USER MANUAL

LAPR2 - INTEGRATIVE PROJECT

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User Manual

REAL ESTATE USA

Developed by CTRL-ALT-DEFEAT

Contents & Review

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Glossary

Table 1 - Glossary

***TEA* (EN)**	***Description* (EN)**
Address	The unique identifier of a location including the number of the house, the street, the zip code, the city, the county, and the state.
Agency	A business or organization providing a particular service on behalf of another business, person, or group. (Synonym of Store)
Agent	Person responsible for selling or renting one or more properties.
Air Conditioning	System for controlling the humidity, ventilation, and temperature in a building.
Announcement	A piece of news intended to promote a product, a service or an idea.
Announcement Demand	A demand for advertising a property.
Announcement State	Announcement state refers to the status of an announcement, indicating whether it is currently available or has been sold.
Apartment	Type of property.
Basement	Division of a house.
Booking Request	Synonym of Message.
Branch	Refers to a division or a secondary location of a company that operates under the same name and shares the same legal entity as the main company but is in a different physical location. (Synonym of Store)

TEA (EN)	*Description* (EN)
Brute Force Algorithm	A brute force algorithm is a straightforward approach that exhaustively tries all possible solutions to find the desired outcome.
Bubble Sort	Bubble sort is a simple sorting algorithm that repeatedly compares adjacent elements and swaps them if they are in the wrong order, gradually moving larger elements towards the end of the list.
Buyer	Person who is interested in buying one or more properties from the ones available.
Central Heating	System that converts fuel or electricity to heat in a house or apartment.
City	Territorial division within a district.
Client	Person that wants to buy or rent a property.
Commission	Fixed amount or percentage that is paid to the employees based on the sales.
Configuration File	A configuration file is a file used to specify settings for a software application or system's behavior.
CVS file	A CSV file is a plain text file that stores tabular data with each value separated by commas.
DEI Service	DEI Service is an email service provided by the Department of Informatics Engineering at ISEP (Instituto Superior de Engenharia do Porto), allowing users to send, receive, and manage electronic messages through its platform.
District	Territorial division withing a state that comprises several cities.
Email	Email is a digital communication method used to send and receive electronic

TEA (EN)	*Description* (EN)
	messages containing text, attachments, and multimedia content.
Email Address	A unique identifier that allows individuals to send and receive electronic messages over the internet.
Employee	Person who carries out a set of operations related to the real estate business.
Gmail Service	Gmail Service is a popular email service developed by Google, offering users a platform for sending, receiving, and organizing electronic messages.
Hotmail Service	Hotmail Service is a widely used email service provided by Microsoft, enabling users to send, receive, and manage electronic messages on its platform.
House	Type of property.
Inhabitable loft	Division of a house that a person can live.
Land	Type of property.
Merge Sort	Merge sort is a recursive sorting algorithm that divides the input list into smaller halves, sorts them individually, and then merges them back together in sorted order.
Message	A message is a communication from a client to an agent, sent through the real estate app, to schedule a visit to a property of interest. Synonym of Booking Request.
Message State	Message state refers to the status of a message, indicating whether it has been responded to or remains unanswered.
Multilinear Regression	A multilinear regression model is a statistical technique used to analyze and predict the relationship between multiple independent variables and a

TEA (EN)	*Description* (EN)
	dependent variable.
Offer	It refers to the amount of money that a client is inclined to pay for a specific property.
Offer State	Offer state refers to the status of an offer, indicating whether it is pending (awaiting a decision), accepted (agreed upon), or declined (rejected).
Owner	Person that wants to sell or rent a property.
Passport Number	Number in the passport that identifies the person to whom it belongs.
Phone Number	Number that is used to call or make connections with other persons.
Property Owner	Person who contacts Real Estate USA to sell or rent properties.
Real Estate USA	A fiction United States of America company that has a network of real estate agencies.
Regression Model	A regression model is a statistical approach used to analyze and predict the relationship between dependent and independent variables.
Rent	A periodic payment made to the owner for the use of the owner's property.
Role	The function or position of an employee.
Selection Sort	Is an algorithm that find the smallest element and swap it with the first element, gradually building a sorted sequence.

TEA (EN)	*Description* (EN)
Single Linear	A single linear regression model is a statistical technique used to analyze and predict the relationship between one independent variable and a dependent variable.
SMS	SMS (Short Message Service) is a text messaging service used to send and receive short text messages between mobile devices.
Sorting Algorithm	A sorting algorithm is a method or process used to arrange a collection of items in a particular order or sequence.
State	Territorial division in the USA that comprises several districts.
Store	Place where you can buy or rent properties.
Store Manager	Person who monitors and streamlines the branch with the aim of getting to know better the business carried out and to analyze and evaluate the performance of employees.
Store Network Manager	Person responsible for registering all employees and branches of the network as well as preparing the system to facilitate the use of the application.
System Administrator	Person responsible for carrying out various business supporting activities on the system.
Sun Exposure	Period of sunlight direction, directly or indirectly. (North, South, East and West).
Tax Identifying Number	A unique identification number assigned to individuals and businesses for tax purposes.
Type of property	Related to the variety of proprieties that the Real Estate USA possess, such as apartment, house, or land.

TEA (EN)	*Description* (EN)
Unregistered User	A person who is not registered or logged in to a particular website or online platform.
URI	Acronym for Uniform Resource Identifier, which is a string of characters that identifies a name or a resource on the internet.
Yahoo Service	Yahoo Service is an email service offered by Yahoo, allowing users to send, receive, and manage electronic messages through its platform.

Introduction

This manual provides comprehensive guidance on how to use our Real Estate program and provides useful information for its users.

The purpose of this user manual is to provide detailed instructions and information on how to effectively navigate, utilize, and maximize the features of our Real Estate application. This manual is designed to assist our users in understanding its functionalities, tools, and resources available within the app. Whether you are a homebuyer or a real estate agent, this document will help you to make informed decisions and to use the app's capabilities to achieve your goals.

The product described in this user manual is Real Estate app. This digital application is specifically developed to provide users with a convenient platform for searching and managing various real estate properties. The application may offer features such as property listings, search filters, publish property announcements, request visits to the property, make offers, and much more. This manual will walk you through the app's interface, functionalities, and usage guidelines, enabling you to find what you need with ease.

This user manual is primarily addressed to individuals and professionals involved in the real estate industry or those interested in buying or renting properties. The target audience includes homebuyers, property investors, all the real estate employees involved, and anyone who seeks to utilize the app's features and resources to facilitate their real estate-related endeavors.

Regardless of whether you consider yourself a tech-savvy user or are just beginning to explore real estate apps, this document is dedicated to ensuring that you have the necessary knowledge and instructions required to use the app at its fullest and make well-informed decisions.

System Overview

This project aims to develop an application that will serve as a comprehensive management tool for Real Estate USA's business operations related to property lease and sale. It will enable both buyers visiting the agencies and the company's employees to perform various tasks associated with real estate transactions. This application was developed by aggregating all the knowledge acquired by the development team during this semester in the curricular units (ESOFT, PPROG, MDISC, MATCP and LAPR2).

The application was developed for different kinds of users that have their purpose to use the application, and they can only access the features designated for them. There are 7 types of users: System Administrator, Agent, Unregistered User, Owner, Client, Network Manager and Store Manager.

The System Administrator is the person that is responsible for carrying out the various business supporting activities on the system. The accessible app features of System Administrator are:

- Register a new employee.
- Register a store.
- Specify states, districts, and cities in the system.
- Import information from a legacy system that has been in use in several agencies.

The Agent is the person that is responsible for selling or renting one or more properties. The accessible app features of Agent are:

- Publish any sale announcement on the system.
- See the list of property announcement requests made to the agent, so that he/she can post the announcement.
- List real estate purchase orders to accept or decline a purchase order for a property.
- List all booking requests for properties managed by him/her.
- Respond to the user that scheduled the visit, when viewing a booking request.
- Register the visit and the opinion about the business, at the end of the visit.

The Unregistered User is not registered or logged into a particular website

or online platform. The accessible app features of Unregistered User are:

- Display listed properties.
- Register in the system to buy, sell, or rent properties.

The Owner is person that wants to sell or rent a property. The accessible app features of Owner are:

- Submit a request for listing a property sale or rent, choosing the responsible agent.

The Client is a person that wants to buy or rent a property. The accessible app features of Client are:

- Leave a message to the agent to schedule a visit to a property of their interest.
- Place an order to purchase the property, submitting the order amount.
- Read the response for the appointment requests, to accept or reject it.
- Read the response for the appointment request, to accept or reject it.

The Network Manager is a person that is responsible for registering all employees and branches of the network. The accessible app features of Network Manager are:

- List all employees working in every store of the network.
- List all deals by him/her.
- Divide the set of all stores into two subsets, so that the total number of properties of the stores between the two subsets is the closest possible.

The Store Manager is a person who monitors and streamlines the branch with the aim of getting to know better the business carried out and to analyze and evaluate the performance of employees. The accessible app features of Store Manager are:

- Analyze the deals (only the sale of houses and apartments) made.

To see the diagram of all the role’s features, please see Annex A.

System Requirements

To execute this application, your machine must match the following specifications:

- **Operating System:** Windows, macOS, or Linux
- **Disk Space:** Sufficient free space to extract and store the application files, to download and install the Java Development Kit (JDK) and any required dependencies, and to download and install the IDE, JDK, and JavaFX libraries.
- **IntelliJ IDEA:** Latest version installed and configured on your system or install (see software installation chapter).
- **RAM:** Minimum 4 GB of RAM (recommended 8 GB or more) for a smoother operation.
- **Processor:** A compatible processor with support for the required operating system.
- **Internet Connection:** A stable internet connection to download the required components.

Software Installation

For the proper functioning of the application and for better use, you must carefully follow all the following steps:

IntelliJ IDEA:

1. Visit the JetBrains website: Go to the JetBrains website at [https://www.jetbrains.com/idea/].
2. Download IntelliJ IDEA: On the IntelliJ IDEA webpage, click on the "Download" button to download the installer for your operating system (Windows, macOS, or Linux).
3. Run the Installer: Once the installer is downloaded, locate the file and run it to start the installation process.
4. Choose Installation Options: In the installation wizard, you will be presented with various installation options. Review and select the desired options such as installation location and whether to create desktop shortcuts.

5. Choose Data Sharing Settings (optional): JetBrains provides the option to participate in their data sharing program. Review the information and select your preference.
6. Choose UI Theme (optional): You can choose the theme for the IntelliJ IDEA user interface, either Light or Dark, based on your preference.
7. Choose Keymap (optional): IntelliJ IDEA offers different keymap options, including the default keymap or keymaps based on other popular IDEs. Select the keymap that suits you best or choose the default option.
8. Install: Click on the "Install" button to begin the installation process. The installer will copy the necessary files to your computer.
9. Launch IntelliJ IDEA: Once the installation is complete, you can choose to launch IntelliJ IDEA immediately or manually launch it later.
10. Configure IntelliJ IDEA (optional): Upon launching IntelliJ IDEA for the first time, you may be prompted to import settings or configure the IDE according to your preferences. Follow the on-screen instructions to set up the IDE as desired.
11. Activate IntelliJ IDEA (optional): If you have a license for IntelliJ IDEA, you can enter your license information to activate the IDE. Alternatively, you can choose to start a free trial or use the Community Edition.
12. Start using IntelliJ IDEA: With the installation and configuration complete, you can start using IntelliJ IDEA to develop Java applications.

Open a Java project from a zip file in IntelliJ IDEA:

1. Launch IntelliJ IDEA and click on "Open" or select "File" > "Open" from the menu.
2. Locate and select the zip file of your Java project that you want to open.
3. IntelliJ IDEA will extract the contents of the zip file and create a new project based on the extracted files.
4. In the "Import Project" window, select "Create project from existing sources" and click "Next".
5. Ensure that the project root directory is correctly set to the extracted folder from the zip file. Verify that the project structure looks accurate in the "Project Structure" panel.

6. Choose the project SDK (Java version) that you want to use for the project. If the desired SDK is not listed, click on "New" and configure a new SDK.
7. Click "Next" and review the project settings. Make any necessary adjustments, such as module dependencies or additional libraries.
8. Choose the project name and the location where you want to save the project on your local machine. Then, click "Finish" to complete the project setup.
9. IntelliJ IDEA will open the project.

JavaFX installation:

1. Visit the official JavaFX website to download the JavaFX SDK.
2. Select the appropriate version of JavaFX for your operating system.
3. Once the download is complete, extract the contents of the downloaded archive to a preferred location on your system.
4. Then, open your Java project in an Integrated Development Environment (IDE) such as IntelliJ IDEA.
5. Inside the Java Project go to "File" > "Project Structure" > "Libraries". Click the "+" button to add a new library. Browse to the location where you extracted the JavaFX SDK and select the "lib" folder. Click "OK" to add the library to your project.
6. Set the JavaFX runtime as a VM argument in your project configuration. Go to "Run" > "Edit Configurations". Select your Java application configuration, go to the "VM options" field, and enter the following argument:

“`--module-path /path/to/javafx-sdk/lib --add-modulesjavafx.controls,javafx.fxml`”

7. Replace "`/path/to/javafx-sdk/lib`" with the actual path to the JavaFX SDK on your system.

To run the application in the Java program in IntelliJ IDEA:

1. Make sure that your project has a main class with a main method. This is the entry point of your program. (If you want to use the console, go to the class “Main.java”, if you want to run in the interface, go to the class “MainAppGUI.java”)
2. Navigate to the main class file in the Project Explorer or the Project tool window.
3. Right-click on the main class file and select "Run <Main Class Name>". Alternatively, you can use the keyboard shortcut Shift+F10 (Windows/Linux) or Control+R (macOS) to run the program.
4. Enjoy the application!

Features

After logging in into the application, you can start using the system. The application is organized in menus, having each user role a different menu, depending on their permissions.

In the following table, you can check the different roles that users can have, as well as a full list of their accessible features by their respective menus.

Table 2 - User Roles

User Role	Permissions/Accessible Features
System Administrator	Register a Store; Register an Employee; Read information from a csv.file.
Agent	Publish Announcement; Publish Announcement Request; Display List of Offers; Display List of Messages.
Unregistered User	Display List of Properties; Do the Register. (For this feature, there is no requirement to log in or be registered in the application.)
Client	Request an Announcement; Inbox; Send a message to an agent; Place an Order.
Network Manager	See all employees working in every store; List all deals made.

Although the login page and all menus predominantly use a command-line interface to interact with the user, some options are also accessible through a graphical interface. In the table above, features accessible using a graphical interface are underlined.

Command-line interface

Main menu

In this section, you will be able to get the access of the functionalities of the application and it's based on 4 options:

```
Main Menu
1. Login
2. Register
3. See properties
4. Know the Development Team

0 - Cancel
```

Image 1 - Main Menu

- **Login:** Functionality that enables you to get access to other functionalities depending on what type of user you are such as: System Administrator, Agent, Client, Store Manager, Store Network Manager. To access other functionalities, you must type your email and your password in the respective spaces.

```
Login UI:

Enter UserId/Email:
ExampleEmail@this.app

Enter Password:
ExamplPassword
```

Image 2 - Email and Password

- **Register:** Functionality for clients that want to have access to all the functionalities that the application makes available for that specific role.
- **Display Properties:** Functionality for Unregistered Users that want to see all the properties available on the application and filter as they understand to do so.

- **Know the development team:** Functionality that enables to see the development team of this application.

```
Development Team:
     Pedro Coelho - 1220688@isep.ipp.pt
     Luna Silva - 1221184@isep.ipp.pt
     Diogo Moutinho - 1221014@isep.ipp.pt
     Vasco Sousa - 1221700@isep.ipp.pt
     Rafael Araújo - 1201804@isep.ipp.pt
```

Image 3 - Development Team

- **Cancel:** Functionality that closes the application.

Unregistered User Menu

The Unregistered User Menu can be accessed by anyone that enters the application, and it's the same as the main menu.

Register | Unregistered User

After starting the application, it should appear the main menu that was stated previously. If you wish to register, you must select the option "Register" by typing the number "2" on your keyboard and you will be redirect to a console-line interface.

This functionality allows the unregistered user to register in the application, to be able to access the client menu.

To do that, he must meet the following requirements:

- **Register with Address:** If you want to register in the application with your address, you must type "Y", if not "N". In case the answer is "Y".

```
Do you want to register with you address:(Y/N)
```

Image 4 - Register with Address

- **User Personal Information:** For this part, please check the "Employee Personal Information" in "Admin Menu" chapter.
- **Password:** To choose your password you must have in total 7 characters, being three of them capital letters and two numbers. (Take the values of the image only for example)

```
Choose your password(7 characters,3 capital letters,2 digits):
PASs12d
```

Image 5 - Password

In the end if you want to access the client menu, you must choose the option “Login” and insert your credentials. If you want to check your email and/or password, you can access to the file “emailRegistation.txt”:

```
Email:ExampleEmail@this.app
Password:PASs12d
```

Image 6 - Email and Password

Display Properties | Unregistered User

After starting the application, it should appear the main menu that was stated previously, so to display properties, you must select the option “See properties” by typing the number “3” on your keyboard and you will be redirect to a console-line interface.

This functionality allows the unregistered user to access all published announcements in the application, even if he is not registered in the app. To do that, he must meet the following requirements:

- **List Sorted by Most Recent:** To see this list you must type “3” in the main menu.

```
List of Properties (Sorted By most recent):
```

Image 7 - List Sorted by Most Recent

- **Filter List:** In this section you can filter the list of properties by property type (House, Apartment or Land), by business type (Buy or Rent) and number of rooms. If the message “There are no properties matching those requirements” appears it means that there is still no property published that has the type of characteristics previously chosen. (Take the values of the image only for example)

```
Do you wish to filter the list?

1. Yes
2. No
1
```

Image 8 - Filter Property List (pt.1)

```
Property Types:
1 - House
2 - Land
3 - Appartment
Select a Property Type: 1

Business Types:
1 - Buy
2 - Rent
Select a Type of Business: 1

Number of Rooms: 2
```

Image 9 - Filter Property List (pt.2)

- **Sort List:** To access this functionality, you must respond “2” (“No”) in the question of the previous topic, and answer “1” (“Yes”) in this question: (Take the values of the image only for example)

```
Do you wish to sort the list?

1. Yes
2. No
1

Sorting Options:

1. Price
2. City
3. State
Choose a sorting criteria: 2

Sorting methods:
1. Ascending
2. Descending
```

Image 10 - Sort Property List

- As you can see you can choose the price, the city, or the state to sort the properties by ascending or descending order.

