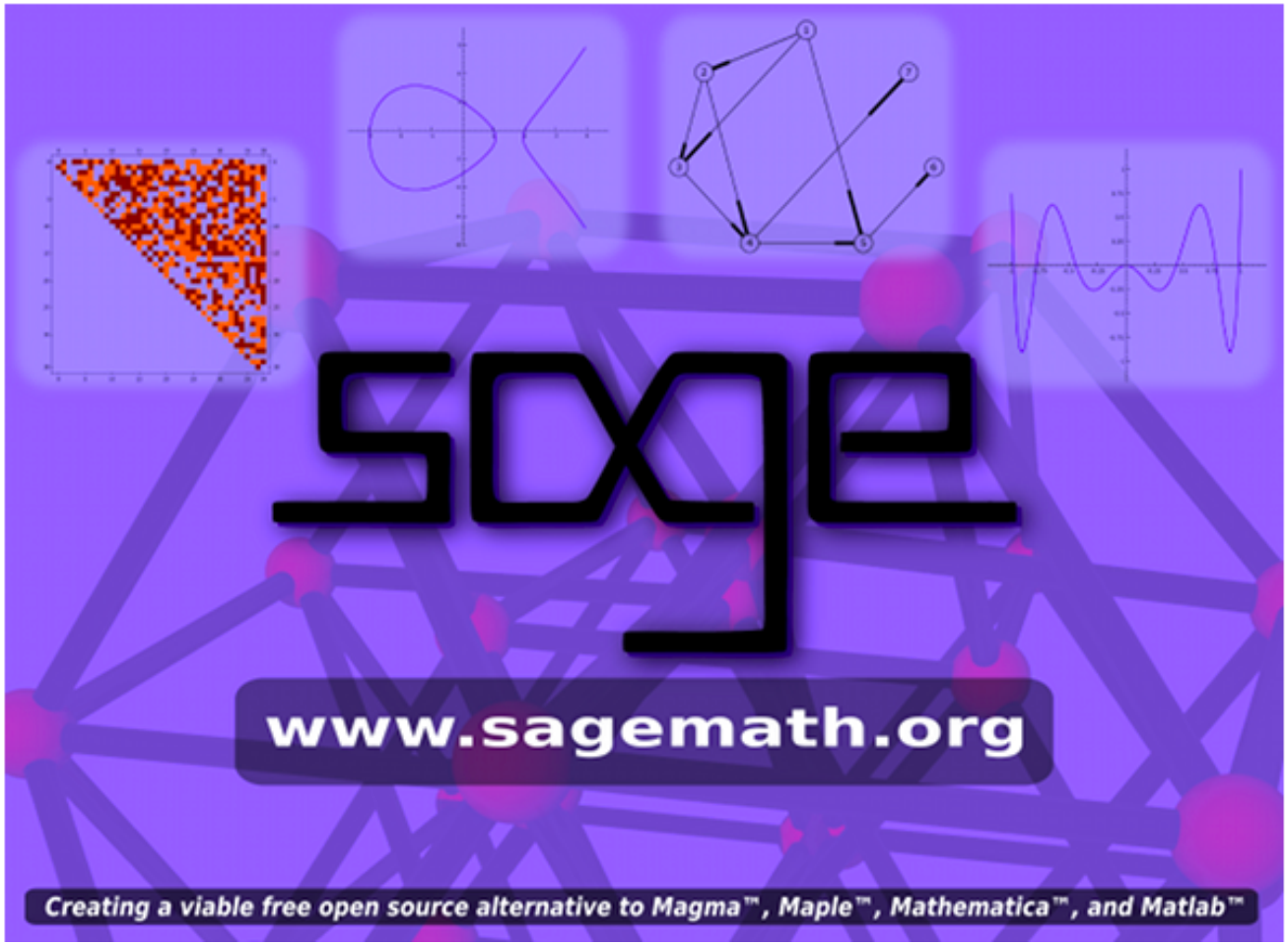
Creating an Open Source Alternative to Magma, Maple, Mathematica, and MATLAB

William Stein, Professor of Mathematics, University of Washington



Mission Statement

Create an open source alternative to Magma, Maple, Mathematica, and Matlab.

