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ANALYTICAL DECISION MAKING IN BUSINESSES AND THE ROLE OF MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE

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Abstract
In recent years, machine learning and statistical prediction models have been used successfully to solve business problems. This is mostly due to the exponential growth of consumer data and how easy it is to get access to computer power. Visualizing and making sense of this data to help consulting organisations make better business decisions is hard and has room for improvement. One reason why these companies are so successful is that they can accurately estimate how long a job will take and, by extension, how much money it will cost. The goal of this study is to do two things: first, figure out which machine learning and statistical methods are best for predicting internal costs in a consulting firm; and second, make a user interface with visual analytics that shows the results of these methods and helps people make decisions in an interactive way. Through the research, both of these goals will be met. The customer relationship management (CRM) database that the consulting firm kept was used to get the information needed for this study. The database had information about several consulting projects and covered a period of twelve years. In the past, we've used statistical linear models and machine learning decision trees to do research. We proposed models based recurrent neural networks .to analytical decision making in businesses and the role of machine learning and artificial intelligence.

Keywords: analytical decision , machine learning , artificial intelligence.

1. Introduction

Consulting firms try to sell their knowledge to customers so they can help them solve their problems [1]. The ways that these companies figure out how much to pay their employees for their time are not always easy to understand. In some industries, it is common for consultants to charge by the hour. However, before hiring a consultant, many businesses (especially in the construction industry) want a firm quote for the project [2]. This could cause the project to take an unusually long time, but that depends on how the project is set up. A high-risk part of the process of setting a fixed quotation is that it relies on the experience and gut feeling of the person making the decision. The main goal of this research is to make a tool to help people make decisions that uses statistical models and/or machine learning algorithms to figure out how much a project will cost before the work has even started. The second goal is to come up with possible ways to show these findings visually so that users can understand and accept the information better. The results of statistical and machine learning algorithms are both very

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complex and based on a lot of numbers. This information needs to be summed up visually in a way that people who don't know anything about data science can understand. At the beginning of the paper, the method will be talked about. Then, some preliminary results will be given, and the rest of what needs to be done to finish the project will be explained. Even though there is a lot of research on both how to predict business profits and how to use visual and interactive analytics, the two topics are rarely talked about together. This body of work is mostly about how prediction methods can be used to solve real-world problems that businesses with customers who buy things face, such as studies on customer attrition. Ravi Kumar and Ravi [3] showed that neural networks were the most common machine learning model used to solve these business problems. Other models, like decision trees, RNNs, and linear models, were also used. In predictions about internal staff turnover were made using an RNN model, naive bayes, and neural networks. As shown by the fact that there aren't many studies like Saradhi and Palshikar's Employee Churn study [4] that have been published, there aren't enough studies that can accurately predict the success of an internal business. d did research on visual user engagement and built a predictive framework with an easy-to-use interactive plot to help users filter out tweets they don't want to see. After using an interactive method to clean up data, users gave us positive feedback and model errors went down by more than 50%. This study will learn from what the users know about the subject, and that information will be added to the prediction platform.

AI decision making

AI decision making is when a computer programme instead of a person processes data, such as by looking for patterns and suggesting courses of action. This makes it possible for the data to be used to make better predictions and decisions. In theory, if you send your data to an AI platform, it should be able to do things like data crunching, finding trends, finding outliers, and doing complicated analysis. After that, the final decision is made either by a person or by a computer system.

2. Related work

H. Zhang, et al[1] The findings of this research indicate a social trust driven minimum adjustments consensus model as a means of making SNGDM more accessible (STDMACM). At the same time, a model called the Social Trust Driven Consensus Maximum Optimization Model (STDCMOM) is offered as a method for maximising the degree to which decision-makers are able to come to an agreement with one another. The assessments-modifications suggestions provided by the STDMACM are used as the references for directing the process of reaching consensus when the maximum consensus level obtained from the STDCMOM is acceptable; otherwise, assessments-modifications proposals are generated from the designed STDCMOM.

M. S. A. Rahman et al[2] When it comes to improving their decision-making processes, businesses can reap benefits from employing statistical modelling and machine learning (ML) algorithms. Because machine learning algorithms and statistical models boost productivity and efficiency while also enabling rapid monetisation and lowering risk and returns, the implementation of these technologies will result in improved business decisions. Prior to

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making important business decisions, it may be beneficial to make use of a variety of mixed analytic approaches. This could result in improved overall decision support for stakeholders and corporate owners.

