# Diagnosis on embedded systems

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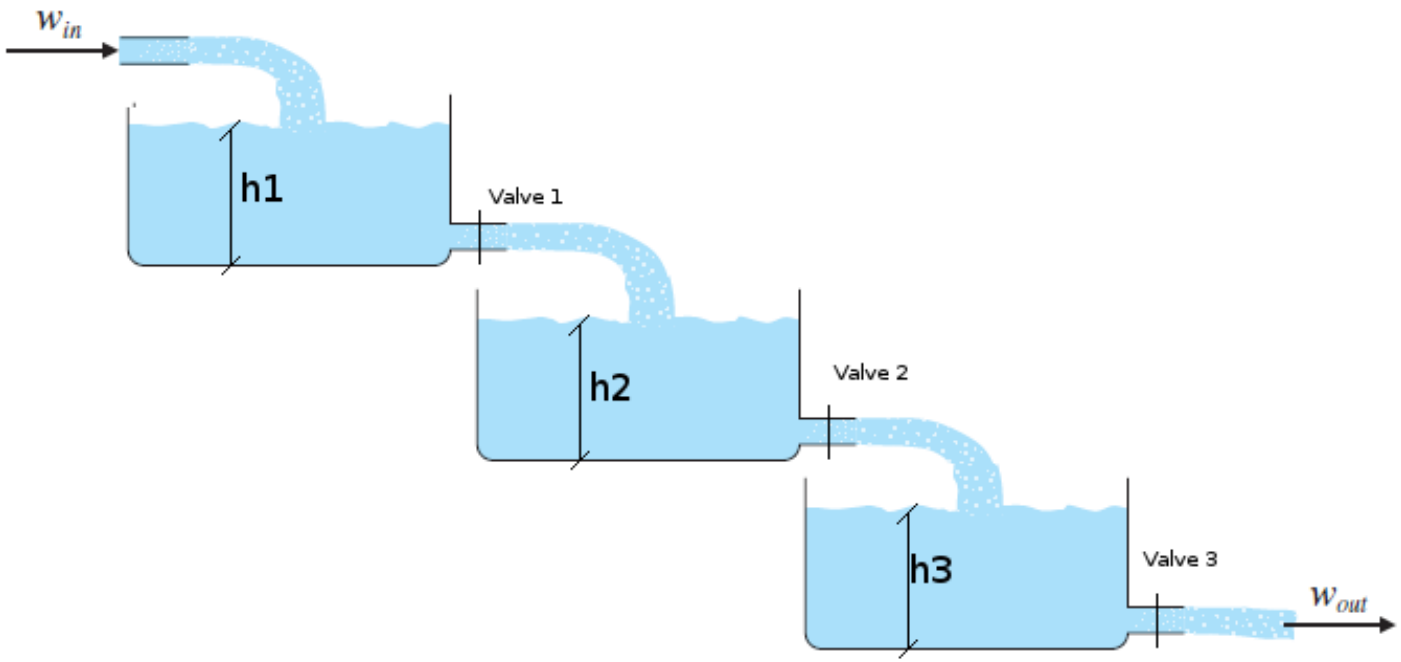
# Three tanks

Diagnosis of errors in high-fidelity models using a data-driven approach



# Three tanks

Differential equation: $\delta(h_i) = \dfrac{in_i - out_i}{h_{max}}$

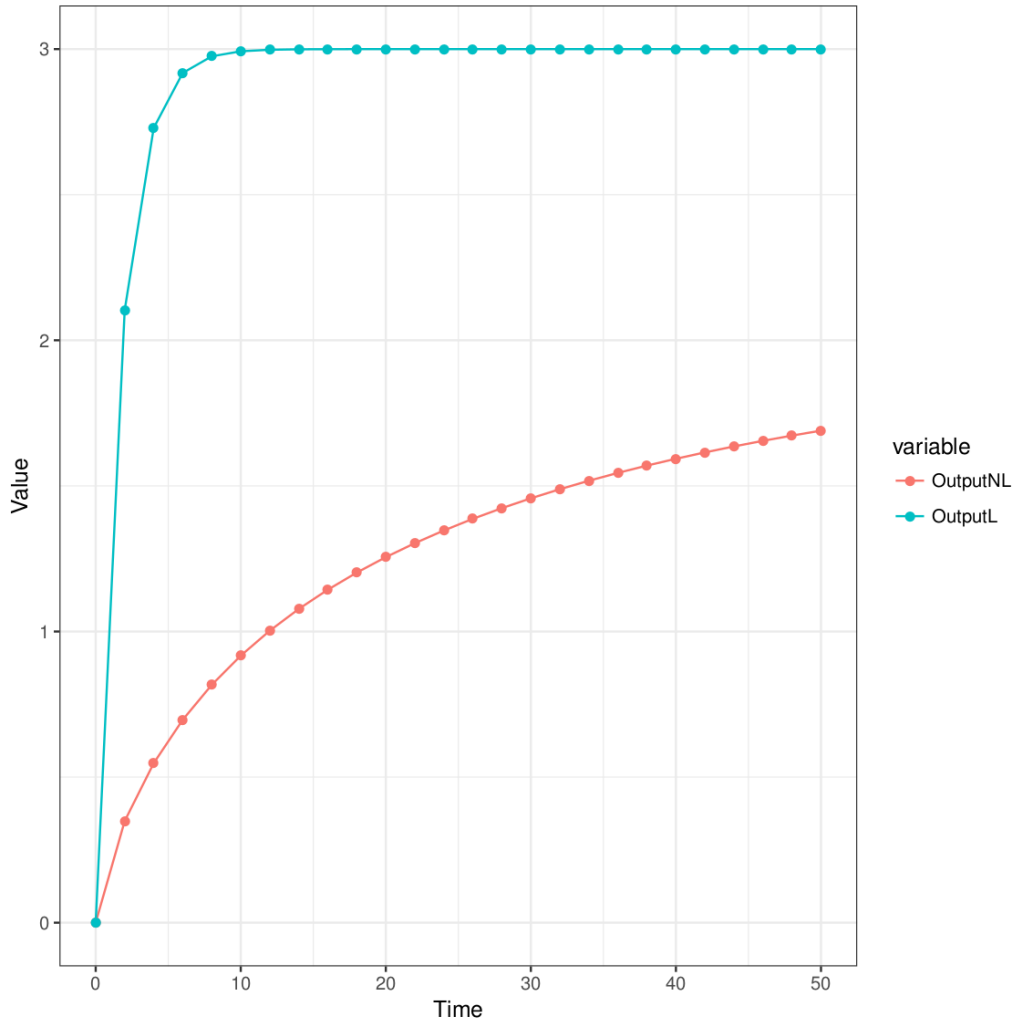
Non Linear model:

$$out_i = \mathsf{Valve}_i \cdot \sqrt{\max\left(0, 2 \cdot g \cdot h_{max} \cdot (h_i - h_{i+1})\right)}$$

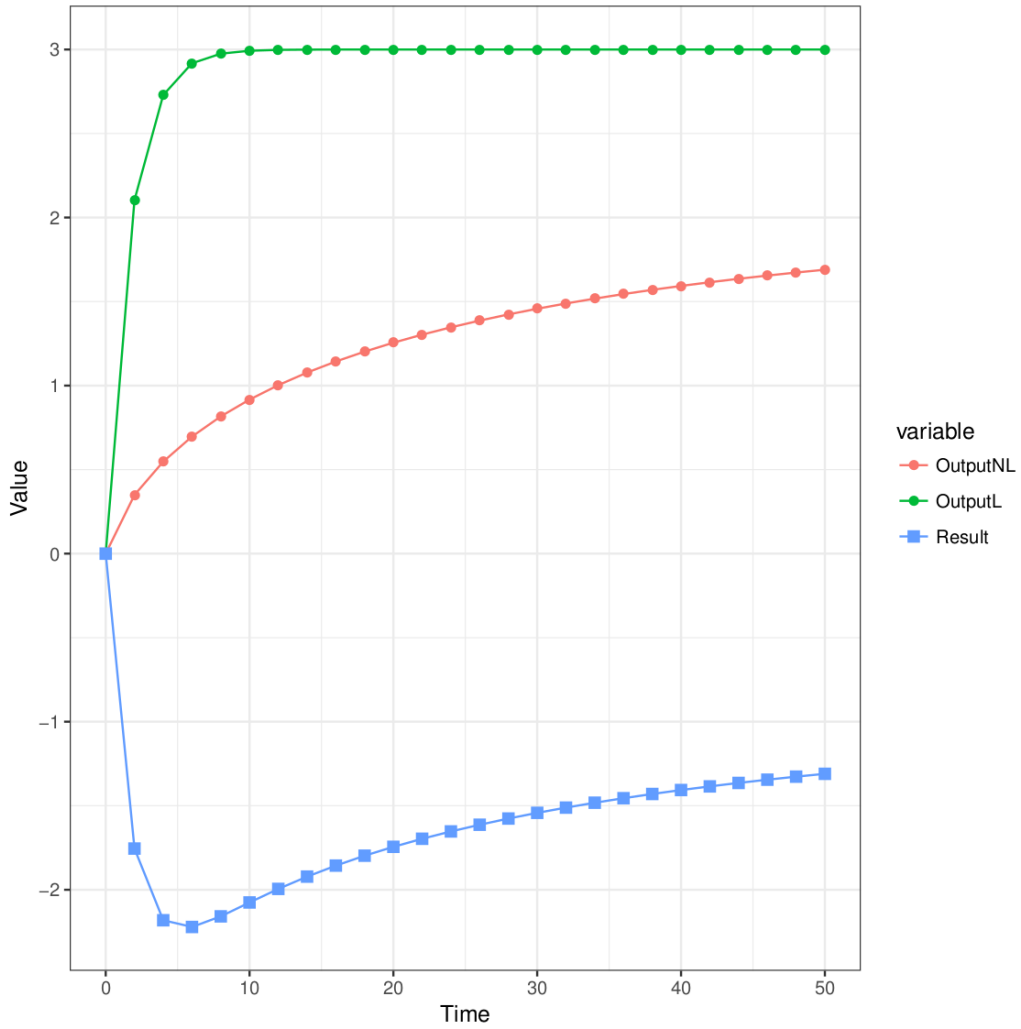
Linear model:

$$out_i = \mathsf{Valve}_i \cdot \max\left(0, 2 \cdot g \cdot h_{max} \cdot (h_i - h_{i+1})\right)$$

