FarmBay – Android Mobile App using Machine Learning and Predictive Analysis (May 2018)

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***Abstract* — This paper describes the high level architecture, technologies and usage governing the FarmBay app which has been designed taking farmers into perspective. The entire work flow of the app development is described including the front end, back end and supporting technologies used. The paper also takes you through the app workflow to give a broader understanding of the implementation. The motivation behind the app is to provide farmers a one stop app where they can make important decisions about their crops and also to give them a platform to sell their yield using the latest web technologies available.**

***Keywords* — crop, yield, farming area, investment, Machine Learning, Model Training, Database.**

I. INTRODUCTION

Though farming was once big business in the United States, by 2012 less than 1 percent of Americans were professional farmers. Many challenges face today's farmers, many of which are largely unknown to the general public. Many people have an outdated view of a farm as a small, family-owned and operated parcel of land where livestock is raised in open pens and crops are hand-harvested when ripe. The reality is that modern-day farms have had to overhaul operations to meet demand and remain competitively priced while adapting to the ever-changing ways technology infiltrates all parts of life.

The ongoing recession of the last half-decade has also affected farmers. In November of 2012, the United States Bureau of Labor Statistics indicated that the unemployment rate within the agriculture, forestry, fishing, and hunting industries was at 13.6 percent, far higher than the national unemployment rate. As a result, many farm families have found themselves stuck between a rock and a hard place, as rising costs for equipment and poor decision making are being coupled with decreasing profits and rising unemployment.

This paper describes a solution to the decision-making process for a farmer to ensure that he/she is making the right crop choice for the fields and at the same time give a transparent access to a market place where communication can be directly done with the buyers without any involvement of third parties thus eliminating commissions.

II. MISSION STATEMENT

Our aim is to make the lives of millions of farmers easier by helping them make critical decisions about the type of crops best suited for their fields with respect to maximum monetary gains and at the same time giving them an online market place where they can easily sell off their produce based on an auction framework. This will not only help farmers but also wholesale buyers of crops and give them access to more options thus creating better-interconnected network for business.

To achieve the first objective, we implement Machine Learning and Predictive Data Modeling on the dataset collected for the previous years for all the crops from the National Agricultural Statistics Service (NASS) arm of United States Department of Agriculture (USDA). Data is refined as per requirement so that it gives a list of best suited crops in descending order for the farmer based on key input parameters namely Zip Code, State, Farming Area, Time Duration, Amount Invested and Expected Returns. Using the suggestion from the Machine Learning algorithm, the farmer can make a well informed decision about the crop he's most likely to receive maximum profits from.

The second objective involves giving the farmer the ability to list his crop on an online market place and place a minimum value of his produce as per his calculations. That is the minimum bid at which the farmer can make the sale. Once the crop is placed on the market place, a buyer anywhere in the nation will be able to see the listed crop and place a bid accordingly. Firebase Database instance is used to store the crop data for all farmers and the consequent bidding process. Blockchain is implemented to approve the transactions in real time and make the entire process as seamless as possible.

The inspiration behind this project is to create something to serve the farmers who even after putting in so much effort into their fields end up losing huge sums of money because of insufficient information. We believe in serving and creating a better community and improving the lives of people by doing our part in the bigger scheme of things.

Use Cases/Personas:

Farmers: Paul, a farmer located in California is running low on funds due to losses incurred in the last season and is concerned about the stability, development and fluctuations in financial markets. He wants optimal recommendations about the crops that he can grow in the upcoming season to maximise his yield. He also wants to get in touch with new potential buyers in order to sale the yield at the best price. The app will allow him to exercise both these functionalities at a single platform by listing out the suitable crops, predictive yields and necessary practices needed to put in place to ensure a good produce. He would also be able to access an online marketplace where he can put the produce for auction and let the market do the hard-yards for him to get in touch with prospective buyers.

Buyers: Buyers from all across the country can use the marketplace to bid for the yield of a particular farmer. They'll be provided complete details of the yield (location, quantity, farmer's history, expected costs, other buyers' recent purchases, etc) to make an informed decision to bid. Suggestions will also be made based on ML algorithms to buyers for the future yields and the quality of the yield based on the practices employed by the farmer.