Agent Menu

The Agent Menu is only accessed by registered agents, and has the following options:

- **Publish Announcement:** It's a functionality that the agent has, which publishes an advertisement, received a phone call, for example, of a property.
- **Publish Announcement Request:** It's a functionality that allows the agent to publish an announcement request that has been already submitted in the application by an owner.
- **See List Of Offers:** This option enables the agent to review purchase or lease requests that have been made by clients and accept or reject them.
- **See List Of Messages:** In this feature, the agent can list and respond to any visit requests made for him.

```
Agent Menu:
1. Publish Announcement
2. Publish Announcement Request
3. See List of Offers
4. See List of Messages

0 - Cancel

Type your option:
```

Image 11 - Agent Menu

- To access any of these functionalities you must type the desired one, for example, if I want to publish an announcement I would type "1".

Publish Announcement | Agent

After you log in as an Agent, it should appear the menu that was stated previously. To publish an announcement, you select the option “Publish Announcement” by typing the number “1” on your keyboard and you will be redirect to a console-line interface.

This functionality allows the agent to publish an advertisement in the application. To do that, you must meet the following requirements:

- **Select a Property Type:** If you want to publish an announcement for a “House”, you type “1”, for a “Land”, you type “2” and if it is for an “Apartment”, you type “3”. After typing the desired option, the application will ask for the specifications about the property type selected.

```
Publish Announcement
1 - House
2 - Land
3 - Appartment
Select a Property Type:
```

Image 12 - Select a Property Type

- **Select a Type of Business:** In this section you can type “1” if the property is to “Buy” and “2” if the property is to “Rent”.

```
1 - Buy
2 - Rent
Select a Type of Business:
```

Image 13 - Type Of Business

- **Owner Email:** You must type the owner’s email. Remember that an email must have an “@” and an ".", and that the owner must already be registered in the application.

```
Owner Email:
```

Image 14 - Owner Email

- **Area, Price and Distance From City Center:** In these requirements, you must type the area in square meters, the price (you will be prompted to enter either the total price if the property is for buying or the price per month if the property is for renting.), and the distance that the property is from the city center in meters, respectively. (Take the values of the image only for example)

```
Area:
150
Price:
190000
Distance From City Center:
300
```

Image 15 - Area, Price and Distance From City Center

- **URI of the Photos:** In this section you should insert at least 1 photo, in URI format, of the property and a maximum of 30. After inserting the photo, you type “N” if you don’t want to introduce more photos and “Y” if you want to. (Take the values of the image only for example)

```
Please enter the URI of a photo for the property (1):
https://i.maxwork.pt/l-view/listings/12490/6517860/f2e4aaca-c2d9-4736-8956-71387fed4c3c.jpg
Do you want to add more photos? (Y/N):
N
```

Image 16 - URI of the Photos

- **Address:** In this section you will select the desired state, district, and city, according to the address of the property. You should also type the zip code (This zip code must have 5 digits) and the street name. (Take the values of the image only for example)

```
1 - Alabama AL
2 - Arizona AZ
Select a State:
1
1 - Jefferson
Select a District:
1
1 - Hoover
2 - Mulga
3 - Clay
4 - Cardiff
Select a City:
1
Zip Code:
12345
Street:
Example Street
```

Image 17 - Address

- **Bathrooms, Bedrooms and Parking Spaces:** In this section you must type the number of bathrooms, bedrooms, and parking spaces. (This option is only available to apartments and houses. Please take the values of the image only for example.)

```
Number Of Bathrooms:
2
Number Of Bedrooms:
3
Parking Spaces:
2
```

Image 18 - Bathrooms, Bedrooms and Parking Spaces

- **Available Equipment:** In this section you must select the desired option of available equipment, if it doesn't appear as one of the options, you select "Other", by typing "4" and then you should type the name of the equipment you desire. (This option is only available for houses and apartments. Please take the values of the image only for example.)

```
1 - Air Conditioning
2 - Central Heating
3 - None
4 - Other
Select a Available Equipment:
4
Write the Other available equipment:
Example Available Equipment
```

Image 19 - Available Equipment

- **Basement, Inhabitable Loft and Sun Exposure:** In this category you should type "Y" if the house has a basement and an inhabitable loft, or "N" if it doesn't. As for the sun exposure, you must type either "South", "North", "East" or "West" based on the direction of the sunlight. (This option is only available for houses. Please take the values of the image only for example.)

```
Basement (Y/N):
N
Inhabitable Loft (Y/N):
Y
Sun Exposure:
South
```

Image 20 - Basement, Inhabitable Loft and Sun Exposure

- **Commission:** You must select a commission percentage by typing the number of the corresponding commission.

```
1 - 50.0
2 - 20.0
3 - 10.5
4 - 23.7
Select a Comission:
```

Image 21 - Commission

When you complete all the steps the ad should be shown in the console as it follows:

```
Date: Wed Jun 14 14:00:29 WEST 2023

Responsible Agent:
Name: Miguel
Email: agent@this.app
Phone Number: 1234567890

Client:
Name: Owner
Email: owner@this.app
Phone Number: 1234567891

Property ID: 0
Type Of Business: Buy
Property Type: House
Comission Selected: 50.0
Price: 190000.0
Area: 150
Distance From The City Center: 300
Photos: [[https://i.maxwork.pt/l-view/listings/12490/6517860/f2e4aaca-c2d9-4736-8956-71387fed4c3c.jpg]]
Address: Example Street, Hoover, Jefferson, Alabama AL, 12345
Number Of Bedrooms: 3
Number Of Bathrooms: 2
Parking Spaces: 2
Available Equipment: Example Available Equipment
Basement: N
Inhabitable Loft: Y
Sun Exposure: South
```

Image 22 - Publish Announcement Example

In addition, a message will be sent to the "Owner" to notify that the property has been published in the application.

```
Dear client Owner,

Your property located in Example Street, Hoover, Jefferson, Alabama AL, 12345 has
been published on our website since Wed Jun 14 14:00:29 WEST 2023.

The agent Miguel with phone number 1234567890 will be responsible for your
announcement.
If you have any doubts do not hesitate in contact us.

Best regards,
Real Estate USA
```

Image 23 - Publish Announcement Message

Publish Announcement Request | Agent

After you log in as an Agent, the menu should appear like it was stated previously. To publish an announcement request you must select the option “Publish Announcement Request” by typing the number “2” on your keyboard and you will be redirect to a console-line interface.

This functionality allows the agent to publish an advertisement in the application. To do that, you must meet the following requirements:

- **Announcement Request:** In this section you should select the desired announcement request to publish by typing the respective number.

```
Publish Announcement Request:
1 - Date:Wed Jun 14 14:08:24 WEST 2023
Type of business:Buy
Property Type:House
Price:10111.0
Area: 1
Distance From The City Center: 1
Photos: [https://i.maxwork.pt/l-view/listings/12490/6517860/f2e4aaca-c2d9-4736-8956-71387fed4c3c.jpg]
Address: Steet Example, Hoover, Jefferson, Alabama AL, 12345
Number Of Bedrooms: 3
Number Of Bathrooms: 2
Parking Spaces: 2
Available Equipment: Example Available Equipment
Basement: Y
Inhabitable Loft: Y
Sun Exposure: South


Select a Announcement Request:
```

Image 24 - Select Announcement Request

- **Accept or Reject:** In this division, you must type “A” if you want to “Accept” the announcement request or “N” if you want to reject it.

```
Do you want to reject or accept this announcement (A-Accept/R-Reject):
```

Image 25 - Accept or Reject

- **Commission:** Please check the “Publish Announcement | Agent” chapter in the commission unit.

When you complete all the steps, the following message should be shown in the console.

```
The ad was published successfully!!!
```

Image 26 - Publish Announcement Request Example

In addition, a message will be sent to the "Owner" to notify that the property has been published in the application. If the announcement request is declined by the responsible agent, a .txt file will be generated automatically stating the reason on why the announcement request was rejected like the following example:

```
--------------------------------------------------------------------------------
From: agent@this.app
For:client@this.app
---------- Your Announcement Request was declined -----

Date:Sun Jun 18 16:41:35 WEST 2023
Type of business:Buy
Property Type:Land
Price:1.0
Area: 1
Distance From The City Center: 1
Photos: [n]
Address: awdadw, Hoover, Jefferson, Alabama AL, 12345



The following Announcement Request was rejected by the following reason/s:
example text

Best regards,
--------------------------------------------------------------------------------
```

Image 27 - Reject Announcement Request

See List Of Offers | Agent

After you log in as an Agent, the menu should appear like it was stated previously. To display the list of offers you must select the option “See List Of Offers” by typing “3” on your keyboard and you will be redirect to a console-line interface.

This functionality allows the agent to see all offers made to a specific property. To do that, you must meet the following requirements:

- **Choose an Announcement and type an Offer:** After you choose this feature, the list of announcements will be shown and underneath it will be the list of offers associated to that announcement. (Please take the values of the image only for example.)

```
8. Date: Wed Jun 14 14:00:29 WEST 2023

Responsible Agent:
Name: Miguel
Email: agent@this.app
Phone Number: 1234567890

Client:
Name: Owner
Email: owner@this.app
Phone Number: 1234567891

Property ID: 0
Type Of Business: Buy
Property Type: House
Comission Selected: 50.0
Price: 190000.0
Area: 150
Distance From The City Center: 300
Photos: [[https://i.maxwork.pt/l-view/listings/12490/6517860/f2e4aaca-c2d9-4736-8956-71387fed4c3c.jpg]]
Address: Example Street, Hoover, Jefferson, Alabama AL, 12345
Number Of Bedrooms: 3
Number Of Bathrooms: 2
Parking Spaces: 2
Available Equipment: Example Available Equipment
Basement: N
Inhabitable Loft: Y
Sun Exposure: South


    1. Offer: The client Example Name, has submitted an offer with the following price: 9102.0.
```

Image 28 - Announcement and Offer Example (pt.1)

```
List of Offers:
1. Date: Sun Jun 25 00:00:00 WEST 2023

Responsible Agent:
Name: Ruben
Email: agentó@hotmail.app
Phone Number: 1765432345

Client:
Name: Luna
Email: luna@hotmail.com
Phone Number: 1987654321

Property ID: 6
Type Of Business: Sale
Property Type: Land
Comission Selected: 25.0
Price: 135000.0
Area: 21373
Distance From The City Center: 212334
Photos: [https://i.maxwork.pt/l-view/listings/12291/6528121/5d6cf1e
Address: 199 W 45th St, New York, Manhattan, New York, 10036
Number Of Bedrooms: 1
Number Of Bathrooms: 123
Parking Spaces: 123
Available Equipment: None


    No offers for this announcement
```

Image 29 - Announcement and Offer Example (pt.2)

After that, you must choose an announcement and type the respective number. Following that, the agent should type the number of the offer of his liking. If the message “No offers for this announcement” appears is because no customer has sent an offer for that announcement. (Please take the values of the image only for example.)

```
Choose an announcement:
8

Choose an offer:
1
```

Image 30 - Choose an Announcement and an Offer

Accept or Decline: If you want to “Accept” the offer you type “1”, to “Decline” type “2” and to “Cancel” type “0”.

```
1. Accept
2. Decline
0. Cancel
```

Image 31 - Accept or Decline

When you complete all the steps, the following message should be shown in the console.

```
File created: EmailNotification - client@this.app.txt
Successfully wrote to the file.
```

Image 32 - Success Message Email Notification (Offer)

If you accepted the offer, the following email will be sent to the client that posted the offer. (Please take the values of the image only for example.)

```
From: no-reply@this.app
To: client@this.app
Subject: Offer Decision Update.
Body: Dear Client,

Your offer for the property located in 3655 S Las Vegas Blvd,
Las Vegas, Paradise, Nevada, 892109 has been accepted.
Please contact us if you have any doubts.

Best regards,
Real Estate USA
```

Image 33 - Accepted Email (Offer)

If you rejected the offer, the following email will be sent to the client that posted the offer. (Please take the values of the image only for example.)

```
From: no-reply@this.app
To: client@this.app
Subject: Offer Decision Update.
Body: Dear Client,

Your offer for the property located in 3655 S Las Vegas Blvd,
Las Vegas, Paradise, Nevada, 892109 has been rejected.
Please contact us if you have any doubts.

Best regards,
Real Estate USA
```

Image 34 - Rejected Email (Offer)

See List Of Messages | Agent

After you log in as an Agent the menu should appear like it was stated previously. To display a list of messages you must select the option “See List Of Messages” by typing “4” on your keyboard and you will be redirect to a console-line interface.

Attention, if you want to change the sort algorithm used, you must go to the configuration file (“config.properties”) and change the “sortingAlgorithmClass” path:

- If you want with the bubble sort algorithm:

```
sortingAlgorithmClass =pt.ipp.isep.dei.esoft.project.domain.sortAlgorithms.BubbleSort
```

Image 35 - Bubble Sort

- If you want with the merge sort algorithm:

```
sortingAlgorithmClass =pt.ipp.isep.dei.esoft.project.domain.sortAlgorithms.MergeSort
```

Image 36 - Merge Sort

Different email services will also be available. To choose the desired service, you must go to the configuration file (“config.properties”) and change the “emailServices” path:

- If you want with the Gmail Service:

```
emailService = pt.ipp.isep.dei.esoft.project.domain.emailServices.GmailService
```

Image 37 - Gmail Service

- If you want with the Yahoo Service:

```
emailService = pt.ipp.isep.dei.esoft.project.domain.emailServices.YahooService
```

Image 38 - Yahoo Service

- If you want with the DEI Service:

```
emailService = pt.ipp.isep.dei.esoft.project.domain.emailServices.DEIService
```

Image 39 - DEI Service

- If you want with the Hotmail Service:

```
emailService = pt.ipp.isep.dei.esoft.project.domain.emailServices.HotmailService
```

Image 40 - Hotmail Service

This functionality allows the agent to see all the visit requests made to a specific property. To do that, you must meet the following requirements:

- **Enter the Begin and End date**: In this part you should type a time slot to see the list of messages made to the properties managed by him/her. The list of messages will appear in ascending order (from the from oldest message to newest message). (Please take the values of the image only for example.)

```
Enter the begin date (dd-MM-yyyy):
01-01-2023
Enter the end date (dd-MM-yyyy):
31-12-2023


Booking Requests for the specified period (sorted by date in ascending order):
```

Image 41 - Enter the Begin Date and End Date

- **Choose the Message:** After that you can choose the message that you want to respond to by typing the respective number.

```
Enter the message number to respond (0 to cancel):
```

Image 42 - Choose Message

- **Respond to a Message:** To respond to a message you should type “1” and then the client’s email. If you want to accept the visit request, type “1”, if not, type “2”. (Take the values of the image only for example)

```
1. Respond
2. Cancel
Enter your choice:
1
Enter client email:
exampleEmail@this.app

1. Accept
2. Deny
Enter your response:
```

Image 43 - Respond to a Message

In case you reject the message, a justification will be requested:

```
Reason for denying the visit request:
```

Image 44 - Reason of the Rejection

In the end, you should be able to see a successful message, as shown in the image below.

```
Email sent successfully.
```

Image 45 - Respond Message Email Success

The email that will be sent to the customer will have the following format:

- When you accepted the message:

```
From: no-reply@this.app
To: exampleEmail@this.app
Subject: Your Visit Booking Request Has Been Accepted
Body: Dear Customer,

Thank you for your interest in the property listed with ID: 1 and located at: 3655 S Las Vegas Blvd, Las Vegas, Paradise, Nevada, 892109.

You had requested a visit for the date: Tue Jun 20 00:00:00 WEST 2023,  starting at: 11 and ending at: 12.

We are pleased to inform you that your booking request has been accepted. You will be greeted by our agent Miguel.
In case of any changes or queries, you may contact the agent at the following number: 1234567890.

We look forward to welcoming you for the visit.

Best Regards,
Miguel
```

Image 46 - Email Example (Accepted)

- When you rejected the message:

```
From: no-reply@this.app
To: Example@this.app
Subject: Your Visit Booking Request Has Been Rejected
Body: Dear Customer,

Thank you for your interest in the property listed with ID: 1 and located at: 3655 S Las Vegas Blvd, Las Vegas, Paradise, Nevada, 892109.

You had requested a visit for the date: Tue Jun 20 00:00:00 WEST 2023, starting at: 11 and ending at: 12.

We regret to inform you that your booking request has been rejected for the following reason:

The property is no longer for sale in our application.

If you have any doubts and need help, you may contact the agent Miguel at the following number: 1234567890.

Thank you for your understanding.

Best Regards,
Miguel
```

Image 47 - Email Example (Rejection)

Admin Menu

The Admin Menu is only accessed by registered Admins and has the following options. You need to be logged in as a System Administrator to have these functionalities:

- **Register a Store:** Functionality that allows the system administrator to register a store on the application.

- **Register an Employee:** Functionality that allows the system administrator to register a employee on the application and give the employee the login credentials to use the application.

- **Read information from a csv. File:** Functionality that enables the system administrator to register all the legacy information of an excel file to save all the information on the application.

```
Admin Menu:
1. Register a Store
2. Register an Employee
3. Read informations from a csv.file

0 - Cancel

Type your option:
```

Image 48 - Admin Menu

Register A Store | Admin

After you log in as a System Administrator, the menu should appear like it was stated previously, so to register a store you must select the option “Register a Store” by typing the number “1” on your keyboard and you will be redirect to a console-line interface.

This functionality allows the System Administrator to register any store. To do that, you must meet the following requirements:

- **ID, Designation and Contacts**: In this part you should type the number ID that you want the store to have and the respective designation. After this you also must insert the store email and phone number (Remember that the email should have a “@” and a “.” and that the phone number should have 10 digits. Please take the values of the image only for example).

