alpaka Parallel Programming – Online Tutorial

Lecture 30 – Portability with alpaka

Lesson 31: Changing the Accelerator

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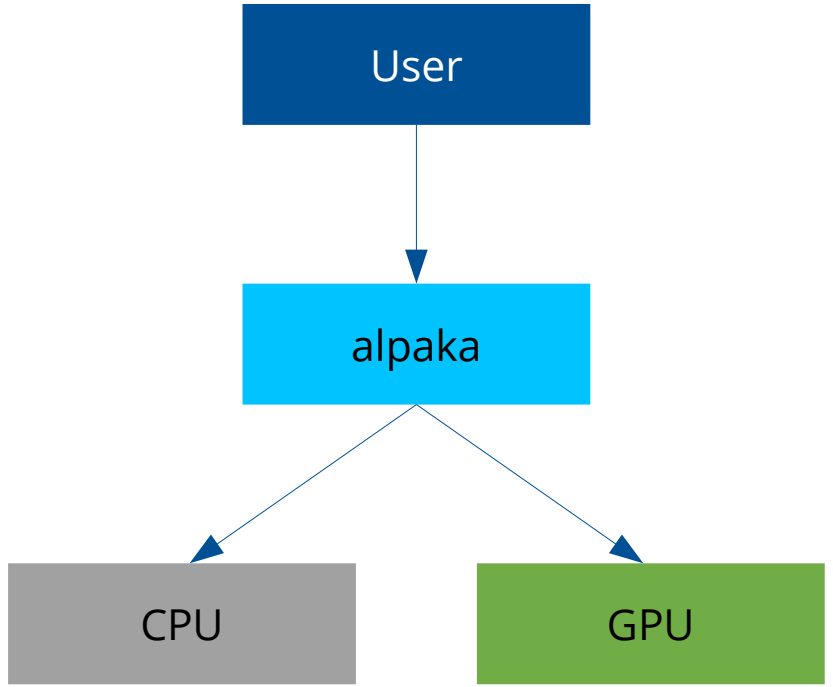
Moving from CPU to GPU

alpaka allows for easy ...

- ... exchange of the accelerator
- ... porting of programs across accelerators
- ... experimentation with different devices
- ... mixing of accelerator types



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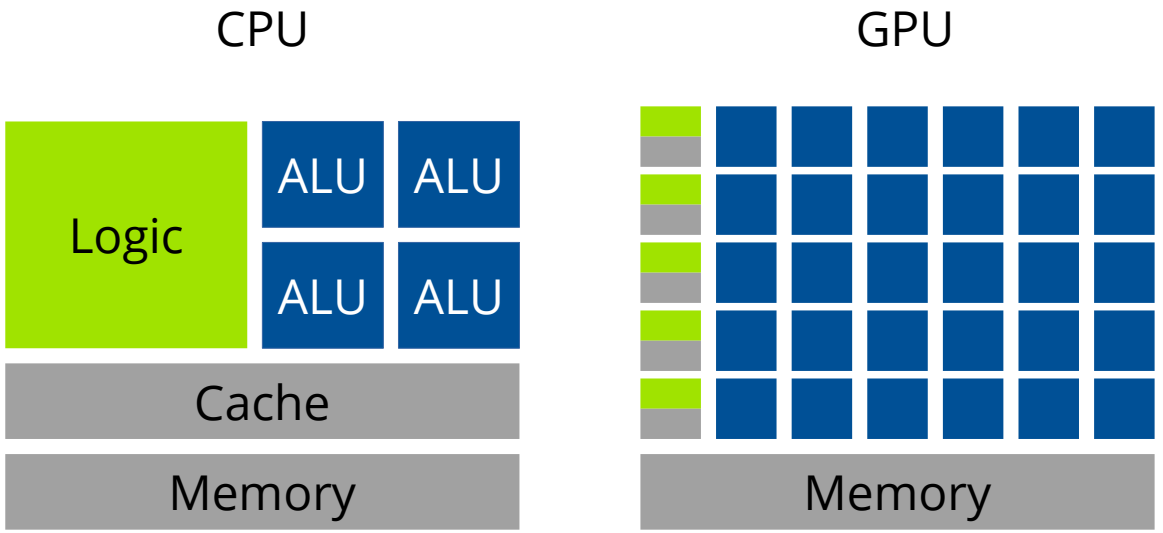
Architectural differences

- Rule of thumb: Offload computationally intensive parts to GPUs
- GPUs are designed for high throughput
  - Many lightweight threads
  - High memory latency
- CPUs are designed for low latency
  - Few heavyweight threads
  - Low memory latency



Source: Pradeep Gupta, *CUDA Refresher: Reviewing the Origins of GPU Computing*. https://developer.nvidia.com/blog/cuda-refresher-reviewing-the-origins-of-gpu-computing/. Access date: 25 June 2020

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Switching the Accelerator

- alpaka provides a number of pre-defined Accelerators in the `acc` namespace.
- For GPUs:
  - `AccGpuCudaRt` for NVIDIA GPUs
  - `AccGpuHipRt` for AMD and NVIDIA GPUs
- For CPUs
  - `AccCpuFibers` based on Boost.fiber
  - `AccCpuOmp2Blocks` based on OpenMP 2.x
  - `AccCpuOmp4` based on OpenMP 4.x
  - `AccCpuTbbBlocks` based on TBB
  - `AccCpuThreads` based on `std::thread`

```
// Example: CPU accelerator
using Acc = acc::AccCpuOmp2Blocks<Dim, Idx>;

// Example: CUDA GPU accelerator
using Acc = acc::AccGpuCudaRt<Dim, Idx>;

// Example: HIP GPU accelerator
using Acc = acc::AccGpuHipRt<Dim, Idx>;
```

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Changing the work division

- GPUs have many more cores than CPUs
  → More parallel threads possible
- GPUs have several multiprocessors
- Each multiprocessor can execute multiple threads
- Threads are grouped into blocks
- Blocks are scheduled to run on multiprocessors

```
// CPU work division (example)
Idx blocksPerGrid     = 8;
Idx threadsPerBlock   = 1;
Idx elementsPerThread = 1;

// GPU work division (example)
Idx blocksPerGrid     = 64;
Idx threadsPerBlock   = 512;
Idx elementsPerThread = 1;
```

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GPU performance hints

- Avoid divergent `if`-`else`-blocks
  - GPU threads are organized into groups (NVIDIA: *warp*, AMD: *wavefront*)
  - Groups are executed in lock step
    → If there is divergence, all threads execute the `if` block first and the `else` block next
- GPU threads are much more lightweight than CPU threads
  - Context switch is much cheaper on GPUs
  - Spawn many more threads than you have GPU cores
    → Hide memory latency behind computation

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