Atomic Pi

Begin my copying /home/courses/cs180j/lab8.cu. This is a stand-alone version of the final histogram program from the chapter. Compile it (be sure to include the flag -arch compute12) and verify that it works. This is your example of using CUDA atomics; I suggest that you spend a couple of minutes refreshing yourself with this code.

The interesting part of that program is concerned with adding the partial histograms. Instead of using random data, we’ll do something similar to approximate the value of $\pi$. Our approach is based on the fact that the area under the function $\sqrt{1-x^2}$ between -1 and 1 is $\pi/2$. We approximate this area as the sum of many rectangles. Here is Java code to do so:

```java
public class Integral {
    public static void main(String[] args) {
        int numRect = 10000000; // number of rectangles
        double width = overallWidth / numRect; // width of each rectangle
        double startingX = -1.0;
        double overallWidth = 2.0;
        double x; // x value of midpoint
        double pi, halfPI = 0.0; // sum of area of rectangles gives pi/2
        x = startingX - width/2; // setup for x to be at midpoint
        for(int i=0; i<numRect; i++) { // calculate area of each rectangle
            x += width;
            halfPI += width * Math.sqrt(1.0 - x*x);
        }
        pi = 2.0 * halfPI;
        System.out.println("Pi = " + pi);
    }
}
```

Start by writing a CUDA program to perform a similar calculation. Have each thread compute an area (or some areas) and then use a reduction similar to the one from the histogram program to compute the overall sum. Note that in order for atomicAdd work with floats, you need compute capability 2.0. Replace the flag given above with -arch compute20. (Note that only the new cards on descartes and huygens have this ability.)

If you have time after finishing that, see if you can implement a version that does not require floating point atomicAdd calls. You can do this by following the model of “Dot product revisited” in Appendix A of the book. Begin by reading these pages and then adapting their technique to compute $\pi$. 