# Loop

An integrated and interoperable platform enabling 3D stochastic geological modelling

## (partial, brief) Overview of current state of inversion research globally and specifics of what will be covered

**Us all**

**Presented by Jeremie Giraud**

# Research Organisations

MONASH University

THE UNIVERSITY OF WESTERN AUSTRALIA

RING

RWTH AACHEN UNIVERSITY

UNIVERSITÉ TOULOUSE III PAUL SABATIER

British Geological Survey
Expert | Impartial | Innovative

CANADA 1842 GEOLOGICAL SURVEY - COMMISSION GÉOLOGIQUE

Australian Government
Geoscience Australia

Geoscience for a sustainable Earth
brgm

AuScope

# Funding Organisations (cash & in-kind)

Australian Government
Australian Research Council
ARC LP170100985

MinEx CRC

Geological Survey of Western Australia

BHP

Australian Government
Geoscience Australia

Geological Survey of Western Australia

AngloAmerican

MICROMINE

NORTHERN TERRITORY GOVERNMENT

NSW GOVERNMENT Department of Industry Resources & Energy

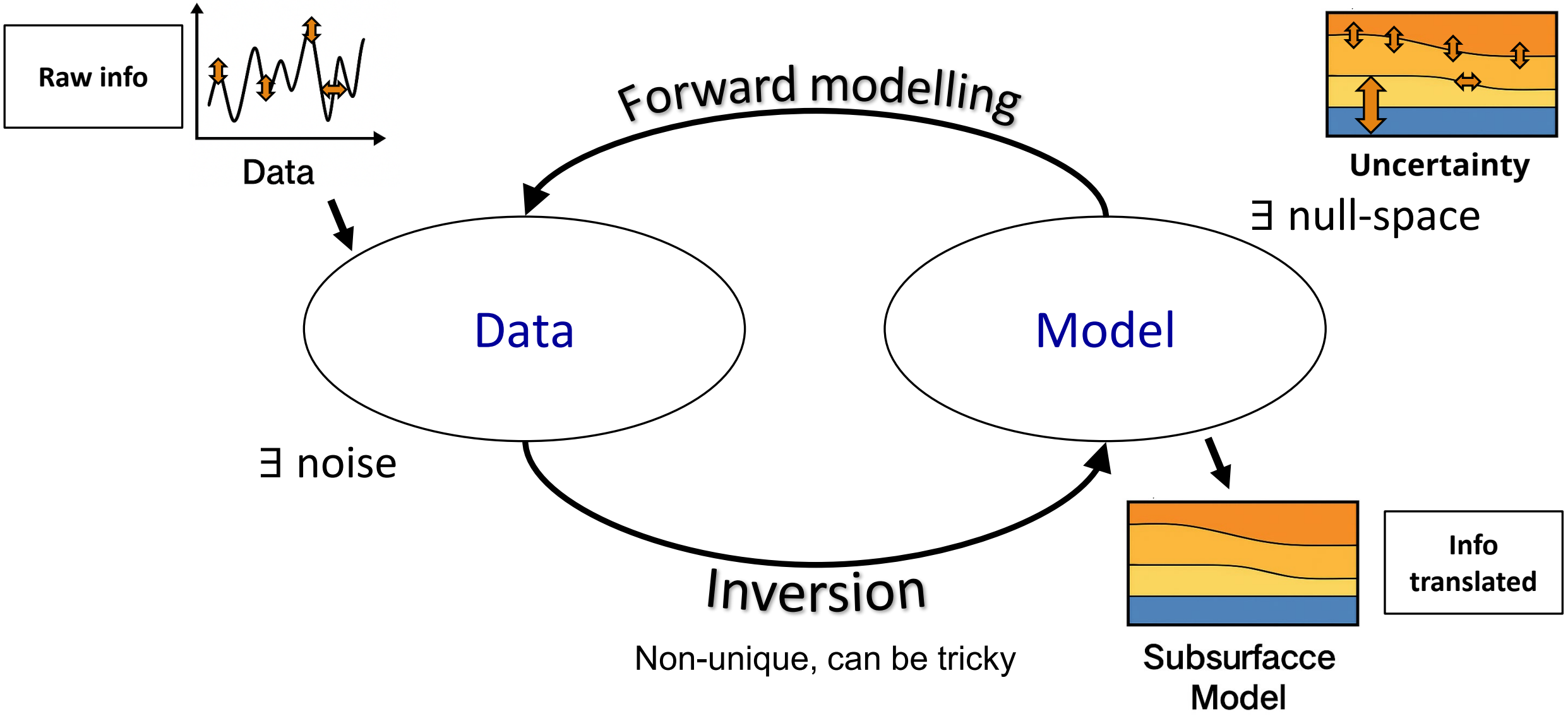
Government of South Australia
Department of State Development

