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## Toward Prediction of Entrepreneurial Exit in Iran; A Study Based on GEM 2008-2019 Data and Approach of Machine Learning Algorithms

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### Abstract

This study discusses the prediction model of Entrepreneurial Exit from Entrepreneurial Perceptions, acquired the data from the Global Entrepreneurship Monitor's (GEM) database in 2008-2019. Some essential indicators include Opportunity Perception, Fear of Failure, Capability Perception, Role Model, and Entrepreneurial Intention. Data mining results show that the exit reasons and entrepreneurial intention have a more significant impact on entrepreneurial exit than other variables. This research applies the Random Forest Algorithm to get a prediction model that shows the entrepreneurial exit. According to the Random Forest Algorithm results, accuracy, ROC-AUC score, AUC curve, precision, recall, and F1 score validate the classification method. The prediction model shows that the best accuracy predictor of entrepreneurial exit is 99 percent, and another criteria ROC\_AUC score 96%. Consistent results demonstrate that the proposed method can consider a promisingly successful predictive model of entrepreneurial exit with excellent predictive performance. These results can predict the individuals' entrepreneurial exit possibility before the psychological and financial impact and loss of capital and failure.

**Keywords:** Entrepreneurial exit, Entrepreneurial perceptions, Machine learning, Global Entrepreneurship Monitor (GEM).

## 1 | Introduction

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Scholars affirm that the going of entrepreneurs from the firm they founded and created generally mentioned as entrepreneurial exit is an essential event. Which may be the end of a person's entrepreneurial activity or the starting point of a new activity [1]-[3]. This study focuses on Iranian entrepreneurial exit; according to the report of the Global Entrepreneurship Monitor (GEM) in Iran, the entrepreneurial exit is 6.6%, which is higher than the average of efficiency-oriented economies. Iran ranks 11th among GEM member countries [4].

Recently scholars acknowledge that this shows that the entrepreneurship exit is a process in which the founders of firms leave the company they created or co-founded for diverse reasons. This



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elimination may occur to varying degrees [2] and [5]. Entrepreneurship exit is a critical process for entrepreneurs which significantly impacts companies, industries, and the economy [1]. The literature recognizes the importance of an entrepreneurial exit as an individual-level phenomenon; it should be preferable to a firm exit. It contains multiple dimensions that individual entrepreneurs can realize both as positive and negative consequences [6]-[8]. Recent developments in the entrepreneurial process have heightened the need for an entrepreneurial exit. Many ordinary or serial entrepreneurs complete this process numerous times throughout their entrepreneurial careers [9] and [10]. However, scholars have little case history about this event. The entrepreneurial process is beyond new investment, and creating a business does not end, but the end of the entrepreneurial process is the exit [1]. It is now well established that entrepreneurial perceptions are one of the most critical challenges affecting business and entrepreneurial processes. The evidence of this emphasis is that the GEM survey, used to research entrepreneurial activity, attitudes, and perceptions in various countries, stack up data on entrepreneurship [11].

So far, scholars' have paid very little attention to the role of entrepreneurial perceptions in investigating entrepreneurial exits. Even though successful or unsuccessful entrepreneurial exit detection is considered necessary to detect an exit event [8], [1] and [12], the present theory is restricted by its focus on exit prediction from entrepreneurial perceptions.

Therefore, the current paper examines the impact of entrepreneurial perceptions on the exit business. For this purpose, we use data mining and machine learning techniques. This study's empirical research approach was the predictive model for entrepreneurial exit prediction based on entrepreneurial perceptions. The data were collected using GEM data that includes Iranian SMEs from 2008 to 2019. We examine entrepreneurs' perceptions to exit the business that use Random Forest techniques to analyze and build a prediction model based on the entrepreneurial perceptions. Therefore, the article first discusses various definitions of 'entrepreneurial exit' and 'entrepreneurial perceptions' and then examines the following issues: the exploration of the knowledge to identify entrepreneurial perceptions and exit, making a predictive model for predict exit, and classifying entrepreneurs to exit the firm or stay at business.

## 2 | Conceptual Background

### 2.1 | Entrepreneurial Exit

DeTienne [2] research has focused on the entrepreneur's decision to leave the firm. The founder's entrepreneurial exit process leaves the company in various degrees, from its fundamental owner to the decision-making change [8]. Most of our understanding of Entrepreneurial exit arises from the personal impact of the entrepreneur. Nevertheless, we have little knowledge of entrepreneurs' perception of exit effectiveness. A great deal of previous research has developed conceptual models and typologies of the individual exit track [3] and [13]. In addition to the importance of entrepreneurial exit for the founder, it also

It substantially affects the enterprise, industry, and economy [2] and [14]; even though entrepreneurship suffers, failure repeatedly occurs in an exit event. Scholars describe failure as the Interruption in the business's continuation because of the lack of prosperity of the entrepreneur's minimum economic prospects [15], and voluntary exit does not have a satisfactory result for the entrepreneur [16].