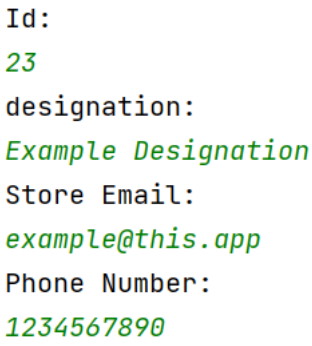


Image 49 - ID, Designation and Contacts

- **Address:** Please check the “Publish Announcement | Agent” chapter in the address unit. After this, you should see a success message followed by the store characteristics:

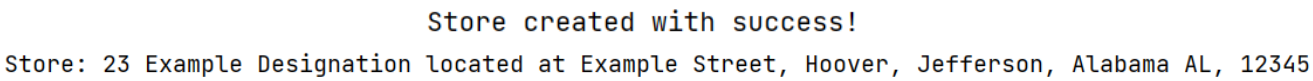


Image 50 - Store Message Success

Register An Employee | Admin

After you log in as a System Administrator, the menu should appear like it was stated previously. To register an employee, you have to select the option “Register an Employee” by typing “2” on your keyboard and you will be redirect to a console-line interface.

This functionality allows the System Administrator to register any employee. To do that, you must meet the following requirements:

- **Select Role:** In this command-line interface, you will be presented with a list of roles available for registration of your employee. The roles specified for this Real Estate Application are "Admin," "Agent," "Store Manager," and "Store Manager".

```
Employee
1 - Admin
2 - Agent
3 - Store Manager
4 - Store Network Manager
Select a role:
```

Image 51 - Select Role

It also has the option that enables you to register your employee with more than one role:

```
Do you want to add more Roles (Y/N):
Y
1-Admin
3-Store Manager
4-Store Network Manager
Select a role:
```

Image 52 - Select 1 Role or more

- **Select a Store:** After you choose all the roles that you want from the ones that are available, a store list will be displayed for you to choose where the employee will be working at:

```
1 - Holloway ID:10234
2 - Maltip ID:104224
3 - Elvis ID:224
Select a Store:
```

Image 53 - Select a Store

- **Address:** Please check the “Publish Announcement | Agent” chapter in the address unit.

- **Employee Personal Information:** To conclude, to register an employee you should fill in the “Name” of the employee, the “Employee Email” (Should follow the email format (e.g. example@example.com)), the “Phone Number” (Should have 10 digits), the “Passport Number” (Should have 9 digits) and the "Tax Number” (Should have 9 digits). (Take the values of the image only for example).

```
Name:
Example Name
Employee Email: ExampleEmail@this.app
Phone Number:
1234567890
Passport Number:
123456789
Tax Number:
123456789
```

Image 54 - Employee Personal Information

In the end, the Admin must be able to see all employee personal information with the respective roles and the store that he will work at.

```
--------Employee---------
Name:Example Name
Roles:[Agent, Store Manager]
Address: Street Example,Hoover,Jefferson,Alabama AL,12345
Store:104224
Tax Number: 123456789
Passport Number: 123456789
Phone Number: 1234567890
Employee Email: ExampleEmail@this.app
--------Confirm-----------
Do you want to register this employee:(Y/N)
Y
Employee successfully created!
```

Image 55 - Register Employee Example

After the admin registers the employee successfully, a .txt file with the

credentials for the new employee to use the application, like the following example:

```
---------------------------------------------------------------------------
From :admin@this.app
To :ExampleEmail@this.app

Email: ExampleEmail@this.app
Password: T2zc9HM
---------------------------------------------------------------------------
```

Image 56 - Credentials Email

Read Information From A Csv File | Admin

After you log in as a System Administrator, the menu should appear like it was stated previously. To import a CVS file, you must select the option “Read Information From a CVS File” by typing “3” on your keyboard and you will be redirect to a console-line interface.

This functionality allows the System Administrator to read a CVS file into the application. To do that, you must meet the following requirements:

- Choose CSV File: In the application we can read 2 types of files. To read the “legacyRealStateUSAMoodle.csv” type “1”, and to read the “legacyRealStateUSAMoodle_MATCP_MDISC.csv”, type “2”. After that you should see a success message. (Take the values of the image only for example).

```
Choose a csv file to read:

1. legacyRealStateUSAMoodle.csv
2. legacyRealStateUSAMoodle_MATCP_MDISC.csv

Option: 1
The file was read with sucess
```

Image 57 - Choose CSV File

Once the file has been successfully read, all the information contained within it will be accessible within the application, ensuring that all users have access to the updated data.

Client Menu

The Client Menu is only accessed by registered Clients, and has the following options:

- **Send message to an agent:** It's a functionality that facilitates the client to send a visit request to a property. After filling in all required fields, the agent responsible for that property will be notified.
- **Inbox:** It's a functionality that allows the client to see the agent's response to the visit appointment request and confirm the appointment if accepted by the agent.
- **Request Announcement:** It's a functionality that enhances the client experience, by sending a request to publish an announcement to an agent.
- **Place an Order:** It's a functionality that helps the client to send an offer to a publish announcement to the agent, after filling in all required fields.

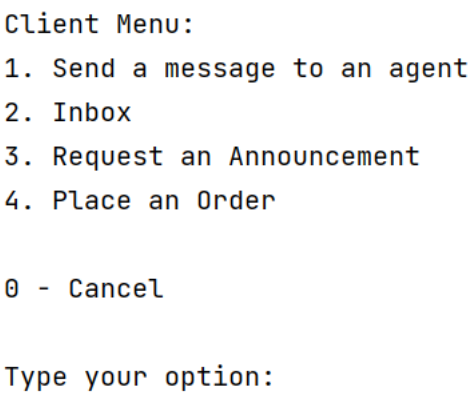


Image 58 - Client Menu

Send A Message To An Agent | Client

After you login as a Client, the menu should appear like it was stated previously. To send a visit request you must select the option "Send Message to An Agent" by typing "1" on your keyboard and you will be redirect to a console-line interface.

This functionality allows the client to send a visit request to the agent in the application. To do that, you must meet the following requirements:

- **Select Property:** Please check the “Place An Order | Client” chapter in the select property unit.

- **Message description, Name and Phone Number:** In this section you can type a simple message to the agent, with any additional information, the “Name” and “Phone Number”. Remember that the phone number should have 10 digits. (Take the values of the image only for example).

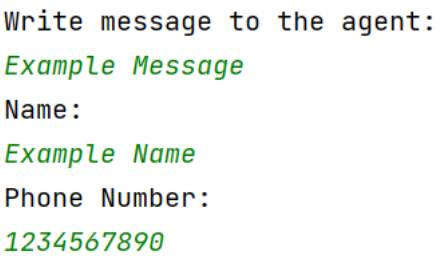


Image 59 - Message Description, Name and Phone Number

- **Date and Time for visit:** In this part you should type a date, an initial time, and an end time for visit. Pay attention to the date, because the date should be in this format “dd-MM-yyyy” and you can’t type a data from a day that already passed, only future events. For the initial time, you select from a 24-hour cycle and for the end time it needs to be at least an hour after what the client has asked for the initial time to be. Be careful, because if a visit is already scheduled for the same time, the application will ask you for another time at your choice. (Please take the values of the image only for example)

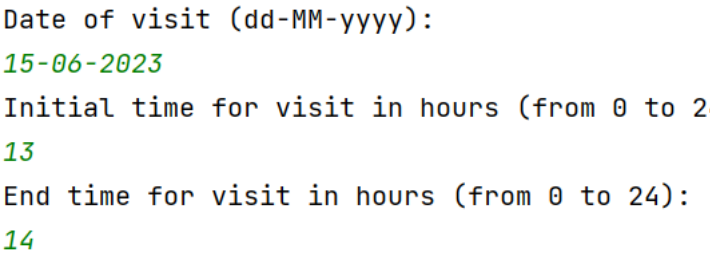
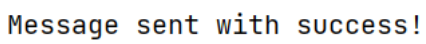


Image 60 - Date and Time of the visit

In the end, you must be able to see a success message as shown in the image.



Inbox | Client

Image 61 - Success message for a Visit Request

After you log in as a Client, the menu should appear like it was stated previously. To send a visit request you must select the option “Inbox” by typing “2” on your keyboard and you will be redirected to a console-line interface.

This functionality allows the client to see the response given by the agent as well as the information about the property. To do that, you must meet the following requirements:

- **Select Message:** In this section you can select a message from the list of messages displayed on the screen by typing the respective number. The message displays information such as the name of the agent who responded and the subject of the message. (Take the values of the image only for example).

```
1. Message From: Jorge Subject: Your Visit Booking Request Has Been Accepted

Select a message to open:
```

Image 62 - Select Message

- After selecting a message, the contents of it will be displayed and an email will be automatically sent to the responsible agent notifying him that the message was opened.

```
Message:
The client Rafael, with phone number 1425432897, wants to schedule a visit from 14 until 15 at 24-06-2023.

Description:
Podemos já fazer negócio?

Property:
Date: Sat Jun 24 00:00:00 WEST 2023

Responsible Agent:
Name: Jorge
Email: agent5@gmail.com
Phone Number: 1345678901

Client:
Name: Rafael
Email: rafael@gmail.com
Phone Number: 1425432897

Type Of Business: Sale
Property Type: House
Comission Selected: 10.0
Price: 200000.0
Area: 274
Distance From The City Center: 2576
Photos: [https://i.maxwork.pt/l-view/listings/12325/6516582/f608e960-5797-4a79-8232-8b46739fb035.jpg, https://
i.maxwork.pt/l-view/listings/12325/6516582/582185b1-40df-42b2-acbb-1fea14d37576.jpg]
Address: 3655 S Las Vegas Blvd, Las Vegas, Paradise, Nevada, 892109
```

Image 63 - Message Description

```
From: no-reply@this.app
To: Example@this.app
Subject: Your message has been opened
Body:
Your message for the client Vasco has been opened!

Visit Details:
Located at: 199 W 45th St, New York, Manhattan, New York, 10036
Date of visit: Fri Jun 23 00:00:00 WEST 2023
Starting time at 9 and ending at 10
Client Name: Vasco

This is an automatically generated email. Please do not reply
```

Image 64 - Email Notification to Agent

- If the agent declines the appointment, you will be redirected back to the client's menu since you can only respond back to an accepted appointment.

- **Respond to a Message**: To respond, type “1”. If you do not wish to respond, type “0”, once you press enter the email of the agent you’ve requested an appointment will be automatically selected and displayed. For accepting a visit request, enter "1", otherwise, enter "2". (Take the values of the image only for example)

```
Do you wish to respond?
1. Yes
0. No
1
Responding to: agent5@gmail.com

Do you wish to accept or deny the appointment?
1. Accept
2. Deny
```

Image 65 - Respond to a Message

- In case you deny the appointment request, a justification will be requested:

```
Reason for denying the visit request:
```

Image 66 - Deny the Appointment Request

- When you accept the message:

```
From: no-reply@this.app
To: Example@this.app
Subject: Your Booked Visit Has Been Confirmed
Body: Dear Agent,
Your Booked Visit has been confirmed

Visit Details:
Located at: 3655 S Las Vegas Blvd, Las Vegas, Paradise, Nevada, 892109
Date of visit: Sat Jun 24 00:00:00 WEST 2023
Starting time at 14 and ending at 15
Client Name: Rafael

Best Regards,
Rafael
```

Image 67 - Email (Accepted Appointment)

- When you reject the message:

```
From: no-reply@this.app
To: Example@this.app
Subject: Your Booked Visit Has Been Rejected
Body: Dear Agent,
I am unable to attend the scheduled property visit that was planned.
Reason:

Visit Details:

Located at: 3655 S Las Vegas Blvd, Las Vegas, Paradise, Nevada, 892109
Date of visit: Sat Jun 24 00:00:00 WEST 2023
Starting time at 14 and ending at 15
Client Name: Rafael

Best Regards,
Rafael
```

Image 68 - Email (Reject Appointment)

In the end, you should be able to see a successful message, as shown in the image below.

```
Email sent successfully.
```

Image 69 - Email Success Message

Request An Announcement | Client

After you log in as a Client, the menu should appear like it was stated previously. To send an announcement request you must select the option “Request an Announcement” by typing “3” on your keyboard and you will be redirected to a console-line interface.

This functionality allows the client to send an announcement request to an agent. To do that, you must meet almost all the same steps as the agent to publish an announcement in the application (Please go to “Publish Announcement | Agent” section), but you can select the agent that will publish his advertisement in the application. Therefore, the customer must insert the number corresponding to the agent you want to.

```
1 - Miguel resident in 3655 S Las Vegas Blvd, Las Vegas, Paradise, Nevada, 892109 that
Employee of Store: 10234 Holloway located at 3655 S Las Vegas Blvd, Las Vegas, Paradis
2 - Vasco  resident in 199 W 45th St, New York, Manhattan, New York, 10036 that posses
Employee of Store: 10234 Holloway located at 3655 S Las Vegas Blvd, Las Vegas, Paradis
3 - Manuel resident in 9641 Sunset Blvd, Los Angeles, Beverly Hills, California, 90210
Employee of Store: 104224 Maltip located at 199 W 45th St, New York, Manhattan, New Yo
4 - Pedro resident in 199 W 45th St, New York, Manhattan, New York, 10036 that possess
Employee of Store: 224 Elvis located at 9641 Sunset Blvd, Los Angeles, Beverly Hills,
5 - Jorge resident in 9641 Sunset Blvd, Los Angeles, Beverly Hills, California, 90210
Employee of Store: 104224 Maltip located at 199 W 45th St, New York, Manhattan, New Yo
6 - Ruben resident in 3655 S Las Vegas Blvd, Las Vegas, Paradise, Nevada, 892109 that
Employee of Store: 104224 Maltip located at 199 W 45th St, New York, Manhattan, New Yo
Select an Agent:
```

Image 70 - Choose Agent

In the end, you must be able to see your Announcement Request like in the example. (Please take the values of the image only for example.)

```
Date:Wed Jun 14 14:08:24 WEST 2023
Type of business:Buy
Property Type:House
Price:10111.0
Area: 1
Distance From The City Center: 1
Photos: [https://i.maxwork.pt/l-view/listings/12490/6517860/f2e4aaca-c2d9-4736-8956-71387fed4c3c.jpg]
Address: Steet Example, Hoover, Jefferson, Alabama AL, 12345
Number Of Bedrooms: 3
Number Of Bathrooms: 2
Parking Spaces: 2
Available Equipment: Example Available Equipment
Basement: Y
Inhabitable Loft: Y
Sun Exposure: South
```

Image 71 - Announcement Request Example

Place An Order | Client

After you log in as a Client, the menu should appear like it was stated previously. To send an offer you must select the option “Place an Order” by typing “4” on your keyboard and you will be redirected to a console-line interface.

This functionality allows the client to place an order in the application. To do that, you must meet the following requirements:

- **Select a Property:** In this section, you must analyze the list of properties and type the corresponding number.

```
Choose one of the properties above.
```

Image 72 - Select Property

- **Offer Amount and Name:** In this part, you must type the offer amount in dollars and type your name. (Please take the values of the image only for example)

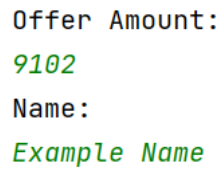


Image 73 - Offer Amount and Name

In the end, you must be able to see a message of success.

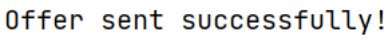


Image 74 - Offer Success Message

Network Manager Menu

The Network Manager is only accessed by the Network Manager, and has these options:

```
Network Manager Menu:

1. See all employees working in every store
2. Generate Deal Analyses
3. See deals made

0 - Cancel
```

Image 75 - Network Manager Menu

See All Employees Working In Every Store | Network Manager

After you log in as a Network Manager, the menu should appear like it was stated previously. To display the employees list you must select the option “See all employees working in every store” by typing “1” on your keyboard and you will be redirected to a console-line interface.

This functionality allows the Network Manager to see all employees in every store in the application. To do that, you must meet the following requirements:

```
List of Employees:

1 . Name of the store: Holloway Id: 10234 Number of properties: 3

    1 . Name: Miguel Passport: 123456789 Tax: 987654321 Phone Number: 1234567890 Address: 3655 S Las Vegas Blvd, Las Vegas, Paradise, Nevada, 892109 Roles: [Agent]

    2 . Name: Vasco  Passport: 12345677 Tax: 12231311 Phone Number: 1123456789 Address: 199 W 45th St, New York, Manhattan, New York, 10036 Roles: [Agent]

2 . Name of the store: Maltip Id: 104224 Number of properties: 2

    1 . Name: Jorge Passport: 123456321 Tax: 17634589 Phone Number: 1345678901 Address: 9641 Sunset Blvd, Los Angeles, Beverly Hills, California, 90210 Roles: [Agent]

    2 . Name: Manuel Passport: 123456432 Tax: 123456789 Phone Number: 1234567892 Address: 9641 Sunset Blvd, Los Angeles, Beverly Hills, California, 90210 Roles: [Agent]

    3 . Name: Ruben Passport: 12345687 Tax: 192837465 Phone Number: 1765432345 Address: 3655 S Las Vegas Blvd, Las Vegas, Paradise, Nevada, 892109 Roles: [Agent]

3 . Name of the store: Elvis Id: 224 Number of properties: 1

    1 . Name: Pedro Passport: 12345123 Tax: 124356789 Phone Number: 1643267806 Address: 199 W 45th St, New York, Manhattan, New York, 10036 Roles: [Agent]
```

Image 76 - Employees working in Every Store

See Deals Made | Network Manager

After you log in as a Network Manager, the menu should appear like it was stated previously. To the list of deals made you must select the option “See Deals Made” by typing “3” on your keyboard and you will be redirect to a console-line interface. This functionality allows the Network Manager to see all the deals made in the application.
Firstly, it will ask for you to insert the algorithm that you want sort the list of deals made, and it will be three options: **1 - Bubble Sort Algorithm, 2 - Sort Selection Algorithm and 0 – Cancel**. Then it will be displayed the order that you want to see this list, **Ascending or Descending** and a third option that enables you to choose no one of the criteria **0 - Cancel**.If you don’t select any of the algorithms or any of the orders the list will be displayed from the most recent to the oldest.

