Knowledge Discovery in Surveys using Machine Learning: A Case Study of Women in Entrepreneurship in UAE

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Abstract—Knowledge Discovery plays a very important role in analyzing data and getting insights from them to drive better business decisions. Entrepreneurship in a Knowledge based economy contributes greatly to the development of a country’s economy. In this paper, we analyze surveys that were conducted on women in entrepreneurship in UAE. Relevant insights are extracted from the data that can help us to better understand the current landscape of women in entrepreneurship and predict the future as well. The features are analyzed using machine learning to drive better business decisions in the future.

Keywords—Knowledge Discovery, Machine Learning, Survey Analysis, Women in Entrepreneurship, UAE, Logistic Regression, Naïve Bayes, Decision Tree Learning, LDA, k Nearest Neighbors Classifier

1. INTRODUCTION

The word entrepreneur is derived from a French verb which can be translated as “to undertake”. An entrepreneur is the one who begins a new business, manages its risks and enjoys most of its rewards. They have the skills to anticipate the future needs of their customers, and accordingly they bring new ideas to the market thereby increasing the country’s GDP.

Economists never included entrepreneurship in their formal models of classical economy until the 20th century as they believed that there is no room for risk taking in economics. However, this trend changed from the mid-20th century, when they realized that entrepreneurship improves the national economy and lives of the people by creating new jobs, solutions to problems and acceleration to globalization.

In 2005, Global Entrepreneurship Monitor confirmed that women’s participation in entrepreneurial activities across 37 GEM countries has led to the establishment of multiple enterprises for job and wealth creation, making women entrepreneurship a central aspect of economic development and public policy concerns [1]. Prior research suggests that female entrepreneurs make less money compared to men as they face more obstacles. China, Greece, Malaysia, Portugal, Turkey, and the UK have reported multiple obstacles ranging from sexual stereotyping, lesser access to capital, to lack of entrepreneurial education and social and cultural impediments. In UAE, women actively participate in business and entrepreneurial activities.

Machine Learning is the art of learning the patterns in data and making sense out of databases. It is a vital tool for gaining insights from datasets to drive business decisions. In this paper, we have analyzed the survey, mentioned in Section 4, conducted regarding women in entrepreneurship in UAE, using Machine Learning algorithms and have tried to make the right predictions about the choice of women when it comes to entrepreneurship.

The paper has been divided in the following manner. Section 2 present the research that has happened in the field of entrepreneurship for women till now. Section 3 builds up on the main topic by mentioning about the background of women in entrepreneurship and the surveys conducted in UAE for the same. Section 4 presents the questions and the results of the survey that was conducted in UAE, to facilitate this research.

Section 5 depicts the experimental methodology used to analyse the data and gather insights using several Machine Learning models. Section 6 discusses and compares the results of the different machine learning algorithms that have been used for prediction and classification tasks. This section also discusses the results of the survey that was conducted earlier. The paper concludes with remarks and possible future work in Section 7.
II. LITERATURE REVIEW

Few researches states that organizational performance is gendered, as businesses owned by women are less successful compared to those owned by men. On the other hand, other researchers don’t find gender related differences in entrepreneurial success. Most of the time, it is very difficult to measure the performance of both the genders as men tend to focus more on the aspect of the result or outcome and women tend to emphasize more on the process itself [2].

Research asserts that women focus more intensively on team development compared to men, they tend to complement their employees’ achievements more often which leads to better performance. Women entrepreneurs are good in market research, strategic planning and innovation [3].

Most entrepreneurship research suggests that women tend to start their business with very less financial capital compared to men and smaller companies tend to face more difficulties such as capital raise or attraction of qualified employees. This can be the main reason why women-led firms tend to underperform. Regarding social capital, women tend to discuss personal matters, finances, and family matters with their prime contacts. On the other hand, men tend to discuss business matters. This tends to affect the brand’s reputation and consequently, female entrepreneurs are perceived as less business focused.