An exit intention is the entrepreneur's tendency or goal in the future to leave. This approach may include exit facilities ranging from founder exit to a complete suspension of the firm. This aim is likely to be tied to the entrepreneur's motivation at a startup [1], the founders a venture to add current income [17] and [18]. Albeit the shift is difficult and costly at the time of founding organizations, early organizational patterns can limit companies' future strategic actions [19]. Although entrepreneurial exit occurs at different stages of the business (start-ups, growth, and maturity), there are many disagreements between

business managers when the firm is growing or in a better financial position than in the past [20]. Thus, the intention to exit (or not) at a determined time or in an appointed procedure may make it arduous for the entrepreneur to choose a different route [8]. Khosravi et al. [21] had theorized the Intention theory of reasoned action as the most immediate antecedent of specified behavior towards entrepreneurial behavior, and experiential investigation in entrepreneurship has evidenced a clear link between intentions and outcomes [22].

## 2.2 | Entrepreneurial Perceptions

With the development of the corporate entrepreneurship strategy literature, entrepreneurship is defined mental concept resulting from creating business opportunities and mobilizing organizational resources to expand products and services and markets and competencies beyond the status quo [23] and [24]. As addressed in entrepreneurship theory, these entrepreneurial perceptions of corporate executives play a critical role in identifying opportunities to reconfigure business models and operational processes [23]-[27]. Entrepreneurial perceptions as the vital ability of the entrepreneur are rooted in the entrepreneur's understanding of formal experiences specific to the industry, management, and operations [23] and [28]. First, the entrepreneurial industry experience includes interactions with buyers, suppliers, distributors, and other stakeholders. Such an industry-specific experience creates an understanding of opportunities, threats, competitive conditions, and government regulation. Second, the experience of entrepreneurs from the management team on how to discuss strategic decisions, risk-taking by the company, and the economic committee lead to some strategic actions in an environment of uncertainty [23].

The present study examined five GEM surveys variables (e.g., perceived opportunities, perceived capabilities, Fear of failure, entrepreneurial intention, and role model) under entrepreneurial perceptions, the definitions of each of which are summarized below.

### 2.2.1 | Opportunity Perception

Scholarship on entrepreneurial opportunities has grown dramatically over the past 21 years since Shinnar et al. [28] first published the study. The opportunity perception is a significant driver of people's encouragement to start a new business [29] and [30]. Understanding opportunity is identifying the new and desirable opportunities to start a business. Many people decide to start a business when they recognize a particular entrepreneurial opportunity [31]. Discovering entrepreneurial opportunities in addition to prior knowledge requires cognitive abilities to exploit and value that knowledge [32]. According to Stevenson's theory, identifying and selecting the right opportunities to start a business is one of the essential abilities of a successful entrepreneur. The most critical factor in the difference between entrepreneurial and non-entrepreneurial individuals is recognizing and understanding new opportunities in the environment [33].

Previous research has shown that entrepreneurs can build a well-organized knowledge structure by acquiring and managing internal and external resources and prior knowledge to understand and anticipate the existence of opportunities and develop innovative opportunities [34] and [35]. In addition, Baron [35] noted that the impact of entrepreneurial awareness is an essential cognitive ability that has important implications for critical dimensions of the entrepreneurial process, including the recognition and exploitation of opportunity. Awareness includes sensitive behaviors to understand and identify emerging entrepreneurial opportunities [36] and [37]. According to Ajzen's theory of programmed behavior, people's behavior influences their attitudes [38]. Ajzen defines attitude as "the learned tendency to respond favorably to a goal that is less stable than individual characteristics and can change at different times and situations through the interaction of individuals with the environment." When a person realizes the existence of a job opportunity, he evaluates his ability to trap opportunities. If he evaluates it positively, he develops a favorable attitude towards behavior [38]. This favorable attitude also leads to the creation of intention and behavior. In this regard, previous research has argued that understanding profitable entrepreneurial opportunities lead to entrepreneurial intent [39] and [40].

### 2.2.2 | Capability Perception

According to the GEM, capability perception is the strength to inception different and risky businesses in people's mentality and based on an individual's cognitive perceptions and vital factors of a person's desire to start a business. When an entrepreneur recognizes the skills, knowledge, and motivation to start a business to take advantage of opportunities, creating a new business occurs [41]. Confidence in personal skills and abilities plays a crucial role in starting a new business and successfully developing an entrepreneurial activity. Various studies show that entrepreneurial self-efficiency is an integral part of entrepreneurial activity [42]-[44]. Therefore, it predicted that people who have confidence in their entrepreneurial skills (for example, entrepreneurial self-efficacy) are likely to start new activities. In other words, capability perception and Entrepreneurial action have a positive relationship with each other. The managers who have a higher level of skills required to grow a business are risk-taker, attract more human and social capital, and attain higher levels of growth and success in their business [45] entrepreneurial skills include all the knowledge, skills, and competencies that help identify opportunities to start and manage a business. Many entrepreneurs can identify new entrepreneurial opportunities only because of their past knowledge and experience in specific fields [46].

### 2.2.3 | Role Model

Identifying people who can consider as role models to increase people's desire to become entrepreneurs is called role model identification [47]. Knowing other entrepreneurs provides examples of peers that encourage them to become entrepreneurs [48]. Many empirical studies show that entrepreneurial patterns are one of the main aspects of effective learning, thus accelerating the decision-making process for entrepreneurial activities [49] and [50]. Patterns are also important when choosing entrepreneurship as a career option. They are good examples for imitating, inspiring, and conveying a positive message that can facilitate a person's ability to discover and act on new business ideas and opportunities in the early stages of starting a business. Put, observation and interaction between the individual and their model promote learning and provide the opportunity to understand better the tasks of the skills needed to succeed in entrepreneurship [44]. Not only do patterns positively affect increasing access to entrepreneurial knowledge, but they also enhance the learning of entrepreneurial behaviors [51]. By analyzing the characteristics, behaviors, and skills needed to achieve the desired goal, individuals perceive similarities in entrepreneurs that they consider a valid model, thus reducing the Fear of entrepreneurship [48] and [52].

