

ASPECTS OF COMPUTATIONAL GROUP THEORY

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1. GETTING STARTED IN SAGE

To get started with the Sage notebook, do one of the following.

- (1) Open a web browser anywhere in the world. Go to

<http://www.sagenb.com/>

to open the `sage.math` notebook, hosted by William Stein at the University of Washington. Follow the steps to create an account, and after following the directions in the confirmation e-mail, log in.

- (2) Go to Perkins 102 and let me log you in as an administrator. (Eventually, you will be able to login with your CEMS username and password; currently there are currently nettlesome issues with file privileges, stay tuned!)

Double-click on the *VMware Server* on the desktop. A terminal-like window will open, with the following screen.

```
sage login: notebook
Linux sage 2.6.17-12-386 #2 Sun Sep 23 22:54:19 UTC 2007 i686
```

```
The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.
```

```
Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.
```

```
Open Firefox to the address http://192.168.235.128
It may take up to about 10 seconds for the server to start. Press refresh.
(Click here and press control-C twice to stop the notebook server)
```

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- (3) Acquire a computer running Linux, Windows, or MacOS X. Open a browser to the page
<http://www.sagemath.org/download.html>
and download the binary for Sage corresponding to your platform. Install it on your machine and run according to the README.

Now, from the Sage *Worksheet list*, click on the *New Worksheet* button. A blank worksheet will open. In the box, type

2+2

Click *evaluate* (or type Shift-Return) to get the answer 4.

Now click the *Back* button or *Home* to return to the worksheet list. Click *Upload*, and in the second field enter the URL

`http://www.cems.uvm.edu/~voight/252/252-LAB01.sws`

Click the *Upload Worksheet* button. This will load the worksheet we will be using today.

Now, at your leisure, go to

`http://www.sagemath.org/documentation.html`

and take the tutorial and read the documentation.

2. LABWORK

Problem 1. Compute the multiplication table for A_4 .

Problem 2. How many conjugacy classes are there in $GL_2(\mathbb{F}_7)$? [*Hint: Create the group via the command `GL(2,7)`.*]

Conjecture a formula for the number of conjugacy classes in $GL_2(\mathbb{F}_p)$ for p an odd prime.

Problem 3. Experiment with the following command:

`[g for g in SymmetricGroup(6) if g.order() == 2].`

How many elements of order dividing 4 are there in A_7 ?

Problem 4. How many nonabelian groups of order 24 are there? How many do you recognize? Which group has the most conjugacy classes, and can you ‘explain’ why?

Problem 5. Put your Rubik’s cube in the superflip state. Play with it and see if you can get it back and forth out of other interesting states.