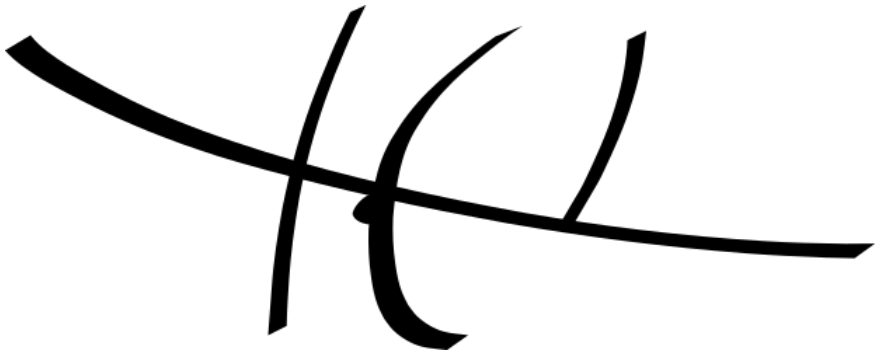
HCL Compiled Language



Design and implementation of a programming language

Aalborg University

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Preface

This report is written during the fourth semester of the bachelor's degree in Software at Aalborg University, for the study board of computer science at the School of Information and Communication Technology. The report is written with the guidance of one supervisor.

The topic of the semester is 'Design, Definition and Implementation of Programming Languages'.

The system to be developed was chosen by the project group.

Terms and abbreviations used in the report:

WW : Whole Word

Contents

Introduction 1

In recent years, there has been a bigger focus on computer science, technology and programming in the danish school system. This is in large part due to the prediction that Denmark will lack skilled programmers, cyber security specialists and other skilled computer science workers in the near future. According to business insider, there will be a shortage of 19,000 IT professionals in Denmark by the year 2030.[1]

As a result, more students are being introduced to programming and programming languages during their time at the danish gymnasiums. The goal of this introduction is to give the students a basic idea of how the computers they use everyday function, but also to impart an interest or motivation for studying programming in their continued education.

As programming languages are ever evolving and new languages are constantly designed it becomes relevant that students, who might be interested in studying programming, are introduced to the field in a way that teaches them the fundamentals of programming, in an exciting environment.

One of the most common tools for introducing programming and electrical engineering in danish gymnasiums, is the Arduino development board. The Arduino platform consists of its own dedicated IDE and language. The Arduino programming language is based on C/C++ and designed to both be easy to use, as well as being more hardware-oriented.[2] The Arduino platform maintains its simplicity by oftentimes shielding away a lot of complexity by ways that are non-present in most programming languages. Although this is an advantage in terms of simplicity, it might halter, or even frustrate, the student when learning other programming languages.

As such the motivation for this project is to create a new language for the Arduino platform, with a focus on promoting simplicity and teaching the thought process that goes into programming, rather than difficult syntax and extraneous setup code.

Basedo on these considerations, the following initial problem statement has been drafted:

How can a programming language for Arduino be optimized for learning without loosing the functionality of high-level languages

Analysis 2

2.1 Languages for beginners

There are a wide variety of different tools, games and languages with the intend to teach students how to program. These span from very specific game creation tools, to general purpose programming languages. In order to gather some inspiration for the group's own programming language, some of the existing solutions, and most common languages for beginners have been analysed.

2.1.1 Scratch

Scratch is a programming language that lets the user program interactive stories, animations and games. It is one of the most common programming languages among youngsters and students who are just getting into programming. It is designed for children from the age of 8 to 16, and aims to help children "think creatively, reason systematically, and work collaboratively". In scratch the user do not actually have to write any code, since it utilizes drag and drop elements to build and structure your program. Although no exact programming is actually done, scratch helps to bring an understanding of the common programming concepts like variables, loops and conditionals.[3]

Scratch is one of the most popular block building programming languages, but there are a lot of different languages challenging it, for instance google's refinement of scratch which is called blockly.[4]

2.1.2 Game maker

Game maker is a powerful tool for developing games. It is arguably more complicated than scratch, but also more powerful and still aiming to be easy to use. Quoting their website:

