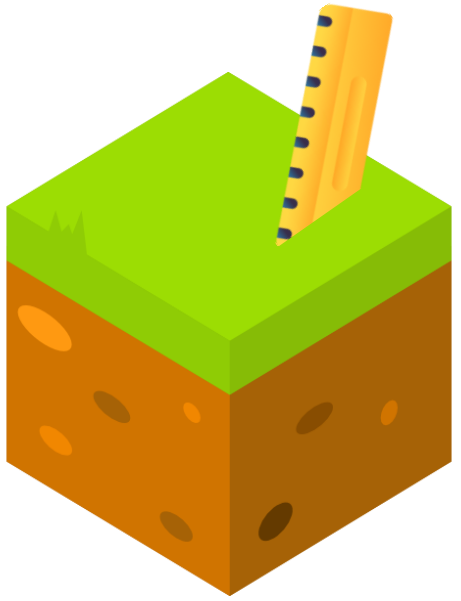
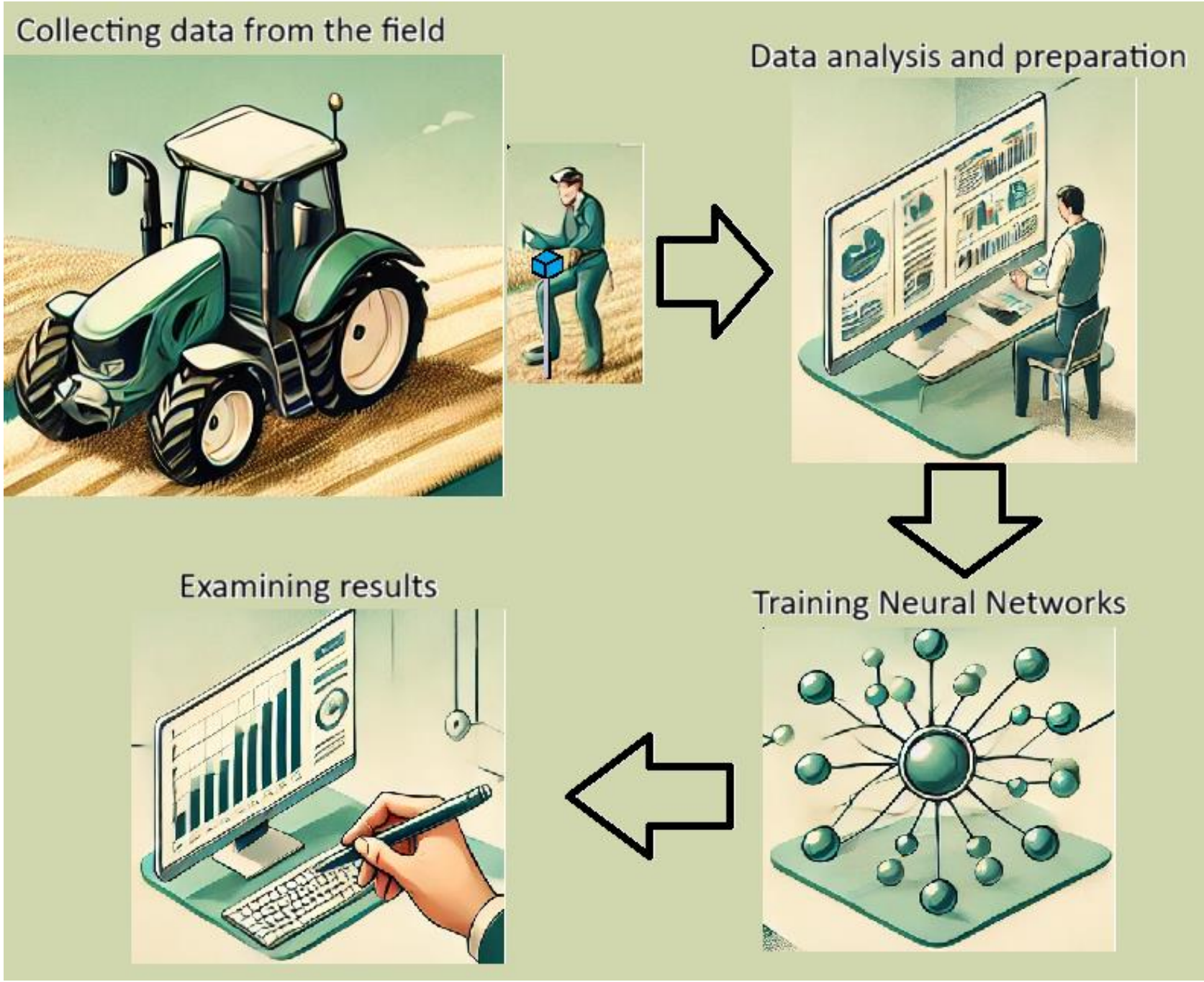
The potential of sensor technology for soil condition assessment

