

# **CAR RESALE VALUE PREDICTION**

# **Project Report Format**

1. **INTRODUCTION**
  - 1.1 Abstract
2. **LITERATURE SURVEY**
  - 2.1 Existing problem
  - 2.2 References
3. **IDEATION & PROPOSED SOLUTION**
  - 3.1 Empathy Map Canvas
  - 3.2 Ideation & Brainstorming
  - 3.3 Proposed Solution
  - 3.4 Problem Solution fit
4. **REQUIREMENT ANALYSIS**
  - 4.1 Functional requirement
  - 4.2 Non-Functional requirements
5. **PROJECT DESIGN**
  - 5.1 Data Flow Diagrams
  - 5.2 Solution & Technical Architecture
  - 5.3 User Stories
6. **PROJECT PLANNING & SCHEDULING**
  - 6.1 Sprint Planning & Estimation
  - 6.2 Sprint Delivery Schedule
  - 6.3 Reports from JIRA
7. **CODING & SOLUTIONING (Explain the features added in the project along with code)**
  - 7.1 Feature
  - 7.2 Database Schema (if Applicable)
8. **TESTING**
  - 8.1 Test Cases
  - 8.2 User Acceptance Testing
9. **RESULTS**
  - 9.1 Performance Metrics
10. **ADVANTAGES & DISADVANTAGES**
11. **CONCLUSION**
12. **FUTURE SCOPE**
13. **APPENDIX**
  - Source Code
  - GitHub & Project Demo Link

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# **1.ABSTRACT**

Predicting the price of used cars is one of the significant and interesting areas of analysis. As an increased demand in the second-hand car market, the business for both buyers and sellers has increased. For reliable and accurate prediction it requires expert knowledge about the field because of the price of the cars dependent on many important factors. This paper proposed a supervised machine learning model using KNN (K Nearest Neighbor) regression algorithm to analyze the price of used cars . Through this experiment, the data was examined with different trained and test ratios. As a result, the accuracy of the proposed model is around 85% and is fitted as the optimized model. The predictions are then evaluated and compared in order to find those which provide the best performances. A seemingly easy problem turned out to be indeed very difficult to resolve with high accuracy. All the four methods provided comparable performance. In the future, we intend to use more sophisticated algorithms to make the predictions . Determining whether the listed price of a used car is a challenging task, due to the many factors that drive a used vehicle's price on the market. The focus of this project is developing machine learning models that can accurately predict the price of a used car based on its features, in order to make informed purchases. We implement and evaluate various learning methods on a dataset consisting of the sale prices of different makes and models across cities in the United States. Our results show that Random Forest model and K-Means clustering with linear regression yield the best results, but are compute heavy. Conventional linear regression also yielded satisfactory results, with the advantage of a significantly lower training time in comparison to the aforementioned methods

## **2.LITERATURE SURVEY**

### **2.1. EXISTING PROBLEM**

Several studies and related works have been done previously to predict used car prices around the world using different methodologies and approaches, with varying results of accuracy from 50% to 90%. In (Pudaruth, 2014) the researcher proposed to predict used car prices in Mauritius, where he applied different machine learning techniques to achieve his results like decision tree, K-nearest neighbours, Multiple Regression and Naïve Bayes algorithms to predict the used cars prices, based on historical data gathered from the newspaper.

Achieved results ranged from accuracy of 60-70 percent, the author suggested using more sophisticated models and algorithms to make the evaluation, with the main weakness off the decision tree and naïve Bayes that it is required to discretize the price and classify it which accrue to more inaccuracies. Moreover, he suggested a larger set of data of data to train the models hence the data gathered was not sufficient.

(Monburinon, et al., 2018) Gathered data from a German e-commerce site that totalled to 304,133 rows and 11 attributes to predict the prices of used car using different techniques and measured their results using Mean Absolute Error (MEA) to compare their results. Same training dataset and testing dataset was given to each model. Highest results achieved was by using gradient boosted regression tree with a MAE of 0.28, and MEA of 0.35 and 0.55 for mean absolute error and multiple linear regression respectively. Authors suggested adjusting the parameters in future works to yield better results, as well as using one hot encoding instead of label encoding for more realistic data interpretations on categorical data.

(Gegic, Isakovic, Keco, Masetic, & Kevric, 2019) from the International Burch University in Sarajevo, used three different machine learning techniques to predict used car prices. Using data scrapped from a local Bosnian website for used cars totalled at 797 car samples after pre-processing, and proposed using these methods: Support Vector Machine, Random Forest and Artificial Neural network. Results have shown using only one machine learning algorithm achieved results less

than 50%, whereas after combining the algorithms with pre calcification of prices using Random Forest, results with accuracies up to 87.38% was recorded.

(Noor & Jan, 2017) were able to achieve high level of accuracy using Multiple linear regression models to predict the price of cars collected from used cars website in Pakistan called Pak Wheels that totalled to 1699 records after pre-processing, and where able to achieve accuracy of 98%, this was done after reducing the total amount of attributes using variable selection technique to include significant attributes only and to reduce the complexity of the model.

(K.Samruddhi & Kumar, 2020) Proposed using Supervised machine leaning model using K-Nearest Neighbour to predict used car prices from a data set obtained from Kaggle containing 14 different attributes, using this method accuracy reached up to 85% after different values of K as well as Changing the percent of training data to testing data, expectedly when increasing the percent of data that is tested better accuracy results are achieved. The model was also cross validated with 5 and 10 folds by using K fold method.

(Gongqi, Yansong, & Qiang, 2011) proposed using Artificial Neural Network (ANN) through a combined method of BP neural network and nonlinear curve fit and have achieved accurate value prediction with a feasible model.

(Listiani, 2009) used Support Vector Machines to evaluate leased cars prices, results have shown that SVM is far more accurate in large dataset with high dimensional data than Multiple linear regression. Whereas the computation Multiple linear regression can take several minutes and the SVM would take up to a day to compute the results. Multiple linear regression may be simple, but SVM is far more accurate. Moreover, the study includes Samples with up to 178 attributes which is far more than the proposed variable in our study, hence the use of multiple linear regression may be more suitable in our case.

(Kuiper, 2008) Collected data from General Motor of cars that are produced in 2005, where he as well used variable selection technique to include the most relevant attributes in his model to reduce the

complexity of the data. He proposed used Multivariate regression model that would be more suitable for values with numeric format.

In order to predict the price of used cars, researchers (Nabarun Pal, 2018) used a supervised learning method known as Random Forest. Kaggle's dataset was used as a basis for predicting used car prices. In order to determine the price impact of each feature, careful exploratory data analysis was performed. 500 Decision Trees were trained with Random Forests. It is most commonly used for classification, but they turned it into a regression model by transforming the problem into an equivalent regression problem. Using experimental results, it was found that training accuracy was 95.82%, and testing accuracy was 83.63%. By selecting the most correlated features, the model can accurately predict the car price.

In light of the number of works that have been done in this field, another group of researchers (Jian Da Wu, 2017) conducted research on this topic and tried to develop a system that consists of three components: a data acquisition system, a price forecasting algorithm, and a performance analysis. Due to its adaptive learning capability, a conventional artificial neural network (ANN) with a back-propagation network is compared to the proposed ANFIS. In the ANFIS, qualitative fuzzy logic approximation as well as adaptive neural network capabilities are included. Using ANFIS as an expert system in predicting used car prices showed better results in the experiment. Using GUI, the consumer can get accurate and convenient

information about used cars' purchasing prices, and experiments proved that the proposed system could provide accurate and convenient price forecasting.

Hence, from all literature review it is concluded that used cars price prediction is an important topic which is the area of many researchers nowadays. So far, the best achieved accuracy is 83.63% on kaggle's dataset using random forest technique. The researchers have tested multiple regressors and final model is regression model using linear regression.

**Method :**

The topic such as this can be assessed with mathematical models derived from quantitative data. A multiple variable regression can analyze the data by assessing the role each independent variable plays in determining the dependent variable (in this case, resale value). Significance can also be assessed by observing the p-values for each variable. The use of a statistical model will aide in making a claim on this, and to identify some of the major contributors to resale value in automobiles.

**Data Collection :**

The data used for this regression will be quantitative in nature. The sources of data are what someone would expect for used car information. Four sources that are used include Kelly Blue Book, Edmunds, a government fuel economy resource, and Car and Driver. Kelly Blue Book and Edmunds will both serve as data sources, with each source providing different aspects of the independent variables used. With the cooperation of these sources, data regarding price of a car-including new and used-with the respective age, mileage, make, condition, miles per gallon, safety ratings, and hybrid technology information will be obtained. These variables will allow for a regression to be run and an equation to be estimated.

**Expected Outcomes :**

Before I can make predictions regarding the influence each variable will have on resale value, a review of prior research and literature is appropriate. This will allow me to make a more confident prediction as well as confirm which variables are needed to produce a strong equation that explains much of the variations in vehicle depreciation. An expected equation could look like this:

Resale Value (DV) = Intercept- B3(Age) - B4(Mileage) + B1(Make) + B2(MPG) + B5(Hybrid Tech)



## 2.2.REFERENCES

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### 3.IDEATION PHASE

#### 3.1.EMPATHY MAP



3.2.BRAINSTROMING

Template

Brainstorm & idea prioritization

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

10 minutes to prepare

1 hour to collaborate

2-8 people recommended

Share template feedback

Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

10 minutes

A

Team gathering

Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.