Firefox <--> Internet Explorer, Opera

Open Office, Latex <--> Microsoft Office

Linux <--> Microsoft Windows

PostgreSQL, MySQL <--> Oracle, Microsoft SQLserver

GIMP <--> Photoshop

Sage <--> Magma, Maple, Mathematica, Matlab

History of Sage

- *I started Sage* at Harvard in **January 2005**.
- Sage-1.0 released **February 2006** at Sage Days 1 (UC San Diego).
- **Nearly 30 Sage Days Workshops** (!) at UCLA, UW, Cambridge, Bristol, Austin, France, San Diego, Seattle, MSRI, ..., Barcelona, Leiden... and just got funding for about 20 more workshops.
- Sage **won first prize** in the Trophees du Libre (November 2007)
- Funding from **Microsoft, Univ of Washington, UC San Diego, NSF, DoD, Google, Sun,** private donations, etc.
- **Strong interest across all math.** Developer mailing: 1222 subscribers; Trac server: over 400 users; sage-support has 1793 subscribers.
- About **8,000 downloads** per month.
- **Future:** Company, Institute, much more use in undergraduate teaching.

What is Sage?

- Sage = Python + Math
- A unified self-contained **distribution** of ***open source*** mathematical software.
- Nearly a **half million lines of new Python (and Cython) code/documentation** that implements new capabilities and algorithms.
- Over 100,000 lines of **automated tests**.
- A "**cloud" application** like GMail or Google Docs: http://sagenb.org (over 33,000 accounts); of course, Sage also runs on ***your*** desktop.


Sage: Open Source Mathemat
http://sagemath.org/
v4.4.4 (2010-06-24) · an / Share 208 · Language
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Sage is a free open-source mathematics software system licensed under the GPL. It combines the power of many existing open-source packages into a common Python-based interface.
Mission: Creating a viable free open source alternative to Magma, Maple, Mathematica and Matlab.
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testing: alpha, Solaris SPARC
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Alexandre Casamayou Guillaume Connan Thierry Dumont
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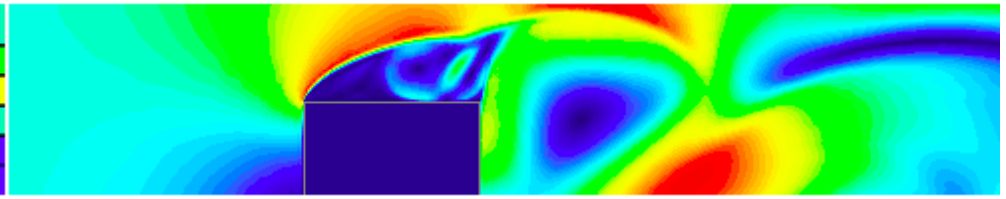
Version 1.0 — Juillet 2010

`http://www.loria.fr/~zimmerma/sagebook.htm`

New high quality Creative Commons *French* book on Sage for undergraduate mathematics.



The FEMhub Online Numerical Methods Laboratory

The goal of the FEMhub online lab is to make scientific computing accessible to anyone. No need to be a rocket scientist. No need to own a strong computer or buy expensive software either. Everything takes place inside the web browser window. Yes, the same browser that you use for emails or to watch YouTube movies. And yes, you can use your favorite iPhone or iPod. The online lab is backed up with substantial computing power of the University of Nevada, Reno, that the University gives you free of charge.

In the online lab you can edit and modify many different numerical methods, use them for your own projects, and share with others if you like. To facilitate your endeavors, FEMhub provides an easy access to many useful software libraries. To access the FEMhub community with any questions or ideas, use the FEMhub mailing list (femhub@googlegroups.com). We'd like to hear from you!

Currently, the FEMhub online lab uses some functionality of the Sage web notebook.

How to get started with the FEMhub online lab http://lab.femhub.org/

The best way is to try out simple worksheets that explain elementary methods of numerical analysis.

