

# LITERATURE SURVEY

The aviation industry is capital intensive, and is subject to stringent environmental and safety regulations. To minimize risk, technological improvements of aircraft engines are generally made incrementally, drawing heavily from experiences and lessons learned. Engine companies have generated and collected large amounts of data over the years.

These big data, from various sources such as the development projects, and the designs that were not manufactured, are valuable resources of intelligence that can support new engine development. With increasing computational power and employing machine learning, data can be mined to provide valuable insights that could bring high levels of efficiency to engine conceptual design.

The basic engine architecture in this study was an axial-compressor turbofan. The engine database consisted of 144 manufactured engines and 39 engines that were studied previously in various NASA aeronautics projects. These commercial engines span the era from the mid-1960s to mid-2010s. The database captures over half-a-century of engine technology improvements and lessons learned.

Machine learning is a branch of artificial intelligence that uses statistical techniques and mathematical algorithms to enable a machine to learn from data, to analyze data patterns, and to make decisions with minimal human intervention. In this work, the author developed a machine learning-based predictive analytics for TSFC predictions.

In this work, engine core-size prediction was treated as a classification problem, since the actual engine core sizes from the commercial engines were not publicly available. A machine-learning predictive analytics based on SVM.

Cruise TSFC prediction was considered a regression problem. Due to the high degree of accuracy required for the TSFC prediction, its predictive analysis was developed using a deep-learning neural network (DNN) that established correlations between the input variables and the TSFC. DNN is essentially an artificial neural network with several hidden layers.

With the machine learning algorithms described in the previous section, the author developed two types of predictive analytics: a regression model for turbofan TSFC prediction, and a classification model for turbofan core-size prediction. For the NASA engines, core size were classified according to the blade-height data obtained from the system studies. The python programming language was used to develop both analytics.

Even though turbine inlet temperature ( $T_4$ ), turbine cooling, and turbo efficiencies were important design parameters, these engine data were not publicly available. For the NASA engines, the certification years were assumed to be 2025, 2030, and 2040 respectively to correspond with the N+1, N+2, N+3 timeframes. These timeframes were directed at three generations of aircrafts in the near, mid, and far terms that were studied under NASA aeronautics projects.