B

Set the goal

Think about the problem you'll be focusing on solving in the brainstorming session.

C

Learn how to use the facilitation tools

Use the Facilitation Superpowers to run a happy and productive session.

Open article

PROJECT:  
CAR RESALE  
VALUE  
PREDICTION

1

Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

5 minutes

PROBLEM

How might we [your problem statement]?

Key rules of brainstorming

To run an smooth and productive session

Stay in topic.

Defer judgment.

Go for volume.

Encourage wild ideas.

Listen to others.

If possible, be visual.

Need some inspiration?

See a finished version of this template to kickstart your work.

Open example

2

Brainstorm

Write down any ideas that come to mind that address your problem statement.

10 minutes

Jenix

Collecting the car deatils from the sellers

Checking the deatils of the car

Verifying the deatils are valid or not

Filtration based on color of the car

Providing details of the car to users

Profile verification

Filtration based on brands of the cars

Creating user profile

Product Profile privacy

Asking customer queries

Act based on queries

Collecting feedback

Joe

Filtration based on the quantity of the car based on seats

Providing the feasible amount to buy the car

Providing insurance and service details

Vijay

Providing contact details

Searching based on fuel type

Analysing and preparing the dates

3

Group Ideas

Take turns sharing your ideas while clustering similar or related notes as you go. In the last 10 minutes, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.

20 minutes

CAR DETAILS

Collecting the car details from sellers

Providing details of the car to users

Updating the new details

Providing the feasible amount to buy the car

Providing contact details

REFINEMENT

Filtration based on color of the cars

Filtration based on brands of the cars

Filtration based on the quantity of the car based on seats

Searching based on fuel type

TESTING:

Testing UI application

Testing the process and debugging

PREPARATION

Preprocessing the data

analysing and preparing the dates

HISTORY

Proving insurance and service details

Providing details of historical owners

Collecting feedbacks

Act based on queries

Profile privacy

Profile verification

Preparing the UI Application

FEEDBACK

Asking customer queries

CHECKING

Verifying the details are valid or not

Checking the condition of the car

USER PROFILE

Creating user profile

4

Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

20 minutes

Importance

If each of these tasks could get done without any difficulty or cost, which would have the most positive impact?

Preprocessing the data

profile privacy

Preparing the UI Application

Collecting the car details from the seller

Providing details for the car user

Analysing and preparing the dataset

Testing the process and debugging

Testing the UI Application

Creating user profile

Verifying the details are valid or not

Checking the condition of the car

Providing insurance and service details

Profile verification

Asking customer queries

Updating the new details

Filtration based on color of the cars

Collection of feedback

Providing the feasible amount to buy an car

Searching based on fuel type

Providing contact details

Feasibility

Regardless of their importance, which tasks are more feasible than others? (Cost, time, effort, complexity, etc.)

After you collaborate

You can export the mural as an image or pdf to share with members of your company who might find it helpful.

Quick add-ons

A

Share the mural

Share a view link to the mural with stakeholders to keep them in the loop about the outcomes of the session.

B

Export the mural

Export a copy of the mural as a PNG or PDF to attach to emails, include in slides, or save in your drive.

Keep moving forward

Strategy blueprint

Define the components of a new idea or strategy.

Open the template

Customer experience journey map

Understand customer needs, motivations, and obstacles for an experience.

Open the template

Strengths, weaknesses, opportunities & threats

Identify strengths, weaknesses, opportunities, and threats (SWOT) to develop a plan.

Open the template

Share template feedback

1

2

3

4

### 3.3.PROPOSED SOLUTION

#### Proposed Solution Template:

Project team shall fill the following information in proposed solution template.

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	I am a customer. I'm trying to buy a second hand car. But I cannot estimate the price of the car. Because I need a trustworthy platform to predict the price of the car. Which makes me feel Frustrated and Confused.
2.	Idea / Solution description	Deciding whether a used car is worth the posted price when you see listings online can be difficult. Several factors, including mileage, make, model, year, etc. can influence the actual worth of a car. From the perspective of a seller, it is also a dilemma to price a used car appropriately [2-3]. Based on existing data, the aim is to use machine learning algorithms to develop models for predicting used car prices.
3.	Novelty / Uniqueness	As there are so many ongoing experiments that use statistical approaches and some traditional methods to focus on predicting item sales. Most researches have experimented by taking single algorithm to predict sales. In this thesis Machine Learning algorithms such as Simple Linear Regression, Support Vector Regression, Gradient Boosting algorithm, and Random Forest Regression are considered for predict the most effective metrics such as accuracy, mean absolute error, and max error are considered for measuring algorithm efficiency. This method will be very beneficial in the future for advanced item sales forecasting.
4.	Social Impact / Customer Satisfaction	Predicting prices of a used car is a challenging task because of a high number of features and parameters that should be considered to generate accurate results. The first and foremost step is data gathering and pre-processing data. Therefore the results generated are highly accurate.so the customer was satisfied.
5.	Business Model (Revenue Model)	Deciding whether a used car is worth the posted price when you see listings online can be difficult. Several factors, including mileage,

		make, model, year, etc. can influence the actual worth of a car. From the perspective of a seller, it is also a dilemma to price a used car. Based on existing data, the aim is to use machine learning algorithms to develop models for predicting used car prices.
6.	Scalability of the Solution	We started with understanding the use case of machine learning in the Automotive industry and how machine learning has transformed the driving experience. Moving on, we looked at the various factors that affect the resale value of a used car and performed exploratory data analysis (EDA). Further, we build a Random Forest Regression model to predict the resale value of a used car. We could have also used simpler regression algorithms like Linear Regression and Lasso Regression. Still, we need to make sure there are no outliers in the dataset before implementing them. Pair plots and scatter plots help visualize the outliers

## 3.4.PROBLEM SOLUTION FIT

Project Title: Car Resale Value Prediction

Project Design Phase-I - Solution Fit Template

Team ID: PNT2022TMID00778

Define CS, fit into CC	<b>1. CUSTOMER SEGMENT(S)</b> <span>CS</span> Who is your customer? i.e. working parents of 0-5 y.o. kids  <b>Dealers who sell used cars and customers who buy them.</b>	<b>6. CUSTOMER CONSTRAINTS</b> <span>CC</span> What constraints prevent your customers from taking action or limit their choices of solutions? i.e. spending power, budget, no cash, network connection, available devices  <b>Some constraints that the customers face may be worried about the condition of the car, is too expensive and so on.</b>	<b>5. AVAILABLE SOLUTIONS</b> <span>AS</span> Which solutions are available to the customers when they face the problem or need to get the job done? What have they tried in the past? What price & costs do these solutions have? i.e. pen and paper is an alternative to digital marketing  <b>Customers can be assured about the condition of the car and can be given a test drive, then the customer may be more inclined to buy the car.</b>	Explore AS, differentiate
	<b>2. JOBS-TO-BE-DONE / PROBLEMS</b> <span>J&amp;P</span> Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one, explore different sides.  <b>We help dealers and customers predict the price of a used car.</b>	<b>9. PROBLEM ROOT CAUSE</b> <span>RC</span> What is the real reason that this problem exists? What is the back story behind the need to do this job? i.e. customers have to do it because of the change in regulations.  <b>The root cause may be because the customer doesn't want to make a decision that he might regret later because he is the one using the car.</b>	<b>7. BEHAVIOUR</b> <span>BE</span> What does your customer do to address the problem and get the job done? i.e. directly related: find the right solar panel installer, calculate usage and benefits, indirectly associated: customers spend free time on volunteering work (i.e. Greenpeace)  <b>The Customer may spend some time researching the prices of used cars and may also see if the dealer has any reviews.</b>	
Identify strong TR & EM	<b>3. TRIGGERS</b> <span>TR</span> What triggers customers to act? i.e. seeing their neighbour installing solar panels, reading about a more efficient solution in the news.  <b>People around them buying used cars.</b>	<b>10. YOUR SOLUTION</b> <span>SL</span> If you are working in an existing business, write down your current solution first, fill in the canvas, and check how much it fits reality. If you are working on a new business proposition, then keep it blank until you fill in the canvas and come up with a solution that fits within customer limitations, solves a problem and matches customer behaviour.  <b>Our solution is that we will predict the ideal price for the car based on a lot of research and data and give the customer the most affordable approach.</b>	<b>8. CHANNELS of BEHAVIOUR</b> <span>CH</span> <b>8.1 ONLINE</b> What kind of actions do customers take online? Extract online channels from #7  <b>8.2 OFFLINE</b> What kind of actions do customers take offline? Extract offline channels from #7 and use them for customer development.  <b>1. The customer can talk see the car and compare it with other cars and offers</b>  <b>2. The customer can see if the car is really in good condition and if it suits their needs.</b>	Identify strong TR & EM
	<b>4. EMOTIONS: BEFORE / AFTER</b> <span>EM</span> How do customers feel when they face a problem or a job and afterwards? i.e. lost, insecure + confident, in-control - use it in your communication strategy & design.  <b>Customers feel frustrated because they don't how much a used car is worth.</b>			