Step 1: Sign up for a new FEMhub online lab account This is automatic and fast. Report any problems to

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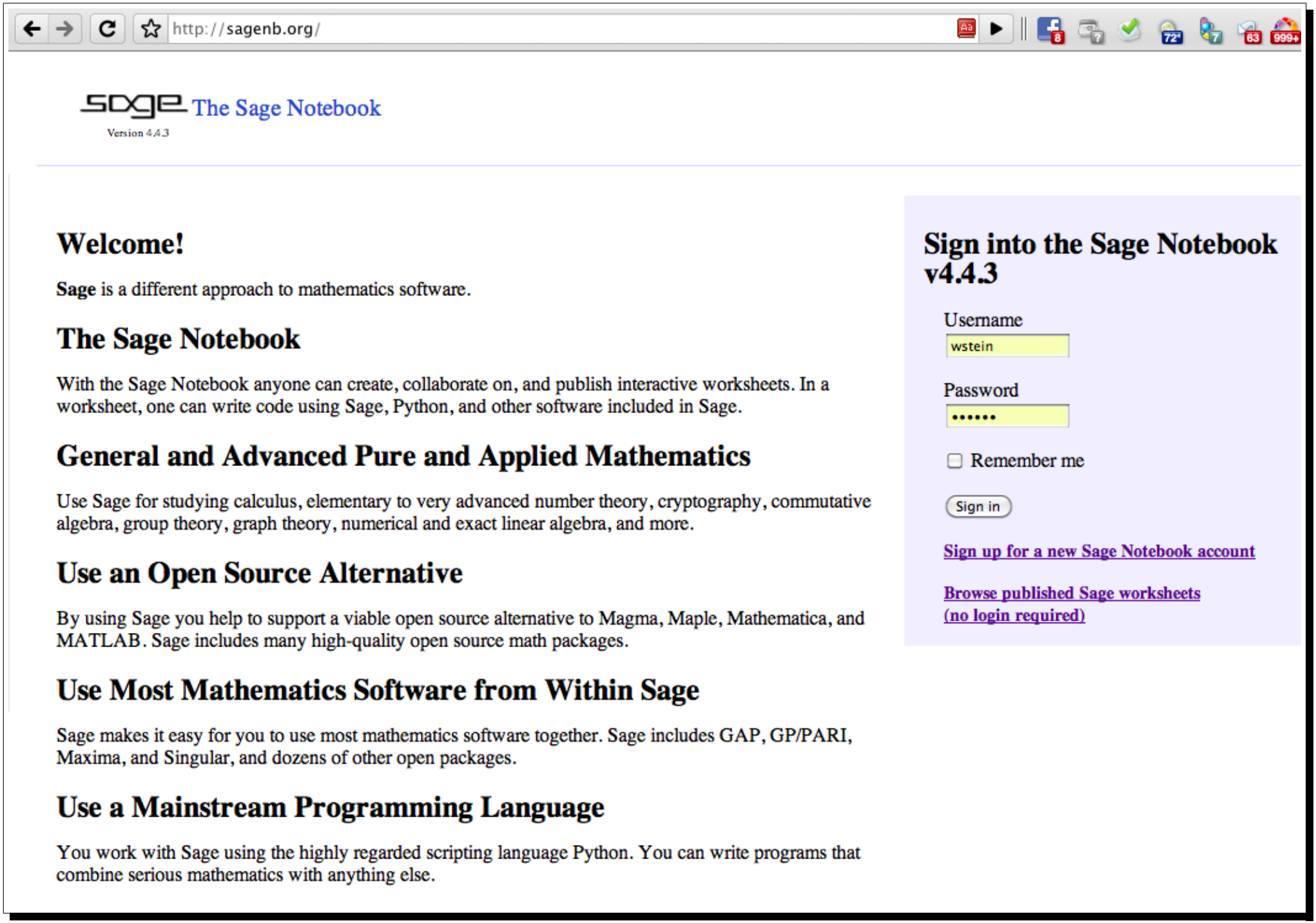
FEM Engines

