Geoist - An Open-Source Geophysical Python Library for Geoscience Prototype Research

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- Motivation
- Ambition
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Existing Python libraries

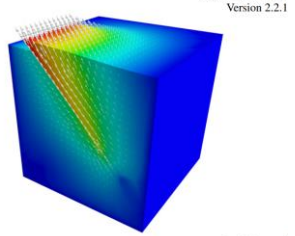
ObsPy
A Python Framework for Seismology

cartopy

PySIT
Seismic Imaging Toolbox
for Python

fatiando a terra

PyLith
User Manual
Version 2.2.1



Brad Aagaard
Matthew Knepley
Charles Williams

geodynamics.org

NASA

Repositories 186 People 33 Projects 0

Search repositories... Type: All Language: Python

28 results for repositories written in Python

https://en.wikipedia.org/wiki/Comparison_of_free_geophysics_software

Why another geophysical Python library?

- New algorithms (Bayesian inversion framework)
- Borrow and lend power from/to the open source community
- Adopt Python
  - Easy to learn/use
  - Python ecosystem
  - Vitality

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What does it do?

- It mainly works on gravity related forward modelling and inverse problems

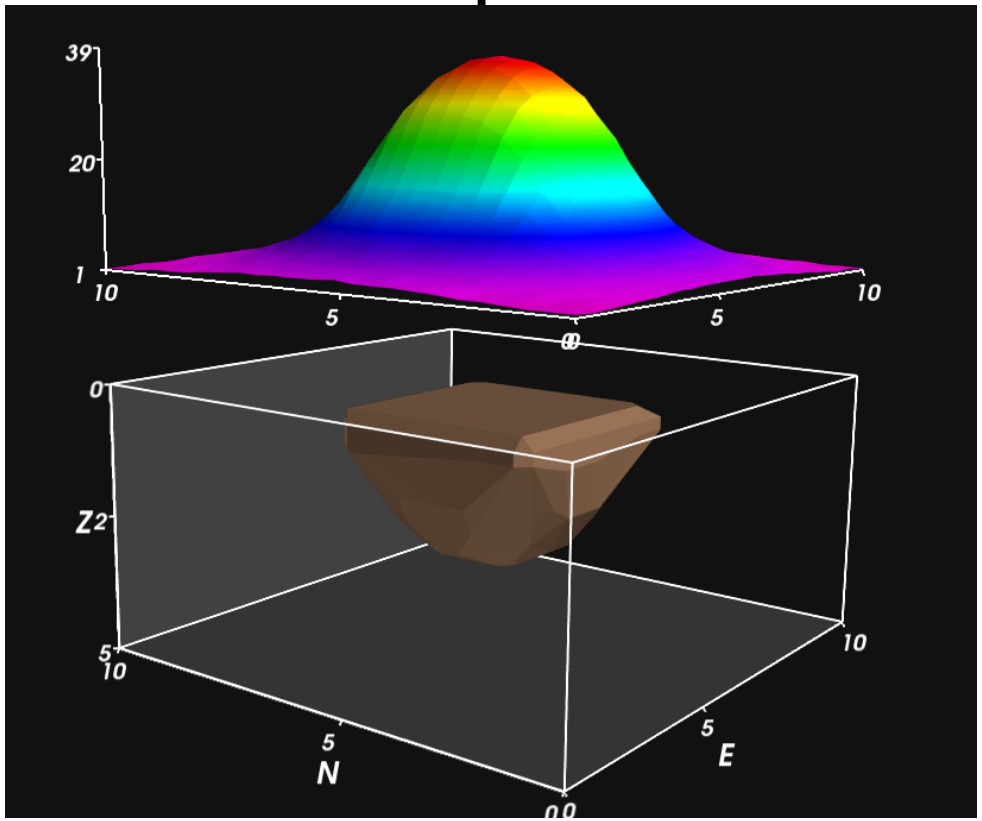
satellite orbit

subduction

sea level

coordinate system

...



Earth's structure

mass distribution

material composition

exploration

...