"Making games development accessible to everyone means taking away the barriers to getting started. Using our intuitive 'Drag and Drop' development environment you can have your game up and running in a matter of minutes without ever having to write any code!".[5]

Besides using drag and drop like scratch, game maker also created a very simple programming language called "GML". GML resembles the syntax of common

languages like C and Java. However, it is a simple language, for instance type declaration is not needed or even supported. However, one thing to note is that the type system is indeed static, but types are inferred. As such types may not be altered at runtime.[6]

2.1.3 Python

Although not directly aimed at students or youngsters, Python is a common entry point for many newcomers. Python also advertises itself as easy to learn for both new and experienced programmers. It provides a simple syntax, along with dynamic typing and type inference.[7] An example of pythons simple syntax free of all the usual ceremonials is easily represented just from the simple "Hello World" program.

Snippet 2.1: Hello World in python

```
1 print("Hello World")
```

now compare this to that of C++:

Snippet 2.2: Hello World in C++

```
1 #include <iostream>

3 using namespace std;

5 int main() {
6   cout << "Hello World" << endl;
7   return 0;
8 }
```

The C++ "Hello World" could potentially lead to a lot of questions, and all this just to be able to print to the screen.

Besides the easy and simple syntax python also includes a large collection of libraries to ease the development of different tasks.[8] This means you will be using less time reinventing the wheel and thus faster accomplishing the desired end goal.[9]

2.1.4 Takeaways

Although the above three languages only makes up a small subset of the analysed languages, they seem to be very representative for the general takeaways. Languages intended for beginners will often require little to no code to be written. This seems to be because they want to learn the students about the general programming concepts, before having to worry about syntax and formalities. Expanding on this, these languages also removes explicit type declaration, making the programmer write less ceremonial code.

Moreover the languages strives to have a simple, easy to learn syntax. Finally the languages generally want to provide a lot of methods and libraries for the user to use, so that he will not have to code these from scratch. This enables the programmer to spend more time telling what should be done, rather than how it should be done.

2.2 Educational single-board computers

While the group pretty quickly decided on developing for the Arduino platform, both because it is often used in the danish school system, as well as being the offered platform from AAU, it was still deemed necessary to look at other educational computer platforms.

Apart from the Arduino board, a lot of other single-board computers(SBCs) have been created with educational purposes in mind. To figure out why these SBCs are so popular for technical learning, some of the most popular ones were analysed. This should help to figure out which functionality the HCL programming language should include in order to comply with the educational intend of the SBCs.[10]

2.2.1 Raspberry Pi

The Raspberry Pi is one of the most widely known SBCs. It is a complete ARM-based computer, and may run anything ARM based on it, including both linux and windows based ARM operating systems. This first of all makes it a common entry point into the GNU/Linux operating system stack, which is generally considered to be highly educational in regards to how computers work. The default Raspberry Pi distribution ships with both scratch and python, allowing the user to quickly get started with programming.[11]

On top of this, one of the major selling points of the Raspberry Pi is the GPIO[1] pins. These allow the user to attach all kind of devices to the board, this includes both sensors, lights, cameras and breadboards. The Raspberry Pi allows the user to easily interact with the GPIO pins, making it an ideal device for both IoT, home automation and robotics.[11]

2.2.2 Lego Mindstorm

Lego Mindstorm is a robot kit from Lego. The intend is to built a robot out of Lego, with the belonging motors and sensors which can then be controlled by the "head". The head is a small computer, which can control and monitor all the attached motors and sensors. The computer can be programmed from either a tablet or a computer using a drag and drop programming environment similar to that of scratches (2.1.1). [12]

[1] general purpose input output

2.2.3 Takeaway

Apart from being cheap, the big motivation behind these SBCs seem to be the extensibility through attachments. This allows the users to create something very concrete. For instance, it may be more rewarding for the user to get an actual lamp to blink or a car to drive, rather than just outputting something on the computer screen. The attachments will in the end allow the user to build something robotic, which is a common desire or goal for both new and experienced programmers.[13]

Since the Arduino also has the ability to connect various devices through its GPIO pins, it would be ideal to incorporate some easy to use GPIO handling into the HCL programming language.

