MACHINE LEARNING ALGORITHMS FOR RATTLING DETECTION

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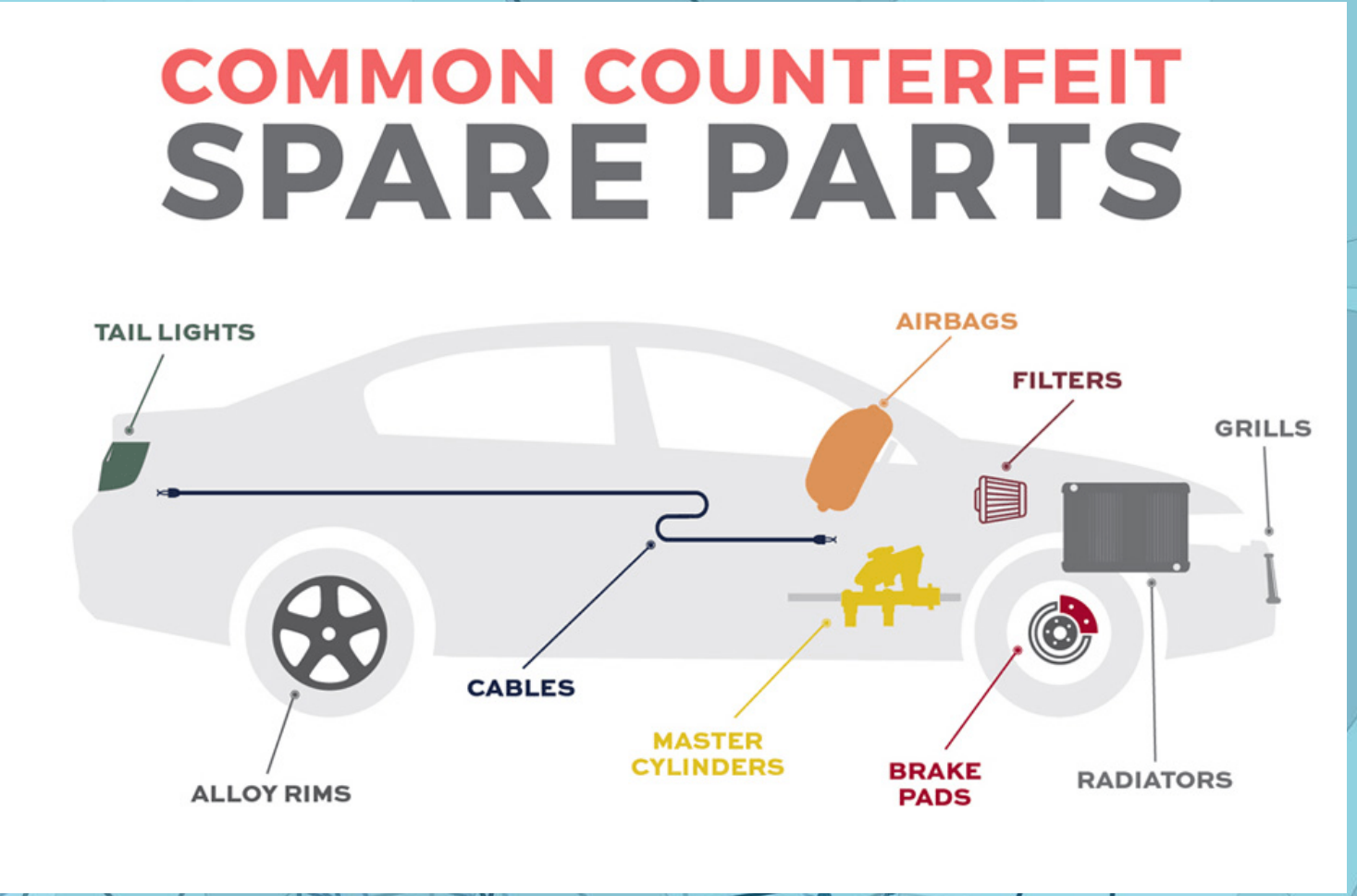
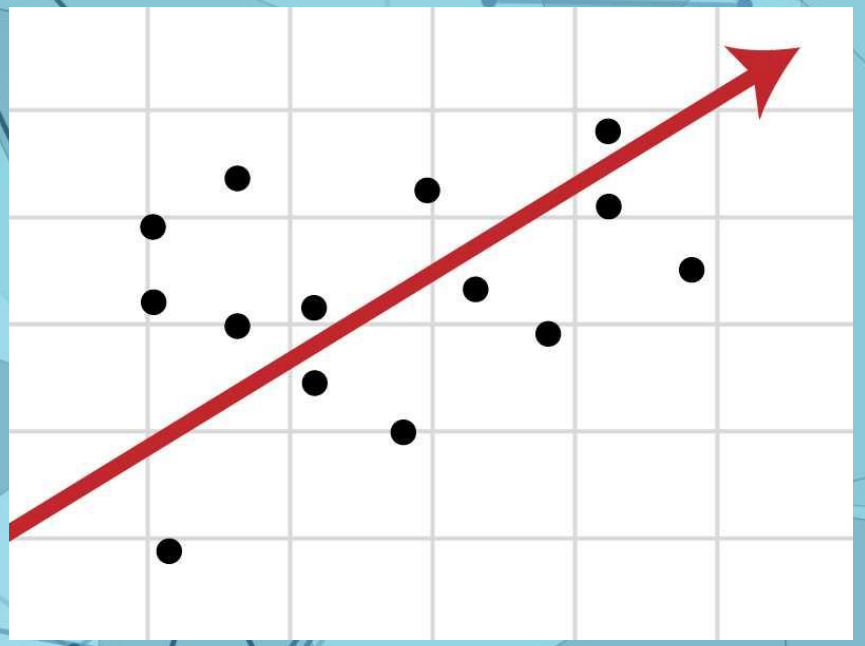
Introduction