### 2.2.4 | Fear of Failure

Fear of entrepreneurial failure is recognized as a social trait associated with the perceptual stigma of business failure [53]. In the context of entrepreneurship, the social fear of entrepreneurial failure (fear of failure) is a personality property that can act as a barrier to entrepreneurship by stigmatizing business failure [43] and [54]. Consequences of business failure, such as social embarrassment, may negatively affect people's entrepreneurial choices [52]. Social consequences of business failure; social embarrassment, for example, acts as a barrier to entrepreneurship. From an economic point of view, personal perceptions of risk-taking and working in an environment of uncertainty harm one's entrepreneurial decision-making, often leading to someone else choosing a job. On the other hand, the psychological perspective shows that people's attitudes toward entrepreneurial failure are due to social norms that are mostly considered shameful [54]. At the individual level, the social stigma of entrepreneurial failure shapes one's future economic decisions and may discourage individuals from engaging in entrepreneurial activities and have economic and psychological consequences for the individual [55]-[57]. In the entrepreneurial process, some entrepreneurs exit for Fear of possible failure. This Fear of failure is especially evident in businesses operating in the manufacturing and industrial sectors [58].

## 2.2.5 | Entrepreneurial Intention

Entrepreneurial intention considers being the most critical factor in predicting business startups. Bird [59] believes that intention as a mental factor can define as guiding a person's desires, experiences, and behavior toward a specific goal or path. Bandura [60] also considers intention and foresight to be the depth of human qualities. In his opinion, it shows the intention of a person's behavior in the future. The intention is influenced by individual choices and leads to behavioral persistence. Ajzen believes that entrepreneurial intent can predict one's entrepreneurial future better than environmental conditions and personality traits [38]. Because "individual perceptions" are expected to impact entrepreneurial intent more than "reality" significantly. People decide to start a new business based on their perceptions of the environment. Zampetakis and Moustakis [61] also argue that empirical analyzes of individuals indicate that intentions predict individual behaviors and that individuals' attitudes and views provide the basis for predicting intention. As a result, examining the predictions of entrepreneurial intention factors is essential in promoting and developing entrepreneurship.

## 2.3 | Datamining

Data mining is a portion of the knowledge discovery in databases process, including data selection, preprocessing, data transformation, data mining, and measurement results [62]-[64]. Data mining is an analytical method of the dataset to find complex relationships and summarize data differently from before, which can be understood and beneficial for data owners [65]. A recent systematic literature review concluded that data mining applies pattern diagnosis, statistics, machine learning algorithms, databases, and data visualizations to handling information detection problems from significant databases [66].

## 2.4 | Random Forest Algorithm

Random Forest is easy to use and presents high performance for various tasks, constructing it one of the most popular Machine Learning algorithms. Random Forest is mainly a supervised machine learning ensemble algorithm used for classification and regression that actuates by constructing a significant number of decision trees during the training process. A decision tree by a tree-like graph is a nonparametric model described [67]. Random Forests iteratively divided the data into branches based on a preset criterion to increase the prediction accuracy, resulting in a tree-shaped structure [68]. The algorithm makes decision trees on data samples in the random tree, predicts each, and finally selects the best solution by voting. A group method is better than a single decision tree because averaging the result reduces over-fitting [67].

## 3 | Methodology

This section gives a succinct introduction of the designed framework for Iranian entrepreneurs' exit prediction. Divided process into three parts. In the first part, all the variables needed to build the machine learning model were selected and transferred to a new data frame. The second part is the data merged each year sequentially to create a new, matched data frame. Data preprocessing involves identifying the options of each variable and operating on lost and missing data. Then the variables were analyzed for statistical relationships. Also, it investigated the correlation between the discussed variables and the statistical distribution of the variables. Statistical analysis of business exit rate in each year and gender and geographical areas and age of entrepreneurs also examined. The quantitative results of these studies are as follows. Afterward, we obtained impressive results by examining the effect of exit on other variables such as year and age, gender, and geographical areas.

After preprocessing the data, divided the data into testing, training, and validation sets. Dataset was split into 70 to 30 for training data and Testing datasets. In the next step, 30% of the training data is allocated for validation data sets. The prediction model's target was the entrepreneurial exit, which divided the dataset into x and y. Since the rate of entrepreneurial exit in Iranian entrepreneurs is less than 9%, as a

result, our data is imbalanced. The model must be balanced to avoid over-fitting the target. Using the SMOTE method, the target was equal for both options.

### 3.1 | Experimental Method

#### 3.1.3 | Data Collections and Provision

This disquisition data is mainly from 2008 to 2019 Iranian Entrepreneurs collected from the GEM. The initial data sample was 39,400, which reduces to 12,100 by selecting startup entrepreneurs or business owners.

By analyzing the subjects' entrepreneurial perceptions, role models, gender, age, and geographical area of Iran, this study investigates the importance and interrelationships of these attributes to establish a predictive model for the entrepreneurial exit. The variables report is in the *Table 1*.

