GPU Computing with CUDA
Lab 5 - Thrust

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Objectives

- Experiment with Thrust
- Outline
  - Walk through various examples
  - Implement “weld triangles” example

Thrust - Example 1

```
#include <thrust/device_vector.h>
#include <thrust/reduce.h>
#include <iostream>

int main(void)
{
  thrust::device_vector<int> data(4);

  data[0] = 10;
  data[1] = 20;
  data[2] = 30;
  data[3] = 40;

  int sum = thrust::reduce(data.begin(), data.end());

  std::cout << "sum is " << sum << std::endl;

  return 0;
}
```

Thrust - Example 2

```
#include <thrust/device_vector.h>
#include <thrust/transform.h>

struct triple
{
  __host__ __device__
  int operator()(int x)
  {
    return 3 * x;
  }
};

int main(void)
{
  thrust::device_vector<int> input(4);
  input[0] = 10;
  input[1] = 20;
  input[2] = 30;
  input[3] = 40;

  thrust::device_vector<int> output(4);
  thrust::transform(input.begin(), input.end(), output.begin(), triple());

  for (int i = 0; i < output.size(); i++)
    std::cout << output[i] << std::endl;
  return 0;
}
```

Thrust - Example 3

```
#include <thrust/device_vector.h>
#include <thrust/sort.h>
#include <thrust/functional.h>

int main(void)
{
  thrust::device_vector<int> data(8);
  data[0] = 6;
  data[1] = 3;
  data[2] = 7;
  data[3] = 5;
  data[4] = 9;
  data[5] = 0;
  data[6] = 8;
  data[7] = 1;

  thrust::sort(data.begin(), data.end());
  std::cout << "ascending" << std::endl;
  for (int i = 0; i < data.size(); i++)
    std::cout << data[i] << std::endl;

  thrust::sort(data.begin(), data.end(), thrust::greater<int>());
  std::cout << "descending" << std::endl;
  for (int i = 0; i < data.size(); i++)
    std::cout << data[i] << std::endl;
  return 0;
}
```

Thrust - Example 4

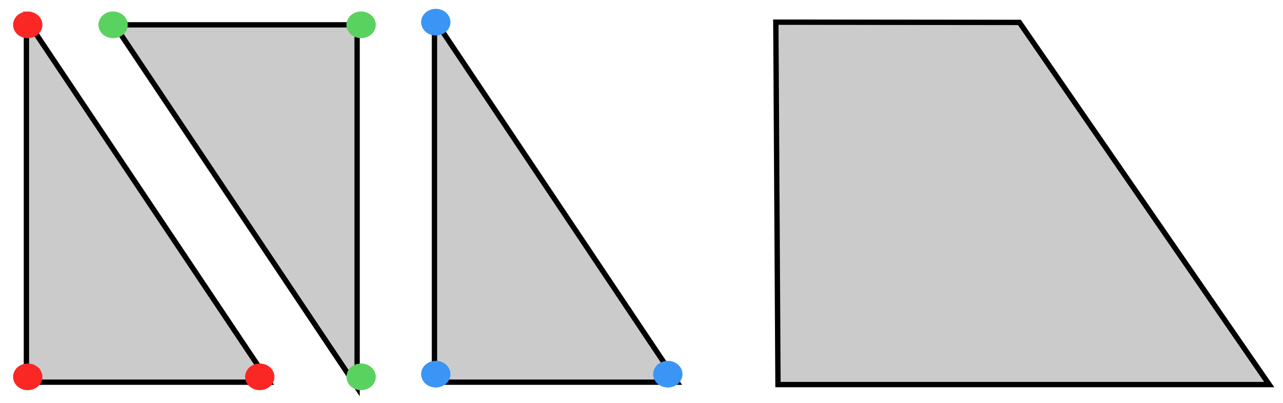
```
#include <thrust/device_vector.h>
#include <thrust/count.h>
#include <thrust/copy.h>

struct is_odd
{
  __host__ __device__
  bool operator()(int x)
  {
    return (x % 2) == 1;
  }
};
int main(void)
{
  thrust::device_vector<int> data(8);
  data[0] = 6; data[1] = 3; data[2] = 7; data[3] = 5;
  data[4] = 9; data[5] = 0; data[6] = 8; data[7] = 1;

  int N = thrust::count_if(data.begin(), data.end(), is_odd());
  std::cout << "counted " << N << " odd values" << std::endl;

  thrust::device_vector<int> odds(N);
  thrust::copy_if(data.begin(), data.end(), odds.begin(), is_odd());

  for (int i = 0; i < odds.size(); i++)
    std::cout << odds[i] << std::endl;
  return 0;
}
```

Thrust - Example 5

```
#include <thrust/host_vector.h>
#include <thrust/device_vector.h>
#include <thrust/reduce.h>
#include <iostream>

int main(void)
{
  int N = 100000;

  thrust::host_vector<int>   h_data(N);
  thrust::device_vector<int> d_data(N);

//  // method 1: (one cudaMemcpy per element)
//  for (int i = 0; i < N; i++)
//    d_data[i] = i;

//  // method 2: one cudaMemcpy for entire array
//  for (int i = 0; i < N; i++)
//    h_data[i] = i;
//
//  thrust::copy(h_data.begin(), h_data.end(), d_data.begin());

  return 0;
}
```

Thrust - Weld triangles

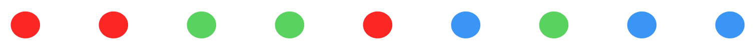
- Eliminate redundant vertices to form figure



- Procedure
  - Sort vertices
  - Collapse spans of like vertices
  - Search for each vertex's unique index

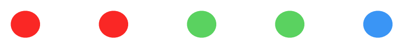
Thrust - Weld triangles

- Sort triangles:
  - Use sort with functor to sort respect to x and then to y



- Collapse spans of like vertices
  - Use **`unique`**: reorders array and points to the first repeated value

```
#include <thrust/unique.h>
...
const int N = 7;
int A[N] = {1, 3, 3, 3, 2, 2, 1};
int *new_end = thrust::unique(A, A + N);
// The first four values of A are now {1, 3, 2, 1}
// Values beyond new_end are unspecified.
\endcode
```



- Delete values beyond new iterator: **`vertices.erase()`**