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# Using SVM for Smart Direct Marketing (SDM): A case of predicting bank customers interested in the Term Deposits

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# Using SVM for Smart Direct Marketing (SDM): A case of predicting bank customers interested in the Term Deposits

**Abstract:**
The objective of this study is to reveal how important and necessary it has become to adopt the new methods and technical of Data Mining derived from artificial intelligence (AI), and this in the process of marketing banking products and precisely that of Term Deposit (TD). Therefore, in our research study we adopted the Support Vector Machine (SVM) method, and we succeeded through the process of modeling borrowed by the techniques of Data Mining (DM) to build a model that will allow us to predict the behavior of bank customers toward term deposits, for this the SVM method has been applied on a database of customers of a bank which includes historical responses of customers during a marketing campaign of the product DT.
For the manipulation tool we used, we chose the Python programming language, recognized by its power in modeling and exploiting DM techniques. For the methodology adopted, we started with a pre-treatment and cleaning of the data to keep only the significant explanatory variables and also for any extreme or aberrant variables, subsequently the modeling was carried out by adopting the DM process, at the end of this process we were able to measure the perfection and the level of predictability of our obtained model, thus we obtained the accuracy of 93% using the metric Accuracy, Thus according to the ROC curve we have that AUC=98, this reflects the performance of our obtained model. So, we were able to build a model that will help bankers make decisions in terms of predicting customers interested in the term deposit product.

**Keywords:** SVM, ROC, Python, Data Mining, artificial intelligence, marketing.
**JEL Classification :** C02, C19, C35, C55, C6, M31, G2
**Paper type:** Empirical research

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## 1. Introduction:

Data has become the new oil in the last decade it represents an ostentatious sign for big boxes; for this purpose, the one who holds a large quantity of data will be the one who holds the source of the information necessary for an admirable economic development. Indeed, several areas have invested in the storage of data in order to obtain relevant and essential information to make adequate decisions.

The banking sector is one of the sectors that holds more customer data, which will enable decision-makers to make decisions on several aspects of banking, Direct marketing is one of those areas and is a necessary pillar for a bank to continue to market banking services and products.

The high availability of large amounts of data and the impending need to transform this data into useful information and knowledge, Data Mining has recently attracted much attention in the information industry (Han &Kamber, 2006).

That is why we conducted this scientific study, however, the problem of our article is to answer the hypothesis of the efficiency of using Data Mining techniques to predict the behavior of banking customers interested in a banking product. For this, the SVM method was chosen, using historical customer data.From this article, an attempt was made to reveal the importance of using artificial intelligence techniques in modeling banking problems. For the methodology adopted throughout the modeling, we followed the Data Mining process, which includes a preliminary step of pre-processing and data cleaning, then we analyze the variables that will be used to drive our model, Then we build our model by the SVM method and at the end of the process we evaluate our model by the different metrics used by the DM techniques. Therefore, in order to explore the importance of this SVM method, the following structure has been adopted in this article; we began with a literature review of the various scientific studies that have used these techniques and precisely that of the SVM, thus the classical marketing techniques used in the marketing of banking products and services have been illustrated, the SVM method and their usefulness in the prediction of dichotomous variables have subsequently been mentioned, The interest of this technique in direct marketing for the marketing of the Term Deposit product has been illustrated in the light of the results obtained from an empirical study of the application of this technique to data of a bank's commercial character.

## 2. What is Smart Direct Marketing (SDM)?

Direct marketing has seen a surge in interest in the last decade, thanks to the mass of data stored and which is the fundamental means of exploiting artificial intelligence methods in the marketing of products and services,so by activating this alliance between these two concepts, we can produce a new term that is Smart Direct Marketing (SDM).

In this respect a better knowledge of its customers allows more targeted marketing acts and personalization of messages, offers but also products.

SDM is based mainly on the fact that a company can retrieve a lot of information through the customer data stored beforehand and that will allow it to build a clear image of the desires and needs of its customers, but also for potential customers.

