

# Proseminar on computer-assisted mathematics

## Session 2 - Matrices in Sage

### Matrices in Sage

When we define a matrix in Sage, we can specify the ring or field in which we take the entries.

Let us for instance consider the matrix

$$\begin{pmatrix} 2 & 4 & 6 \\ 4 & 5 & 6 \\ 3 & 1 & 2 \end{pmatrix}$$

and declare it first as a matrix  $A$  with entries in  $\mathbb{Q}$ , then as a matrix  $B$  with entries the field with seven elements  $\mathbb{F}_7$ .

```
A = matrix( QQ, [[2,4,6],[4,5,6],[3,1,2]] )  
show(A)
```

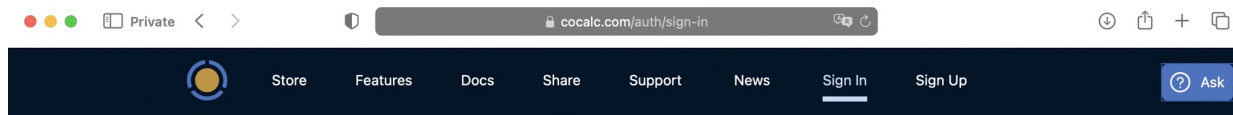
Florent Schaffhauser  
Heidelberg University, Summer semester 2023

We have just seen a brief introduction to Sage.

You can now download the notebook from the Zulip channel or the seminar webpage.

Two options for you to practice:

- ① Install Sage and JupyterLab or team up with someone who has, then launch it and upload the notebook there.
- ② Sign in on cocalc.com using your GitHub account and upload the notebook there.



[Sign In](#) Password Reset



## Sign In to CoCalc

Sign in using your email address or a single sign-on provider. [Use your GitHub account.](#)



[Institutional Single Sign-On:](#)



Sign in using your  
GitHub account.



Sign in to GitHub  
to continue to CoCalc

Username or email address

Password

[Forgot password?](#)

Sign in

New to GitHub? [Create an account.](#)

You can also  
create one on the  
spot.

Once logged in, create a new project and start the first steps guide (recommended).

