



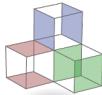
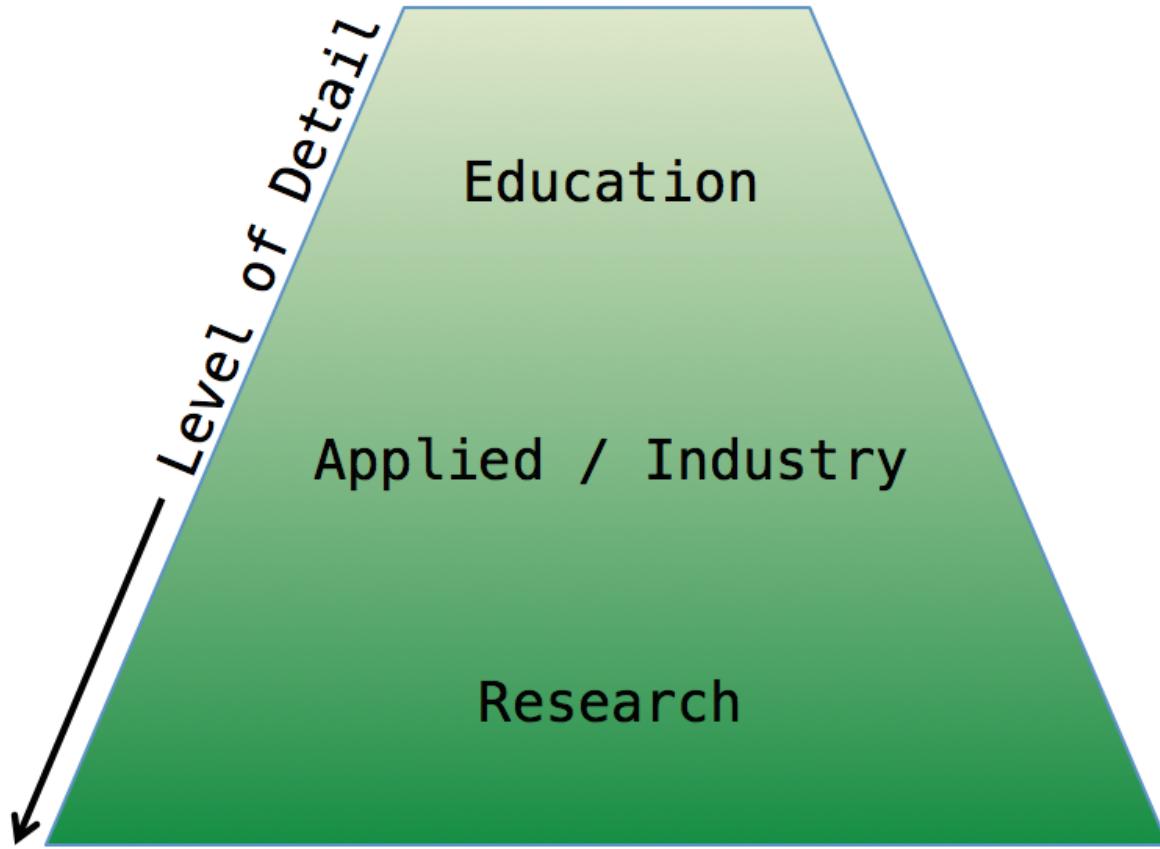
Using Python to span the gap between education, research, and industry applications in geophysics

Lindsey Heagy

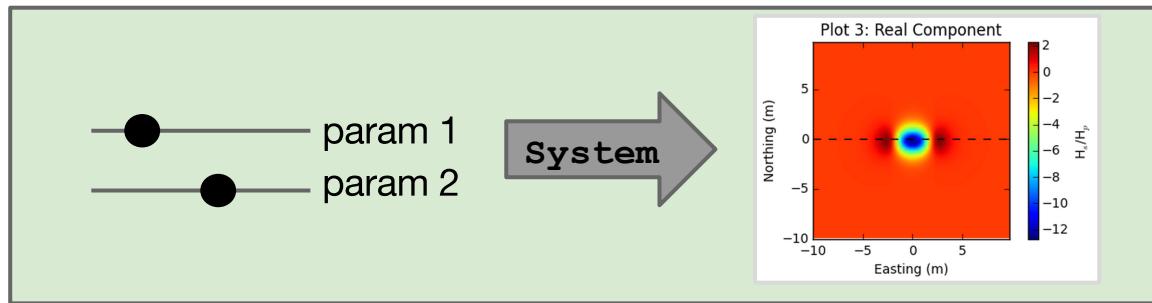
& Rowan Cockett, Gudni Rosenkjaer, Seogi Kang, Doug Oldenburg, et al.



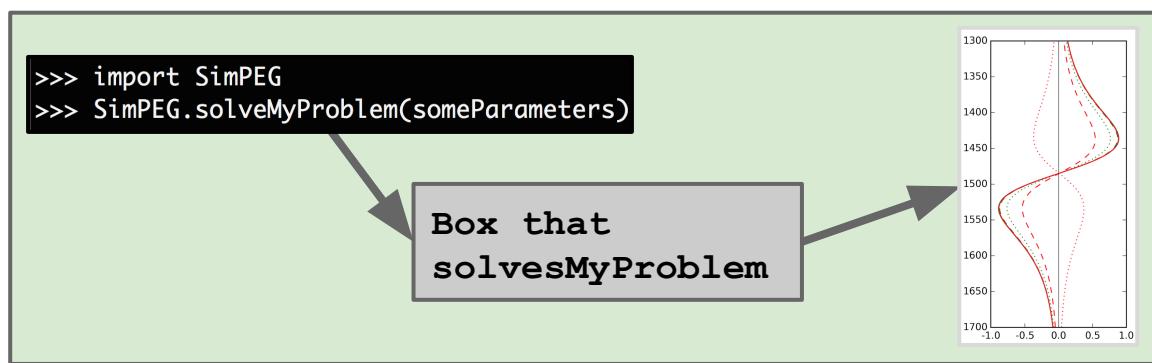
Geophysical Inversion Facility
University of British Columbia



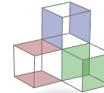
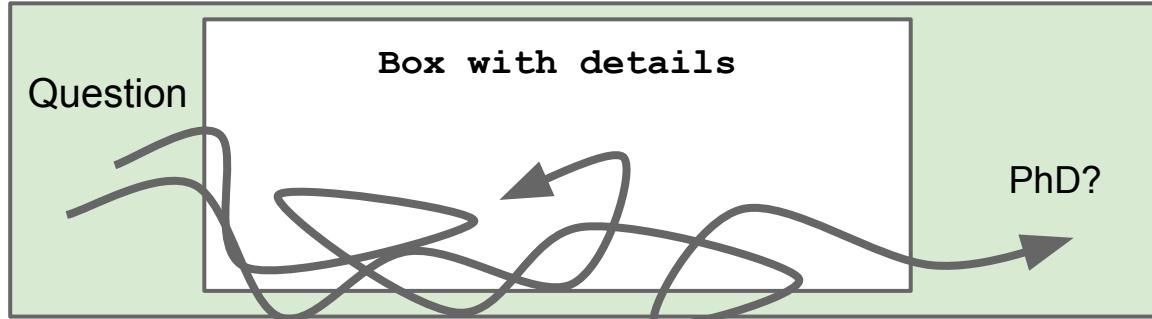
Education



