Chapter 1

Introduction

1.1 Solver theory

Euler

Take derivative, multiply with timestep, add to initial value, repeat until end.

Runge-Kutta methods

Take derivatives at some time points, multiply with proper coefficients, add all to intial value, repeat until end.

1.2 Functional programming

Don't know whether I should add a section on this in order to make everything understandable for people not familiar with FP/Haskell.

1.3 Solving ordinary differential equations in Haskell

Functional languages have several properties which make them suitable for the purpose of solving problems in numerical mathematics.

- Haskell notation close to mathematics + partial function application + referential transparency
- Clear type system for (1) checking errors/eliminating wrong implementations and (2) quick glance at what the program does

- Declarative – hide the details and let the exact execution be figured out by the compiler. You simply specify what you want as answer.
- Reasonably high performance [1]

```
type Equation    = ODEState -> D_ODEState
type SolveMethod = TimeSettings -> Equation -> ODEState -> ODEState
type Solver      = SolveMethod -> TimeSettings -> Equation -> ODEState -> [ODEState]
```

The types in Haskell reveal lots of information about the structure and functionality of the program. The three main types making up the numerical solver for ordinary differential equations are listed above.

1.4 Conversion to Mealy Machines

1.5 FPGAs

- What are FPGAs used for?
- Why should I care about FPGAs
- What is the current workflow for programming FPGAs

1.6 Data transfer to LaTeX ?

The most famous equation in the world: $E^2 = (m_0 c^2)^2 + (pc)^2$, which is known as the **energy-mass-momentum** relation as an in-line equation.

A *LaTeX class file* is a file, which holds style information for a particular LaTeX.

Lorem Ipsum is simply dummy text of the printing and typesetting industry. Lorem Ipsum has been the industry's standard dummy text ever since the 1500s, when an unknown printer took a galley of type and scrambled it to make a type specimen book. It has survived not only five centuries, but also the leap into electronic typesetting, remaining essentially unchanged. It was popularised in the 1960s with the release of Letraset sheets containing Lorem Ipsum passages, and more recently with desktop publishing software like Aldus PageMaker including versions of Lorem Ipsum.

References

[1] Computer language benchmarks game. http://benchmarksgame.alioth.debian.org/u32q/compare.php?lang=ghc&lang2=gcc, 2015. [Accessed:].