Leonardo Uieda, 2013

A sample of Bayesian inversion

- Model:

$$d_1 - G_1\rho = \varepsilon_{d_1} \sim N\left(0, {\sigma_1}^2\right) \qquad d_2 - G_2\rho = \varepsilon_{d_2} \sim N\left(0, {\sigma_2}^2\right)$$

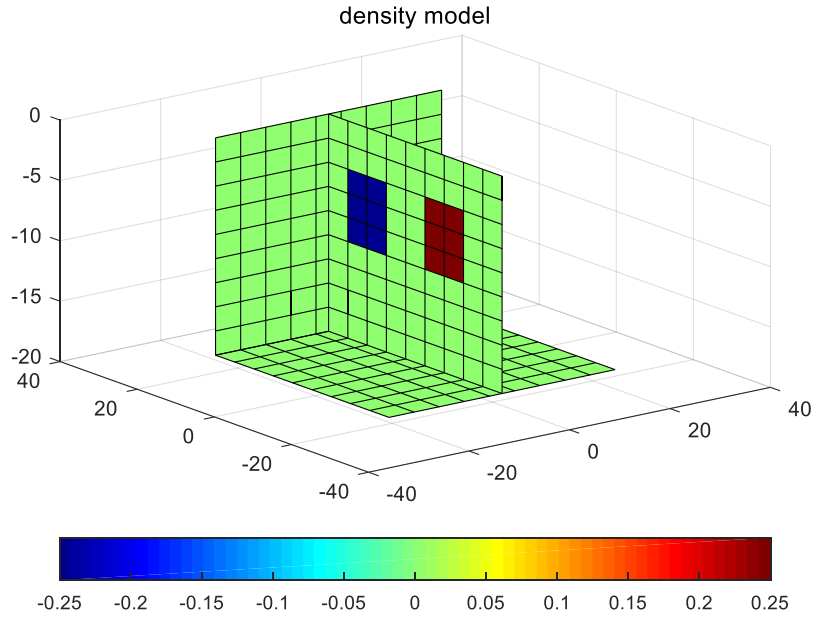
- Constraints(Prior information):

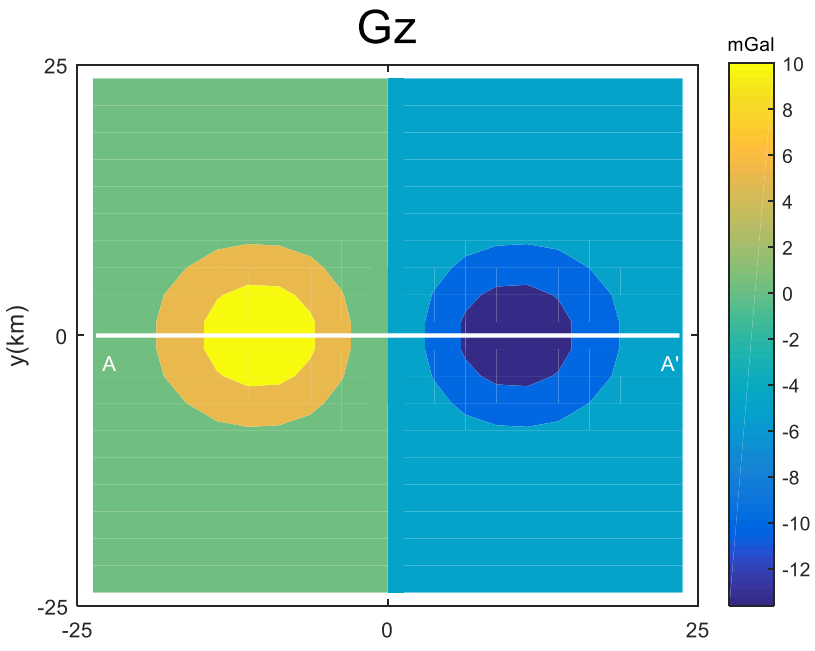
$$\rho - \rho_0 = \delta\rho \sim N\left(0, {\sigma_3}^2\right)$$ Constraints of reference model

