Programming Assignment #5
CUDA Matrix-Vector Product

Tips & Tricks

CS 3220

Spring 2024

Matrix-Vector Product

Suppose I have the 3-by-3 matrix M and the 1-by-3 vector x

Assuming zero indexing for M and for x and y, then the product y = Mx is given by

$$y[0] = M[0, 0] * x[0] + M[0, 1] * x[1] + M[0, 2] * x[2]$$

$$y[1] = M[1, 0] * x[0] + M[1, 1] * x[1] + M[1, 2] * x[2]$$

$$y[2] = M[2, 0] * x[0] + M[2, 1] * x[1] + M[2, 2] * x[2]$$

Matrix-Vector Product

Now suppose that M is stored as a 1-D matrix, of length 3*3 = 9

Then we can write the calculation of y = Mx this way:

y[0] = M[0] * x[0] + M[1] * x[1] + M[2] * x[2]

y[1] = M[3] * x[0] + M[4] * x[1] + M[5] * x[2]

y[2] = M[6] * x[0] + M[7] * x[1] + M[8] * x[2]

Each element M[i, j] is now located at M[3*i + j]

Comparing Vectors

Suppose we want to compare two comparably sized vectors y1 and y2

- and assume that y2 is not zero

One way to do this: compare the magnitude of the difference between y1 and y2 to the magnitude of y2

Context:

- compute y1 = Mx using one technique (using a function that runs on the CPU)
- compute y2 = Mx using a different technique (using a function that runs on the GPU)
- and then compare y1 and y2

The Magnitude of a Vector

One way to compute the magnitude (also called the norm) of a vector y of length n, stored as y[0], y[1], ..., y[n-1]

norm(y) = sqrt(y[0]*y[0] + y[1]*y[1] + ... + y[n-1]*y[n-1])

Comparing Vectors

So to compare two comparably sized vectors y1 and y2, do the following:

First compute the difference d: set d = y1 - y2

- this is d[0] = y1[0] - y2[0]; d[1] = y1[1] - y2[1]; etc.

Then take norm(d) / norm(y1)