SymPy Tutorial

Ondřej Čertík, Mateusz Paprocki, Aaron Meurer

SymPy

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Outline

SymPy Introduction

- Goal
- History
- Current status
- Features

Tutorial

- Basic SymPy commands
- Solving real life problems

SymPy Goal

Goal
Provide a symbolic manipulation library in Python.

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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."

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: $\lim_{x \to 0} x \log(x) = 0$
  - ☐ 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 250 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

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

- Risch algorithm for symbolic integration: Chetna Gupta
- Faster Algorithms for Polynomials over Algebraic Number Fields: Katja Sophie Hotz
- Improved ODE Solver in SymPy: Manoj Kumar
- Lie Algebras: Mary Clark
- Vector calculus module: Prasoon Shukla
- Addition of electromagnetism features to sympy.physics: Sachin Joglekar
- Diophantine Equation Module for SymPy: Thilina Rathnayake

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-2013-ideas for full list of things we want done
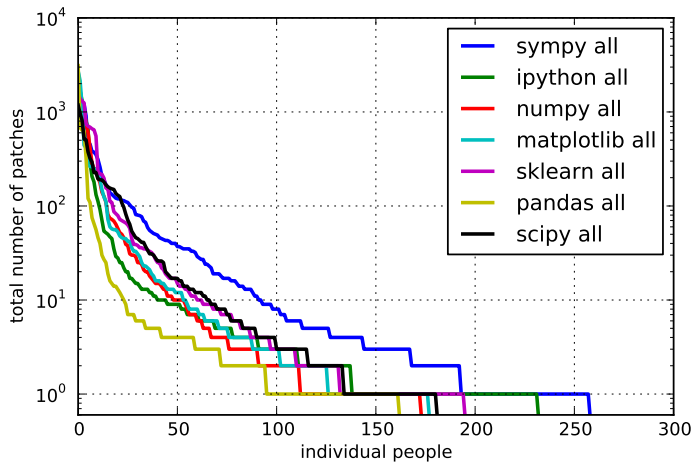
Git Commits Plots

Last Year
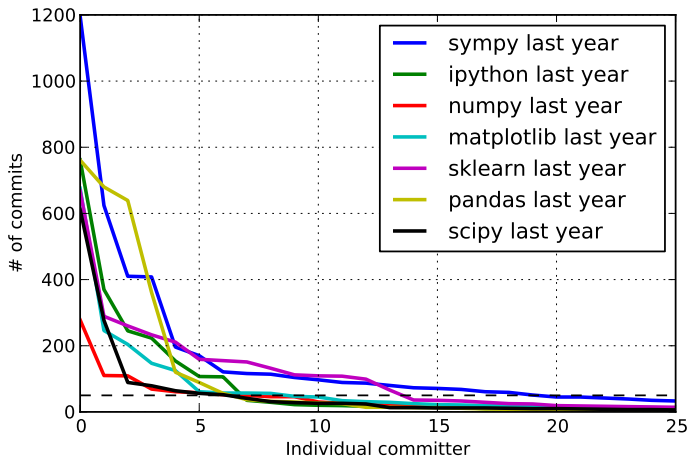
Git Commit Plots

Last Year

- The dotted line is 50 contributors
- Rough measurement of each project's "bus factor"

Git Commits Plots

All Time

Git Commit Plots

All Time

- SymPy has more total contributors than any other scientific project (other projects are actually exaggerated, because they don't use `.mailmap`)
- SymPy has a very welcome and friendly community, which is open, and actively encourages contributions.
- The SymPy code base is very approachable to new contributors.
- To be fair, Google Code-In accounts for a lot of this...

Authors

Chris Smith
Aaron Meurer
Mateusz Paprocki
Ondřej Čertík
Matthew Rocklin
Julien Rioux
Ronan Lamy
Raoul Bourquin
Kirill Smelkov
Øyvind Jensen
Tom Bachmann
Sergiu Ivanov
Mario Pernici
Saptarshi Mandal
Stefan Krastanov
Brian E. Granger
Vinzent Steinberg
Vladimir Perić
Raymond Wong
Sergey B Kirpichev
David Li
Fredrik Johansson
Sean Vig
Fabian Pedregosa
Bharath M R
Gilbert Gede
Addison Cugini

Thomas Hisch
Guru Devanla
Priit Laes
Prasoon Shukla
Alexey U.
Gudchenko
Matt Habel
Tomo Lazovich
Matt Curry
Timothy Reluga
Jason Gedge
Aleksandar Makelov
Sachin Joglekar
Brian Jorgensen
Kendhia
Andy R. Terrel
Ramana Venkata
Grzegorz Świrski
Sebastian Krämer
Pearu Peterson
Manoj Kumar
Toon Verstraelen
Siddhanathan
Shanmugam
Joan Creus
Jorn Baayen
Christian Muise

Jeremias Yehdegho
Joachim Durchholz
Kevin Hunter
Riccardo Gori
Matthew Hoff
Steve Anton
hm
Sanket Agarwal
Robert Schwarz
David Ju
Luke Peterson
Angadh Nanjangud
Bilal Akhtar
Stepan Roucka
Miha Marolt
Renato Coutinho
Saurabh Jha
Niklas Thörne
Alexander Hirzel
Nathan Alison
jerryma1121
Brian Stephanik
Sam Sleight
Sachin Irukula
Robert Kern
Patrick Lacasse
Angus Griffith

