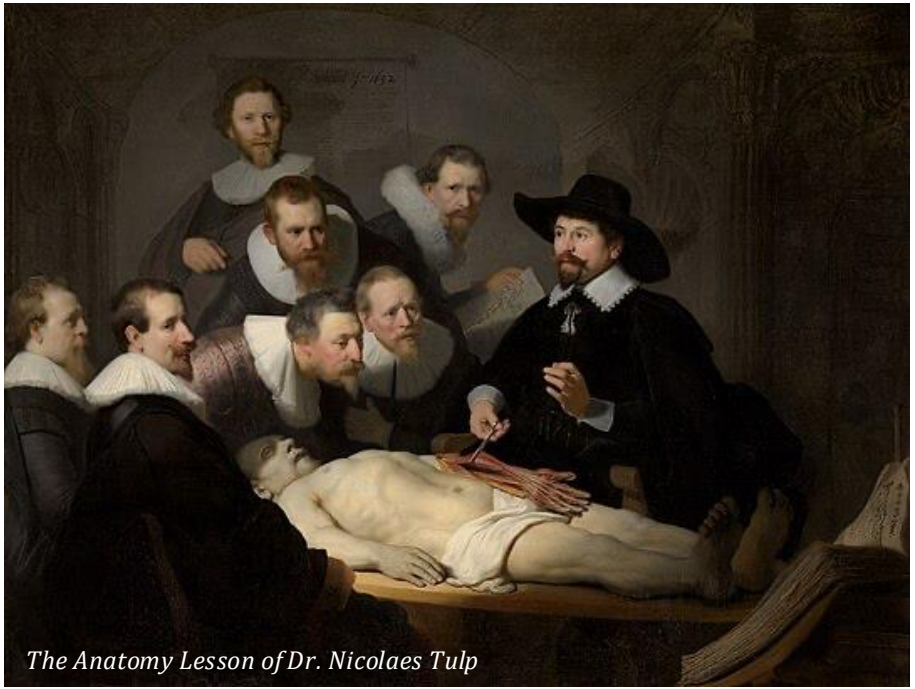


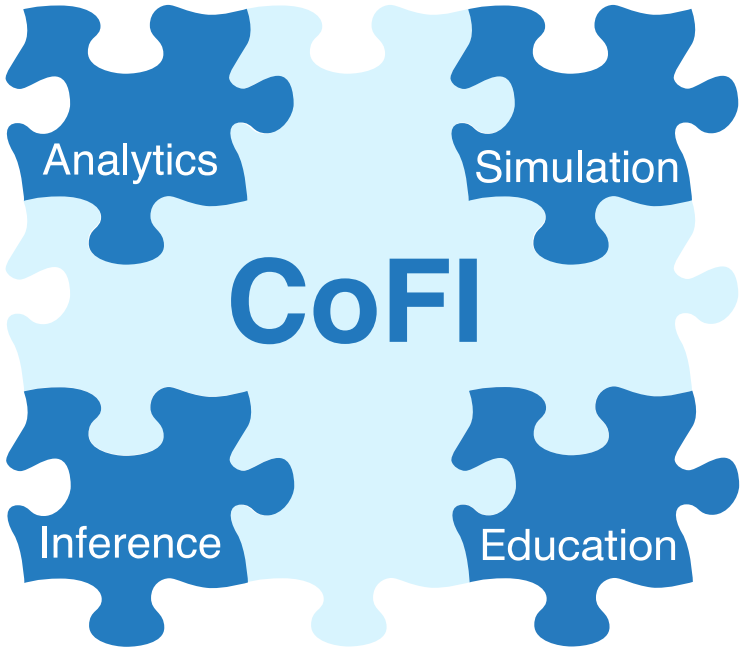
Using CoFI to experiment with geophysical inversion

This will be an interactive session where participation is encouraged…

A **Co**mmon **F**ramework for **I**nference

AuScope CSIRO Australian National University InLab

A **Co**mmon **F**ramework for **I**nference



Vision

CoFI provides industry, academia and government with a software platform underpinning research, training, and services in the application of inference methods to data.

- *Lower barriers in access to leading edge approaches*
- *Reduce time in application of inference methods to data*
- *Interactive education environment for training in inversion*

"A good example is the best sermon"