2.3 Existing languages

Before doing any work on the group's own language, it was decided to look into the high-level languages that already exist for the Arduino platform, and what distinguishes them from each other. This was done in part to find out what kind of competition there may be for HCL, and in part to gain inspiration from the existing languages. There is a variety of languages to choose from when programming for the Arduino. Some of these are:

- Arduino C++ (the official Arduino language)
- Occam-pi
- NanoVM
- Juniper
- ArduinoBlocks

Arduino C++ is a subset of the C++ language with its own libraries, designed specifically for the Arduino. Because of this, it is compatible with the C and C++ languages. There are a few changes made to the language, but the basic functionality and syntax of C and C++ are still present, meaning users are able to use both the imperative- and the object-oriented paradigms of C and C++ respectively to program the Arduino.

The following is a brief overview of the basic syntax of the Arduino C++. Snippets 2.3 and 2.4 show an example program showcasing the syntax. All information is taken from the official Arduino reference[14].

The language requires two functions to be declared; the `setup` function which is called at startup, and the `loop` function with is called in an infinite loop after the `setup` code is run.

All *statements* are finished with a semi-colon.

Variables are declared by specifying a type and following it up with an identifier (snippet 2.3, line 11). Declarations can be prefixed with the `const` keyword to make

the variable immutable, or `static` to mark it as persistent between function calls. All variables have to be initialized before they are used.

Functions are declared with a return type, a name, parameters enclosed in parentheses, and a body encapsulated with curly-brackets (snippet 2.3, line 29). If the function does not return a value, the return type is set to `void`. If it is a class function, the class must be specified in the declaration (snippet 2.3, line 22).

Classes are declared with the keyword `class` followed by a name and the class body encapsulated in curly-brackets (snippet 2.4, line 1). The class' field is declared in the body, but isn't initialized here. Similarly, functions aren't given bodies in the class declaration either. Instead, the functions must be given a body outside of the class, and the variables must be initialized in the constructor function, also outside of the body.

Preprocessor directives such as including a header file, or setting up macros are written with a pound symbol (snippet 2.3, lines 6-9).

Comments can be written in two different ways. The end-of-line comment is prefixed with two slashes (snippet 2.3, line 6). The multi-line comment is prefixed with a slash followed by an asterisk (`"/*"`), and postfixed with an asterisk followed by a slash (`"*/"`) (snippet 2.3, line 1-4).

Snippet 2.3: An example program written in the Arduino language.

```
1  /*
2   * This program makes an LED connected to pin 13 on the arduino
3   * board blink on and off every 500 milliseconds
4   */

6  #include "Arduino.h" //The Arduino standard library
7  #include "Blinker.h" //The Blinker custom library

9  #define LED_PIN 13 //Symbolic constant

11 const int BLINK_DELAY = 250; //Constant, global integer variable

13 Blinker blinker(LED_PIN, BLINK_DELAY); //Object instantiation

15 void setup() {} //No setup code for this program

17 void loop()
18 {
19     blinker.Blink(); //Program blinks infinitely
20 }

22 Blinker::Blinker(int pin, int msDelay)
23 {
24   pinMode(pin, OUTPUT);
25   _pin = pin;
26   _msDelay = msDelay;
27 }

29 void Blinker::Blink()
30 {
```

```
31   digitalWrite(_pin, HIGH);
32   delay(_msDelay);
33   digitalWrite(_pin, LOW);
34   delay(_msDelay);
35 }
```

Snippet 2.4: The Blinker.h header file.

```
1  class Blinker
2  {
3    public:
4      Blinker(int pin, int msDelay); //Constructor
5      void Blink();
6    private:
7      int _pin;
8      int _msDelay;
9  };
```

Occam-pi is a language that focuses on making parallel programming easy for programmers. It is based on Occam that first appeared in 1983. The full documentation of Occam-pi can be read on the official website of the language, `concurrency.cc`, but following here is a short description of some of the syntax, and an example program in Snippet 2.5.