Demo


http://sagenb.org/
sage The Sage Notebook
Version 4.4.3
Welcome!
Sage is a different approach to mathematics software.
The Sage Notebook
With the Sage Notebook anyone can create, collaborate on, and publish interactive worksheets. In a worksheet, one can write code using Sage, Python, and other software included in Sage.
General and Advanced Pure and Applied Mathematics
Use Sage for studying calculus, elementary to very advanced number theory, cryptography, commutative algebra, group theory, graph theory, numerical and exact linear algebra, and more.
Use an Open Source Alternative
By using Sage you help to support a viable open source alternative to Magma, Maple, Mathematica, and MATLAB. Sage includes many high-quality open source math packages.
Use Most Mathematics Software from Within Sage
Sage makes it easy for you to use most mathematics software together. Sage includes GAP, GP/PARI, Maxima, and Singular, and dozens of other open packages.
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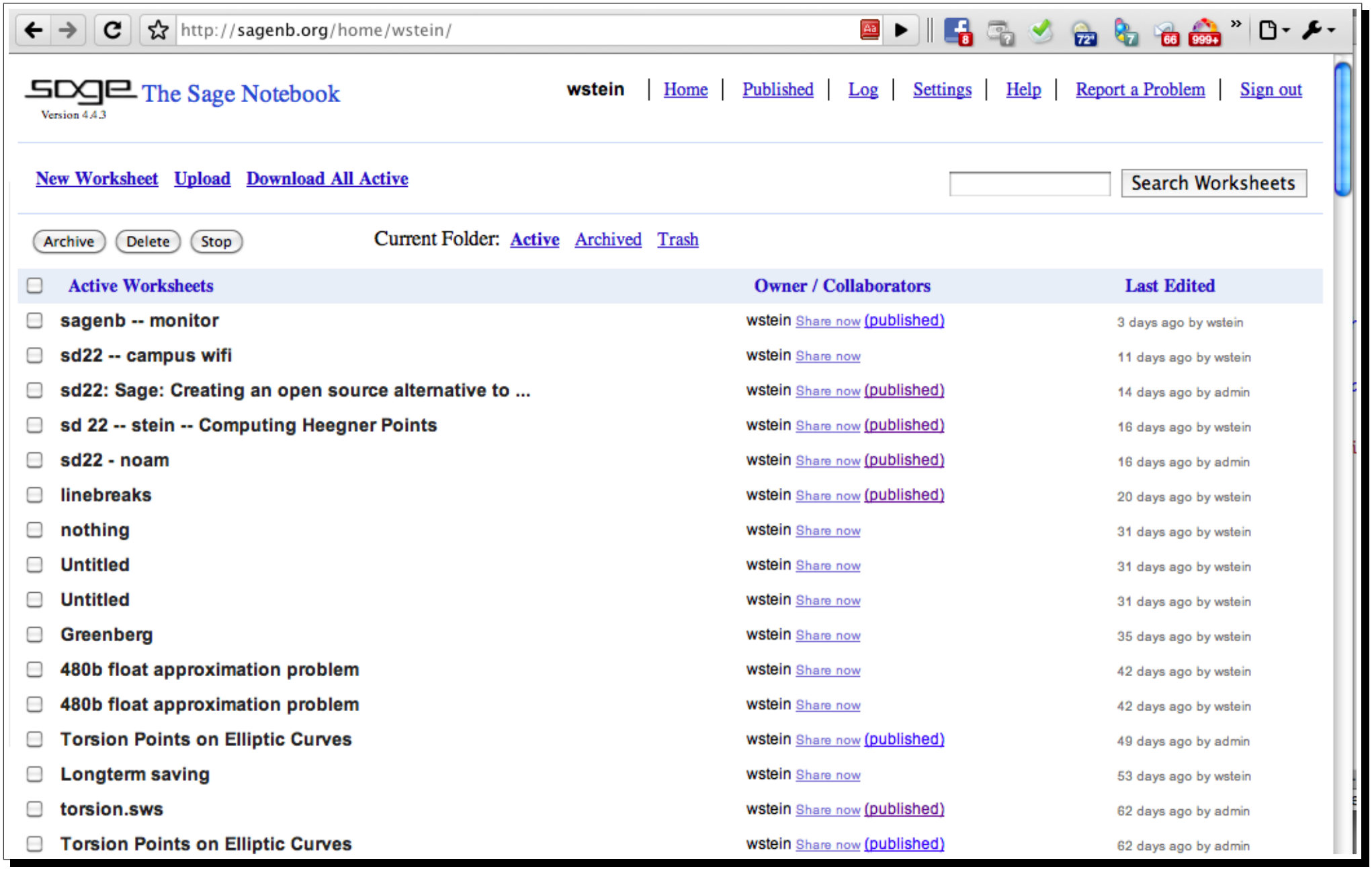
http://sagenb.org/home/wstein/
The Sage Notebook
Version 4.4.3
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New Worksheet Upload Download All Active
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16 days ago by admin
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wstein Share now (published)
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wstein Share now (published)
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Longterm saving
wstein Share now
53 days ago by wstein
torsion.sws
wstein Share now (published)
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Torsion Points on Elliptic Curves
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62 days ago by admin

sagenb -- monitor

last edited on July 06, 2010 07:29 AM by wstein

Save | Save & quit | Discard & quit

File... | Action | Data... | sage | Typeset | Print | Worksheet | Edit | Text | Undo | Share | Publish