C. Griffy-Brown et al[3] New technologies like artificial intelligence (AI), the Internet of Things (IoT), and distributed ledgers are changing industries and making it possible to create value in ways that have never been done before. AI, the Internet of Things (IoT), and distributed ledgers are some examples. Because of what they could lead to, they are a threat to society. Unfortunately, these risks are hard to spot and judge, which makes it hard to take steps to keep them from happening. Both the good and the bad things about the situation are uncertain. The first people to talk to are the bosses of companies that are already using these technologies. These data are used as a starting point to make three different risk optimization models and to do a first evaluation of them. As a result of this study, we've put together a list of the main parts of a risk model and the possible parts of a dashboard that executives can use when thinking about how to use these technologies.

R. Xue, et al[4] built histograms to illustrate the distribution of customer data across different categories. After determining the ideal value of K, we used the K-means clustering technique to classify our customers into several groups. The radar map served as a visual depiction of our findings once we had arrived at that conclusion. Because the company is able to get a clear picture of what each type of customer looks like, it is in a better position to make decisions based on this knowledge.

C. -N. Wang et al[5] This study aims to evaluate some key LMD companies in Vietnam regarding their sustainability performance. For this evaluation, the present research proposes a fuzzy multi-criteria decision-making (F-MCDM) based framework combining the fuzzy analytic hierarchy process (FAHP) and the fuzzy weighted aggregated sum product assessment (FWASPAS), and triangular fuzzy numbers are applied to express the linguistic evaluation statements of experts. FAHP was utilized for the determination of criteria weights, then based on the most impactful criteria, FWASPAS was used to prioritize the companies.

A. Kaplunovich, et al[6] designed and implemented many convenient commands, improving usability and multi-modal user experience. Our innovative approach, serverless architecture and Big Data methodology can help millions of people to stay on top of the coronavirus situation and make day-to-day choices using the information provided.

V. Kharchenko et al[7] The paper focuses on Digital Twin (DT) in Manufacturing using Artificial Intelligence (AI) and Industrial IoT. According to the concept, the manufacturing includes three main units: equipment, personnel and processes. All data from these units are inherited to manufacture model (DT) and decision support system with the use of AI. DT data technology allows finding the required knowledge that can be interpreted and used to support the process of decision-making in the management of the enterprise. AI applications open up a broad spectrum of opportunities in manufacturing to add value by optimizing processes and generating new business models. The Landscape was described by a formal model to assure the possibility to analyze the state and development of landscape in detail considering DT and other technologies

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I. Proposed methodology

In addition to the earlier processes of data exploration and fundamental statistical modelling, a prototype user interface has been developed as of the time this article was written. The data provided by the company used for the case study describes more than four thousand different consulting engagements extending[8]. You have the ability to view specifics on each project, such as the organization that served as the client, the job's title and area of expertise, the number of hours worked, the hourly rate for each individual, and the total amount that was invoiced. Two of the insights that were able to be retrieved when additional variables were generated and visually plotted were the kind of projects that brought in the most money and the association between the proportion of hours worked by each position in the organisation. According on the input provided by the organisation on the project, it appears to be quite complicated and could definitely benefit from the direction of an expert, as illustrated in Figure 1. The trend is depicted in Figure 1 by means of a loess regression line with a mean shaded interval. The second phase was feature selection, in which the most important variables for the prediction modally function[9] found in the Party R package were chosen; this package makes use of an unbiased classification trees-based inference framework [10]. Feature selection was the second step in the process. It was found that the category of the customer's business and the average number of people working on the project were the two criteria that had the most bearing on the outcome. One such T insight could be to cut down on the number of "handoffs" that occur when profitable client relationships are transferred from one individual to another. At the moment, we are evaluating random forest and SVM models to determine[11] which one provides more accurate project forecasts. In the past, both of these algorithms have demonstrated the ability to accurately forecast the results of business endeavours. By looking at graphs depicting uncertainty and clustering, it is also possible to determine whether or not the findings produced by the algorithm are significant to the person making the choice. Used image enhancement techniques[21] that can be applied to our research.

