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Global data assimilation hotspots...

ECMWF TU Delft

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: Bergen ! .
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Check out EQNR's Foss Data assimilation tool...

github.com/equinor/ert

A quick example

temp.
est.

₁

Sensor

$$\mu \quad \sigma$$

$$20^\circ\text{C} \pm 2^\circ\text{C} \rightarrow 4 \rightarrow \frac{9}{4+9} = 0.7 \rightarrow 14$$

$$\sim N(20, 4)$$

temp.
est.

₂

Model

$$25^\circ\text{C} \pm 3^\circ\text{C} \rightarrow 9 \rightarrow \frac{4}{4+9} = 0.3 \rightarrow 7.5$$



KALMAN FILTER

$$\frac{4 \times 9}{4 + 9} = 2.8$$

the variance of the best est.

$$\overbrace{}^{\text{weight}}$$

+



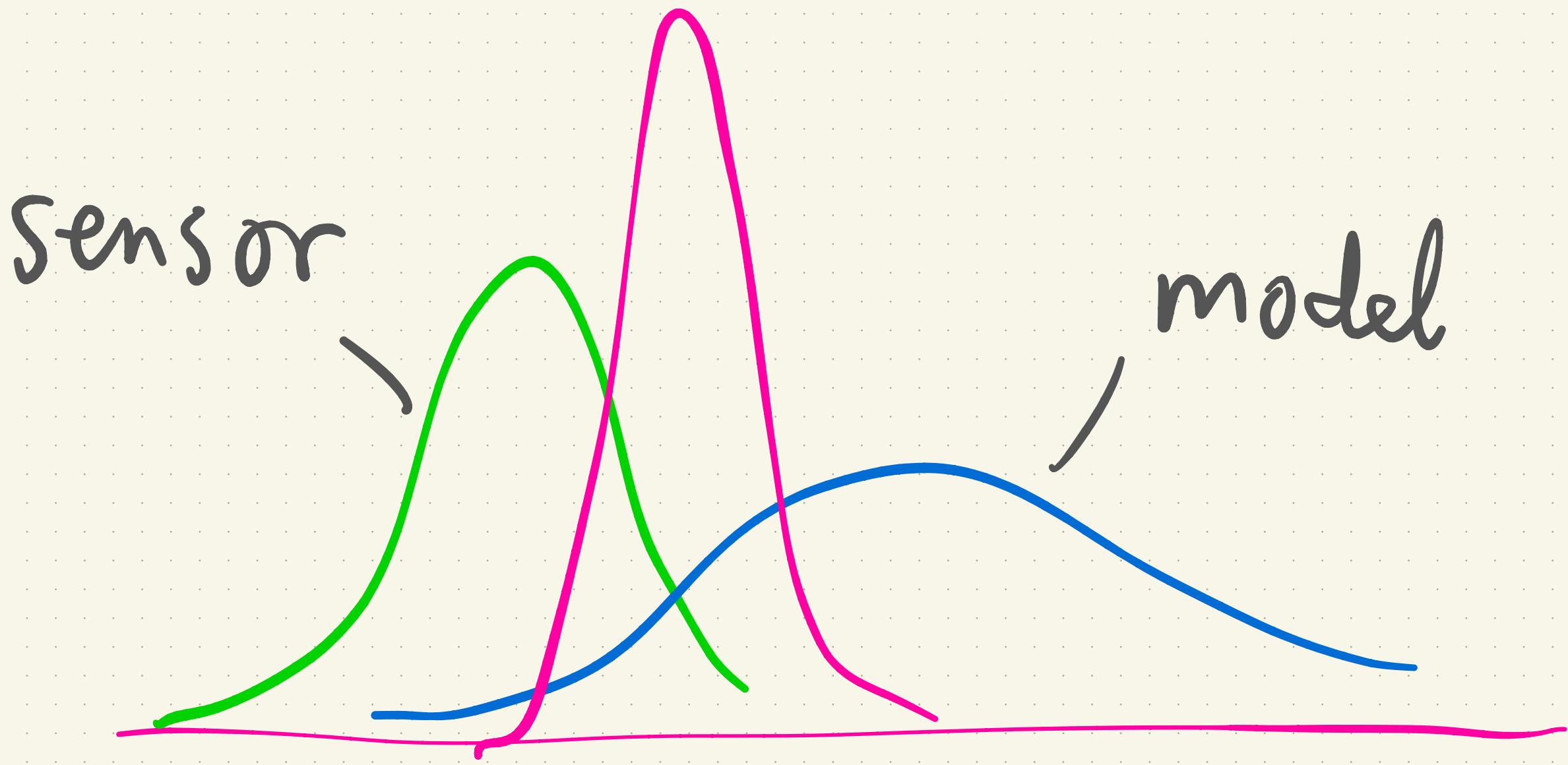
$$\sigma^2$$

↓ ↓ ↓

$$\overbrace{}^{7.5}$$

- 21.5 -

Best estimate



MODEL can be...

- expensive
- physics-based
- proprietary
- nonlinear

$$\hat{y} = f(x, w)$$

ML

TRUE
target, labels y

features
- abundance

x

$\sim 1000s$ DA
observations
measurements

state

BEST weights
- few

w

parameters
- millions

N
 0
 1
 S
 y

Cost functions for 4DVAR ← a kind of D.A. strategy

measurements
actual pred

State
 x, w

cost

$$\bar{J} = \frac{(y - f(w, x))^2}{\sigma^2} + \frac{(x - x_b)^2}{\sigma^2} + \frac{(w - u)^2}{\sigma^2}$$

\uparrow \uparrow \uparrow

familiar from ML unique to DA analogous regularization (L^2)

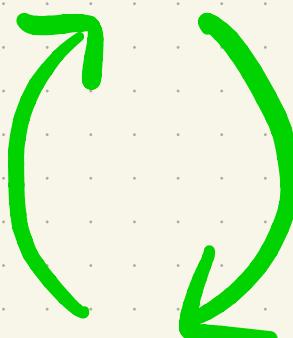
Learning resources

I've tried them all ;)
These 2 are all u need

① rlabbe's github

- Python code
- elementary
- Kalman Filter book

iterate



② Fundamentals of Data Assimilation

Evensen et al (2022)

- Rigorous but approachable
- No code :(

③ Comparison table <https://swu.ng/Rsekjc>