Have you ever wondered how many people are using http://sagenb.org? This worksheet will tell you, and includes historical plots. See this page for a different view of this data. Below, **v** is the number of active worksheets:

```
%auto
v = [x.split() for x in open('/sagenb/monitor/users.log').readlines()[-100000:]]
```

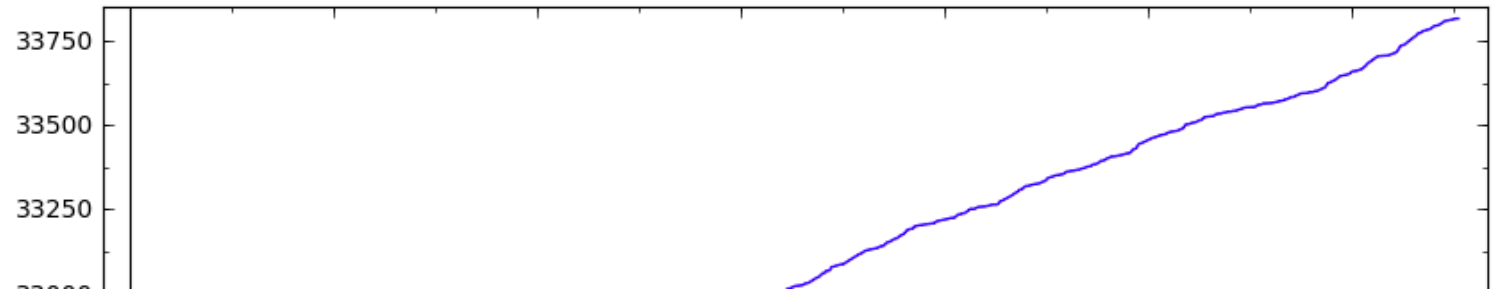
```
%hide
```

n 1200

select worksheets users

histogram

```
Last 823.3 hours (34 days)
```



```
f = mathematica('Sin[x^2]')
type(f)
```

```
<class 'sage.interfaces.mathematica.MathematicaElement'>
```

```
f.Integrate(x)
```

```
Sqrt[Pi/2]*FresnelS[Sqrt[2/Pi]*x]
```

```
maple('sin(x^2)').integrate(x)
```

```
1/2*2^(1/2)*Pi^(1/2)*FresnelS(2^(1/2)/Pi^(1/2)*x)
```

```
show(integrate(sin(x^2),x))
```

$$\frac{1}{8}\left((i-1)\sqrt{2}\mathrm{erf}\left(\left(\frac{1}{2}i-\frac{1}{2}\right)\sqrt{2}x\right)+(i+1)\sqrt{2}\mathrm{erf}\left(\left(\frac{1}{2}i+\frac{1}{2}\right)\sqrt{2}x\right)\right)\sqrt{\pi}$$

```
var('nu,C_2,r,sigma,k,x')      # or use automatic_names(True)
S_k = nu*exp(-C_2*r^2/sigma^(3/2))*sin(k*x); S_k
```