Like traditional direct marketing, MDS is a key element in building a healthy marketing process for a product or service, but its relevance lies in the fact that the company holds a maximum of clear and precise data of its customers; they will help decision-makers make appropriate decisions and minimize resources and waste energy to sell their brands, but also to attract the interest of new customers. Thanks to the IT tool we can build efficient models that are able to make us predictions about the behavior of customers vis-à-vis the products or the market services.

So, the SDM is an alliance between the computer tool but also mathematics with the classic marketing methods, this combination has allowed us to optimize marketing strategies but also to double profits, and this by trying to predict which target or ideal customers are most likely interested in a proposed well.

This is thanks to Data Mining techniques derived from artificial intelligence that allows us to extract fundamental information to know the customers who are likely interested in a good.

These techniques can be divided into two axes:

- Supervised learning techniques (SVM, RNA, KNN, etc.) consist of learning with a supervisor. This involves extracting classes or groups of individuals with common characteristics.
- Unserved learning techniques (K-means, RNA, etc.) consist of learning without a supervisor. This involves extracting classes or groups of individuals with common characteristics.

In this article we will discover together one of these methods and precisely that of SVM, and we will try to measure its performance via the obtained results, using the different metrics of performance measurement of the obtained model.

## 3. Supports Vector Machines

Supports Vectors Machines (SVM) is one of the methods used in the classification problem, the basic idea of the SVM method is to maximize the contour field separator (hyperplane) that separates data into two classes in an entity space (Armin Lawi et al, 2017). The support vector machine method is suitable for use on linearly separable data (C. J. C. Burges,1998).

Support vector machines (SVM) use a linear model to implement non-linear class limits via certain non-linear input vectors in a large descriptor space. The linear model constructed in the new space may represent a non-linear decision boundary in the original space. In the new space, an optimal separation hyperplane (OSH) is built. Thus, SVM is known as the algorithm that finds a special type of linear model called the maximum margin hyperplane, which gives the maximum separation between decision classes (Jae H. Min and Young-Chan Lee, 2005). Examples of learning that are closest to the maximum margin hyperplane are called support vectors (Cristianini and Shawe-Taylor, 2000).

## 4. Literature Review:

The public image of a product or service is a necessary element in deciding and making a choice by a consumer. In their decision's consumers assess the attributes of different products, services or brands. Given that today it is necessary that the management of the brand image takes an important axis in the reflections of the companies but also for the financial institutions. For this there is a multitude of methods and techniques related to marketing strategies.

Identifying the customer who is likely to be interested in a product or service is one of the purposes of Direct Marketing (Deichmann et al., 2002), but the SDM represents an alliance between traditional direct marketing techniques and new communication and information technologies; to this end a wide range of studies have shown the value of these techniques.

According to (Amira M. Omare et al., 2020) because of the digital atmosphere and the digital world, customers will make the decision whether to buy a product before going to the seller.

For (Amzile R. and Amzile K., 2020) Digital marketing it does not challenge the fundamental principles of traditional marketing such as segmentation, targeting and positioning, but takes into account the massive development of new digital uses by

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individuals and that of new technologies, so the methods of Data Mining have shown their usefulness in predicting the behavior of customers vis-à-vis banking products.

For (Liye Ma and Baohong Sun, 2020) machine learning methods have great potential to help solve important research problems from all these angles. Effectively incorporating machine learning methods for marketing research is a challenge. However, the opportunities are vast and the potential contributions resulting from the successful use of these methods justify the effort required to meet the challenges.

According to a report published by the Direct Marketing Association (Johnson and Frankel, 2005), total direct marketing advertising spending in 2005 was approximately $161.3 billion, with direct marketing activities accounting for 10.3% of US GDP in 2005. So, for (Barwise and Farley, 2005) reported that in some European countries, direct marketing spending increased from 2001 to 2004. For example, the rate of increase is respectively 14.6% in Germany, 73.6% in the United Kingdom and 5.5% in France, this allows us to conclude that direct marketing is characterized by high efficiency.

For (Arushi Gupta et al, 2021) and based on their comparative study of various algorithms such as Support Vector Machine (SVM), Gaussian Naïve Bayes, Random Forest, Light Gradient Boosting (GBM), they obtained significant results in terms of Accuarcy of 84% for the use of SVM in the prediction of customers interested in term deposit.