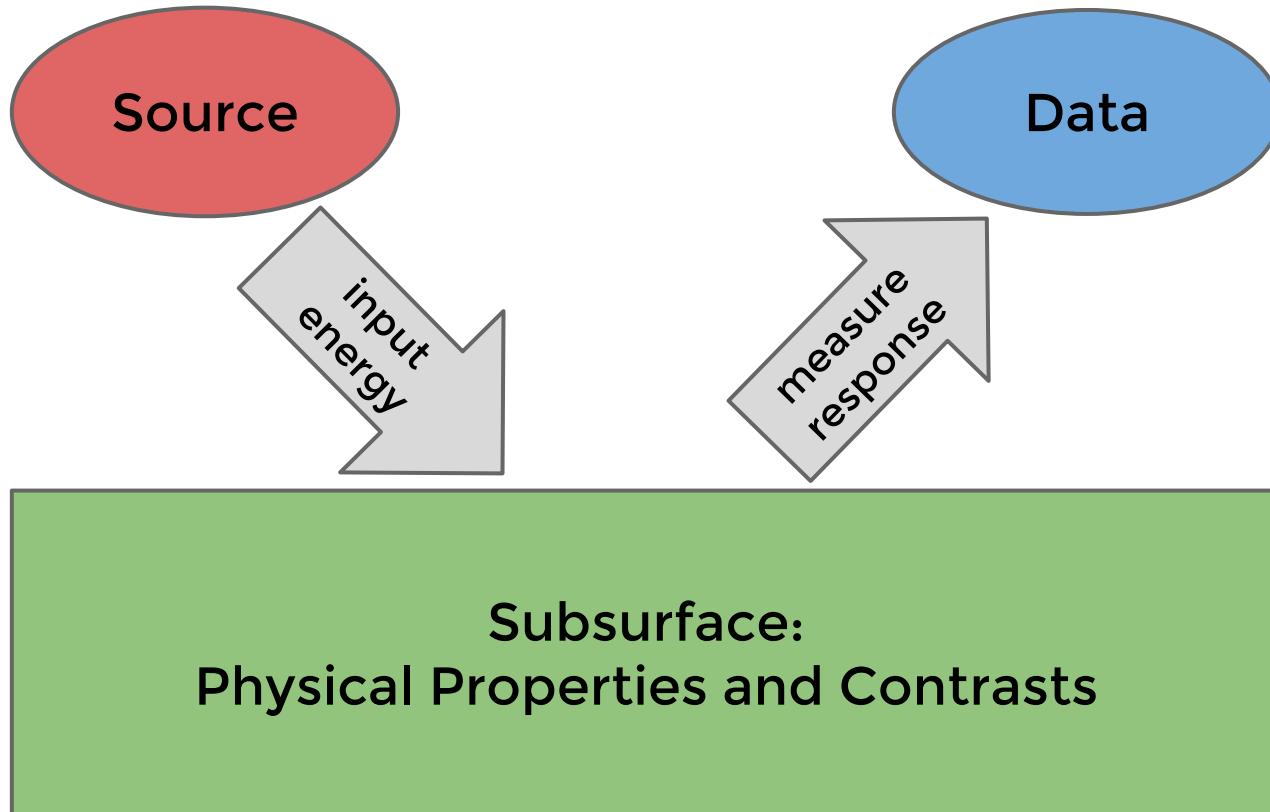
Industry & Applied



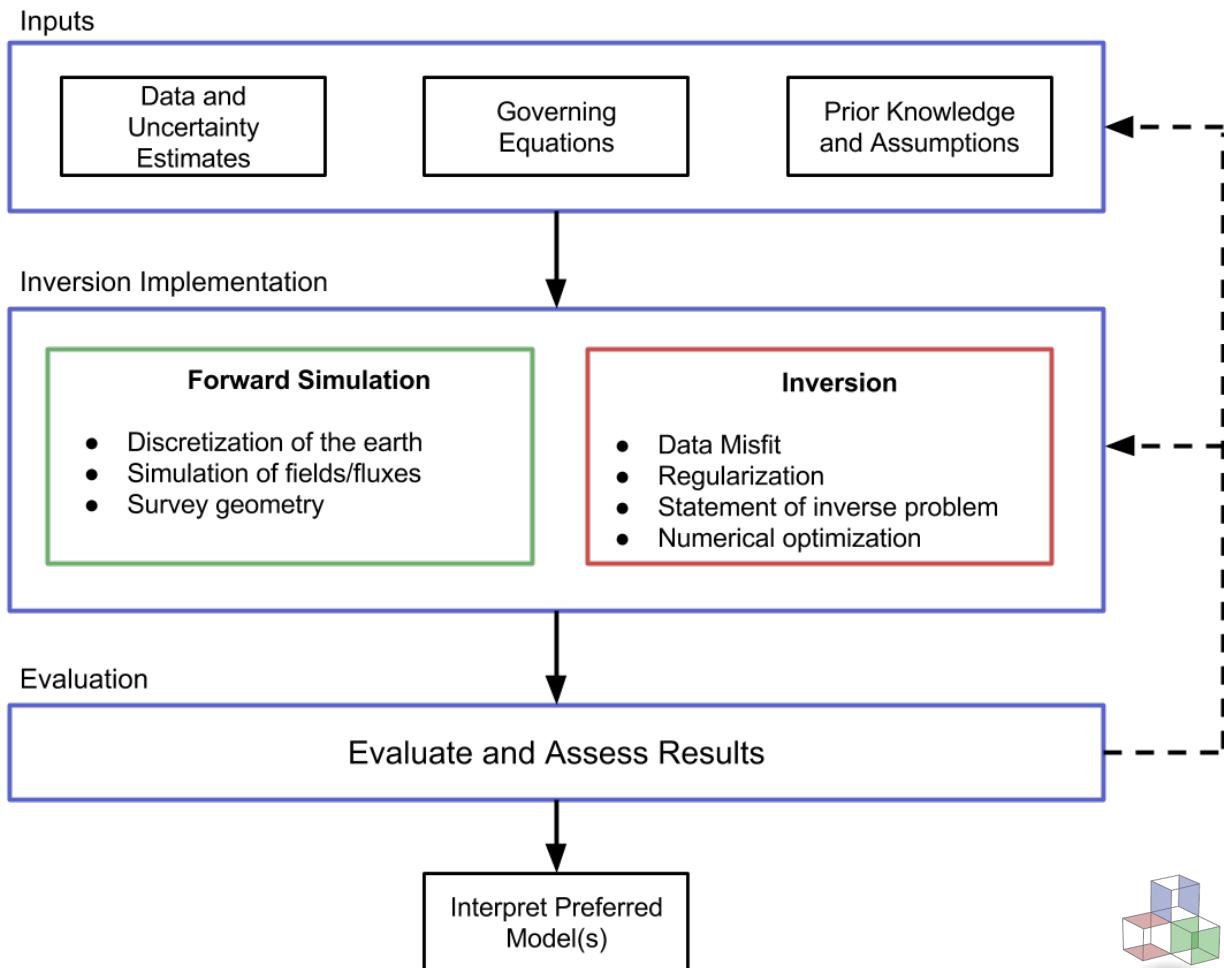
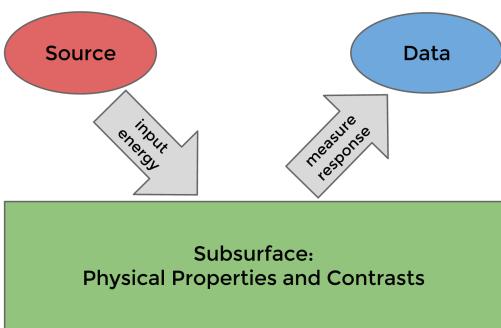
Research



Geophysics!

