# Response Surface Modeling vs. Machine Learning Algorithms in Fused Layer Modeling

TTZ OBERFRANKEN
Digitale Intelligenz in Lichtenfels

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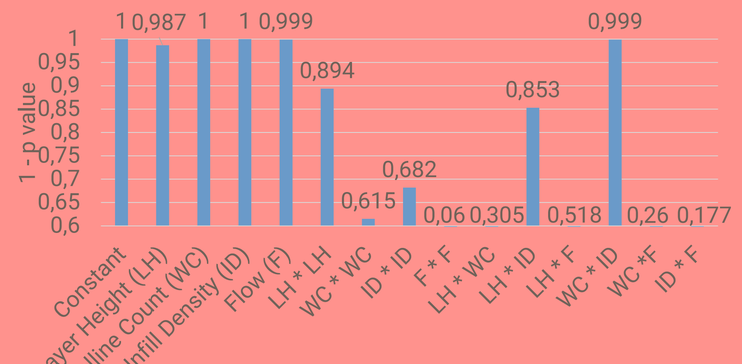
HOCHSCHULE COBURG

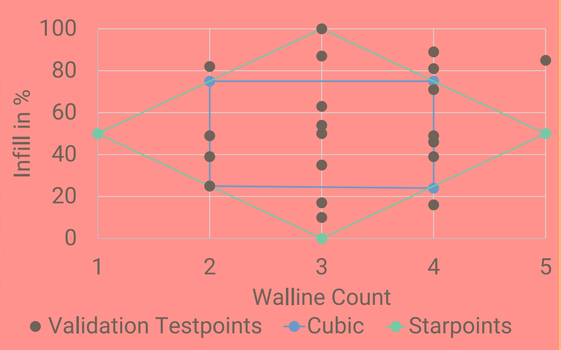
## Response Surface Model

The RSM is a method that specifies the test points for data collection. This can be used to create a mathematical model that shows the dependency of the variables on each other and predicting the target variable.




**ANOVA**
The significance of each variable is defined as given if it reaches a 1 - p value of 0.95 or higher. The main input variables LH, WC, ID, F and the interaction of WC * ID are therefore important in mathematically modelling the tensile strength as a function of the FLM printed specimens.

**Exemplary 2D Test Design**
The central composite design is a type of response surface model which has the major advantage of being able to model quadratic dependencies which have to be included in the evaluation. The parameter combination is given by the cubic and star points of the design. A total of 78 samples are evaluated. Based on the experimental data, the RSM is calculated and gives a standard deviation of 102 N. To validate this daviation, 17 mostly random printing parameter combinations are selected. The results considering only the validation test points show a standard deviation of error of 81 N.



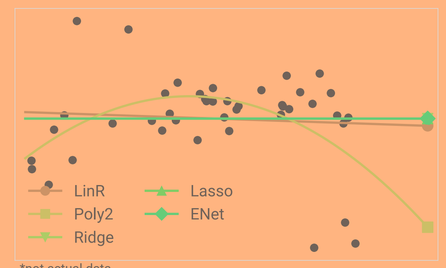

VS

## Machine Learning

Machine learning is a subset of the broader field of artificial intelligence. The relationship between the input and target variables being modeled, is considered supervised learning. The quality of a trained model is characterized by how well the predicted values $\hat{y}_j = f(\boldsymbol{x}_j)$ match the actual values $y_j$ for unknown data $j$.

**Linear- (LinR), Polynomial (Poly2) Regression**
model a simple linear or more complex polynomial relationship between the target variable and the feature variables.

**Ridge-, Lasso-, Elastic Net Regression**
address the problem of overfitting by integrating different regularization term into the cost function of linear regression.

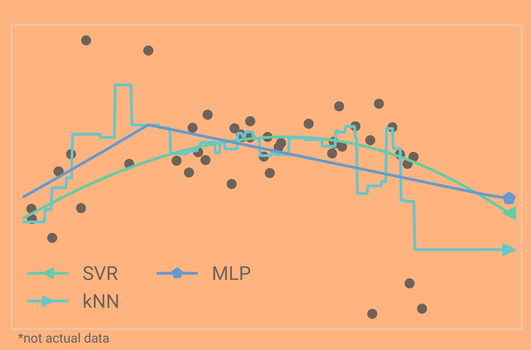


*not actual data

**Support Vector Regression (SVR)**
is an extension of the principles of support vector machines to regression problems. The objective is to identify a line that encompasses the majority of the sample data within the specified tolerance range, as defined by the epsilon parameter.

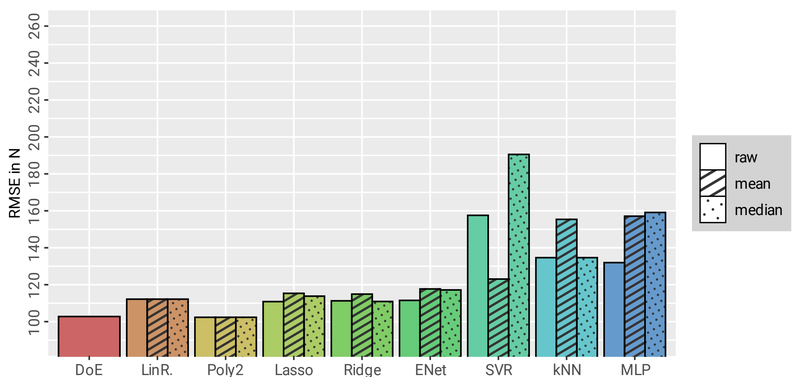
**k-Nearest Neighbors (kNN)**
predicts the value of a point by taking the average of the target values of its k nearest neighbor points.

**Multi-Layer Perceptron (MLP)**
is a specialized type of Artificial Neural Network (ANN). ANNs consist of sequentially ordered layers of neurons designed to solve classification or regression problems. Each neuron applies a non-linear activation function to a linear combination of inputs, associated weights, and a constant bias term.



*not actual data

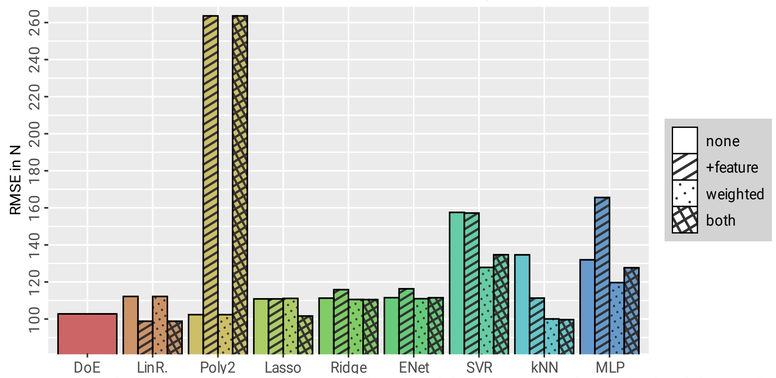
# ROUND 1




Performance comparison of the regressors for the original dataset and for aggregated datasets where identical feature combinations are merged into one

# FIGHT

# ROUND 2




Performance comparison of the regressors with additional weighting of significant features and inclusion of WC*ID feature based on DoE results