**Table 1. Description of dataset constituent items.**

	<b>Variables</b>	<b>Definitions</b>	<b>Description</b>
<b>F1</b>	ysurv	Years of research	2008 to 2019 Iran's GEM data.
<b>F2</b>	age	Age of statistical population	Entrepreneurs 18 to 64 age groups.
<b>F3</b>	gender	Gender of the statistical population	Male and female entrepreneurs respectively by 1 and 2.
<b>F4</b>	irstrata	Geographical areas of Iran	Divided the country into six geographical regions.
<b>F5</b>	opport	Opportunity perception	Percentage of 18–64 age group who see good opportunities to start a firm in the area where they live.
<b>F6</b>	knowent	Role model	Percentage of 18–64 age group who knows entrepreneurs in the area where they live.
<b>F7</b>	fearfail	Fear of failure	Percentage of 18–64 age group with positive perceived opportunities who indicate that Fear of failure would prevent them from setting up a business.
<b>F8</b>	bstart	Entrepreneurial intention	Percentage of 18–64 age group (individuals involved in any stage of entrepreneurial activity excluded) who intend to start a business within three years.
<b>F9</b>	suskill	Capability perception	Percentage of 18–64 age group who believe they have the necessary skills and knowledge to start a business.
<b>F10</b>	exreason	Reasons of exit	Entrepreneurial reason of leaving the business into 10 group.
<b>F11</b>	discent	Entrepreneurial exit	Exited a business as owner-manager in the last 12 months are represented by 1 and 0.

The empirical experiment had conducted on a Windows server 10 operating system with Intel (R) Core (TM) i7-6600U CPU (2.81GHz), 64bit operating system, and 16GB of RAM, with Python programming V3.8 in Jupyter Notebook.

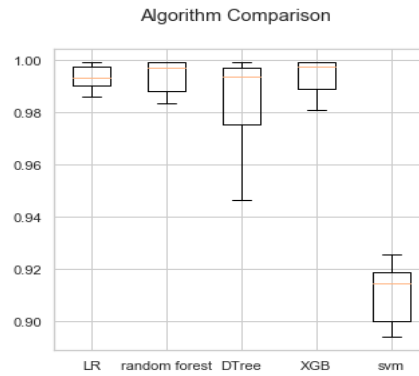
After creating a new data frame from previous years' data, preprocessing data was with the missing data with alternative values considered the most common. Because the data are nonparametric, the Spearman method is used by the data correlation. The correlation results of the variables came in the next section. Investigating from entrepreneurial perceptions and role models to entrepreneurial exit have exciting results that show in the following.

To validate the methodological approach, we have operated a comparative analysis between the proposed method and several supervised and ensemble algorithms based on other learning methods, including logistic regression, XGboost, decision tree, and Support Vector Machine (SVM). The results show that Random Forest and XGboost have the upper rate of accuracy in these algorithms. However, the accuracy is not the actual rate, so the Confusion Matrix calculated was implemented. *Table 2* shows

the accuracy, precision, recall, and F1 score calculation for each algorithm. As Fig. 2 shows, Random Forest and XGBoost algorithms have the highest accuracy in algorithms comparison.

**Table 2. Performance of algorithms.**

	Accuracy	Precision	Recall	F1_score
Logistic Regression	99.31	96.03	97.75	96.88
Random Forest	99.35	96.03	94.37	95.38
Decision Tree	98.28	96.03	82.88	88.97
XG Boost	99.38	97.35	93.64	95.46
SVM	91.09	78.41	21.47	33.71



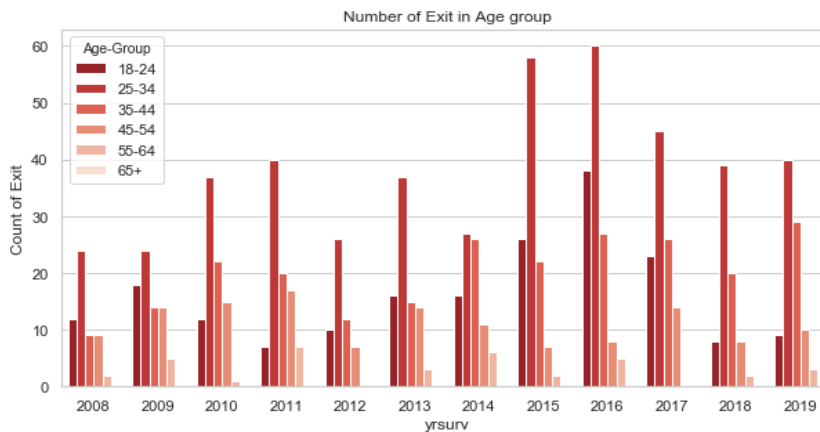
**Fig 1. Algorithm comparison.**

Followed tables displayed the statistical survey from independent variables in Iran's geographical area.

## 4 | Experimental Results and Discussion

### 4.1 | Data Mining Results of Variables

The sample population's age distribution is 25 to 34 years higher than the other age groups in all years. The dependent variable in this study is the entrepreneurial exit, and according to previous research, entrepreneurial exit has a negative relationship with age. The figure below shows the frequency of entrepreneurial exit in the age groups in the studied years. This reason is not clear, but it may age have an Impact on entrepreneurial exit, as shown in the diagram. The highest exit counts in the 25-34 age group are in 2015 and 2016, and the lowest occurred in 2008 and 2009.