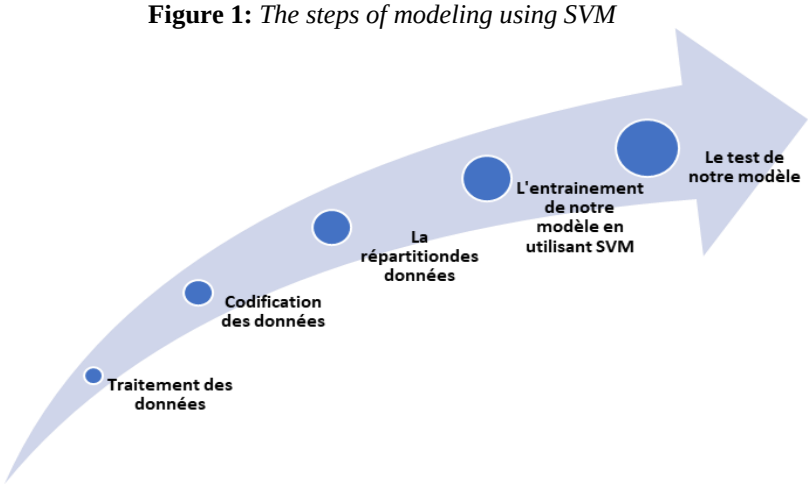
For (NazeehGhatasheh et al., 2020) several machine learning methods derived from artificial intelligence have been compared, in the marketing of banking products; among which the best precision was offered by the random forest (RF) method with Accuaracy equal to 89.98%.

## 5. Research Method or Methodology

Throughout this article we tried to follow the same process of Data Mining techniques, we started with a data processing that includes a series of steps; start with data clean-up by eliminating any rows that contain one or more missing, aberrant or erroneous data, then we go to the codification stage which allows us to reduce the time of execution of the learning program but also to unify the type of data used; For the last stage of this first phase, the data is divided into three parts (Learning data, Test data, Validation data).

For the second phase represents the learning stage of our model, we provide it with the learning data, then we go to the testing stage of our model using different techniques and assessment tools of the model, it is in this last phase that we can weigh the quality and relevance of our model.

**Figure 1:** *The steps of modeling using SVM*




***Source:*** *Author*

### 5.1. The mathematical formulation of support vector machines:

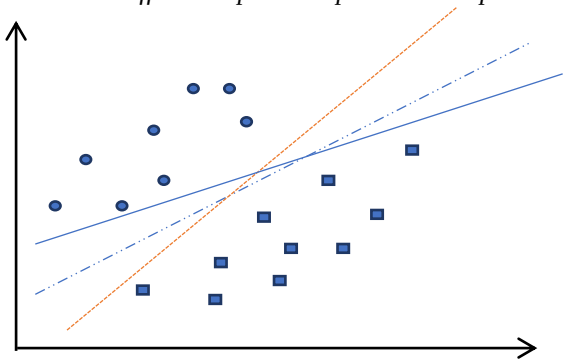
The main function of this method is to classify data from dichotomous outputs using a separator hyperplane, SVM uses kernel methods to classify non-linear problems. According to the classical empirical risk minimization principle, the best hyperplane will be the one that minimizes the number of examples misclassified by this decision function in the learning sample.

$$S = \langle (X_i, y_i) \rangle_{i=1..m}.$$

The distance of a point$X'$to the hyperplane of equation $h(x) = w^T.X + w_0$is equal to: $d(X', h) = \langle w, X' \rangle$withwan orthogonal vector to the hyperplane h(X).The ability to compare several separator hyperplanes of guiding vectors wdeterrents, normalize the distance $d(X', h) = \langle w, X' \rangle$, and this by dividing it by the norm[1]of the vectorw :

$$\frac{\langle w, X' \rangle}{\|w\|} = \frac{d(X', h)}{\|w\|}$$

**Figure 2:** *The different separators possible to separate the data*



***Source:*** *Author*

In a point cloud (data) we can have several separators or classifiers (Figure above) but how can we choose the best separator, for this we use the following definition:

$$\underset{W,w_0}{\text{Argmax}}\ \min\{\|X - X_i\| : \ X \in \mathcal{R}^d, \quad (W^T X + w_0) = 0, \quad i = 1,..,m\}$$

