CoFI workshop

Sub22, 30th November 2022

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

On the menu

- Introduction: Why CoFI?

- Interactive session 1: CoFI toy examples (Malcolm)

- Espresso: Earth Science PRoblems for the Evaluation of Strategies, Solvers and Optimizers (Jiawen)

Lunch and coffee

- Interactive session 2: X-ray and seismic Tomography with CoFI (Malcolm)

- Interactive session 3: Electrical Resistivity Imaging with CoFI (Juerg)
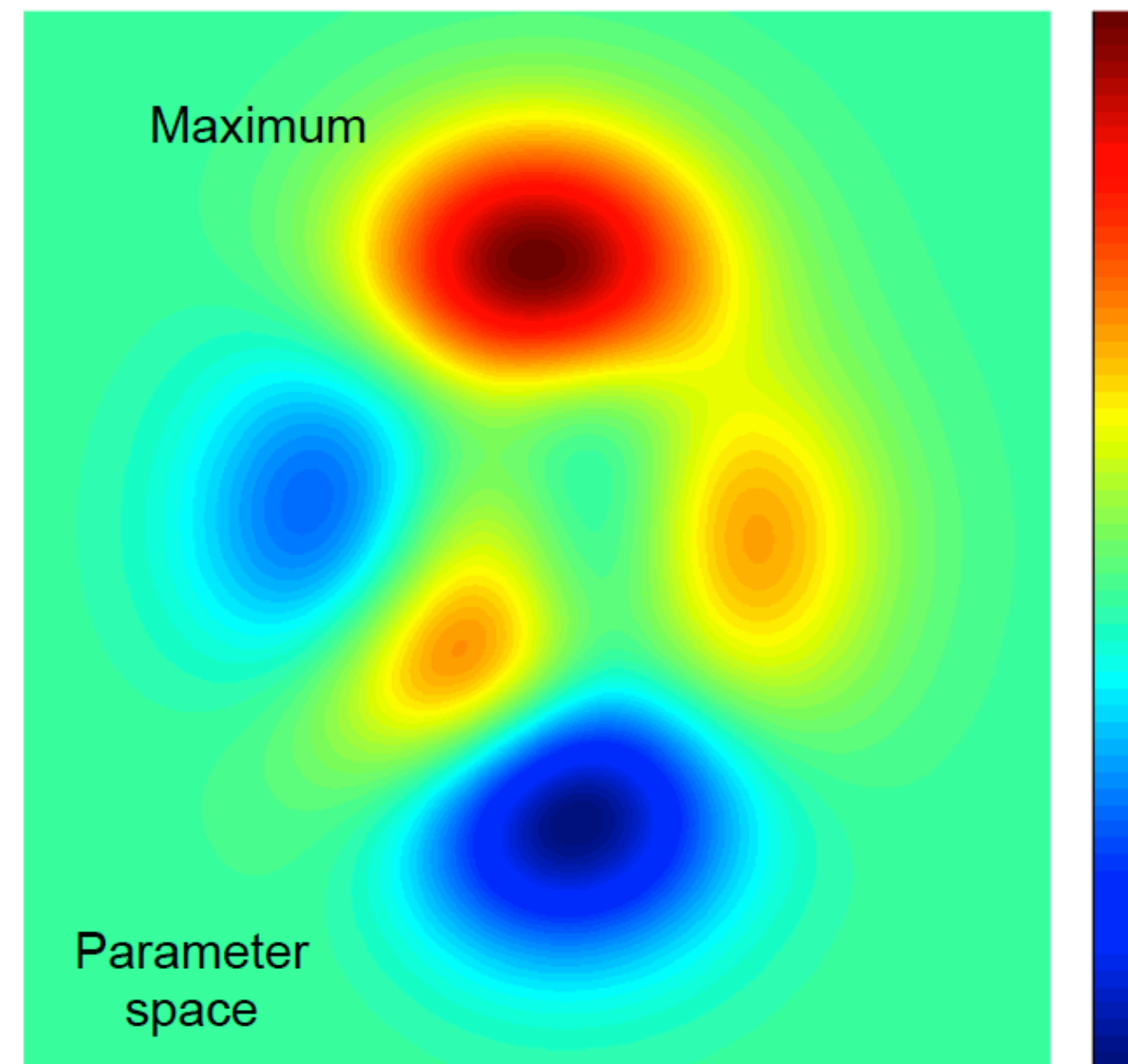
- Wrap up and discussion.

