



**KTH Computer Science
and Communication**

SimpleGraphPlotter v1.6

Programkonstruktion för F, DD1342
Laboration 4A

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Chapter 1

Introduction

In the following part firstly the problem will be explained and secondly the requirements for a basic plotter will be enlisted. A plotter is a program that can plot functions from strings which defines the functions by ordinary math syntax. This project uses `C++` programming language and the `gtkmm`¹ wrapper for the `GTK+`² toolkit to generate the graphical user interface. It is compiled with the `GNU gcc` compiler.

1.1 Requirements

A few basic things is needed to have a functioning math plotter:

1. Define a function given ordinary math syntax.
2. Parse the inputed function and plot it accordingly.
3. Add/Remove functions from plotarea.
4. Plotarea should be scrollable both vertical and horizontal.
5. Range should be fixed to the unit-cube.³
6. Display axis of the plot.
7. Parser must be properly tested.

1.2 Scope

The amount of functionality that is possible to put in a system like this is almost endless so a few delimitations has to be made in order to complete the project. The

¹Documentation, binaries and source can be found at: www.gtkmm.org

²Documentation, binaries and source can be found at: www.gtk.org

³This restriction will be handled in section 1.2

currently biggest restriction to the plotter is the lack of ability to zoom or change the range from the unit-cube. No support for parametric nor complex functions.⁴

1.3 Assistance

Besides the reference manuals for `gtkmm` and `C++` no external help for this project was received.

⁴ Since no native support in `C++` for complex numbers which means all the basic math functions would have to be rewritten in order for this to work.

Chapter 2

Structure

An basic overview of the structure can be seen in figure 2.1, all public non-self-explanatory parts will then be enlisted and explained in a `javadoc` like manner. In the actual code the definition and implementation was separated into `.h` and `.cpp`-files respectively as long as possible,¹ in a `C++` manner. One goal of the structure is to have as flexible code as possible.

2.1 Parser

The parser code can be divided into to parts the algorithm code, that is the actual parser, and the data structure in the form of a parse tree.

2.1.1 interface iparser

An *abstract base class* (ABC) that defines the *interface* for what a parser needs to have to be considered as a parser, in case for example we want to compare different parser implementations.

public parse(expr : std::string) Virtual method that should be overloaded so that it will parse the string `expr` to generate a parse tree that represents the math expression in `expr`.

Parameters:

`expr` - The string to be parsed.

Returns:

A pointer to the root of the parse tree.

¹Some small trivial methods where left out from this distinction as well as a few things that is hard or impossible to separate in `C++`.

2.1.2 class parser

The parser is an implementation of a *recursive descent parser*. Two types of methods are used in the parsing, `is-a`² and `read-it`³. The `is-a` is used for look-ahead to determine which type of expression that lays ahead, while `read-it` is used to do the actual syntactic information gathering from the expression fragment.

The EBNF syntax for the parsing made by this algorithm is as follows:

```

plots = term-(-1),[';',expression-(-1)],'\n' (* no support in this
implementation *)
expression-i = [unary-i],expression-(i+1),[op-(i+1),expression-i]  \\
(* -1 is the lowest order expression *)  \\
(* either unary-(i+1) or op-(i+1), unary (since on the left)  \\
has higher priority *)
term-n = var | num | [function],(,term-(-1),)  \\
(* n is the number of the highest order operator *)  \\
(* if function is left out it will be handled as the unit function *)

op-0 = '>' | '<'
op-1 = '+' | '-'
op-2 = '*' | '/' | '%'
op-3 = '^'
unary-3 = '+' | '-' | '*'
num = ? all numbers ?
var = 'x'
function = cos | sin | tan | acos | asin | atan | cosh  \\
| sinh | tanh | exp | log | log10 | sqrt | ceil | abs  \\
| floor | pi | e (* where pi and e are constant
functions *)

```

public parse(expr : std::string) Parses the string `expr` to generate a parse tree that represents the math expression in `expr`.