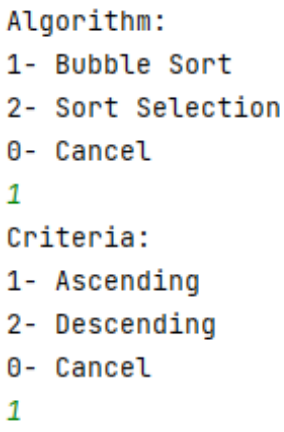


Image 77 - Select Options

Once you choose all the options it will be displayed all the deals made registered on the application with this format:

```
2 -
Offer:
The client Offer122, which has the following email: clienti@realstateUS.com, has submitted an offer with the following price: 98595.0.
Status: ACCEPTED

Property:
Date: Wed Jan 24 00:00:00 WET 2001

Responsible Agent:
Name: Denver Agent7
Email: Denveragent@realstateUS.com
Phone Number: 7016991508

Client:
Name: AmeliaLONGMUIR
Email: AmeliaLONGMUIR2155@hotmail.com
Phone Number: 9074881516

Type Of Business: sale
Property Type: house
Price: 3850.0
Area: 0
Distance From The City Center: 1152
Address: 1836WazeeStreet, Denver, CO, 80202
Number Of Bedrooms: 2
Number Of Bathrooms: 2
Parking Spaces: 0
Available Equipment: Y
Basement: N
Inhabitable Loft: N
Sun Exposure: S
```

Image 78 - Display Deals Made

Store Manager Menu

The Store Manager Menu is only accessed by the Store Manager, and has the following options:

```
Store Manager Menu:
1. Generate Deal Analyses

0 - Cancel
```

Image 79 - Store Manager Menu

Generate Deal Analyses | Store Manager

After you log in as a Network Manager, the menu should appear like it was stated previously. To display the employees list you must select the option “See all employees working in every store” by typing “2” on your keyboard and you will be redirect to a console-line interface.

This functionality allows the Network Manager to get a report with different parameters such as: property values/prices (sale prices and forecast prices), the regression model used to estimate each value, R(SLR), R2 and R2 adjusted for SLR and MLR, confidence intervals and hypothesis tests for regression coefficients and significance model with ANOVA. It should also give a prediction price for a property that the manager wants to know about. To do that, you must meet the following requirements:

- **Select the type of regression:** In this section, you must choose between a simple linear regression and multilinear regression.

```
Deal Analysis:

Which regression model do you wish to use?

1. Multi-Linear Regression
2. Simple Linear Regression
0. Cancel
```

Image 80 - Select the Type of Regression

- **Define the values for the parameter [Multilinear]:** In this section, you must define the values for the parameters requested to make the regression.

```
Choose the value for the area you wish to predict:

Choose the value for the distance from city center you wish to predict:

Choose the value for the number of bedrooms you wish to predict:

Choose the value for the number of bathrooms you wish to predict:

Choose the value for the number of parking spaces you wish to predict:
```

Image 81 - Values of the parameters (Multilinear)

- **Choose the parameter that you want to use [Simple Linear]:** In this section, you must select the parameter that you want to use in the regression.

```
Choose which parameter you wish to use:

1. Area in m2

2. Distance from the city center

3. Number of Bedrooms

4. Number of Bathrooms

5. Number of Parking Spaces

0. Cancel
```

Image 82 - Select the value of the parameter (Simple Linear)

- **Define the value for the parameter [Simple Linear]:** In this section, you must define the value for the parameter you chose and that is requested to make the regression.

```
Choose the value for the parameter you wish to predict:
```

Image 83 - Value of the parameter (Simple Linear)

After all this steps you must be able to see an output like the one below:

```
Report: -----RegressionModel-----
n = 499
Sxx= 285,082
Syy= 7709791182,451
Sxy= 1032704,155
SE= 3968842062,444
SR= 3740949120,007
ST= 7709791182,451
avgX= 1,735
avgY= 9063,177
slope= 3622,479
intercept= 2776,47
R^2 = 0,485
R =0,697


 Equation -> y = 2776,47 + (3622,479)X +

||-=-=-=- Intercept Confidence Interval -=-=-=-||
 Intercept: 2776,47
 Intercept Standard Error: 316,812
 Intercept Confidence Interval (99.0) -> ] 1957,276; 3595,663[

||-=-=-=- Slope Confidence Interval -=-=-=-||
 Slope : 3622,479
 Slope Standard Error: 167,367
 Slope Confidence Interval (99.0) -> ] 3189,71; 4055,248[

||-=-=-=- Intercept Hypothesis Test -=-=-=-||
 s :2825,88
-=-=-=--=-=-=-
H0 : a = a0
H1 : a != a0
-=-=-=--=-=-=-
 t = 8,764
 tc =2,586
|t| > tc
 -> H0 rejected

||-=-=-=- Slope Hypothesis Test -=-=-=-||
 s :2823,041
-=-=-=--=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=--=-=-=-
 t = 21,644
 tc =2,586
|t| > tc
 -> H0 rejected
||-=-=-=- Significance Model With ANOVA -=-=-=-||
 MSR:3740949120,007
 MSE:7985597,711
 F0 :468,462
 F de Snedecore : 6,686
-=-=-=--=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=--=-=-=-
F0 > F de Snedecor
H0 is rejected -> regression model is significant
Forecast | Sale
10021,428 | 4680
10021,428 | 7925
10021,428 | 6445
10021,428 | 9987,5
10021,428 | 9000
10021,428 | 10450
6398,949 | 4487,5
6398,949 | 3900
2776,47 | 6197,5
10021,428 | 10000
10021,428 | 8650
10021,428 | 5698,2
6398,949 | 4270
2776,47 | 3995
10021,428 | 6125
10021,428 | 9050
2776,47 | 4050
10021,428 | 10600
10021,428 | 5800
6398,949 | 5950
6398,949 | 4517,5
10021,428 | 5500
13643,907 | 27750
2776,47 | 5900
10021,428 | 8145
13643,907 | 8625
10021,428 | 10500
10021,428 | 6375
10021,428 | 9500
10021,428 | 9995
6398,949 | 5975
6398,949 | 6000
6398,949 | 5500
10021,428 | 14000
10021,428 | 10200
10021,428 | 10500
10021,428 | 9400
10021,428 | 8775
13643,907 | 4900
10021,428 | 12800
6398,949 | 8050
6398,949 | 5500
10021,428 | 13171,75
10021,428 | 7750
6398,949 | 3119,15
6398,949 | 9435
2776,47 | 6200
10021,428 | 8937
10021,428 | 8350
6398,949 | 7325
13643,907 | 12500
10021,428 | 9350
10021,428 | 10600
10021,428 | 9500
10021,428 | 7400
13643,907 | 22000
10021,428 | 12550
10021,428 | 6625
10021,428 | 10445
13643,907 | 19000
13643,907 | 14850
10021,428 | 4473,55
13643,907 | 16300
13643,907 | 18700
6398,949 | 7750
10021,428 | 8200
6398,949 | 6625
6398,949 | 7350
10021,428 | 7800
10021,428 | 8750
10021,428 | 8000
6398,949 | 4300
6398,949 | 5750
6398,949 | 6650
10021,428 | 8639,25
6398,949 | 7750
6398,949 | 4565
2776,47 | 1745
10021,428 | 21500
6398,949 | 9200
6398,949 | 6500
6398,949 | 6000
6398,949 | 5650
10021,428 | 11335
10021,428 | 7000

Prediction:

Prediction:6398,949
Confidence Interval (99.0%) : ]-922,332, 13720,229[
```

Image 84 - Output

Graphical interface

Main Menu (Graphical Interface)

In this section, you will be able to get the access of the functionalities of the application:

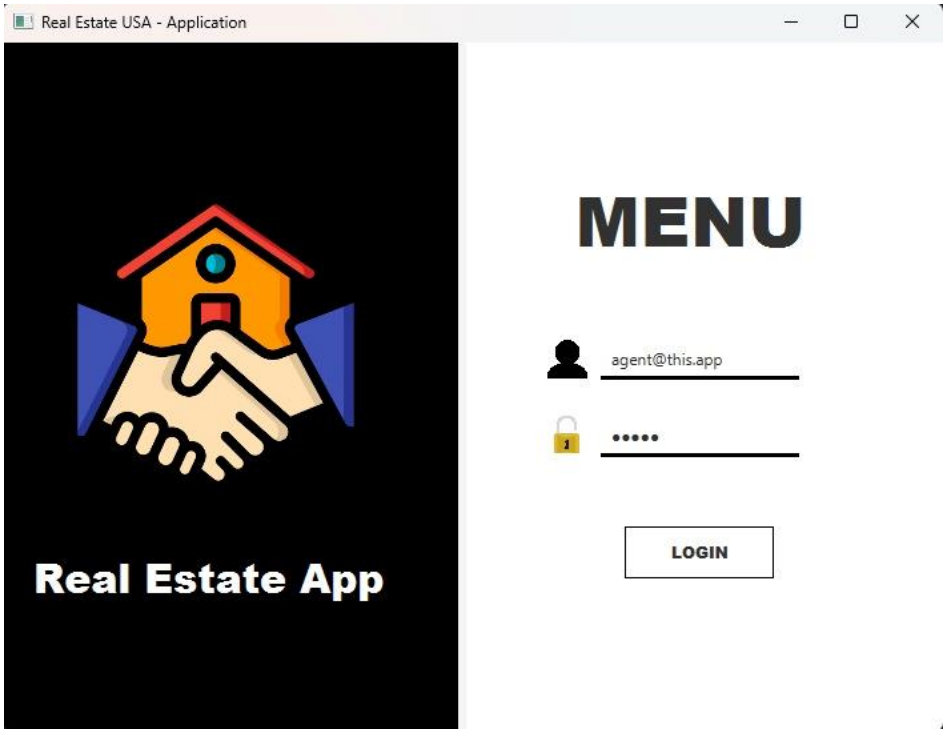


Image 85 - Interface Main Menu

- **Login:** Functionality that enables you to get access to other functionalities depending on what type of user you are such as: System Administrator, Agent, Client, Store Manager, Store Network Manager. To access other functionalities, you must type your email and your password in the respective spaces, as shown in the picture.

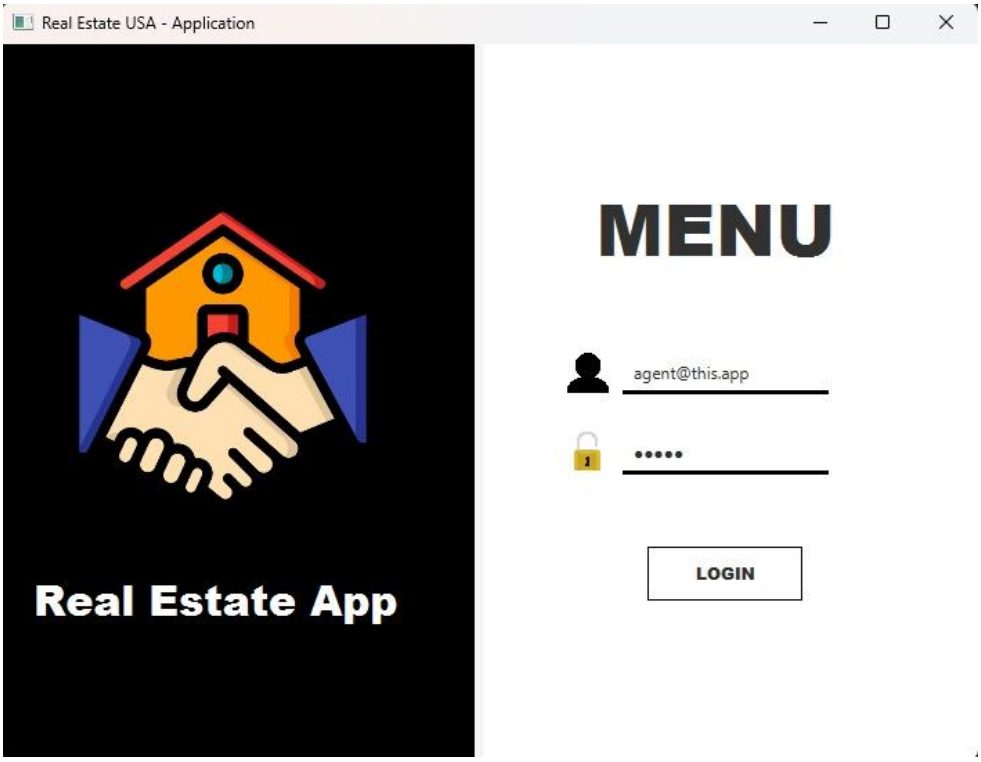


Image 86 - Interface Login

After that, you must press the "LOGIN" button to proceed. If the email or password is wrong, the following message will be displayed:

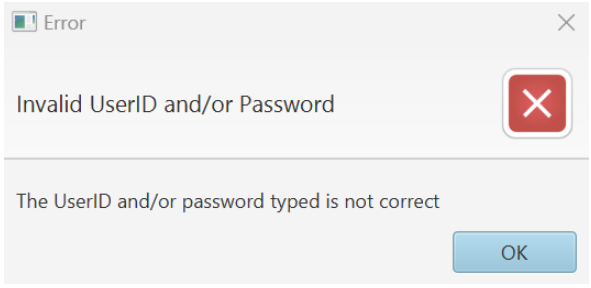


Image 87 - Interface Error Login

To resolve this, just click on the "x" in the error message and re-enter your login details. If you have any questions about the Login, please check the "**Password**" topic in the "Register | Unregistered User" chapter.

Agent Menu (Graphical Interface)

The Agent Menu is only accessed by registered agents, and has the following features as shown in the picture:

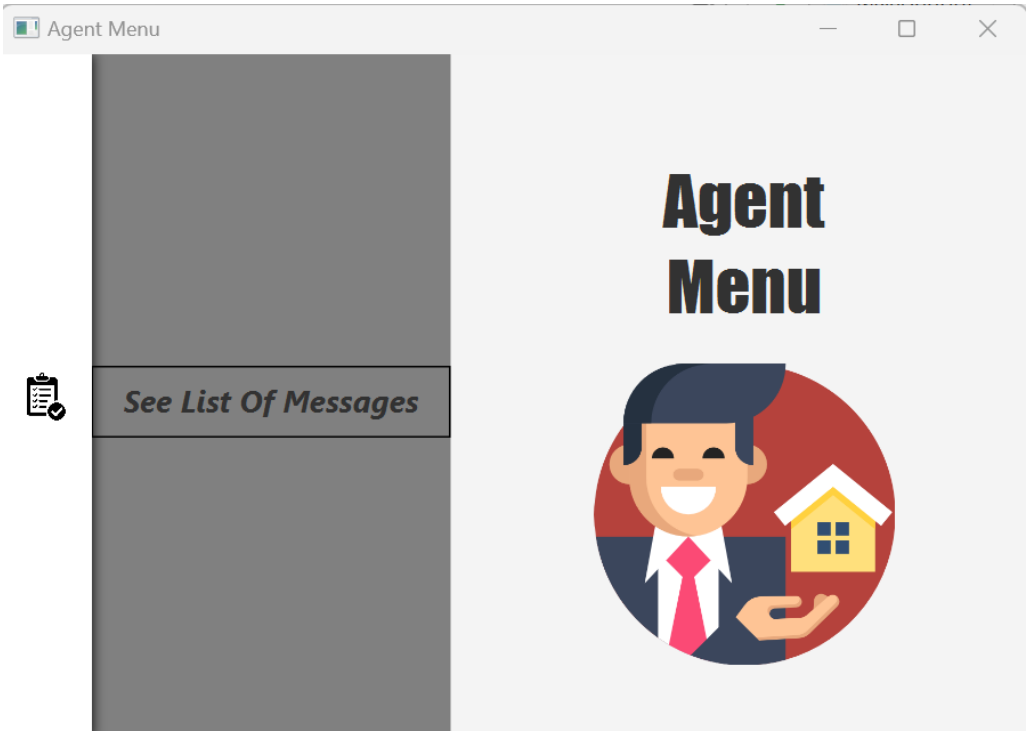


Image 88 - Interface Agent Menu

See List Of Messages: In this feature, the agent can list and respond to any visit requests made for him. To have access for this functionality you must click on top the “See List Of Messages”.

After clicking, the following window will open:

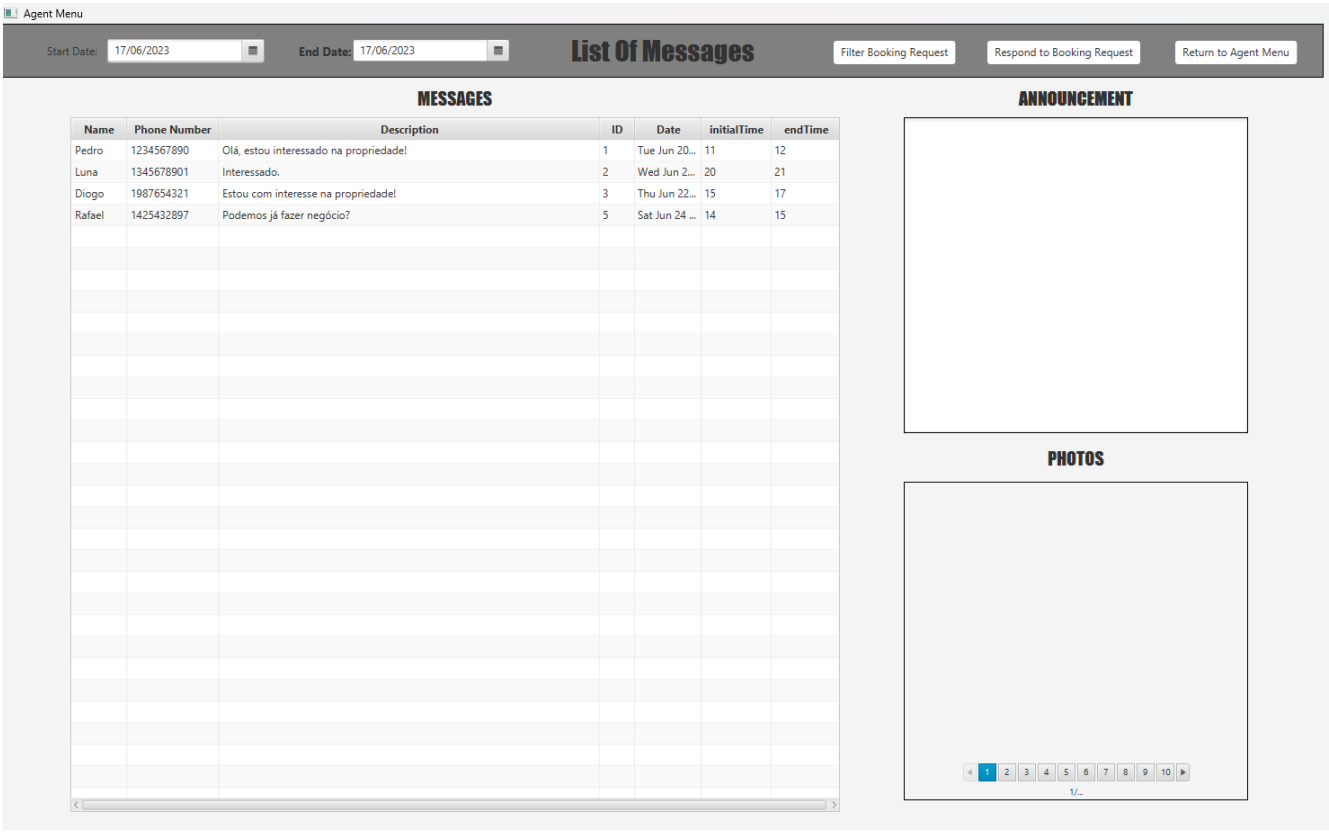


Image 89 - See List Of Messages Interface (pt.1)