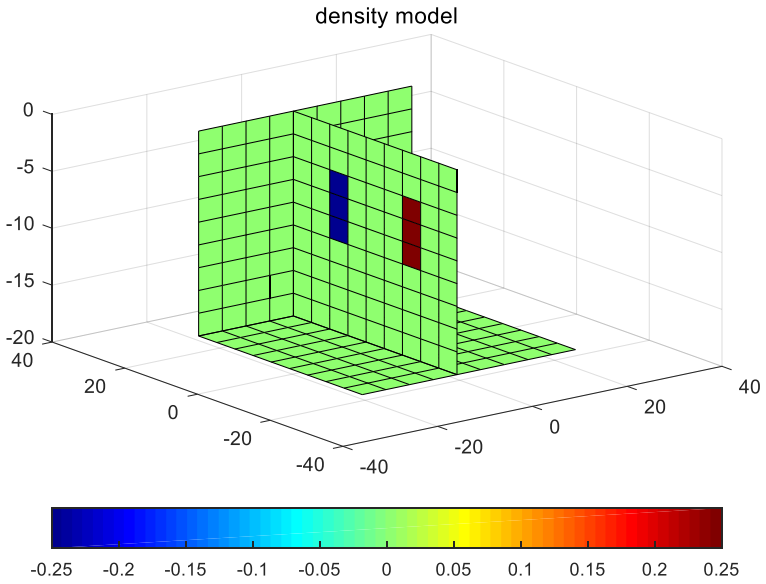
$$\rho_{j-1} - 2\rho_j + \rho_{j+1} = \Delta\rho_{j2} \sim N\left(0, {\sigma_{\alpha\beta}}^2\right)$$ Constraints of smoothness

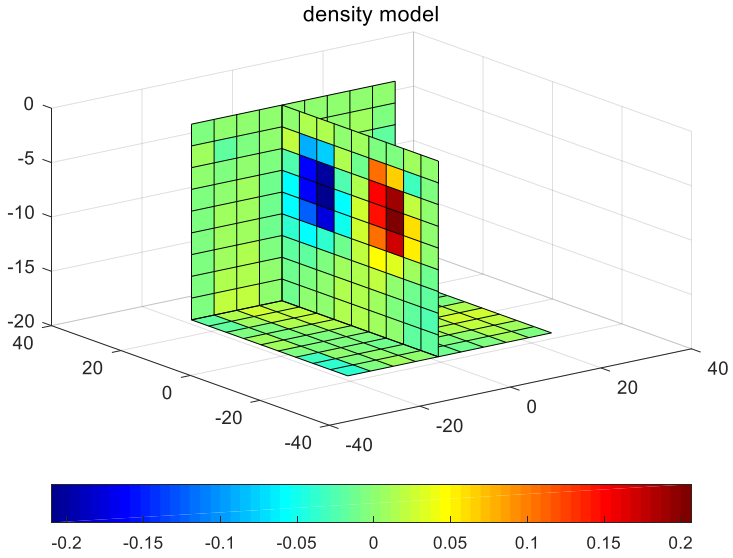
Where

d: observations
G: Green's function
ρ: density (unkowns to be solved)
σ: hyper-parameter