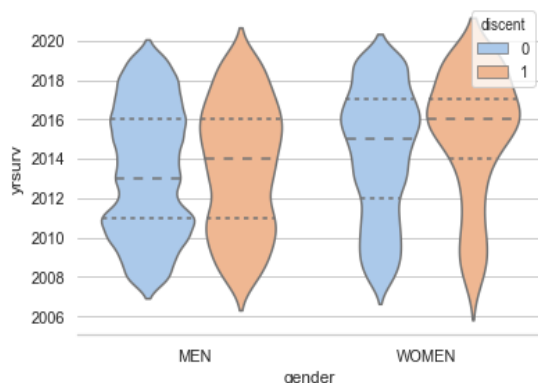


**Fig. 2. Entrepreneurial exit in age group.**

In this study, entrepreneurs surveyed in Iran's statistical population are 23.9% women and 76.1% men. The entrepreneurial exit gap between men and women is predicted in the coming years toward equality.

This number is almost equal in men and women, and 7.66% and 7.76% of the study population, respectively, have left their business.

The chart below shows the rate of entrepreneurial exit by gender in different years. As shown in the chart, women's entrepreneurial exits have grown more in recent years, while men's entrepreneurial exits have had an almost uniform distribution over the years. The population distribution in age groups is different in women and men entrepreneurs. As mentioned earlier, the number of men is higher than women, but women entrepreneurs are younger than men.



**Fig. 3. Entrepreneurial exit in gender.**

Respectively, the most reason for leaving in men is: not profitable, followed by financing and personal reasons, while the most common reason for leaving the business in women is not profitable, followed by personal reasons and in the third place, the problem of financing. Men's lowest ranks for leaving the business are other reasons and opportunities for sale and retirement, and in women, retirement, and accident and opportunities for sale. Justo et al. [75] study found that female entrepreneurs (compared to men) leave voluntarily than fail in their business.

The office of the GEM in Iran has divided the country into six geographical regions: 1) Tehran and Alborz, 2) Northwest, 3) Northeast, 4) Central, 5) South and Southwest, and 6. Southeast. The chart below shows the frequency distribution percentage of each entrepreneurial perception and the role model and exit from the business in each geographical area. According to the diagram, the capability perception and the role model have received the most positive response among the research's independent variables. It also the Fear of failure has the lowest level. Regions 4 and 5 had the most entrepreneurial exit in the entrepreneurial exit, and the lowest was related to 1.

Apperceived of were identified of exits from the business each year, and that the highest number of exits is related to 2016, and the next rank is 2019. It is noteworthy that in 2016, due to the implementation of the Joint Comprehensive Plan of Action (JCPOA) and the liberalization of Iran's financial reserves, the highest economic growth occurred in the last ten years, but the main reason for leaving the business was not profitable [69].

Based on the entrepreneurial exit, the reasons for leaving are sales opportunity, another job or opportunity, unprofitable, scheduled exit, financing problem, financial policy, accident, retirement, personal reasons, other. As shown in the chart below, the main reason for leaving the business was unprofitable and financial problems. Behaviors and decisions of entrepreneurs exit in Iran are not much different from the common indicators in the research literature and the world businesses. But what makes the difference is the exit planning and the factors that lead to the exit decision [58].





Fig. 4. Distribution of variables in Iran's geographical area.