Variables are declared by initializing them with the colon-equals operator (lines 6-7). Type is automatically inferred by the expression on the right hand side of the initializing assignment.

Functions in Occam-pi are declared using the keyword `PROC` followed by a name and the function parameters enclosed in parentheses (line 5). Unlike C, Occam-pi doesn't use curly-brackets to encapsulate the body. Instead, the body is indented using a tab, similar to the Python language. The end of the function is marked using a colon. One of the key features of Occam-pi is the fact that it separates expressions that are evaluated sequentially and ones that are evaluated concurrently using the `SEQ` and `PAR` keywords.

Preprocessor directives are, like in C, prefixed with a pound symbol (line 3).

Comments are prefixed with two dashes (`"--"`) (line 1).

Snippet 2.5: An example program written in Occam-pi.

```
1  --This program makes two

3  #INCLUDE "plumbing.module" --Include module preprocessor directive

5  PROC main ()
6    SEQ --Expressions are evaluated sequentially
7      x := 4 + 3
8      y := x * 5
9    PAR --Expressions are evaluated concurrently
10     blink(12, 1000) --A function from the plumbing module
```

```
11      blink(13, 1000)
12  :
```

NanoVM is a virtual machine (VM) for the Atmel AVR ATMega8 CPU. It allows programmers to write code in a subset of Java that can be run by Arduino and similar microcomputers. The VM includes many of the features that have made the Java VM (JVM) popular such as object-oriented programming, automatic dynamic memory allocation, and garbage collection. It comes packaged with native classes such as Object, System, and PrintStream.

The following is a short description of the basic Java syntax. Snippets 2.6 and 2.7 showcase the syntax.

The program is started by calling the `main` function (snippet 2.6, line 5).

All statements are finished with a semi-colon.

In Java all variables and functions must be declared inside a class, and each class must be declared in a file for itself.

Class fields and methods are declared identically to how variables are declared in Arduino C++, except each field variable is prefixed with an optional access modifier (snippet 2.6, lines 3, 5). Variables can be made into class variables (called so because the variables belong to the class instead of instances of the class) with the `static` keyword before the name in the declaration. The same can be done to methods.

Comments are written exactly like in C and C++.

Snippet 2.6: An example program written in Java.

```
1  public class HelloWorld {
2
3    private static Printer printer = new printer(); //Class variable
4
5    public static void main(String[] args) { //Program start
6      printer.print("Hello World!");
7    }
8
9  }
```

Snippet 2.7: Printer class with one method written in Java.

```
1  public class Printer {
2    public void print(String str) { //Instance method
3      System.out.println(str);
4    }
5  }
```

The downsides of using NanoVM instead of Arduino C++ is, as stated on the

official website of NanoVM[2] that the VM's interpreter doesn't perform as well as C compiled to AVR code, and it reserves some of the RAM used for applications to run the VM. NanoVM also has to be installed on the CPU's flash memory, which will overwrite the bootloader.

Juniper is a functional programming language designed specifically for the Arduino. The intention behind creating Juniper was to provide a higher level language than Arduino C++, which at the same time was more suited for programming electronic devices[15].

The following is a description of the basic syntax of Juniper. Figure 2.8 showcases the syntax.

Variables are declared using the `let` keyword followed by a name, an equal sign, and an expression (line 4). Variables are by default immutable, ie. they can't be assigned another value after declaration, but they can be made mutable by inserting the `mutable` keyword before the name in their declaration.

Functions are declared using the `fun` keyword followed by a name, parameters enclosed in parentheses, an equal sign, and the function body encapsulated in parentheses (line 9).

Modules have the same purpose and functionality as they do in Occam-pi - to provide predefined functions to the programmer.

Comments in Juniper can be written in two different ways. End-of-line comments are prefixed with two slashes (just like C++ and Java). Multi-line comments are prefixed with a start parenthesis followed by an asterisk (`"(*"`), and post fixed with an asterisk followed by an end parenthesis (`"*)"`).

