## **INFOB3CC:** Accelerate

Trevor L. McDonell

January 9, 2022

## Introduction

Since it is the first week back after the break and we haven't covered any new theory yet, these are just some extra practical questions to get you familiar with the Accelerate, which you will use for the third practical.

## Questions

- 1. Why does the Accelerate library make a distinction between Acc and Exp? How does this correspond to GPU programming in a language such as CUDA or OpenCL?
- 2. The Mandelbrot set is generated by sampling complex numbers c in the complex plane and determining whether under iteration of the polynomial:

$$z_{n+1} = c + z_n^2$$

that the magnitude of  $z_n$  remains bounded however large n gets.

(a) Follow this tutorial to implement a Mandelbrot set generator in Accelerate: https://www.acceleratehs.org/examples/mandelbrot.html

Note: As explained in the Accelerate documentation as well, lift and unlift are very general functions that you need in specific situations, but require you to be very clear to the compiler about what types things has (and if you're not quite clear enough, you will get difficult-to-understand type errors). To combat this difficulty, pattern synonyms such as T2, I1, etc. were defined, which work more conveniently and give you better type errors when you make a mistake.

The tutorial was written before the implementation of T2, I1, etc. in Accelerate. As such, it still uses lift and unlift to convert back and forth between e.g. Exp (Z :. Int) and Exp Int. In modern Accelerate code, as long as you're not defining your own data types (in this Mandelbrot tutorial, as well as in the Quickhull practical, you aren't), you should be able to program without using lift and unlift at all.

In particular, instead of (unlift -> x :+ y), use (x ::+ y) (search for ``pattern (::+)" in the documentation for the Data.Array.Accelerate.Data.Complex module). And instead of lift (x :+ y), use x ::+ y. Similarly, instead of (unlift -> Z :. i :. j), use (I2 i j), etc.

(b) What are the problems with executing this kind of program on the GPU?