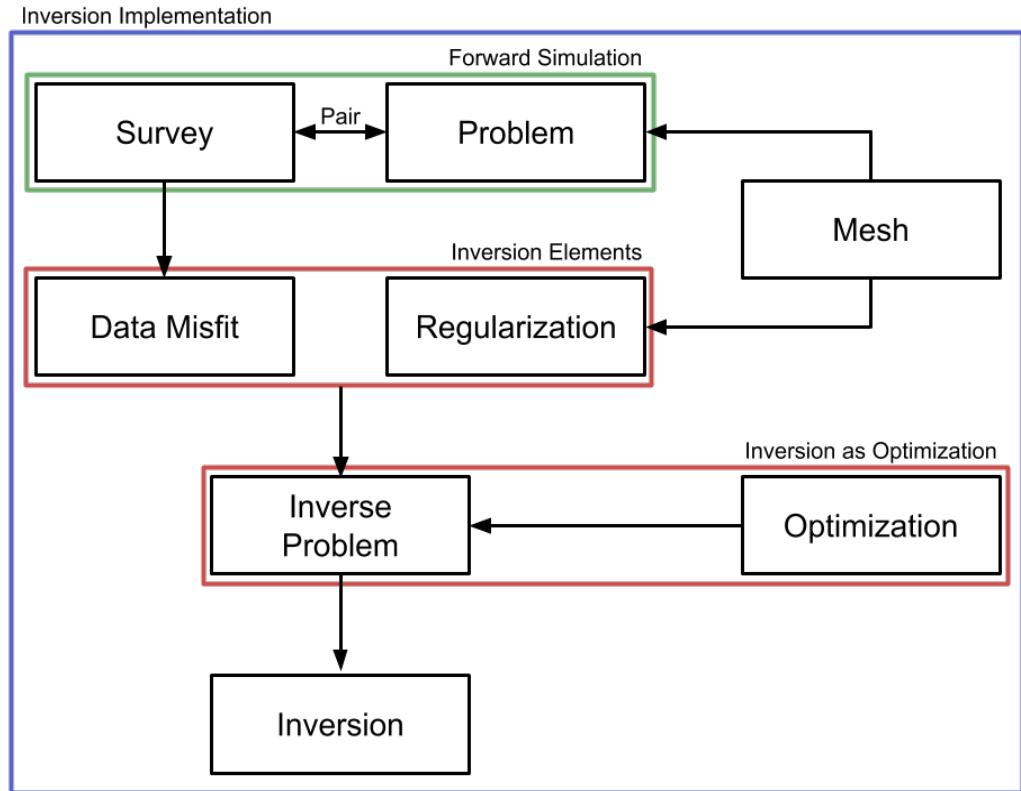


Geophysics!



How?

- Framework
- Modularity
- Testing
- In the open.



pypi v0.1.3

downloads 3k/month

license

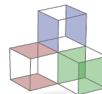
MIT

build

passing

coverage

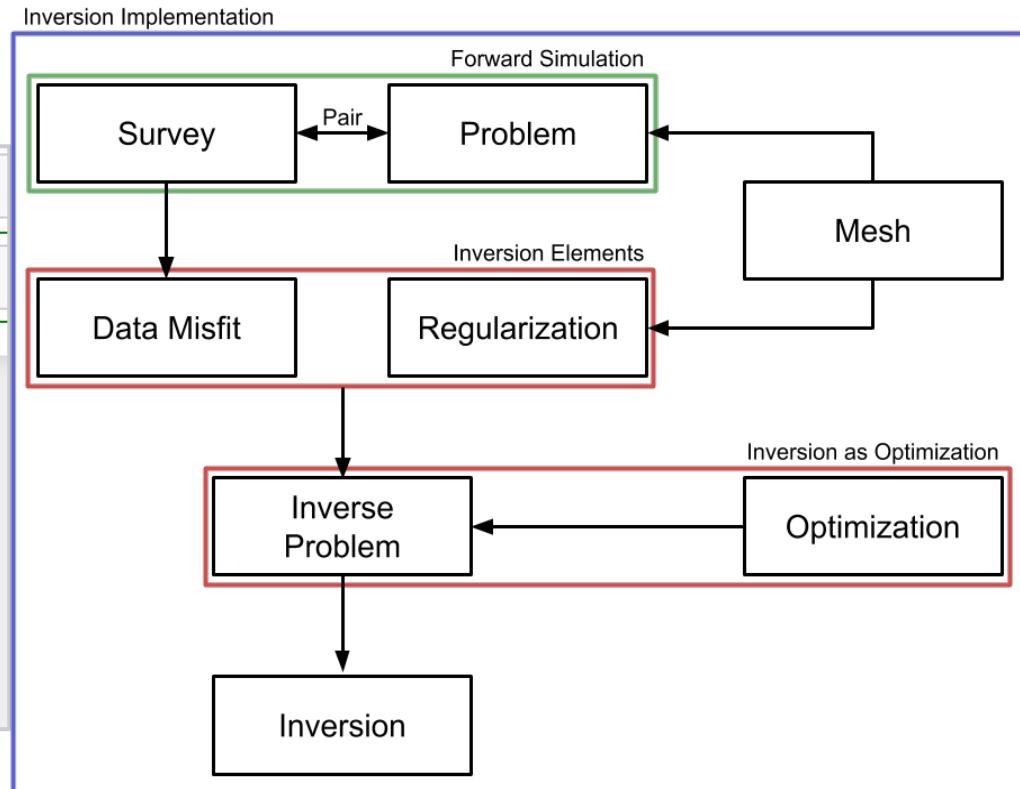
83%



How?

```
In [1]: import SimPEG
```

```
In [ ]: SimPEG.  
SimPEG.DataMisfit  
SimPEG.Directives  
SimPEG.Fields  
SimPEG.InvProblem  
SimPEG.Inversion  
SimPEG.Maps  
SimPEG.Mesh  
SimPEG.Models  
SimPEG.Optimization  
SimPEG.Problem
```