## 4.Solution Requirements (Functional& Non-functional)

### 4.1.Functional Requirements

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form Registration through Gmail Registration through LinkedIN
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	User Profile	User information Bank details
FR-4	Database	Car database Customer database
FR-5	Features and Technology	Performance of the car Fuel capacity,mileage etc.
FR-6	Feedback	Feedback through Form Feedback through Gmail Feedback through LinkedIN

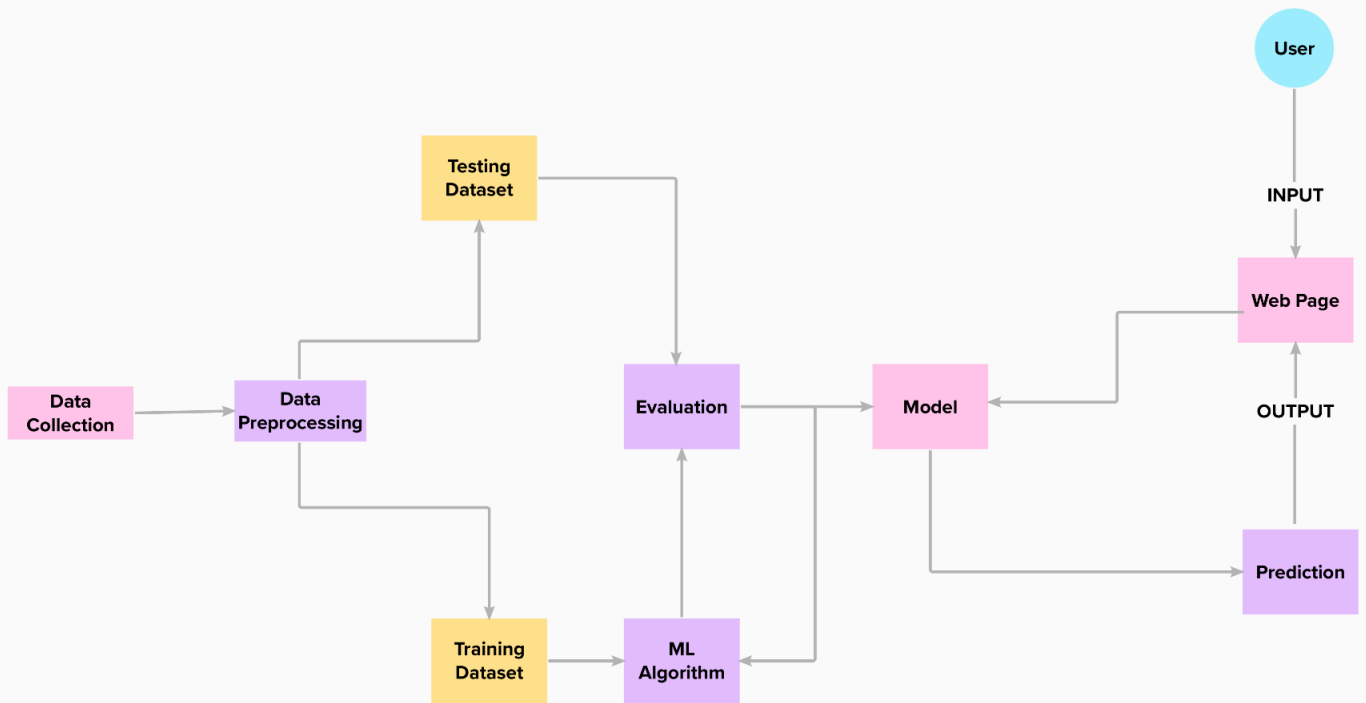
### 4.2.Non-functional Requirements

Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	<b>Usability</b>	Great UI (user interface), Quick adaptation of user.
NFR-2	<b>Security</b>	Aware of fraud and scams, Protect your password and account personal details.
NFR-3	<b>Reliability</b>	Rate of occurrence of failure is less, Failure free.
NFR-4	<b>Performance</b>	Perform value and correct prediction value, The landing page must support several users must provide 5 second or less response time
NFR-5	<b>Availability</b>	Uninterrupted services must be available all time except the time of server updation.
NFR-6	<b>Scalability</b>	that can handle any amount of data and perform many computations in a cost-effective and timesaving way to instantly serve millions of users residing at global locations.

## 5.Project Design Phase-I

### 5.1.Data Flow Diagram & User Stories



### User Stories

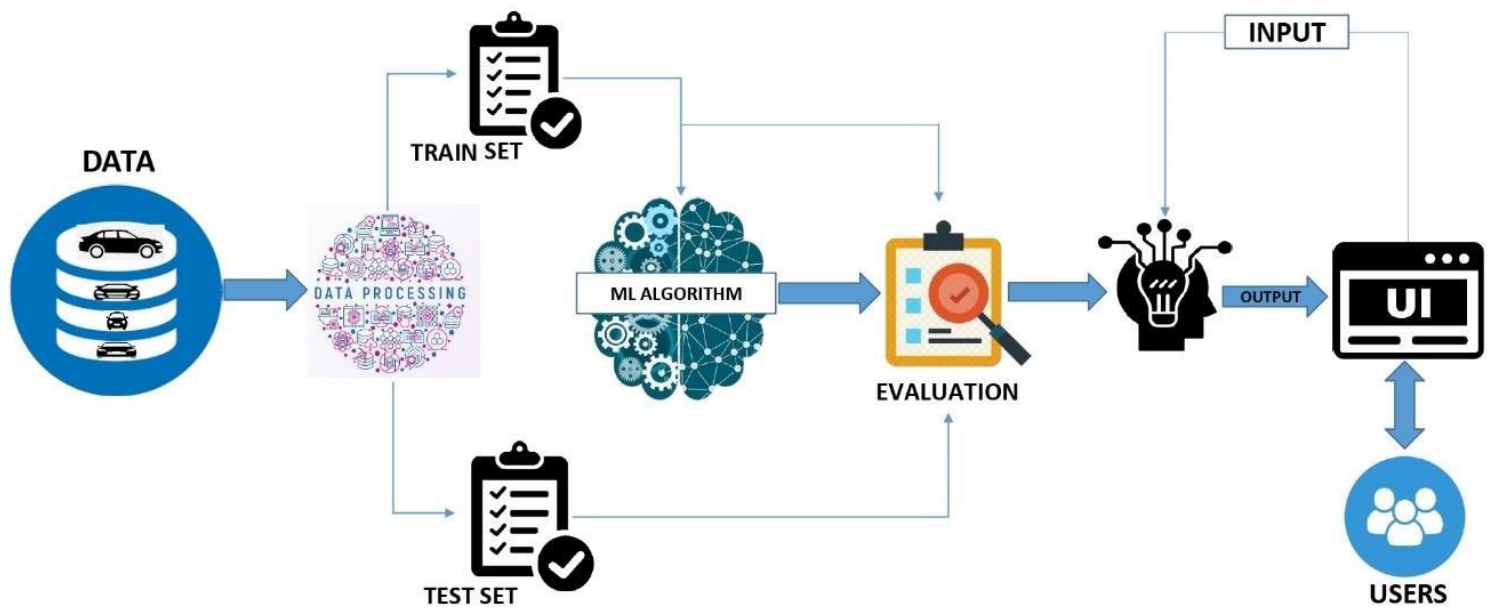
User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Data Entry	USN-1	As a user, I can enter the car details in the application.	I can enter the car details	Medium	Sprint-1
Customer (Mobile user)	Obtain output	USN-2	As a user, I will receive car resale value in the application.	I can receive my car resale value	High	Sprint-1
Customer (Mobile user)	Data Entry	USN-1	As a user, I can enter the car details in the application.	I can enter the car details	Medium	Sprint-1
Customer (Mobile user)	Obtain output	USN-2	As a user, I will receive car resale value in the application.	I can receive my car resale value	High	Sprint-1