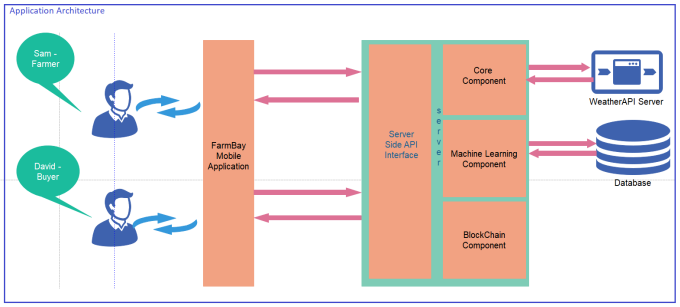


Figure 1: Overview of the Architecture Design

III. FRONT-END INTERFACE

For this project the front-end interface is used in an Android app. The android app has been developed using Android Studio. The total app has been mainly been divided into six screens of the following:

- Login screen
- Main activity screen
- Recommendations screen
- Suggestion screen
- Bid screen
- Market place

The first screen provides us with the basic login features such as login with Facebook login, Google login, and sign in as a guest.

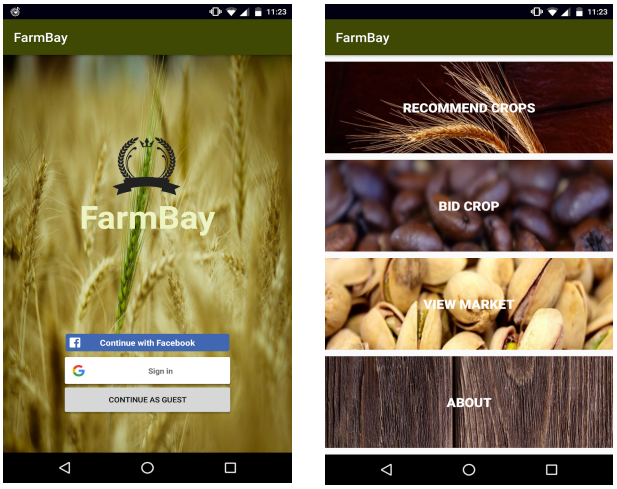


Figure 2: First and Second Screen of the App

The second screen is the main activity menu screen, which consists of all the functionality. This screen provides the customers with the following options Recommend Crops,Bid Crop, View Market, About.that farmers can choose from these options.

In the third screen we provide recommendations to the farmers based on the farmer input data. This screen of the android app is integrated with a machine learning RestAPI, which would provide suggestions based on the farmers input data. The input data used for suggestions are mainly Zip code, state, area of farming, investment, returns and the duration of farming. This will thus provide a suggestion based on the supervised Machine Learning model.

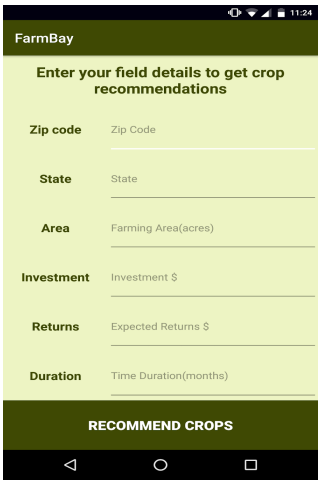


Figure 3: Third Screen of the App

Year	State	Commodity	Data Item	Value
2017	ALABAMA	CORN	CORN, GRAIN - YIELD, MEASURED IN BU / ACRE	4.18
2017	ALABAMA	CORN	CORN, SILAGE - YIELD, MEASURED IN TONS / ACRE	17.00
2017	ALABAMA	COTTON	COTTON - YIELD, MEASURED IN LB / ACRE	0.41
2017	ALABAMA	OATS	OATS - YIELD, MEASURED IN BU / ACRE	0.90
2017	ALABAMA	PEANUTS	PEANUTS - YIELD, MEASURED IN LB / ACRE	2.00
2017	ALABAMA	SOYBEANS	SOYBEANS - YIELD, MEASURED IN BU / ACRE	1.24
2017	ALABAMA	WHEAT	WHEAT - YIELD, MEASURED IN BU / ACRE	2.08
2017	ALASKA	BARLEY	BARLEY - YIELD, MEASURED IN BU / ACRE	0.97
			OATS - YIELD,	

Figure 4: Sample of Backend Database for Crop Recommendation

The fourth screen in the app consists of the suggestion screen where the crops are recommended to the farmers based on their input provided. The suggestions are provided using a supervised Machine Learning model. Where the data is tagged with the recommendations.

