GLOBAL FLOW
MEASUREMENT WORKSHOP
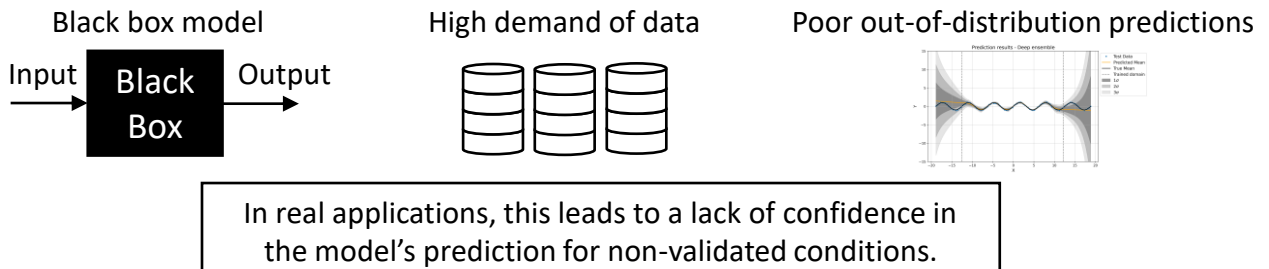### measuring for the energy transition

Development of a physics-informed virtual flow meter with uncertainty

André Mendes Quintino
Norwegian University of Science and Technology
Department of Geoscience and Petroleum
Trondheim, Norway
andre.m.quintino@ntnu.no

Milan Stanko
Norwegian University of Science and Technology
Department of Geoscience and Petroleum
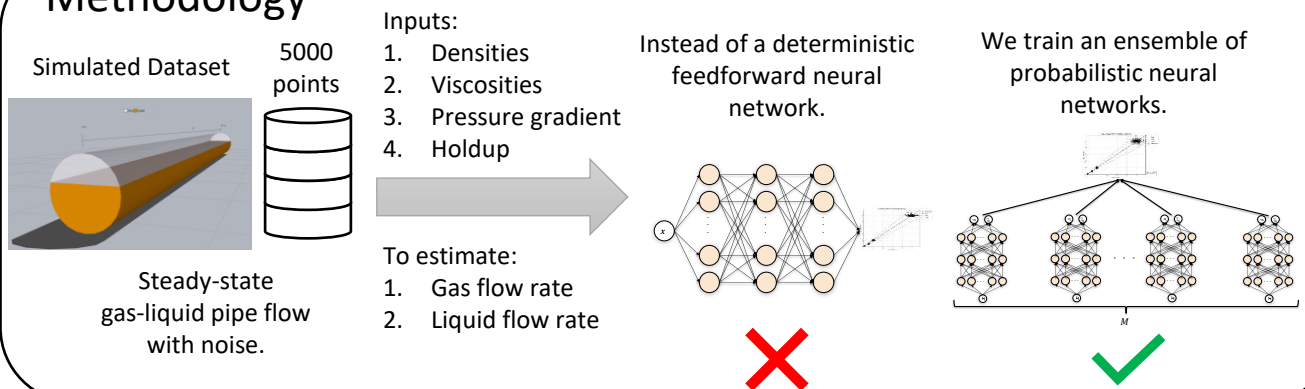*Trondheim, Norway*
milan.stanko@ntnu.no

Content

Introduction – Core challenges for machine learning in VFM

Black box model

Input → Black Box → Output

High demand of data

Poor out-of-distribution predictions

In real applications, this leads to a lack of confidence in the model's prediction for non-validated conditions.

We propose a model not only to fit the data, but also to know what it knows.

Methodology

Simulated Dataset

5000 points

Steady-state gas-liquid pipe flow with noise.

Inputs:
1. Densities
2. Viscosities
3. Pressure gradient
4. Holdup

To estimate:
1. Gas flow rate
2. Liquid flow rate

Instead of a deterministic feedforward neural network. ❌

We train an ensemble of probabilistic neural networks. ✅

Results

Liquid

- Accurate prediction.
- Low uncertainty. ✅

- User can trust the model for decision making. ✅

Gas

Greatly reducing available data for training (20%) AND Limiting available inputs (no holdup or gas properties)

Liquid

- Still good for liquid. ✅

- Poor for gas + high uncertainty. ❌

Gas

- Model informs the user to use the gas predictions carefully. ✅