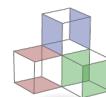
pypi v0.1.3

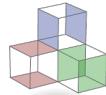
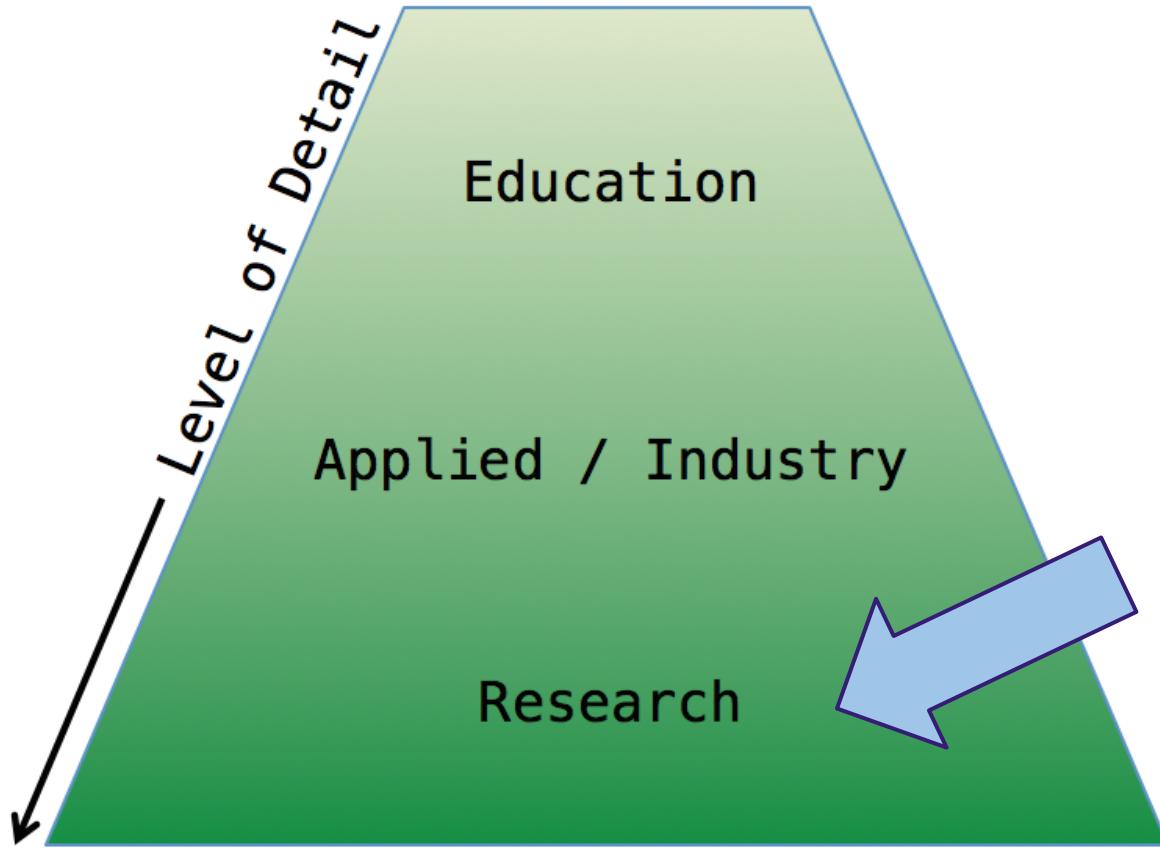
downloads 3k/month

license MIT

build passing

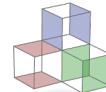
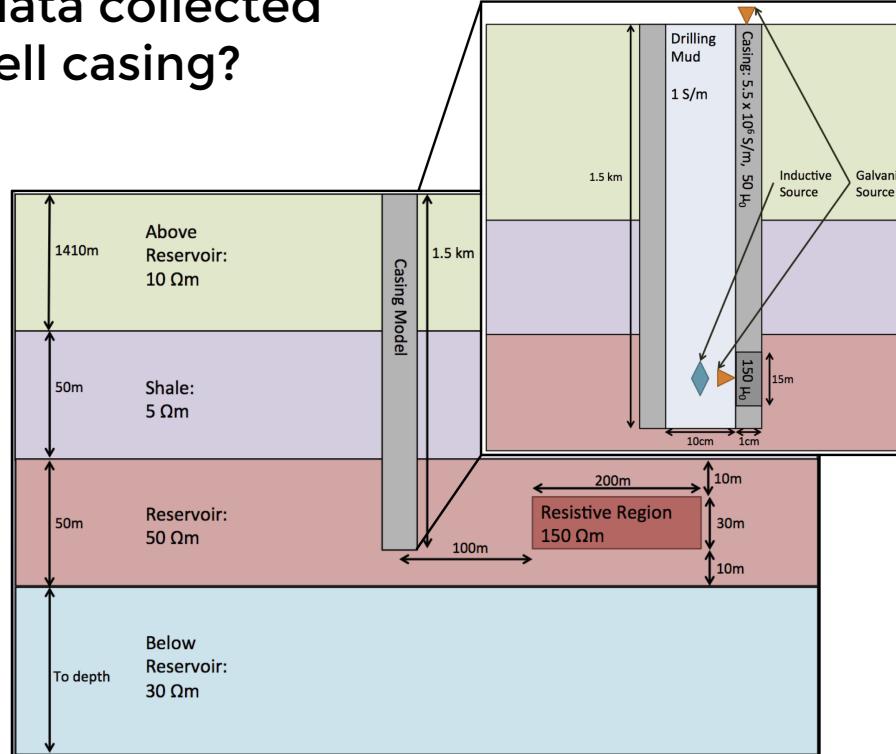
coverage 83%





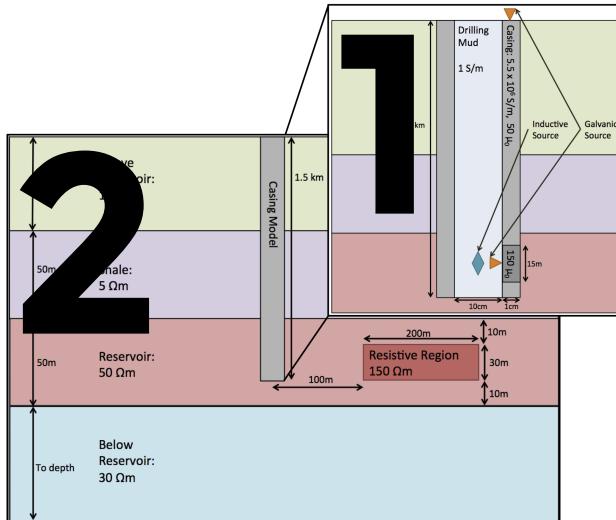
Research

Problem: How do we model and invert electromagnetic data collected in settings with well casing?



Research

Approach: Split it into two problems using primary-secondary

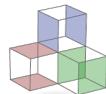


Details...

- Multiple variable physical properties
- Primary problem: 2D problem with 3D fields
 - problem formulation

```
In [ ]: EM.FDEM.  
EM.FDEM.ProblemFDEM_b  
EM.FDEM.ProblemFDEM_e  
EM.FDEM.ProblemFDEM_h  
EM.FDEM.ProblemFDEM_j
```

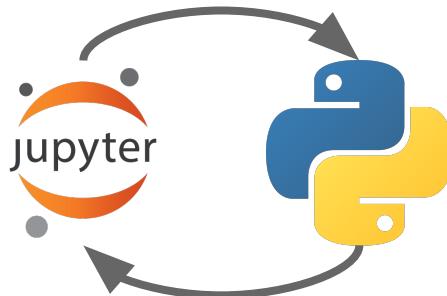
- Secondary Problem: source depends on the model
 - need derivatives in inverse problem
- ...