## 5.2.SOLUTION ARCHITECTURE

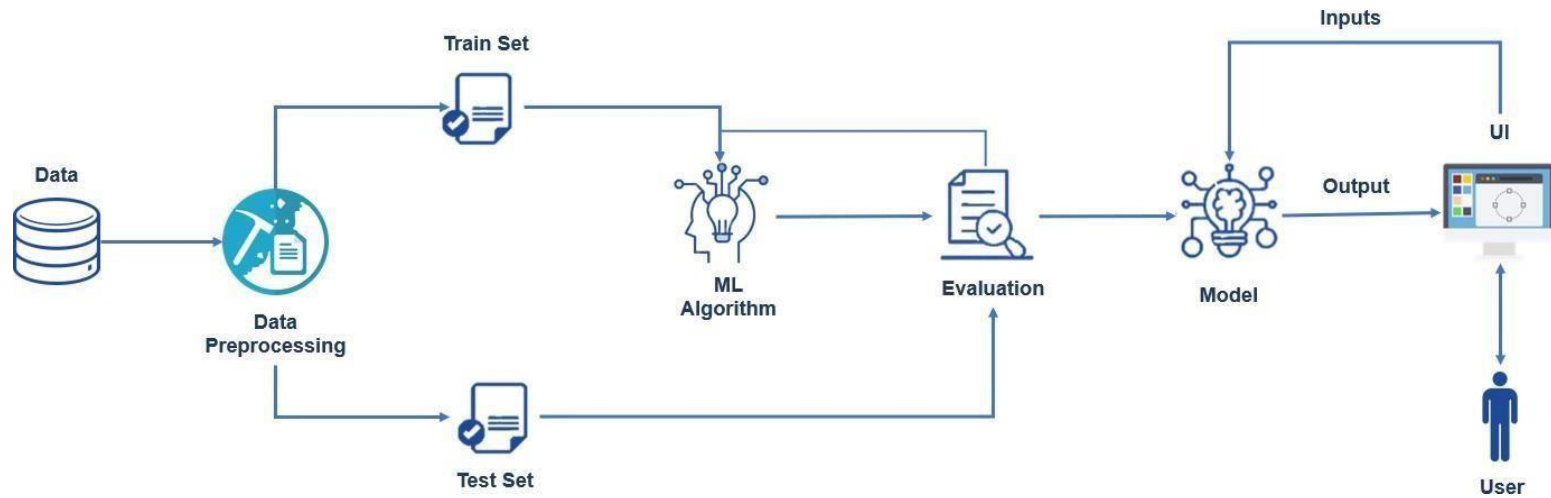
### CAR RESALE VALUE PREDICTION ARCHITECTURE

TEAM ID:  
PNT2022TMID00778



## 5.2.Technology Architecture

### Technical Architecture:



**Table-1 : Components & Technologies:**

S.N o	Component	Description	Technology
1.	User Interface	How user interacts with application e.g.Web UI, Mobile App, Chatbot etc.	HTML, CSS, JavaScript / Angular Js /React Js etc.
2.	Data Pre - Processing	Checking if the given data has any missing values,duplicate values, outliers and other noises that can affect the performance of the model.	Python, Pandas, Numpy, Matplotlib,Seaborn.
3.	Splitting the DataSet	The data set is split into test and train data for themodel.	Python, Sk - Learn
4.	Predicting the values	After the model is trained using various machine learning algorithms, some code is written to predict the value of a used car.	Python, Sk - Learn
5.	Database	The data is stored in the database.	MySQL, NoSQL, etc.
6.	Cloud Database	Database Service on Cloud	IBM DB2, IBM Cloudant etc.
7.	File Storage	File storage requirements	IBM Block Storage or Other StorageService or Local Filesystem
8.	Machine Learning Model	There are various Machine Learning Models that can be used like Linear Regression, Multi-Linear Regression, Decision Tree, Random Forest, SVMetc.	Python, Sk - Learn

**Table-2: Application Characteristics:**

<b>S.No</b>	<b>Characteristics</b>	<b>Description</b>	<b>Technology</b>
1.	Open-Source Frameworks	Anaconda Navigator, Jupyter Notebook, Python,Flask.	Python
2.	Security Implementations	Aware of Fraud and Scams, Protection of password and account details.	e.g. SHA-256, Encryptions, IAM Controls, OWASP etc.
3.	Scalable Architecture	Whether demand increases gradually or abruptly, scalable web architecture can accommodate any load without compromising the application's integrity.	Microservies, Progressive Web Apps(PWA)
4.	Availability	Availability of application like load balancers,distributed servers etc	IBM Cloud
5.	Performance	Good Performance is expected.	IBM Cloud

# 5.3.CUSTOMER JOURNEY

<div><div>1</div><div>Phases</div><div>High-level steps your user needs to accomplish from start to finish</div></div>	<div>OPEN WEBAPP</div>	<div>ENTER THE CAR FEATURES</div>	<div>PREDICT CAR RESALE VALUE</div>	<div>Team ID : PNT2022TMD00778</div> <div>RESULT</div>
<div><div>2</div><div>Steps</div><div>Detailed actions your user has to perform</div></div>	<div><div>Wants to predict the resale value of the car accurately</div><div>open the car resale value prediction module</div></div>	<div><div>Enter the features of the car</div><div>Click predict and get result</div></div>	<div><div>prediction of car resale price</div></div>	<div><div>Display the predicted value</div></div>
<div><div>3</div><div>Feelings</div><div>What your user might be thinking and feeling at the moment</div></div>	<div><div><div>👍</div><div>Eager and Happy</div></div><div><div>👎</div><div>Unexcited</div></div></div>	<div><div><div>happy to find a car resale predicted price</div><div>SAD</div></div></div>	<div><div><div>ecstatic</div><div>Unhappy</div></div></div>	<div><div><div>Feeling Good</div><div>Feeling bad</div></div></div>
<div><div>4</div><div>Pain points</div><div>Problems your user runs into</div></div>	<div><div>Not happy with number of features to enter</div></div>	<div><div>stressed for entering more features</div></div>	<div><div>worried about time taken to see result</div></div>	<div><div>worried about accuracy</div></div>
<div><div>5</div><div>Opportunities</div><div>Potential improvements or enhancements to the experience</div></div>	<div><div>Better and Good design</div></div>	<div><div>user friendly</div></div>	<div><div>Quicker response</div></div>	<div><div>High and Good accuracy</div></div>

## 6. Project Planning Phase

### 6.1. SPRINT DELIVERY PHASE

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Dataset reading and Pre processing	USN-1	Cleaning the dataset and splitting to dependent and independent variables	2	High	Jenix A
Sprint-2	Building the model	USN-2	Choosing the appropriate model for building and saving the model as pickle file	1	High	Jesh uran Benedict
Sprint-3	Application building	USN-3	Using flask deploying the ML model	2	Medium	Joe Nikesh PJ
Sprint-4	Train the model in IBM	USN-4	Finally train the model on IBM cloud and deploy the application	2	Medium	Arjunan Vijay Manohar

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date(Actual)
Sprint-1	15	5 Days	24 Oct 2022	29 Oct 2022	15	29 Oct 2022
Sprint-2	15	5 Days	31 Oct 2022	05 Nov 2022	15	05 Nov 2022
Sprint-3	15	5 Days	07 Nov 2022	12 Nov 2022	15	12 Nov 2022
Sprint-4	15	5 Days	14 Nov 2022	19 Nov 2022	15	19 Nov 2022

#### Velocity:

We have a 5-day sprint duration, and the velocity of the team is 15 (points per sprint). The team's average velocity (AV) per iteration unit (storypoints per day)

$$\text{Actual Velocity} = \frac{\text{Sprint}}{\text{Duration}} = \frac{15}{5} = 3$$

## Burndown Chart:

A burn down chart is a graphical representation of work left to do versus time. It is often used in agile software development methodologies such as Scrum. However, burn down charts can be applied to any project containing measurable progress over time



## 6.2. MILESTONE AND ACTIVITY LIST

Activity Number	Activity Name	Detailed Activity Description	Assigned To	Status / Comments
1	Preparation Phase	<ul style="list-style-type: none"> <li>Access the resources (courses) in projectdashboard</li> <li>Access the guided project workspace</li> <li>Create GitHub account &amp; collaborate withProject Repository in project workspace</li> <li>Set-up the Laptop / Computers based on the prerequisites for each technology track</li> </ul>	Jenix A, Jeshuran Benedict, Joe Nikesh P J, Arjunan Vijay Manohar.	It refers to done the listed activitiesin the preparation phase and done Prerequisites, Registration, Environment setup
2	Ideation Phase	<ul style="list-style-type: none"> <li>Literature survey on the selected project &amp; Information Gathering</li> <li>Preparation of Empathy Map Canvas to capture the user Pains &amp; Gains. Prepare listof problem statements</li> <li>List the ideas by organizing thebrainstorming session and prioritize the top3 ideas based on the feasibility &amp; importance</li> </ul>	Jenix A, Jeshuran Benedict, Joe Nikesh P J, Arjunan Vijay Manohar	The activities in ideation phase refers to when gathering the ideafor project information and picturize in Empathy map
3	Project Design Phase -I			

3.1	Proposed Solution	Preparation of proposed solution document, which includes the novelty, feasibility of idea,business model, social impact, scalability of solution	Jenix A, Jeshuran Benedict, Joe Nikesh P J, Arjunan Vijay Manohar	The solution for the project is preparedas a standard document structure from Team members
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3.2	Problem SolutionFit	Prepared problem is analyzed and make effectivesolutions for the problem	Jenix A, Jeshuran Benedict, Joe Nikesh P J, Arjunan Vijay Manohar	
3.3	Solutio n Archite cture	Prepare an architecture for solution	Jenix A, Jeshuran Benedict, Joe Nikesh P J, Arjunan Vijay Manohar	Suitable block diagram template used to prepare Solution architectu re
4	Project Design Phase -II			
4.1	Require ment Analysi s	Prepare the Functional Requirement and NonFunctional Document	Jenix A, Jeshuran Benedict, Joe Nikesh P J, Arjunan Vijay Manohar	Listing of functional and non-functional requirement s of project.
4.2	Customer Journey	Preparation of customer journey maps to understand the user interactions & experiences with the application (entry to exit)	Jenix A, Jeshuran Benedict, Joe Nikesh P J, Arjunan Vijay Manohar	Customer j ourneymap prepared by suitable temp late by team mem bers.
4.3	Data Flow Diagrams	Prepare a Data Flow Diagram for Project use level0(Industry Standard)	Jenix A, Jeshuran Benedict, Joe Nikesh P J, Arjunan Vijay Manohar	Use suitable data flow diagram rulesand standards to prepare level 0 DFD
4.4	Techno logy Archite cture	Prepare Technology Architecture of the solution	Jenix A, Jeshuran Benedict, Joe Nikesh P J, Arjunan Vijay Manohar	