$\sigma_1^2 = 0.0478$

$\sigma_2^2 = 0.0135$

$\sigma_3^2 = 0.3560$

$\sigma_4^2 = 0.2328$

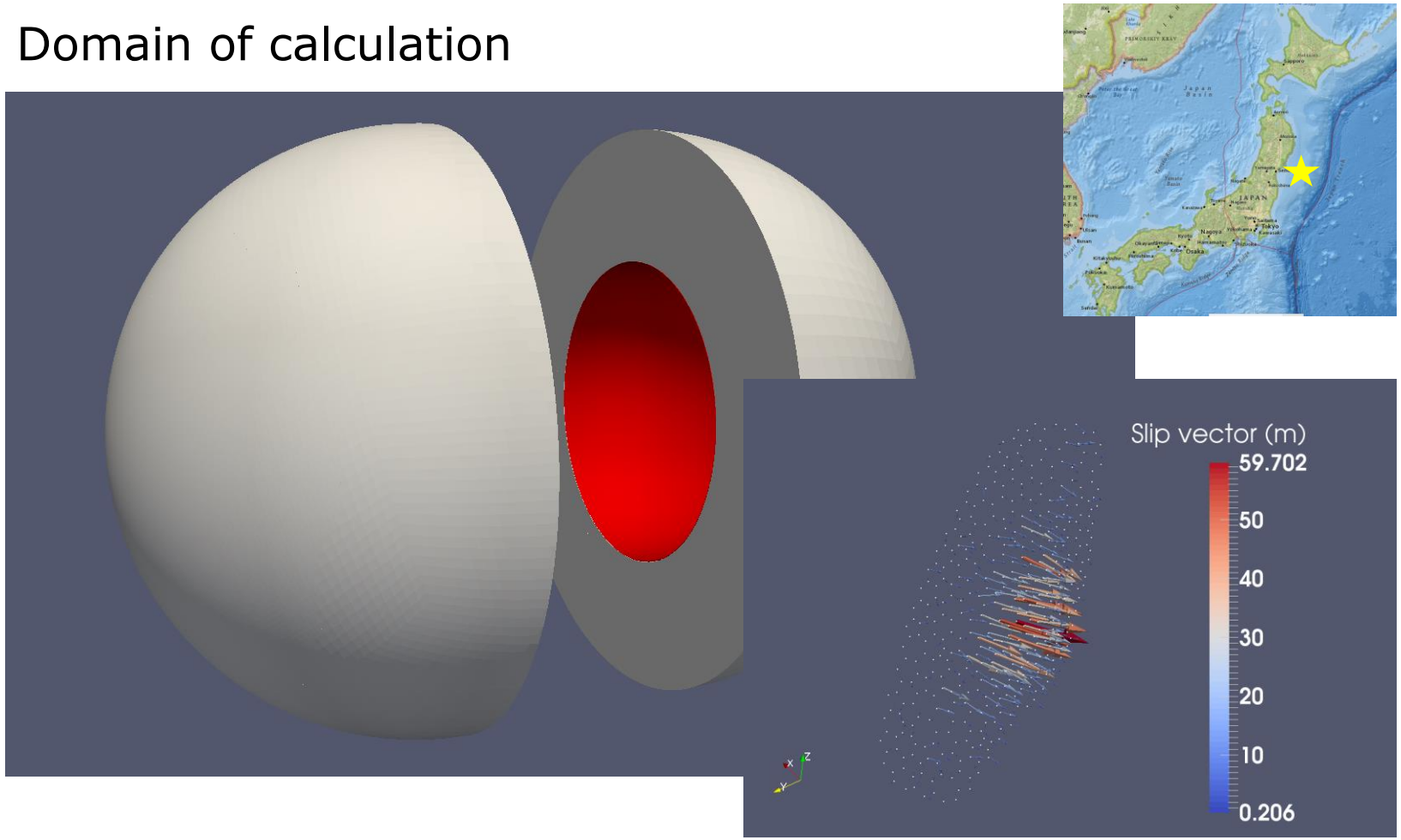
A sample of forward modelling