# Three tanks simulation



# Correction function



# Types of problems

- Valve problems

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- Different type of inputs

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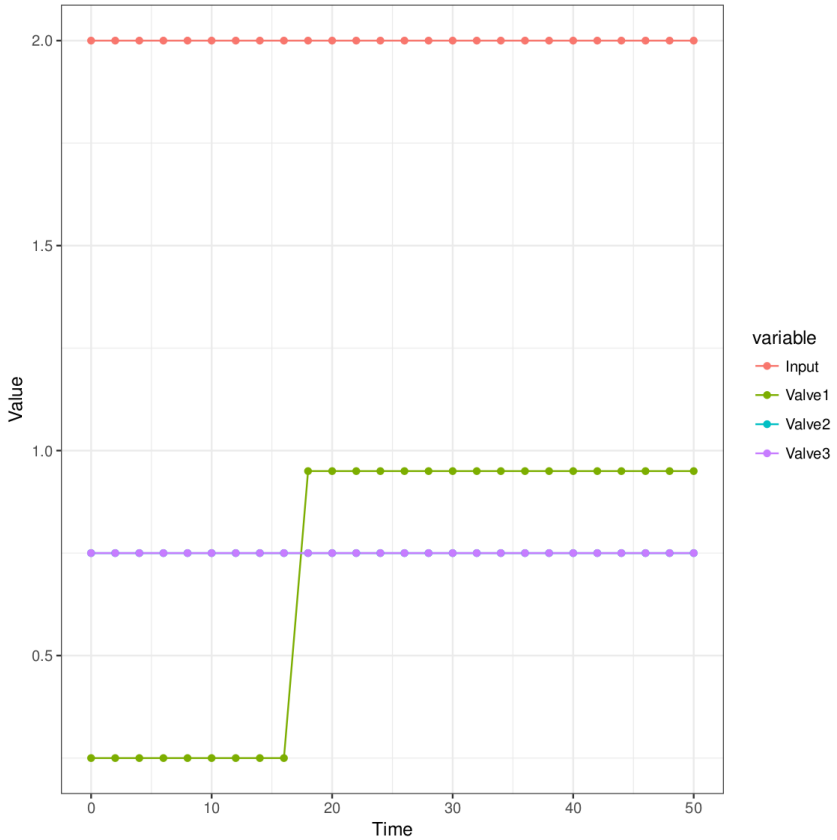
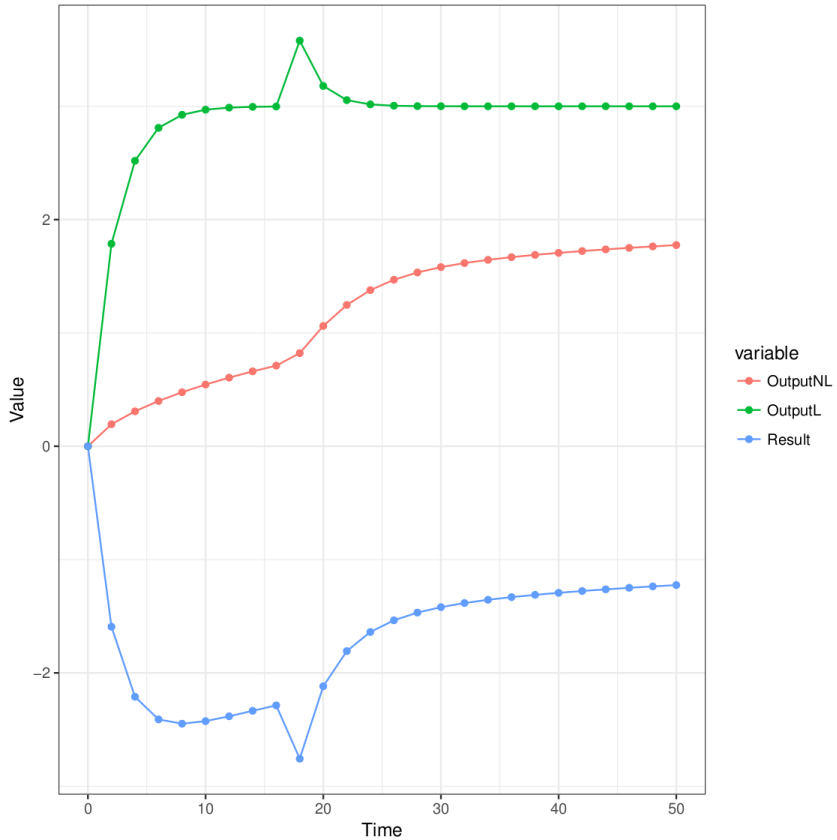
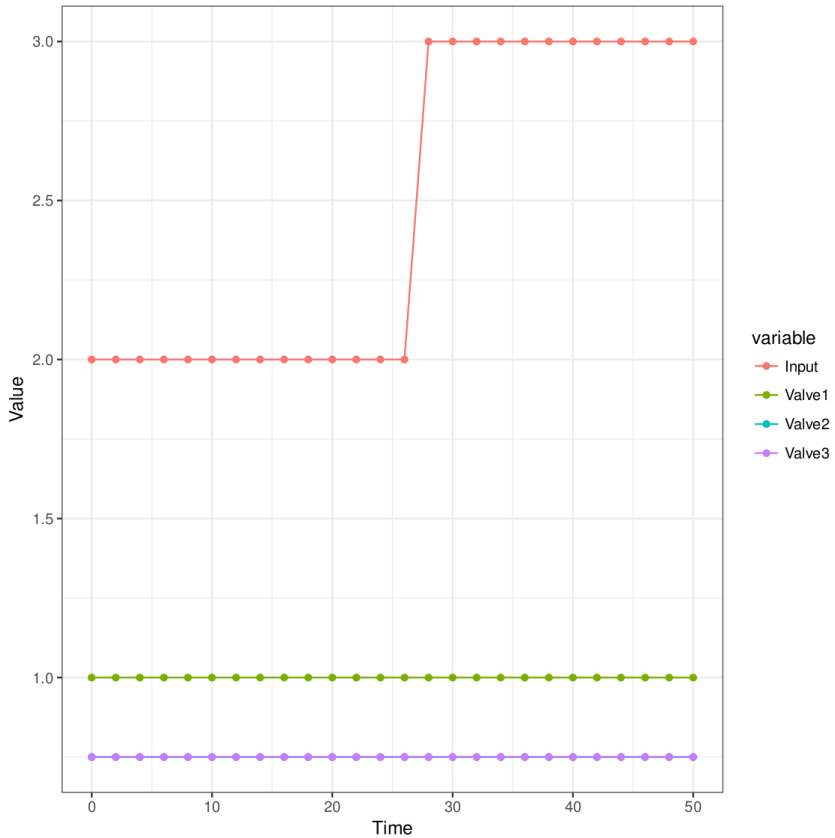
- Valve problems
- Different type of inputs
- Combinations of the above