To select the desired date, so that messages are filtered, click on the square after the date and choose the desired date:

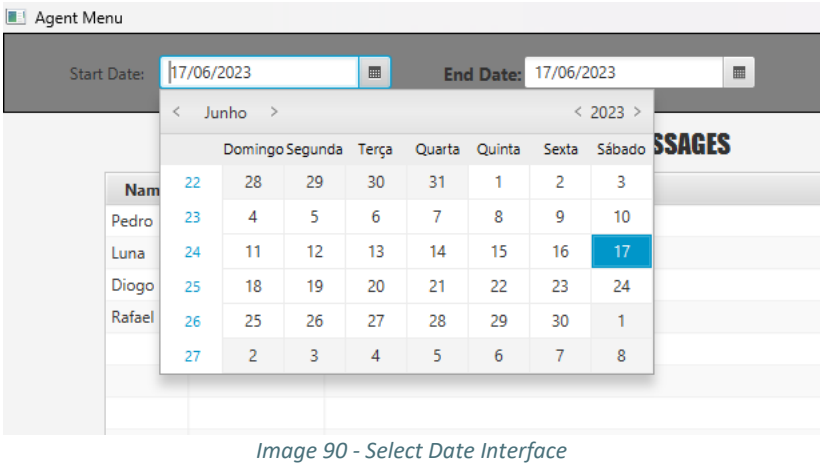


Image 90 - Select Date Interface

Do this for both the "Start Date" and the "End Date". To submit the dates, click on "Filter Booking Request" and all the messages corresponding to the interval you entered will be shown, in ascending order:

To select a booking request, double-click on the desired request and,

shortly afterwards, the description of the corresponding publish announcement will be shown on the right side:

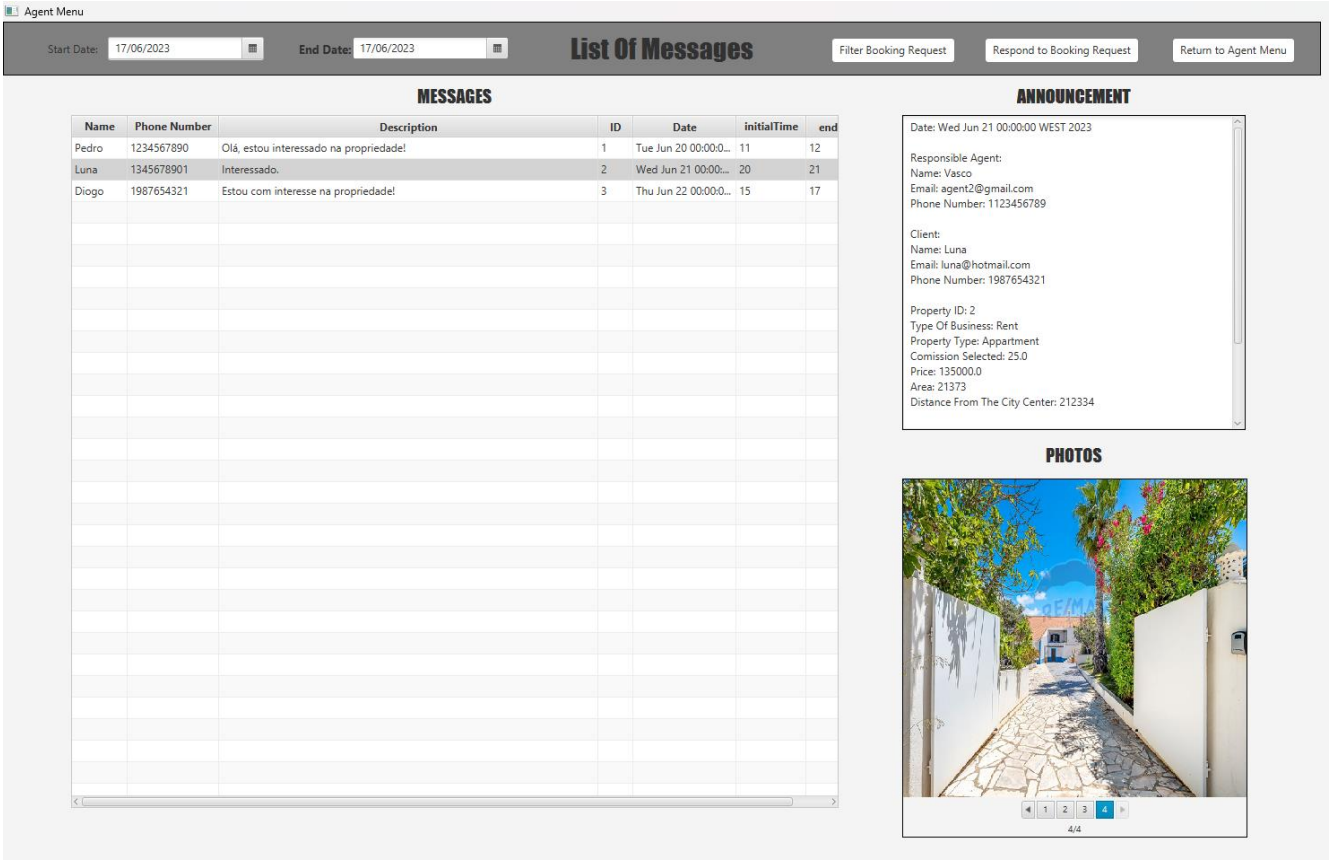


Image 91 - Select Booking Request Interface

If you would like to respond to the booking request you selected, please click on top of "Respond To Booking Request" button. After that a window will open.

If you want to accept the visit request, you must enter the client's email, press “Accept” and click on the “Submit” button:

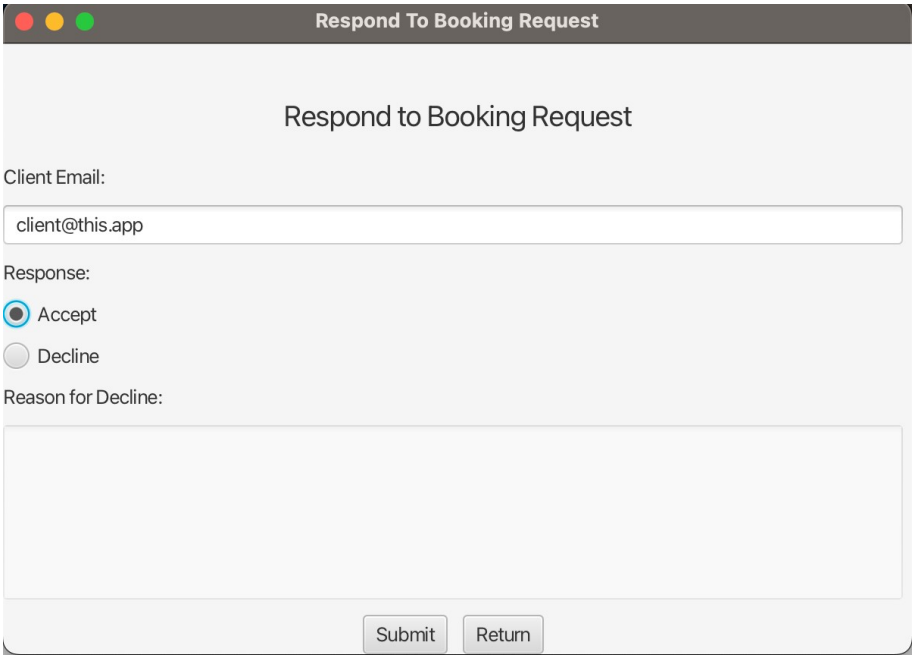


Image 92 - Accept Visit Request Interface

If you want to reject the visit request, enter the customer's email, select the "Reject" option, enter the reason for rejection and click on the "Submit" button:

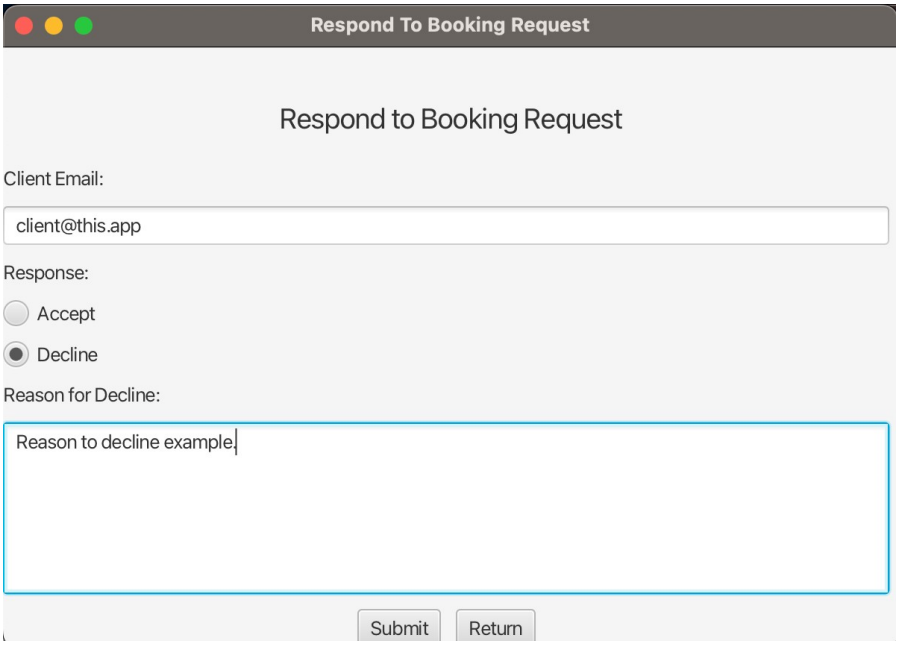


Image 93 - Reject Visit Request Interface

Network Manager Menu (Graphical Interface)

The Network Manager is only accessed by the Network Manager, and has the following features as shown in the picture:

Image 94 - Network Manager Menu Interface

- **List All Deals Made**: In this feature, the network manager can list all the deals made. To have access for this functionality you must click on top the “List all deals made”.

Once you have clicked on the button, you will be redirected to this page , where it will be displayed a table that contains the **ID** of the offer the **order amount** that the property was sold and **the client email of the buyer** of that property and firstly the offers are ordered **from the most recent to the oldest**:

Image 95 - Home Page List Deals Menu

At the top left corner there is a choice box for you to first choose the algorithm do you want to sort the list of offers by area, the algorithm that our development team implemented was the **Bubble Sort Algorithm and Sort Selection Algorithm**:

Image 96 - Select Algorithm

After you decide what the algorithm you will choose to sort the list of the deals made, you can also decide in what order do you want this list to be displayed at, and the options are **Ascending or Descending:**

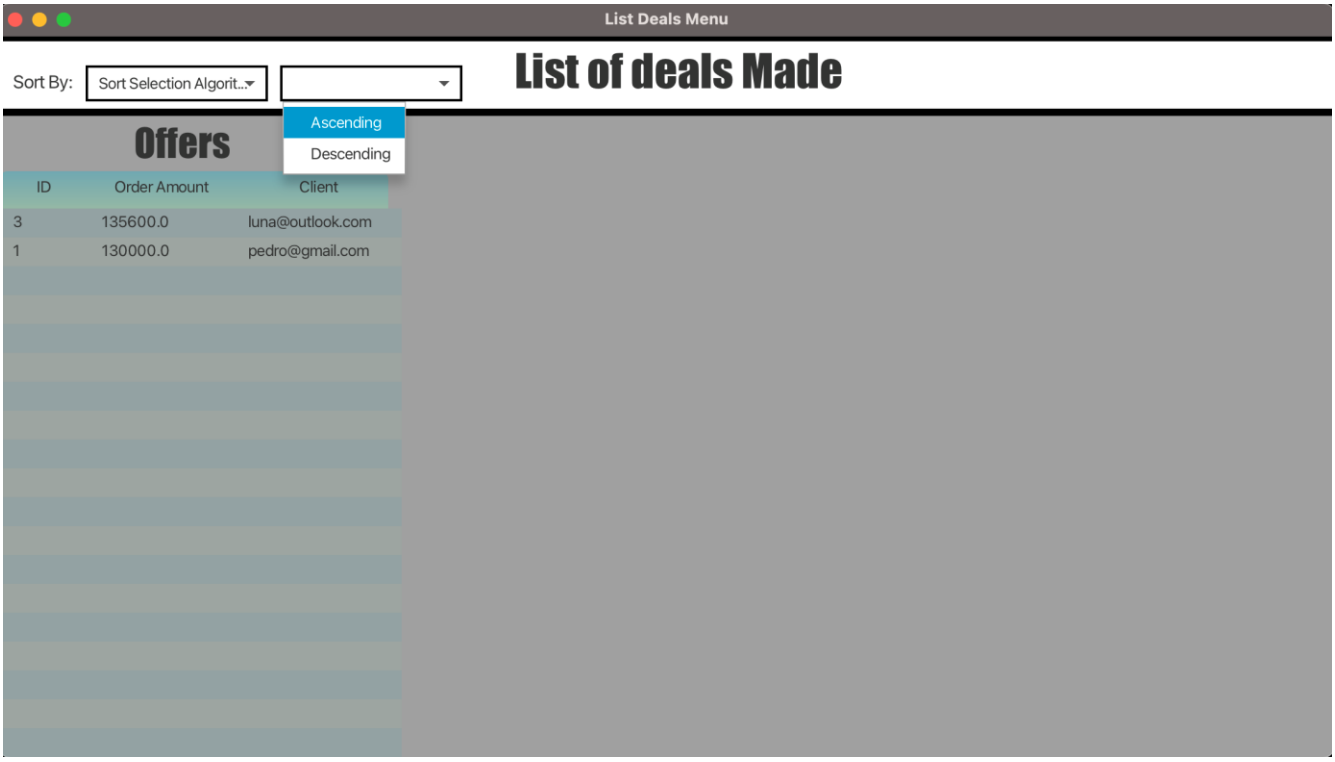


Image 97 - Select Order

Finally, for you to be able to see the announcement which correspond to the offer that is on the list, you must click it with your mouse on what offer do you want to see.

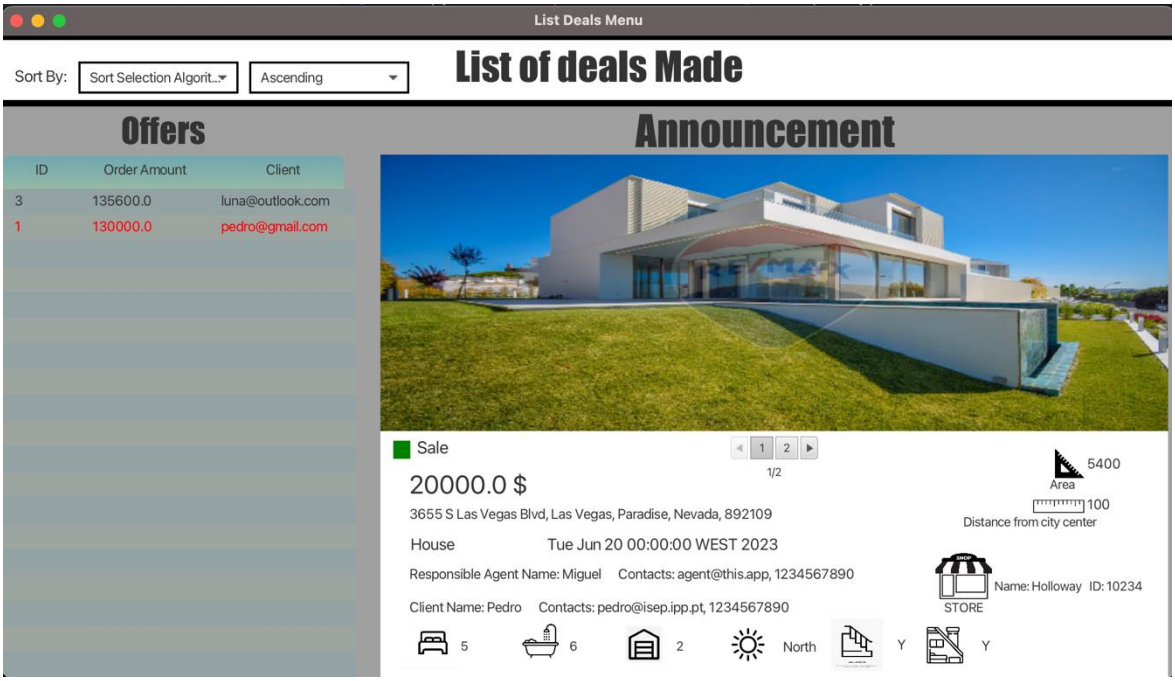


Image 98 - See Offer

- **Divide Stores into two subsets**: In this feature, the network manager can divide all the stores that are registered on the system into two subsets that the difference between the sums of the two subsets are minimum. To have access for this functionality you must click on top of the “Divide stores into two Subsets”.