SOUTH AUSTRALIA

# Partner Organisations

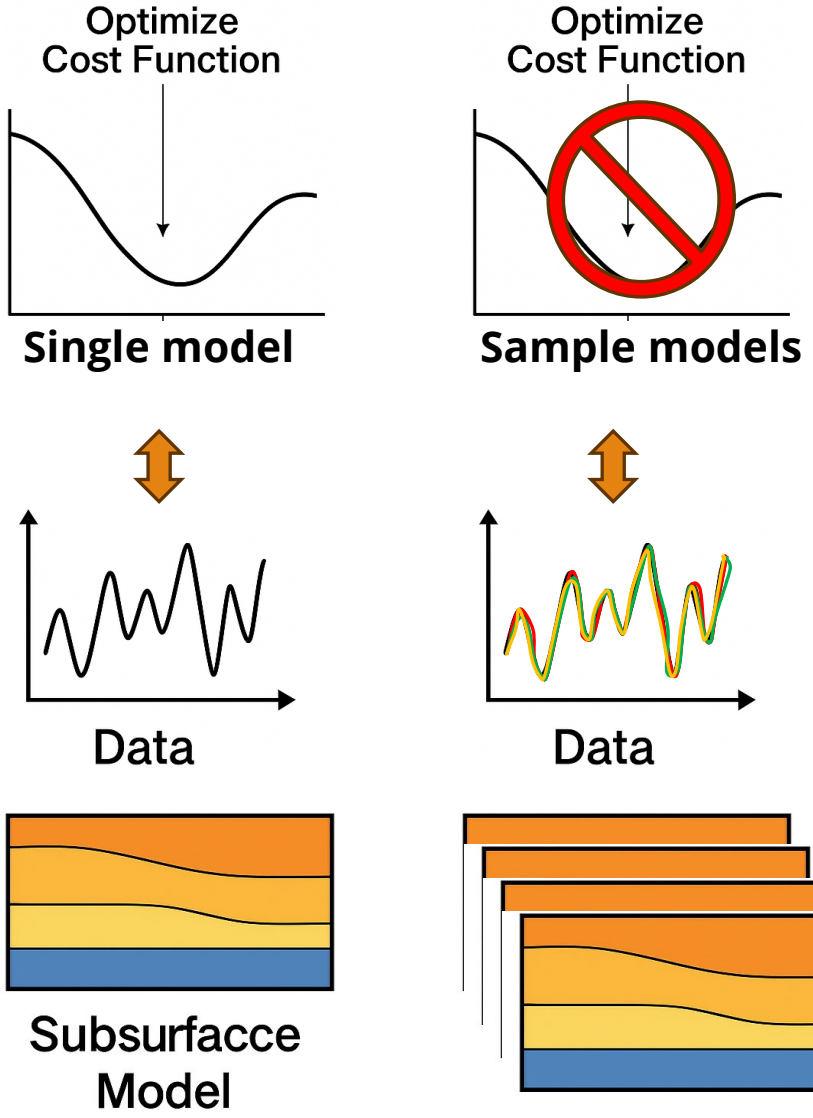
Loop

# Inversion in a nutshell



# Some definitions

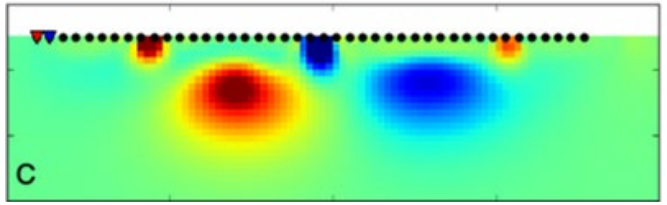
## Deterministic vs Stochastic inversions



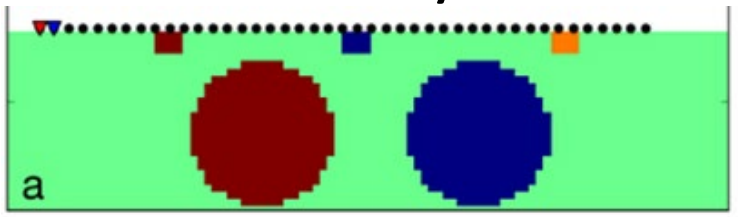

Many models
→ get some stats
→ do some analysis

## Property inversion vs Geometry inversion

Primary unknown:
Petrophysical values




Primary unknown:
Geometry of units




Right hand side pictures: https://giftoolscookbook.readthedocs.io/en/latest/content/fundamentals/Concept.html

# Overview

A new idea in a new place → **RARE**

An old idea in an old place → **COMMON**

A new idea in an old place →

- **New optimization**
- **New mesh**
- **New sampler**
- **New interpolation**

An old idea in a new place →

- **Same code, new data or new context**
  - **Antarctica, moon**
- **Port algo from e.g.**
  - **Bio: Particle swarm**
  - **Mechanics: Level-sets**
  - **Phys/stats: MCMC**