This is a decision-making model that is powered by artificial intelligence:

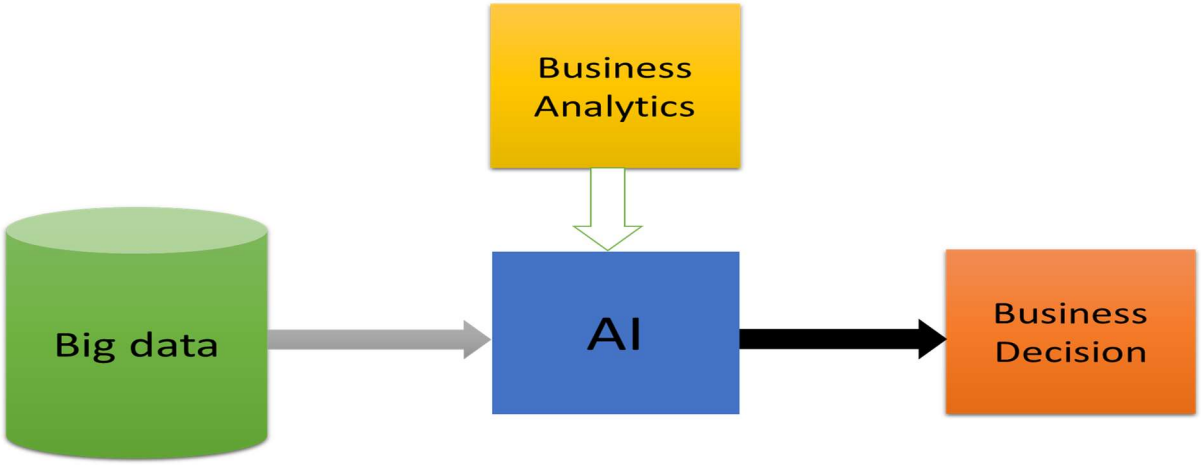

Figure 1 This is a decision-making model that is powered by artificial intelligence

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This approach to making decisions streamlines things, but at the expense of completely removing individuals from the process, which is not always a good thing. Because of this, methods that include collaboration between humans and AI are gaining a lot of popularity. It would be an understatement to suggest that the use of AI decision making might potentially have a significant effect on businesses. When confronted with the quantity, complexity, and distributed nature of data, as well as the speed of response and constant intelligence required by digital business, structures and technologies that are rigid and centralised are rendered useless. The capacity of any organisation to adopt a flexible, data-centric architecture that is capable of keeping[12] up with the rapid pace of change will be critical to the future success of any company. The ability of artificial intelligence (AI) to teach itself makes it beneficial for businesses; the more decisions it makes based on data, the more it picks up on its surroundings and improves. Artificial intelligence (AI) learns by itself and builds models with the use of data collections; these models eventually become very, very good at making predictions and classifications based on the data they are given. When applied to streaming data in real time, the same models can be used to generate predictions, classifications, and recommendations that can help businesses make lucrative decisions. As an illustration, Peak makes use of things like consumer transaction data, which is compiled from hundreds upon thousands of individual purchases, to gain insight into the types of products that particular groups of customers tend to purchase together. The results of this model are subsequently put to use on a website in the form of product recommendations. If you find that this seems similar, it's because numerous businesses, like Amazon, employ this tactic to deliver superior product suggestions and drive more sales. This is a significant divergence from the way that the vast majority of businesses have operated over the course of the previous century, half century, or even just the last two decades. For the straightforward reason that, up until this point, each and every significant decision had to be sanctioned by a single person. Data was analysed by people, not algorithms, so that judgments could be made about things like which customers should receive the most attention, which marketing plans should be put into action, and how much money should be set aside for a new launch.

With the assistance of AI, better decisions may[13] be made in the corporate world. Large datasets are capable of being analysed very quickly, which enables organisations to make decisions very quickly, such as what content to generate for their target audience or how to change an advertising campaign that is not performing well. This would take an enormously long time for a person to accomplish, but a machine could complete the task in an instant.

It can assist in marketing and sales activities in a variety of ways, including the following: Applications of artificial intelligence such as Natural Language Processing help businesses learn about the interactions their customers have with their brand, including the language they use and the tone they should use when marketing their products. This information is extremely helpful to marketers.

Because it helps businesses gain a better understanding[14] of their clients, it can be beneficial to such businesses. AI technologies like as chatbots, algorithms, and machine learning provide businesses with a greater understanding of the pain points, expectations, and levels of

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satisfaction of their customers.

It gives companies the ability to make decisions that take into consideration massive amounts of complicated data. Artificial intelligence is in a prime position to assist make sense of massive amounts of data, particularly in situations in which a clearly defined outcome is being monitored. Because it can digest huge amounts of data all at once, artificial intelligence can make decisions far more quickly than humans can because of this ability.