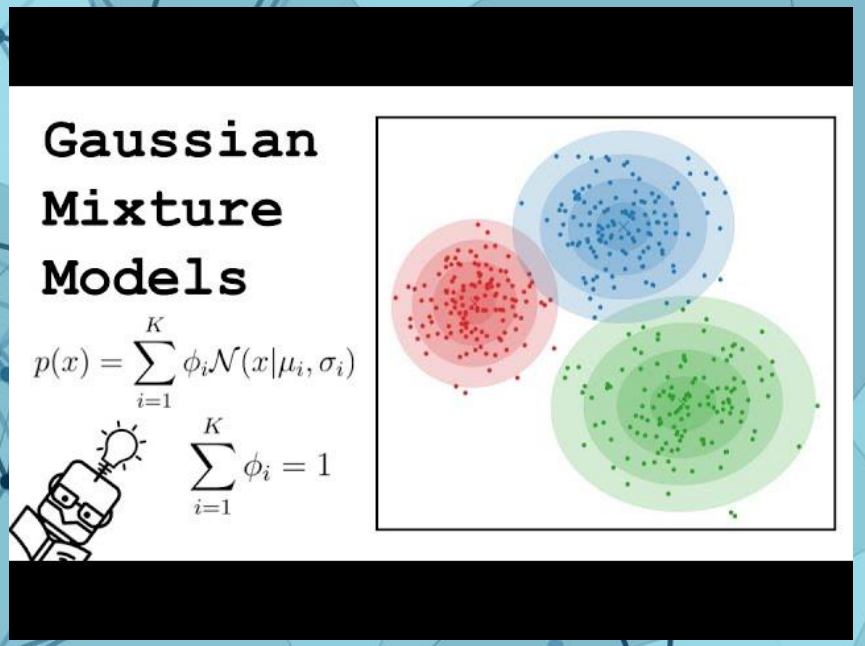
- Importance of detecting design flaws and faulty components in automotive manufacturing
- Using noise to infer defects
- Project aim: Develop ML models to localize noise sources from vibration measurements