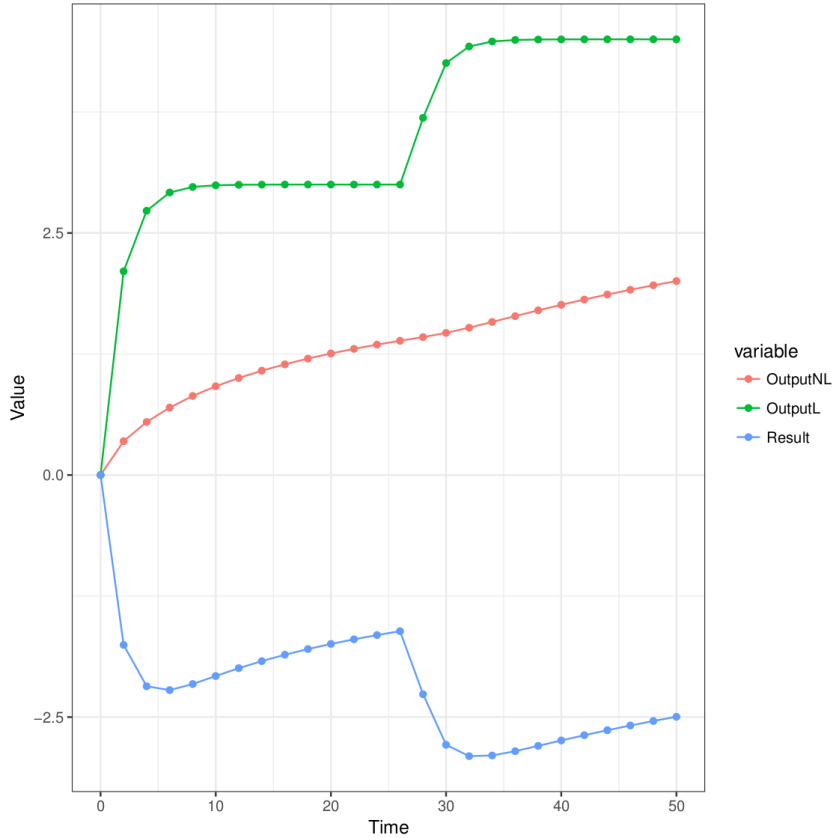
# Valve problems



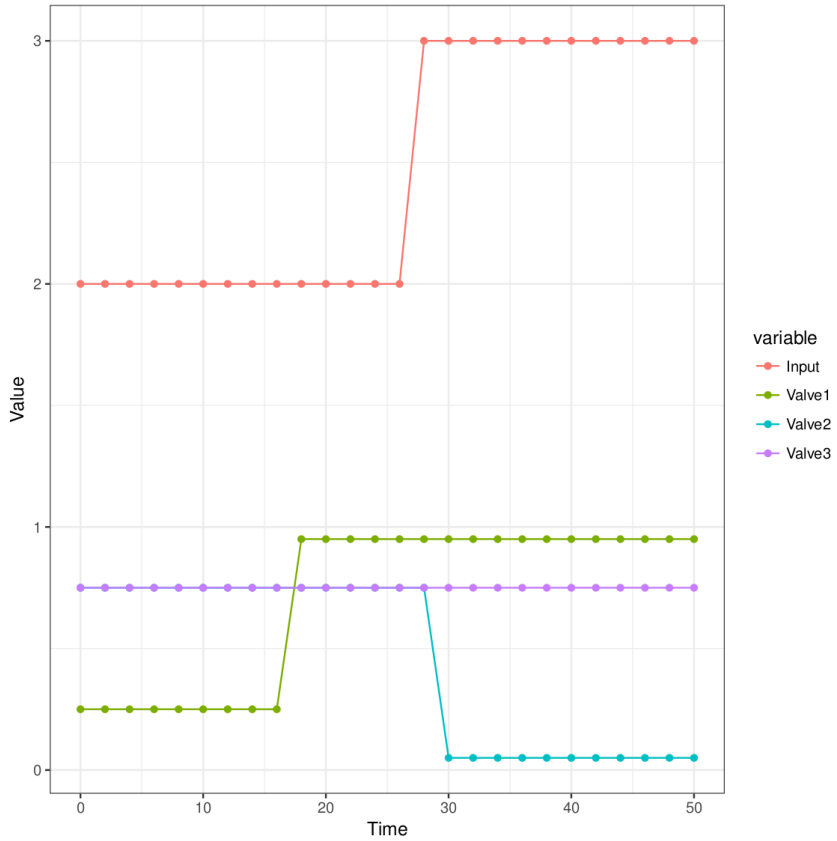



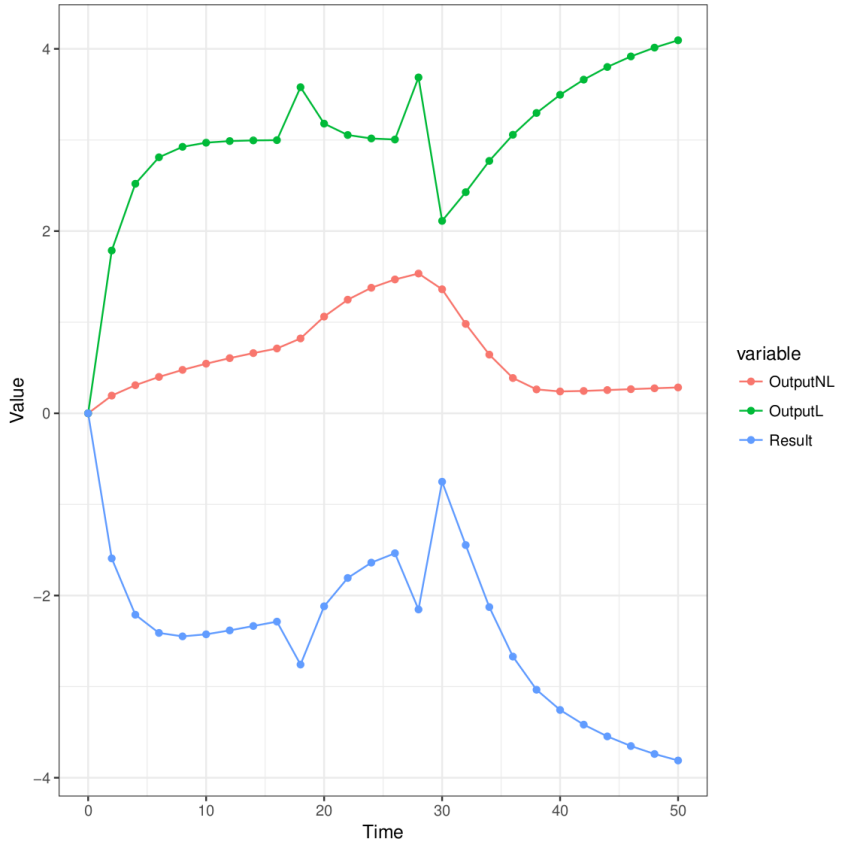
# Different inputs



# Combinations of issues



# Best corrective function

Can we find the best corrective function for our linear model?

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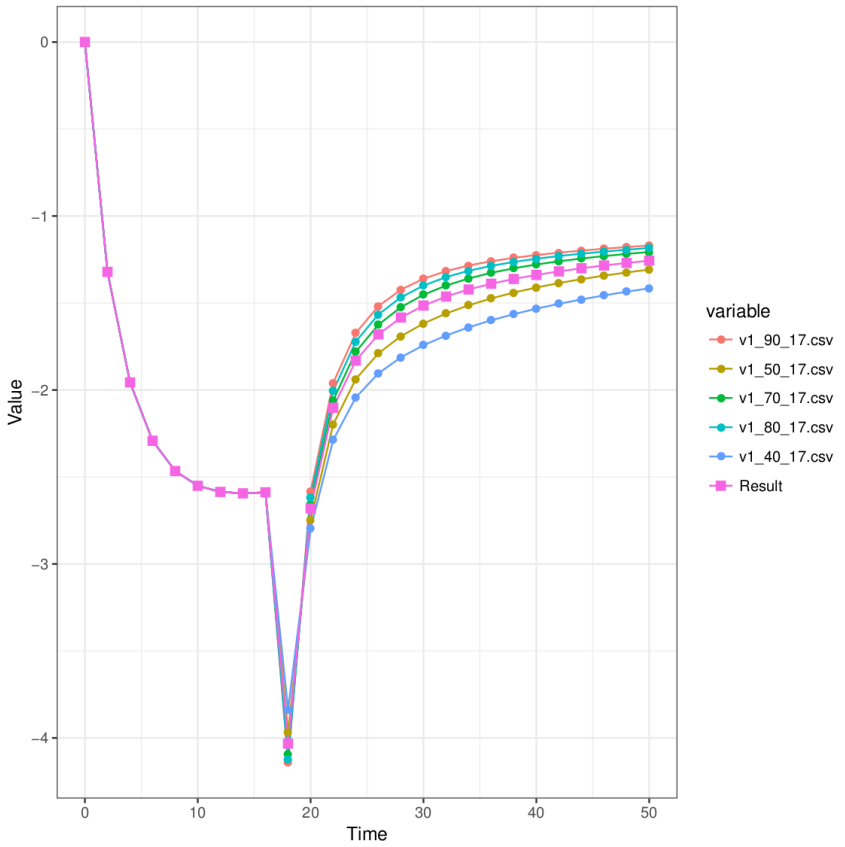
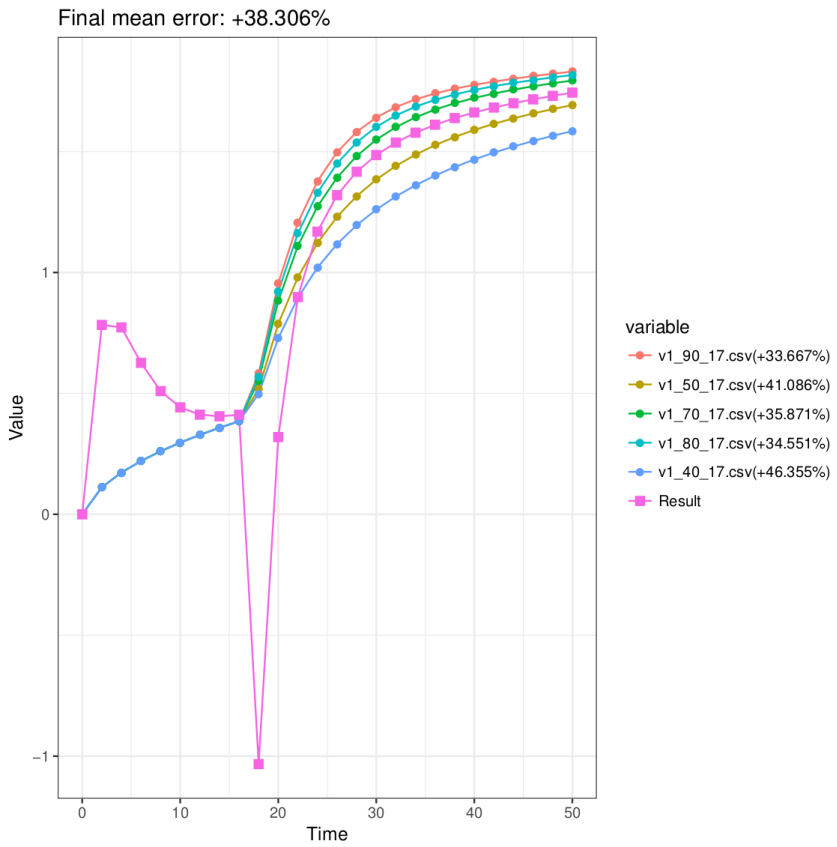
We are looking for a corrective function that could work in anytime for anything

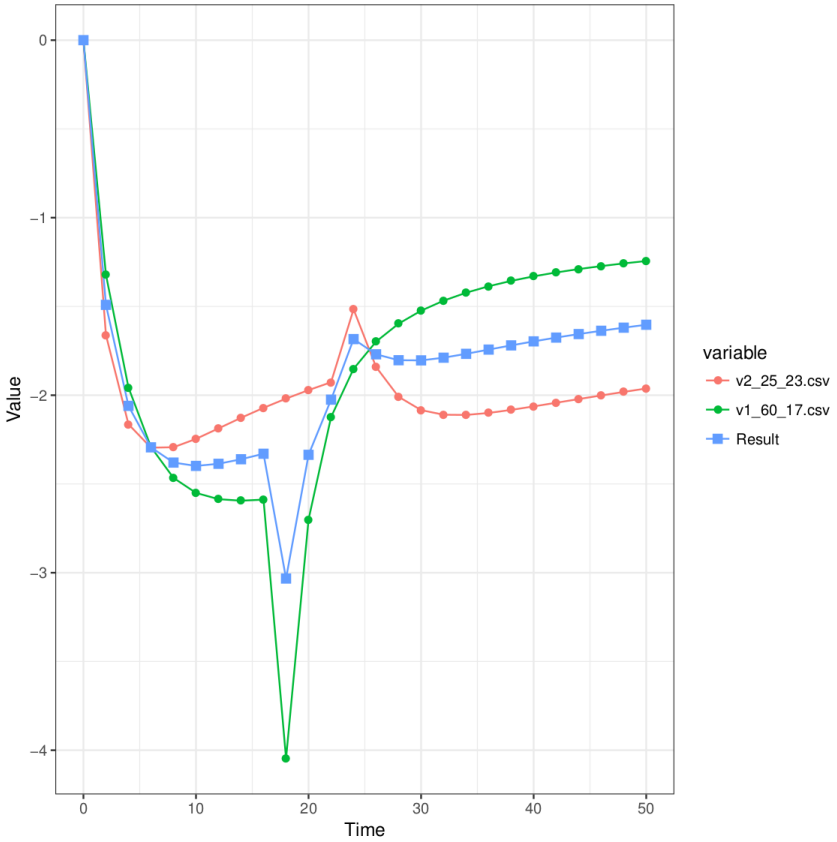
# "Best" for..

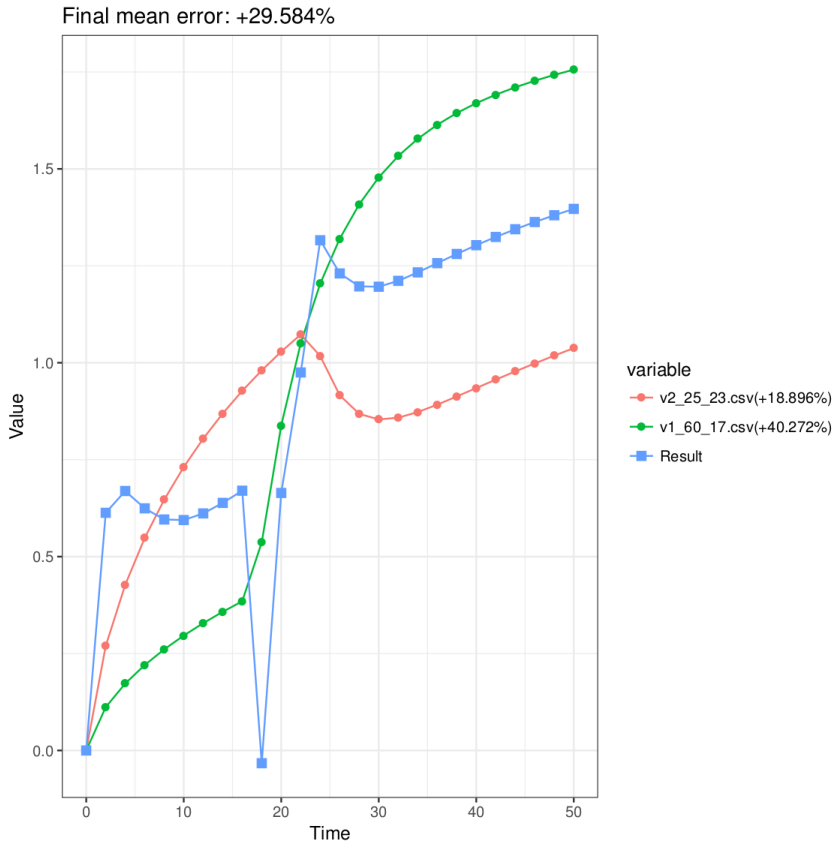
Combine different corrective function and find the optimal between them



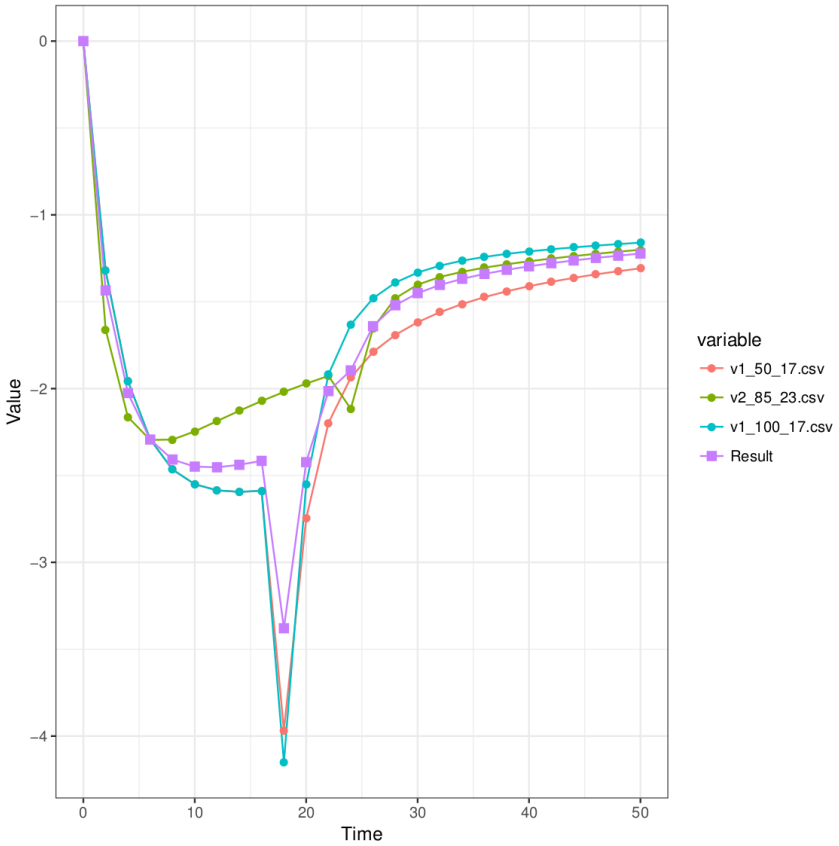



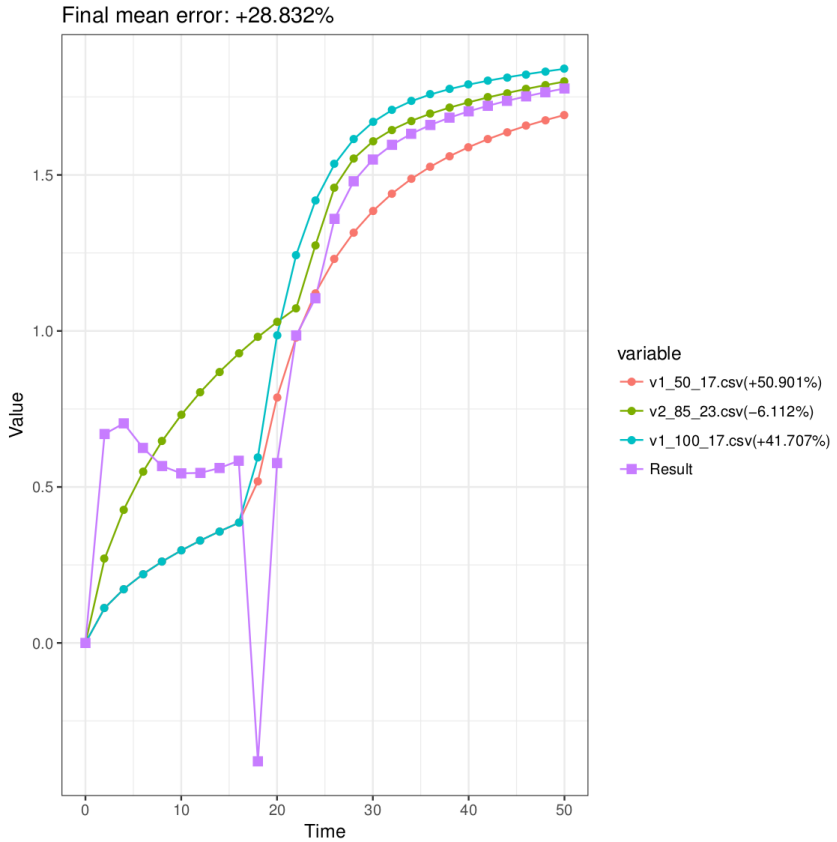
# "Best" for..