Heli Leskelä, Petri Junttila 12.12.2024

Is there a connection between tractor's sensor data and soil conditions?



Case example: from field to results



Test drive

- Multiple test tracks
  - Total 1 km on a soft soil
  - Total 600 m on sand
- Standardized test runs
  - Tire pressures 2.1 bar
  - 15 km/h speed
  - Same driver every time

Penetrometer

(The variable to be predicted)

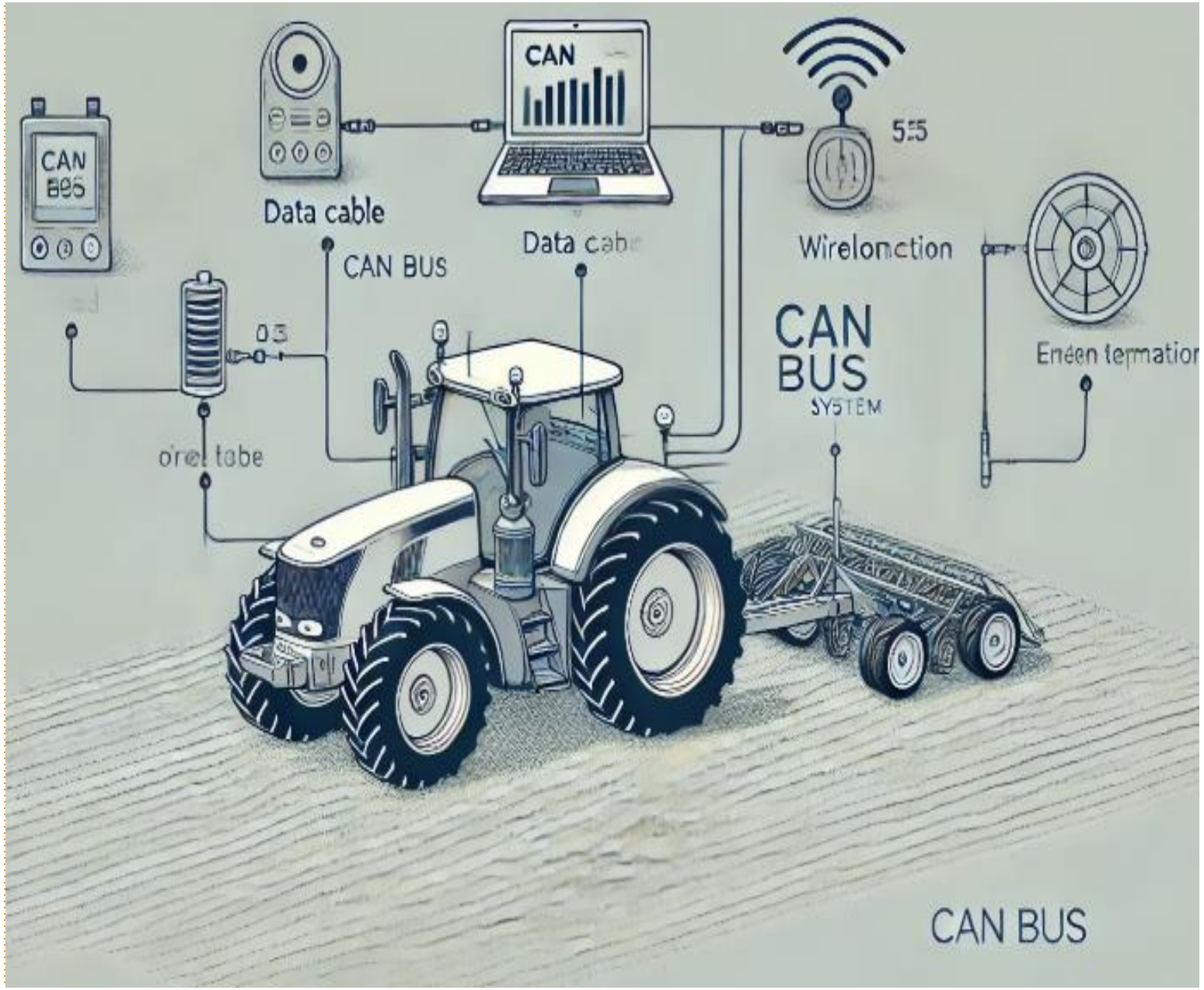
- Measures penetration resistance (MPa)
  - Cone-index
- Measured before driving
- Around 140 measurements in total
- Soft soil and sand