After you click at the button, it will appear an alert that informs the user that depending on how many stores does the application have the operation to divide the stores into two subsets might take minutes:

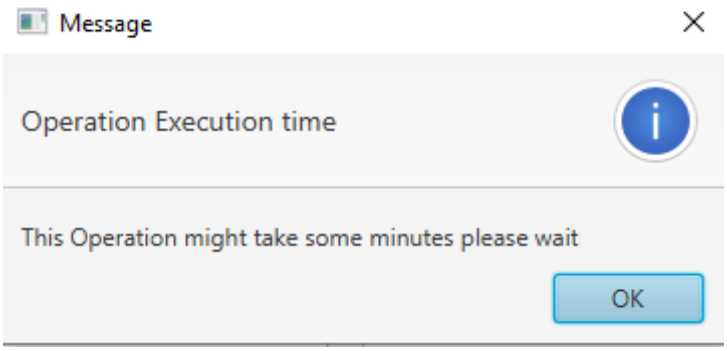


Image 99 - Message Information

Once the operation is finished you will be redirected to a menu that has two tittles subset1 and subset2 and below them it has a text area that will display the stores that corresponds to each subset with the ID of each store and number of properties of each store. Also, at the center of the page it will be displayed the minimum difference:

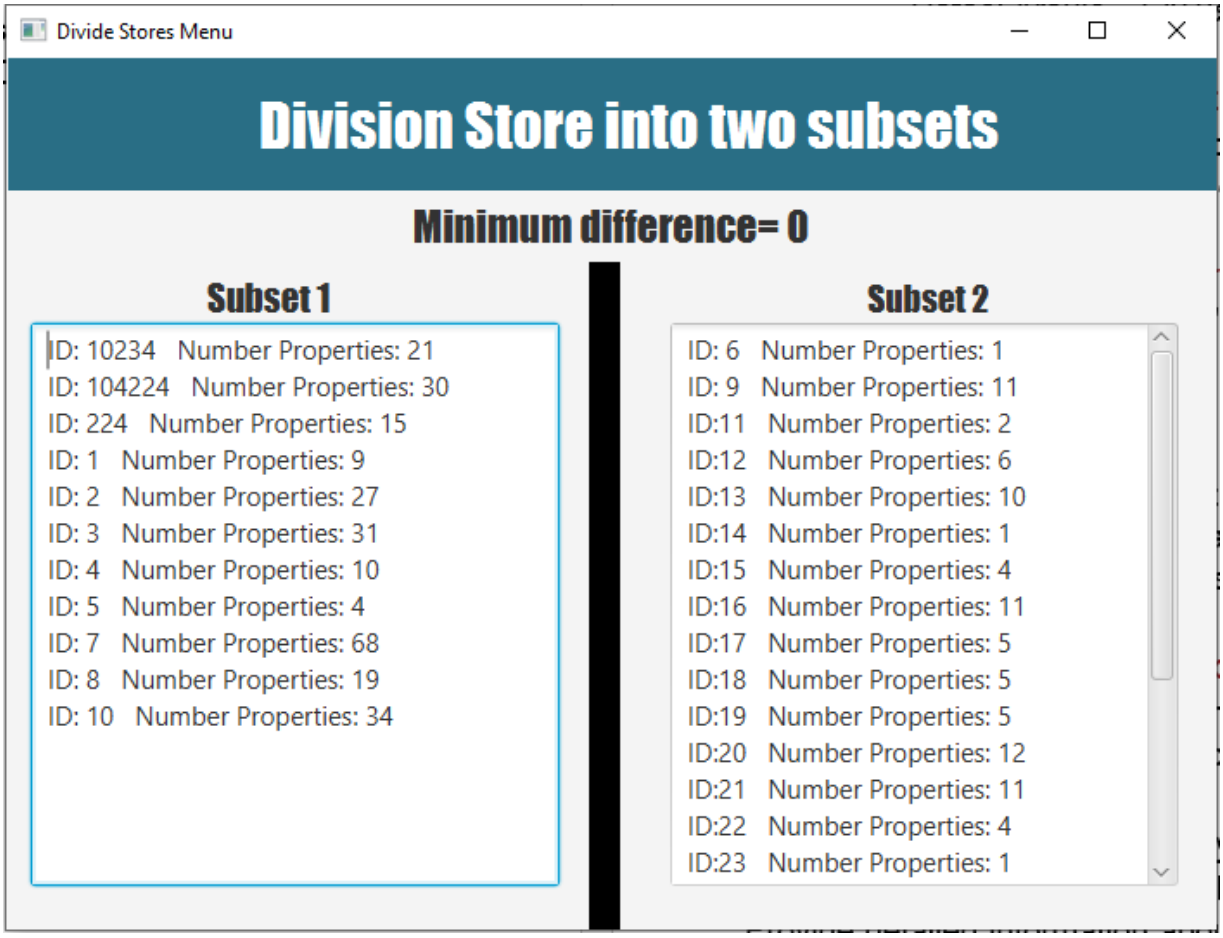


Image 100 - Divide Stores Menu

Store Manager Menu (Graphical Interface)

The Store Manager Menu (Graphical Interface) is only accessed by the Store Manager, and has the following features as shown in the picture:

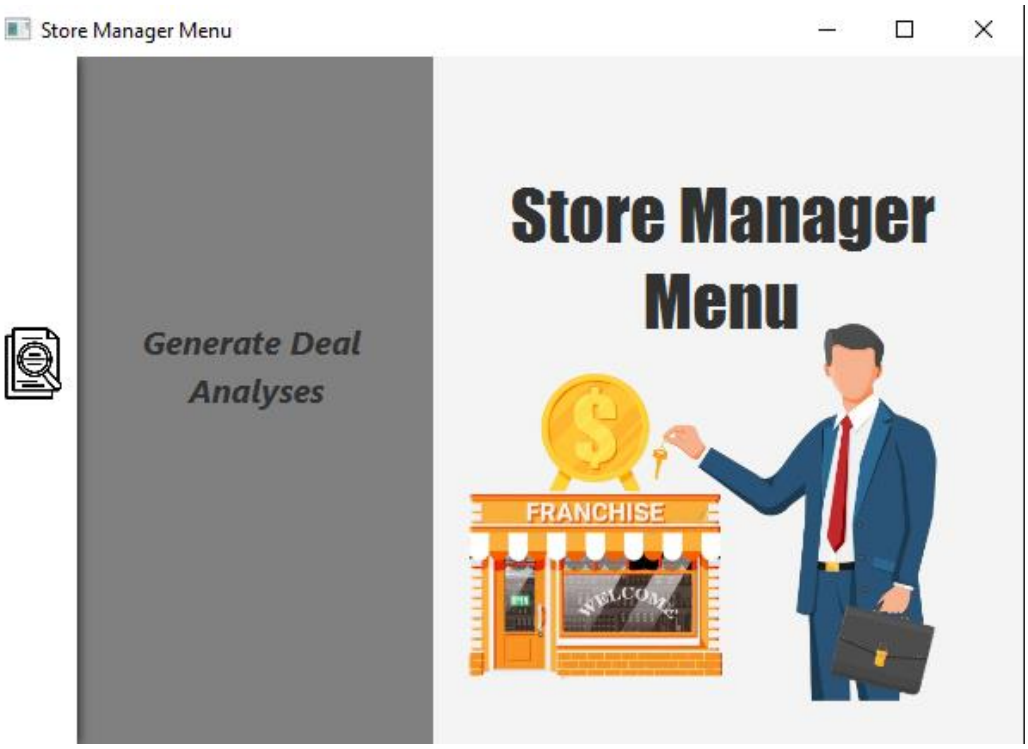


Image 101 - Store Manager Menu Interface

Generate Deal Analyses: In this feature, the Network Manager to get a report with different parameters such as: property values/prices (sale prices and forecast prices), the regression model used to estimate each value, R(SLR), R2 and R2 adjusted for SLR and MLR, confidence intervals and hypothesis tests for regression coefficients and significance model with ANOVA. It should also give a prediction price for a property that the manager wants to know about. To have access for this functionality you must click on top of the “Generate Deal Analyses”.

After clicking, the following window will open:

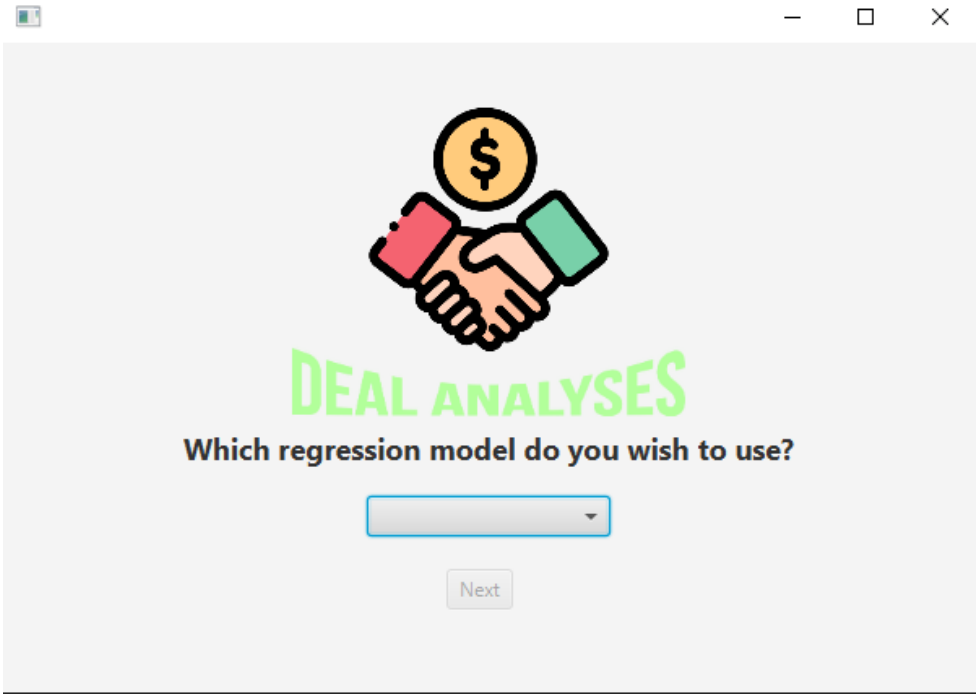


Image 102 - Select Regression Model

To select the regression model that the user wants to use, we must click on the choice box and click on the type of regression, after that the user must click on the button “Next” and it will redirect to one of the following optional screens:

Optional Screen for Simple Linear Regression:

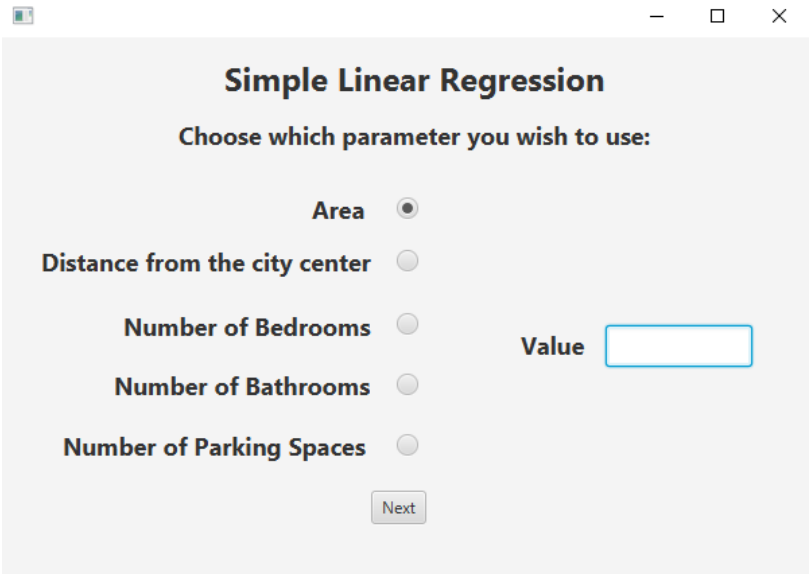


Image 103 - Select the parameter to use (Simple Linear)

In this Screen you click in one of the options to select the parameter and then you write the value of that same parameter in the textbox. After completing

those steps, you click in the button “Next”.

Optional Screen for Multilinear Regression:

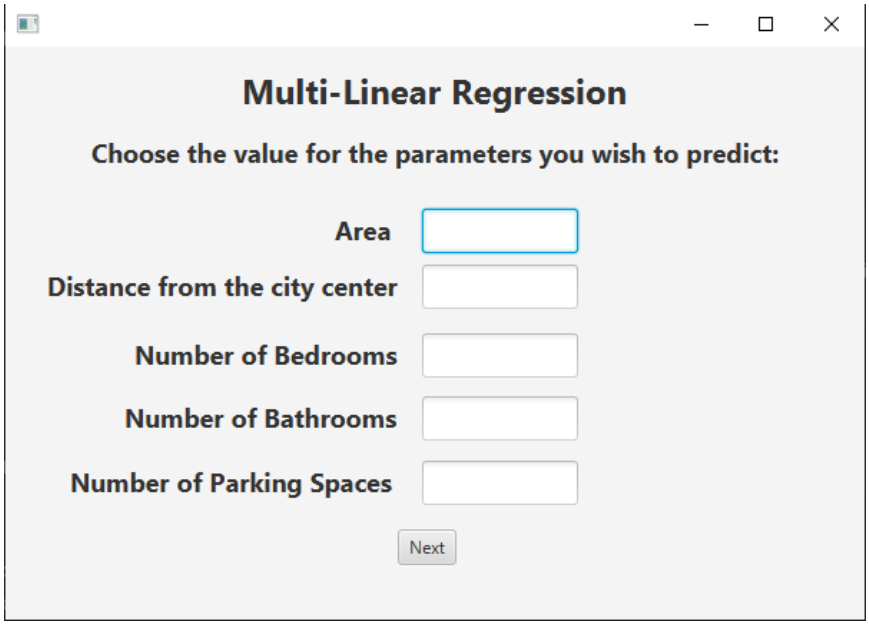


Image 104 - Define the values to use (Multilinear)

In this Screen you write the values of that parameters in the textboxes. After doing that, you click in the button “Next”.

For both optional screens if you try to write invalid inputs, it will appear one popup message like the following one:

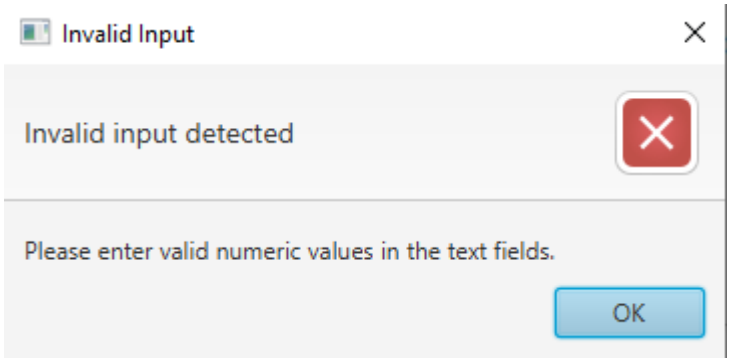


Image 105 - Invalid Input Detected

After clicking in the Button “Next”, in both screens, it will go to the screen below:

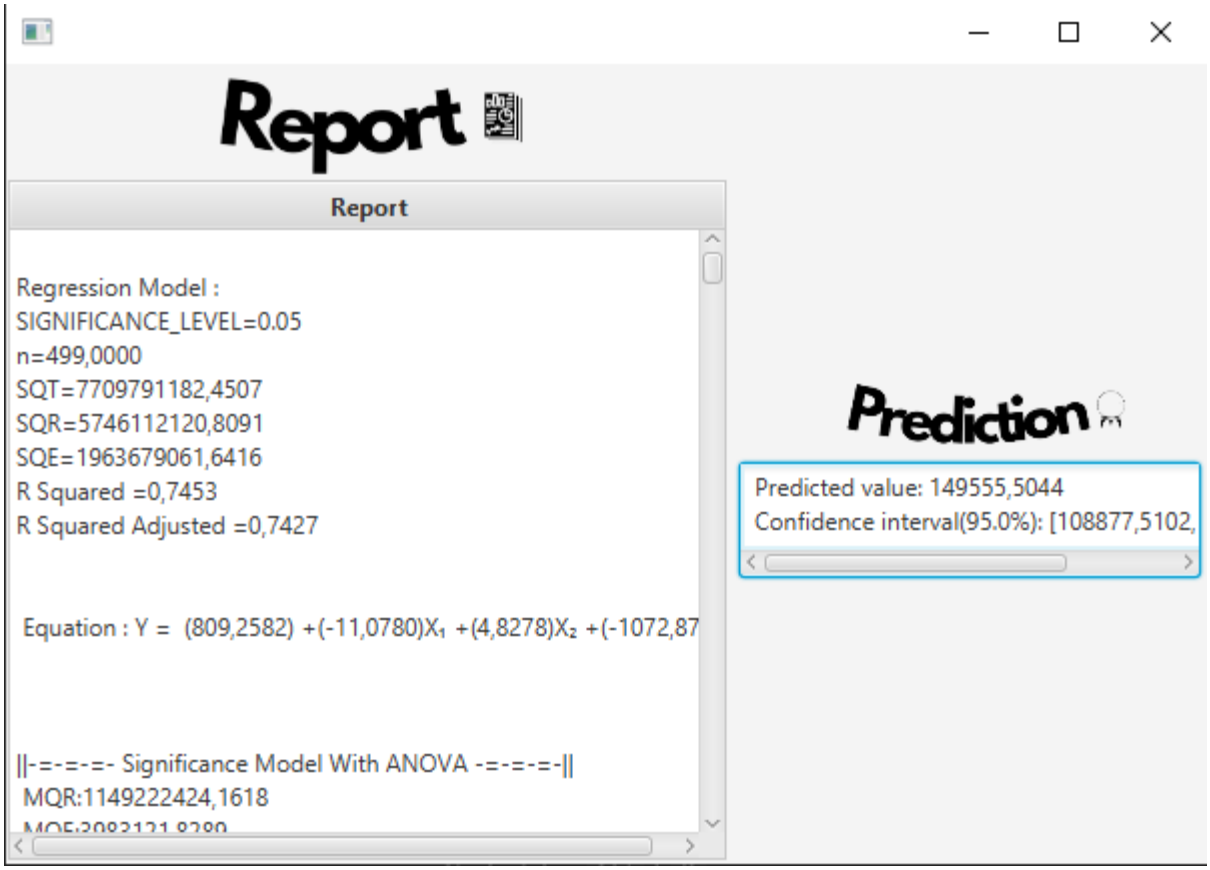


Image 106 - Report and Prediction

In this screen we can finally check the report and the prediction price for the parameter/s we wrote in the previous screens.

Troubleshooting

In this section, you will find common problems that you might have while using the application. If you have other problems apart from the ones listed, please contact our team.

Contacts:

- Pedro Coelho - 1220688@isep.ipp.pt
- Luna Silva - 1221184@isep.ipp.pt
- Diogo Moutinho - 1221014@isep.ipp.pt
- Vasco Sousa - 1221700@isep.ipp.pt
- Rafael Araújo - 1201804@isep.ipp.pt

Check internet connectivity: Ensure that you have a stable internet connection. If you're experiencing connectivity issues, try restarting your modem/router or connecting to a different network.

Verify login credentials: Double-check that you're entering the correct username and password. If you're not able to log in, make sure that you are registered into the application.