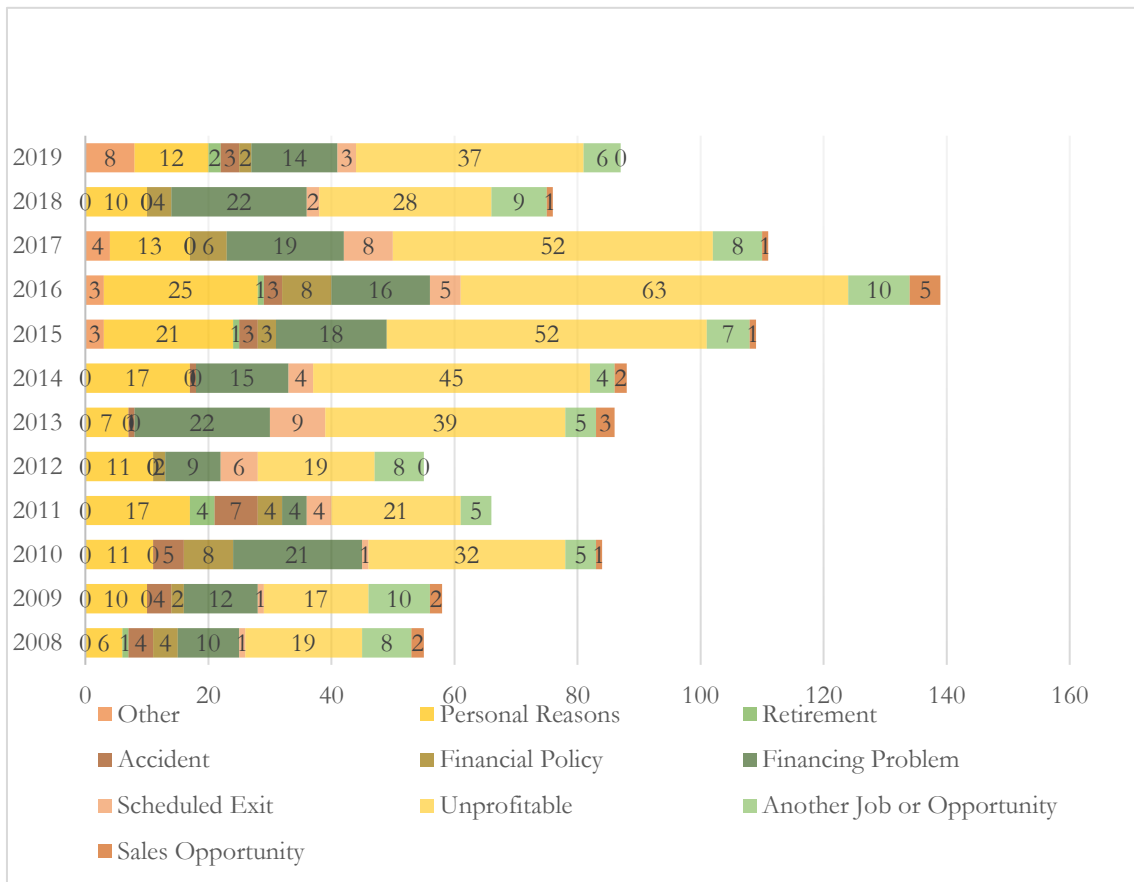


Fig. 5. Distribution of exit reasons.

The exit reasons separately for men and women in each of Iran's regions are shown in Fig. 6. After unprofitability, which is the highest reason for men in all areas, Tehran and Alborz, South and Southwest, personal reasons, and in other regions, financing problem, more than other reasons, has caused men to leave. For women, these reasons are different. Northwest women are for personal reasons and others

mainly for unprofitable, exit the business. Also, the variety of answers in women of Tehran and Alborz was more than in other regions. They received the most unprofitable, financing problem, another job or opportunity, and personal reasons responses. The opportunity to sell to women has been answered only in Tehran and Alborz and the southeast.

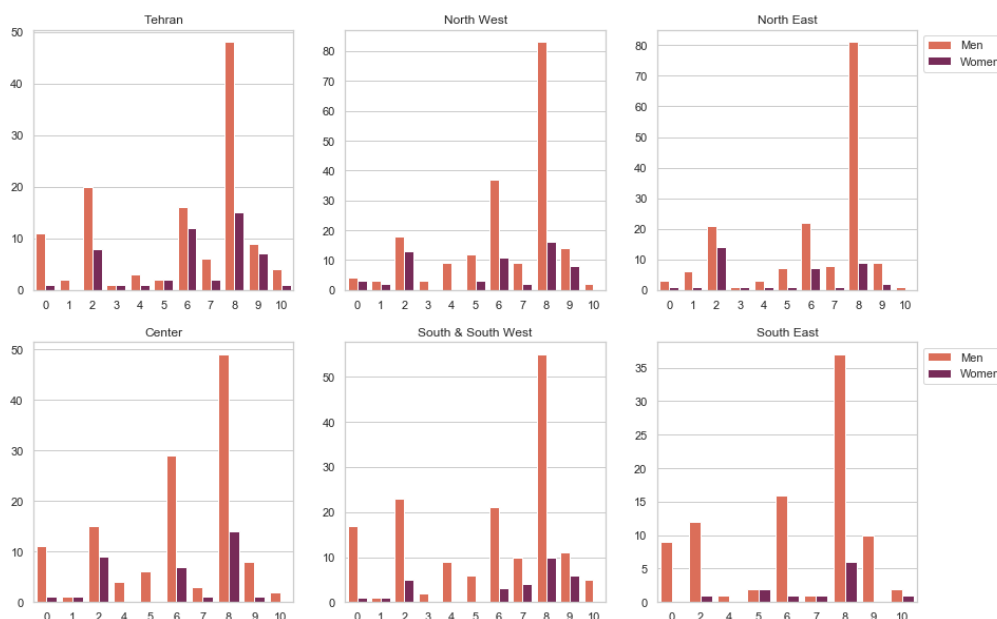


Fig. 6. Exit reason for men and women in each region.

### 4.2 | Correlation of Variables

Since the present study variables are nonparametric, the Spearman method should calculate the correlation between the variables. Fig. 7 shows the degree of correlation between dependent and independent variables. As shown, the independent variables are significantly related to each other, also confirmed for the dependent variable. It is not unreasonable to expect that the entrepreneurial exit and the exit reasons are most correlated with each other for 97%. Capability perception with opportunity perception also shows a 21% correlation, and between age and entrepreneurial intention, correlation is 18%.

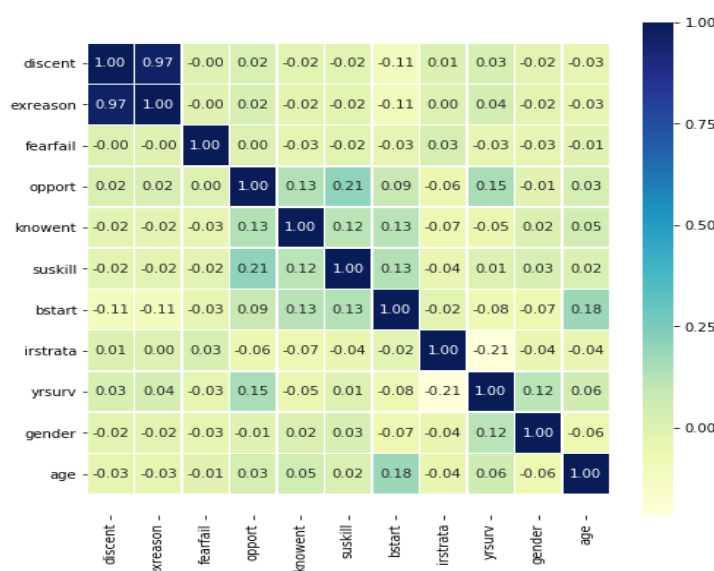


Fig. 7. Correlation of variables.

### 4.3 | The Random Forest

As discussed above, split the data into training, validation, and test dataset, constructed the Random Forest model on the training dataset with independent variables as entrepreneurial perceptions. Then built the model using 1000 estimators with maximization of the depth and the entropy for criterion.

The following figure shows the plot for the Random Forest model with the mean decrease in entropy factor. We can see that for the entrepreneurial exit, exit reasons are the most crucial factor for the decision to entrepreneurial exit, followed by the entrepreneurial intention and opportunity perception

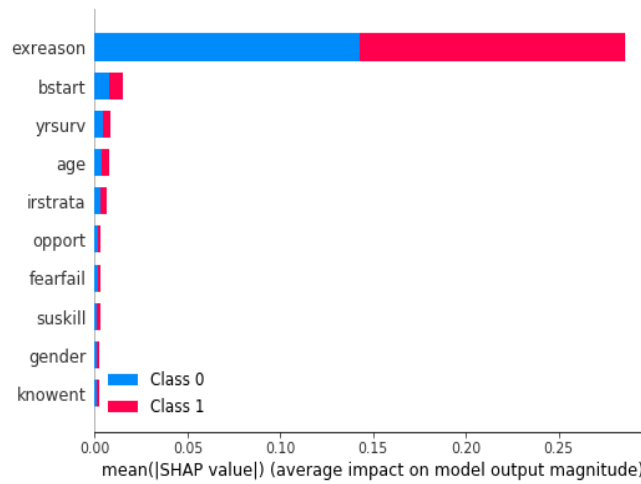


Fig. 8. Factors affecting entrepreneurial exit.

After oversampling with SMOTE method, 10788 training data built the Random Forest model. Fig. 9 is the model's confusion matrix showing the predicted values procreated by the Random Forest model and the actual values present in the validation dataset. The validation dataset's confusion matrix exhibits 2314 actual true negative values (not entrepreneurial exit) that the model has predicted accurately. Also, there are 218 actual true positive values (entrepreneurial exit) that the model has predicted accurately



Fig. 9. Confusion matrix result.

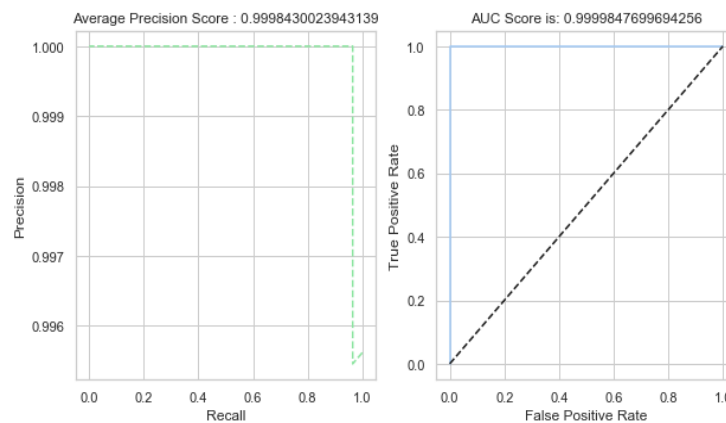
Out of 2541 data points, 2532 are predicted correctly by the Random Forest model. The accuracy rate of the model is around 99.6%. However, if we talk about the prediction model's error, 9 data points were predicted inaccurately (9 positive values that model predicted negative). Thus, this model is moderately performing well if we wish to focus on exiting the business. The table below shows the accuracy, precision, recall, and F1 score values for validation and test datasets. Since both validation and test results are close to each other, the model is not over-fitted, and the validity indicators of the model show a high percentage.

**Table 1. Predictive random forest model results.**

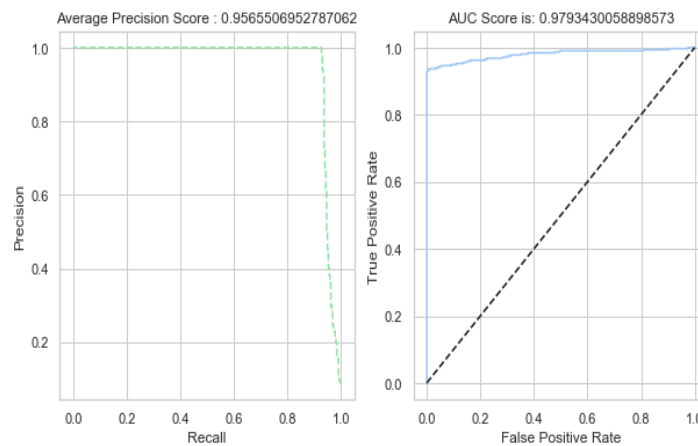
	Accuracy	Precision	Recall	F1 Score
Validation dataset	0.996	0.960	1.0	0.979
Test dataset	0.993	0.930	1.0	0.963

The Receiver Operator Characteristic Curve (ROC Curve) portrays the performance of the predicted model. The ROC curve comprises True positive rate and false positive rate, and the third axis indicates the Area Under Curve (AUC). True positive rate is the percentage of positive values that the model can accurately predict the total positive values in the data set. Similarly, the false positive rate is the percentage of positive values that the model incorrectly predicts from the total negative values. A model has the maximum True positive rate, and the minimum false positive rate is ideal. The third axis represents the cumulative probability for deciding the entrepreneurial exit probability. An excellent model has AUC near the 1, which means it has a good separability measure. (Random Forest model AUC is 99.9%, shown in figure 10) A flawed model has an AUC near 0, which means it has the worst gauge of separability. It means the result is inverse. It is predicting 0s as 1s and 1s as 0s.

