SymPy Tutorial

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All materials for today's tutorial are at
`http://certik.github.io/scipy-2013-tutorial/`

Outline

SymPy Introduction

- Goal
- Features
- History
- Present
- Future

Tutorial

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

SymPy Goal

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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

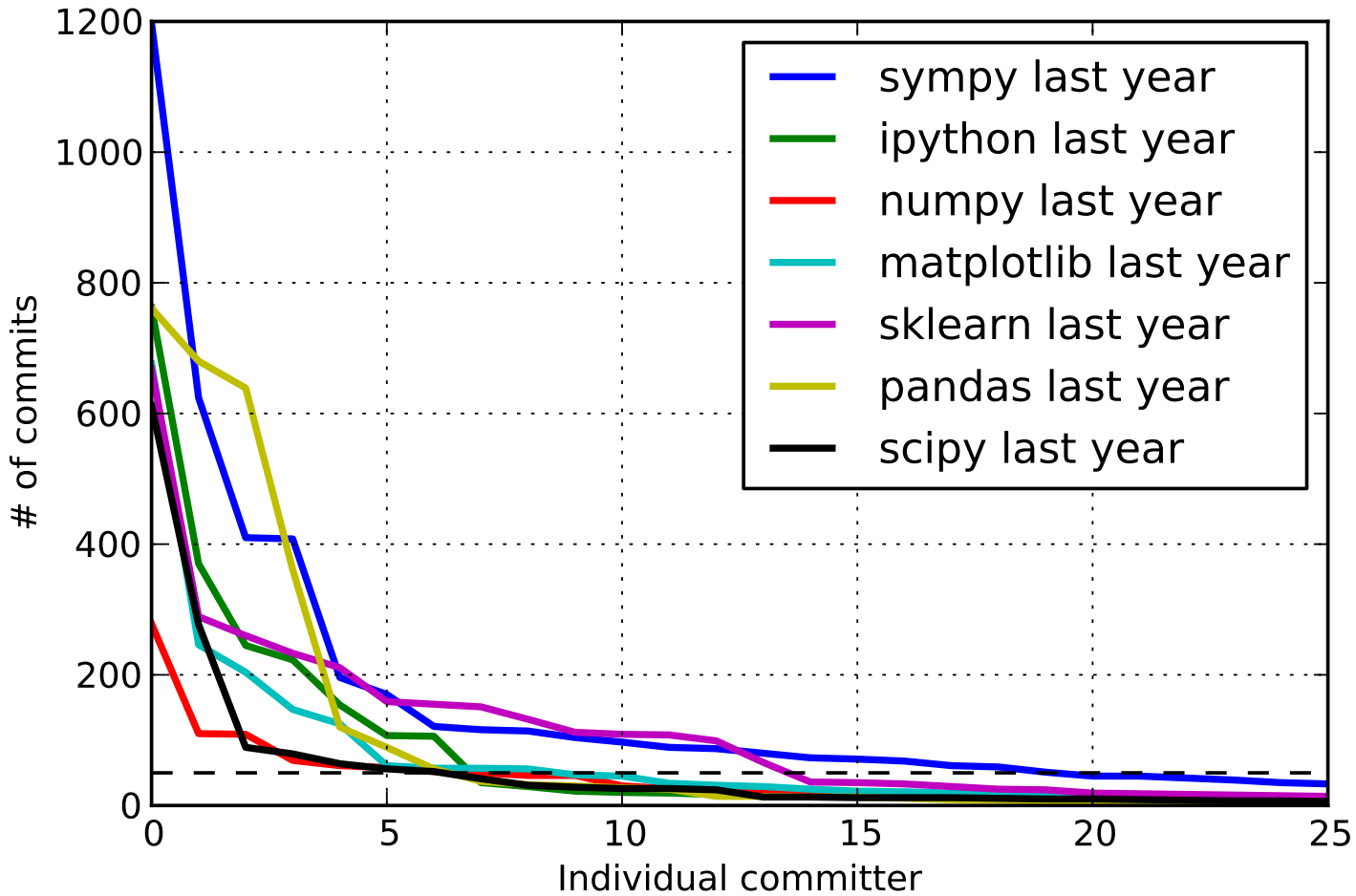
Future

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



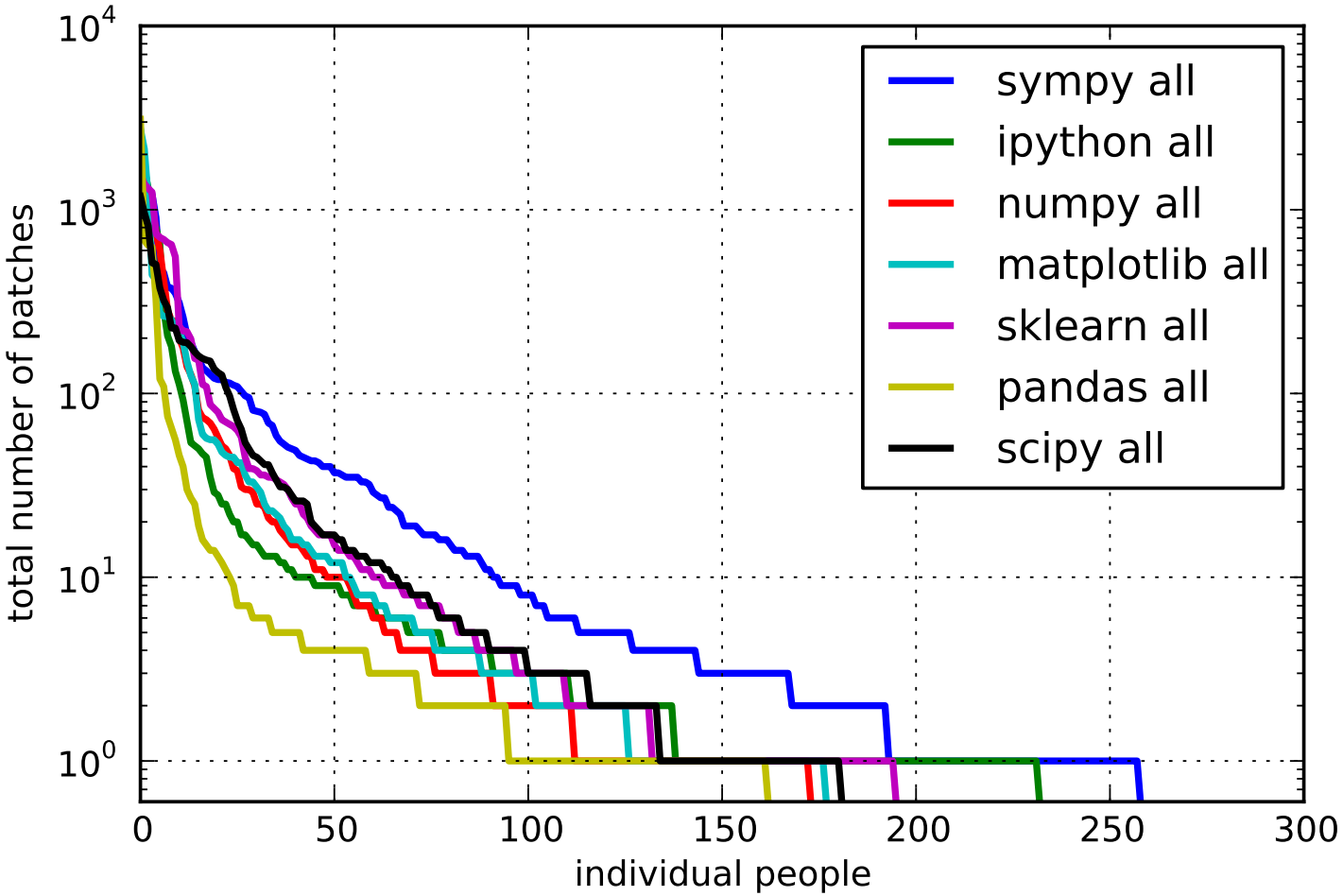
Git Commit Plots

Last Year

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

Git Commits Plots

All Time



Git Commit Plots

All Time

- SymPy has more total contributors[1]
- 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. . .

[1] some of the other projects are actually exaggerated, because they don't use `.mailmap`

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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*.
  Thursday 02:10 PM - 02:30 PM General - Rm 204
- David Li, *SymPy Gamma and SymPy Live: Python and Mathematics Online*.
  03:50 PM - Thursday 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

Let's begin!