Past researches have suggested that women tend to fear failure more than men, as they are comparatively less optimistic and have low self-confidence [4]. Different authors associate different factors which may contribute to motivate women entrepreneurs. In 1999, Vesalainen and Pihkala identified two schools of thought which determines the Entrepreneurial action among women: environmental and people school of thought. The environmental factor includes cultural and structural conditions that emphasize on government legislation, financial, family and community support, etc. This is also known as the circumstantial approach. The people factor, also known as trait approach, emphasizes on entrepreneurial characteristics such as skill and creativity, need for achievement, risk taking, tolerance of ambiguity, etc.

Also, Bartol and Martin conceptualized women entrepreneurial motivation into the following factors [5]: (i) Personal characteristics, (ii) Life-path circumstances and (iii) Environmental factors, which is shown in Fig1a.

In 2011, Sayed conducted a survey [6] which showed that 74 percent of males and 65 percent of females believed that a working woman makes family life suffer. Most of the women tend to leave their career after marriage or giving birth, even though the UAE government entitles Emirati women to 70 days of maternity leave.

In order to assist and encourage women to join economic activities, the federation of UAE chambers had established a Businesswoman council in 2002 which has its head quarter in Abu Dhabi. In 2011, a study was conducted to analyze the ambitions and aspirations of UAE women entrepreneurs who were self-employed. It was found that women start a business for personal development and sense of accomplishment. They also suggested that the norms and traditions of UAE should get modernized to facilitate more career quests and help them make an impact in different fields.

According to His Highness Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of UAE and Ruler of Dubai, women comprise of 70 percent in his team. Around 70 per cent of the students are girls, the UAE female participation rate in the workforce is 46.6 per cent, and 66 per cent of all government employees are women [7]. In order to bridge the gender pay gap in United Arab Emirates, a presidential decree mandated equal pay for men and women in the private sector in 2020. This law helped UAE take another step forward towards social inclusivity. The UAE ranked 26th globally in the United Nations Development Programs’ 2019 Gender Inequality Index.

III. CASE STUDY OF UAE

In olden times, Emirati women actively participated in agriculture and related services.
IV. SURVEY ANALYSIS ON WOMEN IN ENTREPRENEURSHIP

A survey was conducted using google forms to gather data on professional preferences of women in UAE and explore the factors that contribute to choose an entrepreneurial career. Here are the features of the survey that were collected:

| Table 1: Demographic Details |
|-----------------------------|
| **Age**                     |
| Below 20 Years              | 20.5% |
| 20-29 Years                 | 60.3% |
| 30-39 Years                 | 9.6%  |
| 40-49 Years                 | 8.3%  |
| Above 50 Years              | 1%    |

| **Type of Business Interested** |
|---------------------------------|
| Fashion Label                   | 15.5% |
| Accounting and Financial services| 16.1% |
| Legal Advisory                  |      |
| Food and Beverages industry     | 25.8% |
| General Stores, Stationery      | 2%    |
| Training Institute              | 9.7%  |
| Social Service                  | 19.4% |

| **Motivational Factors for Entrepreneurship Career Choices** |
|-------------------------------------------------------------|
| interested in additional income                             | 10.3% |
| Advice of Family and peers                                  | 9%    |
| Planning to grow your business into an established SME       | 25%   |
| Nice opportunity to work on your business hobby              | 39.1% |
| Gaining business experience                                 | 16.7% |

| **Reasons for Starting Own Enterprise**                     |
|-------------------------------------------------------------|
| Unemployment                                                | 12%   |
| Dissatisfying Job                                           | 21.7% |
| Better use of Technical skills                              | 52%   |
| Leisure time on hand                                        | 15.5% |

| **Awareness on UAE Entrepreneurial Opportunities**          |
|-------------------------------------------------------------|
| Yes                                                         | 28%   |
| NO                                                          | 45.2% |
| May Be                                                      | 26.8% |

| **Encouragement and Support for Entrepreneurship**         |
|------------------------------------------------------------|
| Yes                                                        | 45.2% |
| No                                                         | 54.8% |

Source: Primary Data Analysis by Authors

V. EXPERIMENTAL METHODOLOGY

To get further insights from the data, machine learning models have been used to learn the features and predict outcomes on unseen data. To extract useful information, the defined objective function is to classify the outcomes into two categories, the first where the woman aspires to become an entrepreneur in the future and the second being the opposite, i.e. the woman does not aspire to become an entrepreneur. We then make predictions on unseen data and validate the model that has been created. To proceed with the process of Machine Learning, the data has been pre-processed to suit the models on which they are trained.