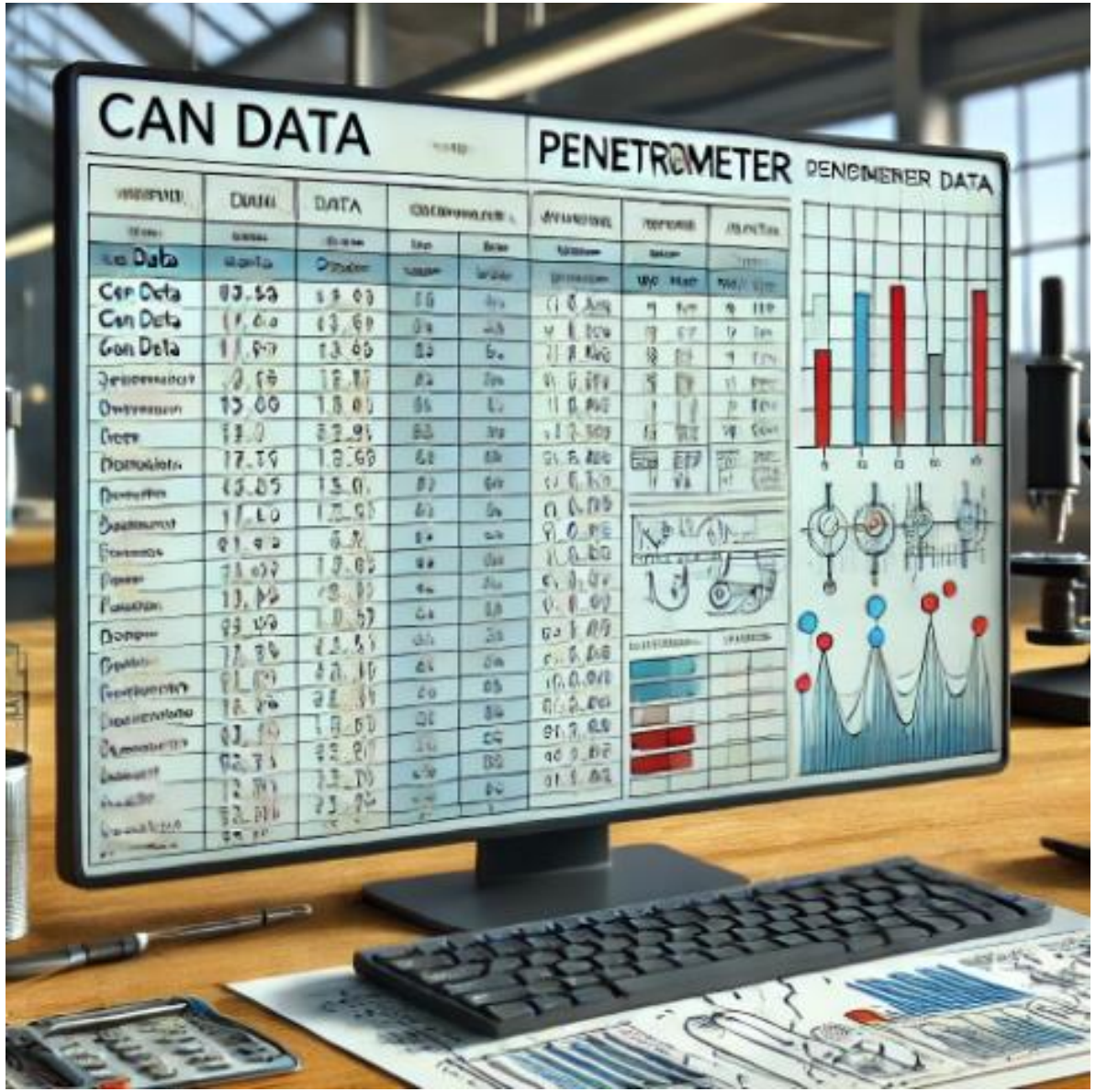
Petri Junttila (left) ja Otto Läspä (right)