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What we hope you will take away today

- An understanding of what CoFI & Espresso are

- How to use CoFI and Espresso.

- How to get involved.

A work in progress and example driven…

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Two approaches to inversion
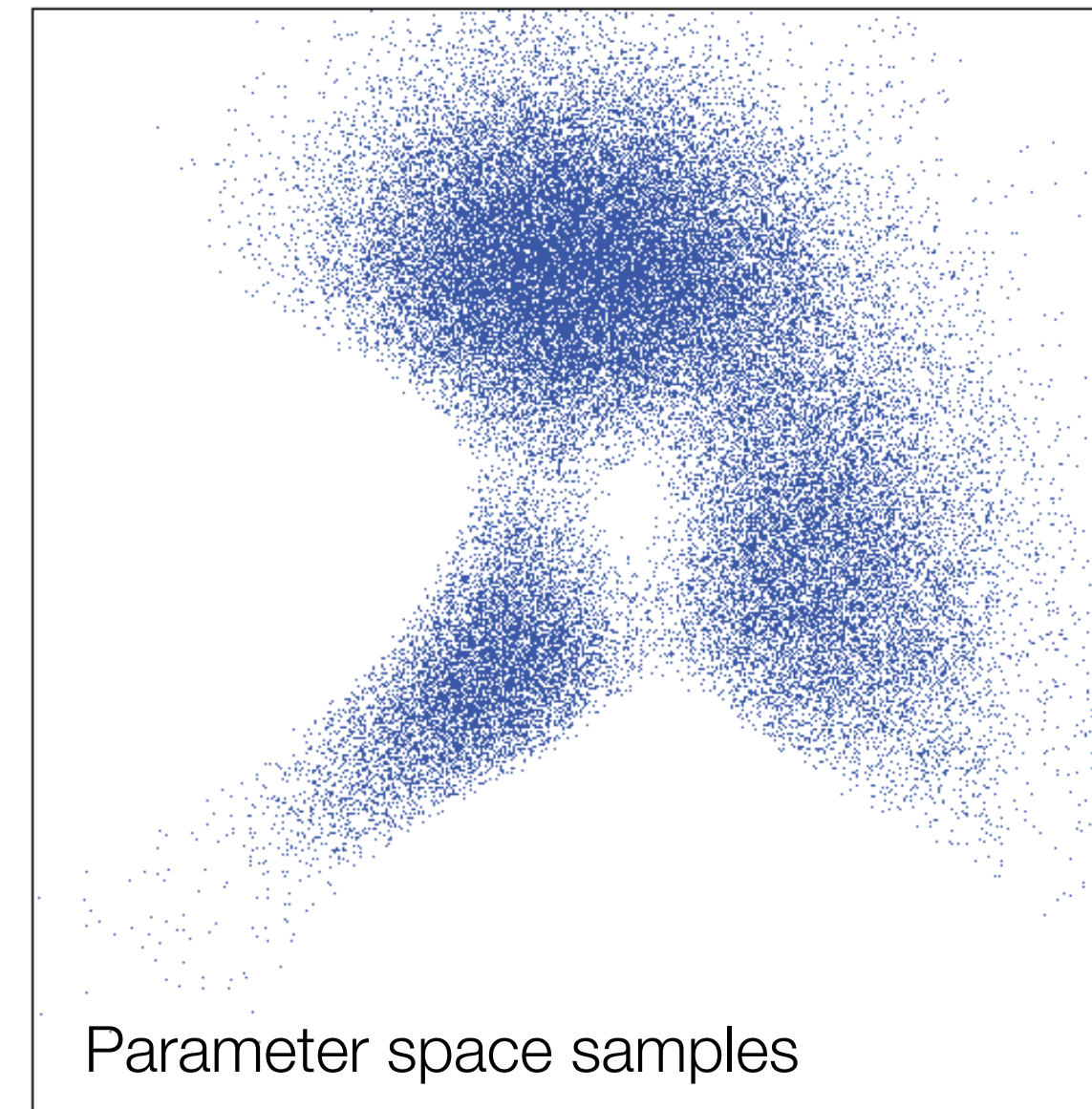
Parameter estimation