Approach overview

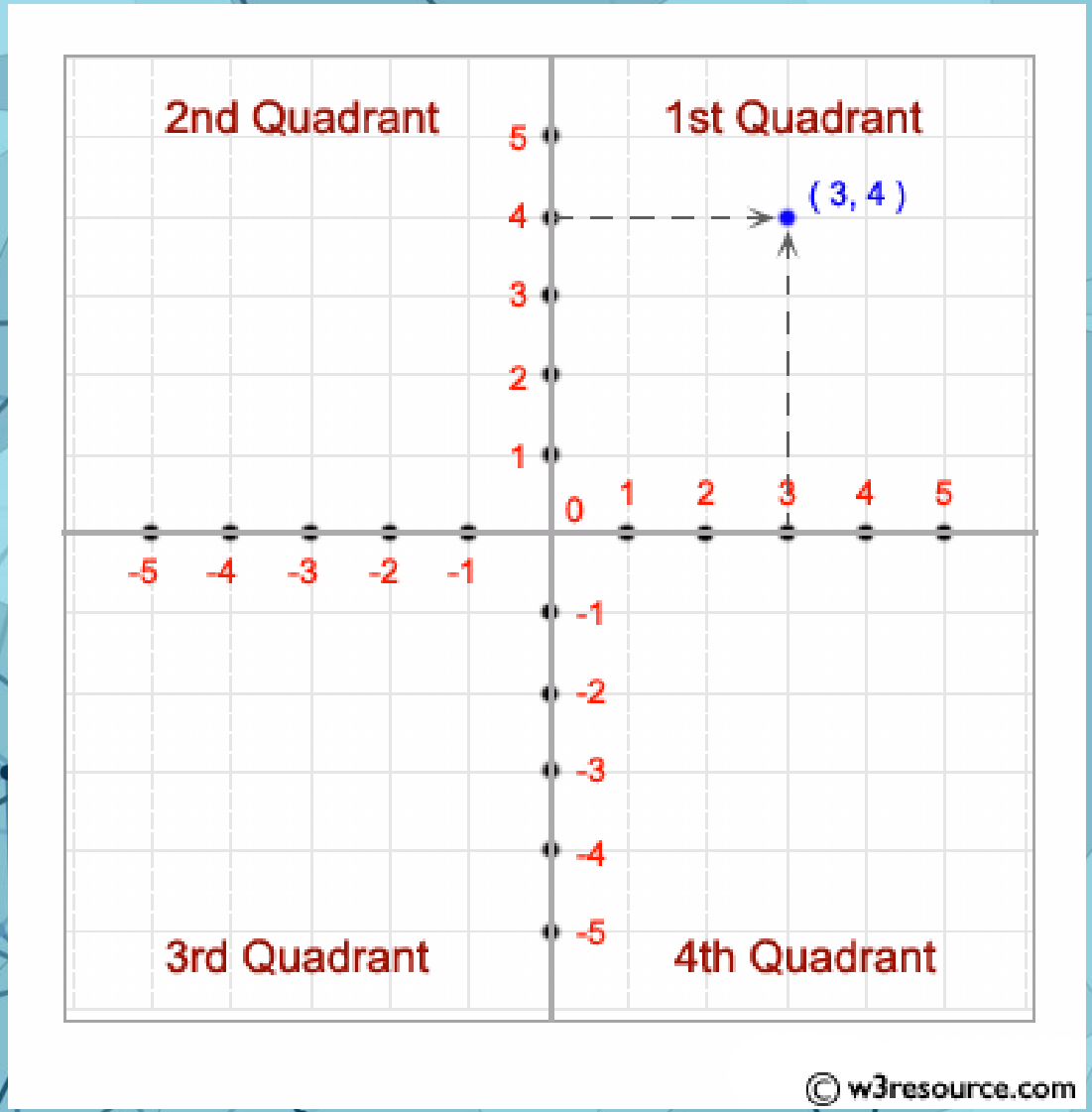
- Goal: Predict the measurement location which is equivalent to infer the excitation point
- Two methods:
  - Regression for distance estimation
  - Discretization by dividing the component into parts