Ellipse: WGS84
Topography: Etopo5
Crust: Crust1.0
Mantle: Gypsum

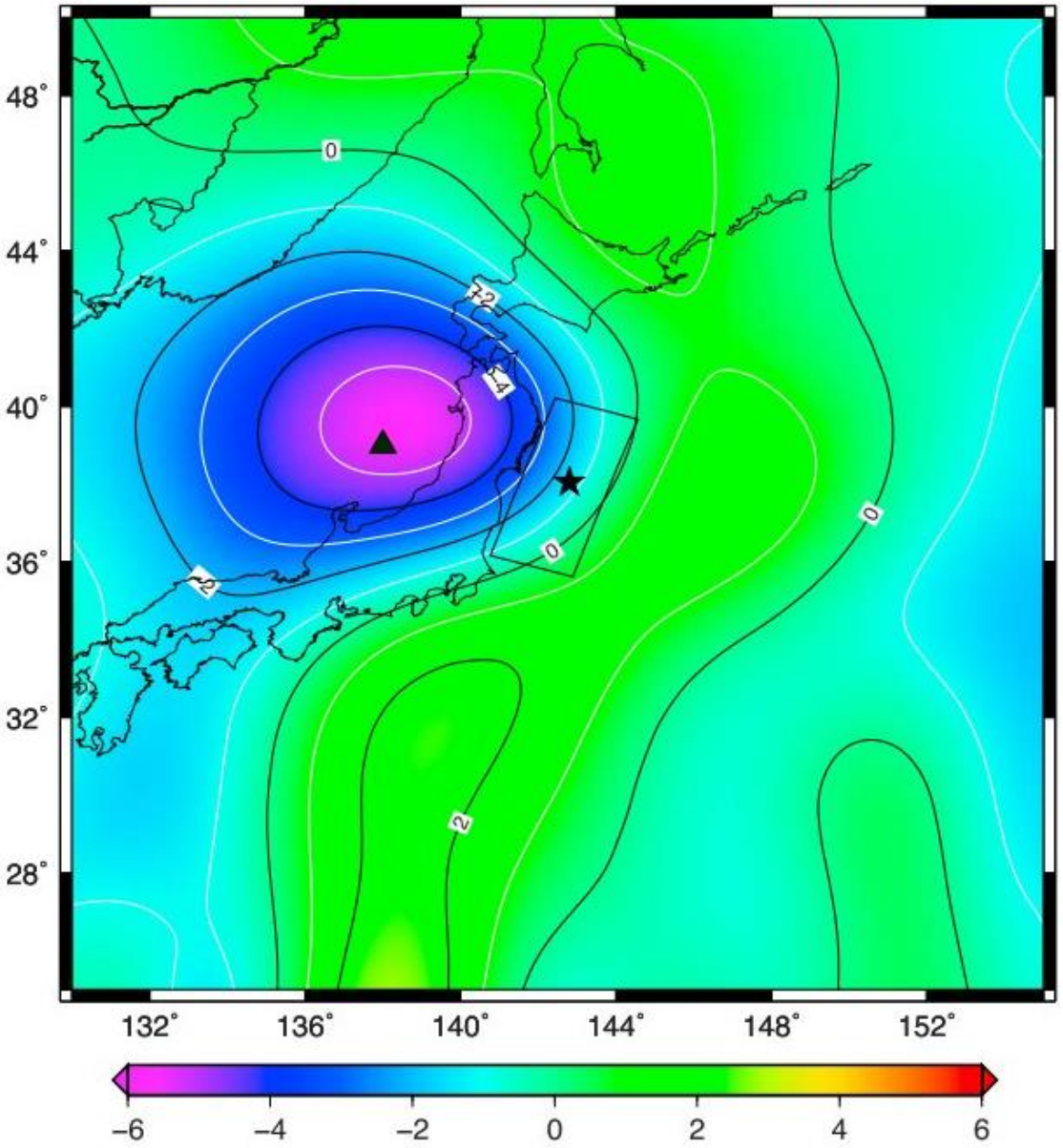
Outer boundary: free
inner boundary(CMB):
Bouyancy