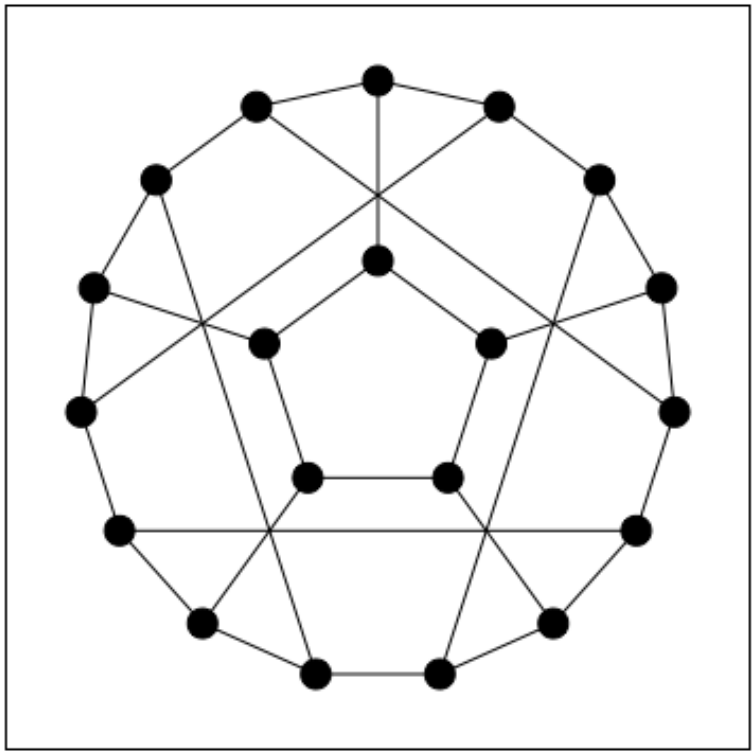
evaluate

```
nu*e^(-C_2*r^2/sigma^(3/2))*sin(k*x)
```

```
g = graphs.FlowerSnark(); g
```

```
Flower Snark: Graph on 20 vertices
```

```
graph_editor(g)
```



Save Close

```
g.automorphism_group()
```

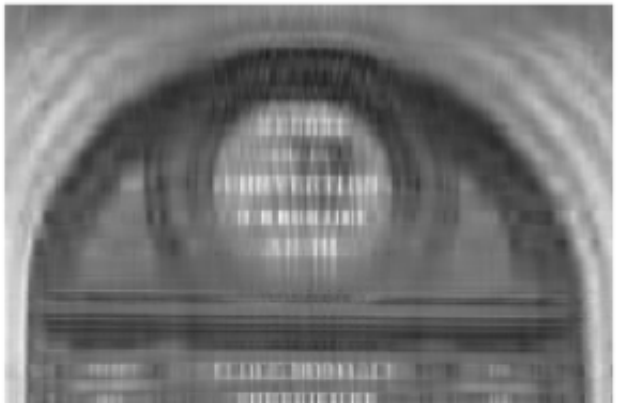
```
Permutation Group with generators
[(2,11)(3,12)(4,13)(5,8)(6,9)(7,10)(16,19)(17,18),
(1,4,7,10,13)(2,5,8,11,14)(3,6,9,12,20)(15,16,17,18,19),
(1,14)(2,4)(5,7)(8,10)(11,13)]
```

```
import pylab
import numpy
image = pylab.imread(DATA + 'ens.png')

A_image = numpy.mean(image, 2)
u,s,v = numpy.linalg.svd(A_image)
S = numpy.zeros( A_image.shape )
S[:len(s),:len(s)] = numpy.diag(s)
```

```
@interact
def svd_image(i = ("Eigenvalues (quality)",(20,(1..A_image.shape[0])))):
    A_approx = numpy.dot(numpy.dot(u[:,:i], S[:i,:i]), v[:i,:])
    g = graphics_array([matrix_plot(A_approx), matrix_plot(A_image)])
    show(g, axes=False, figsize=(8,3))
```