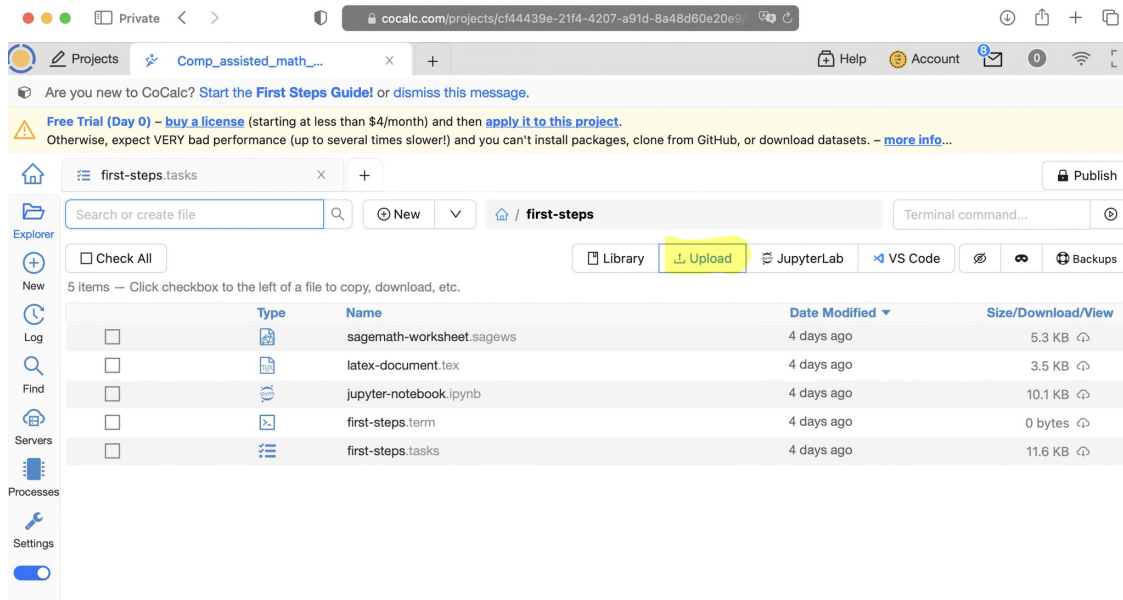
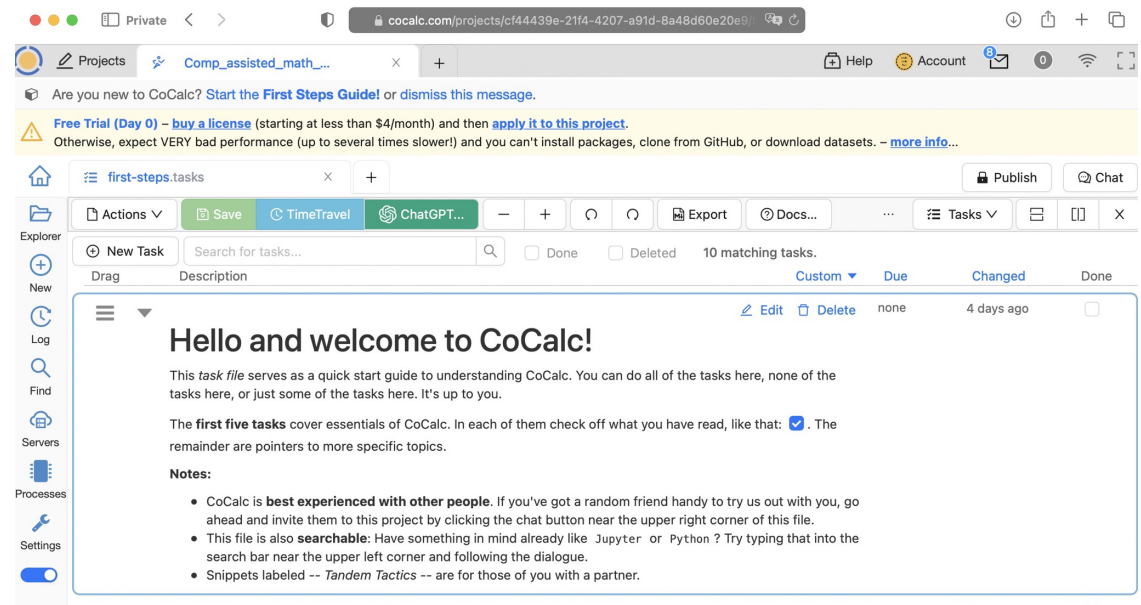
Then upload the notebook about matrices in Sage and start practicing!

The screenshot shows the CoCalc web interface in a browser. The address bar shows the URL `cocalc.com/projects/cf44439e-21f4-4207-a91d-8a48d60e20e9/`. The interface includes a top navigation bar with 'Projects', 'Comp\_assisted\_math...', 'Help', 'Account', and a notification bell. A yellow banner at the top states: 'Free Trial (Day 0) - buy a license (starting at less than \$4/month) and then apply it to this project. Otherwise, expect VERY bad performance (up to several times slower!) and you can't install packages, clone from GitHub, or download datasets. - more info...'. Below this, the notebook '01\_Matrices\_in\_Sage.ipynb' is open. The left sidebar contains icons for Explorer, New, Log, Find, Servers, Processes, and Settings. The notebook's toolbar includes 'Actions', 'Save', 'TimeTravel', 'ChatGPT...', 'Zoom', and various editing tools. The notebook content shows the author 'Florent Schaffhauser, Uni-Heidelberg, Summer Semester 2023' and the title 'Basic operations'. The main text in the notebook reads: 'Matrices in Sage', 'When we define a matrix in Sage, we can specify the ring or field in which we take the entries. Let us for instance consider the matrix', followed by a 3x3 matrix: 
$$\begin{pmatrix} 2 & 4 & 6 \\ 4 & 5 & 6 \\ 3 & 1 & 2 \end{pmatrix}$$
, and then 'and declare it first as a matrix  $A$  with entries in  $\mathbb{Q}$ , then as a matrix  $B$  with entries the field with seven elements  $\mathbb{F}_7$ '.

