Technical Computing for the Earth Sciences, Lecture 2:

Solving some linear inverse problems for the Earth sciences

EARS 80.03

Linear inverse problems

You're already solving a linear inverse problem: Project 1!

- All the detailed matrix math is there, so I won't repeat it here, just a few really general concepts instead..

Linear inverse problems

Generalized linear inverse problem: you have

- some data y
- an equation of the form $y =$

$$a * (something) + b * (something\ else) + c * (something\ else\ else) + \ \ldots$$

(where each *something* is a different function of x)

and you want to invert for a, b, c, …

Or in matrix form: $y = A * \phi \ \ \mathrm{where}\ \phi = [\mathrm{a},\ \mathrm{b},\ \mathrm{c},\ ...]$

What's the difference between *linear* and *nonlinear* inverse problems??

Linear inverse problems

Invert for constants a through **...**. Linear or nonlinear inverse problem?

$y =$

1) $$a + b * x + c * x^2 + d * x^3 + \ldots$$

2) $$a + b * x + c * x^2 + d * x^3 + e * sin(x) + f * log(x)$$

3) $$a + b * x + c * x^2 + d * x^3 + e * sin(x/g) + f * log(h * x)$$

4) $$a + b * x^c$$

Linear inverse problems

Invert for constants a through **...**. Linear or nonlinear inverse problem?

$y =$

1) $a + b * x + c * x^2 + d * x^3 + \ldots$ ✅

2) $a + b * x + c * x^2 + d * x^3 + e * sin(x) + f * log(x)$ ✅

3) $a + b * x + c * x^2 + d * x^3 + e * sin(x/g) + f * log(h * x)$ ❌

4) $a + b * x^c$ ❌

Aside: a pattern I often use for filtering datasets

```
julia> t = .~ isnan.(x)
julia> x[t] # Returns the elements of x that are not NaN

julia> t = 3 .< x .< 5
julia> x[t] # Returns the elements of x between 3 and 5
```

can combine tests with **.&** (and) or **.|** (or)

```
julia> t = (3 .< x .< 5) .& .~ isnan.(x)
julia> xf = x[t] # etc..
```