Eigenvalues (quality) 14



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Eigenvalues (quality) 14

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```

Eigenvalues (quality) 22

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    A_approx = numpy.dot(numpy.dot(u[:,:i], S[:i,:i]), v[:i,:])
    g = graphics_array([matrix_plot(A_approx), matrix_plot(A_image)])
    show(g, axes=False, figsize=(8,3))
```
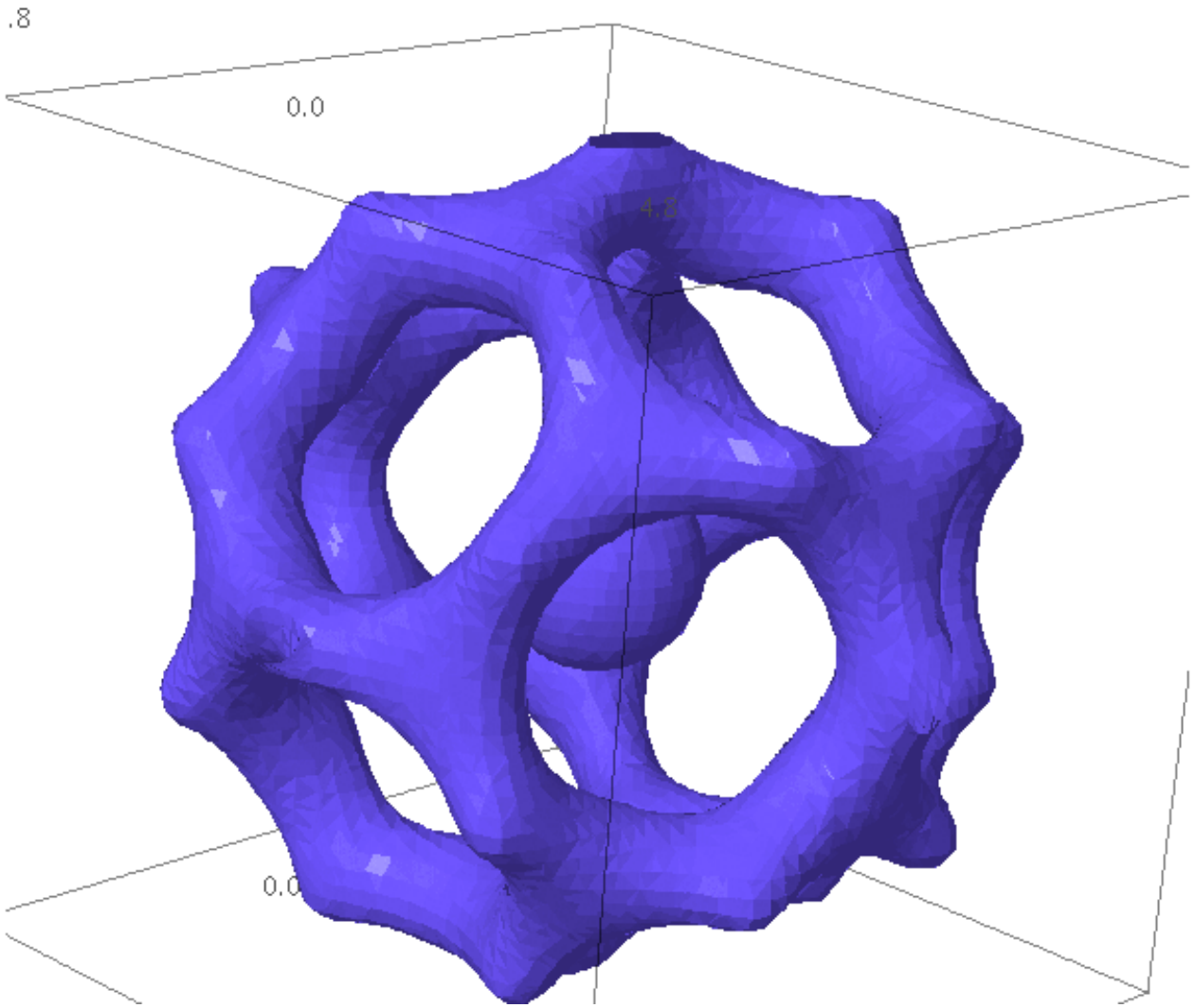

Eigenvalues (quality) 47

```
var('x,y,z')
T = golden_ratio
p = 2 - (cos(x + T*y) + cos(x - T*y) + cos(y + T*z) +
         cos(y - T*z) + cos(z - T*x) + cos(z + T*x))
r = 4.78
implicit_plot3d(p, (x, -r, r), (y, -r, r), (z, -r, r), plot_points=50)
```



```
from scipy import io
x = io.loadmat(DATA + 'yodapose.mat', struct_as_record=True)
from sage.plot.plot3d.index_face_set import IndexFaceSet
V = x['V']; F3 = x['F3']-1; F4 = x['F4']-1
Y = (IndexFaceSet(F3, V, color = Color('#00aa00')) +
    IndexFaceSet(F4, V, color = Color('#00aa00')))
Y = Y.rotateX(-1)
Y.show(aspect_ratio = [1,1,1], frame = False, figsize = 4)
```

evaluate

jsMath

Summary

- I hardly showed you anything. The Sage reference manual is 5600 pages....
- Sage is a **free** GPL-compatible collection of software (5 million lines).
- Includes **all** dependencies.
- Self contained **build system**: Solaris, Linux, OS X, Cygwin.
- **Goal:** Be a viable open source alternative to Matlab, Mathematica, etc.

Ask me questions during the breaks!