A model for making decisions that integrates the capabilities of AI with human judgement:

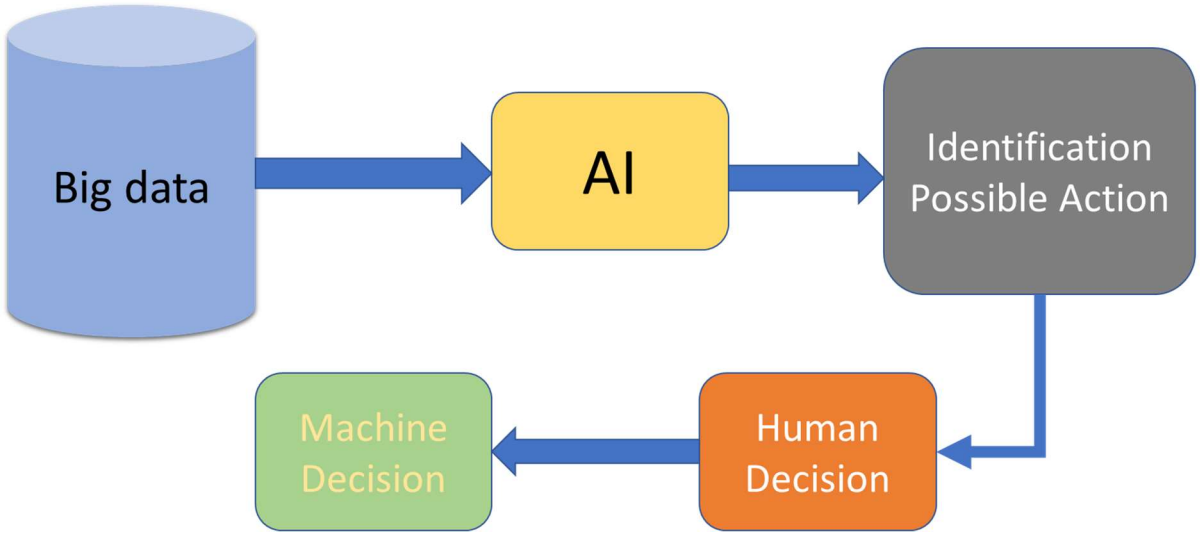

Figure 2:AI based Approach for decision making

An artificial neural network (NN) is a group of connected mathematical models that can be used to solve a wide range of problems, such as regression, discrimination, and the reduction of data sets. Neural systems can also be called "networks," which is a short form. NN gets a lot of ideas from the way the brain works to process information. These helpful tools make it possible to look at large data sets, find patterns, and find correlations[15] that don't follow a straight line. NN is very different from sequential, logic-based, programmed techniques because it is based on learning. In contrast to humans, who base their decisions on real-world observations and experiences, NNs can generalise from past cases to offer solutions based on vague and confusing information, just like people can. Applications that use this ability to figure out what something means based on past actions or patterns are used to help people make decisions that may not be possible with algorithm-based solutions. The basic building block of a computer is the neuron. When a nonlinear transformation is applied to a weighted sum of the input data, the result is new data. This is the typical math model that is used to describe how a single neuron learns: x1, x2,..., xn are the inputs to the neuron, and w1, w2,..., wn are the weights of the connections it has with other neurons. A variable can be given a value that is either stimulating (positive) or stopping (negative). A neural network (NN) can be thought of as a group of neurons that are linked together by a system of numbers that are chosen at random. These neurons are set up in a way that looks like a hierarchy. Neural networks are either feedforward or recurrent, depending[16] on how they are built (feedback). A feedforward neural network is one in which signals move from the inputs to the outputs through one or more hidden layers (which are referred to as hidden layers). Since their behaviour is similar to how

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humans make decisions, feedforward NN have proven to be the best way to handle problems with making decisions. Figure 3 shows a three-layer feedforward network with a hidden layer to keep things simple.