Snippet 2.8: Example program taken from the tutorial on Juniper's website.

```
1  module Blink
2  open(Prelude, Io, Time)

4  let boardLed = 13

6  let tState = Time:state()
7  let ledState = ref low()

9  fun blink() = (
10   let timerSig = Time:every(1000, tState);
11   let ledSig =
12     Signal:foldP(
13       fn (currentTimer, lastState) ->
14         Io:toggle(lastState)
15       end,
16       ledState, timerSig);
17   Io:digOut(boardLed, ledSig)
18 )
```

[2]http://www.harbaum.org/till/nanovm/index.shtml

```
20 fun setup() =
21   Io:setPinMode(boardLed, Io:output())

23 fun main() = (
24   setup();
25   while true do
26     blink()
27   end
28 )
```

ArduinoBlocks is a drag and drop programming language, similar to the language Scratch, wherein the user writes programs by grouping "blocks" together to form functions. It provides a simple graphical user-interface and functions for various add-on modules for the Arduino, and the user isn't required to write much when programming in ArduinoBlocks.

Figure 2.1 shows how the programming interface for ArduinoBlocks looks.

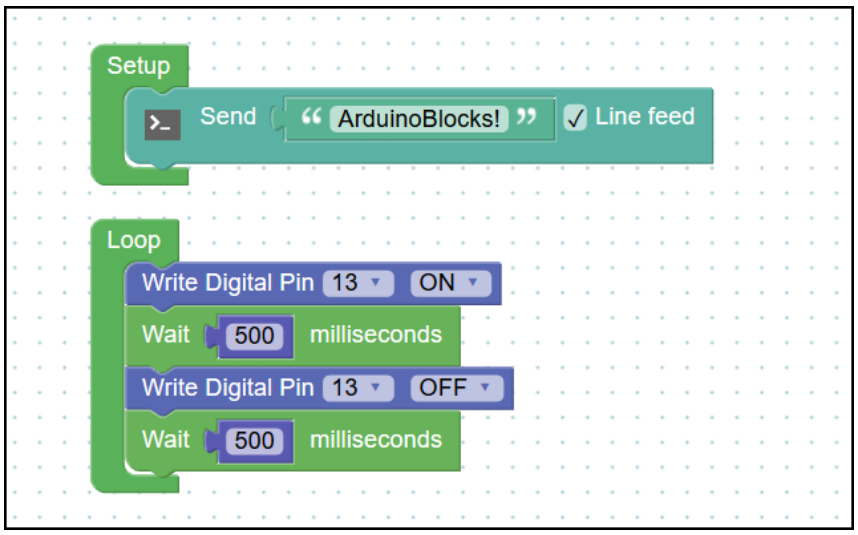

Figure 2.1: The default code when opening ArduinoBlocks

These are, of course, not all the available languages for programming for Arduino. The project group is also aware of a language called DK-BASIC, a subset of BASIC designed to work on Arduino, but that language is still in its alpha stage, so it won't get more than a mention here.

2.4 Arduino and their usage in danish education

During the third year of the HTX[3] programme students are required to take a course in a voluntary technical subject, which utilizes a project-based learning practice.

[3]Higher Technical Examination Program, is a 3-year vocationally oriented general upper secondary programme which builds on the 10th-11th form of the Folkeskole[16]

There are a multiple of courses, one of these regard electronics, where many schools choose to utilize the Arduino platform[4][17].

This technically oriented course, often called electronics[5], aims to familiarize the students with electrical components and circuits as well as basic programming.[18] Arduino is an ideal platform for this, as it is possible to connect I/O devices to the Arduino micro-controller, which in turn can be programmed to do simple tasks. This course is then used to spike the interest of the student regarding engineering fields, such as programming or electronics.

2.4.1 Aalborg Tekniske Gymnasium Electronic Course

In relation to the discipline of understanding the initial problem, the project group contacted one of the major HTX institutions in North Jutland, Denmark, Namely Aalborg Tekniske Gymnasium[6]. The following subsection will summarize the important and noticeable aspects of the electronic course conducted on Aalborg Tekniske Gymnasium. The conclusions reached in this subsection are purely based on the statements made by the students and the teacher of this specific electronics course. The notes, from where the below conclusions were derived, can be found in the Appendix 1 on page 24.