Swapnil Agarwal
Gary Kerr
Sherjil Ozair
Natalia Nawara
Nicolas Pourcelot
Huijun Mai
Jim Zhang
Ljubiša Moćić
Prafullkumar P. Tale
Marek Šuppa
Freddie Witherden
Roberto Nobrega
Jason Moore
Felix Kaiser
Sean Ge
Alan Bromborsky
Chetna Gupta
Friedrich Hagedorn
Saroj Adhikari
CJ Carey
Jaroslaw Tworek
Alexey Subach
Yuri Karadzhov
Rishabh Dixit
Christian Bühler
Ryan Krauss
Min Ragan-Kelley

Demian Wassermann
Christopher Dembia
Sam Magura
Ananya
Mark Dewing
Raphael Michel
Andreas Kloeckner
Tarun Gaba
Christophe
Saint-Jean
Tobias Lenz
Tomasz Buchert
Davy Mao
Ankit Agrawal
Nichita Utiu
Piotr Korgul
Mary Clark
Harold Erbin
Matthew Brett
Chris Wu
Chancellor Arkantos
Katja Sophie Hotz
Alexandr Popov
Abderrahim Kitouni
Stefano Maggiolo
Varun Joshi
Thilina Rathnayake

Authors

Nimish Telang
Tiffany Zhu
Khagesh Patel
Rom le Clair
Imran Ahmed
Manzoor
Jochen Voss
Stefen Yin
David Roberts
Sebastian Kreft
Óscar Nájera
Tristan Hume
Florian Mickler
Pan Peng
Akshay Srinivasan
Akshit Agarwal
Amit Jamadagni
Andrew Straw
Barry Wardell
Benjamin McDonald
Bill Flynn
Case Van Horsen
Cristóvão Sousa
Emma Hogan
Geoffry Song
George Waksman
Jens H. Nielsen

Julio Idichekop Filho
Luca Weihs
Luis Garcia
Manoj Babu K.
Martin Povišer
Nikolay Lazarov
Oliver Lee
Raffaele De Feo
Shravas K Rao
Ted Horst
Oscar Benjamin
Michael Mayorov
David Marek
Goutham
Lakshminarayan
Ben Goodrich
Jezreel Ng
Tomáš Bambas
Ashwini Oruganti
Arpit Goyal
Stephen Loo
Jurjen N.E. Bos
Colleen Lee
James Aspnes
Sai Nikhil
Jack McCaffery
Fernando Perez

Oleksandr Gituliar
Thomas Dixon
Bradley Froehle
Nikhil Sarda
tsmars15
Thomas Wiecki
Pavel Fedotov
Boris Timokhin
Henrik Johansson
James Abbatiello
Sebastian Krause
Hubert Tsang
Gregory Ksionda
Seshagiri Prabhu
Shai 'Deshe'
Wyborski
Gert-Ludwig Ingold
Acebulf
Shruti Mangipudi
Siddhant Jain
Srinivas Vasudevan
Elrond der
Elbenfuerst
Eh Tan
David Lawrence
Stepan Simsa
Comer Duncan

Takafumi Arakaki
Tarang
Christian Schubert
Łukasz Pankowski
Carsten Knoll
Thomas Sidoti
Tim Lahey
Björn Dahlgren
Bernhard R. Link
Benjamin Fishbein
Bastian Weber
Tyler Pirtle
Andrew Docherty
Vasily Povalyaev
Vinay Kumar
Or Dvory
Vladimir Lagunov
Andre de Fortier
Smit
Anatolii Koval
Ali Raza Syed
Alexandr Gudulin
marshall2389
vishal
Pauli Virtanen
Andrej Tokarčík
Prateek Papriwal

Puneeth Chaganti
Alexander
Eberspächer
Randy Heydon
Nicholas J.S. Kinar
Max Hutchinson
Matthias Toews
Matthew Tadd
Matt Rajca
Rizgar Mella
Robert
Robert Cimrman
Marcin Kostrzewa
Madeleine Ball
Roberto Colisteto,
Jr.
Konrad Meyer
Kibeom Kim
Kevin Goodsell
Kazuo Thow
Kaifeng Zhu
Joseph Dougherty
Jorge E. Cardona
Johann
Cohen-Tanugi
James Pearson

Here at SciPy

Talks

- Matthew Rocklin, *Matrix Expressions and BLAS/LAPACK*.
  Thursday 10:15 AM - 10:35 AM General - Rm 204

- Jason Moore, *Dynamics with SymPy Mechanics*.
  02:10 PM - 02:30 PM General - Rm 204

- David Li, *SymPy Gamma and SymPy Live: Python and Mathematics Online*.
  03:50 PM - 04:10 PM General - Rm 203 (High School student!)

Sprints

Come sprint with us!

- Releasing SymPy 0.7.2

- Lot's of tasks that are easy for new contributors

- Friday and Saturday