(More details below)

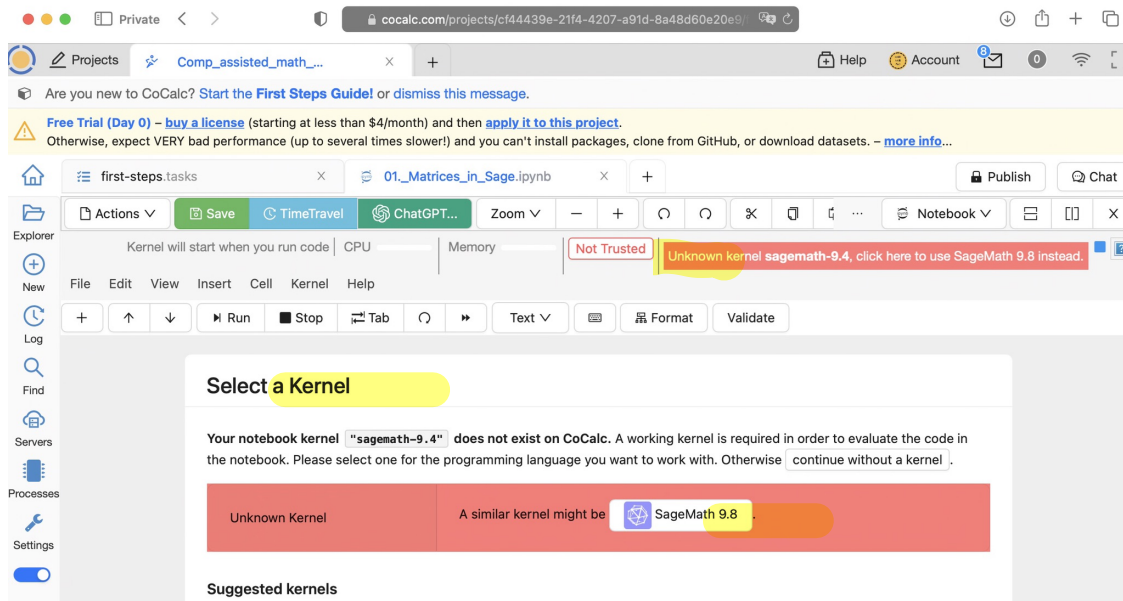
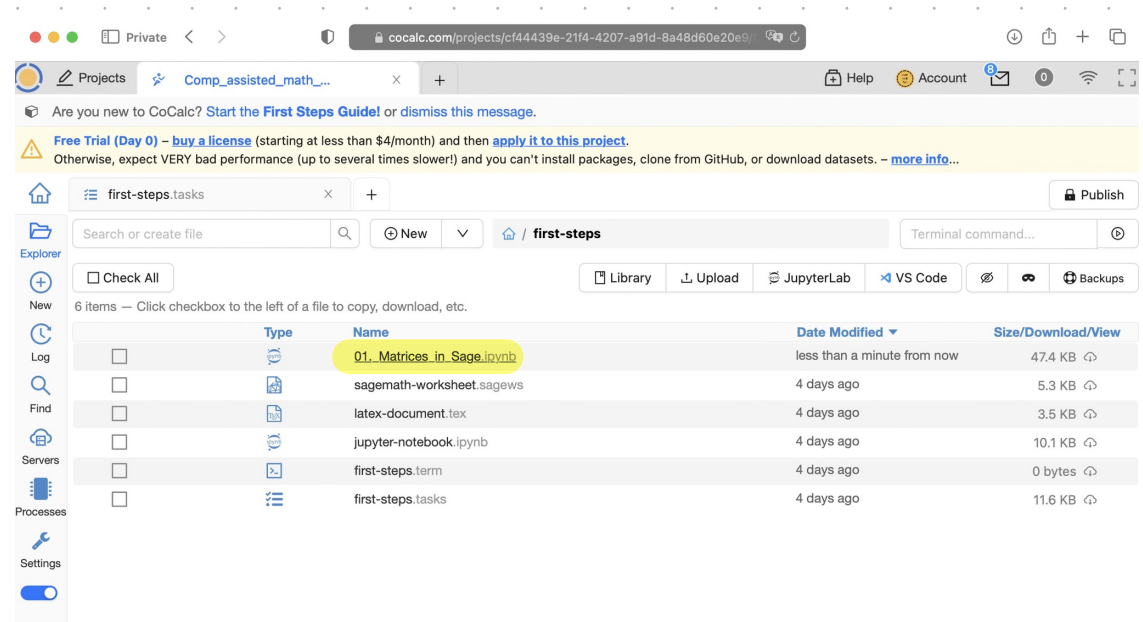
# Step-by-step