The electronics course itself does not teach the students programming directly. Instead it focuses on project based arduino development. Educational programming experience of the students (if any), originates from another optional course called "Programming". The Programming course teaches the students the basic constructions and terminology of general programming. The students are taught C# in the programming course.

The electronics course focuses on engaging the students in making arudino projects, not teaching the students the theory behind the projects. This means that the students both have a very limited understanding of the arduino platform's architecture and a low understanding of the arduino language as explained earlier in the report, which they utilize in the electronics course on Aalborg Tekniske Gymnasium.

Because of all this the electronics course has a relatively high learning curve. Which results in a high number of students abandoning the course in favor of some of the courses with a more defined structures.

Clearly there is a major gap between the students who are interested in programming or electronics and have no prior experience and students who have prior experiences. Based on students' and the teacher's, statements it seems like the course need a

[4]based on the fact that 4 of the students in this group studied at HTX in different parts of Denmark and all utilized the Arduino platform in this course. The HTX institution contacted by the group also utilize the Arduino platform

[5]The name varies between institutions

[6]Aalborg Technical Gymnasium, https://aatg.dk/

better gateway into the arduino platform, the programming aspects of the course or both.

A substantial number of the students in the class expressed their frustration with the relative complexity of the arduino language. The teacher supplemented with saying that the language is not necessary complex, but the time spent on the different concepts is far too short, which is a result of the education being a junior education and not a college/university level education. Clearly there is a need for the course to be able to make shortcuts in some aspects to teach the students the concepts adequately. Simply put the language and the platform is not well suited for this kind of low level education.

The Students Understanding of Syntax and Semantics

Most of the students expressed that they have no real interest in the syntax. In fact a substantial part indicated that they did not understand what the syntax of a programming language actually means. Below is a short summation of the most problematic aspects of general syntax and semantics of the arduino language (or any reference language the students might have), in arbitrary order.

Data Types
Data types in general, seem to cause problems for the students. Most students can name the different types but far less have the proper knowledge to identify and explain the meaning behind them. The students in most cases do not understand why they have to state the data type explicitly, when declaring a variable. When presented with a small example program with type inference on all declarations, the students in most cases, instantly understood how to identify a declaration and how to use the variable properly.

Function Call and Definition
The students concluded that the manner in which C++ and C# makes function/method calls and definitions is somewhat ambiguous to them. In relation to syntax, they expressed some minor frustrations concerning the overhead necessary to define simple methods, such as methods that does not return a value and also when making function calls with no arguments. The most problematic aspect of abstraction in general was the matter of scoping. No students expressed any real knowledge of scoping. This is especially a problem when it comes to understanding error messages from the compiler. Clearly scoping rules must be kept in mind when developing a new language for beginners.

Control Structures
In general the students understood what the different control-structures do. But almost non of them could remember the specific syntax and meaning behind them. The selective control structures seems to be easier to understand than the iterative control structures. A substantial amount of the students stated that the control structures in general are difficult to understand and remember, since they do not

reflect anything else in the language, at least according to them. Clearly the students needs more consistency in the language. The control structures should in some way mirror the syntax of another major aspect of the language, to make it more intuitive to use and remember.

Operator Precedence and Association
Both terms were completely foreign to the students. Their perception of precedence were mostly based on arithmetic notation. This is sufficient in most cases. The biggest concern was with association. Most of students did not understand that different operators could have different association, which proved to be a major issue when presented with code. In most cases the students understood which part of the expression was calculated first. But chose the wrong answer based on mostly random factors. Clearly association needs to be as intuitive as possible.

2.4.2 Summary

Based on interviews done with students having this course, the language used for Arduino, C++, has a steep learning curve, considering the experience of the students. The Arduino, from a hardware point of view, is quite intuitive and it is easy to play around with lights, I/O, modules and components that give the student a visual feedback. Even though the students have no actual understanding of the architecture of the platform they essentially do not need it. Many students interviewed felt like the programming aspects of the course are far too difficult to understand in its entirety (which is reasonable), but even simple syntactic understanding of the programming language are difficult to understand for most students.