$d : being the dimension of the space of the entrances X$

$X_i : the Xi are the learning data$

So we are looking for the hyperplan whose minimum distance to the learning examples is as great as possible. In this case, the normalized margin, also called geometric margin, is $2 \times \frac{1}{\|w\|}$,so we are looking for the maximum margin hyperplane, for this the search for the optimal hyperplane is thus to solve the following optimization problem which concerns the parameters w and $w_0$:

**Equation 1 :** *the optimization problem*

$$\begin{cases} \text{Min } \dfrac{\|w\|^2}{2} \\ \text{S.C:} \quad y_i(w^T X_i + w_0) \geq 1 \ \ i = 1, \dots, m \end{cases}$$

$$\text{with} : \|w\| = \sqrt{w_1^2 + w_{12}^2 + \cdots \dots + w_m^2}$$

So, we see that more$\|w\|$is small, the larger the margin of the corresponding canonical hyperplane. Thus, in order to find the hyperplane that best separates the data, it is necessary to minimize$\|w\|$

[1]A norm of vector, noted || ||, and the distance from A to B : || ||=AB. Either a plane or space vector.

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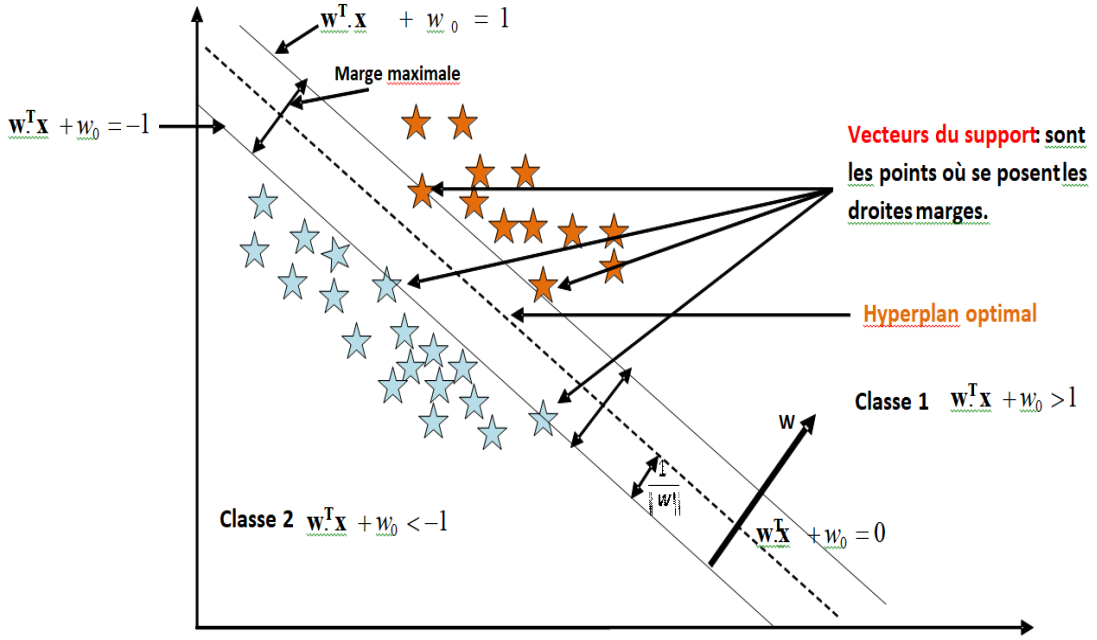
**Figure 3 :** *Graphic representation of the SVM*




***Source:*** *Author*

For non-separable problems linearly, we use the kernel tip, the latter helps us to transform our non-separable problem linearly to a linearly separable problem.