Research

Resources & Practices:

Iterative Development



Testing!

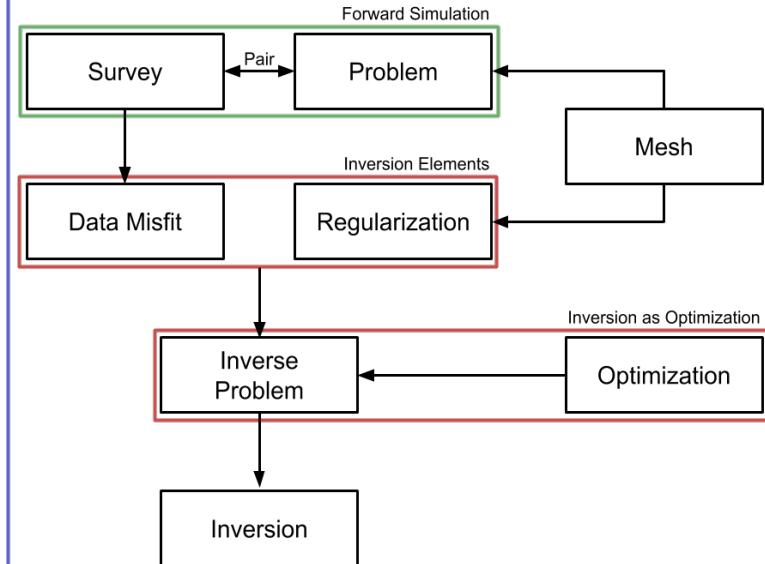
Ran 366 tests in 136.939s

OK



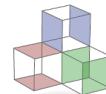
Modular Framework

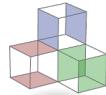
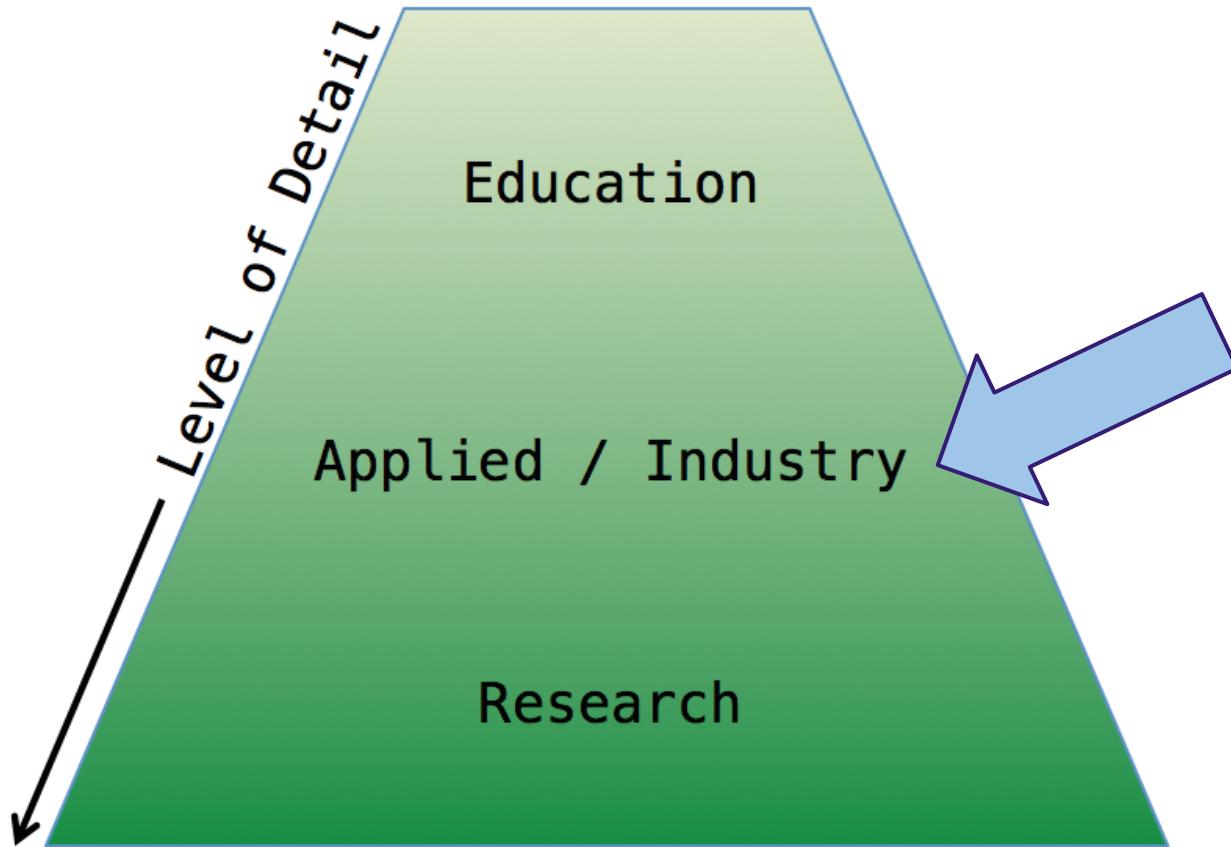
Inversion Implementation



Base Class Inheritance

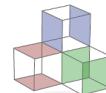
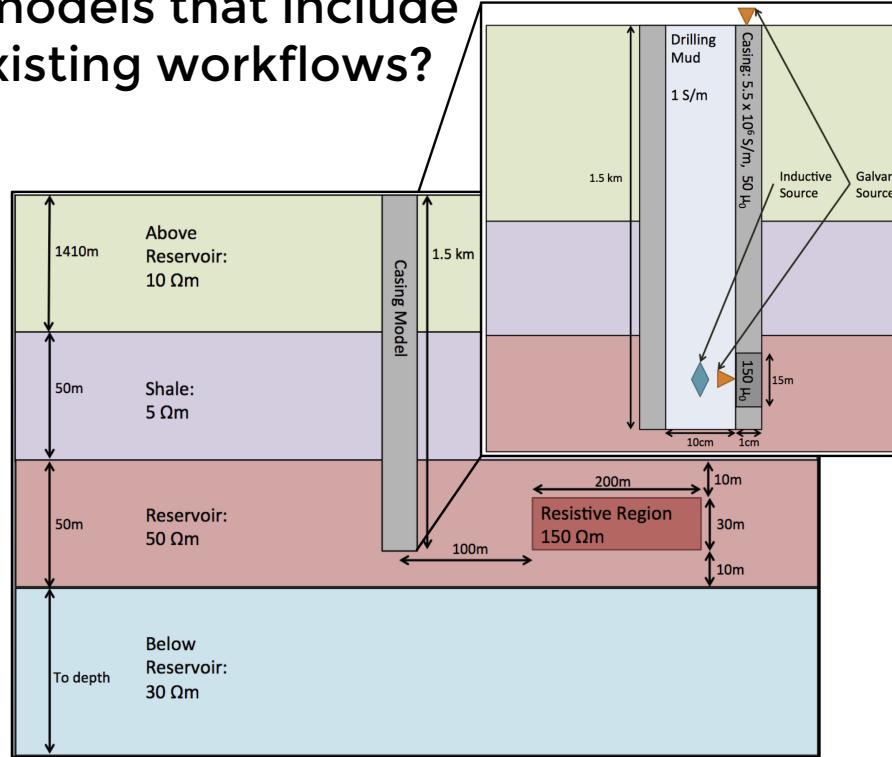
```
class BaseEMProblem(Problem.BaseProblem):  
    pass  
  
class BaseFDEMProblem(BaseEMProblem):  
    pass  
  
class ProblemFDEM_j(BaseFDEMProblem):  
    pass
```