2.5 High-order functions

High-order functions is a concept that has been discussed and valued as an important key feature of HCL. High-order functions allow for some powerful elements to be added to the language. Along with this, high-order functions may also drastically improve development time, since it allows for more generic functions that can be concretized through the high-order functions.

2.5.1 Explanation of high-order functions

High-order functions are functions that either returns a function or takes a functions as one of its parameters. This language feature is often utilized together with the three functions map, filter and reduce. To understand what these does, and why they are useful have a look at the example pseudo code in 2.9. One thing to note, is that the function parameters in the example is passed as lambda functions. Lambda functions are anonymous inline functions, which are very useful along with high-

order functions, since it will allow you to specify the functionality without having to declare an entire function.

Snippet 2.9: An example of the map filter and reduce functions.

```
1 myList = [5, 10, 15, 20, 25]

3 myNewNum = myList.filter{ num => num % 10 == 0 }.map{ num => num * x }.reduce{ ↩
      sumOfNums, num => sumOfNums + num }

5 print(myNewNum) // 500
```

First a list with the numbers 5, 10, 15, 20 and 25 is initialized. The 3 functions are chained to get the sum of all these numbers squared, where the initial number was a divisor of 10. The first function used is the filter function. It takes a list along with a predicate and returns a new list with all the elements that matched the predicate. In the example the predicate is whether the number is a divisor of 10.

Next is the map function. This function takes a list of numbers along with a modify function. It will apply the modify function on all the elements in the list, and return a list with all the modified elements. In the example the modify function will simply square the input number. This means that the returned list will have all the input numbers squared.

The last one is the reduce function (often also called the fold function). This function will take a list and a fold function as input. The fold function will have an accumulator and the current element as function parameters. In the example, the numbers in the list are accumulated.

2.5.2 Benefits of high-order functions

The major benefit from the high-order functions is the ability to create abstract functions that will have their behaviour defined through the input function. The map, filter, and reduce functions are by themselves very useful, but they are also often used to create a lot more concrete functions. For instance a "sum by" function, which is a combination of the reduce and map function.

Another common example is for sorting. A generic sorting algorithm can be implemented, and a comparator function can then be passed to the sorting algorithm to tell it how to compare the different elements. This could be useful; for instance when comparing a person class. The developer may want to sort the persons in alphabetical order, based upon their age or something else. The only thing that the sorting function needs is a function that can compare the persons that are to be sorted.

2.5.3 High-order functions in HCL

Although some of the use cases of high-order functions may be too complex for the new users, who are the target group of HCL, the high-order functions are still valued an important feature. This is due to several reasons.

First of all, new users will often tend to do some basic mathematical computations. The high-order functions like map, reduce and filter will make these computations a lot easier when dealing with collections.

Secondly, high-order functions are a useful programming concept that HCL should strive to make intuitive and understandable for new users, so that they will be able to use and understand it in their next language.

3 Theory

Implementation 4

Conclusion 5

5.1 Discussion

5.2 Conclusion

5.3 Future work

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Part I

Appendix

.1 HTX CAO Student and Teacher Interview

Projektstyring Analog og digital teknik. Programmerbar teknologi. Næsten ingen programmering i faget. Allerede har haft programmering: Visual basic og C++ - B-niveau: Variabler, typer, kontrolstrukturer.

Projekter: - Cykellygte, - Spilprojekt på arduino, - Motor (Robot), - Censorprojektet, - Eksamensprojekt.

Spørgsmål: - Lave en funktion (opbygning) - Lang tid på fejlsøgning.

Snakker meget for visuel programmering. Giver forståelse for de initielle aspekter.

- Semikolon: Måske - (Men ja) - Typer: Brug begge dele. - Static vs dynamic typed: Så længe det virker. (Fare for at gøre noget uhensigtsmæssigt.)

Faget: Ikke så meget forstå - mere bare lave. - Mindre fysik.

Er kurset i høj kurs: Har haft programmering -> vælger dette fag.