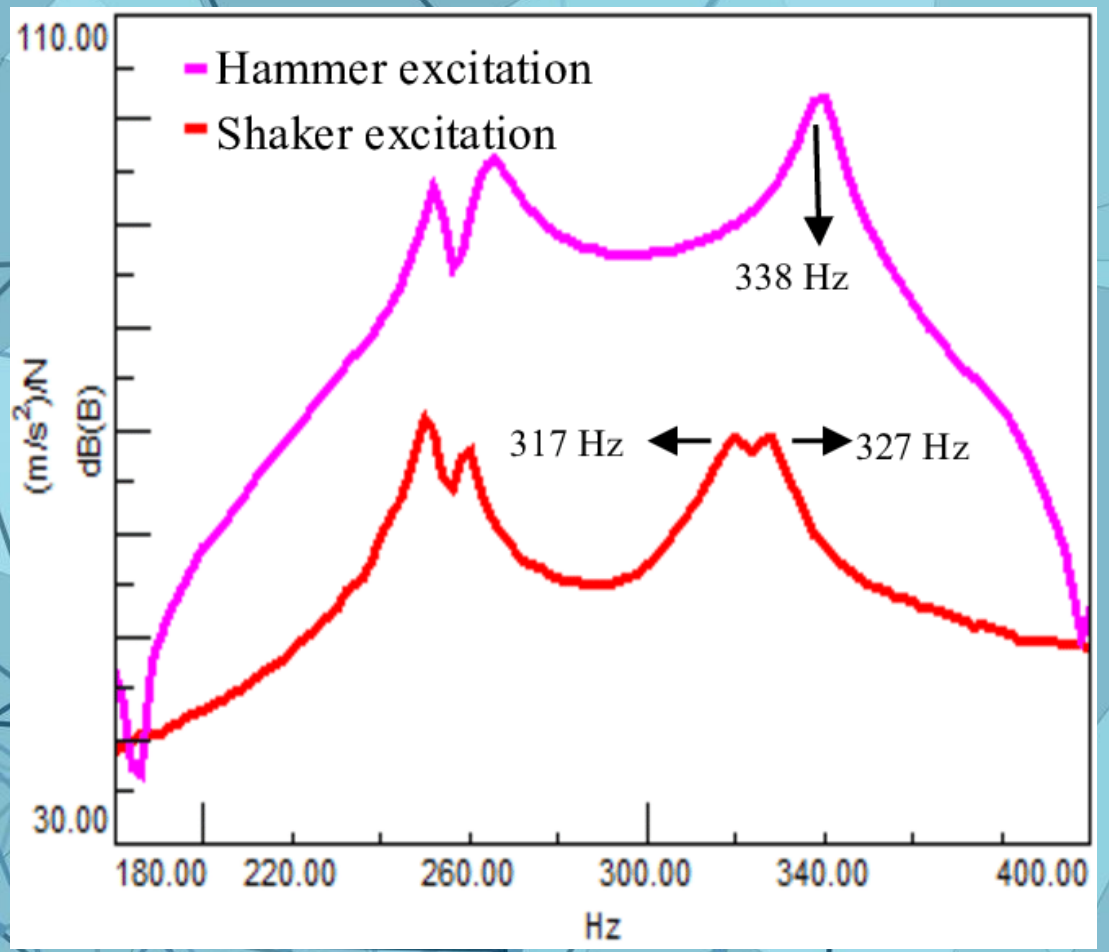
Formal task description

- Coordinate system setup
- Storing excitation and measurement points with coordinates and indices
- Grouping points using clustering algorithms (K-means, Gaussian Mixture)