CAN-bus

(Controller Area Network)

- GPS
- Wheel speed
- Ground speed
- Slip
- Engine speed
- Fuel rate
- Etc...





Data preparation

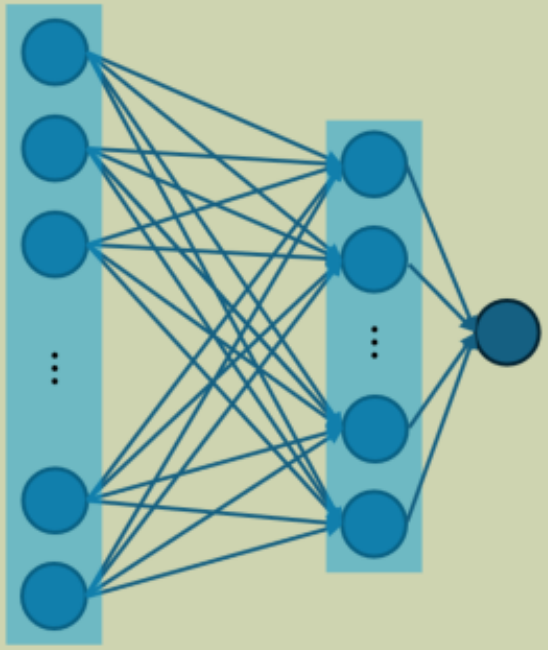
- Important to accurately combine data
  - CAN-bus and penetrometer from the same point of the field
- GPS points were used to combine everything into one Excel
- Normalization for neural networks
  - Example: Engine rpm range is 0-3000, then 1500rpm is 0.5

Training Neural Networks

$$\omega_1 \cdot x1 + \omega_2 \cdot x2 + \omega_3 \cdot x3 + b = z$$

$$f(z) = output\ of\ neuron$$

Neural Network



Can-bus data	Variables:	Value:	Normalized:
	Vehicle speed	5 km/h	x1=0.1
	Torque	100 Nm	x2=0.3
	Engine power	30 Kw	x3=0.3
	Etc.		