## After starting the first steps guide:



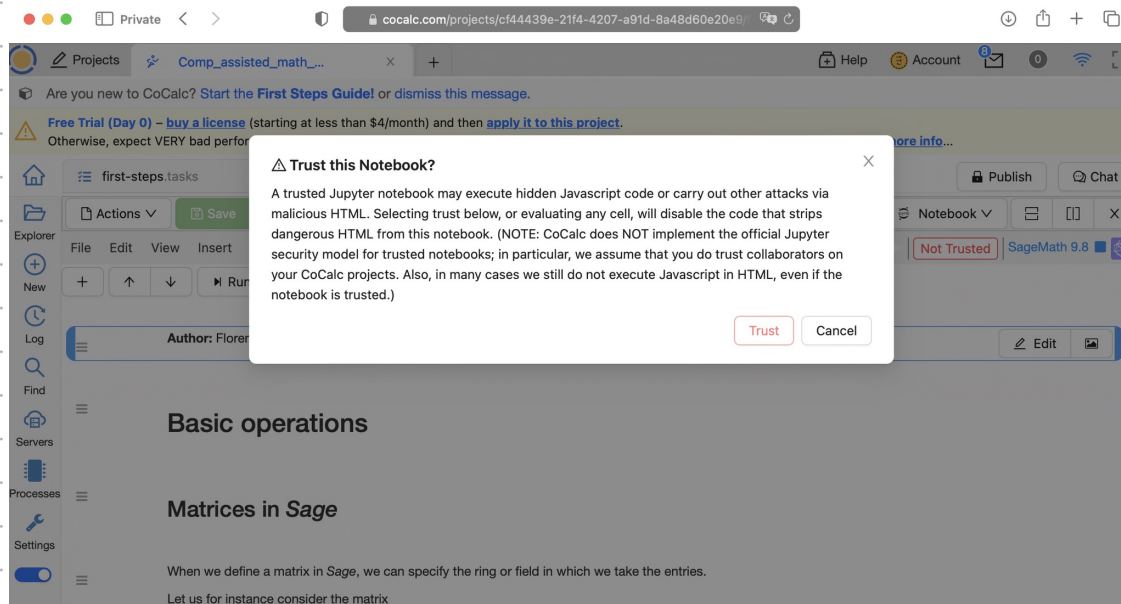
## Click on upload.

Open the  
uploaded file.



You will need to select the  
Sagemath 9.8 kernel, then  
click on 'Not trusted'.





Yes, you can trust this notebook (I promise!).

We are finally there:

