Assignment: Prediction of Injection Molding Data

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Introduction

The goal of this assignment is to apply your knowledge about linear regression to a real-world problem. Your task for the next two weeks will be to analyze the given data using the techniques we have learned up to now.

Injection molding (Spritzgiessen) is a highly complex process. Environmental conditions, varying characteristics of the input materials, and internal machine parameters and conditions have a direct impact on the produced components. Often the machine operator has to tune machine settings for each new part in order to achieve an optimal performance and quality. The institutes ICOM and IWK have completed a joint project with the goal to develop an automated quality assurance system for injection molding machines.

For a set of produced parts, internal machine measurements and parameters, as well as the resulting mass of the part, have been logged. Your task will be to estimate the mass of a part, given the machine measurements. With that, the optimal amount of raw material for new parts can be found. The produced part is an ice scraper, as shown in Figure 1.

Description of Dataset

The dataset consists of two CSV files: `InjectionMoldingData_Train.csv`, which contains all training samples, and `InjectionMoldingData_Test.csv`, which contains all test samples. Both files contain 9 columns: 8 predictors and the response. There are 150 training samples and 82 test samples available. All variables are described in Table 1. A drawing of a typical injection molding machine and the labels of each measurement is shown in Figure 2.

Table 1: Description of predictors and response of the injection molding dataset.

Name	Description
`PowTotAct_Min`	Total power consumption of the machine
`Inj1PosVolAct_Var`	Position of the screw
`Inj1PrsAct_meanOfInjPhase`	Melt pressure on screw
`Inj1HopTmpAct_1stPCscore`	Temperature of the flange
`Inj1HtgEd3Act_1stPCscore`	Cylinder heating
`ClpFceAct_1stPCscore`	Clamping force
`ClpPosAct_1stPCscore`	Clamp position
`OilTmp1Act_1stPCscore`	Oil temperature
`mass`	Mass of the produced part

Questions

1. Analyze the training data. Is there a variable which is highly correlated to another variable? List all variables with correlation coefficients ≥ 0.9.
2. Assume you can only choose one feature to predict the mass as well as possible. Which variable do you select? Explain why you select this variable and show the relevant numbers (p-value and R^2-value).
3. Build a linear regression model which uses as many input variables as required. Keep in mind that each sensor costs money, so remove variables which are not needed from the model. List the selected variables and the relevant numbers for selecting them (p-value and R^2-value).
4. Use the selected model to predict the mass on the test data. Compare the training MSE to the test MSE. How does your model perform on the test data?
5. Add higher-order terms, such as quadratic terms or interaction terms to improve the model. Judge the model quality (R^2 values). Again, compare the training MSE to the test MSE.

Conditions

1. The next two weeks (week 5 and 6 of the semester), you independently work on this assignment. Attendance is *not* required for these two weeks. If you need a computer with Python / Spyder or Matlab installed or if you need any help with the assignment, please let Nicolas Tobler know (nicolas.tobler@ost.ch).
2. You write a short report which answers the questions above and summarizes your findings. The report should be 1 – 2 pages A4 and written in German or English.
3. The report is due on Friday, November 18th 2022 at 17:00. Please also hand in all code written for this assignment. The report in PDF form and all code have to be sent to nicolas.tobler@ost.ch. Add the subject (Betreff) `ML-Assignment` to the email.
4. Parallel to this practical assignment, theoretical exercises are provided on the script server.
5. Everybody hands in their own report. Collaboration and discussion between students, however, is allowed and encouraged.

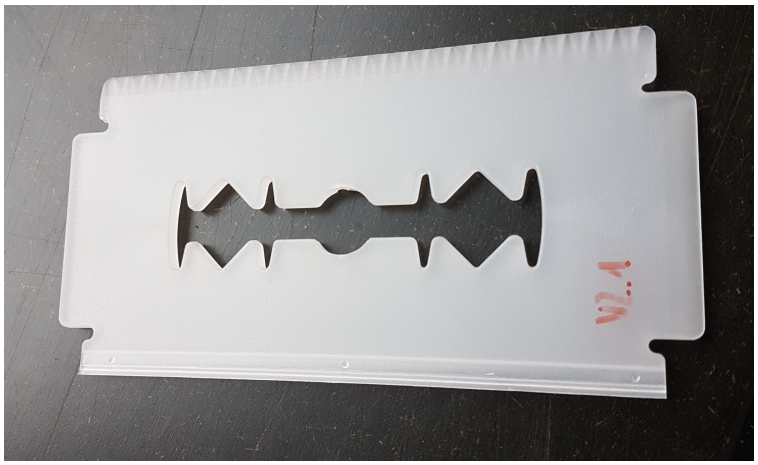

Figure 1: Ice scraper which was produced in this test run.

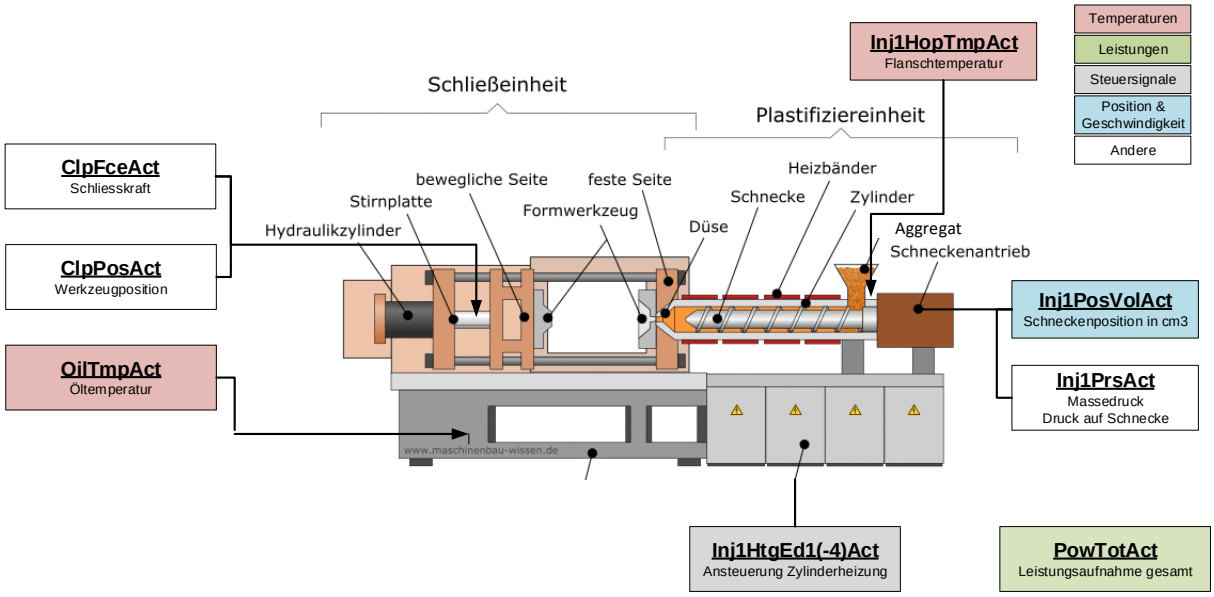

Figure 2: Drawing of a typical injection molding machine.