The design and implementation of a userfriendly object-oriented markup language

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***Abstract*—Neio is a markup language that offers a modern, object-oriented programming model, and that is easy to read, write and learn. The modern programming model allows for full customisation and control of the document. An object-oriented language was chosen because it can easily represent the structure of a document. The design of Neio was based on the results of a the state-of-the-art analysis concerning document creation was researched. To prototype the language, a compiler for it was developed and several libraries were implemented to demonstrate the flexibility of the language. As a demonstration of the power and usability of the language, the thesis itself was written in it.**

***Index Terms*—Markup, Object-oriented, LaTeX, Markdown**

I. Introduction

What You Is What You Get (WYSIWYG) editors, such as Word and Pages, are the best-known solution for document creation. They immediately show the final document and help the user by providing a GUI for all of the features. This allows them to be used by anyone, even people without technical expertise.

However, these solutions do not offer a good solution, outside of the GUI, to manipulate the document. The features offered in the used programming model are not sufficient to allow for full control of the document.

The GUI makes it easy for the user to forget about the structure of a document. As such, the document is often weakly structured, for example text is put in bold instead of using an appropriate style for the element. This allows for inconsistencies to show up in the document and for small changes to have large impacts on the document. A typical example is that images that were placed earlier move around in an unwanted manner later on.

Markup languages put a greater emphasis on the structure and/or customisation of the document. Markdown [1] for example uses a small fixed syntax [2] for the most common elements used in a document. This makes it is very easy to read and write Markdown documents. However, Markdown lacks customisability.

LaTeX [3] on the other hand offers full customisation using the Turing complete programming model of TeX. This programming model is complex and harder to use than modern programming models and also requires a certain technical proficiency to be used.

As such, we developed Neio. It had to be as easy to read, write and learn as Markdown but as powerful as LaTeX.

II. The design of Neio

We decided to use two syntaxes in Neio. The first is the text mode syntax. It is the syntax used by most users to write documents. As such it has to be as simple as possible, which is why it is based on Markdown. In the state-of-the-art analysis, Markdown was found to be very easy to read, write and learn. Documents written in text mode are called Neio documents, an example is shown in Listing. 1.

Listing 1: A simple Neio document.

```
1 [Document]
2
3 # Chapter 1
4 This is the first paragraph.
```

The second syntax is called code mode. It is used to provide the objects and methods that are used in a text document. Code mode is almost a pure copy of the Java syntax. Documents written in code mode are called code files and look almost the same as Java class files.

An important difference compared to Java is that in code mode a method identifier can contain symbols. The symbols that can be used are `#`, `-`, `*`, `_`, `\$`, `^`, `=`, `|`, `'`. There are also reserved methods for the ‘newline‘ and for text.

Java was chosen because it is one of the most popular programming languages [4] of this age. This provides a big advantage because every Java library can be used in Neio. It is also creates a large user base that can already read and understand code mode.

Lastly, an important difference with Markdown is that the semantics of the text mode syntax are not hard-coded into the language, instead they can be defined in the code files. For example, for slide shows, # can be redefined to create a new slide instead of a chapter.

A text document is actually a chain of method calls that create an object model of the document. This object model can then be visualised later on.

This chain is called the `call chain`. The call chain for the example in Listing 1 is shown in Listing 2.

It is also possible to enter code mode in a text mode by opening a pair of curly braces. This is shown in Listing 4.

Listing 2: The call chain of the example in Listing 1.

```
new Document()
        .newline()
        .newline()
    .#("Chapter 1")
    .newline()
    .text("This is the first paragraph.");
```

III. Programming in Neio

A number of libraries illustrate the programming capabilities of Neio. Listing 3 shows how the Table class allows the writer to create a table using the `|`,`-`, and `newline` methods. Figure 1 shows the rendered version.

Listing 3: A table in text mode.

```
|   Student club   | Rounds | Seconds/Round |
-------------------------------------------
| HILOK            |  1030  |       42      |
| VTK              |  1028  |       42      |
| VLK              |   841  |       51      |
| VGK              |   810  |       53      |
| Hermes and LILA  |   793  |       54      |
| HK               |   771  |       56      |
| VRG              |   764  |       57      |
```

Student club	Rounds	Seconds/Round
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HK	771	56
VRG	764	57

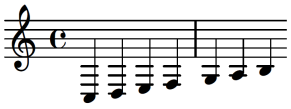
Fig. 1: The rendered version of the example in Listing 3.

The second example shows how to create sheet music and how to reverse the notes in the `Score`.

Listing 4: A Neio document that creates sheet music.

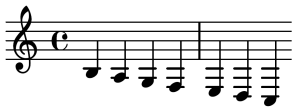
```
[Document]
{
    Score s = new Score().c().d().e().f().g().a().
        b();
    return s;
}
The score is read as {s.print()}.

{
    Score reversed = ss.reverse();
    return reversed;
}
The reversed score is read as {reversed.print()}.
```



The score is read as c, d, e, f, g, a, b.

