Simple OpenMP

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OpenMP Multithreaded Programming

- OpenMP stands for “Open Multi-Processing”
- It is run by a consortium of companies, labs, and universities
- OpenMP (IMHO) gives you the biggest multithread benefit per amount of work you have to put into using it

Much of your use of OpenMP will be accomplished by issuing C/C++ “pragmas” to tell the compiler how to build the threads into the executable

#pragma omp directive [clause]

That’s it! That’s where the compiler comes in.

But, as you are about to find out, doing parallel processing at all is not difficult.

The trick is doing parallel processing well. That’s where you come in.

Using OpenMP on Linux

$ g++ -o proj proj.cpp -lm -fopenmp

Using OpenMP in Microsoft Visual Studio

1. Go to the Project menu → Project Properties
2. Change the setting Configuration Properties → C/C++ → Language → OpenMP Support to “Yes (/openmp)”

If you are using Visual Studio 2019 and get a compile message that looks like this:

`The file 'cs: error C2338: two-phase name lookup is not supported for C++/CLI, C++/CX, or OpenMP; use /Zc:twoPhase'`

then do this:
1. Go to “Project Properties” → “C/C++” → “Command Line”
2. Add `/Zc:twoPhase` in “Additional Options” in the bottom section
3. Press OK
Seeing if OpenMP is Supported on Your System

```c
#ifdef __OPENMP
    fprintf( stderr, "OpenMP version %d is supported here!
", __OPENMP );
#else
    fprintf( stderr, "OpenMP is not supported here – sorry!\n" );
    exit( 0 );
#endif
```

This gives you a year and month of the OpenMP you are using

To get an OpenMP version number:

<table>
<thead>
<tr>
<th>OpenMP Version</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>OpenMP 5.0</td>
<td>November 2018</td>
</tr>
<tr>
<td>OpenMP 4.5</td>
<td>November 2015</td>
</tr>
<tr>
<td>OpenMP 4.0</td>
<td>July 2013</td>
</tr>
<tr>
<td>OpenMP 3.1</td>
<td>July 2011</td>
</tr>
</tbody>
</table>

- By default, flip is using g++ 4.8.5, which uses OpenMP version 3.1
- flip's g++ 9.2.0 uses OpenMP version 4.5
- Looks like Visual Studio 2019's is even older (?)

Threads

We will get into more detail pretty soon, but for now, know that a thread is an independent execution path for your code to take.

Threads are at their very best when each one can run on a separate hardware core.

Creating OpenMP threads for a for loop

```c
#include <omp.h>

#ifndef __OPENMP
    fprintf( stderr, "OpenMP is not supported – sorry!\n" );
    exit( 0 );
#endif

#define omp_set_num_threads( NUM )

#pragma omp parallel for default(none)
for( int i = 0; i < arraySize; i++ )
{
    ...
}
```

This creates a team of threads from the thread pool and divides the for-loop passes up among those threads.

There is an “implied barrier” at the end where each thread waits until all threads are done, then the code continues in a single thread.

The `default(none)` directive forces you to explicitly declare all variables declared outside the parallel region to be either private or shared while they are in the parallel region. Variables declared within the for-loop statement are automatically private.