Log Likelihood or misfit function

Optimisation of a misfit function

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

Parameter sampling

Parameter space samples

Sample a target PDF

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

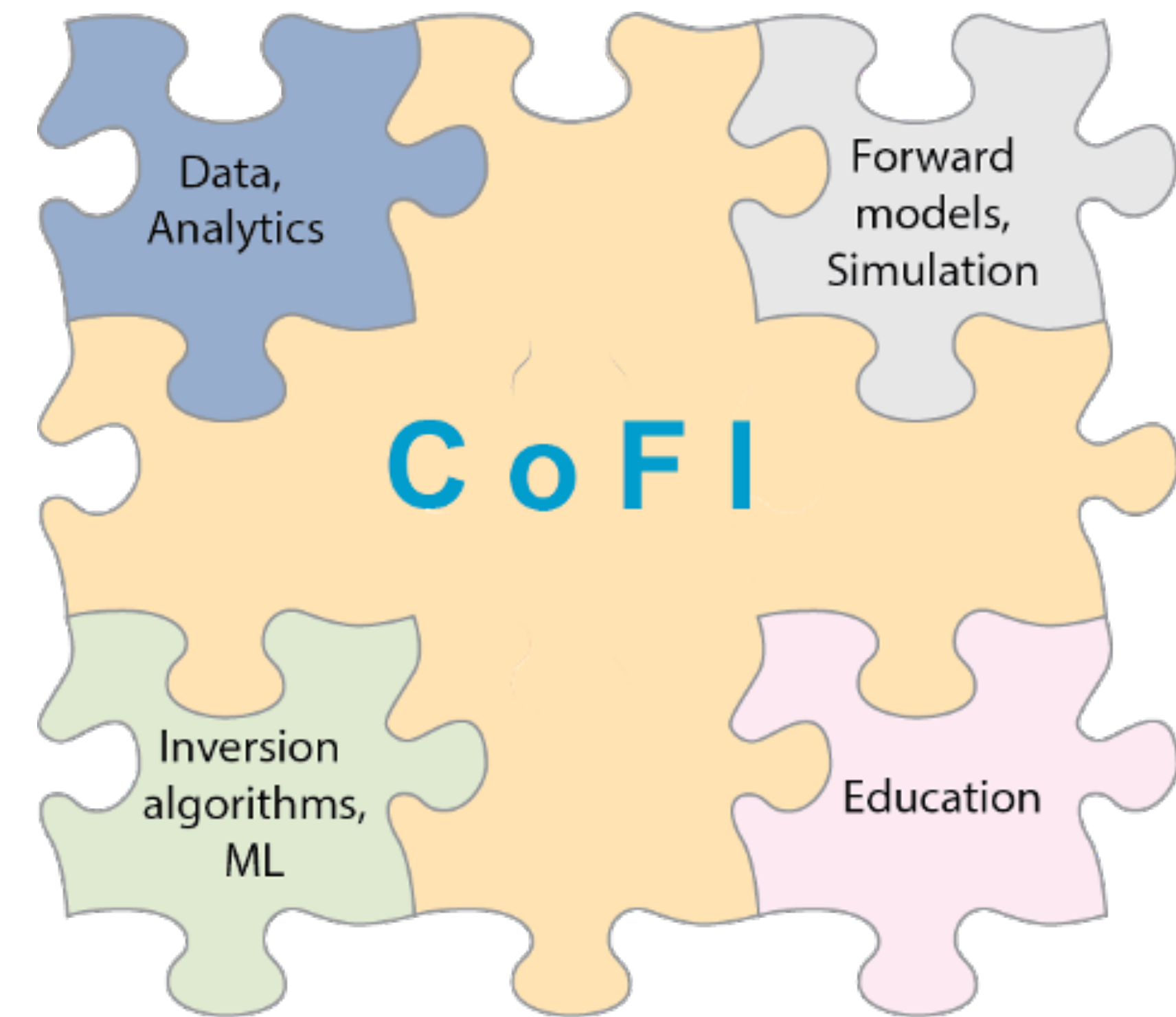**InLab**

The CoFI jigsaw concept

The **researcher** says:
- What inference methods are suited to my data?
- Where can I get access to them?
- How much work is that for me?