Digital design og udvikling (nyt fag, apps, spil, robotdesign)

Nogle skifter hurtigt. Andre har ingen erfaring, men vokser med opgaven.

Generelle hjælpelinjer: - Nem tilkobling og interaktion med hw.

GPIO: LED - DC Motor. Nogle sensorer. Bluetooth.

Duden er hw fan.

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Til elever:

Lidt C# -> Programmering (C#) Meget C# Godt lide computere, men programmering for "boxed" - Ikke skrive forkert. "Hyggeligt når det fungere" Slet ingen programmering. Opnået en del interesse igennem faget. Linjefag. Alle har haft C#. Linjefag. C# Programmering. En rimelige skarp i javascript.

Programmering: - Rigtige funtkionskald, - Semikolon er fint - Det er okay (MEN PISSE TRÆLS NÅR MAN GLEMMER.) - Arrays - 0-indexed forvirrende - arrays forvirrende. - Var ikke brugt. -> auto brugt. - Kender ikke funktionskald (Mange forskellige) - Problemer med typer - (Type inference ville være nemmere) - Men kan godt lide eksplicit type. - Semikolon ikke træls - Skulle være. - Aner intet om typer - Ikke problemer med typer. - C# Let at gå til -> IDE'en. - C vs C# i ide -> De mener at det ville være lige svært i en almindelig text editor. - Loops var svære. Forskel på loops. - Kunne ikke se pointe med metoder. - Nemmere uden typer. Lidt svært at lære typer. - Svært ikke at lære typer til start? - Synes det var fint ikke at forholde sig til typer i start (brugte lua) - Meget udenadslære, ikke tænke sig til hvilke kommandoer der gør hvad. Det kunne være bedre fra IDE'en. - Loops

er forvirrende. "For"-navnet er ikke intuitivt. - En med JS synes godt med var. - Lang tid på at lære typerne. - Kunne samle tal typer til num.

Hvad kunne være bedre?: - Dokumentationen kunne være bedre. - Man er vant til overhead -> Så det okay, men lidt tvilende. Men de mener også det er fordi det er det de har lært, og det nok kunne være simplere for begyndere. - Error beskeder lort. - Smart med ikke include. - Kan ikke huske hvordan man laver funktion, men de siger det altid nemt at se hvordan man gjorde sidst. - Bedre dokumentation - Overflod af metoder. - Eksempler til sproget. - Lidt problemer med header og includes. - Scoping er lidt svært. - Nem tilgang til muligt funktions kald. - Godt med afgrænsning fra - En forslår indentation som fra python.

Arduino platformen: - Den er fin, IDE dårlig ikke hjælper. - Minestorm forturkket af en der er "Dårlig" til programmering. - Love it. Det er simpelt. - Arduino er "Dum" gør hvad den bliver bedt om -> godt. - Svært med for mange komponenter, men generelt god læringsplatform. - Godt med hands-on experience. Bedre med noget fysisk, end bare en terminal fra C#. - Svært med hvad forskellige gpio og ports gør. - Ideen med at man får noget til at "Lyse" er fed! - Fejlbeskeder er dårlige. - Editoren burde hjælpe mere.

Læse videre: - Software - Nanoteknologi - Maskinmester - Programmering (Presset mod det.) - Datalog - Bedre sprog kunne have øget interesse. - Maskinmester - En ville lave hjemmesider, men synes programmering ikke var underholdende, fordi læringskurve var for stejl. - Vil gerne hurtigere nå målet. - Sidste gruppe snakker rigtig meget for at et nemmere sprog kunne have øget interessen, og at de er blevet skræmt lidt væk. - En software ingeniør.

- Vores sprog: - Ikke så synligt for dem. Men efter forklaring gav mening.

- Første 3 gik meget hurtigt og klar igennem, 4 var lidt mere besværlig. Hjalp med parenteser.

- Gruppe løste alle 4 opgaver.(Denne gruppe havde IKKE programmeret før)

- Denne gruppe acede det. Stadig en smule problemer med associering.

- Sidste gruppe var rimelig god, men stadig lidt tvivl om associering.