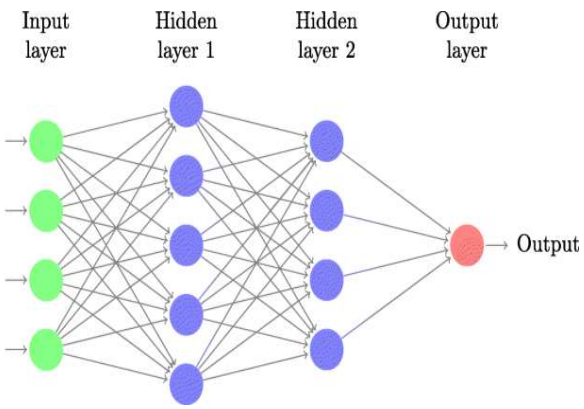

Fig. 3. Illustration of a three-layer feedforward NN with a hidden layer

Figure 2 shows a possible feedback loop for a recurrent neural network. There may or may not be hidden layers in a recurrent neural network. Depending on the model they're using, they might use either full feedback or partial feedback. One of the most important benefits of NN is that it can estimate any limited continuous function with an arbitrary small approximation error. This is especially useful when making decisions. Neural networks "learn" a function by using one of these three main ways to learn: supervised learning, unsupervised learning, or reinforcement learning. Unsupervised learning is a way to train a neural network (NN) in which the NN is not shown examples of right or wrong answers while it is being trained. The goal of this step is to find patterns and connections in the data that were not known before, such as correlations. During supervised learning, a neural network is given a set of data that includes pairs of inputs and outputs. The NN then tries to find and change the weights of the inputs so that the outputs match the sample outputs as closely as possible (or targets). After the network is built, it can be used to predict future outputs based on a new set of inputs. This makes it much easier to make decisions. Reinforcement learning, on the other hand, only gives summary or high-level information about a neural network's (NN) accuracy, like a number that shows how well it did across a dataset. This is different from more traditional ways of learning, where the NN gets feedback[17] after each data point. Over-fitting happens when a neural network (NN) is trained on a decision problem so precisely that it can't generalise well enough to predict future behaviour given a different set of inputs. Under-fitting, on the other hand, happens when the NN is trained on a decision problem with too little precision. Neural networks are now being used in a lot of different areas. One of these is to process natural language. Due to NN's ability to approximate everything, it is important to be able to define a nonlinear mapping between a set of inputs (or choice variables) and the output. This is key to NN's success in making decisions (or decision). Even though NNs are praised for their ability to produce results that are

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very similar to the training data, they have the reputation of being a "black box" because it can be hard to understand the logic behind the results when they are used in situations where decisions need to be made. The fact that processing happens across nodes and possibly hidden layers, and that redundant networks could add more complexity, is a big problem. If the people who make decisions knew more about how the different parts of the decision-making process affect the end result, they would be better able to use interpretability to their advantage. It makes sense to think that something like this might.

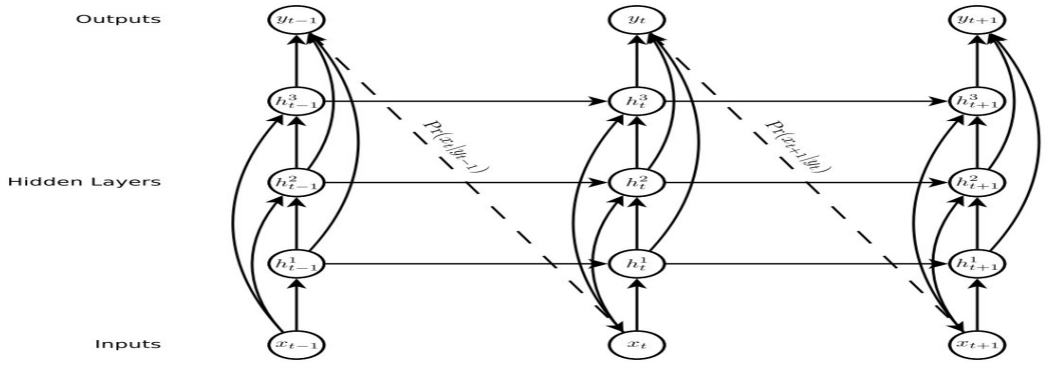

Fig. 4. Illustration of a recurrent neural network

One of the most important benefits of NN is that it can estimate any limited continuous function with an arbitrary small approximation error. This is especially useful when making decisions. Neural networks "learn" a function by using one of these three main ways to learn: supervised learning, unsupervised learning, or reinforcement learning. Unsupervised learning is a way to train a neural network (NN) in which the NN is not shown examples of right or wrong answers while it is being trained. The goal of this step is to find patterns and connections in the data that were not known before, such as correlations. During supervised learning, a neural network is given a set of data that includes pairs of inputs and outputs. The NN then tries to find and change the weights of the inputs so that the outputs match the sample outputs as closely as possible (or targets). After the network is built, it can be used to predict future outputs based on a new set of inputs. This makes it much easier to make decisions. Reinforcement learning, on the other hand, only gives summary or high-level information about a neural network's (NN) accuracy, like a number that shows how well it did across a dataset. This is different from more traditional ways of learning, where the NN gets feedback after each data point. Over-fitting happens when a neural network (NN) is trained on a decision problem so precisely that it can't generalise well enough to predict future behaviour given a different set of inputs. Under-fitting, on the other hand, happens when the NN is trained on a decision problem with too little precision. Neural networks[18] are now being used in a lot of different areas. One of these is to process natural language. Due to NN's ability to approximate everything[19], it is important to be able to define a nonlinear mapping between a set of inputs (or choice variables) and the output. This is key to NN's success in making decisions (or decision). Even though NNs are praised for their ability to produce results that are very similar to the training data, they have the reputation of being a "black box" because it can be hard to understand the logic behind the