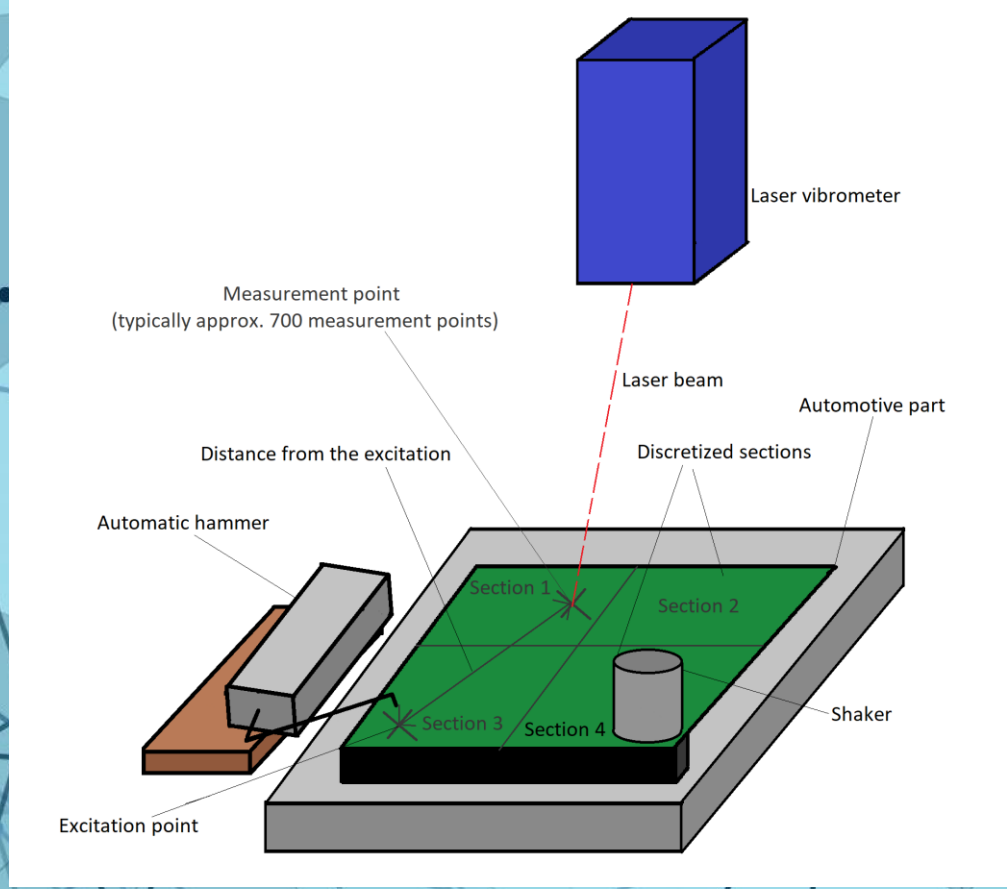
Generalization challenges

- Different forces (Newton): Generalize from larger to smaller forces
- Different excitation shapes: Models generally robust
- Distance prediction: Mean error 1 cm to 7 cm
- Different automotive parts: Mean error 18 cm to 77 cm