The fifth screen in the app consists of creating bid and placing crop for the bid in the market. Here the farmer can input the details of the crop, which he/she is willing to sell. The crop details consisted of information such as Quantity, crop, state, and city, minimum bid. Once the farmer enters these details the crops of the farmers is placed in the market.

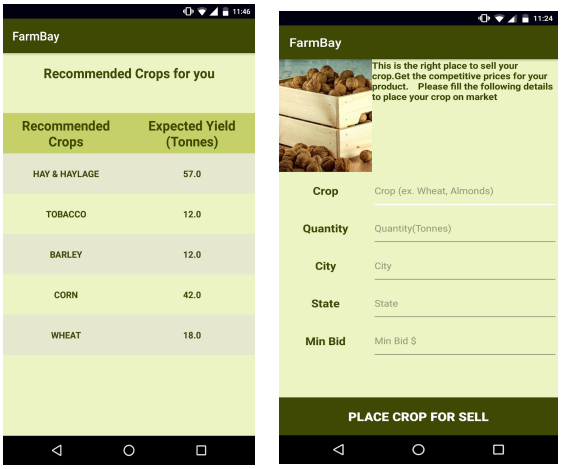


Figure 5: Fourth and Fifth Screen of the App

The Last screen of the app consists of the market, where all the crops placed for bid are available to view for the buyers who are willing to buy the crops. The input data of this market placed is stored in the backend in Google Firebase where the data gets changed in real time environment as and when crops are sold and placed for bid.

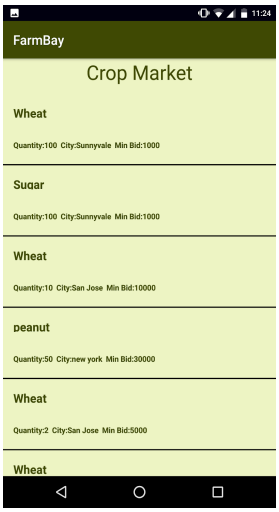
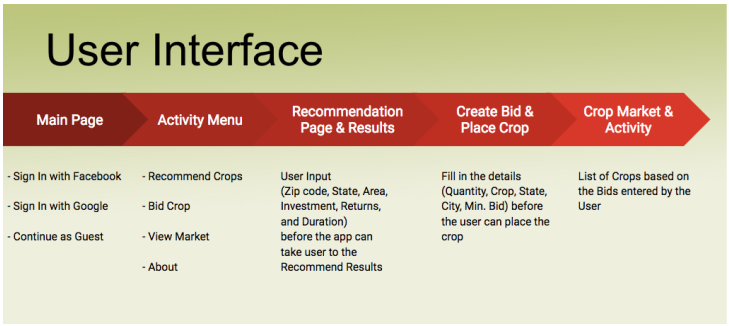


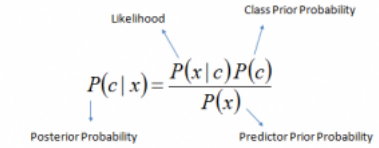
Figure 6: Sixth Screen of the App

Application in Action:



IV. BACK-END ANALYSIS

To implement the back-end crop recommendation model, IBM Watson Machine Learning cloud service is used. It helped to create, train, and deploy Machine Learning model for crop recommendation. Naive Bayes classification technique is used to build the recommendation model using Watson Machine Learning API. It is a classification technique based on Bayes' Theorem with an assumption of independence among predictors. In simple terms, a Naive Bayes classifier assumes that the presence of a particular feature in a class is unrelated to the presence of any other feature. Bayes theorem provides a way of calculating posterior probability P(c|x) from P(c), P(x) and P(x|c). Look at the equation below:



$$P(c|X) = P(x_1|c) \times P(x_2|c) \times \cdots \times P(x_n|c) \times P(c)$$

Figure 7: Bayes' Theorem equation

Back-end implementation consist of following steps :

