A short introduction to SageMath

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The mission

Create a viable free open source alternative to Magma, Maple, Mathematica and Matlab.

Some advantages of SageMath

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Freedom means

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SageMath is based on Python

- no need to learn any specific syntax to use it
- easy access for students
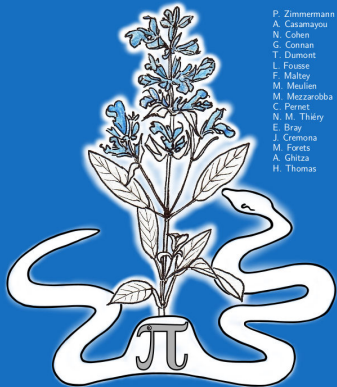- Python is a very powerful *object oriented language*, with a neat syntax

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SageMath is developing and spreading fast

...sustained by an enthusiastic community of developers

The Sage book

by P. Zimmermann, A. Casamayou, N. Cohen, G. Connan, T. Dumont, L. Fousse, F. Maltey, M. Meulien, M. Mezzarobba, C. Pernet, N.M. Thiéry, E. Bray, J. Cremona, M. Forets, A. Ghitza & H. Thomas (2018)

Released under *Creative Commons* license

Freely downloadable from
http://sagebook.gforge.inria.fr/english.html

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- Run on your computer without installation: **Sage Debian Live**
  http://sagedebianlive.metelu.net/
  Bootable USB flash drive with SageMath (boosted with octave, scilab),
  Geogebra, LaTeX, gimp, vlc, LibreOffice,...

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  https://cocalc.com/

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- **Run in SageMathCell**
  Single cell mode: `http://sagecell.sagemath.org/`

Example 1: installing on Ubuntu 16.04 or 18.04

1. Download the archive `sage-8.2-Ubuntu_16.04-x86_64.tar.bz2` from one the mirrors listed at http://www.sagemath.org/download-linux.html

2. Run the following commands in a terminal:
   ```
   bunzip2 sage-8.2-Ubuntu_16.04-x86_64.tar.bz2
   tar xvf sage-8.2-Ubuntu_16.04-x86_64.tar
   cd SageMath
   ./sage -n jupyter
   ```
   A Jupyter home page should then open in your browser. Click on *New* and select *SageMath 8.2* to open a Jupyter notebook with a SageMath kernel.

NB: Ubuntu packages are available for Ubuntu 18.04 (from the package manager, install `sagemath` and `sagemath-jupyter`). However, they are only for SageMath 8.1, so download the tar.bz2 binaries instead to get the latest stable version (8.2).

Example 2: using CoCalc

1. Open a free account on https://cocalc.com/
2. Create a new project
3. In the second top menu, click on *New* to create a new file
4. Select *Jupyter Notebook* for the file type

Simply open http://sagecell.sagemath.org/

Various ways to run SageMath

- Console mode:
  run `sage`
- Jupyter Notebook:
  run `sage -n jupyter`
  $\Longrightarrow$ worksheet file format: `ipynb`
- Legacy Sage Notebook:
  run `sage -n sagenb`
  $\Longrightarrow$ worksheet file format: `sws`
- https://cocalc.com/:
  in your browser, open `https://cocalc.com/`
  $\Longrightarrow$ worksheet file format: `sagews`, `ipynb`

Object-oriented notation in Python

As an object-oriented language, Python (and hence SageMath) makes use of the following **postfix notation** (same in C++, Java, etc.):

$$result = object.function(arguments)$$

In a procedural language, this would be written as

$$result = function(object, arguments)$$

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Examples

1. `riem = g.riemann()`
2. `lie_t_v = t.lie_der(v)`

NB: no argument in example 1

SageMath and Python

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- User commands are preparsed before being transmitted to the Python interpreter. In particular, this allows for standard mathematical notations, e.g. `x^2` instead of `x**2` (recall that `^` is the bitwise exclusive or (XOR) in Python).
  To know what the preparser is doing with the command `command`, run
 `preparse("command")`

Let us try it!

- First contact with SageMath:
  http://nbviewer.jupyter.org/urls/gitlab.obspm.fr/gourgoul/
  SageMathTour/raw/master/Notebooks/first_contact.ipynb
- 2D plots:
  http://nbviewer.jupyter.org/urls/gitlab.obspm.fr/gourgoul/
  SageMathTour/raw/master/Notebooks/plot_tour_2D.ipynb
- 3D plots:
  http://nbviewer.jupyter.org/urls/gitlab.obspm.fr/gourgoul/
  SageMathTour/raw/master/Notebooks/plot_tour_3D.ipynb
- Solving equations:
  http://nbviewer.jupyter.org/urls/gitlab.obspm.fr/gourgoul/
  SageMathTour/raw/master/Notebooks/solve_tour.ipynb
- Solving differential equations:
  http://nbviewer.jupyter.org/urls/gitlab.obspm.fr/gourgoul/
  SageMathTour/raw/master/Notebooks/diff_solve_tour.ipynb

Download all notebooks at once:

git clone https://gitlab.obspm.fr/gourgoul/SageMathTour.git

Tensor calculus with SageMath

SageManifolds project: extends `SageMath` towards **differential geometry** and **tensor calculus**
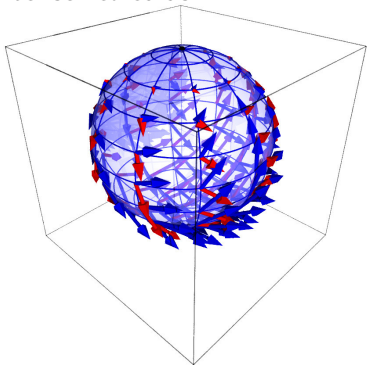
Stereographic-coordinates frame on $\mathbb{S}^2$

- `http://sagemanifolds.obspm.fr`
- fully included in `SageMath`
- a dozen of contributors (developers and reviewers)
  cf. `http://sagemanifolds.obspm.fr/authors.html`
- want to stay tuned: subscribe to the mailing list
- help: `https://ask.sagemath.org`

Everybody is very welcome to contribute:
visit `https://sagemanifolds.obspm.fr/contrib.html`