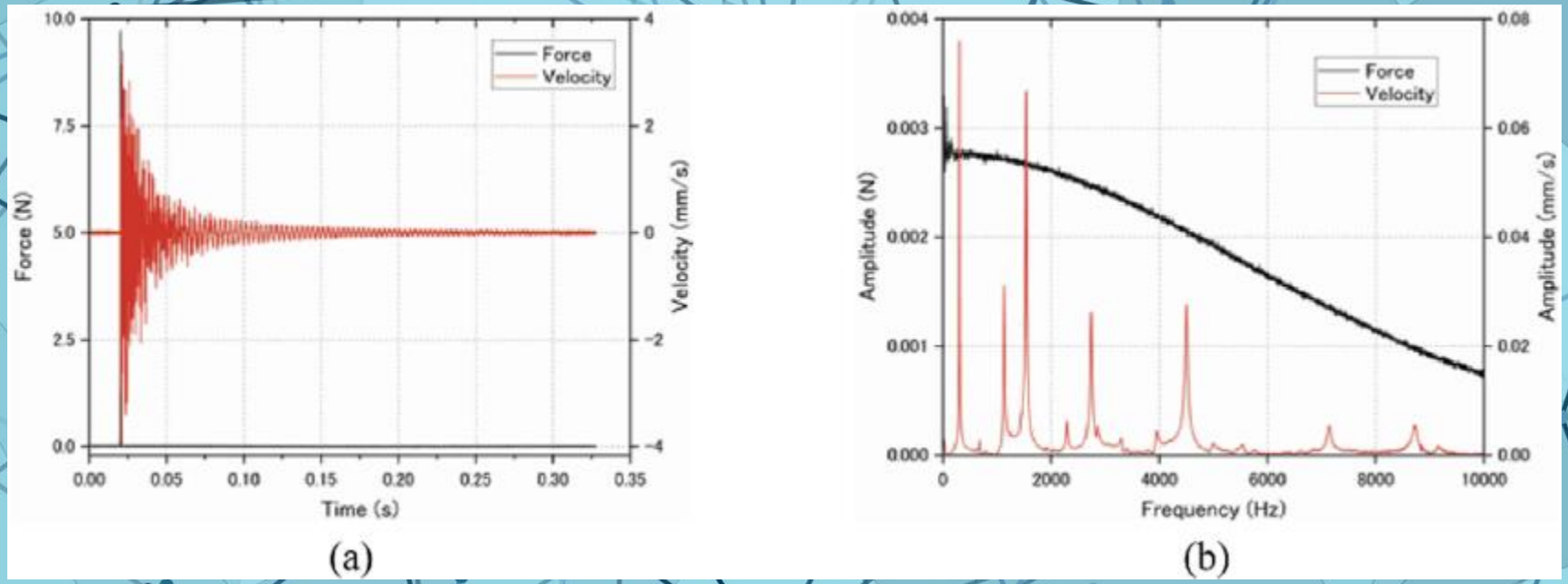
Measurement setup

- Excitation with automatic hammer
- Vibration measured with laser vibrometer
- Resulting in velocity-time signals