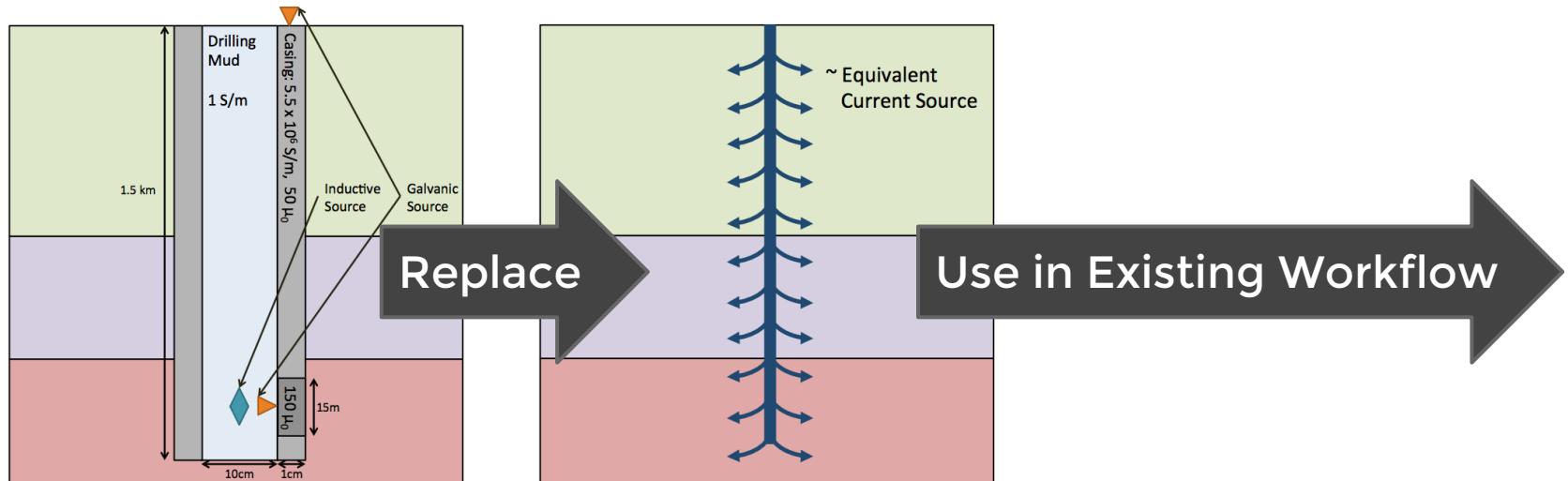
Applied / Industry

Problem: How do we plug in electromagnetic models that include well casing into existing workflows?



Applied / Industry

Approach: Replace complex casing model with a simpler model that can be included in existing codes



Applied / Industry

Resources & Practices:

Packaging

```
>>> computeCasingCurrents(geologyModel,casingModel,sourceType,sourceLoc)
```

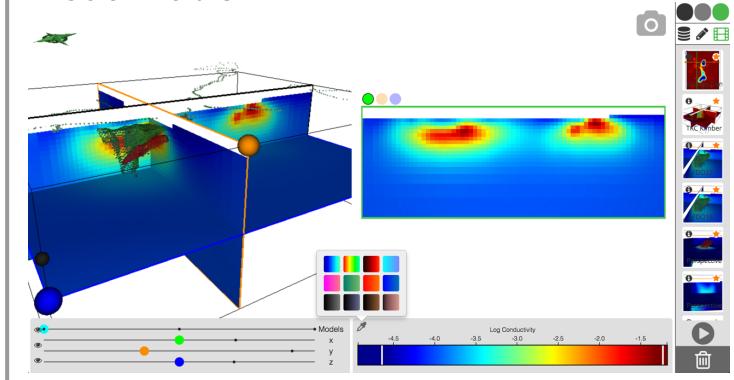
Versioning

Latest release

v0.1.3

0c432e1

Visualization



Testing!

Ran 366 tests in 136.939s



OK

Documentation

SimPEG

Search docs

Why SimPEG?

License

Authors

Projects Using SimPEG

Installation

SimPEG Meshes

Differential Operators

Read the Docs

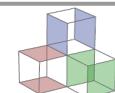
v: latest

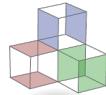
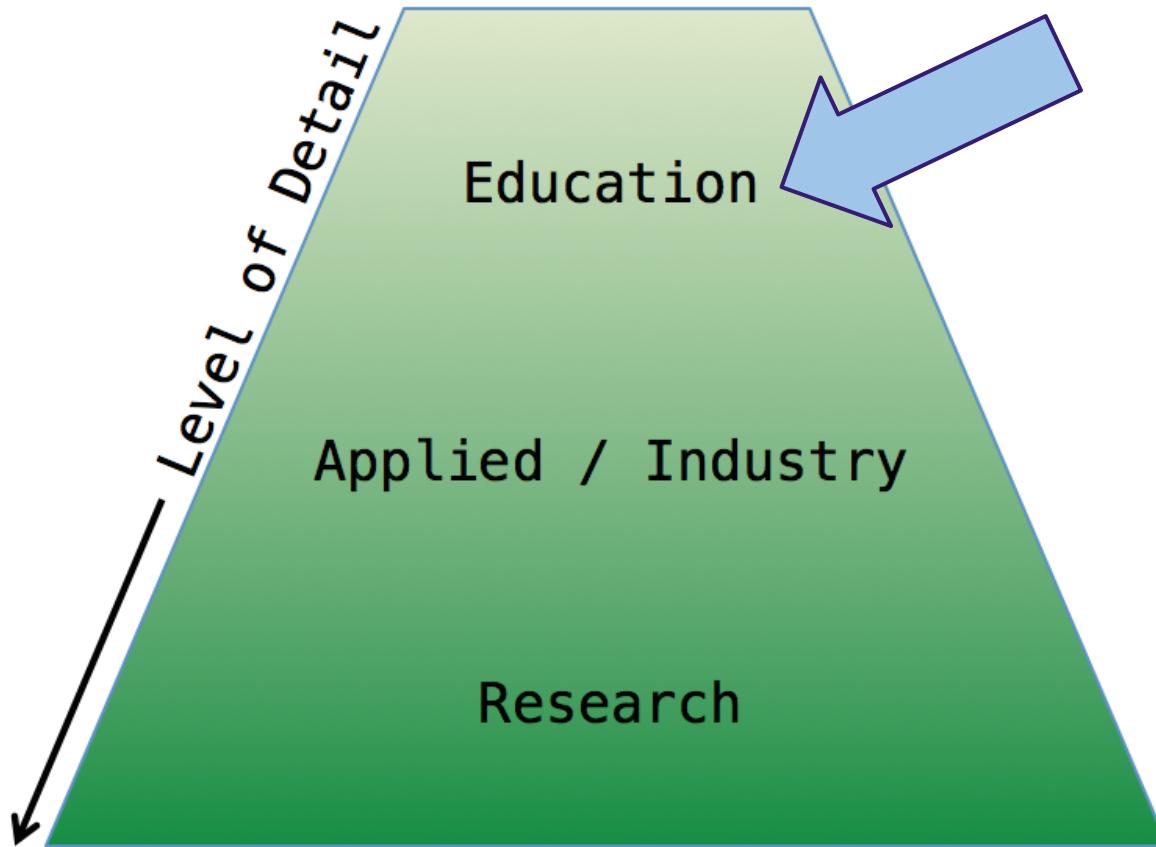
Docs » SimPEG Documentation [Edit on GitHub](#)