A. Data Preprocessing

Since the data columns are categorical in nature, Label Encoder () class of sklearn python module [9] is used to encode the target variables between the values of 0 and n-1, where n is the total number of categories. This label-encoding scheme has been fit and transformed onto the data columns for effectiveness.

B. Splitting of Data

The data has been split into training set and test set with 25% of the data belonging to testing and 75% of data belonging to training with a balanced distribution. Cross-validation techniques have also been explored to cross-verify the training and testing datasets and how they affect the accuracies. Model capacity has been adjusted to several degrees to prevent overfitting and under fitting of the model when trained.

C. Categorical Naïve Bayes

Naïve Bayes is a classifier that works on independence of the feature variables and assumes very less correlations amongst them. It is a probabilistic model for classification that is very effective on large datasets.

It works on the principle of calculating the posterior probability of all features with respect to the outcome and training the model around those values. Categorical Naïve Bayes can be used for classification problems that have categorical features, which is the case in this research.

Naïve Bayes gives an accuracy of 85.29% on the training dataset and 71.14% on the test dataset, which can be considered as a good result as the number of data points are less.

D. Logistic Regression

Logistic Regression is used for classification problems which are modelled using the logistic function given below,

\[
g(z) = \frac{1}{1 + exp(-z)}
\]

The final cost function \( J \) must be reduced in order to facilitate training and to get best results. It is achieved by Eq2.
\[
df{\beta} = \frac{1}{m} \sum_{i=1}^{N} x_i (h_\beta(x_i) - y_i) = 0
\]

Logistic Regression model gave an accuracy of 71% with the training set and an accuracy of 80% with the test set.

**E. Decision Tree Classifier**

Decision trees follow a tree architecture where the nodes are the features under observation and the branches are the decision rules.

![Decision Tree Architecture](image)

Attribute Selection Measure (ASM) is used in splitting of the data points and features into useful and not useful categories. The data that is considered useful is sent to the model for the learning process.

The accuracy observed with training data comes out to be 100% and the accuracy with test data comes out to be 57%. To avoid overfitting, as it takes place in this case, we alter the capacity of the model by changing the depth of the decision tree to a max depth of 3. The new accuracies observed are 76% and 66% for training and test data respectively.

**F. K-Nearest Neighbors**

To classify a new data point for prediction, kNN makes use of distance metrics to compare the distance of the k nearest neighbours in the dataset.

Table 2: Machine Learning Algorithm

| Accuracy | Categorical Naïve Bayes | Logistic Regression | Decision Tree Classifier | K-Nearest Neighbors | Linear Discriminant Analysis | Gaussian Naïve Bayes |
|----------|-------------------------|---------------------|--------------------------|---------------------|-------------------------------|---------------------|
| Train    | 85.29%                  | 71%                 | 76%                      | 100%                | 70%                           | 72%                 |
| Test     | 71.14%                  | 80%                 | 66%                      | 74%                 | 80%                           | 74%                 |

*Source: Data Analysis by Authors: Comparison of model statistics, training and test accuracies as discussed in Experimental Methodology section with respect to different machine learning algorithms*

**VI. RESULTS AND DISCUSSION**

**A. Result of the survey conducted**

There has been a tremendous progress in the dimension of Women entrepreneurship in UAE during the last few decades. However, there is very little empirical evidence, which sheds light on this topic.

To develop an insight on this, we conducted a survey and administered it to the participants via an online platform. Our survey consists of 9 close ended questions and 157 participants were able to successfully complete it.

For k=1, The model gave an accuracy of 100% with training data and an accuracy of 74% with test data. Clearly, the model is over fitted with the training data.

To prevent overfitting, the capacity of the model was altered, by changing the value of k to 4, which gives an accuracy of 72% on training data and 69% on test data.

