What, You Mean GPUs Can Be Fast?!

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Previously, in “What do you mean, I don’t know how to GPU?”

- 2D Stencil code (memory bound case—data set doesn’t fit in caches)
- The speedup was ~2.5× over sequential runs in the best cases
  - The naïve OpenMP code yields a ~3.5/4× speedup (on 2-socket/32 threads and 4-socket/48 threads)
  - Our own data-driven runtime yields ~6× (same platforms), using fine-grain synchronization
- It was kindly suggested to us that we should maybe kinda sorta learn more about writing (good) GPU code:
  - Bad (non-unit) stride memory access pattern
  - One thread was doing 3× more work than the others (was processing the halo all by itself).

The Code, Then and Now.

Before

Now

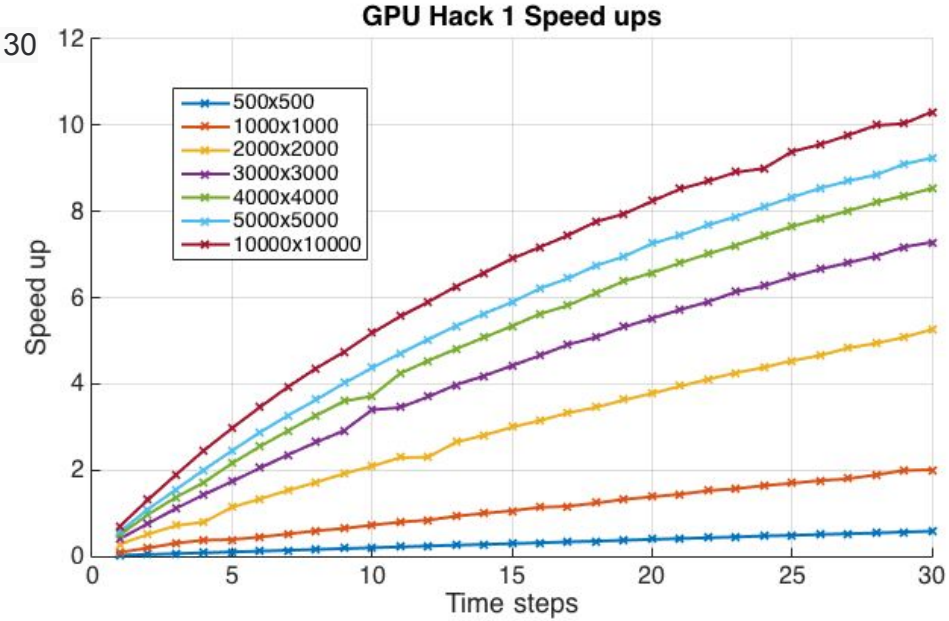
```
__global__ void gpu_stencil2D_4pt_hack1(double * dst, double * src, int M, int N) {
   __shared__ double shared_mem[GRID_TILE_Y + HALO*2 ] [ GRID_TILE_X + HALO*2];
                          //Cols    *  numRows/Tile * tileIndex
   int base_global_idx = ( N ) * ( GRID_TILE_Y * blockIdx.y ) + GRID_TILE_X*blockIdx.x;

   for (int i = 0 ; i < GRID_TILE_Y+2*HALO ; i ++ )
      for (int j = threadIdx.x ; j < GRID_TILE_X+2*HALO ; j+=blockDim.x) {
         shared_mem [i][j] = src[base_global_idx + i*N + j];
      }
   __syncthreads();

   for (int i = HALO ; i < GRID_TILE_Y+HALO ; i ++ )
      for (int j = threadIdx.x + HALO ; j < GRID_TILE_X+HALO ; j+=blockDim.x) {
                                       //left                + right               + top                   + bottom
         dst[base_global_idx + i*N + j] = (shared_mem[i-1][j] + shared_mem[i+1][j] + shared_mem[i][j-1] + shared_mem[i][j+1] )/5.5;
      }
   __syncthreads();
}
```

So, Er, We Finally Did It.

- Note: Yes, we could do better (in fact, our OpenACC code which is GPU-only does run even faster)
- But our objective is to evaluate the Host-GPU communication and overlapping strategies

```
0.11113    ==19330== Profiling application: ./StencilCUDA 1000 1000 30
==19330== Profiling result:
Time(%)      Time     Calls       Avg       Min       Max  Name
51.00%  206.18ms       600  343.62us  341.39us  346.38us
gpu_stencil2D_4pt_hack1
25.51%  103.12ms        40  2.5781ms  1.8760ms  3.0319ms  [CUDA
memcpy DtoH]
23.49%  94.947ms        40  2.3737ms  2.1776ms  5.3558ms  [CUDA
memcpy HtoD]
```

From 91% spent in the kernel



Next Steps

- Use the shared block memory as a “sliding window” to process more row elements in a single block
- **Start working on the Host ←→ GPU communication schemes:**
  - Write an OpenMP+Cuda version (we expect ~90% of the computation to occur on the GPU)
  - Time permitting: Make use of streams to send/receive the shared rows
  - Time permitting: write a Codelet+Cuda version of the code