CME213, Spring 2022
Parallel Computing
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Homework 4: CUDA GPU Matrix Operations

Goal of the homework is to implement a finite difference solver for the 2-dim heat equation using CUDA GPU programming.

Problem 1: Implement gpuStencil Global Idea: parallelize spatial dimension updates for each time step iteration. One key challenge was to handle the different border sizes for order inputs of 2, 4 and 8. Kernel logic included below.

```
/**
 * Kernel to propagate finite difference grid from the current
 * time point to the next.
 */
template<int order>
__global__
void gpuStencilGlobal(float* next, const float* __restrict__ curr,
                      int gx, int nx, int ny, float xcfl, float ycfl) {

    int borderSize = (int) (order / 2);
    int i = blockIdx.x * blockDim.x + threadIdx.x;

    if (i < nx*ny) {
  int x = borderSize + (int) (i / nx);
  int y = borderSize + (i % nx);
        int idx = gx * y + x;
        next[idx] = Stencil<order>(&curr[idx], gx, xcfl, ycfl);

    }
}
```

3D surface plots of temperature on 256 x 256 grid at iterations 0, 1000 and 2000 respectively, with 8th order. To do this, I used parameter settings of: order = 8 and nx = ny = 248.

Problem 2: Implement gpuStencil Block Idea: ...

... ...

Submission information logs.

```
jelc@cardinal2:~$ /afs/ir.stanford.edu/class/cme213/script/submit.py hw3 private/cme213-
Submission for assignment 'hw3' as user 'jelc'
Attempt 2/10
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    private/cme213-jelc53/hw3/main_q1.cu  [13253 bytes]
```

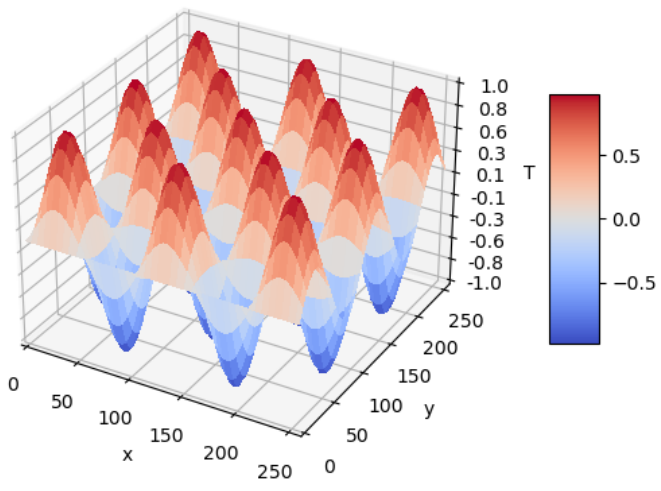

Figure 1: 3D surafce plot of temperature at iteration 0

```
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benchmark.cuh  main_q1.cu  metadata  pagerank.cuh  recurrence.cuh
```

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