).



Author  
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Joshua Berne serves at Bloomberg LP as a senior software engineer on Bloomberg’s core library team. After the difficult choice to pursue a career in software engineering over research mathematics, he has been an active programmer in the financial industry, writing day trading applications in C++ for E\*TRADE Capital Markets and, after that, architecting large distributed trading systems in Java for Instinet and IDC. Since joining Bloomberg in 2017, he has been an active participant in the C++ Standards Committee, seeking to bring the advancements made within Bloomberg to the C++ Standard and thus to the rest of the world. His first WG21 paper was [1]



# Chapter 1

## Application Developers

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### 1.1 What is an Allocator-Aware Type?

#### 1.1.1 Defining a PMR Allocator-Aware Type

#### 1.1.2 `std::pmr` Collections

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### 1.2 Using Allocator-Aware Types

#### 1.2.1 How to use a Custom Memory Resource

#### 1.2.2 How to Choose an Allocator

#### 1.2.3 Testing Code that Allocates

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### 1.3 Case Study 1: Unique Value Counting

# Chapter 2

## Library Writers

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### 2.1 Writing Allocator-Aware Types

#### 2.1.1 Aggregating Other Allocator-Aware Types

#### 2.1.2 Doing Allocation

#### 2.1.3 Testing Allocator-Aware Types

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### 2.2 Case Study 3: PMR Optional and Variant

# Chapter 3

## Writing Allocators

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### 3.1 Implementation

- 3.1.1 Learning from Global Allocators
- 3.1.2 Thread-Unsafe Allocators
- 3.1.3 Reuse Free Allocators
- 3.1.4 Wrapping Other Allocators for Utility

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### 3.2 Benchmarking Allocators

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### 3.3 Case Study 4: A Buffered Sequential Allocator

# Chapter 4

## Advanced

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### 4.1 Modern Hardware

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### 4.2 Effective Benchmarking

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Here we would be discussing the approach we have to benchmarking.

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### 4.3 Optimizing Large Allocator-Aware Systems

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### 4.4 Designing Effective Allocator-Aware Architectures

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# Bibliography

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- [1] Joshua Berne, Nathan Burgers, Hyman Rosen, John Lakos, “Contract checking in c++: A (long-term) road map,” Tech. Rep. P1332R0, WG21 - The C++ Standards Committee, 2018.





# Appendix A

## Other Libraries

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### A.1 BDE

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### A.2 Thrust

# Appendix B

## Future Developments

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### B.1 More PMR Types

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### B.2 Automating Allocator Suppoer

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