Fig. 2: The rendered version of the score in Listing 4.



The reversed score is read as b, a, g, f, e, d, c.

Fig. 3: The rendered version of the reversed score in Listing 4.

In Listing 4, we also see that code mode can be entered in a sentence. This allows us to easily execute simple expressions such as as the `s.print()` shown in the example.

It is also worth noting that the entire thesis was written in Neio.

IV. Compiler

The process a Neio document goes through from Neio source code to LaTeX code, is shown in Figure 5.

The Neio compiler is created using Chameleon [5], [6] and Jnome [7]. Chameleon is a framework for defining abstract ASTs of software languages. It enables the reuse of generic language constructs and the construction of language-independent development tools. It defines language-independent objects (`Element`, `CrossReference`, ...) as well as paradigm-specific ones (`Type`, `Statement`, `Expression`, ... for Object-Oriented Programming). Jnome is a Chameleon module for Java 7 that provides language specific objects. These libraries allowed us to reuse most language semantics, and to obtain IDE support with only a few lines of code. The architecture is shown in Figure 4.

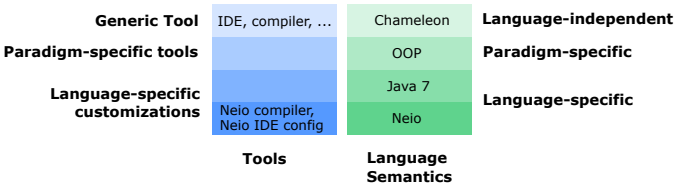


Fig. 4: The Chameleon architecture.

The compiler also copies resources, such as images and configuration files to the output folder.

The final transformation to LaTeX is done by the Neio standard library. To generate the LaTeX code the `toTex` method is called on the root of the object model which recursively calls it on all the other objects. The `toTex` method can also call other programs. To produce the scores in Figure 2 and 3, it calls LilyPond [8], which generates a PDF that is then imported in LaTeX.

References

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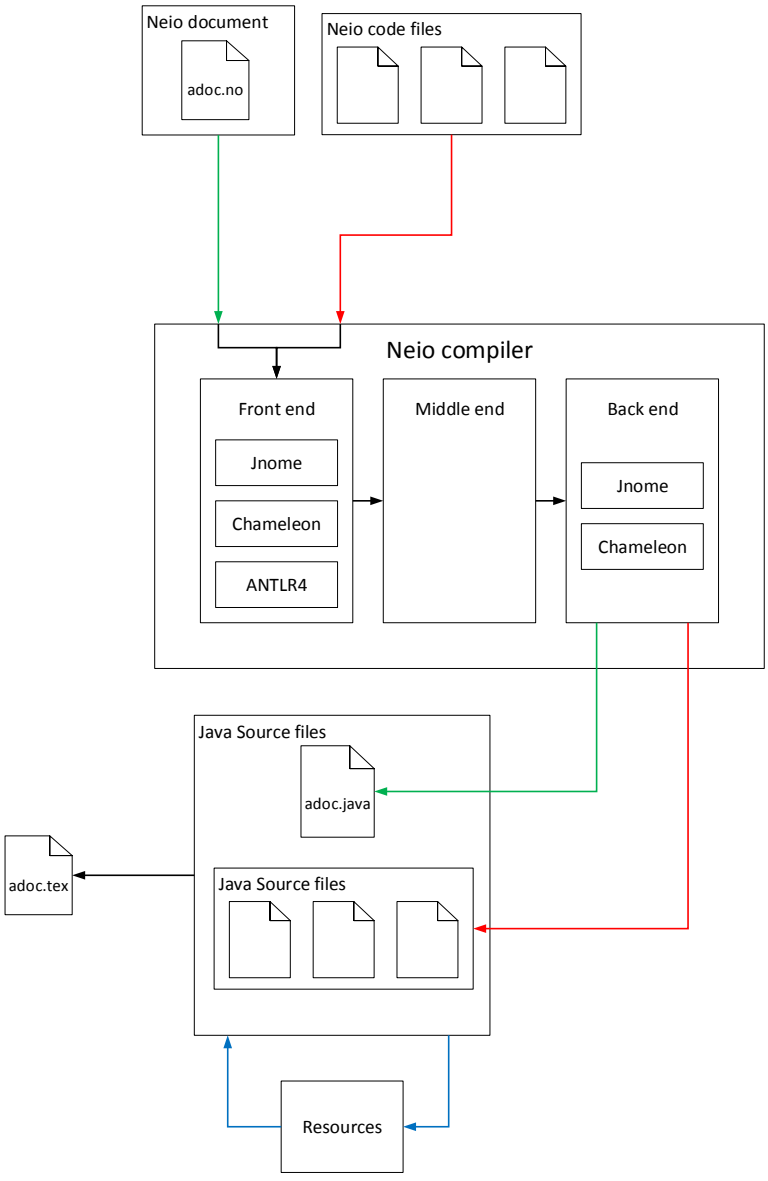

Fig. 5: The process of compiling Neio source code to LaTeX.