**G. Linear Discriminant Analysis**

LDA is a statistical method and a generalization of Fisher’s Linear discriminant. It is used to find a linear combination of independent or closely correlated features on which the outcome or the independent variable depends.

The scatter can be defined by a simple covariance of the mean of all classes, with respect to the class variabilities as given in Eq 3.

\[
\Sigma_b = \frac{1}{C} \sum_{i=1}^{C} (\mu_i - \mu)(\mu_i - \mu)^T
\]

LDA model gives a train accuracy of 70% and a test accuracy of 80% with the dataset used in this research.

**II. Gaussian Naïve Bayes**

This approach is very similar to Naïve Bayes, with a small difference that it follows Gaussian normal distribution and works with data that is continuous in nature. This is also a probabilistic model and the conditional probability can be calculated as shown in Eq 4.

\[
P(x | y) = \frac{1}{\sqrt{2\pi\sigma^2_y}} \exp \left( -\frac{(x_i - \mu_y)^2}{2\sigma^2_y} \right)
\]

Gaussian Naïve Bayes gives an accuracy of 72% with the training data and an accuracy of 74% with test data in our case.
Fifty two percent of our participants want to start their own enterprise to make better use of their technical skills. Dissatisfying job was the second most common reason, which made individuals, think of career transition to entrepreneurship. We asked a question related to the possible difficulties and found that lack of in-depth knowledge (47.5%) and lack of managerial abilities (52.2%) made our participants feel demotivated at some point in their entrepreneurial career. Further, in a question regarding the strengths of an enterprise 121 participants (77.6%) suggested that commitment and dedication goes a long way.

Lastly, we chose to determine whether our participants feel encouraged in UAE to get into this career and follow their passion, 54.8% answered with a yes and 45.2% refused. Also, 45.2% of our participants claimed that they were not aware of the support facilities provided by the UAE government to female entrepreneurs. However, 28% stated otherwise.

B. Results of Machine Learning models

The results of the Machine Learning model are presented in Table 2, compares the training and test accuracies of the machine learning algorithms. Some results of experimental analysis are given below.

- The Categorical Naive Bayes algorithm performs the best amongst all other algorithms with a training accuracy of 85.29% and a testing accuracy of 71.14%.
- The Gaussian Naive Bayes has the least overfitting as the difference between the training and test accuracies is minimum.
- The k-Nearest Neighbours algorithm peaks up with performance with k=1 neighbours while overfitting the model with the training data. The overfitting is reduced by altering model capacity and changing the k value to 4.
- LDA and Decision Tree Classifiers do not perform very well with the training dataset but LDA performs really well with the unseen test data.
- On comparison, Bayesian Machine Learning algorithm shows great promise with our dataset, which is entirely categorical in nature.

VII. CONCLUSION

The entrepreneurial industry has been admired by all since the past few decades due to its huge impact on society and global economy. In the present scenario, women are also the flagbearers of the ongoing entrepreneurial revolution, which was once dominated by men.

We have analysed a survey to better understand the opinions and choices of women when in comes to entrepreneurship in UAE. Machine Learning algorithms were applied in various disciplines but no researcher tried till now on women entrepreneurship. Interesting insights are drawn about women in entrepreneurship and analysed with several machine learning models to figure out the architecture that best fits the data. The model can be used by the UAE government, by companies and by educational institutes to predict if a woman would like to take up an entrepreneurial career. Some of the future work that can be done in this field are as follows: gathering more data from a diverse audience that is not limited to UAE only, training the data on more machine learning models and modelling the problem space with Neural Networks. Women entrepreneurs must overcome multiple obstacles to be successful such as lesser access to capital and sexual stereotyping, which makes individuals assume that they underperform. As they tend to emphasize more on the process of reaching a goal, they excel in strategic planning and innovation, compared to men.

The United Arab Emirates is the land of possibilities, which tries to excel in all fields. In order to encourage women entrepreneurship, a Businesswomen council has been established in Abu Dhabi to assist women who are interested in joining economic activities. The data gathered from the survey mentioned in this paper suggests that 54.8% of our respondents want to start their entrepreneurial career in United Arab Emirates.

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