

SymPy Tutorial - SciPy India 2015

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All materials for today's tutorial are at
<http://www.cse.iitb.ac.in/~sumith/scipy/>

Outline

SymPy Introduction

- Goal
- Features
- History
- Present
- Future

Tutorial

- Intro to SymPy and Basic features
- Solving real life problems

SymPy Goal

Goal

Provide a symbolic manipulation library in Python.

“SymPy is an open source Python library for symbolic mathematics. It aims to become a full-featured computer algebra system (CAS) while keeping the code as simple as possible in order to be comprehensible and easily extensible. SymPy is written entirely in Python and does not require any external libraries.”

Why SymPy?

- Standalone
- Full featured
- BSD licensed
- Embraces Python
- Usable as a library

Features

■ Core Capabilities

- Basic arithmetic: Support for operators such as $+$, $-$, $*$, $/$, $**$ (power)
- Simplification
- Expansion
- Functions: trigonometric, hyperbolic, exponential, roots, logarithms, absolute value, spherical harmonics, factorials and gamma functions, zeta functions, polynomials, special functions, ...
- Substitution
- Numbers: arbitrary precision integers, rationals, and floats
- Noncommutative symbols
- Pattern matching

■ Polynomials

- Basic arithmetic: division, gcd, ...
- Factorization
- Square-free decomposition
- Gröbner bases
- Partial fraction decomposition
- Resultants

■ Calculus

- Limits: $\lim_{x \rightarrow 0} x \log(x) = 0$
- Differentiation
- Integration: It uses extended Risch-Norman heuristic
- Taylor (Laurent) series

■ Solving equations

- Polynomial equations
- Algebraic equations
- Differential equations
- Difference equations
- Systems of equations

■ Combinatorics

- Permutations
- Combinations
- Partitions
- Subsets
- Permutation Groups: Polyhedral, Rubik, Symmetric, ...
- Prufer and Gray Codes

Features

■ Discrete math

- ☐ Binomial coefficients
- ☐ Summations
- ☐ Products
- ☐ Number theory: generating prime numbers, primality testing, integer factorization, ...
- ☐ Logic expressions

■ Matrices

- ☐ Basic arithmetic
- ☐ Eigenvalues/eigenvectors
- ☐ Determinants
- ☐ Inversion
- ☐ Solving
- ☐ Abstract expressions

■ Geometric Algebra

■ Geometry

- ☐ points, lines, rays, segments, ellipses, circles, polygons, ...
- ☐ Intersection
- ☐ Tangency
- ☐ Similarity

■ Plotting

- ☐ Coordinate modes
- ☐ Plotting Geometric Entities
- ☐ 2D and 3D
- ☐ Interactive interface
- ☐ Colors

■ Physics

- ☐ Units
- ☐ Mechanics
- ☐ Quantum
- ☐ Gaussian Optics
- ☐ Pauli Algebra

■ Statistics

- ☐ Normal distributions
- ☐ Uniform distributions
- ☐ Probability

■ Printing

- ☐ Pretty printing: ASCII/Unicode pretty printing, LaTeX
- ☐ Code generation: C, Fortran, Python

History

History

- Ondřej Čertík started the project in 2006.
- Development took off in 2007 when SymPy first participated in Google Summer of Code. We have participated in every Google Summer of Code since.
- In 2011, Aaron Meurer (who also joined from Google Summer of Code) took over as lead developer.

Present

Current Status

- Over 400 contributors.
- Current code base has over 400,000 lines of code and documentation.
- We have crossed the point of “sympy a toy” to “sympy a tool”

Future

GSoC (1/2)

These are our current GSoC projects. Expect to see these features by the end of the summer.

- Improving Solvers : Extending SolveSet Amit Kumar
- Make Sage use SymEngine as a symbolic engine Isuru Fernando
- Ruby bindings to the SymEngine C++ symbolic library Abinash Meher
- Improving the series package and limits in SymPy Sartaj Singh

Future

GSoC (2/2)

These are our current GSoC projects. Expect to see these features by the end of the summer.

- Fast Sparse Series Expansion Shivam Vats
- Improving assumptions in SymPy Sudhanshu Mishra
- Implementing polynomial module in SymEngine Sumith

Future

Other Plans

- New assumptions
- Make things faster
- Implement more algorithms, so we can compute more things (and also make them faster)
- Make it easier for people to define custom behavior of their own objects in Add and Mul
- Encourage people to use SymPy for many applications
- <https://github.com/sympy/sympy/wiki/gsoc-2015-ideas> for full list of things we want done

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Let's begin!