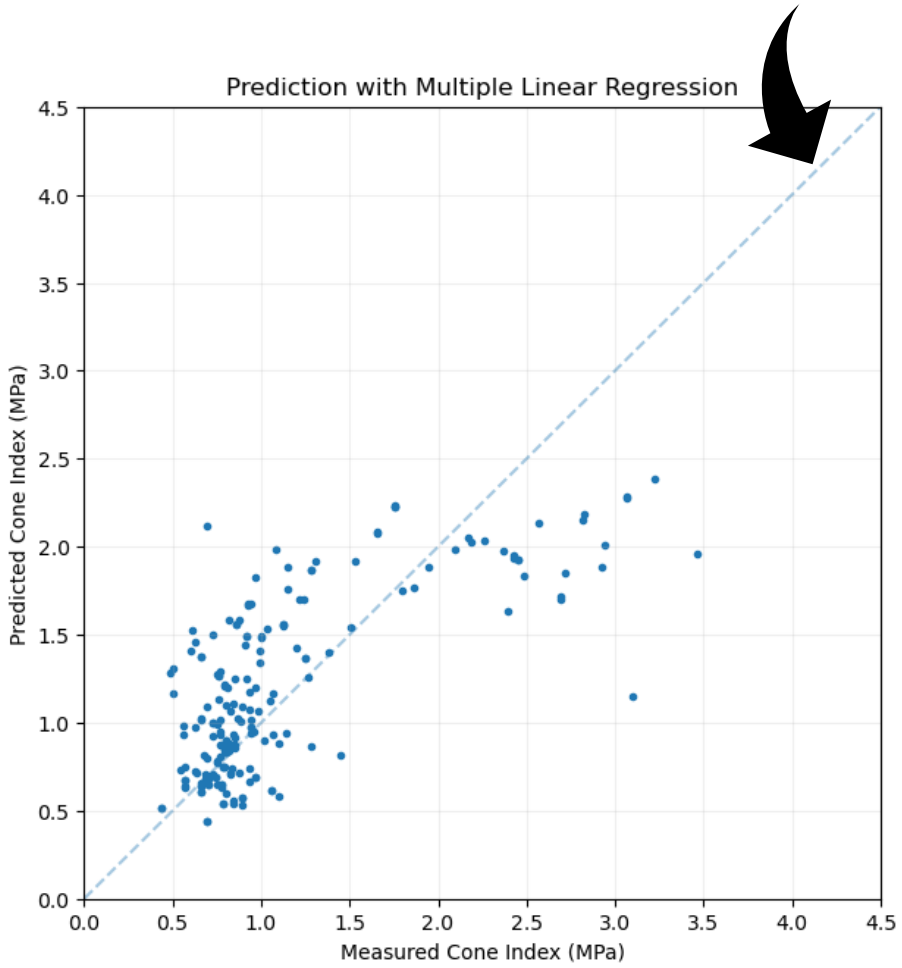
Prediction: 0.1 Mpa

Measured Cone index: 2.2 MPa

Step2: Backpropagation

Results

The line represents a perfect prediction



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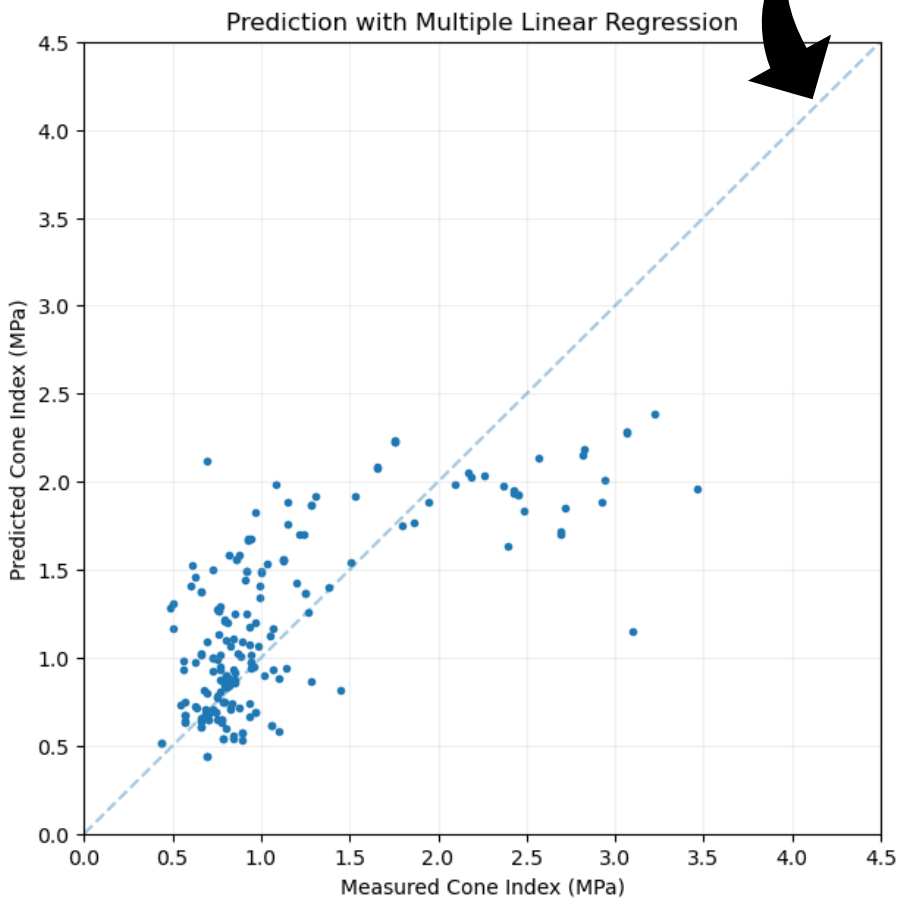