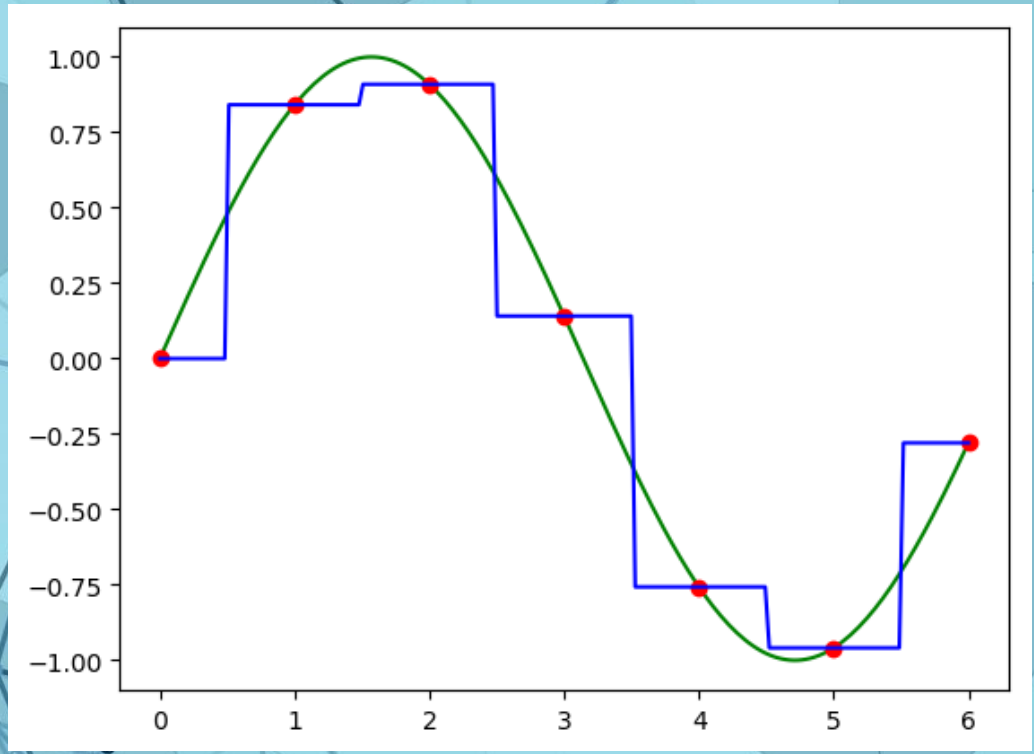
Categorization of the data

- Excitation shapes: Single, double, triple, etc.
- Force applied
- Direction of excitation: +Z or –Z
- Location of excitation: Logical association with distance estimation



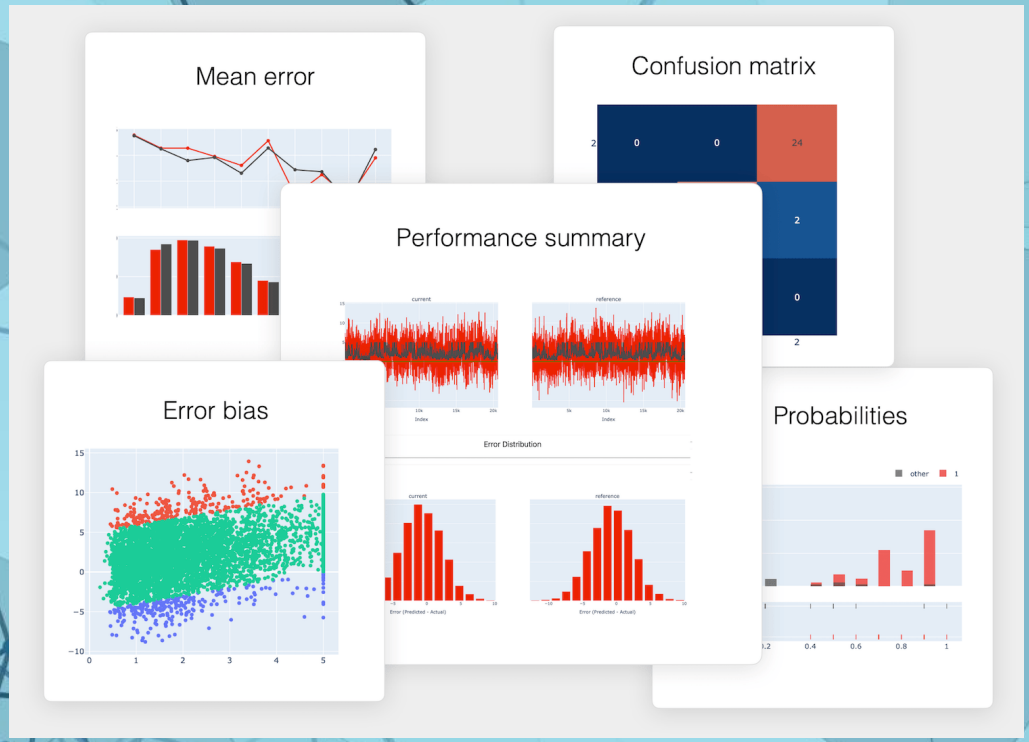
Prediction methods

- Distance estimate by interpolation: Nearest neighbor approach
- Triangulation: Using three excitation points for estimation
- Triggered signals: Removing resting phase to „make the task harder”