SimPEG Documentation



SimPEG: Simulation and Parameter Estimation in Geophysics





Education

Problem: Electromagnetics??

$$\nabla \times \vec{E} + i\omega \vec{B} = 0$$
$$\nabla \times \mu^{-1} \vec{B} - \sigma \vec{E} = \vec{J}_s$$

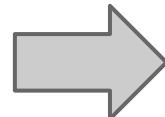
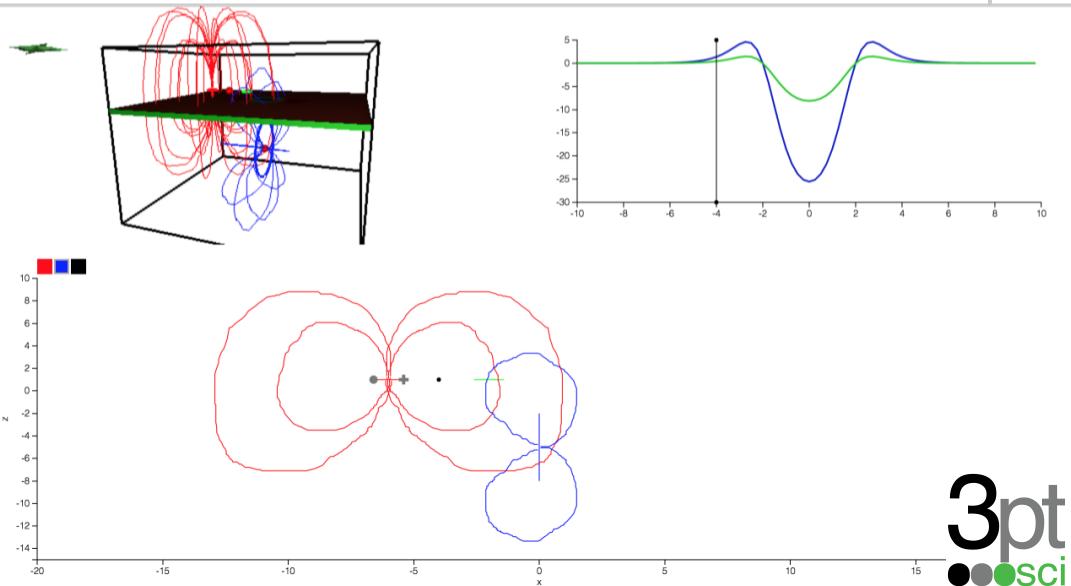


IMAGE NOT
AVAILABLE



Education

Approach: Lower barriers to entry by exposing an appropriate level of detail and making it interactive!



DC Resistivity

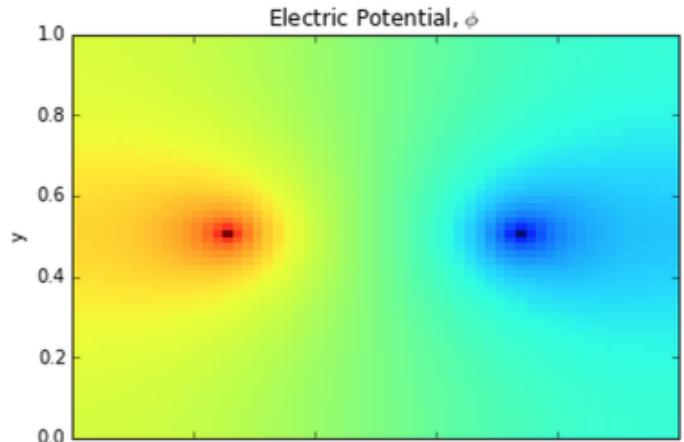
$$\nabla \cdot \sigma \nabla \phi = -s$$

```
In [9]: # Construct A Matrix
Div, Sigma, Grad = getOperators(mesh,sigma)
A = Div * Sigma * Grad # looks like the equation!
Ainv = Solver(A)
```

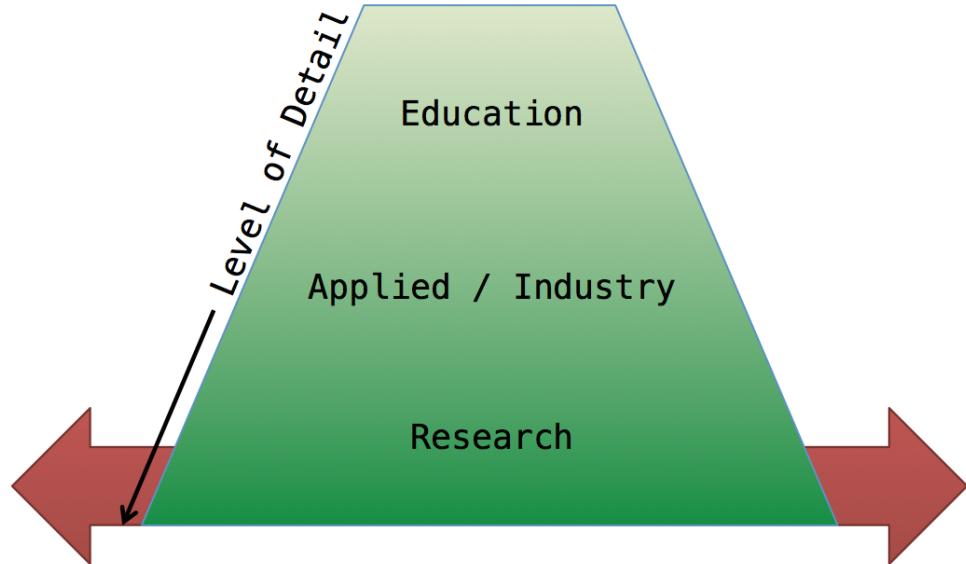
```
In [10]: phi = Ainv * -s
```

```
In [11]: mesh.plotImage(phi)
plt.title('Electric Potential, $\phi$')
```

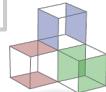
```
11: <matplotlib.text.Text at 0x108b6e210>
```