Cells	4,390,896
Vertices	4,117,181
DoFs	12,351,543

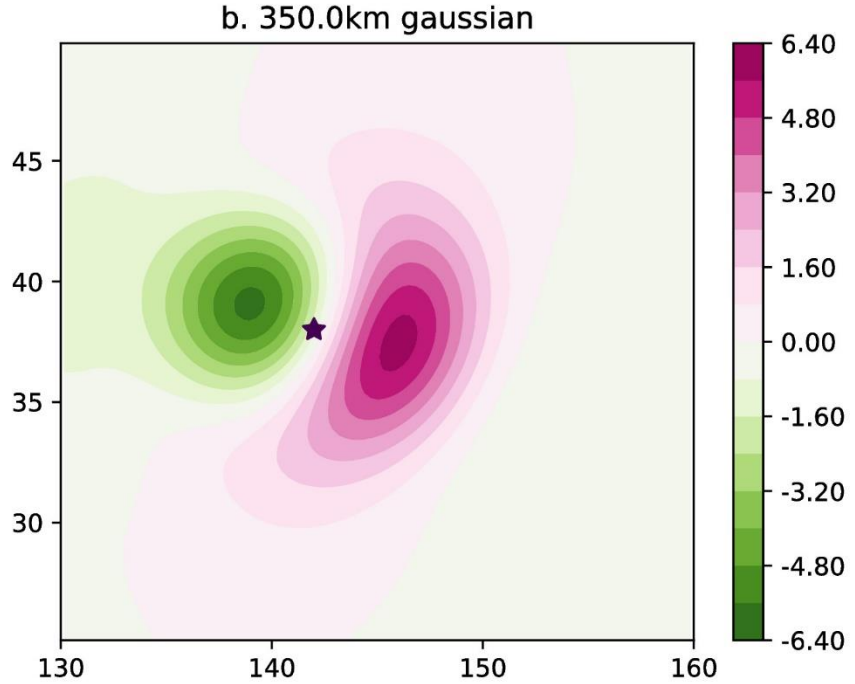
Domain of calculation

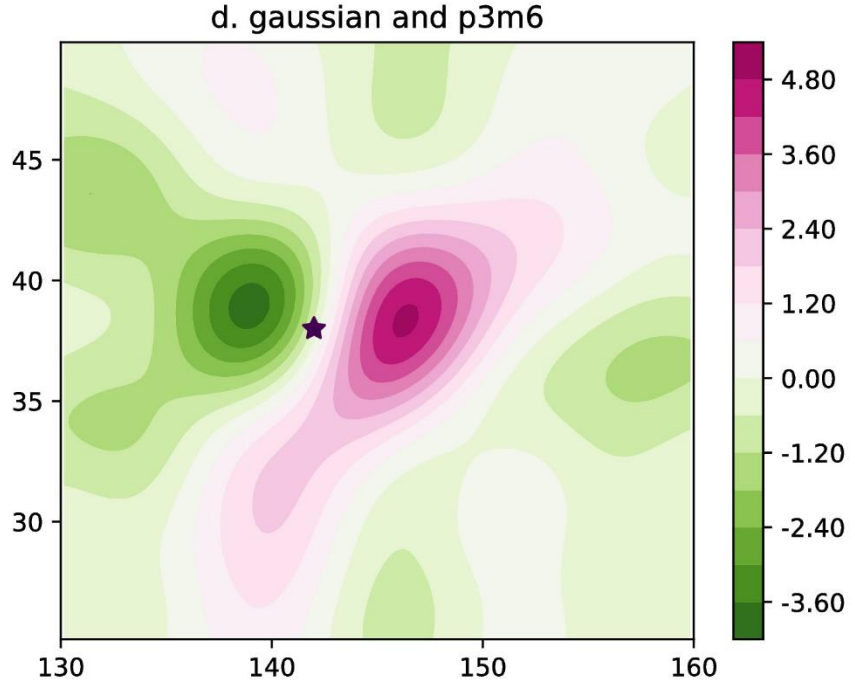


Slip distribution (Simons 2011)



Grace observation (Zhou et.al, 2012)





Who use it?

- People who study gravity
  - Common tasks
  - Our algorithms
- People who need calculate gravity occasionally
  - As black box
- Teachers and students
  - Concentrate on specific topics
  - Jupyter notebook

Properties

- High performance
  - State-of-the-Art algorithms
  - Use c/c++ at low level if needed
- Easy to use
  - Well documented
  - Well integrated into python ecosystem: Build upon popular Python packages (Numpy,Scipy,Pandas,statsmodels,Matplotlib,Mayavi/Paraview)
  - Simplified APIs
- Long term maintenance

Sample code:

Object Oriented Style

```
from geoist.gravity import interface
```

```
data=interface.load('observation.dat')
tmp=data.preprocess()
result=tmp.adjustment()
result.plot()
```

Procedure Oriented Style

```
from geoist.gravity import interface
```

```
data=interface.load('observation.dat')
tmp=interface.preprocess(data)
result=interface.adjustment(data)
interface.plot(result)
```

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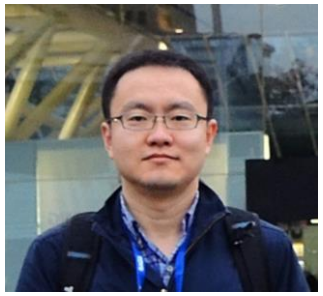
Schedule

- 2018.9--2018.11: Gravity dynamic adjustment
  [Chen, S., Zhuang, J., Li, X. et al. J Geod (2018). https://doi.org/10.1007/s00190-018-1190-7]
- 2018.11--2018.12: Basic forward modelling functionality
- Following: Bayesian inversion and our latest works

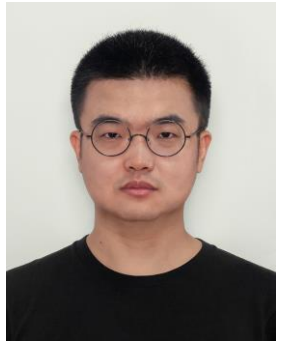
- https://github.com/igp-gravity and Pypi

Our Team



Dr. Chen
Geodynamics and Geodesy

Dr. Li
Geodesy



Dr. Han
Geodesy

Dr. Zhao
Geophisical modelling

Dr. Zhang
Geodynamical modelling

Thank You!