Parameters:

`expr` - The string to be parsed.

Returns:

A pointer to the root of the parse tree.

2.1.3 interface iexpression

Acts as abstract base class (ABC) for a node in the parse tree, as in for example the nodes in figure 2.2. The `iexpression` is a *functor* since it has overloaded the

²Starts with `is_`

³Starts with `read_`

2.1. PARSER

`operator` and can thus be called in the same way as any other function. The `operator` can be both *recursively* implemented, as in `unary`⁴ and `binary`⁵, or *explicitly* implemented, as in `constant`⁶ and `variable`⁷. The operator function is generally defined by:

$$\begin{aligned}\text{expression} : \mathbb{R} &\rightarrow \mathbb{R} \\ x &\mapsto \text{operator}(x).\end{aligned}\tag{2.1}$$

public operator(x : double) double const Virtual definition of the *evaluation* function for expressions. Since the operator is going to act as an mathematical function one must be certain that it behaves like one, that is it does not modifies the functor when called.⁸ Therefore the `const` keyword has been added to prevent this from accidentally happening in the *realizations*.

Parameters:

`x` - Input value for the expression.

Returns:

The output value of this expression given the parameter `x`.

2.1.4 class constant

An *realization* of `iexpression` 2.1.3 which represents a constant. To keep constancy with the `iexpression` this is implemented as a constant-function:

$$\begin{aligned}\text{constant} : \mathbb{R} &\rightarrow \mathbb{R} \\ x &\mapsto c.\end{aligned}\tag{2.2}$$

public constant(c : double) Constructor that constructs the function in the equation 2.2.

Parameters:

`c` - The value of the constant in the expression.

public operator(x : double) double const Explicit realization of `iexpression.operator` returning a constant.

Parameters:

`x` - Input value of the expression, does not matter only there for compatibility reasons.

Returns:

The output value of the expression.

⁴As can be seen in equation 2.4.

⁵As can be seen in equation 2.5.

⁶As can be seen in equation 2.2.

⁷As can be seen in equation 2.3.

⁸In contrast to a method where that behaviour is allowed.

2.1.5 class variable

An realization of `iexpression` 2.1.3 which represents a variable. A variable can simply be seen as a unit-function:

$$\begin{aligned} \text{variable} : \mathbb{R} &\rightarrow \mathbb{R} \\ x &\mapsto x. \end{aligned} \tag{2.3}$$

public unary_operation(op : unary_op, left : iexpression*) Constructor that constructs the function in the equation 2.3.

Parameters:

- `op` - The unary operation performed, which is an `unary_op`⁹.
- `left` - The inner expression on which to perform the operation on.

public operator(x : double) double const Explicit realization of `iexpression.operator` returning the value of the input.

Parameters:

- `x` - Input value of the expression.

Returns:

- The output value of the expression.

2.1.6 class unary_operation

An realization of `iexpression` 2.1.3 which represents a unary operation, a function constructed with `op left`:

$$\begin{aligned} \text{unary} : \mathbb{R} &\rightarrow \mathbb{R} \\ x &\mapsto \text{op}(\text{left}(x)). \end{aligned} \tag{2.4}$$

public unary_operation(op : unary_op, left : iexpression*) Constructor that constructs the function in the equation 2.4.

Parameters:

- `op` - The unary operation performed, which is an `unary_op`¹⁰.
- `left` - The inner expression on which to perform the operation on.

public operator(x : double) double const Recursive realization of `iexpression.operator` returning the returned value of `left` through `op`, as in equation 2.4.

Parameters:

- `x` - Input value for the `left` expression.

Returns:

- The returned value from the equation 2.4.

⁹Typedefined to be a function pointer: `*unary_op(double):double`.

¹⁰Typedefined to be a function pointer: `*unary_op(double):double`.

