



C++ Allocators for the Working Programmer

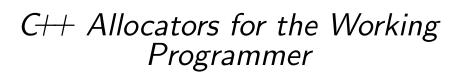






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John Lakos Joshua Berne

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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.

 ${\rm JMB}$



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Foreword

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Preface

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Acknowledgements

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Foundations

1.1 Motivation

- Why local allocation can help
- Limits of global allocation
- Reference Emery's paper?

1.1.1 What is an Allocator

- an allocator allocates and deallocates memory
- what is a "general purpose" allocator
 - same contract and requirements as new/delete malloc/free
 - thread-safe allocate concurrently, deallocate from any thread
 - objects of any size
 - overhead constant in terms of currently allocated memory
- types of "special purpose" allocators
 - Unsynchronized
 - Monotonic
- Global vs. Local allocators
 - global allocators can be specialized
 - local allocators can be general purpose

1.1.2 The History of C++ Allocators

- describe C++03 allocators
- [?] Towards a better allocator model
- [?], [?],
- Scoped allocators: [?], [?],
- c++17, c++20 changes to PMR

1

2

Chapter 1 Foundations

1.1.3 What we'll teach you about allocators

• Summary of what each chapter will teach

1.1.4 Making money with allocators

• Summary of how architecture can facilitate leveraging allocators

1.2 Technical Basics

1.2.1 C++ Allocators

 $\bullet\,$ Go over the mess of c++03 style allocator types

1.2.2 The std::pmr Interface

- $\bullet \ \ Show \ std::pmr::polymorphic_allocator$
- Show simplification to ALLOCATOR types
- $\bullet\,$ Show the memory_resource interface, how to do an allocation





Application Developers

- 2.1 What is an Allocator-Aware Type?
- 2.1.1 Defining a PMR Allocator-Aware Type
- 2.1.2 std::pmr Collections
- 2.2 Using Allocator-Aware Types
- 2.2.1 How to use a Custom Memory Resource
- 2.2.2 How to Choose an Allocator
- 2.2.3 Testing Code that Allocates
- 2.3 Case Study 1: Unique Value Counting





Library Writers

- 3.1 Writing Allocator-Aware Types
- 3.1.1 Aggregating Other Allocator-Aware Types
- 3.1.2 Doing Allocation
- 3.1.3 Testing Allocator-Aware Types
- 3.2 Case Study 3: PMR Optional and Variant





Writing Allocators

- 4.1 Implementation
- 4.1.1 Learning from Global Alocators
- 4.1.2 Thread-Unsafe Allocators
- 4.1.3 Reuse Free Allocators
- 4.1.4 Wrapping Other Allocators for Utility
- 4.2 Benchmarking Allocators
- 4.3 Case Study 4: A Buffered Sequential Allocator



Making Money

5.1 Optimizing exisitng software

5.1.1 Identifying short-lived objects

- escape analysis
- recursive functions
- Automated tooling to help discover?

5.1.2 Replacing many allocations with few

• identify

5.2 Designing for allocator usage

5.2.1 Shaping tasks for allocators

- Differentiating between long and short lived data.
- Message processing in local allocators, updating persistent state in global allocator
- $\bullet\,$ Structuruing persistent data for advantageous cache usage

5.2.2 Keeping allocators with subsystems

• Moving allocators with their data - queues of smart pointers,





Advanced

6.1 Modern Hardware

6.2 Effective Benchmarking

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

```
struct S {
   void foo();
};

void S::foo()
{
}
```



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Appendix A

Other Libraries

A.1 BDE

A.2 Thrust







Appendix B

Future Developments

- **B.1** More PMR Types
- **B.2** Automating Allocator Suppoer

