**DETAILED PROJECT REPORT**

**WAFER FAULT DETECTION**

**ABOUT PROJECT**

The name of the project is Wafer Fault Detection system.

The inputs of various sensors for different wafers have been provided. In [electronics](https://en.wikipedia.org/wiki/Electronics), a wafer (also called a slice or substrate) is a thin slice of [semiconductor](https://en.wikipedia.org/wiki/Semiconductor) used for the [fabrication](https://en.wikipedia.org/wiki/Semiconductor_device_fabrication) of [integrated circuits](https://en.wikipedia.org/wiki/Integrated_circuit). The goal is to build a machine learning model which predicts whether a wafer needs to be replaced or not (i.e., whether it is working or not) based on the inputs from various sensors. There are two classes: +1 and -1.

* +1 means that the wafer is in a working condition and it doesn’t need to be replaced.
* -1 means that the wafer is faulty and it needs to be replaced.

**Features:**

* Able to work with large datasets
* Works even with PC’s, you don’t need high-end systems

**DURATION OF THE PROJECT**

To complete this project efficiently, our team took 5months of time in brainstorming for the right approach, documentation of the project and building the project. For testing and checking for bugs and other faults we took 18 days of time. So, in total the project took roughly about 6months of time to complete.

**TEAM SIZE AND DISTRUBUTION**

The team consist of:

* 1 Product Manager
* 1 Solution Architect
* 1 Lead
* 2 Dev-Ops engineer
* 2 QA engineers
* 1 UI developers and
* 2 Data Scientists

**DATA DESCRIPTION**

**SIZE OF DATA:**

The training data consist of 9 .csv files, and in each file, we have 592 columns with the sensor names as 591 columns and 1 column with wafer number.

**DATA TYPE:**

The wafer number column consists of varchar type of data and all the sensor columns consist of float type of data.

**LOG MAINTAINING**

Logs are important to maintain because they make the debugging part easy when it comes to bug fixing part. Keeping this in mind, we tried to log every possible step that are performed in the training and predicting stages of the project.

We have built a simple class for maintain the logs, the class performs writing the date, time and log message into a file.

The process follows:

**DATA VALIDATION, TRANSFORMATION AND PRE-PROCESSING**

Data validation includes several steps such as:

* File format and file name convention check is done by creating a manual regex creation.
* Length of the time stamp and date stamp is done.
* Number of rows and columns is checked.
* Number of files sent is checked.

Data Transformation involved various techniques and steps. The following steps are performed in data transformation:

* The initial check for the data type is done.
* Missing values are replaced by null vales.
* Double quotes to the string type of data is also checked.

Data pre-processing involved various techniques and steps. The following steps are performed in data preprocessing:

* If null-values are equal to the column length, we move that file to bad files folder and if not, we imputed the null-values using KNN imputation techniques.
* If the data is not-normal, is converted into normal distribution.

A fully-fledged data transformation and loading pipeline is used to automate the data preprocessing.

**FAILURE CASES**

For all the files that are failed to preprocess are moved into bad files folder and finally into archive folder. Further the files were sent to the client for discussion.

**TECHINEQUES FOR TRAINING THE MODEL**

After receiving all the good files from the preprocessing stage, the columns with zero standard deviations is dropped as they will not contribute anything towards the prediction. After dropping the relevant columns, the feature and the label columns are separated for the training purpose. After separation, we check for null-value presence in the feature columns, if yes, we impute the null values using kmean imputer. This is done to increase the model accuracy and to avoid errors that can be triggered while clustering or training. After imputation, we again check for columns with zero standard deviation in the feature columns, and if present, we drop the respective column.

After these above processes are done successfully, we go for the clustering approach for the feature columns. Clustering is done to further increase the model accuracy and to better train the model. Here, in our approach, we have used Kmeans Clustering technique for creating clusters. The number of clusters to be formed is found using the elbow-plot method. After dividing the features through clustering into the obtained number of clusters, we then pass each cluster for training to find the best model. The number of models will be equal to the number of clusters formed.

Each cluster data will further be divided into cluster features and cluster labels. These will again be divided into train and test data sets for feature and label data. These will be used to find the best model for the data set and will be saved as .sav or pickle file format to be used in the prediction stage.

**DEVELOPMENT AND PRODUCTION**

The necessary development of the entire project was done in one development server. The project was running fine with the training phase and although a higher system performance will enhance the speed of building the model faster. We used the development server to create the model and save the model. The same saved model was deployed to the cloud UAT and production environments.

**HYPERCARE**

The postproduction maintenance was done for the possible bugs that were encounter by the client by the QA team. The process includes mostly with the file format, naming convection and the data type in the files.

**ALL TECH**

The project includes a lot of technologies such as:

* SQLite for the database management
* SkLearn for the machine learning approaches
* Flask APIs for hosting and dashboard monitoring purpose
* Heroku platform for hosting the app