1

INTRODUCTION

1.1 WHAT IS SAGE MATH?

If you got a copy of this book, you probably already know that Sage Math is a free open-source mathematics software that is a great alternative to other software such as Mathematica, Maple, Matlab, and even the TI-83/TI-84 calculators. Once you get to master Sage Math, you won't want to use anything else. It's a great tool, easy to use, and very intuitive. And if you can't find a specific function that you may need for a project, then you can easily program it yourself. You will learn how to do this as you read this book.

The official website for Sage Math is `http://Sagemath.org` [16]. On this website, you can find `Quickstart Manuals`, `Official Documentation Manuals`, and `Official Binaries` that you can use in order to install Sage Math on your own machine. Although the website is very nicely organized, you cannot overestimate the use of the `"Search"`, button which is also available. The `source code` is obtainable there too.

Note: As of February 2015, Sage announced that it will add "Math" to its title in order to disambiguate with other "Sages". Throughout this book, we will use both terms "Sage" and "Sage Math" interchangeably.

An Introduction to SAGE Programming: With Applications to SAGE Interacts for Numerical Methods, First Edition. Razvan A. Mezei

1.2 VARIOUS FLAVORS OF SAGE MATH

1.2.1 Sage Math on Your Machine

In order to use Sage Math, you can **install it** on your own computer. This way you won't need Internet connection to run Sage applications and you can also save your own work.

You can find the binaries on the official Sage Math website [16]. One can download binaries for Linux, Mac OS X, and Oracle Solaris. At the moment, the Windows machines need to install a Virtual Machine in order to use Sage Math on such systems. Detailed installation steps can be found here: `http://wiki.sagemath.org/SageAppliance`.

One can also download and use a **Live CD** with Sage.

1.2.2 Sage Cell

The author's favorite way to use Sage Math is through a **Sage Cell**. Using a web browser, one can run Sage Math without the need to install anything on their computer. Moreover, you won't need to worry about having the latest version of Sage Math installed on your computer. One such Sage Math Cell can be found here [13]. All the examples in this book were tested using this Sage Math Cell, running the following version: `'Sage Version 6.3, Release Date: 2014-08-10'`. Before you start using it, be aware of the following two main limitations: you need to be connected to the Internet, in order to use Sage Cell, and you won't be able to save your work in there. On the positive side it is very easy to use. It works well on desktop/laptop computers as well as on smartphones.

Note: We recommend you to try different browsers and see which one works the best with the Sage Cell you are using. It is the author's experience that some browsers will work significantly faster with the above-mentioned Sage Cell, than others.

1.2.3 Sage Cloud

Another flavor of Sage Math is using a **Sage Notebook** (`http://sagenb.org`). As the front page of this website mentions, one can use it to "create, collaborate on, and publish interactive worksheets". Once you register and create a free account, you can create Sage code, save it, access it, and even share it.

The latest development, the collaborative web-based interface of Sage Math is the **Sage Cloud** (`https://cloud.sagemath.com`), which seems to quickly replace Sage Notebook. It adds features and capabilities such as "collaboratively work with Sage Worksheets, IPython notebooks, LaTeX documents", Course Management (an example is a UCLA 400+ student Calculus course), and many others. There is even a Chrome App available that works with it. Sage Cloud is planned to replace Sage Notebook. One can even run code written in other programming languages such as C, C++, Java, and many others, inside Sage Cloud.

To create a free account, just follow the link posted on Sage Math main page (or go to `https://cloud.sagemath.com/`). There you will be invited to either sign in or create a free account.

To create Sage code and run it inside the Sage Cloud, you will first need to create a project. If you click on `"Create New Project"` button, you will be invited to select a name and an optional description. Then, clicking on the link `"Create or Import a File, Worksheet ..."`, one can select `Sage Worksheet`, and create a new Sage Worksheet. There, one can type in Sage code and run it.

Note: All the Sage Math code given in this book was tested using Sage Cell. As such, some of the code may need to be changed/tweaked in order to run in Sage Cloud.

For example, the following code runs well in the Sage Cell, but needs some tweaking for Sage Cloud:

```
#Here come the "fancy" Interacts
@interact
def myInteract1(
    f = input_box(default=e^x ),
    n = slider(vmin=0, vmax=10, step_size=1, \
               default=3, label="Select the order n: "),
    x0 = input_box(default=0 ),
    simplified = selector(values = ["Yes", "No"], \
                  label = "Simplify: ",default = "No" )):
    if(simplified == "Yes"):
        print  f, " = "  , f.taylor(x, x0, n).full_simplify()
    else:
        print  f, " = "  , f.taylor(x, x0, n)
```

The following is a tweaked version of the previous code that runs on both Sage Cloud and Sage Cell:

```
@interact
def myInteract2(
    f = input_box(default=e^x ),  \
    n = slider( 0, 10, step_size=1, \
               default=3, label="Select the order n: "), \
    x0 = input_box(default=0 ),
    simplified = selector(values = ["Yes", "No"], \
                  label = "Simplify: ",default = "No" )):
    if(simplified == "Yes"):
        print  f, " = "  , f.taylor(x, x0, n).full_simplify()
    else:
        print  f, " = "  , f.taylor(x, x0, n)
```

The webpage `https://github.com/sagemath/cloud/wiki/Teaching` contains a list of links to several courses (such as Calculus, Combinatorics, Statistical Computing, Cryptography, Computer Systems Security, Experimental Gravitational Wave Physics, Linear Algebra, Differential Equations, Abstract Algebra, and many others) that are using Sage Math See also: [1], [2], and [3].

Some great references that motivated this work are: [4, 6, 11, 12, 15].