The inference **specialist** says:
- I would like to test my algorithm on a different problem
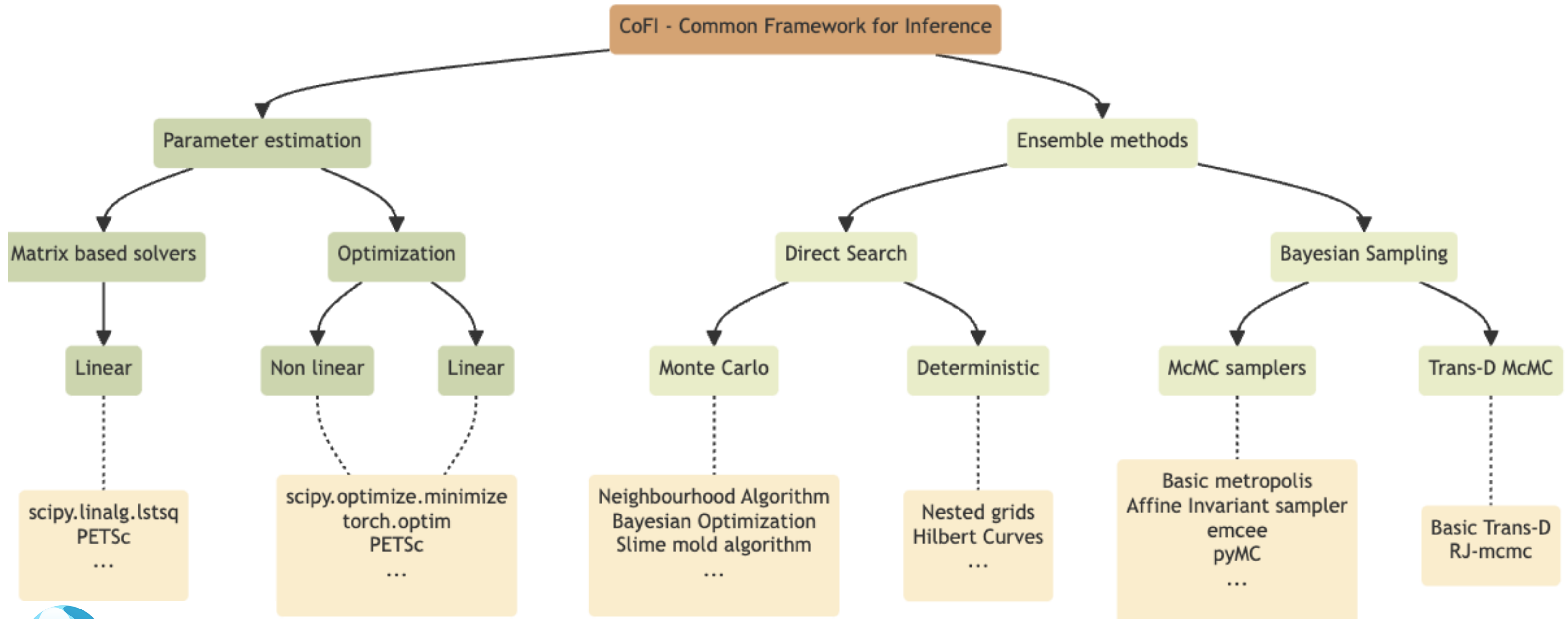- Where can I get access to them?
- How much work is that for me?

