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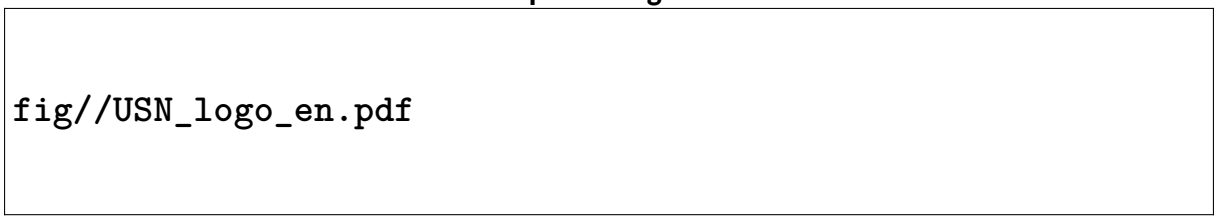
# Assignment 2 - Data Visualization and Regression Models

**<optional figure>**

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# Contents

# 1 Understanding the problem

The following chapter discusses and answers a few questions regarding the problem and the dataset, to better understand the following chapters.

## 1.1 What type of problem is it?

The problem at hand is in fact a regression task. The dataset available contains monitored sensory data, with noise, and can be considered labeled. The goal is to develop a model that can predict/extrapolate the RUL (Remaining Useful Life) of turbofan jet engines.

## 1.2 What category of machine learning is required?

As the dataset can be considered labeled, i.e. the columns in the dataset are labeled and have some physical meaning, the supervised learning category will be used.

## 1.3 What does each column in the dataset represent?

The dataset contains multiple columns, see figure 1.1 for brief descriptions of each column.

Table 1.1: Column descriptions

| | |
|---|---|
| Engine | Identification number. |
| Cycle | Counted rotations since initialization. |
| Settings 1-3 | How the systems configurations change over time. |
| Sensor 1-21 | Various sensor measurements. |
| RUL | Remaining useful life. |

## 1.4 Features and targets

Attributes are data types in the dataset that reflect the name of configured or measured values such as voltage set on a motor or pressure. Features are attributes bundled with a value. Targets are usually the information that is intended to predict. In this case features are all configuration, sensory data, and cycle (time). The target is the RUL. The fact that configurations and settings aren't specifically named makes it hard to tell which are important or not.

## 1.5 Not features or targets

Identification columns aren't features if they are all the same brand and make of fan. Time might be a feature.

# 2 Data Visualization

This chapter contains visualizations of the dataset that can be used to get better understanding of the system.

## 2.1 Histogram

All the available data was plotted as histograms, see figure 2.1. Additionally, correlations were investigated using the Pandas Dataframe correlation function.