2.1. PARSER

2.1.7 class `binary_operation`

An realization of `iexpression` 2.1.3 which represents a binary operation, that is a function constructed with `op` and `left/right`:

$$\begin{aligned} \text{binary} : \mathbb{R} &\rightarrow \mathbb{R} \\ x &\mapsto \text{op}(\text{left}(x), \text{right}(x)). \end{aligned} \tag{2.5}$$

public `binary_operation`(`op` : `binary_op`, `left` : `iexpression*`, `right` : `iexpression*`)

Constructor that constructs the function in the equation 2.5.

Parameters:

`op` - The unary operation performed, which is an `binary_op`¹¹.

`left` - The left expression on which to perform the operation on.

`right` - The right expression on which to perform the operation on.

public `operator`(`x` : `double`) `double` const Recursive realization of `iexpression.operator` returning the returned values of `left` and `right` through `op`, as in equation 2.5.

Parameters:

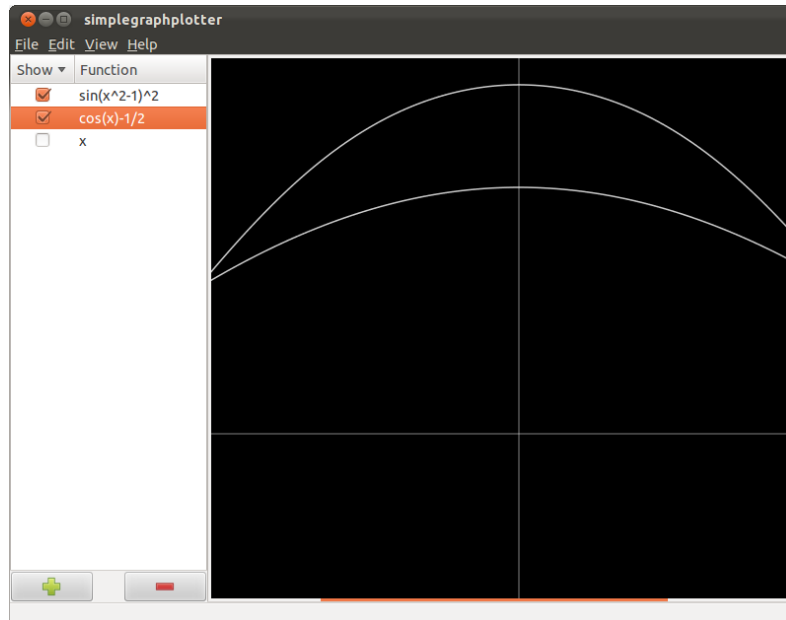
`x` - Input value for the expression.

Returns:

The returned value from the equation 2.5.

¹¹Typedefined to be a function pointer: `*binary_op(double,double):double`.

2.2 Plotter



The GUI code for

the plotter is separated

MVC ? V = plotdrawingarea C = functionlistcontroller M = what? (combined with something?)

<images with the different parts highlighted with a red border, that is the parts being described at the moment> especially point out the inheritance in the custom widgets.

