**Title:** Implementation of AI Algorithms for Characterization of Fiber Optic Sensors

**Abstract:**

The goal of this project was to automate the verification process of fiber optic sensors produced by a company. Currently, after production, the sensors have to undergo a time-consuming and resource-intensive validation procedure in three reference substances: air, water, and isopropanol. To reduce this process, we proposed to use AI algorithms to predict the characteristics of the sensors in water and isopropanol based on their measured characteristics in air.

**Introduction:**

The production of fiber optic sensors is a complex process that requires the verification of various characteristics of the sensor in different reference substances. The current validation process is time-consuming and requires large human resources. In this project, we aimed to reduce the validation process by using AI algorithms to predict the characteristics of the sensors in water and isopropanol based on their measured characteristics in air.

**Data Preparation and Preprocessing:**

The data was collected from 10 fiber optic sensors that were measured three times in air, water, and isopropanol. Each measurement was saved in a separate file and contained a two-dimensional signal (signal wavelength and signal amplitude). Before implementing the AI algorithms, basic data preparation and preprocessing steps were performed, including visualization and computation of basic metrics. In order to simplify further modeling, all 10 sensors data was appended to three data frames - first dataset with 10 sensors wavelength and amplitude data in air, second with water data and third with isopropyl data.

The visualization included a heatmap with the correlation of individual signal features and 10 graphs showing the wavelength and amplitude dependence in three environments, air, water and isopropanol, where each sensor was represented on a separate graph.

**Methods:**

Several AI algorithms were applied to the collected data, including:

Principal Component Analysis (PCA)

Ridge Regression

Random Forest Model

Fourier Transformation with Neural Network

**Results:**

Of the AI algorithms applied, the Random Forest model provided the best results in terms of accuracy and efficiency. We achieved a prediction accuracy on test data of 87.4% in both water and isopropanol based on the measured characteristics in air.

**Conclusion:**

Implementation of AI algorithms has successfully reduced the validation process of fiber optic sensors by enabling the prediction of their characteristics in water and isopropanol based on their measured characteristics in air. The Random Forest model provided the best results in terms of accuracy and efficiency. Despite satisfactory results, there remains ample room for improvement in the performance of models. We hope to continue improving our solution and making it more widely available to the industry.

**Appendix:**

The code and data used in this project are available in my [GitHub repository](https://github.com/IzabelMatusiewicz/Projects/tree/main/AI%20for%20the%20industry%204.0%20project). Google Colab link is available [here](https://colab.research.google.com/drive/1RRDzX_QB9D9gqto0nPSo-UjkyNEAKXbY#scrollTo=c3WGC7sy790e).