5	Project Planning Phase			
5.1	Milestones & Tasks	Prepare Milestone & Activity List	Jenix A, Jeshuran Benedict, Joe Nikesh P J, Arjunan Vijay Manohar	
5.2	Sprint Schedules	Prepare Sprint Delivery Plan	Jenix A, Jeshuran Benedict, Joe Nikesh P J, Arjunan Vijay Manohar	



6	Project Development Phase			
6.1	Coding & Solutioning	Sprint-1 Delivery: Develop the Code, Test and push it to GitHub.	On Progress	
6.2	Acceptance Testing	<ul style="list-style-type: none"> <li>Sprint-2 Delivery: Develop the Code, Test and push it to GitHub.</li> <li>Sprint-3 Delivery: Develop the Code, Test and push it to GitHub.</li> </ul>	On Progress	
6.3	Performance Testing	Sprint-4 Delivery: Develop the Code, Test and push it to GitHub.	On Progress	

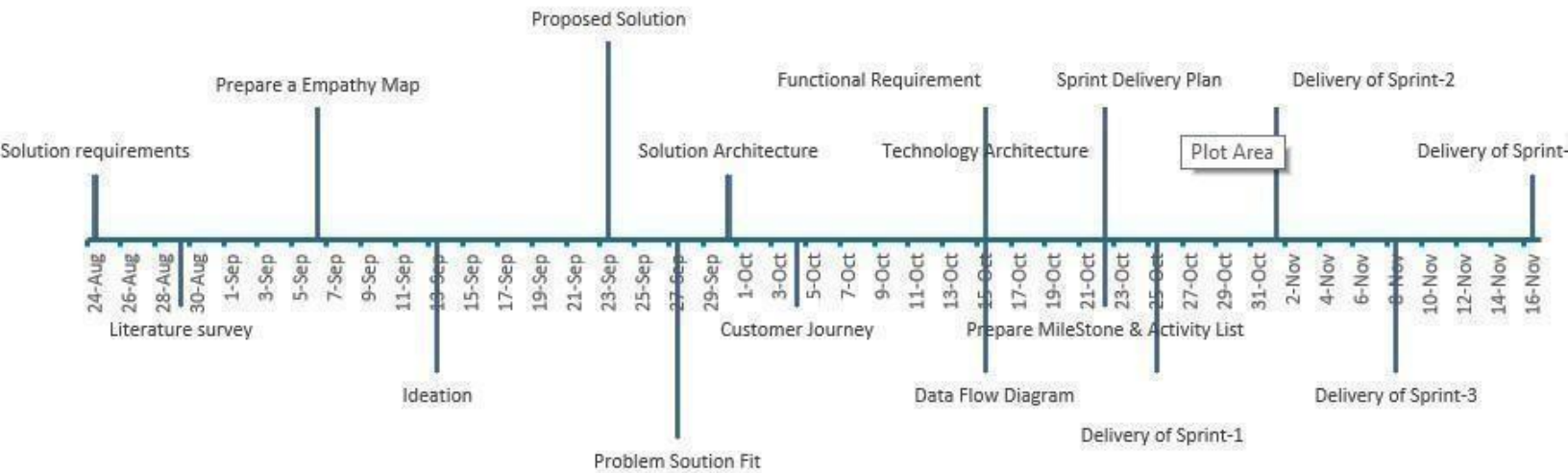
### Milestone:

When project begins then it is expected that project related activities must be initiated. In project planning, series of milestones must be established. Milestone can be defined as recognizable endpoint of software project activity. At each milestone, report must be generated.

Milestone is distinct and logical stage of the project. It is used as signal post for project start and end date, need for external review or input and for checking budget, submission of the deliverable, etc. It simply represents clear sequence of events that are incrementally developed or build until project gets successfully completed. It is generally referred to as task with zero-time duration because they are used to symbolize an achievement or point of time in project. It helps in signifying change or stage in development.

### 6.3.REPORTS FROM JIRA

#### Milestone Timeline Chart



## 7.CODING & SOLUTIONING

### 7.1.FEATURE 1

# Importing Required Libraries

In [ ]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')
```

# Reading the Dataset

In [ ]:

```
df = pd.read_csv('autos.csv', parse_dates=['dateCrawled', 'dateCreated', 'lastSeen'], e
```

# Cleaning the Dataset

In [ ]:

```
df.columns
```

Out[3]:

```
Index(['dateCrawled', 'name', 'seller', 'offerType', 'price', 'abtest',
      'vehicleType', 'yearOfRegistration', 'gearbox', 'powerPS', 'model',
      'kilometer', 'monthOfRegistration', 'fuelType', 'brand',
      'notRepairedDamage', 'dateCreated', 'nrOfPictures', 'postalCode',
      'lastSeen'],
      dtype='object')
```

In [ ]:

```
# Rearranging the Columns
df = df[['dateCrawled', 'name', 'seller', 'offerType', 'abtest',
      'vehicleType', 'yearOfRegistration', 'gearbox', 'powerPS', 'model',
      'kilometer', 'monthOfRegistration', 'fuelType', 'brand',
      'notRepairedDamage', 'dateCreated', 'nrOfPictures', 'postalCode',
      'lastSeen', 'price']]
```

In [ ]:

```
# Dropping the Unwanted Columns
df.drop(columns= ['seller', 'offerType', 'nrOfPictures'], inplace = True)
```

In [ ]:

```
df.drop(columns= ['dateCrawled', 'dateCreated', 'lastSeen'], inplace = True)
```

## Missing Values

In [ ]:

```
# Checking for Missing Values
df.isna().sum()
```

Out[6]:

```
name                0
abtest              0
vehicleType        37869
yearOfRegistration  0
gearbox            20209
powerPS            0
model             20484
kilometer          0
monthOfRegistration 0
fuelType          33386
brand              0
notRepairedDamage  72060
postalCode         0
price              0
dtype: int64
```

In [ ]:

```
# Removing Missing Values
df['vehicleType'].fillna(df['vehicleType'].mode()[0], inplace = True)
df['gearbox'].fillna(df['gearbox'].mode()[0], inplace = True)
df['model'].fillna(df['model'].mode()[0], inplace = True)
df['fuelType'].fillna(df['fuelType'].mode()[0], inplace = True)
df['notRepairedDamage'].fillna(df['notRepairedDamage'].mode()[0], inplace = True)
```

In [ ]:

```
df.isna().sum()
```

Out[8]:

```
name                0
abtest              0
vehicleType         0
yearOfRegistration  0
gearbox             0
powerPS            0
model              0
kilometer          0
monthOfRegistration 0
fuelType           0
brand              0
notRepairedDamage  0
postalCode         0
price              0
dtype: int64
```

## Duplicate Values

In [ ]:

```
# Checking for Duplicates
df.duplicated().sum()
```

Out[9]:

4703

In [ ]:

```
# Removing Duplicates
df = df.drop_duplicates()
```

In [ ]:

```
df.duplicated().sum()
```

Out[11]:

0

## Label Encoding

In [ ]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 366825 entries, 0 to 371527
Data columns (total 14 columns):
 #   Column                Non-Null Count  Dtype  
---  -
 0   name                  366825 non-null object  
 1   abtest                366825 non-null object  
 2   vehicleType           366825 non-null object  
 3   yearOfRegistration    366825 non-null int64   
 4   gearbox               366825 non-null object  
 5   powerPS              366825 non-null int64   
 6   model                 366825 non-null object  
 7   kilometer             366825 non-null int64   
 8   monthOfRegistration   366825 non-null int64   
 9   fuelType              366825 non-null object  
10   brand                 366825 non-null object  
11   notRepairedDamage     366825 non-null object  
12   postalCode            366825 non-null int64   
13   price                 366825 non-null int64   
dtypes: int64(6), object(8)
memory usage: 42.0+ MB
```

In [ ]:

```

from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
df['name'] = le.fit_transform(df['name'])
df['abtest'] = le.fit_transform(df['abtest'])
df['vehicleType'] = le.fit_transform(df['vehicleType'])
df['gearbox'] = le.fit_transform(df['gearbox'])
df['model'] = le.fit_transform(df['model'])
df['fuelType'] = le.fit_transform(df['fuelType'])
df['brand'] = le.fit_transform(df['brand'])
df['notRepairedDamage'] = df['notRepairedDamage'].replace({'nein' : 0, 'ja' : 1})

