COMP.CE.320 High-level Synthesis

Determinant Exercise

In this exercise, we deviate from matrix multiplication to implement determinant calculation. This is a recursive operation so we will leverage C++ template recursion to create a fully parallel architecture. To get you started, part of the code has been pre-made containing instructions for how to complete it.

Task 1

Complete the source code given with this exercise, following the instructions in the comments of the code (remove these comments before submitting). The principle is much the same as given in example 6-22 of the HLS Blue Book. Write the determinant calculation algorithm using the Laplace expansion. A simple testbench has been given to you that you can use to verify that your solution works. It is recommended to expand the testbench with other tests (and required for grade 2). You can use e.g. MATLAB or Wolfram Alpha to check that your TB works correctly.

Task 2

Synthesize the design with N values 1, 2, 3, 4, and 5. Use the same technology settings as previously. Make the "determinant" function the top-level function. Pipeline the main loop with II = 1 and unroll everything.

Questions 1: What is the area score with different N values? How fast does the area score rise as a function of N? Analyze the results. It is a good idea to look at the RTL schematics to see what happens here.

Questions 2: Explain in your own words how C++ template recursion works and how it can be utilized in hardware description.

Grading:

- Grade 1: Your implementation works correctly and your answers to the questions make sense.
- Grade 2: You have expanded the testbench with tests for different sizes of N. The testbench uses a regular (dynamic) recursive C++ function to calculate reference values for the determinant against which the DUT is tested. The testbench prints I/O to a file in an informative manner. The answers to the questions show deeper than rudimentary understanding.

To return:

Return your modified "determinant.cpp" and testbench files in a zip file (include also output file from testbench if you have one). Insert your name and student number as comments to the start of the returned files. Answer the questions as a comment to your Moodle submission.