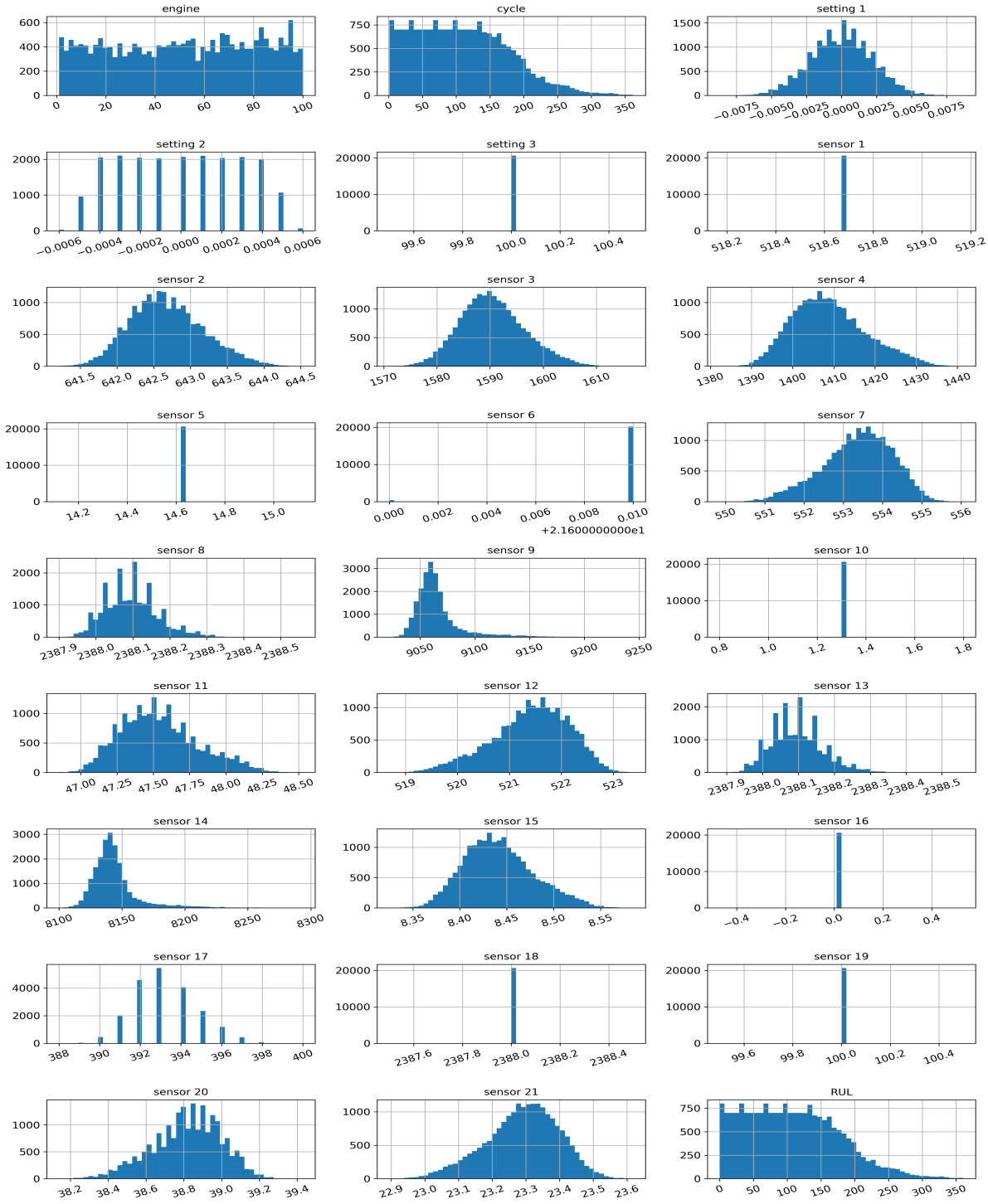


Figure 2.1: Histogram plot of all attributes.

# 3 Preprocessing and feature selection

This chapter discusses the dataset plotted in the previous chapter and which parts of the dataset that should be selected and weather it should be modified.

## 3.1 Feature removal

Initially, some ideas of what features to drop were made through observation of the histogram and the correlation matrix. Following decisions were made:

The engine (ID) attribute is again not a feature or a target, and we can see that most engines have similar amounts of data points, engine attribute could safely be removed. RUL was removed because it is the target. Setting 3 and sensors 1, 5, 6, 10, 16, 18, 19 were removed because they all have constant values. Sensor 7, 11, 12, 15, 17, 20, and 21 were removed because they were too highly correlated to other features, perhaps these are redundant sensors.

Additionally, after running the scikit-learn recursive feature elimination with cross-validation function (RFECV), using a ridge regression estimator, sensor 14 was also deemed unimportant. The reason for using ridge for the estimator here, is to try to avoid bias from using the same regression method as used in later models.

The remaining attributes were then: Cycle, setting 1 and 2, sensor 2, 3, 4, 8, 9 and 13.

# 4 Regression models

Three different models were created: linear, 2nd degree polynomial, and random forest.

## 4.1 Linear model

## 4.2 2nd degree polynomial model

## 4.3 Random forest model

# 5 Regression models with extended features

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# Appendix A

# Source code

The source code, Jupyter notebook, used to load, transform and plot data.