```

In [ ]:

```
df.info()
```

```

<class 'pandas.core.frame.DataFrame'>
Int64Index: 366825 entries, 0 to 371527
Data columns (total 14 columns):
#   Column                                Non-Null Count  Dtype
---  -
0   name                                  366825 non-null  int64
1   abtest                               366825 non-null  int64
2   vehicleType                          366825 non-null  int64
3   yearOfRegistration                   366825 non-null  int64
4   gearbox                             366825 non-null  int64
5   powerPS                             366825 non-null  int64
6   model                               366825 non-null  int64
7   kilometer                           366825 non-null  int64
8   monthOfRegistration                  366825 non-null  int64
9   fuelType                            366825 non-null  int64
10  brand                               366825 non-null  int64
11  notRepairedDamage                    366825 non-null  int64
12  postalCode                           366825 non-null  int64
13  price                               366825 non-null  int64
dtypes: int64(14)
memory usage: 42.0 MB

```

## Identifying and Handling Outliers

In [ ]:

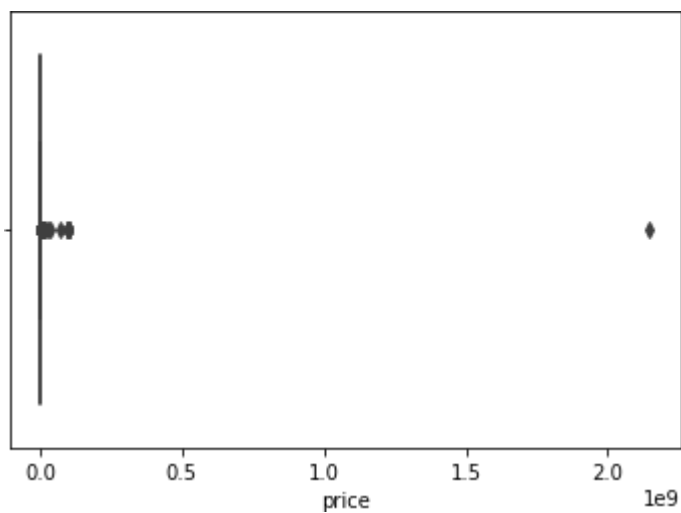
```
# Checking for outliers in 'price' column
```

In [ ]:

```
sns.boxplot(x = df['price'])
```

Out[16]:

<AxesSubplot:xlabel='price'>



In [ ]:

```
a = df['price'].quantile(q=[0.75,0.25])  
a
```

Out[17]:

```
0.75    7150.0  
0.25    1150.0  
Name: price, dtype: float64
```

In [ ]:

```
IQR = a.iloc[0] - a.iloc[1]  
IQR
```

Out[18]:

```
6000.0
```

In [ ]:

```
upper = a.iloc[0]+(1.5*IQR)
lower = a.iloc[0]-(1.5*IQR)
```

In [ ]:

```
upper
```

Out[20]:

16150.0

In [ ]:

```
lower
```

Out[21]:

-1850.0

In [ ]:

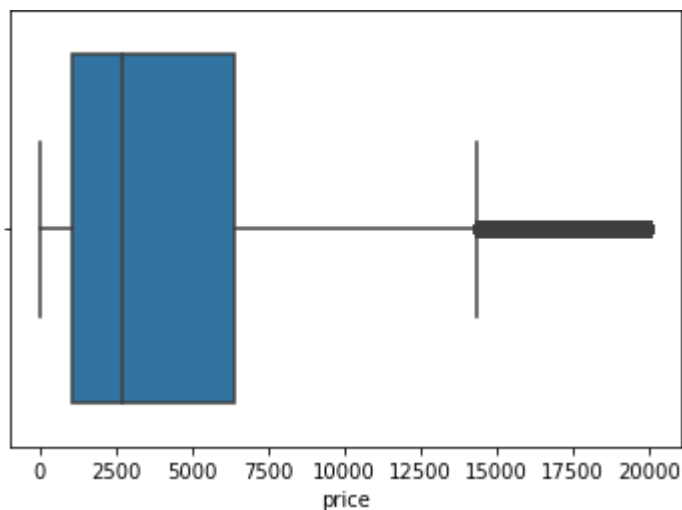
```
# Dropping outliers in price
a = df[df['price'] > 20000].index
df.drop(a, inplace = True)
```

In [ ]:

```
sns.boxplot(x = df['price'])
```

Out[23]:

<AxesSubplot:xlabel='price'>



In [ ]:

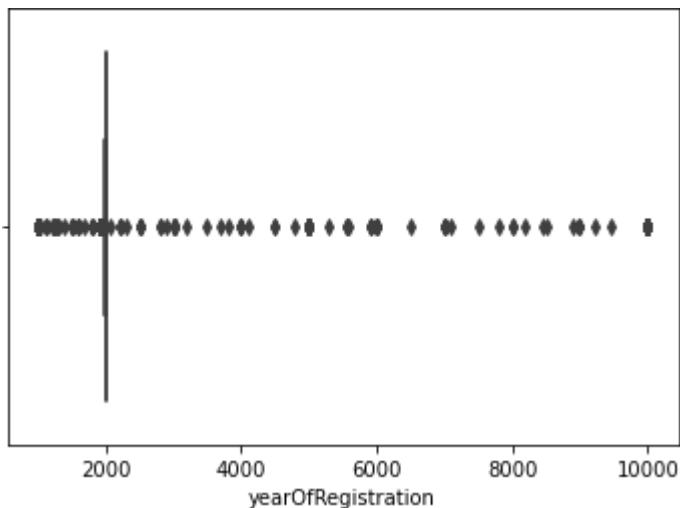
```
# Checking for outliers in 'yearOfRegistration' column
```

In [ ]:

```
sns.boxplot(x = df['yearOfRegistration'])
```

Out[25]:

<AxesSubplot:xlabel='yearOfRegistration'>



In [ ]:

```
a = df['yearOfRegistration'].quantile(q=[0.75,0.25])  
a
```

Out[26]:

```
0.75    2008.0  
0.25    1999.0  
Name: yearOfRegistration, dtype: float64
```

In [ ]:

```
IQR = a.iloc[0] - a.iloc[1]  
IQR
```

Out[27]:

```
9.0
```

In [ ]:

```
upper = a.iloc[0] + (1.5*IQR)  
lower = a.iloc[0] - (1.5*IQR)
```



In [ ]:

```
upper
```

Out[29]:

2021.5

In [ ]:

```
lower
```

Out[30]:

1994.5

In [ ]:

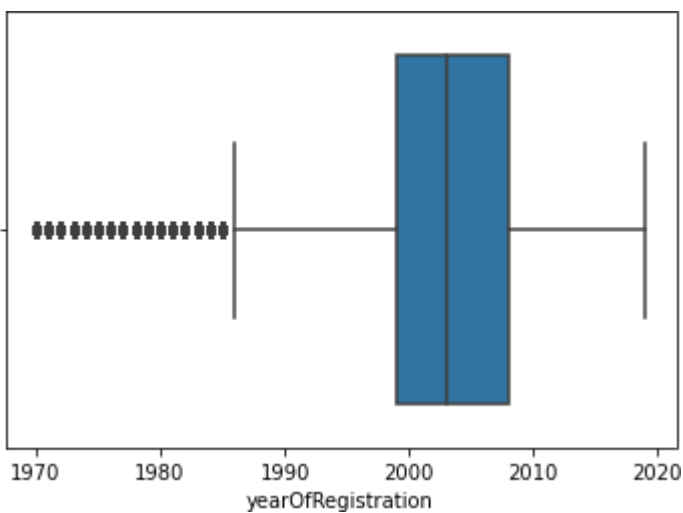
```
# Dropping outliers in yearOfRegistration  
a = df[df['yearOfRegistration'] > 2019].index  
df.drop(a, inplace = True)  
a = df[df['yearOfRegistration'] < 1970].index  
df.drop(a, inplace = True)
```

In [ ]:

```
sns.boxplot(x = df['yearOfRegistration'])
```

Out[32]:

<AxesSubplot:xlabel='yearOfRegistration'>



In [ ]:

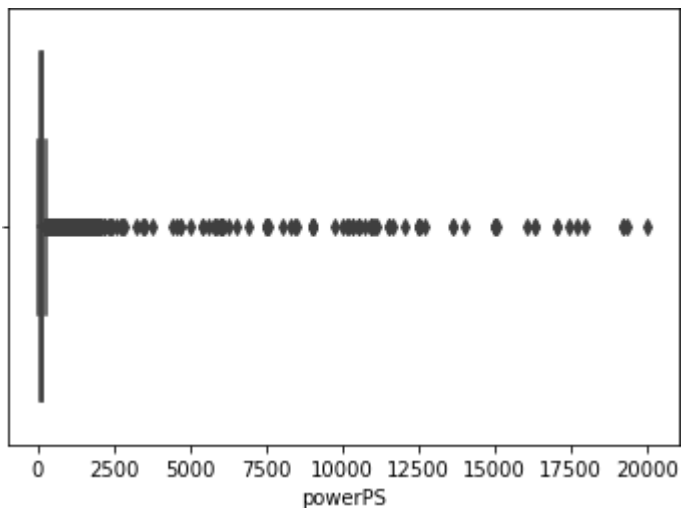
```
# Checking for outliers in 'powerPS' column
```