# In this presentation

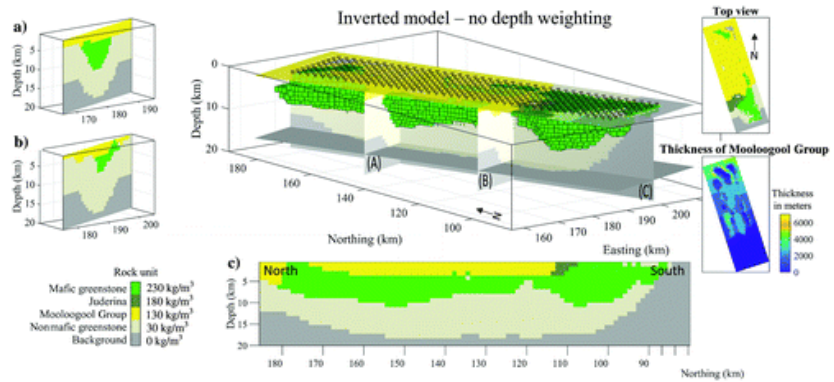
- State of affairs in geophysical inversion / research
  - Geophysical techniques
  - Algorithms
  - New areas
- Specifics that will be covered today
  - Geophysics
  - Geology
  - Computational / user-experience aspects

# New or emerging approaches

- New techniques using similar physical principles
  - e.g. new ambient noise tomography techniques, new electrical methods
  - Formulation of the geophy problem (not Bayes, not Tarantola)

- Not new, but developing
  - Muon tomography (volcanoes, mines, cavities etc.)
  - Trans-d, Optimal transport
  - Geometry inversion (invert for geometry,

Geometry inversion between 11:00-11:45



# Development of algorithms

- Faster codes
  - Wavelet compression

Tomofast-x,
between 08:45-10:00

- AI
  - Machine learning
  - Neural networks
  - Everyday new NN

Inversion using NNs
between 11:45-12:00

- Ensemble methods + sampling techniques
  - Nature-inspired
  - Uncertainty

Equivalent models
13:00-15:00

  - Trans-dimensional inversion

Trans-d inversion,
between 15:30-16:00

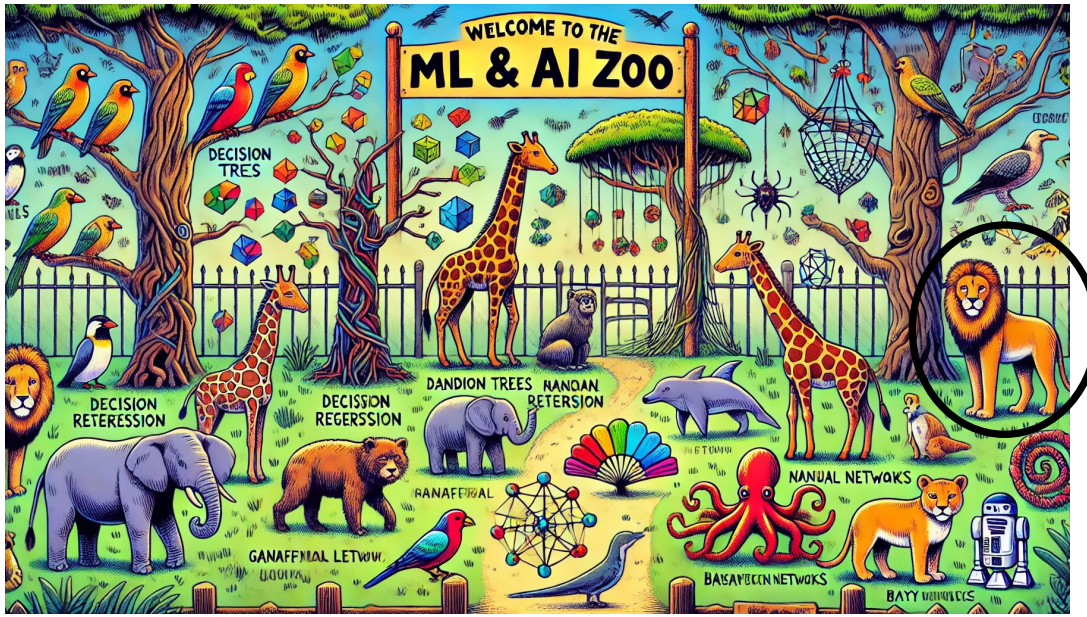



Image: ChatGPT, prompt: “I want to make a drawing making the metaphor between the variety of algorithms that were developed for machine learning and neural networks, and a zoo. Please do the drawing for me so I can copy and paste for personal usage. ”

# New areas and new ideas

Real life

- Earth
  - Antarctica, Greenland, ocean bottom
- Elsewhere
  - Moon, planets, planetoids, asteroids

User experience / Interpretation

- Interaction with data and between software
- Viz and evaluation of (large) sets of models

QGIS plugins
between 10:30-11:00

Analysis of large sets
between 16:00-17:00

# And now…

Tomofast-x,
between 08:45-10:00

08:45-09:15 Introduction to unconstrained inversion and ADMM using Tomofast-x TALK [VO]

09:15-10:00 Tomofast-x unconstrained inversion & ADMM HANDS ON [VO & JG]

10:00-10:30 Morning break: troubleshoot for the lab.

# Questions or requests before we move on ?