### 5.2. The evaluation metrics of the model

Before we measure the performance of our model, we must first trace the confusion matrix, which will allow us to measure the different metrics needed to illustrate the relevance of our model.

**Table1 :** *Confusion matrix (Source:Author)*

| | **Positive prediction** | **Negativeprediction** |
|---|---|---|
| **Positive** | True Positives | False Negatives |
| **Negative** | False Positives | TrueNegatives |

***Source:*** *Author*

Once we have drawn the matrix we can proceed with the calculation of the different metrics:

***Accuracy*** : it is a metric that takes all the points that have been correctly classified (positive and negative points); it gives us the percentage of the performance of our system.

$$Accuracy = \frac{\text{True Negatives} + \text{True Positives}}{\text{True Negatives} + \text{False Negatives} + \text{True Positives} + \text{False Positives}}$$

For precision Only positive points are of interest the choice of metrics depends on the model

$$Precision = \frac{\text{True Positives}}{\text{True Positives} + \text{False Positives}}$$

$$Recall = \frac{\text{True Positives}}{\text{True Positives} + \text{False Negatives}}$$

$$F1 - score = \left(\frac{Recall^{-1} + Precision^{-1}}{2}\right)^{-1} = 2 * \frac{(Precision * Recall)}{(Precision + Recall)}$$

### 5.3. Sample selection or data and description

The data used to belong to a bank, and are collected during a direct marketing campaign; they include a lot of information necessary for the prediction of customers who will be interested in the banking product of the term deposit.

This database consists of 1,572 rows, divided into two categories, with 671 rows representing customers who are interested in the term deposit, and the remainder representing customers who are not interested.

The structure of the data can be illustrated in the table below:

**Table 2 :** *Structure of data*

| The title of the variable | Description of the variable | The type of the variable |
|---|---|---|
| **Age** | age of the customer | numerical |
| **Job** | The job of the client | Categorical (entrepreneur, student, retired, ...) |
| **Marital** | maritalstatus | Categorical (Married, Single, Divorced, …) |
| **Education** | level of education | Categorical(secondary, university, etc.) |
| **Default** | The customer has a credit default? | Boolean (Yes \| No) |
| **Houssing** | Does the client have a home? | Boolean (Yes \| No) |
| **Loan** | Does the client have credit? | Boolean (Yes \| No) |
| **Contact** | the type of contact | Categorical (Telephone, ...) |
| **Month** | The last month of contact | Categorical (January, February, March, April ...) |
| **Dayofweek** | The last day of contact | Categorical (Monday, Tuesday, Wednesday, Thursday ...) |
| **Duration** | Duration of last second phone call | numerical |
| **Compagne** | The number of calls made. | numerical |
| **Target** | Did the client accept the offer? | Boolean (Yes \| No) |

***Source:*** *Author*

The method adopted in this article that of the SVM, requires that the data be of a numerical nature, for this we have codified the different non-numeric variables, to ensure a better execution of our model and to achieve the desired and hoped results.

The following table illustrates the different codes chosen for each column:

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**Table 3 :** *Codification*

| **Éducation** | **Code** | **Job** | **Code** |
|---|---|---|---|
| primary | 1 | admin | 1 |
| secondary | 2 | blue-collar | 2 |
| tertiary | 3 | entrepreneur | 3 |
| unknown | 4 | housemaid | 4 |
| loan | | management | 5 |
| Yes | 1 | retired | 6 |
| No | 0 | self-employed | 7 |
| Marital | | services | 8 |
| divorced | 1 | student | 9 |
| married | 2 | technician | 10 |
| single | 3 | unemployed | 11 |
| Y | | unknown | 12 |
| Yes | 1 | **Housing** | |
| No | 0 | Yes | 1 |
| Contact | | No | 0 |
| cellular | 1 | | |
| telephone | 2 | | |
| unknown | 3 | | |

