

Introduction to SageMath

Chatchawan Panraksa
Applied Mathematics Program
Mahidol University International College

May 1, 2023

What is SageMath?

Sagemath is a free and open source mathematical software. It is in fact a sophisticated computer algebra system (CAS). By CAS, we mean a mathematical software that can do:

What is SageMath?

Sagemath is a free and open source mathematical software. It is in fact a sophisticated computer algebra system (CAS). By CAS, we mean a mathematical software that can do:

- Numerical Computations

What is SageMath?

Sagemath is a free and open source mathematical software. It is in fact a sophisticated computer algebra system (CAS). By CAS, we mean a mathematical software that can do:

- Numerical Computations
- Symbolic Computations

What is SageMath?

Sagemath is a free and open source mathematical software. It is in fact a sophisticated computer algebra system (CAS). By CAS, we mean a mathematical software that can do:

- Numerical Computations
- Symbolic Computations
- Graphing

What is SageMath?

Sagemath is a free and open source mathematical software. It is in fact a sophisticated computer algebra system (CAS). By CAS, we mean a mathematical software that can do:

- Numerical Computations
- Symbolic Computations
- Graphing
- Programming

What is SageMath?

Sagemath is a free and open source mathematical software. It is in fact a sophisticated computer algebra system (CAS). By CAS, we mean a mathematical software that can do:

- Numerical Computations
- Symbolic Computations
- Graphing
- Programming

Commercial CAS

- Mathematica
- MatLab
- Maple
- Magma
- MathCAD

Commercial CAS

- Mathematica
- MatLab
- Maple
- Magma
- MathCAD

You need to pay hundred or thousand dollars to use them. Even to get updates you need to pay almost equal amount of money.

Commercial CAS

- Mathematica
- MatLab
- Maple
- Magma
- MathCAD

You need to pay hundred or thousand dollars to use them. Even to get updates you need to pay almost equal amount of money.

Sage on the other hand is FREE and has capability of most of these commercial software.

Origin of SageMath

Sage was initially developed by William Stein (formerly at the University of Washington). The first version of Sage was released in 2005 at Harvard University. Currently it has version 9.0.

Origin of SageMath

Sage was initially developed by William Stein (formerly at the University of Washington). The first version of Sage was released in 2005 at Harvard University. Currently it has version 9.0.

Purpose:

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

What can we do with SageMath

- One can use SageMath as an advanced scientific calculator.

What can we do with SageMath

- One can use SageMath as an advanced scientific calculator.
- Sage can also do complex and heavy duty Numerical Computations (NumPy, SciPy, GSL, ATLAS, etc.)

What can we do with SageMath

- One can use SageMath as an advanced scientific calculator.
- Sage can also do complex and heavy duty Numerical Computations (NumPy, SciPy, GSL, ATLAS, etc.)
- You can use Sage for visualization and animations.
- Very good at Symbolic manipulation arising in various branches in mathematics such as Calculus, Linear Algebra, Abstract Algebra, Number Theory, Graph Theory, Combinatorics, even differential geometry (and more!)

What can we do with SageMath

- One can use SageMath as an advanced scientific calculator.
- Sage can also do complex and heavy duty Numerical Computations (NumPy, SciPy, GSL, ATLAS, etc.)
- You can use Sage for visualization and animations.
- Very good at Symbolic manipulation arising in various branches in mathematics such as Calculus, Linear Algebra, Abstract Algebra, Number Theory, Graph Theory, Combinatorics, even differential geometry (and more!)
- Programming in Sage is very simple.

What can we do with SageMath?

- Sage has very nice interface with \LaTeX . You can generate latex code of any object in Sage and use them in your \LaTeX document.
- Using a package **sagetex**, you can use sage codes from \LaTeX document. For more detail, see <https://doc.sagemath.org/html/en/tutorial/sagetex.html>.
- Sage worksheets as interactive class-notes, where you can write all the results proofs and show calculation graphs, animations etc.
- Sage in teaching mathematics can bring a lot of pedagogical benefits.

Conclusion

SageMath is a very nice mathematical tool which can help in learning, teaching and doing mathematics.

SageMath in L^AT_EX

$$f(x) = \frac{\cos(2x)}{x^2+1}$$

SageMath in L^AT_EX

$$f(x) = \frac{\cos(2x)}{x^2+1}$$

The first derivative of $f(x) := \frac{\cos(2x)}{x^2+1}$ is $f'(x) = -\frac{2x \cos(2x)}{(x^2+1)^2} - \frac{2 \sin(2x)}{x^2+1}$.