– Benjamin Franklin

https://inlab.au/cofi/

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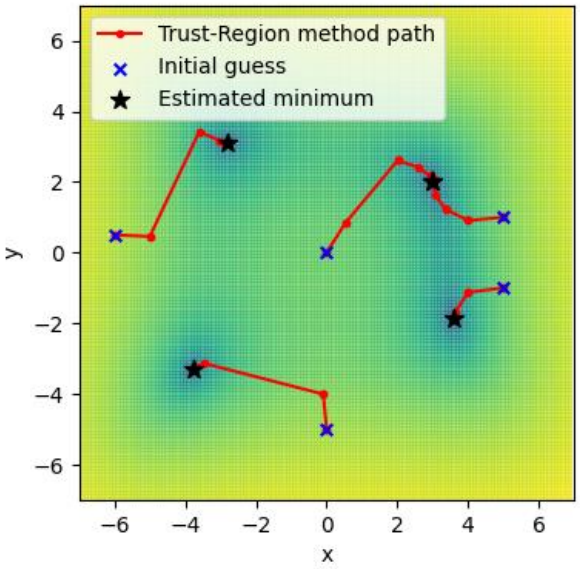
Two approaches to inversion

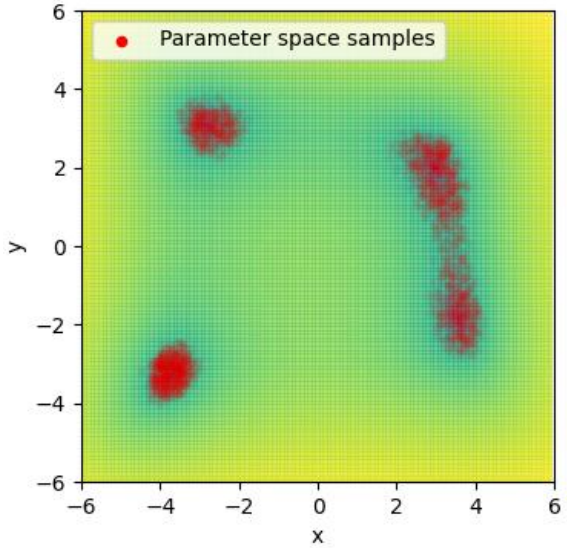
Parameter estimation



Optimisation of a misfit function

$$\phi(\mathbf{m}) = ||\mathbf{d} - g(\mathbf{m})||_2^2 + \alpha^2 ||\mathbf{m}||_2^2$$

Ensemble method



Sample a target pdf

$$p(\mathbf{m}|\mathbf{d}) = k \times p(\mathbf{d}|\mathbf{m})\ p(\mathbf{m})$$

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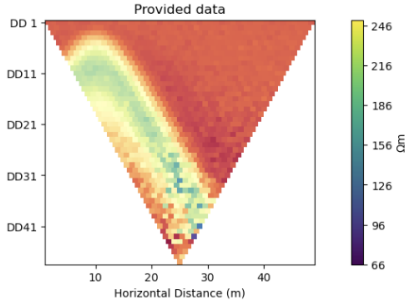
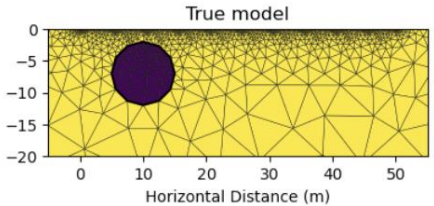
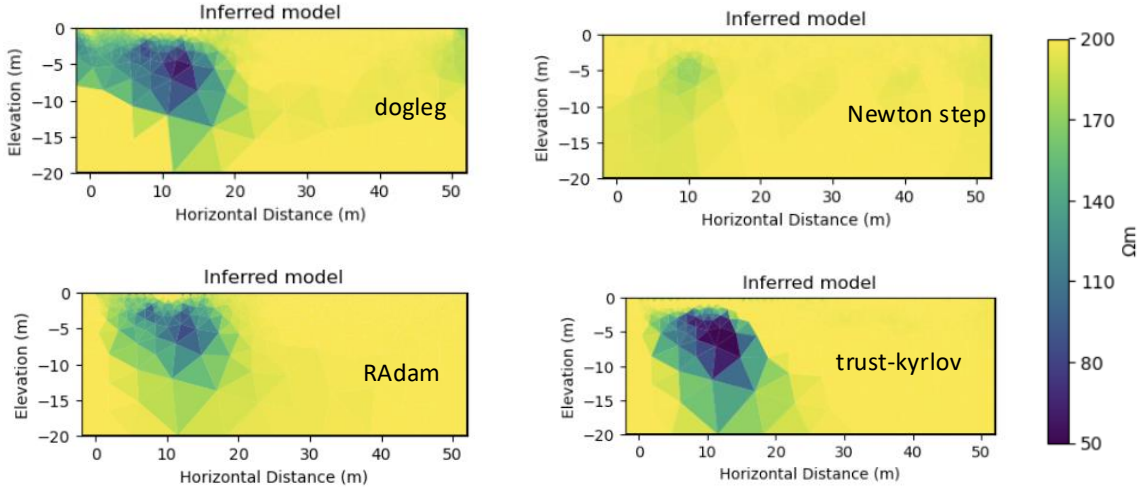
Exploration is about possibilities