***Source:*** *Author*

## 6. Results and discussion

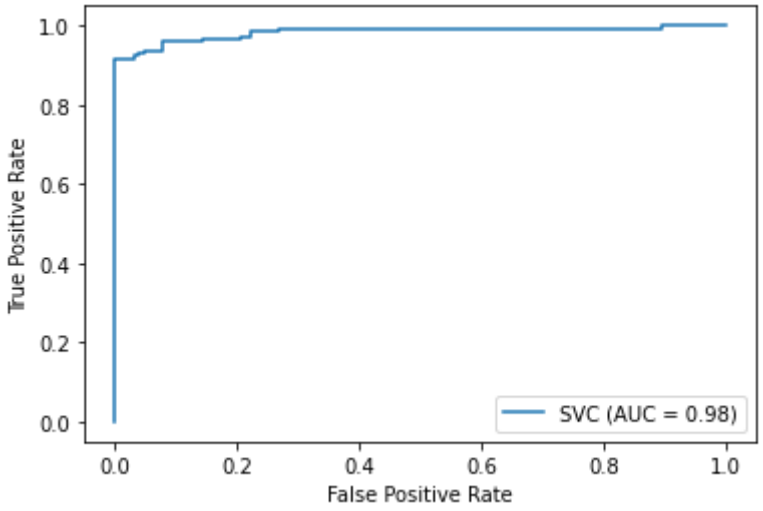
In this scientific study we used Python as the programming language and the creation of our model, to this end we used the different libraries necessary for a better execution of our program.

At the end of our program delivery, we called up the confusion matrix to measure the performance of our model, and we obtained the following results:

```
#imprtation du  scikit-learnmetrics module pour mesurer l'accuracy :
      fromsklearn import metrics
#calculer l'Accuraccy avec la ligne de commande suivante :
      print("Accuracy:",metrics.accuracy_score(y_test, y_pred))
      Accuracy: 0.9301587301587301
```

According to Accuracy we can say that we have been able to build a successful model that will allow us to predict the behavior of banking customers vis-à-vis banking products. So, we can use this model first to predict the customers who are interested in the term deposit, but we can extrapolate this model on any similar product.

**Figure 4:** *ROC curve*




***Source:*** *Author*

We can also measure the level of predictability of our model by interpreting the graphical representation of the ROC curve. According to the illustration above, the ROC curve is closer to the upper left corner of the graph which reflects the performance of our model in terms of customer classification. We also have the area under the ROC curve (AUC) that is a global measure of the performance of our model and that varies between 0.5 and 1, however in our case equal to 0.98, which reflects the perfect performance of our model.

However, the aforementioned results are relevant in terms of model quality in the prediction of clients interested in the TD, therefore and by comparing these results with those obtained in the study conducted by (Arushi Gupta et al, 2021) and (NazeehGhatasheh et al., 2020, we note that our and the most efficient in terms of precision, it also allows us to conclude that the techniques emanating from the DM can help us to prepare very powerful models.

## 7. Conclusions:

Thanks to this scientific study we were able to demonstrate the interest of the different techniques of Data Mining, therefore we were able to find that the techniques of Data Mining offer satisfactory results; according to (NazeehGhatasheh et al, 2020) the best precision was offered by the random forest method with Accuaracy equal to 89.98%, while for (Arushi Gupta et al., 2021) they achieved significant results in terms of Accuarcy of 84% for the use of SVM in the prediction of banking customers interested in term deposit.

According to our study, we succeeded in revealing the value of using Data Mining techniques and specifically SVM, to this end, we adopted the DM process; starting with a pre-processing of the data, we then launched our SVM machine learning algorithm and eventually we evaluated the model obtained by the different evaluation metrics.

We succeeded by following the above process, to build a model capable of predicting bank customers interested in the term deposit, however, we obtained a model with Accuaracy of 93%, This allows us to conclude that we would be predicting customer behaviour with a high level of predictability.

This model obtained it will minimize the cost and expense of a marketing campaign for banks, and this by targeting only customers that we are sure they are really interested in term deposits.

In this article we used medium-sized data, therefore to better model such a problem, we need to think about using fairly large data, to better identify and predict reality. However, you

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need to have hardware powerful enough to generate models that perform in terms of predictability. For this purpose in future work we will think of exploring big data, so we will expand our field of experimentation to exploit other techniques of the DM.

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