Moreover, When AUC is approximately 0.5, the model has no discernment valence to distinguish between positive and negative classes. As mentioned, the AUC value of the random Forrest model for the test dataset is 97.3%, and the validation dataset is 99.9%, which represents the highest measurement indicators of entrepreneurial exit classes. The validation and test datasets have shown 99.9% and 95.6% respectively, the average precision score displayed in Fig. 10 and Fig. 11.



**Fig. 10. ROC curve & precision-recall curve for the validation set.**



**Fig. 11. ROC curve & precision-recall curve for test set.**

The Random Forest model's learning curve has a good fit, that recognized with a minimal gap between the two final loss values, training and validation loss that reductions to the point of stability. As shown in the figure, the model's learning process, aligned from the beginning in training and validation data.

However, in the range of 3700 data, the model does not perform well, optimized by increasing the learning and preventing model overfitting. So, as other researchers have said, by increasing the data, model learning is optimized, and the results of model accuracy are improved.

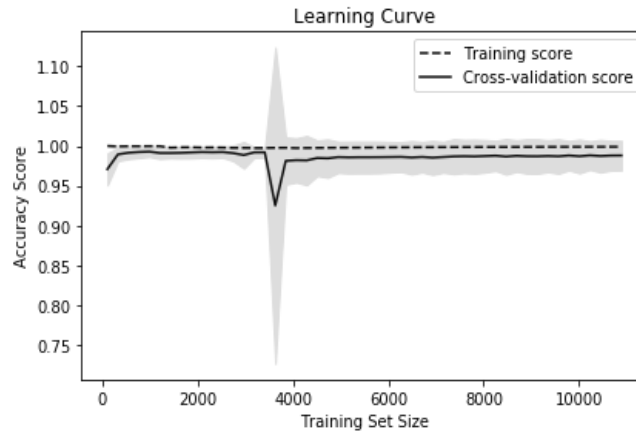


Fig. 12. Learning curve for random forest model.

## 5 | Discussions

The study discovered some exciting results from the experimental results. It is unavoidable to pedestal and benefit from entrepreneurial activity in any dynamic economic society that some of these ventures fail.

Exit allows the entrepreneur to use the liquidity gained to interact with other opportunities. However, leaving entrepreneurship is beyond the individual and has a significant impact on the business and industry and at the macro level on the community economy [2]. May act as a solid obstacle to starting a business in the first place if ending a business is costly or demanding, or even socially or culturally unacceptable. Research on serial entrepreneurship also gives a favorable prospect on entrepreneurial exit, as the exit is mostly the starting point for subsequent entrepreneurial activity [70].

Entrepreneurs can apply the new experience to a new venture or employment opportunities, requiring leaving the current business and starting a new business. Reasons for exiting the business can be positive or negative. Positive reasons may comprise the sales opportunity, another job or opportunity elsewhere, scheduled exit, or retirement. On the other hand, negative reasons can embrace an unprofitable, failure to access finance, the financial policy or taxation or bureaucracy, or human factors such as changing personal situations. Evidence from the GEM Adult Population Survey (APS) shows that the firm may continue when an entrepreneur exits the business. Indeed, in some economies, more than half of businesses continue after the individual has exited [71]. According to previous research, entrepreneurship has a negative relationship with age [72], and most exit of business is in the age group of 24 to 35 years. The obtained results show that Iranian entrepreneurs have a very high capability perception and role models and less Fear of failure than similar economies. Findings of previous research show that the capability perception and role model of entrepreneurship increase entrepreneurial intention. Since the entrepreneurial intention affects the entrepreneurial exit, it is possible to turn a negative exit reason into a positive exit reason by educating business skills and influencing the role model on young people.

## 6 | Conclusions and Research Implications

This study set out to determine and predict entrepreneurial exit from entrepreneurial perceptions based on GEM data. Random Forest model's analysis revealed that the entrepreneurial perceptions like intention and opportunity perceived, capability perceived, and role model are affecting to exit the business. The

model's accuracy for the test dataset is more than 99%, and another criteria ROC\_AUC score 96%. Overall, these results suggest that, as with perceptions, individuals can predict their entrepreneurship probability, so can an entrepreneurial exit before entrepreneur psychological and financial impact of losing capital and preventing failure. This study's findings can help entrepreneurship policy in the young generation and predict entrepreneurial exit in startups. Therefore, we can extract a preliminary conclusion that the proposed prediction framework can effectively predict entrepreneurs' exit. Future work can establish decision support systems based on the proposed framework to help entrepreneurial departments predict entrepreneurs' exit reasons. Besides, evaluate more data samples for other countries to improve the proposed method's predictive performance.

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## Data Availability Statement

The data and python code that support the findings of this study are openly available in [GEM\_IRAN] at [https://github.com/Masmtr/GEM\\_IRAN](https://github.com/Masmtr/GEM_IRAN) [73] and [74].

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