

ME395 - Homework 2

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My proposed project is to investigate the strength of one of the most important engineered materials, concrete. Concrete is all around us and engineers are constantly looking for ways to improve upon the chemical makeup in order to bring incredible ideas to life. This project will research how the actual concrete compressive strength is related to eight quantitative input variables that are mostly the ingredients: kg/m^3 of cement, kg/m^3 of blast, kg/m^3 of fly ash, kg/m^3 of water, kg/m^3 of superplasticizer, kg/m^3 of coarse aggregate, kg/m^3 of fine aggregate, and age of the concrete. The concrete compressive strength measured is the output of the dataset, given in MPa.

This project can be accomplished by following the six steps of Mechanistic Data Science, detailed below:

1. Data collection and generation: Use kaggle dataset as a starting point to find more data online. Once multiple online datasets have been collected, consult departments of civil or materials engineering to see if they have testing data for concrete or if such experiments could be performed at Northwestern.
2. Mechanistic feature extraction: Speak with materials faculty and conduct research in order to determine what aspects of the concrete ingredients list have the greatest impact on the strength of the resulting material.
3. Dimension reduction: Use knowledge gained to eliminate some of the eight input variables in order to reduce the order of the system and make the problem manageable to find correlations.
4. Mechanistic learning through regression: Create linear regressions for each of the selected input variables with the output variable (compressive strength) in order to determine which of the variables have the greatest effect.
5. Reduce order model: Once you have determined which variables have the greatest effect on the output, see if it possible to solely predict the strength of the concrete based on this one variable. If not, keep modifying the model until it has good accuracy and only incorporates a few input variables.
6. System and design: Use knowledge gained through the MDS process in order to design a the correct mixture to create the idealized, strongest concrete. New formula could be given to chemical/material engineers for synthesis and testing.

Dataset source:

<https://www.kaggle.com/vinayakshanawad/cement-manufacturing-concrete-dataset>