Electrical resistivity tomography



CoFI - Common Framework for Inference



and so is finding an inference method using CoFI…

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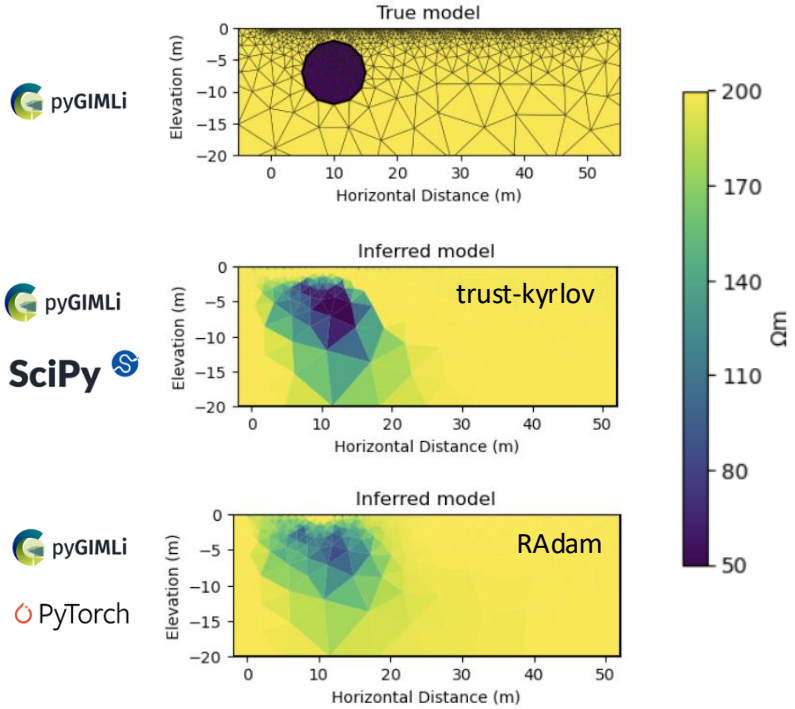
Momentum based optimizers

Vanilla iterative non-linear optimizers only consider the objective function at the current location

Machine learning methods are frequently applied to noisy data

Build inertia into the search direction to overcome local minima



CLASS torch.optim.RAdam(*params*, *lr=0.001*, *betas=(0.9, 0.999)*, *eps=1e-08*, *weight_decay=0*, *decoupled_weight_decay=False*, ***, *foreach=None*, *differentiable=False*) [SOURCE]

https://pytorch.org/docs/stable/generated/torch.optim.RAdam.html

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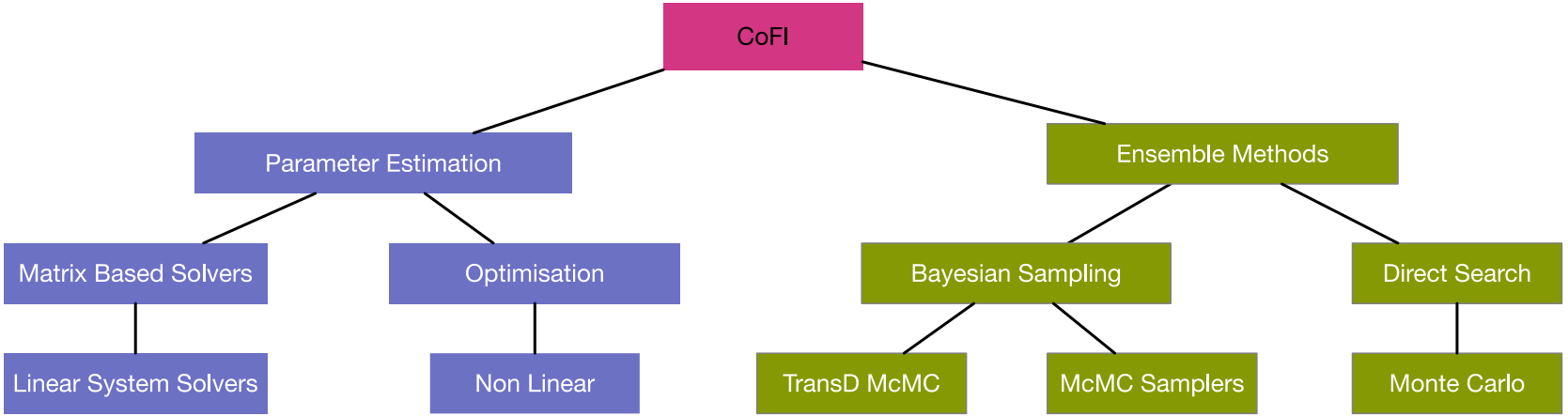
The CoFI explorer



