Umpire: Performing Experiments to Determine Consistency of Coalescing Heuristics Across Different Memory Pools

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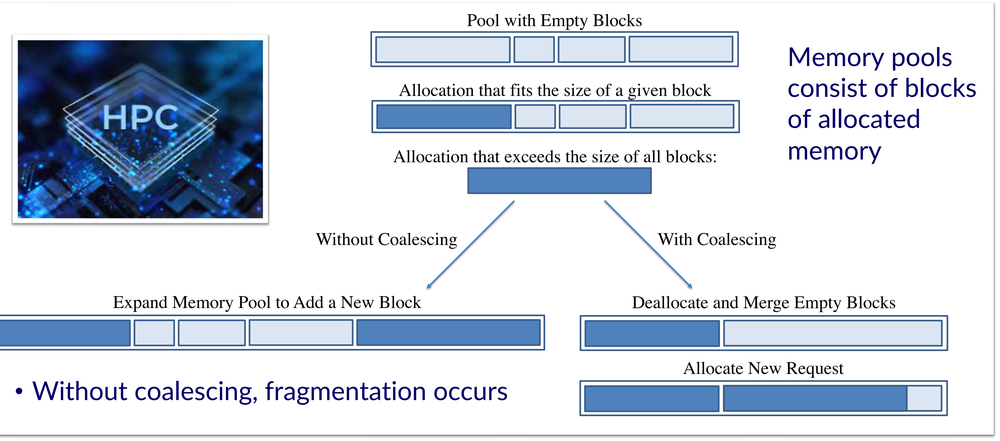
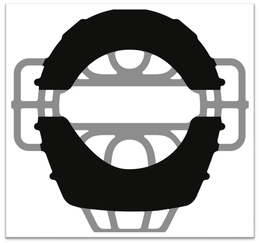
Introduction

- The Umpire API provides memory management abstractions, including memory pools, for high performance applications.



- Without coalescing, fragmentation occurs

- Umpire's heuristics determine when to coalesce and what factors should trigger the call.



- Previous experiments have concluded it is best to call the coalescing function when a specific number of blocks are releasable (Blocks-Releasable heuristic).
- My work will ensure that the previous coalescing heuristic results are valid across different pools (DynamicPoolList and QuickPool) and are consistent from one application from another.

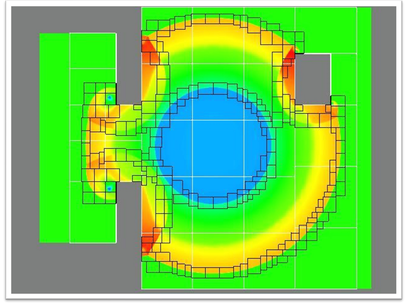
Discussion

- By the end of summer my work will focus on these questions:

- Does the Blocks-Releasable heuristic give consistent performance benefits from one application to another?
- Does the Blocks-Releasable heuristic work equally well for the DynamicPoolList as it does for QuickPool?
- Is the Blocks-Releasable heuristic a good coalescing heuristic to use as a default heuristic in Umpire?

Methods

- Umpire provides a replay tool that can be used to analyze the performance of an application's allocation of memory and reproduce bugs. The replay tool generates a .ult file which can be used with PyDV, a Python data visualizer, to generate plots. To conduct the experiment I will use SAMRAI, a C++ framework for block-structured AMR application development.



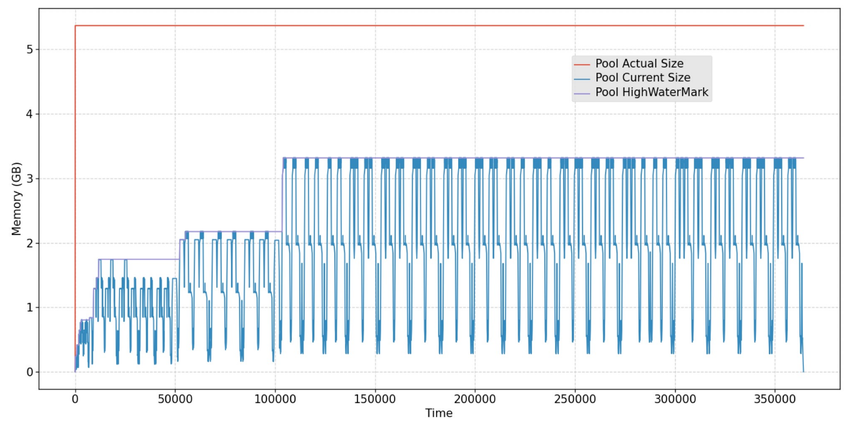
- SAMRAI allows for mesh refinement where high resolution is required.

- The programs used to test will be running on NVIDIA GPUs.

```
// umpire::ResourceManager allows to interact with Umpire API
auto& rm = umpire::ResourceManager::getInstance();

// umpire::Allocator can be used to allocate and deallocate memory
umpire::Allocator allocator = rm.getAllocator("HOST");

// Create a heuristic that will return true when 2 blocks are releasable
auto heuristic_function = umpire::strategy::DynamicPool::blocks_releasable(2);

// Create a dynamic pool with the heuristic
auto pooled_allocator = rm.makeAllocator<umpire::strategy::DynamicPool>("HOST_POOL",
allocator, 1024ul, 1024ul, 16, heuristic_function);

// Pool will contain 4 blocks each of size 1024 bytes
void* a[4];
for(int i = 0; i < 4; ++i)
  a[i] = pooled_allocator.allocate(1024);

// Deallocate
pooled_allocator.deallocate(a[0]);
pooled_allocator.deallocate(a[1]);

// Two blocks left --> Pool will now coalesce the two empty blocks

pooled_allocator.deallocate(a[2]);
pooled_allocator.deallocate(a[3]);
```

- Example code of where the coalescing would occur if there were multiple allocations and deallocations within a pool.

Initial Results



- Umpire's replay tool used to show properties about SAMRAI test application.

- The Current Size fluctuates as the program allocates and deallocates memory while the HighWaterMark stays at the maximum value of the Current Size.

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