Try a different browser or device: If you're encountering issues on a specific browser, try accessing the application using a different browser (e.g., Chrome, Firefox, Safari). Alternatively, switch to a different device (computer, smartphone, tablet) to see if the issue persists.

Contact customer support: If you're still experiencing problems, reach out to the application's customer support team. They can provide further assistance and troubleshoot specific issues related to your account or device.

Report bugs or errors: If you encounter any error messages, unexpected behavior, or bugs within the application, report them to the development team. Provide detailed information about the issue, including steps to reproduce it, so that they can investigate and address the problem.

Check system requirements: Ensure that your device meets the minimum system requirements for running the application. Please check the System Requirements chapter present in this document.

Restart your device: Sometimes, simply restarting your device can resolve temporary glitches or conflicts that may be affecting the application's performance. If the problem persists, please contact our development team.

Check server connectivity: Verify if the server where the application or website is hosted is functioning correctly. Ensure that there are no connection issues with the server and that all necessary services are running.

Frequently Asked Questions (FAQS)

In this section, you find common questions regarding the functionalities of our application. If you have further questions apart from the list below, please contact our team.

How do I register myself in the application?

To register in the application, please visit the main menu of the application and look for the “Register” option. Follow the prompts to provide the required information and create your account. [Please check “Command-line Interface | Main Menu” chapter]

How do I login?

After having your credentials, use the login screen to access the application features. [Please check “Command-line Interface | Main Menu” chapter]

Can I access all the features of the application?

No. Depending on the role you were assigned to by the administrator, you will have a different main screen when loading the app. [Please check “Features” chapter]

How do I navigate in the application?

When entering the application, and after you login, you are presented with a menu depending on the role you have. Use the menu to navigate the accessible features. [Please check “Features” chapter]

How do I find my authentication credentials?

When registered in the system, you will receive a notification by SMS or email containing your credentials. If you were not notified, please contact your administrator. [Please check “Command-line Interface | Main Menu” chapter]

Why was my offer been rejected?

Your offer may have been rejected for several reasons: [Please check “Client | Place An Offer” chapter]

1. The offer price is higher than the price indicated in the advertisement. Please look carefully at the price indicated in the publish announcement and try again.
2. The offer price has already been submitted by another customer. Please insert a different value or contact the agent that is responsible for this property.
3. You may have submitted a previous offer that hasn’t been approved or denied. Please wait for the agent’s response before submitting again.

Conclusion

In conclusion, this user manual provides comprehensive guidance on the usage and functionalities of our Real Estate application. It serves as a valuable resource for both homebuyers and real estate agents, offering detailed instructions on how to effectively navigate, utilize, and maximize the features of the app.

The manual outlines the purpose and target audience of the application, catering to individuals and professionals involved in the real estate industry or those interested in buying or renting properties. It covers the various user roles, including the System Administrator, Agent, Unregistered User, Owner, Client, Network Manager, and Store Manager, along with their specific permissions and accessible features.

Furthermore, the manual provides system requirements for running the application, including the supported operating systems, disk space, RAM, processor, and internet connection. It also offers step-by-step instructions for installing the required software, such as IntelliJ IDEA and JavaFX, ensuring a smooth setup process for users.

The troubleshooting section addresses common issues users may encounter while using the application, such as internet connectivity problems, login issues, browser or device compatibility, and server connectivity. Users are encouraged to contact the provided customer support team for further assistance or to report bugs and errors they encounter.

The FAQ section provides answers to common questions regarding registration, login, accessing application features, navigation, and finding authentication credentials. This helps users quickly find solutions to their queries and facilitates a seamless user experience.

By following the instructions provided in this user manual, users will be equipped with the necessary knowledge and guidance to make the most of our Real Estate application. Whether users are experienced in real estate apps or new to the field, this manual empowers them to navigate the application effectively, make informed decisions, and accomplish their real estate-related goals.

Annex A - Application Diagram

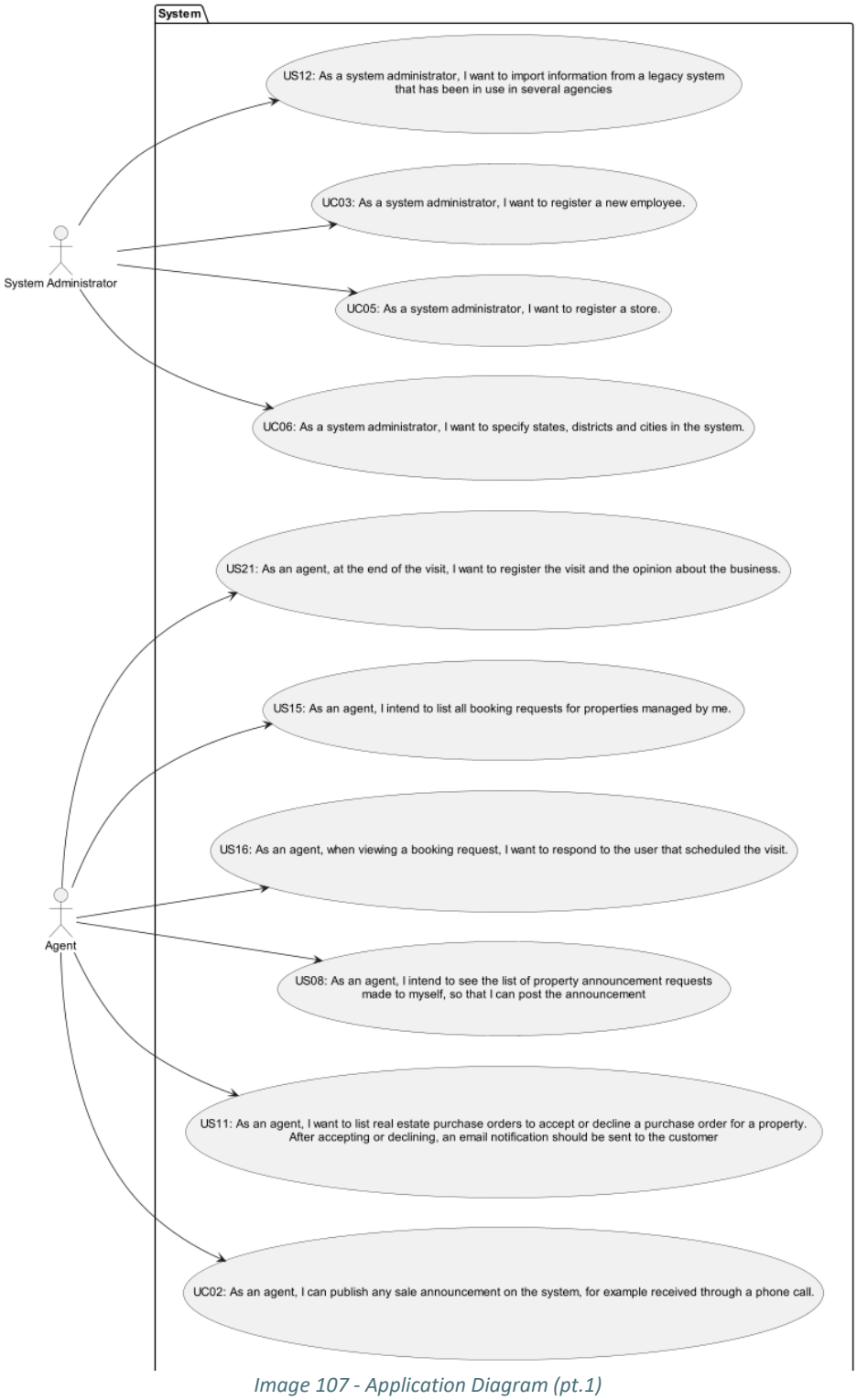


Image 107 - Application Diagram (pt.1)

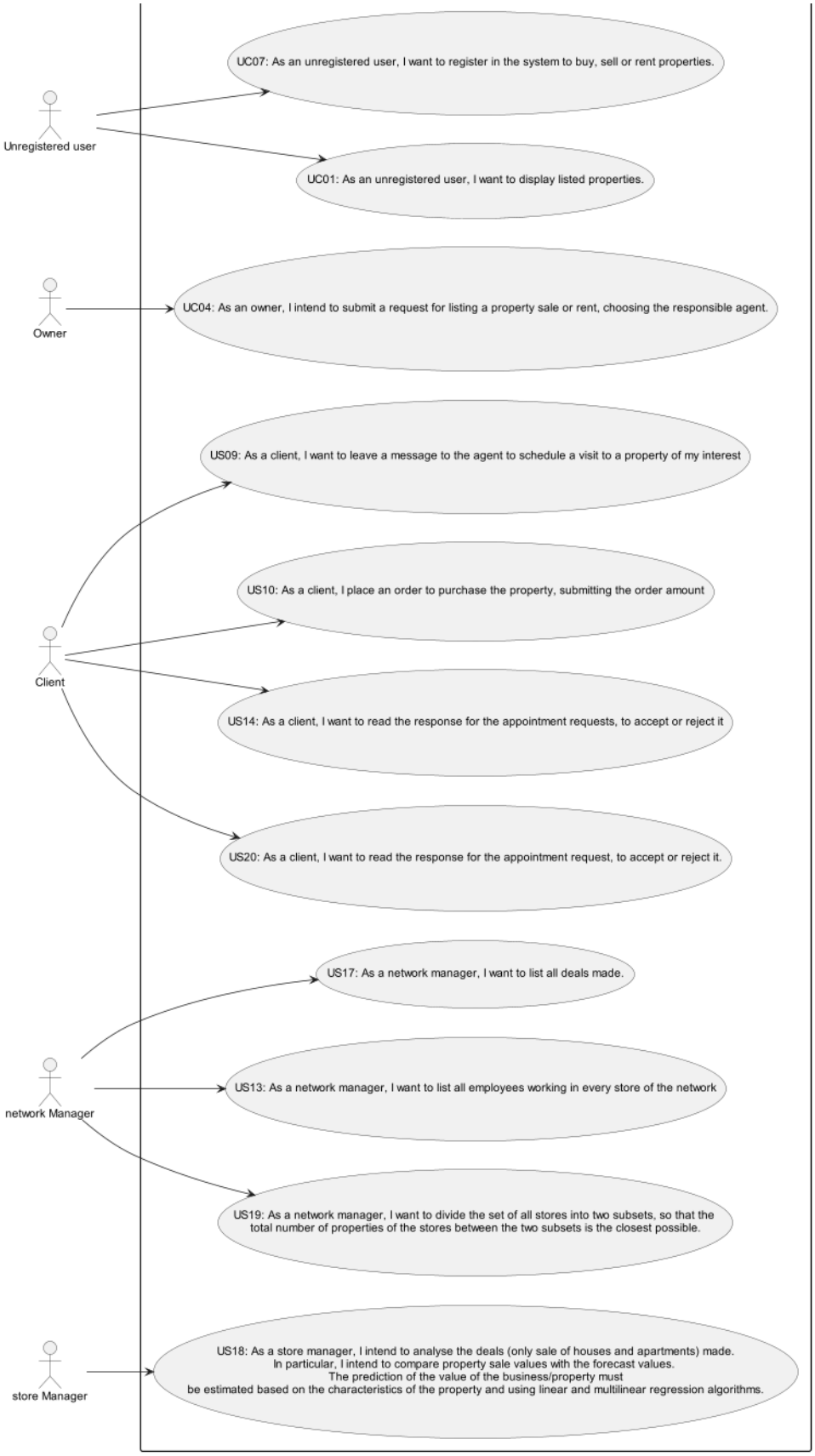


Image 108 - Application Diagram (pt.2)

Annex B. MATCP

Simple Linear Regression

Overview of Simple Linear Regression

In the process of making decisions, it is often necessary to make predictions. When it is possible to establish a relationship between two variables – one, whose values we want to explain (dependent variable), and the other, which is the variable that explains the one mentioned before (independent variable) - the prediction is easier. Simple linear regression is used to estimate the relationship between two variables, more specifically, to establish if there is a statistically significant relationship between the two. Apart from this, it is used when you want to know:

1. How strong the relationship is between the two variables;
2. The value of the dependent variable at a certain value of the independent variables;

Simple Linear Regression Model

The formula for a simple linear regression is:

$$Y_i = \hat{a} + \hat{b}x_i + \varepsilon_i$$

Image 109 - Method_1_MATCP_Theorical_7_Slide_5

- Yi - predicted value of the dependent variable (y) for any given value of the independent variable (x).
- $\hat{a}$ – intercept, the predicted value of y when the x is 0.
- $\hat{b}$ – regression coefficient – how much we expect y to change as x increases.
- xi – independent variable.
- εi – error of the estimate or how much variation there is in the estimation of the regression coefficient.

The simple linear regression is applied in tables of value pairs. Each

observation is a pair of values, one for each variable. After, is constructed a scatter diagram of the observations.

To estimate the values of a and b parameters, there is going to be implemented the Minimum Square Method.

$$S_{xx} = \sum_{i=1}^{n} x_i^2 - n\bar{x}^2 \qquad S_{yy} = \sum_{i=1}^{n} y_i^2 - n\bar{y}^2 \qquad S_{xy} = \sum_{i=1}^{n} x_i y_i - n\bar{x}\bar{y}$$

Image 110 - Method_2_3_4_MATCP_Theorical_7_Slide_10

$$\hat{a} = \bar{y} - \hat{b}\bar{x} \qquad\qquad \hat{b} = \frac{S_{xy}}{S_{xx}}$$

Image 111 - Method_5_6_MATCP_Theorical_7_Slide_11

Model Significance

Anova

The Analysis of Variance (ANOVA) consists of calculations that provide information about the levels of variability within a regression model based on the total variation of the Y (dependent variable).

$$ST = SR + SE$$

Image 112 - Method_7_MATCP_Theorical_10_Slide_32

- ST – total variability of Y observations
- SR – part of the variability of Y´s observations that are eliminated when using knowledge of the independent variable to predict Y
- SE - part of the variability of observations of Y that remain even knowing the value of x.

$$ST = \sum_{i=1}^{n} (Y_i - \bar{Y})^2 \qquad SR = \sum_{i=1}^{n} (\hat{Y}_i - \bar{Y})^2 \qquad SE = \sum_{i=1}^{n} (Y_i - \hat{Y}_i)^2$$

Image 113 - Method_8_9_10_MATCP_Theorical_7_Slide_30_31

The calculations are synthesized in the table:

Source of variation	Sum of squares	Degrees of freedom	Root mean square	F test stats
Regression	SR	1	$MSR = \frac{SR}{1}$	$F = \frac{MSR}{MSE}$
Error	SE	$n-2$	$MSE = \frac{SE}{n-2}$	
Total	ST	$n-1$		

Image 114 - Table_1_MATCP_Theorical_7_Slide30_31

Coefficient correlation

The correlation coefficients are indicators of the strength of the linear relationship between two different variables, x and y. A linear correlation coefficient that is greater than zero indicates a positive relationship. A value that is less than zero signifies a negative relationship. (Nickolas, 2021)

$$R = \frac{S_{xy}}{\sqrt{S_{xx}}\sqrt{S_{yy}}} \qquad R^2 = \frac{S^2{}_{xy}}{S_{xx}S_{yy}} \qquad R^2_{adj} = \frac{\left(1-R^2\right)(n-1)}{n-2}$$

Image 115 - Method_11_12_13_MATCP_Theorical_7_Slide_12_13

Depending on the result of R it is possible to reach different conclusions:

- The closer R is to zero, the weaker the linear relationship.
- Positive R values indicate a positive correlation, where the values of both variables tend to increase together.
- Negative R values indicate a negative correlation, where the values of one variable tend to increase when the values of the other variable decrease.

Outputs:

Simple Linear for 95% (area)

```
n = 499
Sxx= 218955,695
Syy= 7709791182,451
Sxy= -1924158,947
SE= 7692881881,939
SR= 16909300,512
ST= 7709791182,451
avgX= 35,705
avgY= 9063,177
slope= -8,788
intercept= 9376,952
R^2 = 0,002
R =0,047
```

Image 116 - Simple Linear for 95% (Area) - Part_1_ANOVA

```
||-=-=-=- Significance Model With ANOVA -=-=-=-||
 MSR:16909300,512
 MSE:15478635,577
 F0 :1,092
 F de Snedecore : 3,86
-=-=-=--=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=--=-=-=-
F0 < F de Snedecor
H0 is accepted -> regression model is not significant
```

Image 117 - Simple Linear for 95% (Area) - Part_2_ANOVA

Comparing the F-statistic to the critical value, we find that F-statistic < F de Snedecore, indicating that the regression model is not significant. The correlation coefficient (R) provides information about the strength and direction of the linear relationship between the variables. In this case, R = 0.047, indicating a weak positive correlation.

Simple Linear for 99% (area)

```
n = 499
Sxx= 218955,695
Syy= 7709791182,451
Sxy= -1924158,947
SE= 7692881881,939
SR= 16909300,512
ST= 7709791182,451
avgX= 35,705
avgY= 9063,177
slope= -8,788
intercept= 9376,952
R^2 = 0,002
R =0,047
```

Image 118 -Simple Linear for 99% (Area) - Part_1_ANOVA

```
||-=-=-=- Significance Model With ANOVA -=-=-=-||
 MSR:16909300,512
 MSE:15478635,577
 F0 :1,092
 F de Snedecore : 6,686
-=-=-=-=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=-=-=-=-
F0 < F de Snedecor
H0 is accepted -> regression model is not significant
```

Image 119 - Simple Linear for 99% (Area) - Part_2_ANOVA

Based on the ANOVA table, the MSR is 16909300.512, and the MSE is 15478635,577. The calculated F-value (F0) is 1.092, and the critical F-value (F de Snedecore) at a significance level of 1% is 6.686. Since F0 is less than F de Snedecore, the null hypothesis (H0) means that the regression model is not significant. This implies that the regression model does not provide a significant improvement over the mean.