www.inlab.au/inlab-explorer

Build on existing and emerging software packages

Example driven – we only add a method if there is an example that needs it

Findable, accessible, interoperable and reusable software

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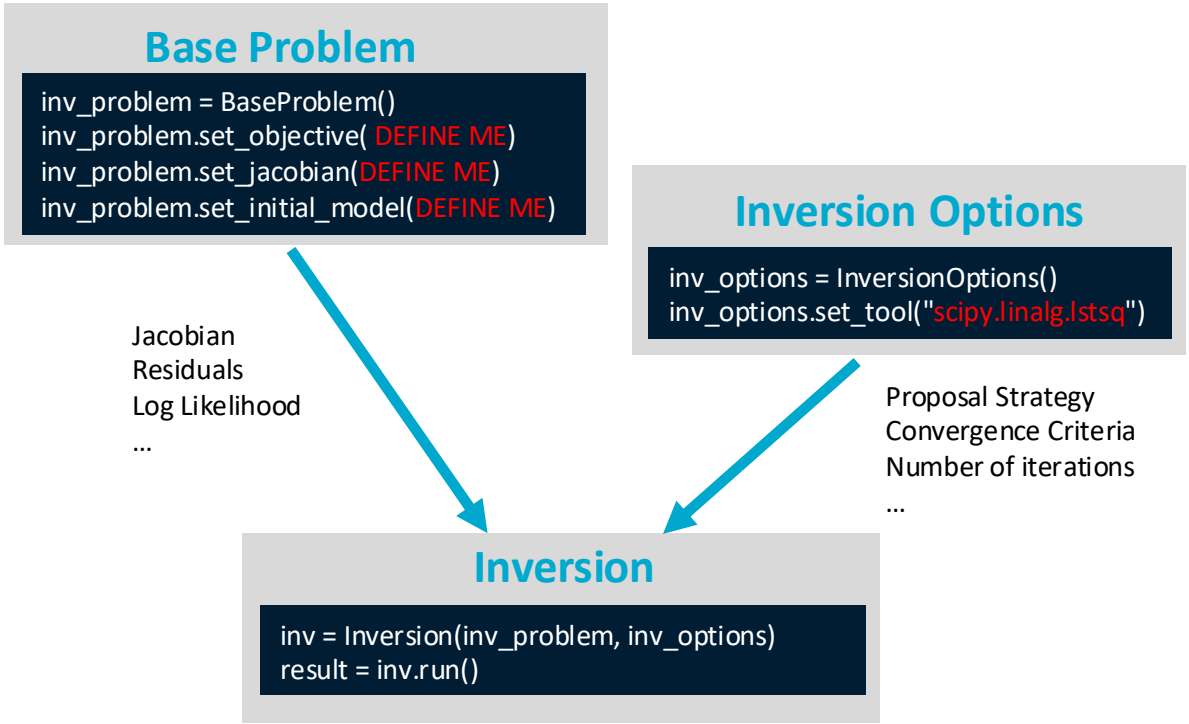
Capturing an inverse problem



An inverse method needs to only access a subset of features of a forward problem

Capturing a rich set of examples

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Take home messages…

What we hope you will take home today:

An understanding what CoFI can do.

Some familiarity with the design and philosophy of CoFI

Cognizance of the avenues to engage with CoFI and InLab

What we hope to take away today:

Priorities: Expanding the methods; the examples, building a community, other?

Wish lists: scalability; real data problems; automatic differentiation…

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CoFI – A **Co**mmon **F**ramework for **I**nference

The application domain expert says:

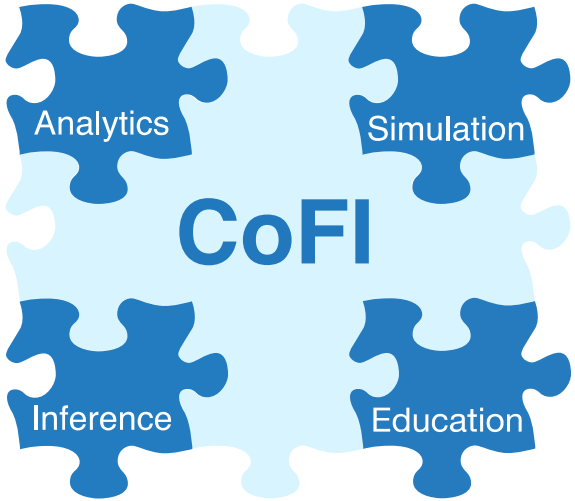
- **What inference methods are suited to my data?**
- **Where can I get access to them? What is required to make them talk to my forward problem/data?**
- **How much work is that for me?**

The research manager says:

- **How can my staff learn about state-of-the-art inference methods**
- **How do we access the expertise?**
- **Can we keep our design options open?**
- **How long will it take?**

The inference specialist says:

- **What other problems can my inference method solve?**
- **Where can I get access to them?**
- **How much work is that for me?**



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