

Sage: 集大成者

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What is Sage?



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Sage Mission

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

创建 Magma, Maple, Mathematica 和 Matlab 的可用的自由开源替代。

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- and more...

Why do I use Sage?



Sage is about math

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丰富的数学领域

- 代数、代数几何、任意精度计算、算术几何、
- 微积分、组合数学、线性代数、图论、群论、
- 数值计算、数论、统计计算、 ...

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强劲的数学功能

- 支持多核处理器、多处理器，以及并行计算
- 许多专用库都有针对硬件的深度优化
- 有着优美的用户界面及输出，支持 $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$

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It's completely free

- Under GPLv2+.
- Built out of nearly 100 open-source packages.
- Use Python.

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| MATLAB | Mathematica | Sage |
|-----------|-------------|------|
| RMB 15000 | \$2745 | FREE |

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代数 GAP , Maxima , Singular

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高精度计算 MPIR, MPFR, MPFI, NTL

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统计计算 R, SciPy

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Shell IPython

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交互编程 Python

网络 Twisted

Sage is more powerful

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Benchmarks from Sage official site

Multiply Integers

$$(12345^{678900} - 1) * (67890^{123456} - 1)$$

Sage 4.1.1

```
sage: a1 = 12345^678900 - 1
sage: a2 = 67890^123456 - 1
sage: len(str(a1))
2777714
sage: len(str(a2))
596516
sage: %timeit a1*a2
10 loops, best of 3: 278 ms per loop
```

Note: "ms" is Milliseconds (

).

Sage is 32% faster.

System: Intel 32bit, Linux

factorial 10000000!

Sage 4.1.1

```
sage: time a = factorial(10000000)
CPU times: user 13.79 s,...
```

Sage is 40% faster.

System: Mac OSX

Mathematica 7

```
In[2]:= a1 = 12345^678900 - 1;
In[3]:= a2 = 67890^123456 - 1;
In[4]:= Timing[a1*a2][[1]]
Out[4]= 0.368023
```

10^{-3}

Mathematica 7

```
In[12]:= Timing[Factorial[10000000]][[1]]
Out[12]= 19.2908
```

Sage is more powerful

Benchmarks from Sage official site

Integer Factorization of

$$2^{512} - 1$$

Sage 4.1.1

```
sage: time a = factor(2^512 - 1)
CPU times: user 92.29 s,...
```

System: Intel 32bit, Linux
Sage is nearly 4 times faster.

Mathematica 7

```
In[10]:= Timing[FactorInteger[2^512 - 1]][[1]]
Out[10]= 346.494
```

Bernoulli Number

$$3 * 10^5$$

Sage 4.1.1

```
sage: %time _ = bernoulli(3*10^5)
CPU times: user 141.04 s,...
```

David Harvey, A multimodular algorithm for computing Bernoulli numbers, 2008

System: Intel 32bit, Linux
Sage is 52% faster.

Mathematica 7

```
In[1]:= Timing[BernoulliB[3*10^5]][[1]]
Out[1]= 214.842
```

Wolfram Blog about Bernoulli Numbers

Sage is more powerful

Benchmarks from Sage official site

5 Million Digits of

π

Sage 4.1.1 (pure and using mpmath)

```
sage: time a = N(pi, digits=5000000)
CPU times: user 28.90 s,...
Wall time: 28.96 s
```

However, mpmath is (barely) faster than Mathematica:

```
sage: from sage.libs.mpmath.all import pi as p
sage: time a = p(dps=5000000)
CPU times: user 12.56 s,...
Wall time: 12.70 s
```

Mathematica 7

```
In[1]:= Timing[N[Pi, 5000000]][[1]]
Out[1]= 13.21
```

Pseudoprimality Test

$2^{19937} - 1$

Sage 4.1.1

```
sage: time a = is_pseudoprime(2^19937 - 1)
CPU times: user 16.61 s,...
```

Mathematica 7

```
In[11]:= Timing[PrimeQ[2^19937 - 1]][[1]]
Out[11]= {28.2604, True}[1]
```

Expanding a Symbolic Expression

Sage 4.1.1

```
sage: R.<a1,a2,a3,a4,a5,a6,a7> = QQ[]
sage: time f = (a1+a2+a3+a4+a5+a6+a7)^25
CPU times: user 8.56 s,...
Wall time: 8.97 s

sage: var('a1 a2 a3 a4 a5 a6 a7')
(a1, a2, a3, a4, a5, a6, a7)
sage: time f = expand((a1+a2+a3+a4+a5+a6+a7)^25)
CPU times: user 19.94 s,...
Wall time: 20.59 s
```

Mathematica 7

```
In[15]:= Timing[Expand[(a1+a2+a3+a4+a5+a6+a7)^25]][[1]]
Out[15]= 15.981
```

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- Sage 集成了众多强大的开源数学库。
- Sage 使用 Python 作为统一的界面和编程语言。

How to use Sage?



Show Time!

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- Notebook 界面和 SageCloud

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- 其他有趣的东西...

Installation

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apt-add-repository -y ppa:aims/sagemath  
apt-get update  
apt-get install sagemath-upstream-binary
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ArchLinux

```
pacman -S sage-mathematics
```

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ArchLinux

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pacman -S sage-mathematics
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Other Linux distro

Download binaries for Linux from

<http://mirrors.ustc.edu.cn/sagemath/>

Thanks!

Questions are welcome.

Sage 主页: <http://sagemath.org/>

Sage 入门指南: <http://sagemath.org/doc/tutorial/index.html>

SageCloud: <https://cloud.sagemath.com/>

Sage Library: <http://sagemath.org/library.html>

USTC Mirror of Sage: <http://mirrors.ustc.edu.cn/sagemath/>

Ad. 欢迎关注人人主页 SageMath