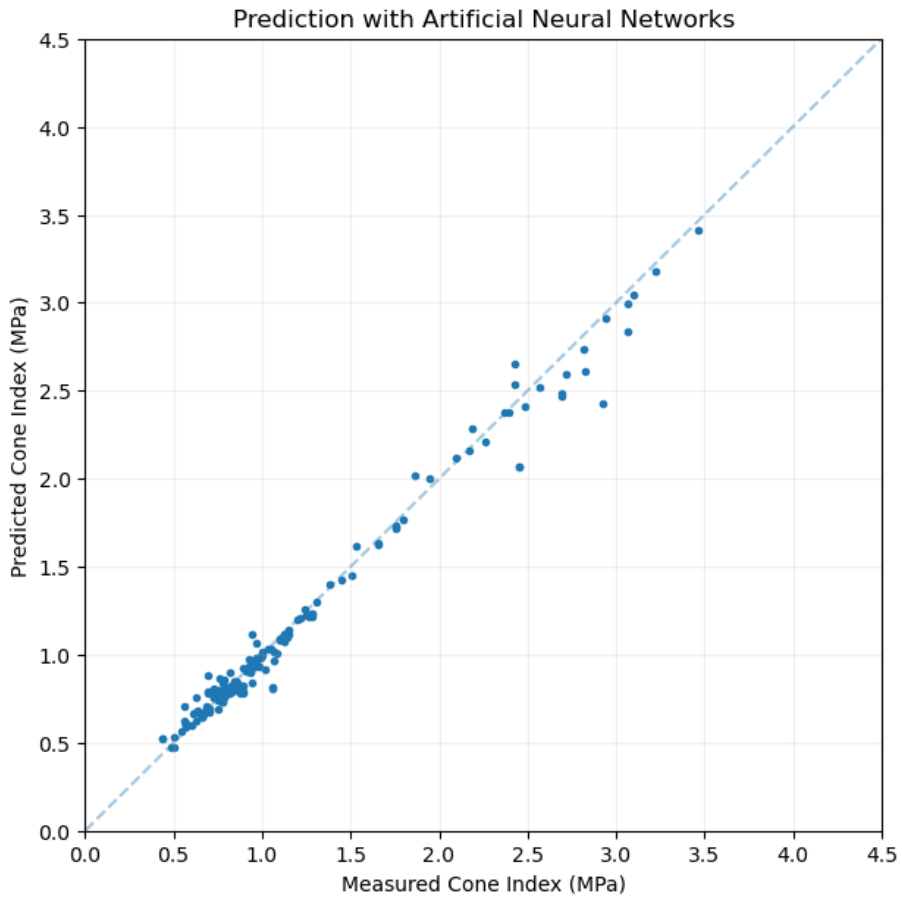

Conclusions

- Very good results
- Indication that it is possible to predict soil conditions from sensor data
- The next step: finalize the scientific paper


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