Offloading Computation to a GPU with OpenMP

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OpenMP: Overview

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OpenMP (Open Multi-Processing) is a portable, scalable programming model used to develop parallel applications on shared-memory architectures. It provides a parallelization interface in C, C++, and Fortran. OpenMP

- uses pragmas (#pragma) to specify parallel regions and tasks, requiring minimal code changes.
- uses threads that share a global address space, simplifying data sharing and communication.
- supports load balancing with multiple scheduling strategies for loops and tasks.

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Common directive:

- **#pragma omp parallel**: Defines a parallel region where threads are created.

```
#include <omp.h>
#include <iostream>

int main() {
    #pragma omp parallel
    {
        int thread_id = omp_get_thread_num();
        std::cout << "Hello from thread " << thread_id << std::endl;
    }
    return 0;
}
```

Example: Computing Pi with OpenMP

```
    double pi = 0.0;

    #pragma omp parallel
    {
        double local_sum = 0.0;

        #pragma omp for
        for (int i = 0; i < num_intervals; ++i) {
            double x = (i + 0.5) * step;
            local_sum += sqrt(1.0 - x * x) * step;
        }

        #pragma omp atomic
        pi += local_sum;
    }

    pi *= 4.0; // Scale to compute full Pi from quarter-circle integration

    std::cout << "Estimated value of Pi: " << pi << std::endl;

    return 0;
}
```

- A team of threads created
- Work is distributed to the threads.

  #pragma omp for: Distributes loop iterations across threads.
- Partial results are reduced atomically.

Example: Computing Pi with OpenMP

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- **Let's work on this OpenMP code.**

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