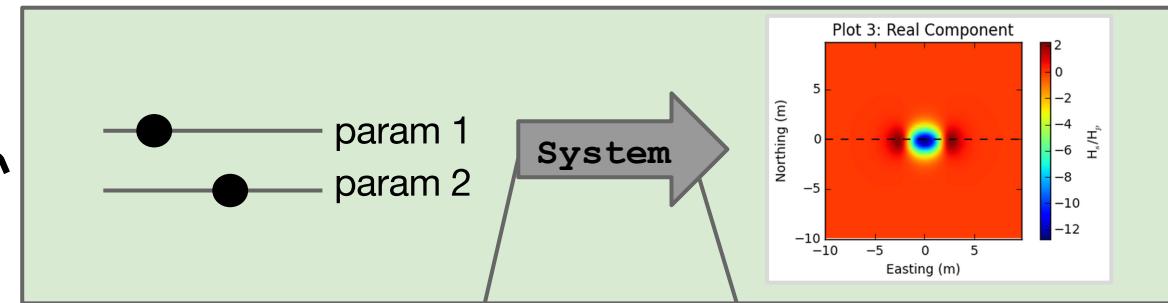
Where we are headed



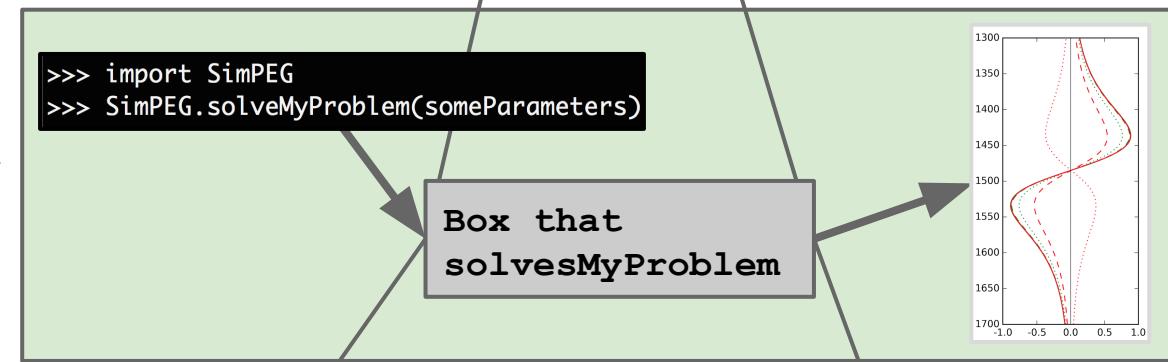
Package	State
SimPEG	✓
simpegEM	↻
simpegMT	↻
simpegFLOW	🧪
simpegDC	⚠️
simpegPF	⚠️
simpegSEIS	🔧
simpegGPR	🔧



Education



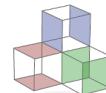
Industry & Applied



Research

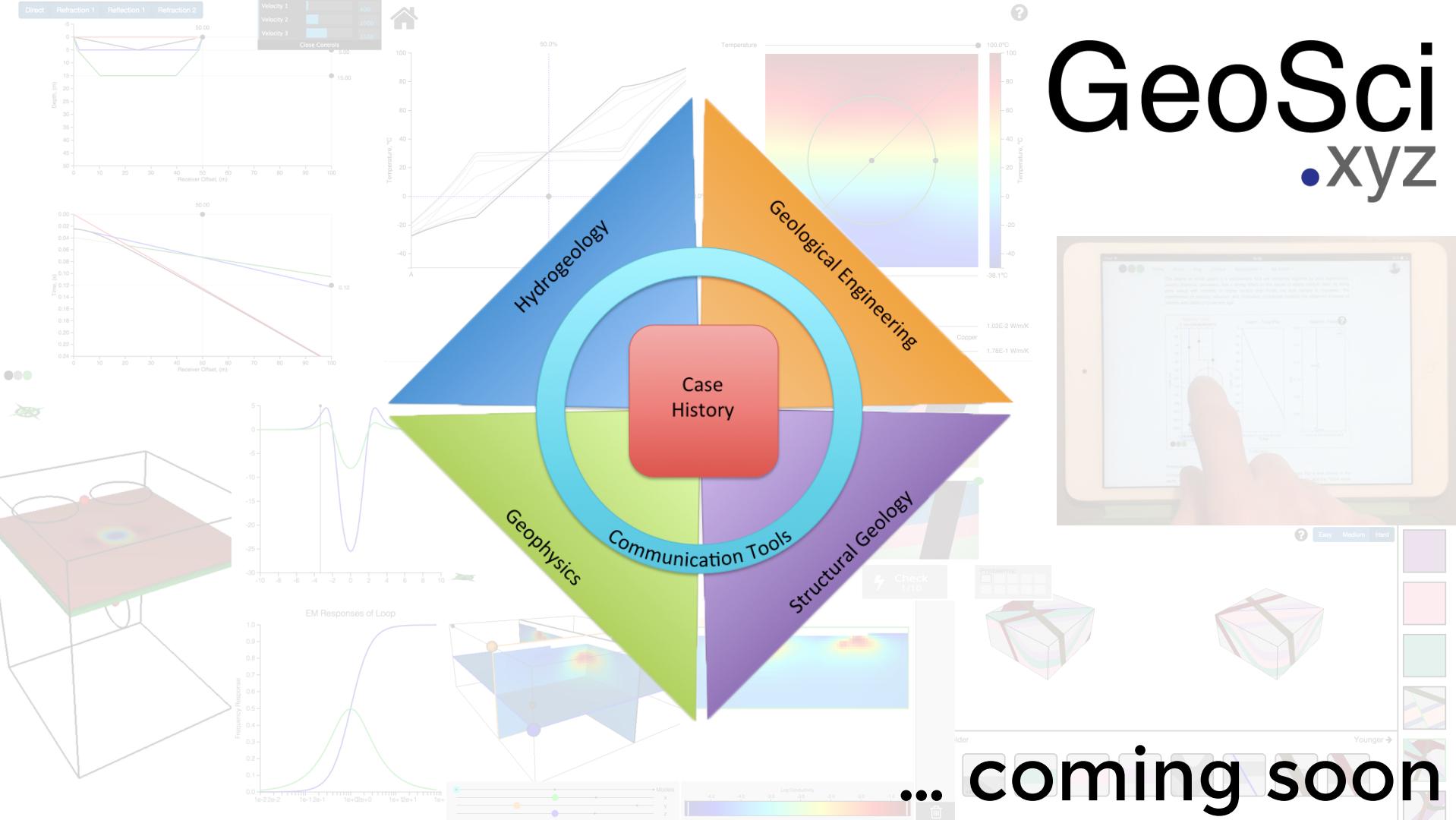


"Lego Color Bricks" by Alan Chia - Lego Color Bricks. Licensed under CC BY-SA 2.0 via Wikimedia Commons



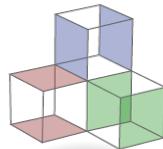
GeoSci

.xyz



... coming soon

Want more?



simpeg.xyz



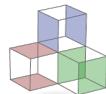
github.com/simpeg



3pt.xyz



lindsey@simpeg.xyz





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