**Overview and Situation**

The impact of aircraft noise on a “community” is well-regulated by the [Federal Aviation Administration](https://www.faa.gov/about/office_org/headquarters_offices/apl/noise_emissions/airport_aircraft_noise_issues/) (FAA). Aircraft manufacturers such as Boeing must adhere to these standards. To retrieve data for aircraft community noise testing, these companies rely on extensive equipment and human labor. This data, primarily in the form of acoustic signals, often becomes “contaminated” by the environment. Sources of contamination can include but are not limited to: bird chirps, wildlife/livestock vocalizations, insect noises, traffic noises, and aircraft noises borne from aircraft besides the target test flight. When environmental noise contamination is present the acoustic signals can be rendered unusable.

Our project is an environmental noise contamination detector. The goal is to monitor, detect, and classify the presence of environmental noise in real-time. The scope of the classification should be sufficient to guide testing engineers on necessary recourse. For example, whether the flight test need be redone or what type(s) of contaminant noise sources need to be removed from the testing site. Human labor designated for these tasks, while reasonably effective, is taxing and not cost-efficient. We propose a signal processing and machine learning-based system for this problem.

**Target Audience**

The target audience of the noise contamination detector is an aircraft manufacturer. Our project would remove the need for multiple on-site work stations and lead to significant cost reductions for Boeing by requiring less human labor. The performance of our system will increase accuracy and classification, further streamlining regulatory noise analysis at the Boeing Test and Evaluation unit which oversees this work.

**Constraints and Requirements**

The project, its models, its software code, and data must not limit the commercial use by The Boeing Company. Furthermore, all software code must be executable in MATLAB, the preferred language for the Boeing Test & Evaluation noise testing division.

**Deliverables:**

* A trained algorithm, an explanation of its selection, and theoretical background, for detecting audio signals contaminated by environmental noise sources.
* Measures of the algorithm’s performance when deployed in various “environments” – i.e. for a wide spectrum of noisy audio signals
* Algorithm pros and cons, with a listing of its benefits over alternative methods utilized in literature, as well as its limitations
* Well-documented process for algorithm retraining and overall project reproducibility

**Information Required From the Sponsor**

We require that the example training data (acoustic signals with/without contamination) must be labeled/classified.

**Proposal**

We seek to research, develop and implement a signal processing into machine-learning pipeline for automating the detection of environmental noise contamination contained in acoustic measurements. A proposed methodology for achieving such results could be:

1. The data from the sponsor (Boeing BT & E) will be of the .wav file format (audio signal). The first step will be to extract features from these signals. This portion of the project will require research and implementation of novel audio signal processing techniques in MATLAB. Signal filtering, Fourier analysis, signal-to-noise ratio/signal energy spectrum methods, wavelet transforms and other time-series transient signal classification methods are potential methods for this purpose.
2. Given a set of features/covariates from (1) above, we will develop classification algorithms using the training data. These machine-learning (ML) algorithms will range from basic to complex: i.e. from softmax multi-classification and multi-layer perceptrons, to recurrent neural networks. Because we plan on delivering an automated system *for real-time* analysis by on-site engineers, the algorithm must be efficient and not require heavy computational resources. The algorithm(s) also must be deployable in MATLAB.
3. Steps (1) and (2) will be continuously re-evaluated according to model performance(s). It is plausible that the features engineered in (1) are not sufficient to result in accurate classification and different signal processing techniques must be researched and deployed. This is also applicable for the ML portion in (2).
4. To assist in the prior steps, we may augment the data set from the sponsor with other examples of environmental noise, such as data from the [United States National Park Service](https://www.nps.gov/subjects/sound/gallery.htm).
5. Once satisfied with the performance of the pipeline, we will provide robust documentation to retrain the algorithm(s) and reproduce and/or adapt our project for BT&E.