Simple Linear for 95% (distance)

```
n = 499
Sxx= 123027159,415
Syy= 7709791182,451
Sxy= 737049650,331
SE= 3294163042,797
SR= 4415628139,653
ST= 7709791182,451
avgX= 1517,379
avgY= 9063,177
slope= 5,991
intercept= -27,365
R^2 = 0,573
R =0,757
```

Image 120 - Simple Linear for 95% (Distance) - Part_1_ANOVA

```
||-=-=-=- Significance Model With ANOVA -=-=-=-||
 MSR:4415628139,653
 MSE:6628094,654
 F0 :666,199
 F de Snedecore : 3,86
-=-=-=--=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=--=-=-=-
F0 > F de Snedecor
H0 is rejected -> regression model is significant
```

Image 121 - Simple Linear for 99% (Distance) - Part_2_ANOVA

Comparing the F-statistic to the critical value, we find that F-statistic > F de Snedecore, indicating that the regression model is significant. The correlation coefficient (R) provides information about the strength and direction of the linear relationship between the variables. In this case, R = 0.757, indicating a strong positive correlation.

Simple Linear for 99% (distance)

```
n = 499
Sxx= 123027159,415
Syy= 7709791182,451
Sxy= 737049650,331
SE= 3294163042,797
SR= 4415628139,653
ST= 7709791182,451
avgX= 1517,379
avgY= 9063,177
slope= 5,991
intercept= -27,365
R^2 = 0,573
R =0,757
```

Image 122 - Simple Linear for 99% (Distance) - Part_1_ANOVA

```
||-=-=-=- Significance Model With ANOVA -=-=-=-||
 MSR:4415628139,653
 MSE:6628094,654
 F0 :666,199
 F de Snedecore : 6,686
-=-=-=--=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=--=-=-=-
F0 > F de Snedecor
H0 is rejected -> regression model is significant
```

Image 123 - Simple Linear for 99% (Distance) - Part_2_ANOVA

The R-squared value of 0.573 indicates that approximately 57.3% of the variability in the dependent variable (Y) can be explained by the independent variable (X). The correlation coefficient (R) of 0.757 indicates a moderate positive linear relationship between X and Y.

Simple Linear for 99% (parking spaces)

```
n = 499
Sxx= 285,082
Syy= 7709791182,451
Sxy= 1032704,155
SE= 3968842062,444
SR= 3740949120,007
ST= 7709791182,451
avgX= 1,735
avgY= 9063,177
slope= 3622,479
intercept= 2776,47
R^2 = 0,485
R =0,697
```

Image 124 - Simple Linear for 99% (Parking Spaces) - Part_1_ANOVA

```
||-=-=-=- Significance Model With ANOVA -=-=-=-||
 MSR:3740949120,007
 MSE:7985597,711
 F0 :468,462
 F de Snedecore : 6,686
-=-=-=--=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=--=-=-=-
F0 > F de Snedecor
H0 is rejected -> regression model is significant
```

Image 125 - Simple Linear for 99% (Parking Spaces) - Part_2_ANOVA

Based on the ANOVA table, the model's F-statistic is 468.462. The critical F-value for a significance level of 1% is 6,686. Since the calculated F-value is greater than the critical F-value, we can reject the null hypothesis and conclude that the regression model is significant.

The correlation coefficient (R) and the coefficient of determination (R^2) can also be used to assess the model's significance. In this case, the correlation coefficient (R) is 0.697, indicating a moderately strong positive linear relationship between X and Y. The coefficient of determination (R^2) is 0.485, which means that 48.5% of the variability in Y can be explained by the linear relationship with X.

To understand the next outputs, we only need to follow the same line of thought that we used in the previous output, so we are only going to show the outputs.

Simple Linear for 95% (bedrooms)

```
n = 499
Sxx= 317,852
Syy= 7709791182,451
Sxy= 259482,401
SE= 7497959326,261
SR= 211831856,19
ST= 7709791182,451
avgX= 2,838
avgY= 9063,177
slope= 816,363
intercept= 6746,603
R^2 = 0,027
R =0,166
```

Image 126 - Simple Linear for 95% (Bedrooms) - Part_1_ANOVA

```
||-=-=-=- Significance Model With ANOVA -=-=-=-||
 MSR:211831856,19
 MSE:15086437,276
 F0 :14,041
 F de Snedecore : 3,86
-=-=-=-=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=-=-=-=-
F0 > F de Snedecor
H0 is rejected -> regression model is significant
```

Image 127 - Simple Linear for 95% (Bedrooms) - Part_2_ANOVA

Simple Linear for 99% (bedrooms)

```
n = 499
Sxx= 317,852
Syy= 7709791182,451
Sxy= 259482,401
SE= 7497959326,261
SR= 211831856,19
ST= 7709791182,451
avgX= 2,838
avgY= 9063,177
slope= 816,363
intercept= 6746,603
R^2 = 0,027
R =0,166
```

Image 128 - Simple Linear for 99% (Bedrooms) - Part_1_ANOVA

```
||-=-=-=- Significance Model With ANOVA -=-=-=-||
 MSR:211831856,19
 MSE:15086437,276
 F0 :14,041
 F de Snedecore : 6,686
-=-=-=-=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=-=-=-=-
F0 > F de Snedecor
H0 is rejected -> regression model is significant
```

Image 129 - Simple Linear for 99% (Bedrooms) - Part_2_ANOVA

Simple Linear for 95% (bathrooms)

```
n = 499
Sxx= 422,228
Syy= 7709791182,451
Sxy= 1170290,286
SE= 4466098504,429
SR= 3243692678,022
ST= 7709791182,451
avgX= 2,405
avgY= 9063,177
slope= 2771,699
intercept= 2397,768
R^2 = 0,421
R =0,649
```

Image 130 - Simple Linear for 95% (Bathrooms) - Part_1_ANOVA

```
||-=-=-=- Significance Model With ANOVA -=-=-=-||
 MSR:3243692678,022
 MSE:8986113,691
 F0 :360,967
 F de Snedecore : 3,86
-=-=-=-=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=-=-=-=-
F0 > F de Snedecor
H0 is rejected -> regression model is significant
```

Image 131 - Simple Linear for 95% (Bathrooms) - Part_2_ANOVA

Simple Linear for 99% (bathrooms)

```
n = 499
Sxx= 422,228
Syy= 7709791182,451
Sxy= 1170290,286
SE= 4466098504,429
SR= 3243692678,022
ST= 7709791182,451
avgX= 2,405
avgY= 9063,177
slope= 2771,699
intercept= 2397,768
R^2 = 0,421
R =0,649
```

Image 132 - Simple Linear for 99% (Bathrooms) - Part_1_ANOVA

```
||-=-=-=- Significance Model With ANOVA -=-=-=-||
 MSR:3243692678,022
 MSE:8986113,691
 F0 :360,967
 F de Snedecore : 6,686
-=-=-=--=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=--=-=-=-
F0 > F de Snedecor
H0 is rejected -> regression model is significant
```

Image 133 - Simple Linear for 99% (Bathrooms) - Part_2_ANOVA

Simple Linear for 95% (parking spaces)

```
n = 499
Sxx= 285,082
Syy= 7709791182,451
Sxy= 1032704,155
SE= 3968842062,444
SR= 3740949120,007
ST= 7709791182,451
avgX= 1,735
avgY= 9063,177
slope= 3622,479
intercept= 2776,47
R^2 = 0,485
R =0,697
```

Image 134 - Simple Linear for 95% (Parking Spaces) - Part_1_ANOVA

```
||-=-=-=- Significance Model With ANOVA -=-=-=-||
 MSR:3740949120,007
 MSE:7985597,711
 F0 :468,462
 F de Snedecore : 3,86
-=-=-=--=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=--=-=-=-
F0 > F de Snedecor
H0 is rejected -> regression model is significant
```

Image 135 - Simple Linear for 95% (Parking Spaces) - Part_2_ANOVA

Hypothesis tests for model coefficients

The hypothesis tests are a statistical procedure that is used to claim about the data of the table of value. The hypothesis tests for model coefficients $\hat{a}$ and $\hat{b}$ follow a five-step procedure (Kumar, 2022):

- Formulate null and alternate hypotheses:

$$H_0: a = 0 \ v.s. \ H_1: a \neq 0 \qquad\qquad H_0: b = 0 \ v.s. \ H_1: b \neq 0$$

Image 136 - Method_14_15_MATCP_Theorical_7_Slide_23_24

- Determine the test statistics:

$$T_a = \frac{\hat{a}-a}{s\sqrt{\frac{1}{n}+\frac{x^2}{S_{xx}}}} \sim t_{n-2} \qquad T_b = \frac{\hat{b}-b}{S/\sqrt{S_{xx}}} \sim t_{n-2}$$

Image 137 - Method_16_17_MATCP_Theorical_7_Slide_23_24

$$s = \sqrt{\frac{1}{n \cdot 2}\sum_{i=1}(y_i - \hat{y}_i)^2}$$

Image 138 - Method_18_MATCP_Theorical_7_Slide_22

- Determine the critical region:

$$t_c = t_{1-\frac{\alpha}{2}}(n-2) \qquad RC =]-\infty, -t_c[U]t_c, +\infty[$$

Image 139 - Method_19_20_MATCP_Theorical_7_Slide_23

- Calculate the statistics.

- Make decisions:
  - with a significance level of α, reject $H0$ when $|t| > t_{1-\frac{\alpha}{2}}(n-2)$

Outputs:

Simple Linear for 95% (area)

```
||-=-=-=- Intercept Hypothesis Test -=-=-=-||
 s :3934,29
-=-=-=-=-=-=-
H0 : a = a0
H1 : a != a0
-=-=-=-=-=-=-
 t = 26,941
 tc =1,965
|t| > tc
 -> H0 rejected

||-=-=-=- Slope Hypothesis Test -=-=-=-||
 s :3930,338
-=-=-=-=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=-=-=-=-
 t = -1,045
 tc =1,965
|t| <= tc
 -> H0 accepted
```

Image 140 - Simple Linear for 95% (Area) - Tests

Intercept Tests:

t-value : 26.941
Critical t-value (tc) : 1.965
|t-value| > tc, leading to the rejection of the null hypothesis. Thus, the intercept is significant.

Slope Tests:

t-value : -1.045
Critical t-value (tc) : 1.965
|t-value| <= tc, leading to the acceptance of the null hypothesis. Thus, the slope is not significant.

Simple Linear for 99% (area)

```
||-=-=-=- Intercept Hypothesis Test -=-=-=-||
 s :3934,29
-=-=-=--=-=-=-
H0 : a = a0
H1 : a != a0
-=-=-=--=-=-=-
 t = 26,941
 tc =2,586
|t| > tc
 -> H0 rejected

||-=-=-=- Slope Hypothesis Test -=-=-=-||
 s :3930,338
-=-=-=--=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=--=-=-=-
 t = -1,045
 tc =2,586
|t| <= tc
 -> H0 accepted
```

Image 141 - Simple Linear for 99% (Area) - Tests

Intercept Tests:

The standard error (SE) of the intercept is 348,058.

The calculated t-value is 26.941, and the critical t-value (tc) at a significance level of 1% is 2,586. Since |t| is greater than tc, the null hypothesis (H0) is rejected. This indicates that the intercept is significantly different from zero.

Slope Tests:

The standard error (SE) of the slope is 8,408.

The calculated t-value is -1.045, and the critical t-value (tc) at a significance level of 1% is 2.586. Since |t| is less than or equal to tc, the null hypothesis (H0) is accepted. This suggests that the slope is not significantly different from zero.

Simple Linear for 95% (distance)

```
||-=-=-=- Intercept Hypothesis Test -=-=-=-||
 s :2574,509
-=-=-=--=-=-=-
H0 : a = a0
H1 : a != a0
-=-=-=--=-=-=-
 t = -0,074
 tc =1,965
|t| <= tc
 -> H0 accepted

||-=-=-=- Slope Hypothesis Test -=-=-=-||
 s :2571,922
-=-=-=--=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=--=-=-=-
 t = 25,811
 tc =1,965
|t| > tc
 -> H0 rejected
```

Image 142 - Simple Linear for 95% (Distance) - Tests

Intercept Tests:

The standard error (SE) of the intercept is 370,576.

The calculated t-value is -0.074, and the critical t-value (tc) at a significance level of 5% is 1,965. Since the absolute value of the calculated t-value (|t|) is less than the critical t-value (|t| < tc), we fail to reject the null hypothesis (H0). This indicates that there is not enough evidence to suggest that the intercept is significantly different from zero.

Slope Tests:

The standard error (SE) of the slope is 0,232.

The calculated t-value is 25.811, and the critical t-value (tc) at a significance level of 1% is 1,965. Since the absolute value of the calculated t-value (|t|) is greater than the critical t-value (|t| > tc), we reject the null hypothesis (H0). This suggests that the slope is significantly different from zero.

To understand the next outputs, we only need to follow the same line of thought that we used in the previous output, so we are only going to show the outputs.

Simple Linear for 99% (distance)

```
||-=-=-=- Intercept Hypothesis Test -=-=-=-||
 s :2574,509
-=-=-=--=-=-=-
H0 : a = a0
H1 : a != a0
-=-=-=--=-=-=-
 t = -0,074
 tc =2,586
|t| <= tc
 -> H0 accepted

||-=-=-=- Slope Hypothesis Test -=-=-=-||
 s :2571,922
-=-=-=--=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=--=-=-=-
 t = 25,811
 tc =2,586
|t| > tc
 -> H0 rejected
```

Image 143 - Simple Linear for 99% (Distance) - Tests

Simple Linear for 95% (bedrooms)

```
||-=-=-=- Intercept Hypothesis Test -=-=-=-||
 s :3884,126
-=-=-=--=-=-=-
H0 : a = a0
H1 : a != a0
-=-=-=--=-=-=-
 t = 10,505
 tc =1,965
|t| > tc
 -> H0 rejected

||-=-=-=- Slope Hypothesis Test -=-=-=-||
 s :3880,225
-=-=-=--=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=--=-=-=-
 t = 3,747
 tc =1,965
|t| > tc
 -> H0 rejected
```

Image 144 - Simple Linear for 95% (Bedrooms) - Tests

Simple Linear for 99% (bedrooms)

```
||-=-=-=- Intercept Hypothesis Test -=-=-=-||
 s :3884,126
-=-=-=-=-=-=-
H0 : a = a0
H1 : a != a0
-=-=-=-=-=-=-
 t = 10,505
 tc =2,586
|t| > tc
 -> H0 rejected

||-=-=-=- Slope Hypothesis Test -=-=-=-||
 s :3880,225
-=-=-=-=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=-=-=-=-
 t = 3,747
 tc =2,586
|t| > tc
 -> H0 rejected
```

Image 145 - Simple Linear for 99% (Bedrooms) - Tests

Simple Linear for 95% (bathrooms)

```
||-=-=-=- Intercept Hypothesis Test -=-=-=-||
 s :2997,685
-=-=-=-=-=-=-
H0 : a = a0
H1 : a != a0
-=-=-=-=-=-=-
 t = 6,384
 tc =1,965
|t| > tc
 -> H0 rejected

||-=-=-=- Slope Hypothesis Test -=-=-=-||
 s :2994,673
-=-=-=-=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=-=-=-=-
 t = 18,999
 tc =1,965
|t| > tc
 -> H0 rejected
```

Image 146 - Simple Linear for 95% (Bathrooms) - Tests

Simple Linear for 99% (bathrooms)

```
||-=-=-=- Intercept Hypothesis Test -=-=-=-||
 s :2997,685
-=-=-=--=-=-=-
H0 : a = a0
H1 : a != a0
-=-=-=--=-=-=-
 t = 6,384
 tc =2,586
|t| > tc
 -> H0 rejected

||-=-=-=- Slope Hypothesis Test -=-=-=-||
 s :2994,673
-=-=-=--=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=--=-=-=-
 t = 18,999
 tc =2,586
|t| > tc
 -> H0 rejected
```

Image 147 - Simple Linear for 99% (Bathrooms) - Tests

Simple Linear for 95% (parking spaces)

```
||-=-=-=- Intercept Hypothesis Test -=-=-=-||
 s :2825,88
-=-=-=--=-=-=-
H0 : a = a0
H1 : a != a0
-=-=-=--=-=-=-
 t = 8,764
 tc =1,965
|t| > tc
 -> H0 rejected

||-=-=-=- Slope Hypothesis Test -=-=-=-||
 s :2823,041
-=-=-=--=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=--=-=-=-
 t = 21,644
 tc =1,965
|t| > tc
 -> H0 rejected
```

Image 148 - Simple Linear for 95% (Parking Spaces) - Tests

Simple Linear for 99% (parking spaces)

```
||-=-=-=- Intercept Hypothesis Test -=-=-=-||
 s :2825,88
-=-=-=-=-=-=-
H0 : a = a0
H1 : a != a0
-=-=-=-=-=-=-
 t = 8,764
 tc =2,586
|t| > tc
 -> H0 rejected

||-=-=-=- Slope Hypothesis Test -=-=-=-||
 s :2823,041
-=-=-=-=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=-=-=-=-
 t = 21,644
 tc =2,586
|t| > tc
 -> H0 rejected
```

Image 149 - Simple Linear for 99% (Parking Spaces) - Tests

Confidence intervals for prediction values

The confidence intervals for prediction values can be used to find the average answer of a variable of their true value. The confidence interval at (1 − α) x 100% for the parameters are given by:

$$]\hat{a} - t_c S\sqrt{\frac{1}{n} + \frac{\bar{x}^2}{S_{xx}}}\,, \hat{a} + t_c S\sqrt{\frac{1}{n} + \frac{\bar{x}^2}{S_{xx}}}[\qquad]\hat{b} - t_c S\sqrt{\frac{1}{S_{xx}}}\,, \hat{b} + t_c S\sqrt{\frac{1}{S_{xx}}}[$$

Image 150 - Method_24_MATCP_Theorical_7_Slide_21

Outputs:

Simple Linear for 95% (area)

```
||-=-=-=- Intercept Confidence Interval -=-=-=-||
 Intercept: 9376,952
 Intercept Standard Error: 348,058
 Intercept Confidence Interval (95.0) -> ] 8693,109; 10060,794[

||-=-=-=- Slope Confidence Interval -=-=-=-||
 Slope : -8,788
 Slope Standard Error: 8,408
 Slope Confidence Interval (95.0) -> ] -25,307; 7,732[
```

Image 151 - Simple Linear for 95% (Area) - Intervals

Simple Linear for 99% (area)

```
||-=-=-=- Intercept Confidence Interval -=-=-=-||
 Intercept: 9376,952
 Intercept Standard Error: 348,058
 Intercept Confidence Interval (99.0) -> ] 8476,966; 10276,938[

||-=-=-=- Slope Confidence Interval -=-=-=-||
 Slope : -8,788
 Slope Standard Error: 8,408
 Slope Confidence Interval (99.0) -> ] -30,529; 12,953[
```

Image 152 - