Analyzing Simulations with Machine Learning

LS-Dyna Forum Germany

15th-17th of October 2018 - C. Diez

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What's the motivation?
What automation possibilities exist?
What are new techologies?

What's the motivation?

Manual Work

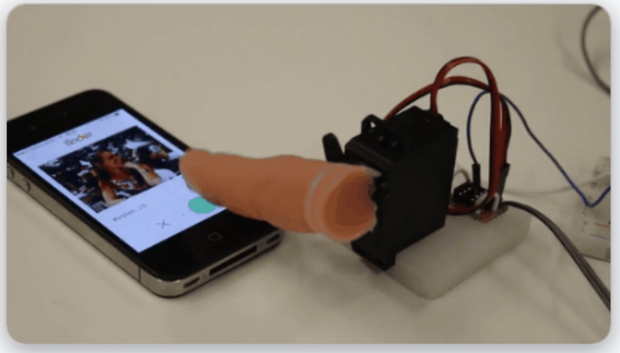
CAE Pre- and Postprocessing is a lot of manual work ...

... and manual work is expensive

Automation

That's why we have powerful CAE tools ...

... and with these tools comes scripting



Future Automation

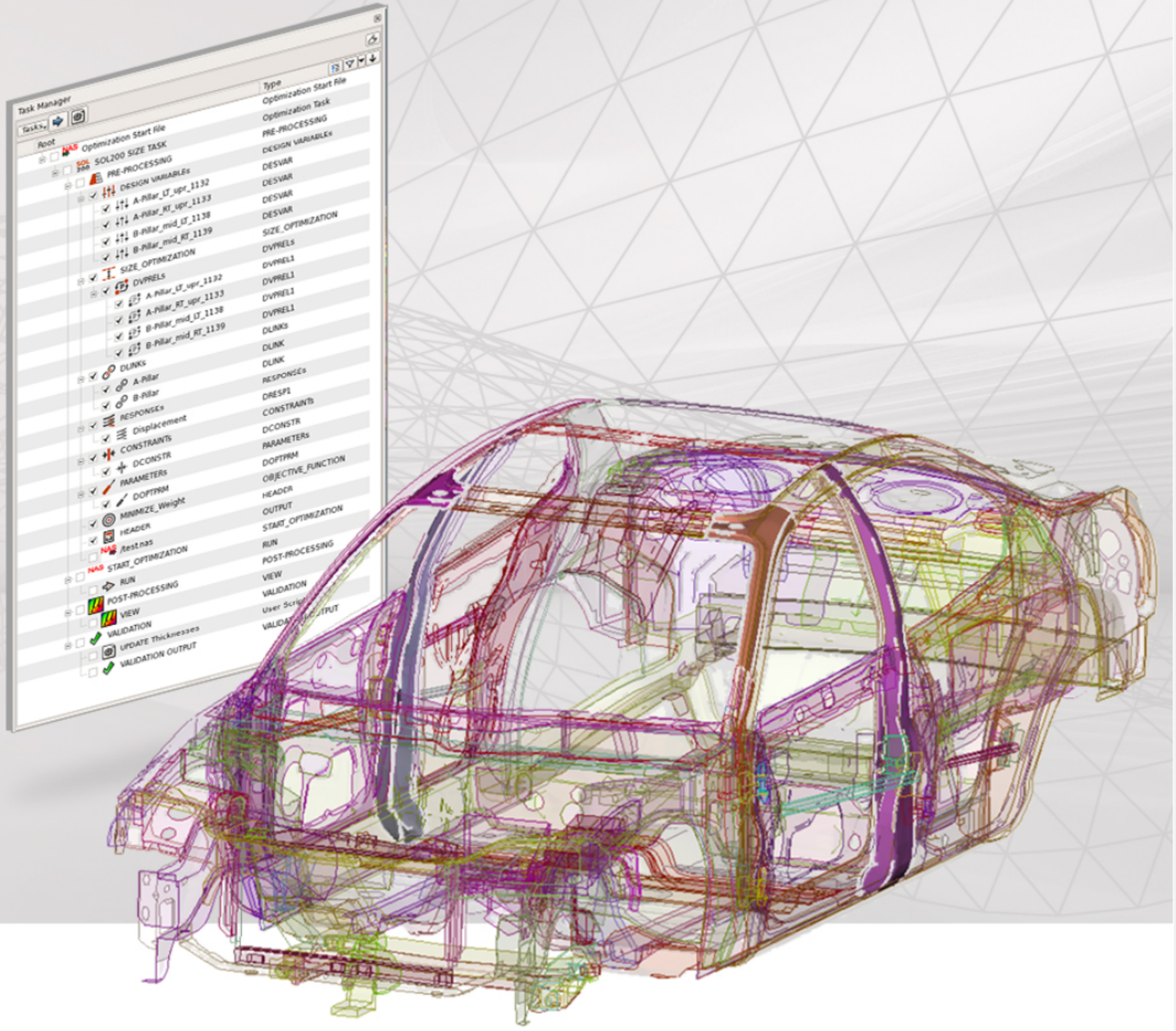
For automation to get more advanced ...

... it requires proper technology

What are the applicable domains?

CAE

- **Pre-Processing**
- **Solver-Domain**
- **Post-Processing**



Machine Learning

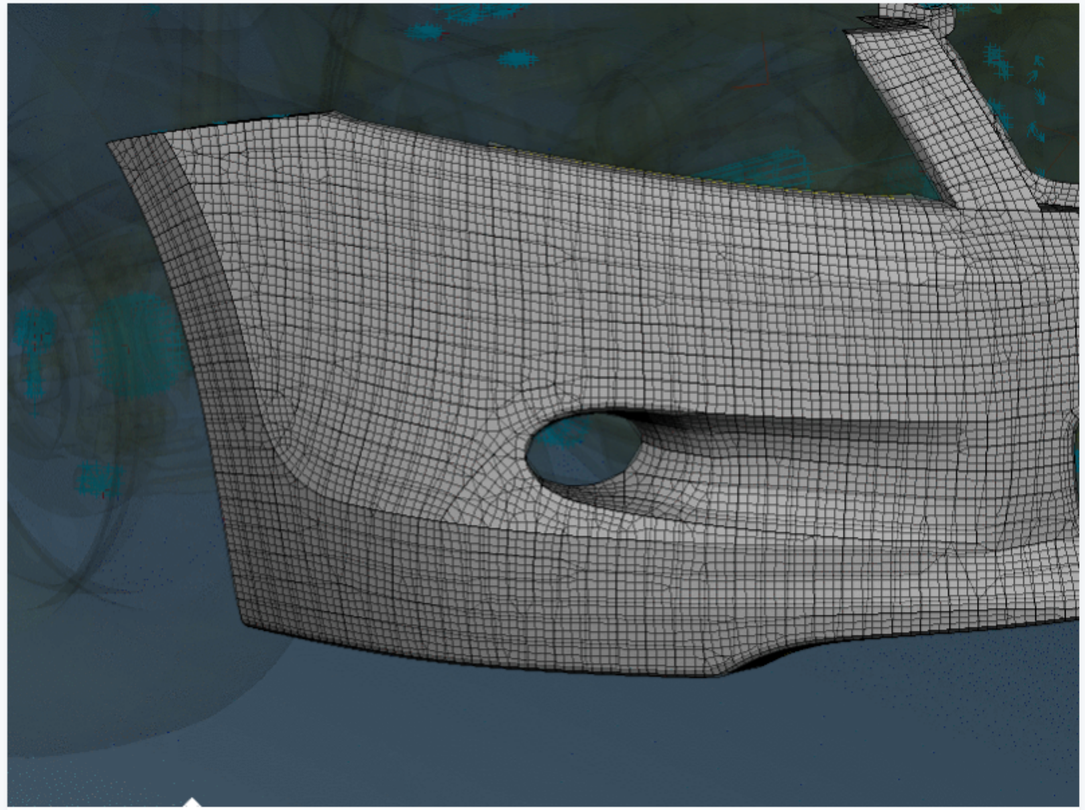
- **Unsupervised Learning**
  "I want to look at the data first ..."
- **Semi-Supervised Learning**
  "I know what a fraction of the data does ..."
- **Supervised Learning**
  "I know what one dataset does ..."
- **Reinforcement Learning**
  "I want to automate a human task ..."


TECHNOLOGY WARNING

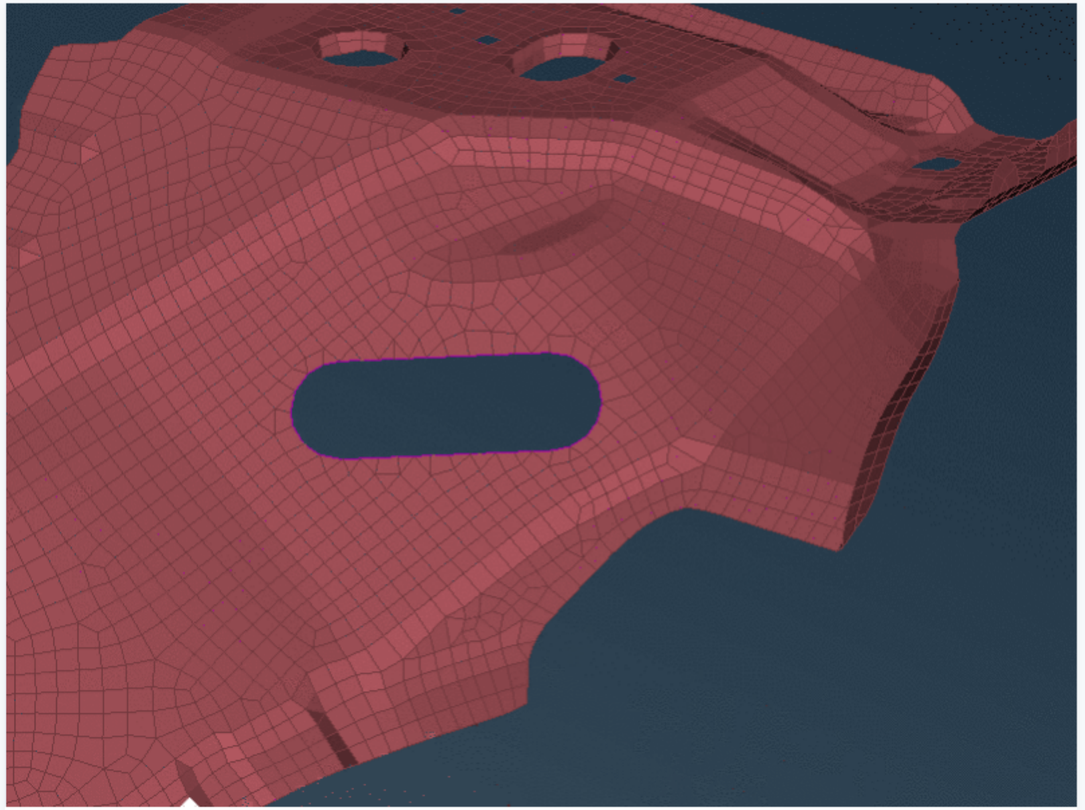
> [...] there is no “default” deep learning component which operates on arbitrary relational structure.

— *Peter W. Battaglia et. al (Google Brain, MIT, University of Edinburgh)*
Relational inductive biases, deep learning, and graph networks (4.6.2018)

CAE Challenges

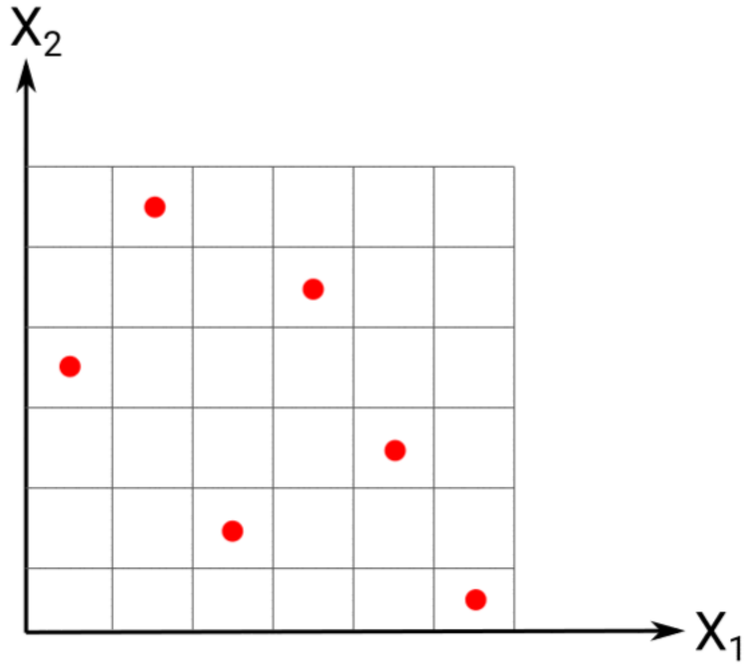


DIFFERENT MESHES

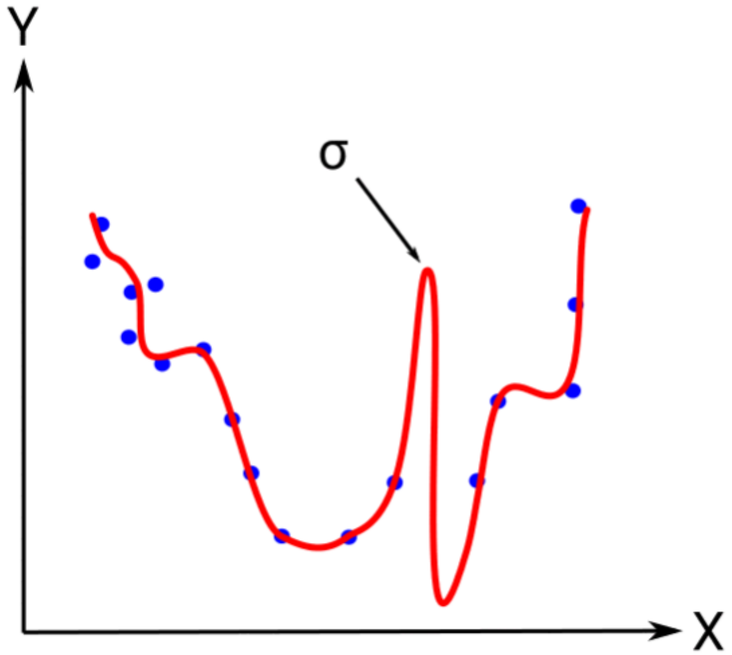


DIFFERENT VERSIONS

Machine Learning Challenges



SAMPLE COUNTS

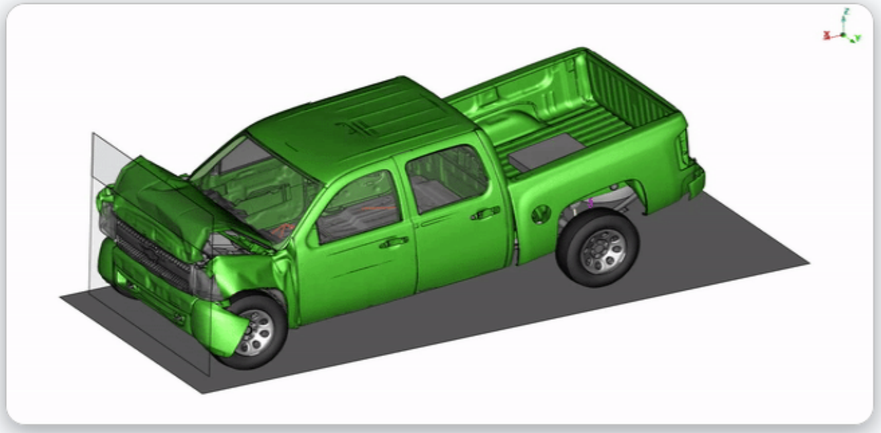


RELIABILITY & USER-FRIENDLINESS

Let's look at an example!

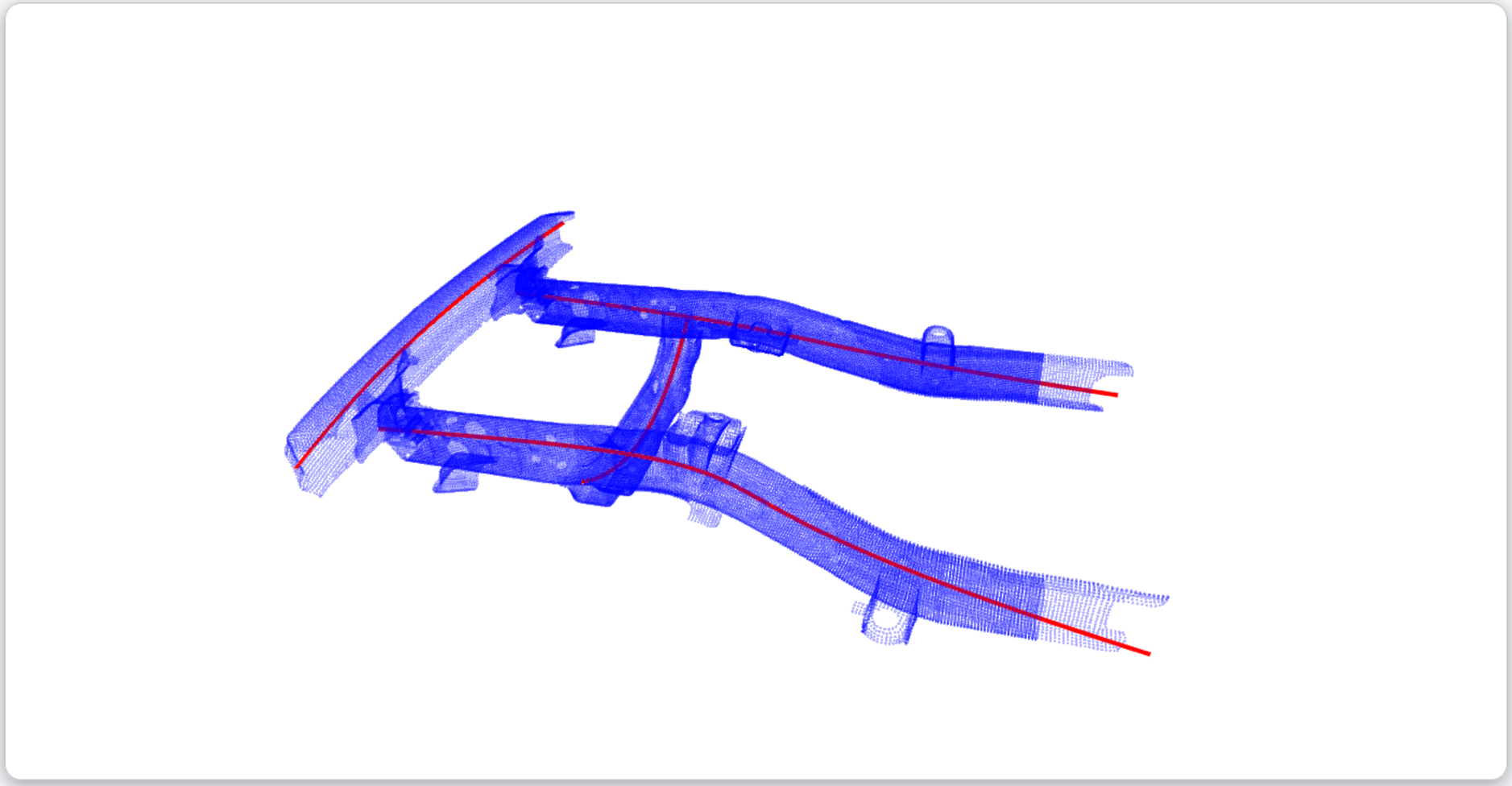
Unsupservised Learning

Comparison of 1000 simulations by using an algorithm.



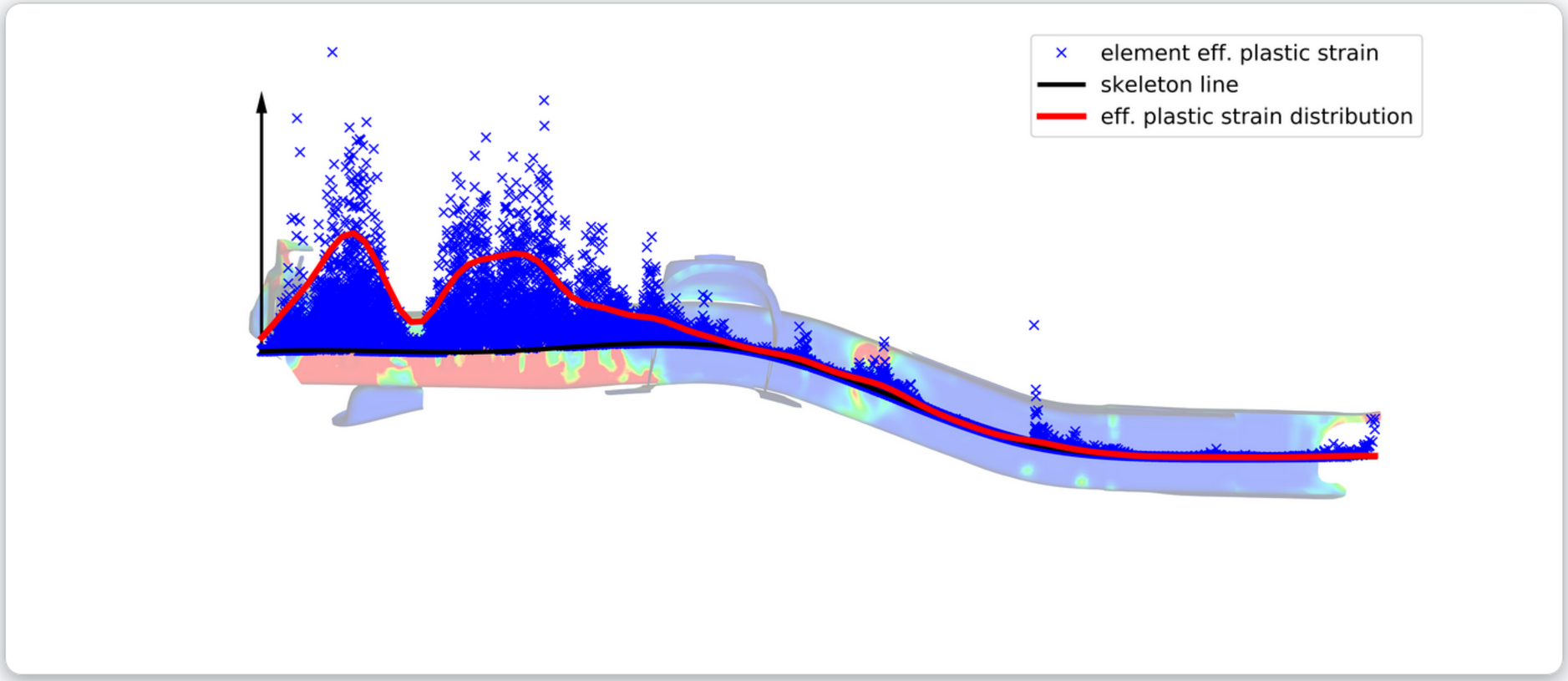
Model Simplification

Focus on relevant crash structure



Result Hashing

Distribution Function of Plastic Strain

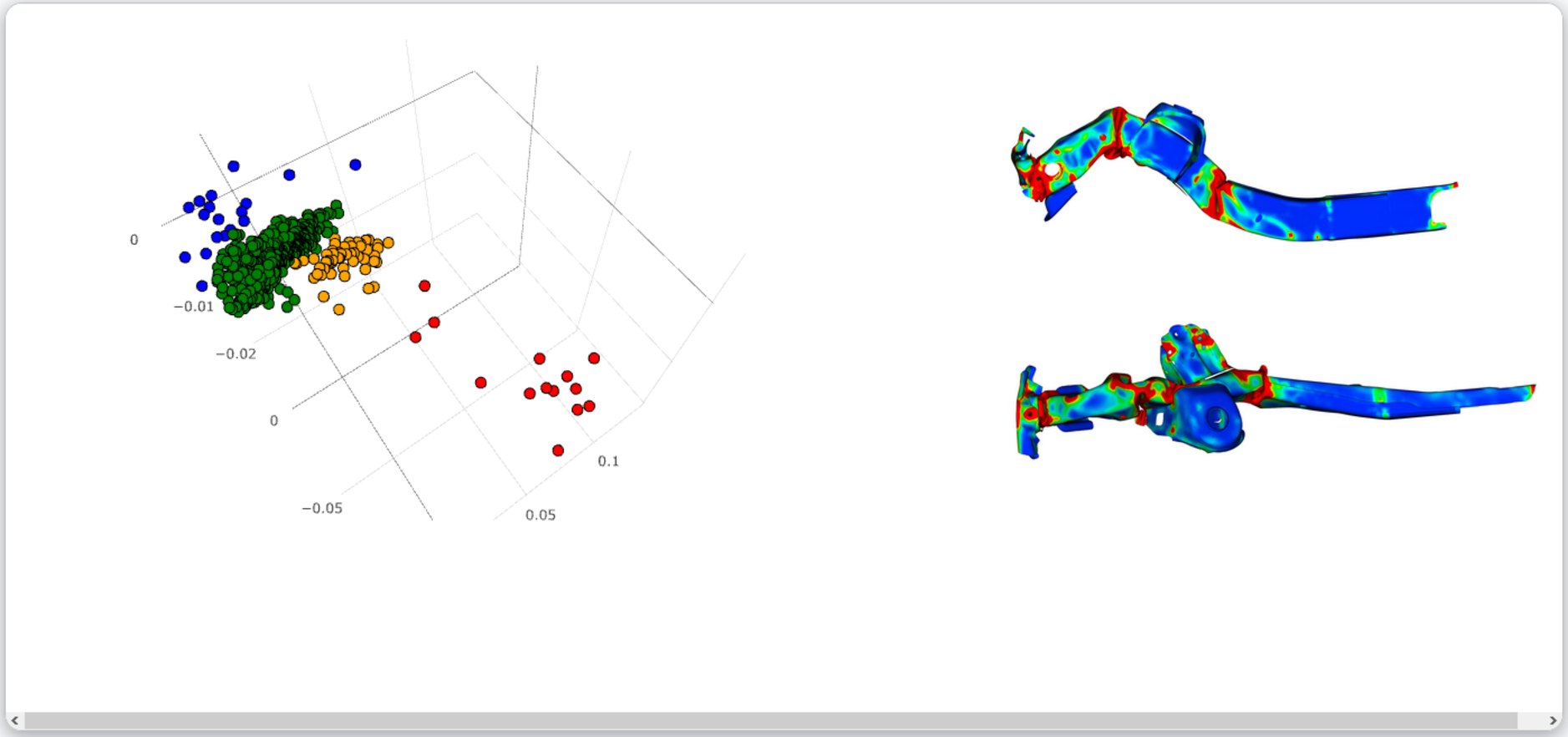


‹ PREV NEXT ›

1 2 3 4 5

Unsupervised Learning

Visualize similarity of 1000 simulations (left rail).



How to avoid the red cluster with bending samples?

Supervised Learning

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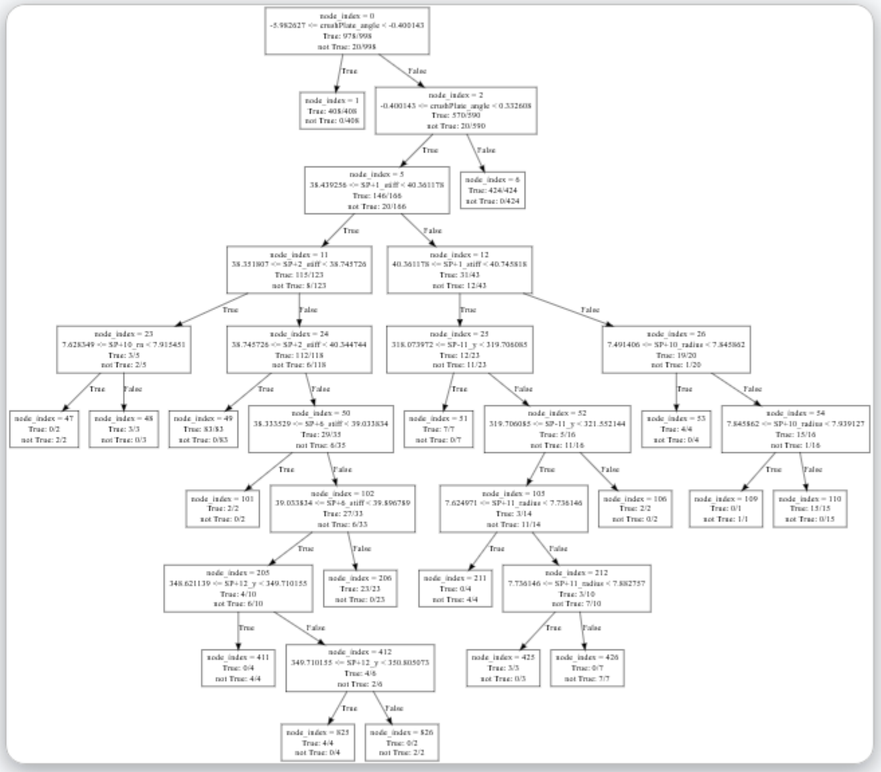
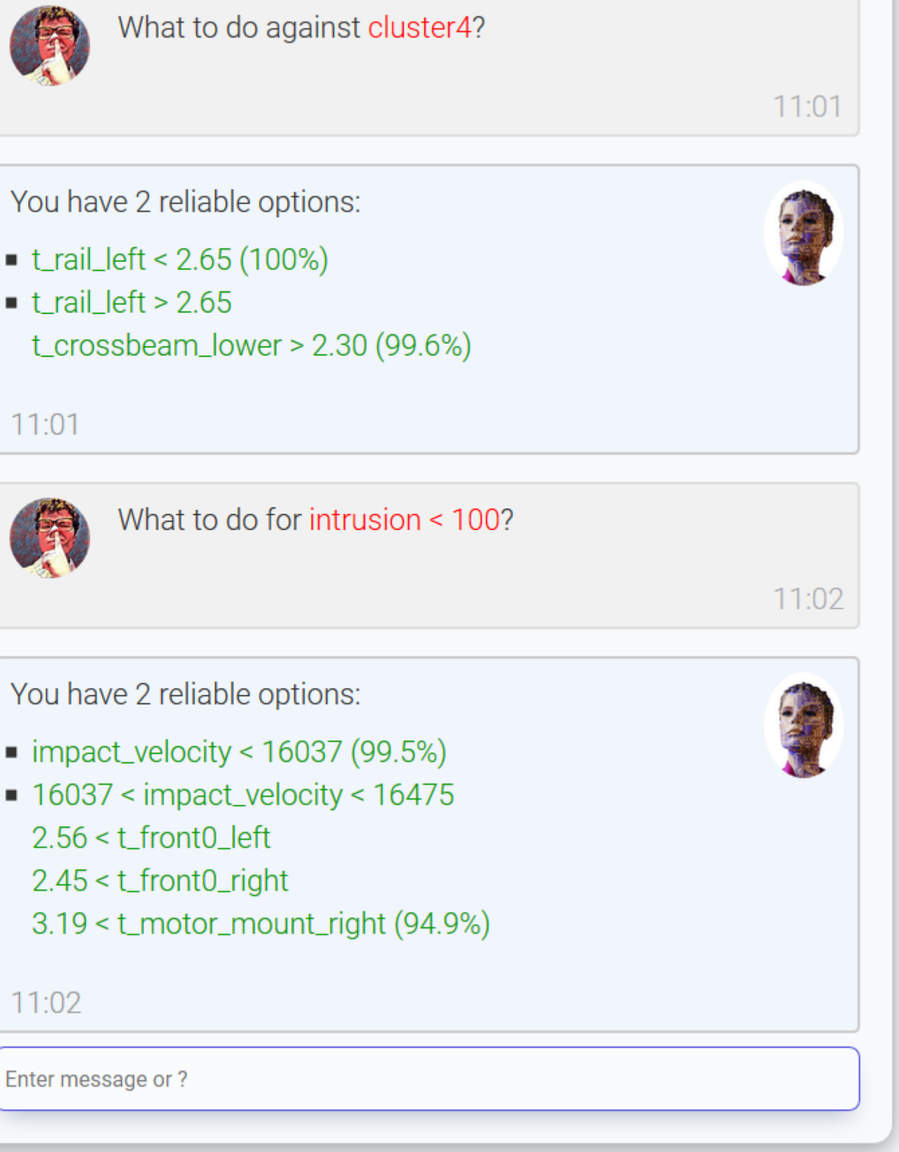
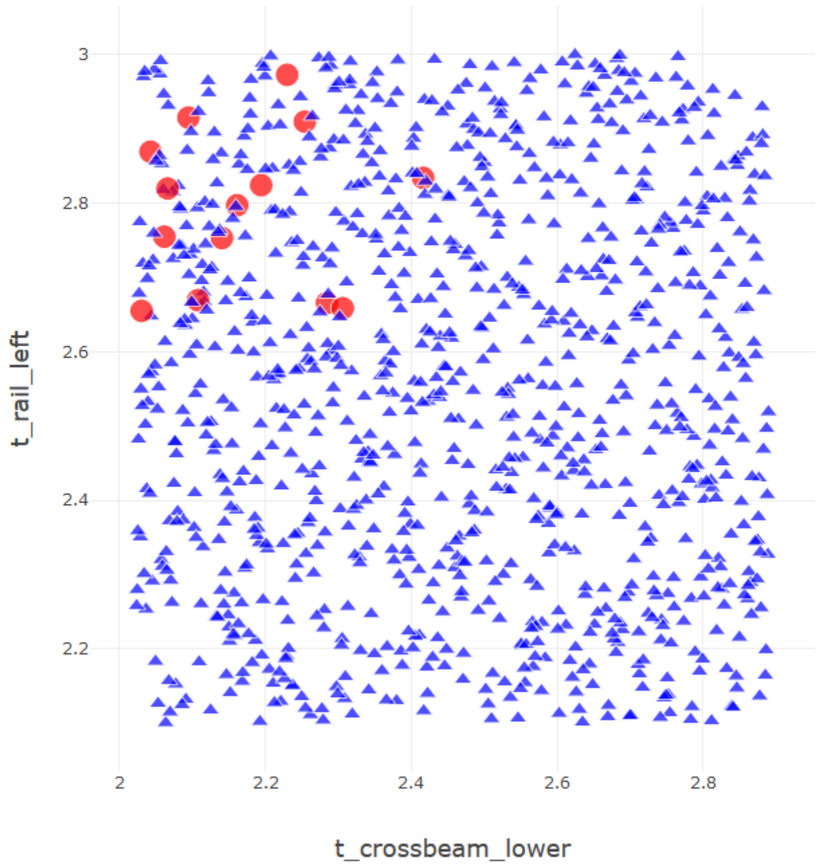


Supervised Learning

Ask an AI for Design Recommendations.





What to do against cluster4?

11:01

You have 2 reliable options:

- t_rail_left < 2.65 (100%)
- t_rail_left > 2.65
  t_crossbeam_lower > 2.30 (99.6%)

11:01

What to do for intrusion < 100?

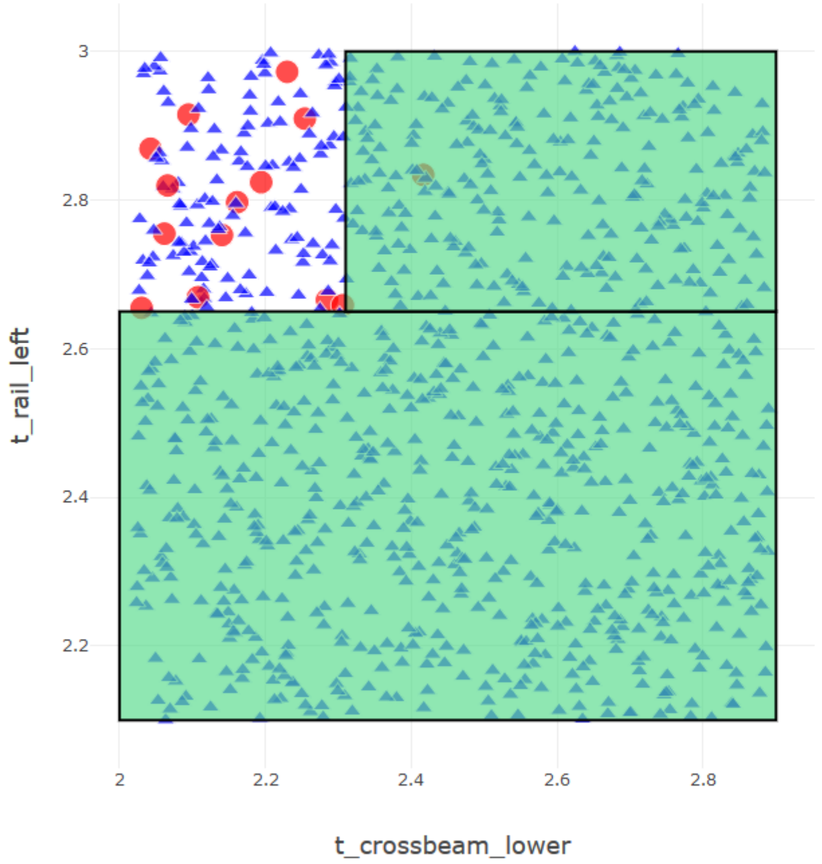
11:02

You have 2 reliable options:

- impact_velocity < 16037 (99.5%)
- 16037 < impact_velocity < 16475
  2.56 < t_front0_left
  2.45 < t_front0_right
  3.19 < t_motor_mount_right (94.9%)

11:02

Enter message or ?



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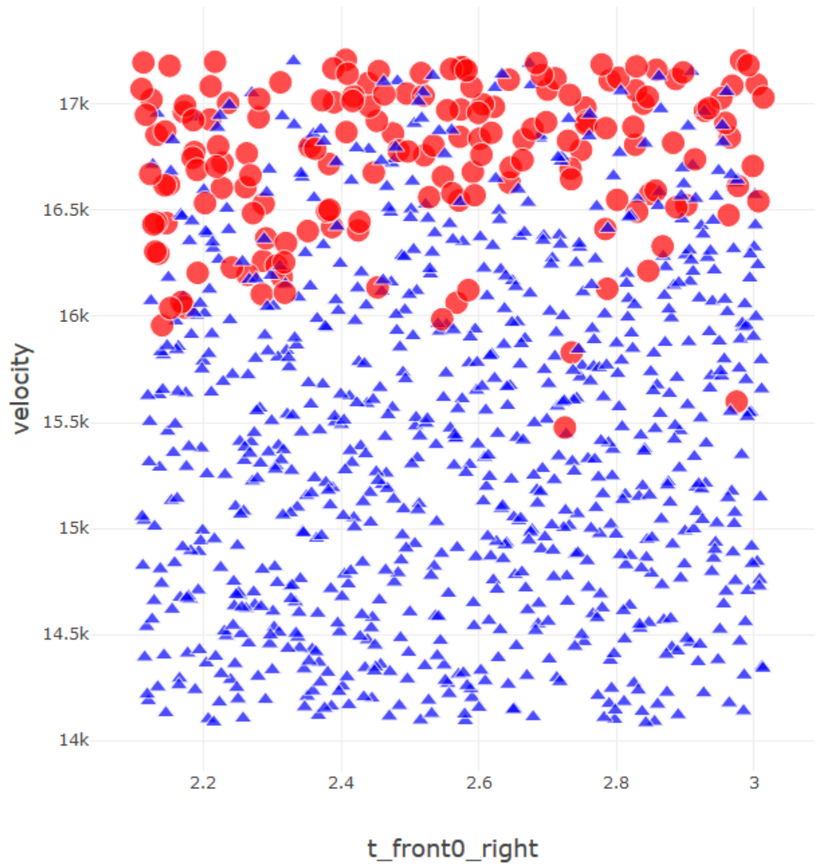

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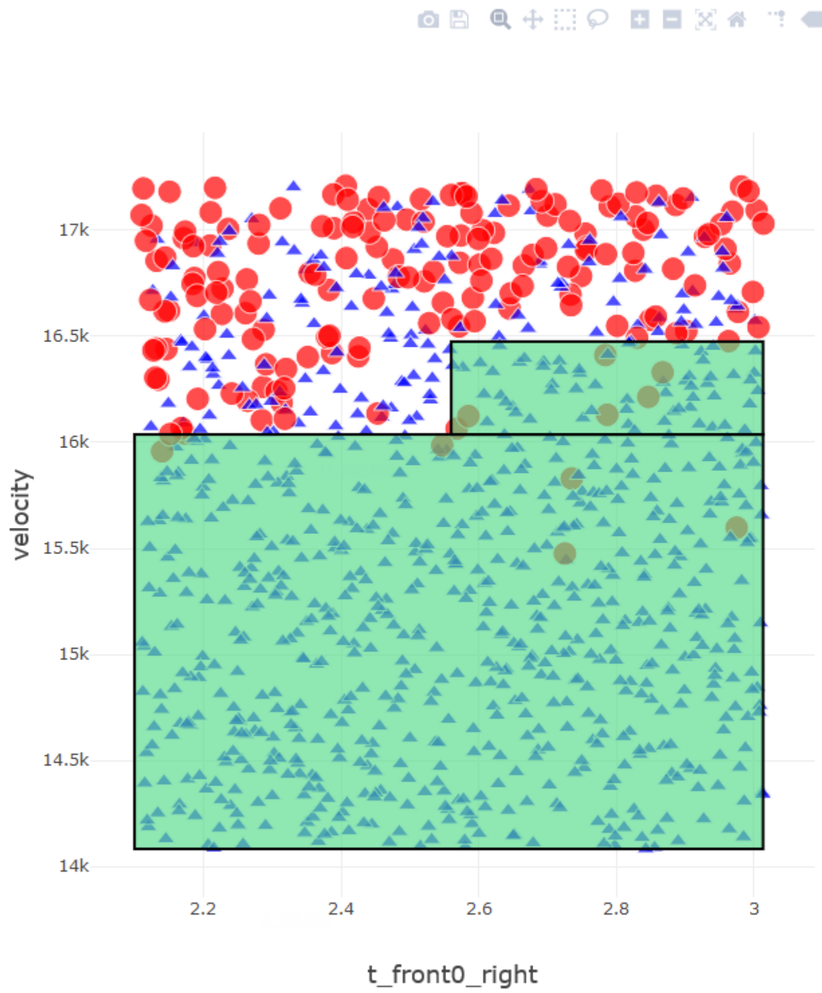

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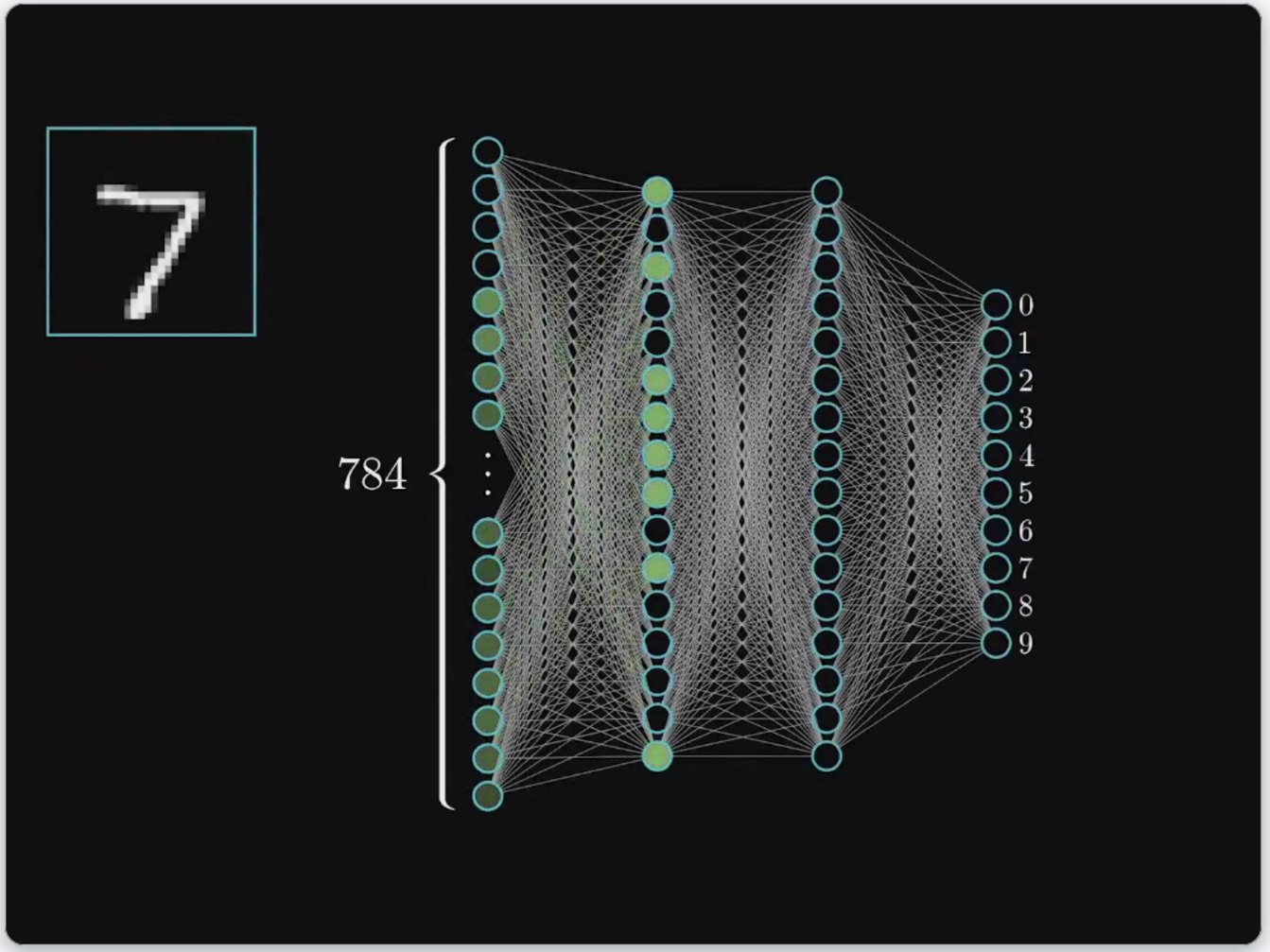
Neural Networks

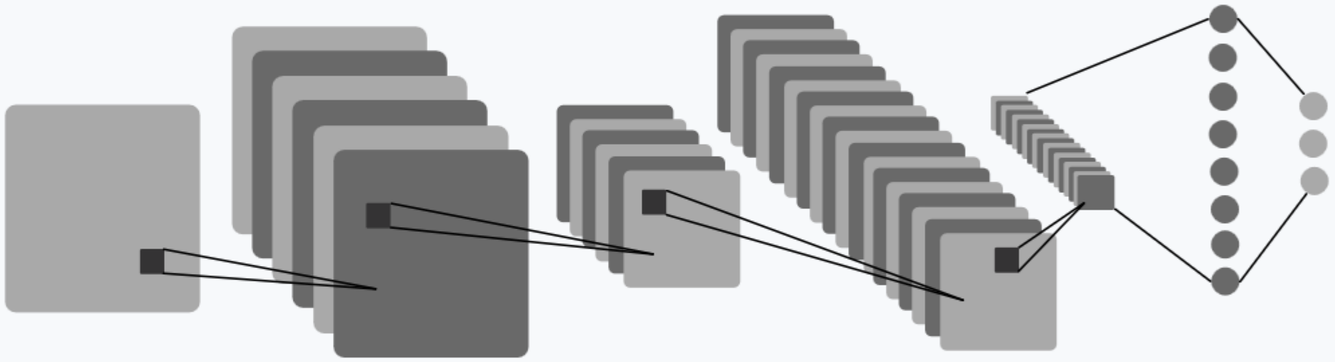
See data as a vector and throw it into a network ...



Source Youtube

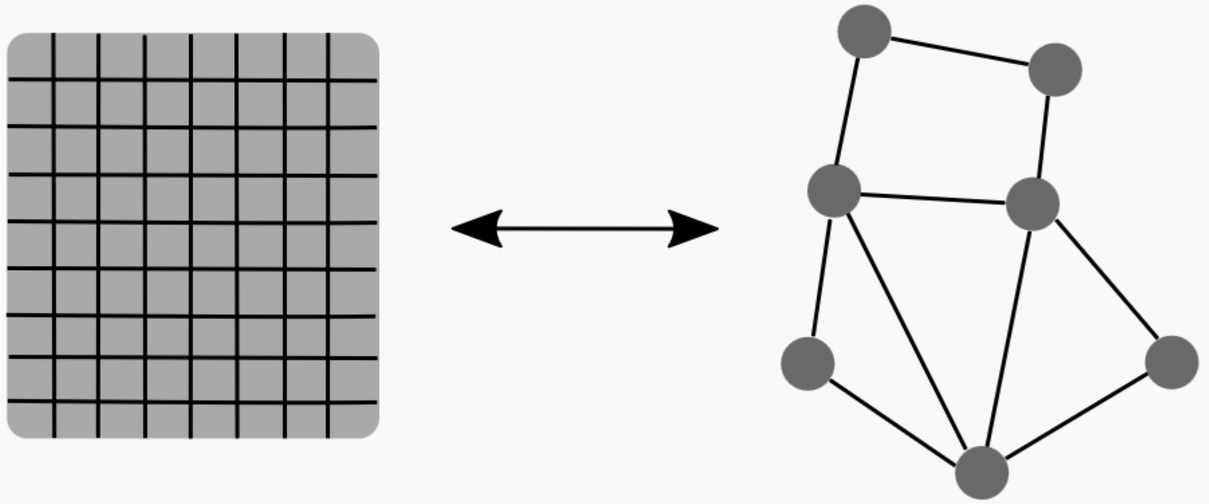
Convolutional Networks

Use spatial correlation in data.



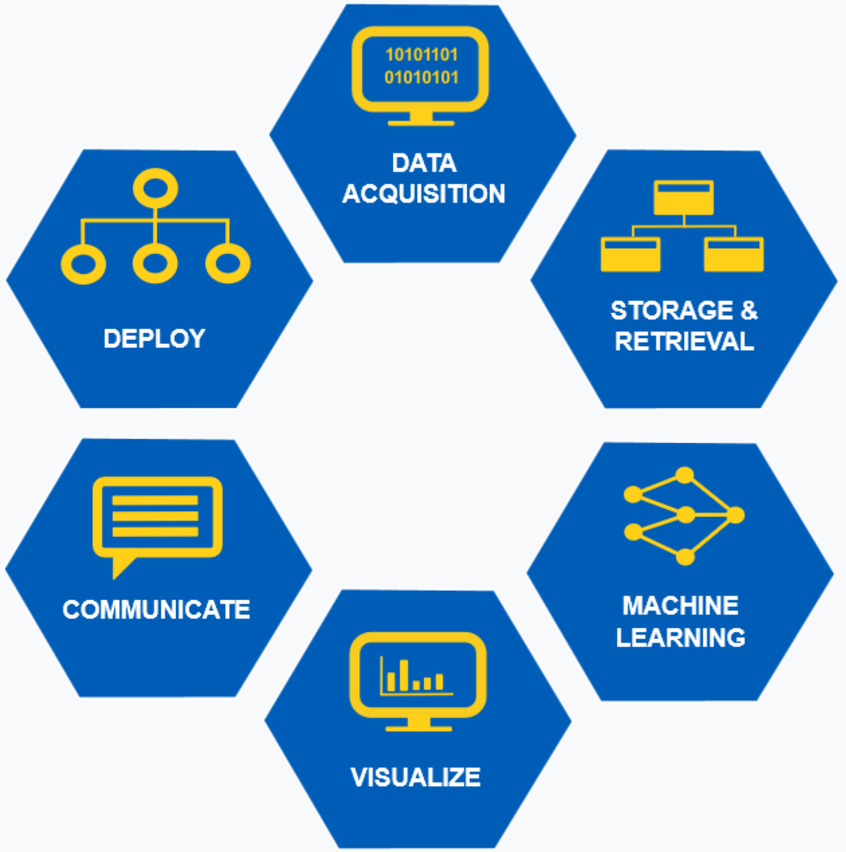
Graph Conv Nets

Work on irregular structures.



Be aware many problems are still around us ...

Data Science



Our Services

- Consulting (Strategic, Algorithms, ...)
- Analyze sets of simulations
- Build and deploy tailored solutions

LASSO

Machine Learning CAE Services

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