SageMath in \LaTeX

$$f(x) = x^2 \cos(x) e^x \sin(x) \sinh(x)$$

SageMath in L^AT_EX

$$f(x) = x^2 \cos(x) e^x \sin(x) \sinh(x)$$

The first derivative of $f(x) := x^2 \cos(x) e^x \sin(x) \sinh(x)$ is

$$f'(x) = x^2 \cos(x) \cosh(x) e^x \sin(x) + x^2 \cos(x)^2 e^x \sinh(x) + x^2 \cos(x) e^x \sin(x) \sinh(x) - x^2 e^x \sin(x)^2 \sinh(x) + 2x \cos(x) e^x \sin(x) \sinh(x).$$

SageMath in L^AT_EX

$$f(x) = x^2 \cos(x) e^x \sin(x) \sinh(x)$$

The first derivative of $f(x) := x^2 \cos(x) e^x \sin(x) \sinh(x)$ is

$$f'(x) = x^2 \cos(x) \cosh(x) e^x \sin(x) + x^2 \cos(x)^2 e^x \sinh(x) + x^2 \cos(x) e^x \sin(x) \sinh(x) - x^2 e^x \sin(x)^2 \sinh(x) + 2x \cos(x) e^x \sin(x) \sinh(x).$$

The second derivative of $f(x) := x^2 \cos(x) e^x \sin(x) \sinh(x)$ is

$$f''(x) = 2x^2 \cos(x)^2 \cosh(x) e^x + 2x^2 \cos(x) \cosh(x) e^x \sin(x) - 2x^2 \cosh(x) e^x \sin(x)^2 + 2x^2 \cos(x)^2 e^x \sinh(x) - 2x^2 \cos(x) e^x \sin(x) \sinh(x) - 2x^2 e^x \sin(x)^2 \sinh(x) + 4x \cos(x) \cosh(x) e^x \sin(x) + 4x \cos(x)^2 e^x \sinh(x) + 4x \cos(x) e^x \sin(x) \sinh(x) - 4x e^x \sin(x)^2 \sinh(x) + 2 \cos(x) e^x \sin(x) \sinh(x).$$

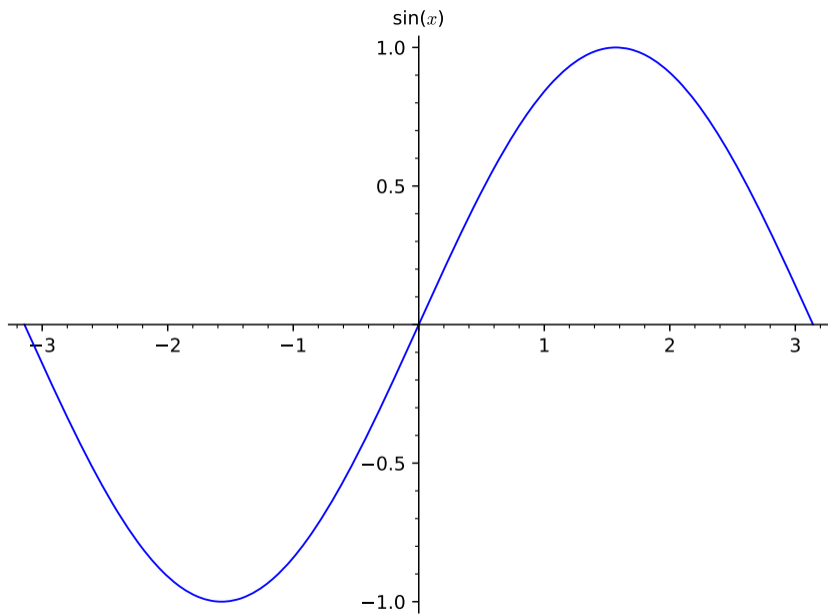
SageMath in \LaTeX

$$f(x) = x^2 \cos(x) e^x \sin(x) \sinh(x)$$

SageMath in L^AT_EX

$$f(x) = x^2 \cos(x) e^x \sin(x) \sinh(x)$$

The 20th derivative of $f(x) := x^2 \cos(x) e^x \sin(x) \sinh(x)$ is $f^{(20)}(x) =$
 $-537395200 x^2 \cos(x) \cosh(x) e^x \sin(x) - 536346624 x^2 \cos(x) e^x \sin(x) \sinh(x) +$
 $2689597440 x \cos(x)^2 \cosh(x) e^x - 5368709120 x \cos(x) \cosh(x) e^x \sin(x) -$
 $2689597440 x \cosh(x) e^x \sin(x)^2 + 2679111680 x \cos(x)^2 e^x \sinh(x) -$
 $5368709120 x \cos(x) e^x \sin(x) \sinh(x) - 2679111680 x e^x \sin(x)^2 \sinh(x) +$
 $12750684160 \cos(x)^2 \cosh(x) e^x + 49807360 \cos(x) \cosh(x) e^x \sin(x) -$
 $12750684160 \cosh(x) e^x \sin(x)^2 + 12750684160 \cos(x)^2 e^x \sinh(x) -$
 $49807360 \cos(x) e^x \sin(x) \sinh(x) - 12750684160 e^x \sin(x)^2 \sinh(x).$



SageMath Installation

There are many ways to use SageMath:

- Download and install SageMath from <https://www.sagemath.org/>
- Use SageMath in the website <https://cocalc.com/>
- For simple calculation, use <https://sagecell.sagemath.org/>
- You can also use SageMath in Jupyter or Anaconda!