2.2.1 class function

Acts as a view of a function which is used by `plot_drawingarea`

2.2.2 class plot_drawingarea

2.2.3 class function_list_controller

2.2. PLOTTER

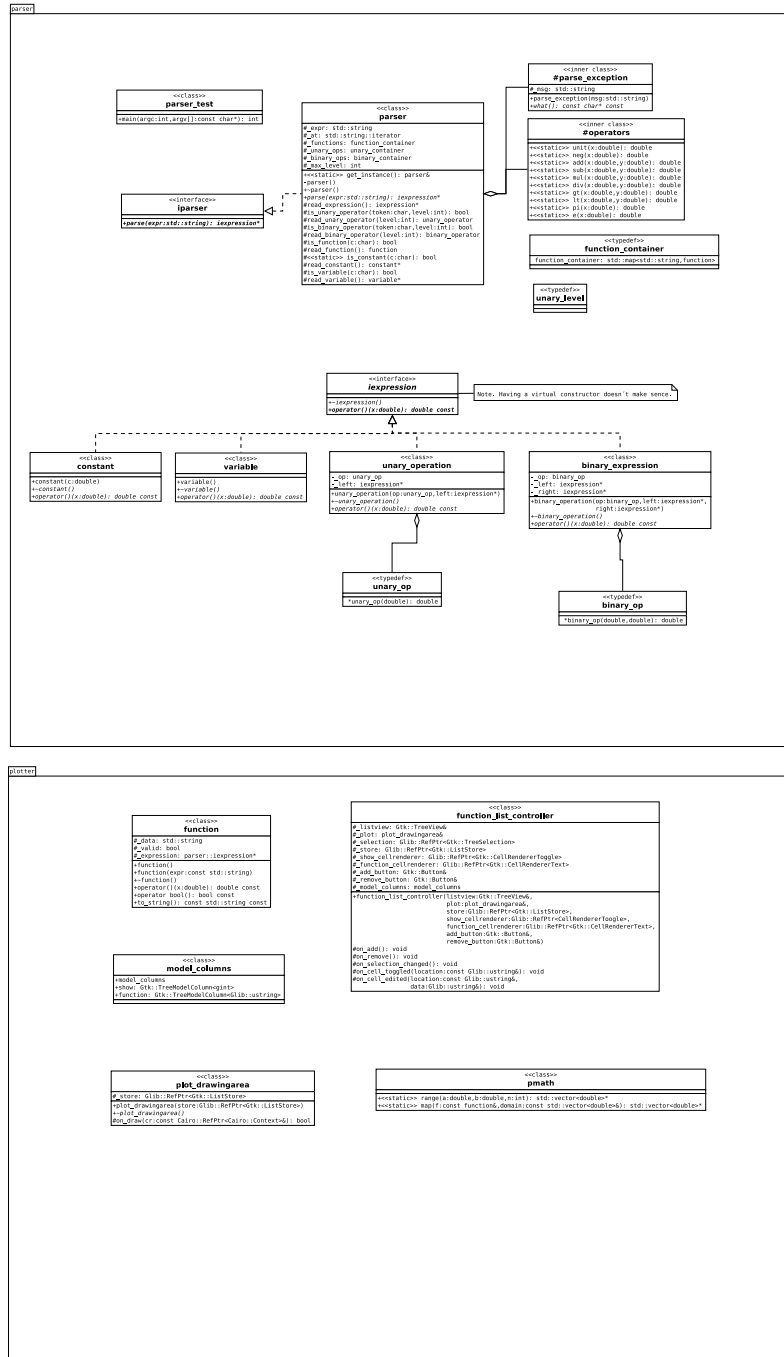


Figure 2.1. An UML showing the structure and the enclosure.

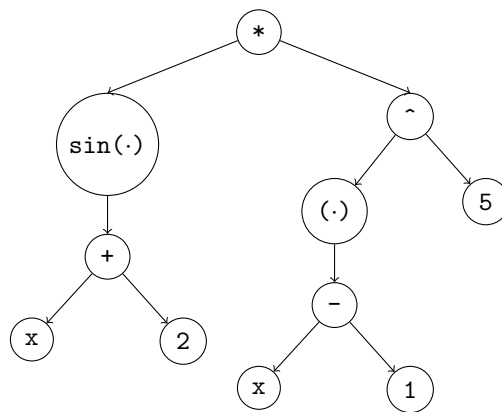


Figure 2.2. An example of the parse tree for the expression $\sin(x+2)*(x-1)^5$. Trivial nodes from the generated by the actual implementation where here left out.

Chapter 3

Results and Discussion

3.1 Results

«screenshots» Runned trough valgrind, results?.

3.2 Discussion

= Problems with the unofficial C++wrapper `gtkmm`, only used it to avoid missing out inheritance, polymorphism and to get it compatible with the standard C++Library. Many normal things easily became hacky. = Easy to miss combinations in the parser and have bugs.