

Geometric Tools for Computer Graphics

Instructions for the lab work

We will use *SageMath* for the lab exercises. If you wish, you can also use it for solving the problems assigned to you.

SageMath was previously called SAGE (System for Algebra and Geometry Experimentation). It is a free and open-source mathematics software system licensed under the GPL (General Public License).

It is convenient for this course because it allows you to go straight from the mathematical formulation of the solution of a problem to its visualization, without having to deal with graphical representation issues. It is convenient in general because it is a powerful tool. It builds on top of many existing open-source packages: [NumPy](#), [SciPy](#), [matplotlib](#), [SymPy](#), [Maxima](#), [GAP](#), [FLINT](#), [R and many more](#), and it is written mostly in Python and Cython. The goal of [William A. Stein](#) with this project is to create a “viable free open source alternative to [Magma](#), [Maple](#), [Mathematica](#) and [Matlab](#)”.

Option 1: *SageMath* installed in FIB computers

1. Start a Linux session.
2. Copy all the files **.sws** from folder `/assig/gtcg-miri/` into your own folder.
3. From a console screen, call *sage* and follow the instructions, i.e.:
 - i) Type *notebook()*.
 - ii) Open Chrome on the required url.
 - iii) Type in your user (admin) and password, if required.
4. Once a sage notebook mode is running, you can start working: either you upload a file or you create a brand new one. Do not forget to save your files in the appropriate folder!

Option 2: *SageMath* cloud

1. Start any session
2. Copy all the files **.sagews** from folder `/assig/gtcg-miri/` into your own folder.
3. Launch any web browser and go to <https://cloud.sagemath.com/>
4. Open an account
5. Once sage cloud is running, you can start working: either you upload a file or you create a brand new one.

Option 3: *SageMath* in your own computer

1. If you want to work in a computer of your own, you can install sage locally from here: <http://www.sagemath.org/>

We provide you with the following files:

1. Getting started with *SageMath*

Sage comes with a nice help. This file does not intend to replace it, but just to make it easier for you to start working, by providing you with the standard key and mouse bindings available in the notebook.

2. Dealing with vectors and matrices in *SageMath*

This short file shows how to declare vector and matrix types and how to operate with them.

3. Plotting linear objects with *SageMath*

Our main reason for choosing sage for your lab exercise is that you will not have to take care of visualization issues, and that you will be able concentrate in solving the geometrical problems. For this to be possible, you need to know how to instruct sage to show your geometric objects in the screen of your computer. We start with polygons and polygonal lines.

4. Plotting curves and surfaces with *SageMath*

And we continue with curves and surfaces.

5. Using quaternions in *SageMath*

This file shows how to declare and use quaternions.