NAME: **SWATHI R**

Batch: **DS Jan 2023 Batch**

Project Name**: Chemical Property Modelling in association with asktalos.com and UltraTech Cement Limited and Aditya Birla Group**

**BRIEF INTRODUCTION ABOUT THE PRODUCT**

Cement is an important element in any construction initiative, from building a small factory to building multi-purpose projects. It is, therefore, correctly ranked as a basic industry.

The Indian cement sector accounts for about 1.2% of GDP and employs more than 0.5 million people. India is the world's second largest cement producer with ~509 million tons per year (mtpa) of cement production capacity as of March 2019 and accounts for over 8% of the global installed capacity.

**CLIENT’S INTRODUCTION**

The Aditya Birla Group is an Indian multinational Fortune 500 company headquartered in Mumbai, Maharashtra. The group has a presence in 36 nations. As of 2022, the company's revenue is worth $60 billion and derives over 50% of its revenue from its global operations.

Owner: Kumar Mangalam Birla

Founder: Seth Shiv Narayan Birla

Parent organization: Aditya Birla Cap

Headquarters: Mumbai

Subsidiaries: Aditya Birla Fashion and Retail, UltraTech Cement, MORE

Founded: 1857

With an annual capacity of 117.35 million tons, UltraTech Cement is the largest cement Company in India and amongst the leading producers of cement globally. UltraTech is also the largest manufacturer of white cement and ready mix concrete (RMC) in India. As a responsible contributor towards sustainable development, UltraTech Cement balances the growing demand for cement and its environmental implications by developing and championing sustainable solutions.

**PROBLEM FACED BY CLIENT**

The manufacturers face several pains such as

* High experimental and R&D cost because of trial and error strategies will add on increased regulatory pressure to increase compression strength.
* Additionally, the variability of raw materials used in cement production can lead to inconsistent product quality and result in the generation of waste.
* Fluctuations of product demand in the market.
* Several big companies often find it difficult to check and track large data mathematically.
* Traditional methods are time consuming.

**SOLUTION**

The solution involves

* Reducing high investment by developing a predictive model that accurately determines the properties of different types of cement mixtures.
* To improve the efficiency and quality of its operations by leveraging data science and machine learning instead of trial and error strategies in R & D.
* With the help of R & D, creating different chemical combinations. Thus, coping up with the demand in the market.
* Visually representing large data in the form of graphs available in the machine learning modules and even creating dashboards using Power BI tool.
* Deployment of machine learning algorithms can process large data in fractions of seconds.
* Designing offline evaluation criteria that includes metrics such as mean squared error, mean absolute error, and mean\_absolute\_percentage\_error that can be used to select the best-performing model(s) before deploying them to the production environment.
* Designing online evaluation criteria that include metrics such as prediction accuracy, prediction error, and model response time, among others. The online evaluation criteria should be used to monitor the performance of the model(s) in the production environment and enable continuous optimisation of the production process.

**SOLUTION APPROACH**

* A variety of modeling approaches must be employed, including classical machine learning models, and ensemble models. Additionally, hyperparameter tuning must be performed to optimize the performance of the models.
* An iterative approach to modeling the task may involve the following steps:

1. Data Pre-processing: This step involves cleaning and transforming the raw data to prepare it for modeling.

2. Feature Selection: This step involves selecting the most relevant features from the pre- processed data. The feature selection process may be performed manually by experts or automated using machine learning algorithms.

3. Model Selection: This step involves selecting the appropriate modeling approach based on the nature of the problem and the available data. Classical machine learning models such as decision trees, random forests, and support vector machines may be used.

4. Ensemble Modeling: This step involves combining multiple models to improve the overall performance of the model(s). Ensemble modeling may involve techniques such as bagging, boosting, and stacking.

5. Hyper parameter Tuning: This step involves optimizing the hyper parameters of the models to improve their performance. Hyper parameter tuning may be performed using techniques such as grid search, random search, or Bayesian optimization.

6. Model Evaluation: This step involves evaluating the performance of the model(s) using offline and online evaluation criteria. The evaluation results should be used to refine and improve the model(s).

7. Model Deployment: This step involves deploying the model(s) to the production environment and integrating them into the production process.

**SOLUTION’S OUT OF SCOPE ITEMS**

The Project offers several significant benefits to the company, customer and other teams.

FOR THE COMPANY:

Since the solution involves the documentation and communication of the entire modeling process to stakeholders within the company. The solution's out-of-scope items include

* Factors needed to be changed in the company's existing production processes or infrastructure.
* Overall, the solution provides a data-driven approach to cement manufacturing, enabling the company to optimize its production process, reduce waste and production costs, increase operational efficiency, and enhance environmental sustainability.
* The solution creates significant value for the industry, positioning the company for success in a competitive and challenging market.

FOR THE CUSTOMER:

* Transparent details of the cement’s chemical composition.
* It gives them the ability to make comparisons between the older composition/ version of the cement with the current composition in terms of performance and also compare against other competitive brands in the market cost-wise.

FOR R & D AND OTHER TEAMS:

* Since the proposed solution doesn’t involve R&D and other teams much in the initial stages, it gives them enough time to focus on other aspects like creating different, new chemical mixtures and composition in a way the company can benefit.
* The exchange of information, knowledge, skills between various teams like data scientists, ML engineers, researchers, and developers can lead to product improvisation and also creating new ideas.

**IMPORTANCE OF SOLUTION**

The solution proposed plays a crucial role in the production efficiency and to obtain a long term hold on the market. This is achieved by

* Effective cost cutting, minimize the time and fund spending on traditional R & D research.
* With exchange of information with the R & D team, opportunity to create different chemical combinations and their efficiency.
* Opportunity to create different chemical combinations at different market prices. Thus, conquering most of the market with diversified products at diversified prices.
* Overall, the iterative approach to modeling the materials and chemical property modeling project for cement manufacturing and R&D teams ensures that the models are robust, accurate, and effective in optimizing the production process.

**CHALLENGES TO THE APPROACH**

* The success of the project depends on the availability and quality of data. The project requires data on the chemical and physical properties of raw materials, manufacturing processes, and finished products. The data must be collected from various sources, including sensors, laboratory experiments, and historical records.
* The project requires a team with a diverse set of skills and expertise.
* The team members should include data scientists, machine learning engineers, chemical engineers, and subject matter experts with experience in cement manufacturing and R&D.
* The project deliverables should include a set of predictive models that accurately predict the chemical properties of cement, as well as a production pipeline that can be integrated into the existing manufacturing process.