- Data Collection: Past year data for crops is collected from National Agricultural Statistics Service (NASS).
- Data Cleansing: This step involved Correction and Curation of data. Data contained many missing values. It is important to extract quality data from the dataset collected for model building. IBM data Refinery tool and R Studio are used to clean and create structured data required to feed ML algorithm.
- Feature Engineering: It involved deciding features that influence the predictive model outcome.
- Evaluation & Deployment: Crop recommendation model is trained, evaluated and deployed on the IBM Bluemix cloud using Watson Machine learning API. Model is trained using 60% of the data, Model is tested using 20% of the data. Rest of the data is used to score the model

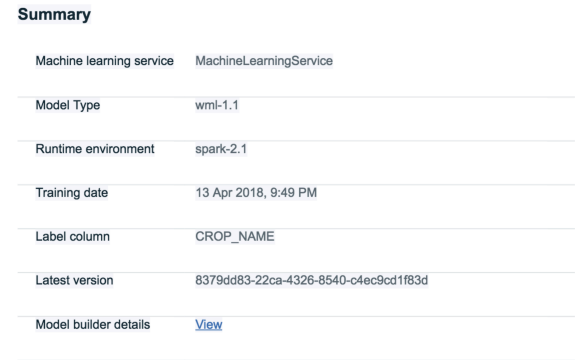


Figure 8: Machine Learning Model Summary

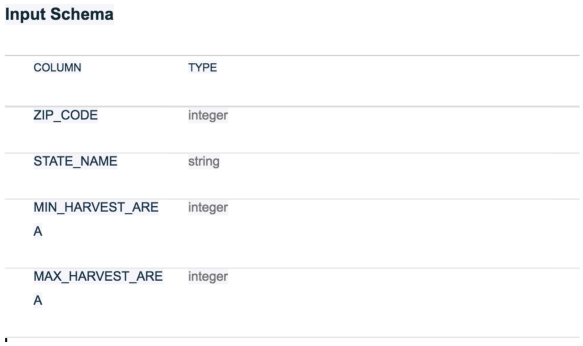


Figure 9: Machine Learning Model Input Schema

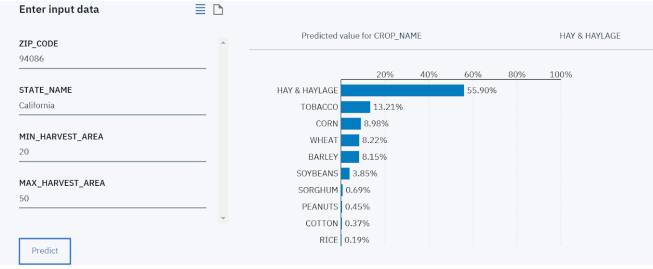


Figure 10: Machine Learning Model Model Testing

V. FUTURE IMPROVEMENT

Here are a few things that we could have done to optimize the features for our project:

1. Blockchain capability: to authorize and process the user transaction to confirm the bid and purchase the crop. Blockchain is useful to connect the end users together.
2. Weather API add-on: to help recommend the crop with real-time weather analysis. Weather is always a crucial factor in deciding the best crops to go with.
3. Farmer's personal information.
4. Front-end interface after the Crop Market.
5. A larger dataset needed to provide more flexible user inputs for crop recommendation.

VI. CONCLUSION

Throughout our research experience, we learn the basic usage of how the Watson Machine Learning API and how to apply its architecture to design our application and solve multiple back-end problems. We went through multiple online database storages to check the pros and cons before deciding to use Google Firebase for our recommended crop information and the crops availability on the market. The model training with Machine Learning takes the longest amount of time to provide the best result as it requires curation, exploration, training, and lastly, evaluation before the final deployment.

FarmBay has many potential use and tremendous growth for application development if it is put into the right market where the consumers can access the information and view the daily activities. There is a redundant amount of farmer apps out there, but FarmBay provides the unique solution integrating the latest technologies and putting altogether the key information a farmer would need the most for his crop. This app can serve both commercial use and personal use to the regions where agriculture markets develop.

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