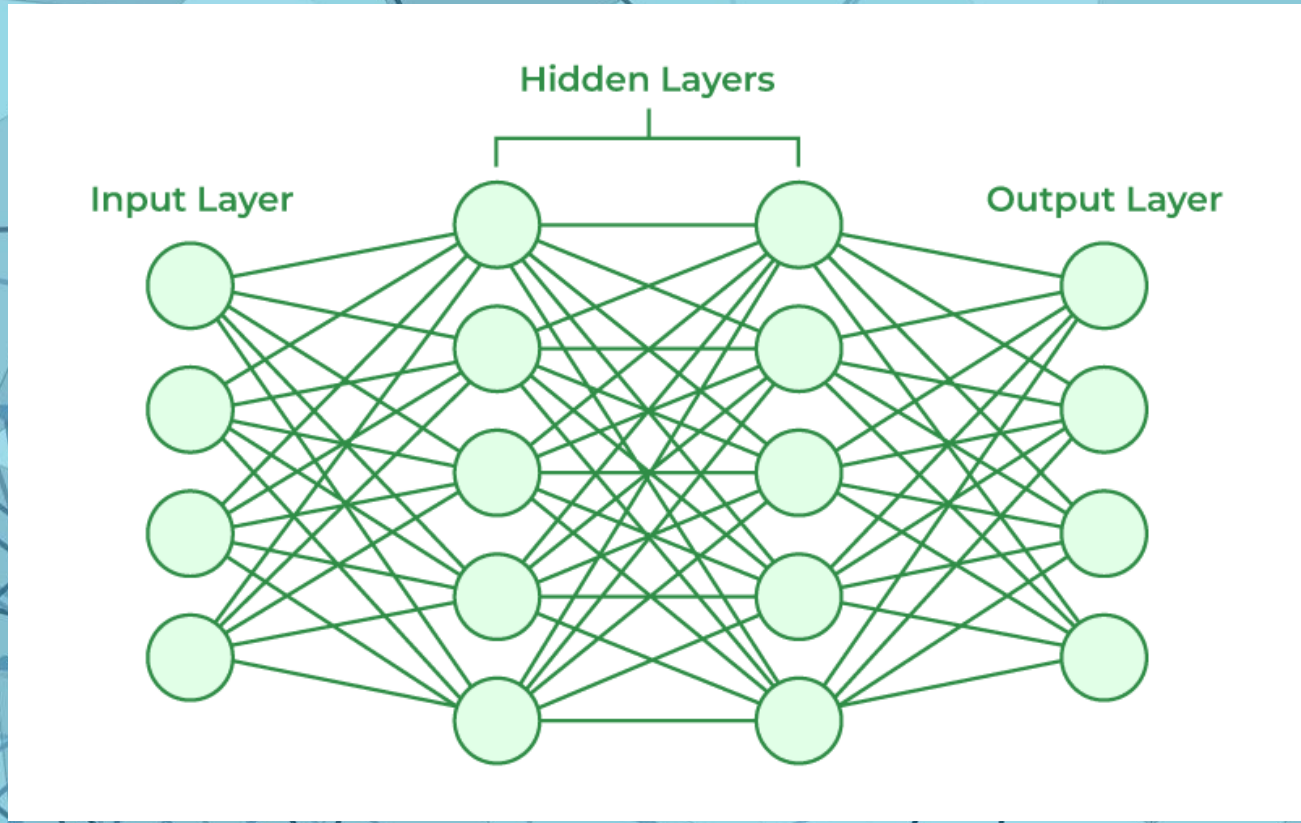
Models and performance

- Triangulation: Comparison of methods (Interpolation, Polynomial regression)
- Cluster prediction: Correlation between number of clusters and accuracy
- Summary: Interpolation works well; neural networks outperform interpolation



Future work and conclusion

- Future focus: Lasso, Forward Selection, Elastic Net for regression
- Neural networks for better accuracy in label estimation
- Conclusion: Promising results with interpolation and triangulation; ongoing improvements needed for generalization across components




Thank you for your attention!