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results when they are used in situations where decisions need to be made. The fact that processing happens across nodes and possibly hidden layers, and that redundant networks could add more complexity, is a big problem. If the people who make decisions knew more about how the different parts of the decision-making process[20] affect the end result, they would be better able to use interpretability to their advantage. Because it is so open, knowledge about the domain, like rules for making decisions, could be added to the way the NN makes decisions, which would improve its performance. When researchers compare their results using many different data sets from different business domains, they find that machine learning algorithms are better at forecasting business-relevant time series data than traditional statistical trend analysis methods. All of the datasets show that a forecasting model built on top of an artificial neural network does an excellent job. Data that has been tabulated on the performance criteria of several machine learning algorithms has been used to make it easier to look at the conclusions of this study. With the software's graphical display, you might be able to quickly find the method that will give you the most accurate predictions just by looking at the wave diagram. The presented studies are used to draw conclusions and generalisations, and the important findings and how they relate to the research goals are discussed in great detail.to perform the simulation using anaconda tools with open source datasets.

Mean Forecast Error (MFE)

$$MFE = \frac{\sum_{i=1}^{n}(e_i)}{n}$$

Mean Absolute Error (MAE)

$$\text{RMSE} = \sqrt{\frac{\sum(y_i - y_p)^2}{n}}$$

$$\text{MAE} = \frac{|(y_i - y_p)|}{n}$$

y_i = actual value
y_p = predicted value
n = number of observations/rows

squared estimate of errors (SSE)

$$SSE = \frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}{n - m - 1}$$

Mean Squared Error

$$\text{MSE} = \frac{1}{n}\sum_{i=1}^{n}(y_i - \tilde{y}_i)^2$$

Regression Error Metrics

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$$MPE = \frac{100\%}{n} \Sigma \left(\frac{y - \hat{y}}{y} \right)$$

Table 1:Results Analysis different machine learning Algorithm

AI/ML Algorithm Name	MFE	MAE	MAPE	MPE	MSE	SSE	RSME	Accuracy
Decision Tree	13.567	21	0.67546	0.34664	764	20234	27.665	87%
Naïve Bayes	10.564	20	0.68787	0.2456	643.13	17657	24.776	90%
KNN	10.789	22.5876	0.78865	0.23456	865.4	24358	32.876	91%
K-Means Clustering	9.656	21.667	0.67899	0.22345	567.4	16543	24.765	92%
Support vector Machine	9.656	21.667	0.65445	0.25677	476.67	9765	23.765	93%
Proposed RNN Algorithm	5.567	9.567	0.45689	0.21234	267.45	8654	15.776	98%

II. Conclusion

studying the pros and cons of using artificial intelligence (AI) systems to help people make decisions, with a focus on the points where people and computers interact. There is a lot of room for improvement when it comes to making decisions, especially when the issue at hand is too complicated for us to fully understand or there are too many variables for us to find connections between. The holy grail of system design is finding a way to make intelligent systems that help people make decisions that are cost-effective, add value, and are acceptable to people. People are working hard to make systems that can adapt to the unique needs of each user and understand what they mean, no matter what language they use or what actions they take. Skepticism about the reliability of autonomous systems is a big reason why intelligent systems that help people make decisions can't be used in the real world. What kinds of decisions do we feel comfortable letting our computers make on their own? is something that must be looked into as soon as possible. How confident can we be that an autonomous system will make the right choices before we give it some responsibility? When and how will we give computers that are not run by people the power to make and enforce decisions? How can we make sure that automated systems don't make too many hasty decisions just to make things easier for people? Do we have any reason to think that AI will want what's best for us? The development of AI tools that can be used to help people make decisions has opened up some very exciting new ways to help people make better decisions and deal with these problems.

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