0
−1
−2
−3
−4
Value
0
10
20
30
40
50
Time
variable
v2_25_23.csv
v1_60_17.csv
Result

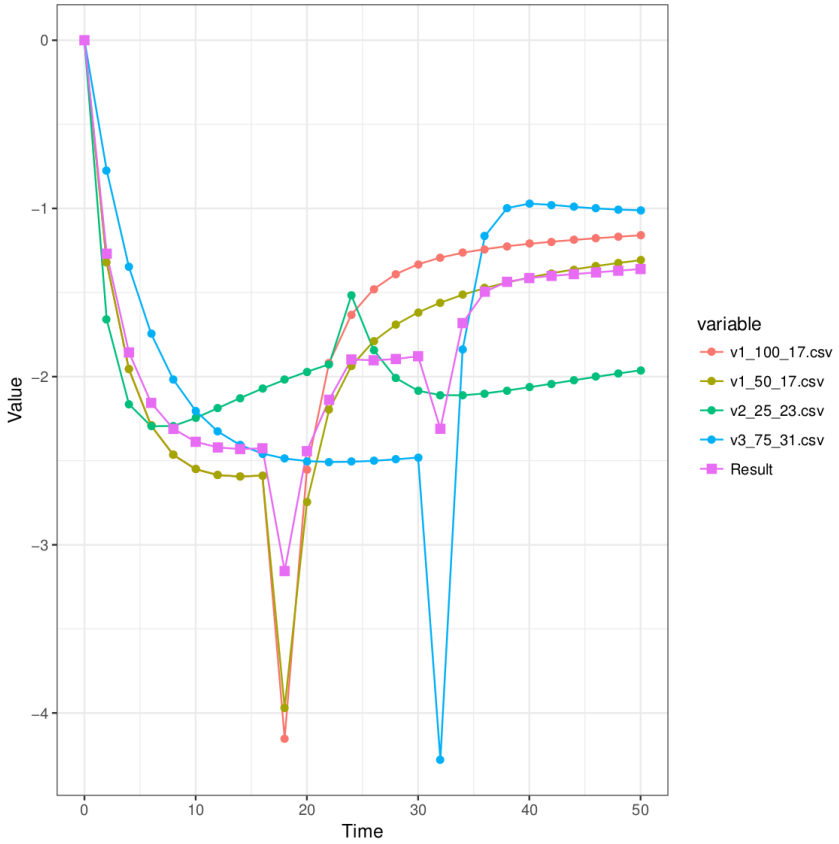

Final mean error: +29.584%
1.5
1.0
0.5
0.0
Value
0
10
20
30
40
50
Time
variable
v2_25_23.csv(+18.896%)
v1_60_17.csv(+40.272%)
Result

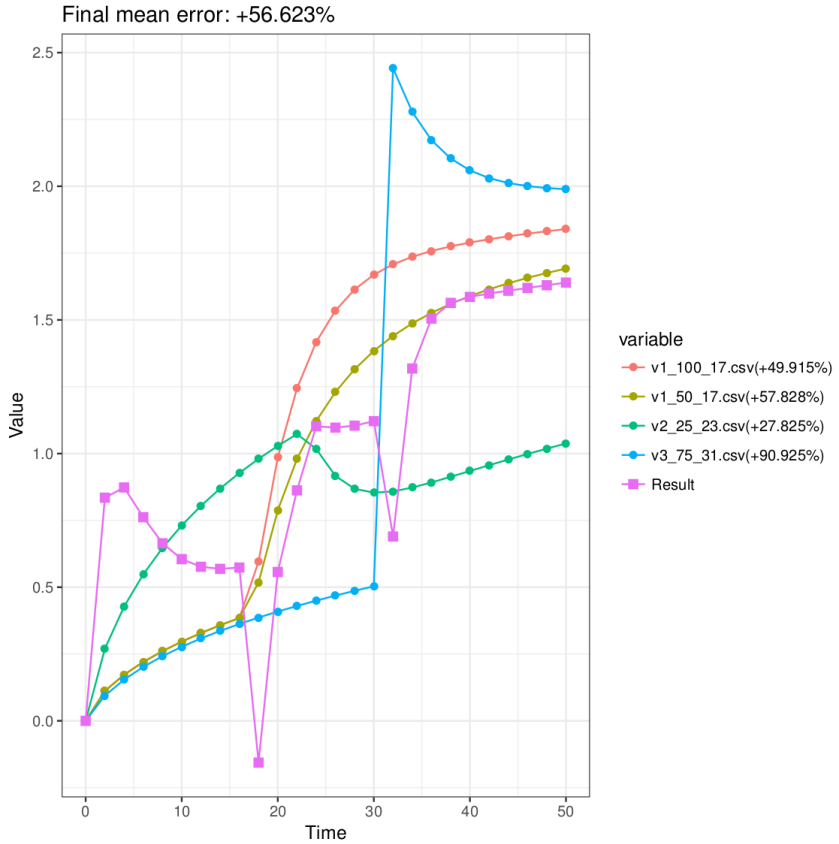
# "Best" for..


0
−1
−2
−3
−4
Value
0
10
20
30
40
50
Time
variable
v1_50_17.csv
v2_85_23.csv
v1_100_17.csv
Result


Final mean error: +28.832%
1.5
1.0
0.5
0.0
Value
0
10
20
30
40
50
Time
variable
v1_50_17.csv(+50.901%)
v2_85_23.csv(−6.112%)
v1_100_17.csv(+41.707%)
Result

# "Best" for..


0
−1
−2
−3
−4
Value
0
10
20
30
40
50
Time
variable
v1_100_17.csv
v1_50_17.csv
v2_25_23.csv
v3_75_31.csv
Result


Final mean error: +56.623%
2.5
2.0
1.5
1.0
0.5
0.0
Value
0
10
20
30
40
50
Time
variable
v1_100_17.csv(+49.915%)
v1_50_17.csv(+57.828%)
v2_25_23.csv(+27.825%)
v3_75_31.csv(+90.925%)
Result

# Observations

- Multi issues independent

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- Initial adapting time

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- Require smoothing on spikes

# Diagnosis

Reversing the process and try to understand which issue has arisen knowing how the surrogate model behaved in that scenario

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**Series of SVM:** train an SVM for each known problem and use it to identify it when it occurs

**Neural Network**


Thank
You