The research **manager** says:
- How can my staff learn about inference methods?
- How do we access the necessary expertise?
- Can we experiment which different approaches?
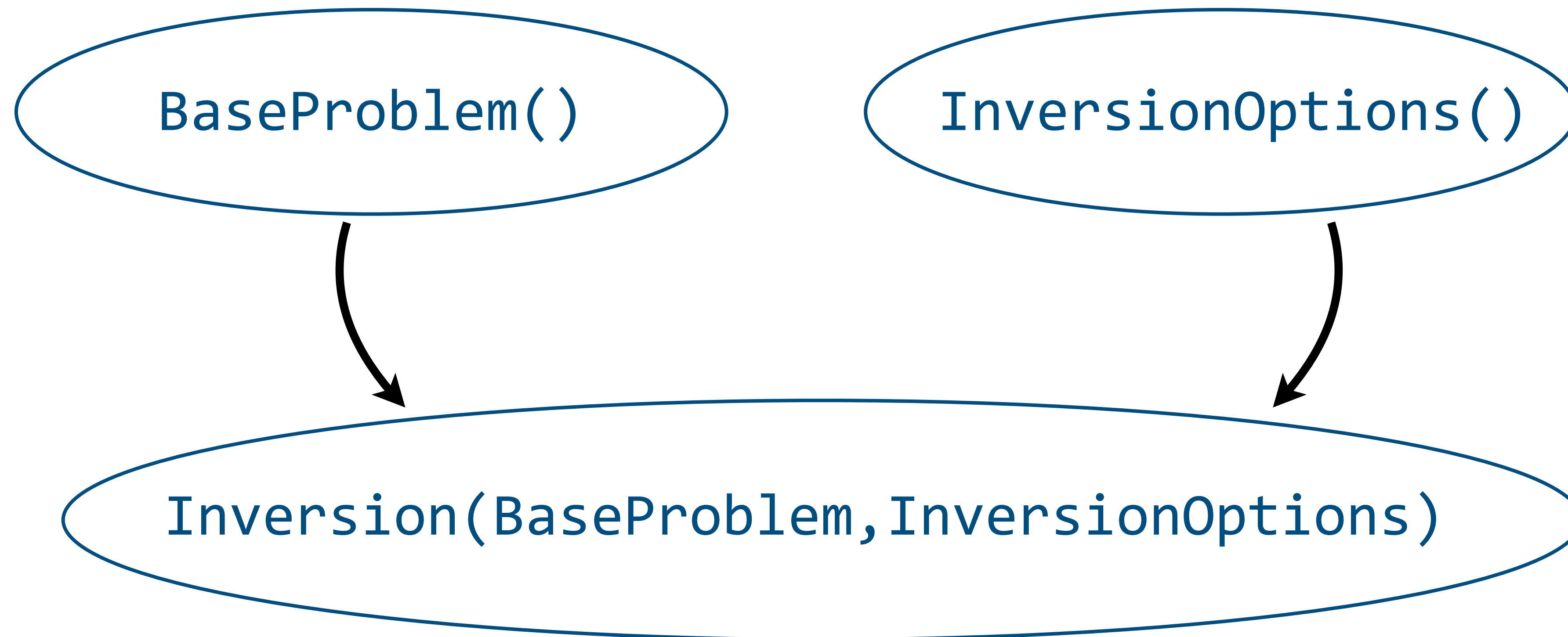- How long will it take?

CoFI connects the pieces

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Some context can be found here: inlab.edu.au/files/CoFI-club.pdf

The CoFI methods tree

CoFI workshop

CoFI - Common Framework for Inference

Parameter estimation

Ensemble methods

Matrix based solvers

Optimization

Direct Search

Bayesian Sampling

Linear

Non linear

Linear

Monte Carlo

Deterministic

McMC samplers

Trans-D McMC

scipy.linalg.lstsq
PETSc
...

scipy.optimize.minimize
torch.optim
PETSc
...

Neighbourhood Algorithm
Bayesian Optimization
Slime mold algorithm
...

Nested grids
Hilbert Curves
...

Basic metropolis
Affine Invariant sampler
emcee
pyMC
...

Basic Trans-D
RJ-mcmc

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The Common Interface

Define the problem…

Choose the options…

BaseProblem()

InversionOptions()

Inversion(BaseProblem,InversionOptions)

Run the code…

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