In [ ]:

```
sns.boxplot(x = df['powerPS'])
```

Out[34]:

<AxesSubplot:xlabel='powerPS'>



In [ ]:

```
a = df['powerPS'].quantile(q=[0.75,0.25])  
a
```

Out[35]:

```
0.75    141.0  
0.25     69.0  
Name: powerPS, dtype: float64
```

In [ ]:

```
IQR = a.iloc[0] - a.iloc[1]  
IQR
```

Out[36]:

```
72.0
```

In [ ]:

```
upper = a.iloc[0] + (1.5*IQR)  
lower = a.iloc[0] - (1.5*IQR)
```

In [ ]:

```
upper
```

Out[38]:

249.0

In [ ]:

```
lower
```

Out[39]:

33.0

In [ ]:

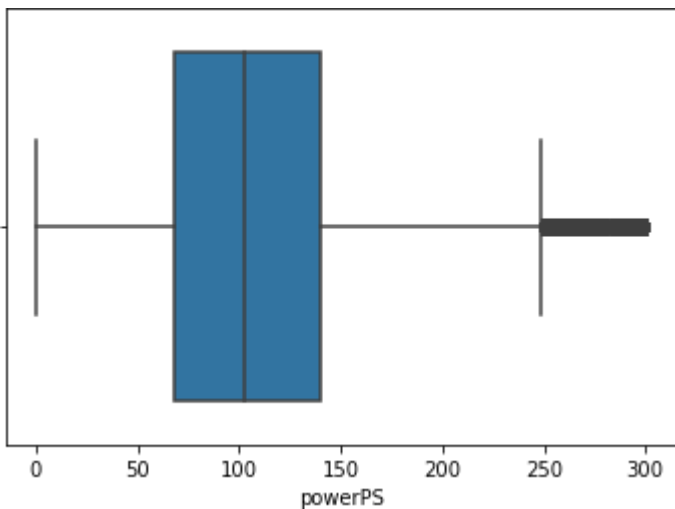
```
# Dropping outliers in powerPS  
a = df[df['powerPS'] > 300].index  
df.drop(a, inplace = True)
```

In [ ]:

```
sns.boxplot(x = df['powerPS'])
```

Out[41]:

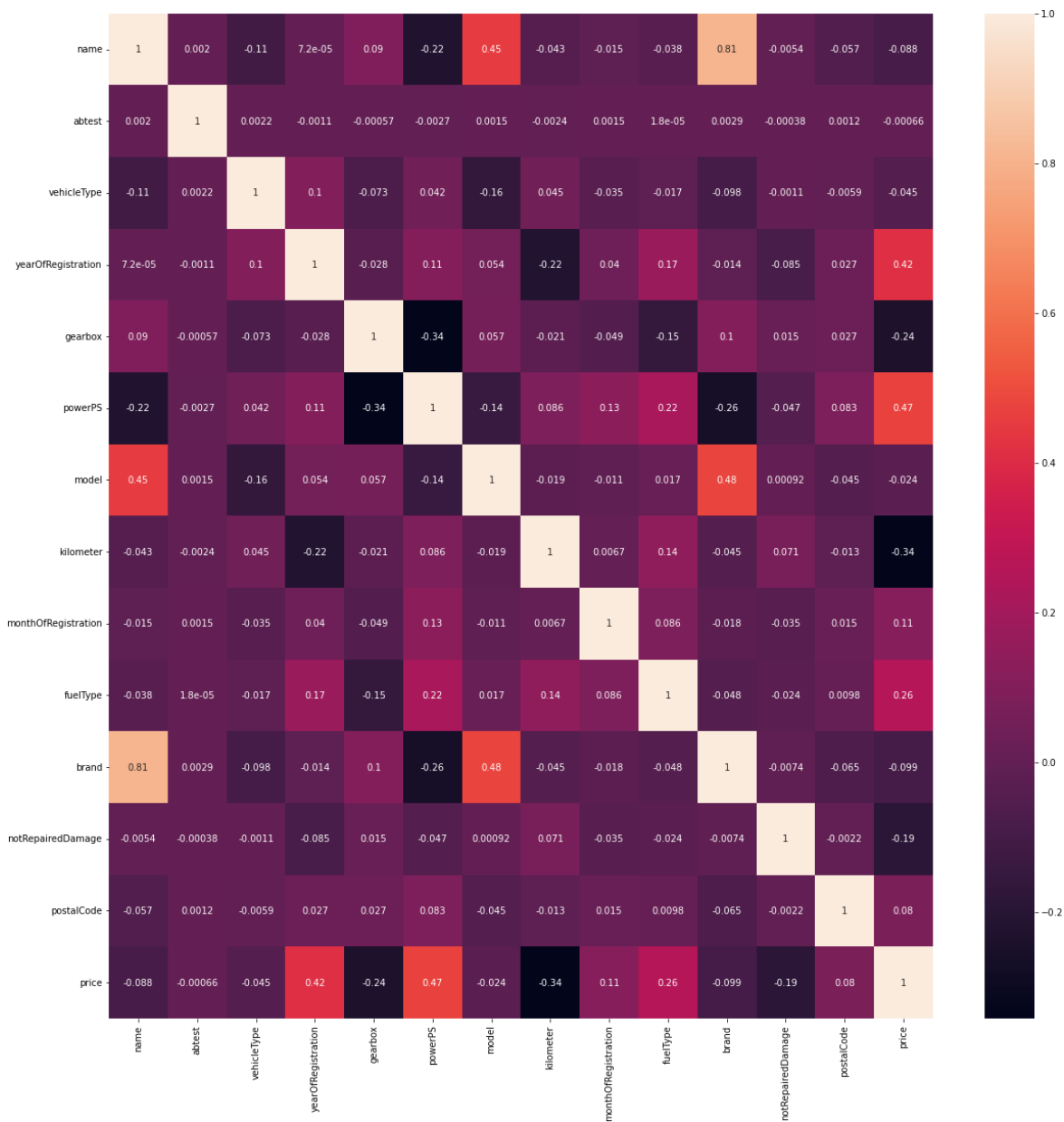
<AxesSubplot:xlabel='powerPS'>



## Visualization

In [ ]:

```
plt.figure(figsize=(20,20))
sns.heatmap(df.corr(), annot = True)
plt.show()
```

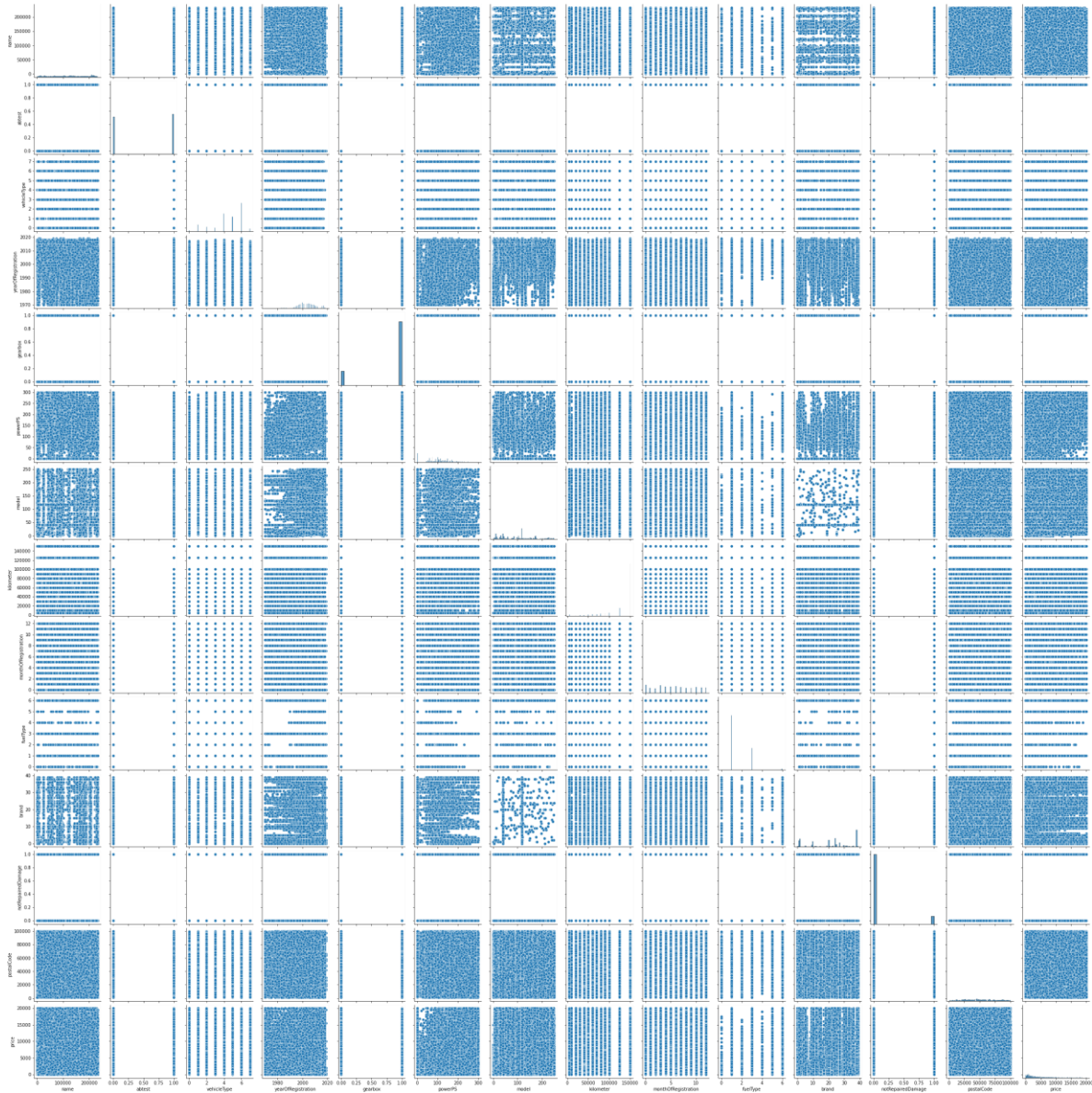


In [ ]:

```
sns.pairplot(df)
plt.show()
```

Out[74]:

```
<seaborn.axisgrid.PairGrid at 0x7fc23cddbc40>
```



## Descriptive Statistics

In [ ]:

```
df.nunique()
```

Out[80]:

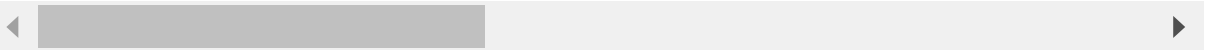
```
name                218805
abtest              2
vehicleType         8
yearOfRegistration  50
gearbox             2
powerPS            299
model              250
kilometer          13
monthOfRegistration 13
fuelType           7
brand              40
notRepairedDamage   2
postalCode         8140
price              3708
dtype: int64
```

In [ ]:

```
df.describe()
```

Out[42]:

	name	abtest	vehicleType	yearOfRegistration	gearbox	
count	344985.000000	344985.000000	344985.000000	344985.000000	344985.000000	34498
mean	117904.585912	0.518202	4.565471	2003.229619	0.819265	10
std	67510.545516	0.499669	1.661815	6.980320	0.384799	5
min	0.000000	0.000000	0.000000	1970.000000	0.000000	
25%	60989.000000	0.000000	4.000000	1999.000000	1.000000	6
50%	119794.000000	1.000000	5.000000	2003.000000	1.000000	10
75%	175396.000000	1.000000	6.000000	2008.000000	1.000000	14
max	233530.000000	1.000000	7.000000	2019.000000	1.000000	30



In [ ]:

```
df.skew()
```

Out[43]:

```
name                -0.022347
abtest              -0.072858
vehicleType         -0.917651
yearOfRegistration -0.360852
gearbox            -1.659392
powerPS             0.189407
model               0.395804
kilometer          -1.737954
monthOfRegistration 0.082692
fuelType            1.542590
brand              -0.172770
notRepairedDamage   2.622955
postalCode          0.075437
price               1.461433
dtype: float64
```

In [ ]:

```
df.kurt()
```

Out[44]:

```
name                -1.200546
abtest              -1.994703
vehicleType         -0.028758
yearOfRegistration  1.432725
gearbox             0.753586
powerPS             0.085471
model              -0.883618
kilometer           1.984077
monthOfRegistration -1.147400
fuelType            2.400634
brand              -1.310623
notRepairedDamage   4.879922
postalCode          -0.962817
price               1.547299
dtype: float64
```

## Splitting the Data

In [ ]:

```
# Splitting x and y variables
x = df.drop(columns = 'price')
y = df['price']
```

In [ ]:

```
# Splitting into test and train
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.2, random_state=0)
```

## Building Models

In [ ]:

```
# Linear Regression
```

In [ ]:

```
from sklearn.linear_model import LinearRegression
lr = LinearRegression()
lr.fit(x_train, y_train)
```

Out[48]:

LinearRegression()

**In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.**

**On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.**

In [ ]:

```
# Lasso Regression
```

In [ ]:

```
from sklearn.linear_model import Lasso
lasso = Lasso(alpha=0.01, normalize=True)
lasso.fit(x_train, y_train)
```

Out[72]:

Lasso(alpha=0.01, normalize=True)

**In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.**

**On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.**

In [ ]:

```
# Ridge Regression
```



In [ ]:

```
from sklearn.linear_model import Ridge
ridge = Ridge(alpha=0.01, normalize=True)
ridge.fit(x_train, y_train)
```

Out[73]:

Ridge(alpha=0.01, normalize=True)

**In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.**

**On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.**

In [ ]:

```
# Decision Tree
```

In [ ]:

```
from sklearn.tree import DecisionTreeRegressor
DT = DecisionTreeRegressor()
DT.fit(x_train, y_train)
```

Out[54]:

DecisionTreeRegressor()

**In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.**

**On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.**

In [ ]:

```
# KNN
```

In [ ]:

```
from sklearn.neighbors import KNeighborsRegressor
knn = KNeighborsRegressor()
knn.fit(x_train, y_train)
```

Out[56]:

KNeighborsRegressor()

**In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.**

**On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.**

In [ ]:

```
# Random Forest
```

In [ ]:

```
from sklearn.ensemble import RandomForestRegressor
RF = RandomForestRegressor()
RF.fit(x_train, y_train)
```

Out[58]:

RandomForestRegressor()

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.

On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

## Checking the Metrics of the models

In [ ]:

```
# Linear Regression
lr.score(x_test, y_test)
```

Out[59]:

0.5046164293159722

In [ ]:

```
from sklearn.metrics import mean_squared_error
np.sqrt(mean_squared_error(y_test, lr.predict(x_test)))
```

Out[60]:

3124.839243816001

In [ ]:

```
# Lasso Regression
lasso.score(x_test, y_test)
```

Out[61]:

0.5046279017842787

In [ ]:

```
np.sqrt(mean_squared_error(y_test, lasso.predict(x_test)))
```

Out[62]:

3124.803059908348

In [ ]:

```
# Ridge Regression  
ridge.score(x_test, y_test)
```

Out[63]:

0.5046132152966406

In [ ]:

```
np.sqrt(mean_squared_error(y_test,ridge.predict(x_test)))
```

Out[64]:

3124.8493806857336

In [ ]:

```
# K Nearest Neighbour  
knn.score(x_test, y_test)
```

Out[65]:

0.3604264656174847

In [ ]:

```
np.sqrt(mean_squared_error(y_test,knn.predict(x_test)))
```

Out[66]:

3550.603057315332

In [ ]:

```
# Decision Tree  
DT.score(x_test, y_test)
```

Out[67]:

0.7351891458983589

In [ ]:

```
np.sqrt(mean_squared_error(y_test,DT.predict(x_test)))
```

Out[68]:

2284.6767997222564

In [ ]:

```
# Random Forest  
RF.score(x_test, y_test)
```

Out[69]:

0.8621941043052054

In [ ]:

```
np.sqrt(mean_squared_error(y_test, RF.predict(x_test)))
```

Out[70]:

1648.1274003735057

## Saving the Model

In [ ]:

```
import pickle  
pickle.dump(RF, open('Car Resale Value Prediction.pkl', 'wb'))
```

## 8.TESTING

### 8.1.USER ACCEPTANCE TESTING

#### 1. Purpose of Document

The purpose of this document is to briefly explain the test coverage and open issues of the [ProductName] project at the time of the release to User Acceptance Testing (UAT).

#### 2. Defect Analysis

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	10	4	2	3	20
Duplicate	1	0	3	0	4
External	2	3	0	1	6
Fixed	11	2	4	20	37
Not Reproduced	0	0	1	0	1
Skipped	0	0	1	1	2
Won't Fix	0	5	2	1	8
Totals	24	14	13	26	77

#### 3. Test Case Analysis

This report shows the number of test cases that have passed, failed, and untested

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	7	0	0	7
Client Application	51	0	0	51
Security	2	0	0	2
Outsource Shipping	3	0	0	3

Exception Reporting	9	0	0	9
Final Report Output	4	0	0	4
Version Control	2	0	0	2

## 8.2.Model Performance Test

### Model Performance Testing:

Project team shall fill the following information in model performance testing template.

S.No	Parameter	Values	Screenshot
1.	Metrics	<b>Regression Model:</b> MAE - 1232.3528089560773, MSE - 5063778.951720876, RMSE - 2250.2841935455344, R2 score - 0.87528399134989	<pre>from sklearn.metrics import r2_score r2_score(y_test, RF.predict(x_test)) 0.8752839913498982  from sklearn.metrics import mean_squared_error mean_squared_error(y_test, RF.predict(x_test)) 5063778.951720876  from sklearn.metrics import mean_squared_error np.sqrt(mean_squared_error(y_test, RF.predict(x_test))) 2250.2841935455344  from sklearn.metrics import mean_absolute_error mean_absolute_error(y_test, RF.predict(x_test)) 1232.3528089560773</pre>
2.	Tune the Model	<b>Validation Method - train_test_split</b>	<pre># Splitting x and y variables x = df.drop(columns = 'price') y = df['price']  # Splitting into test and train from sklearn.model_selection import train_test_split x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.2, random_state=0)</pre>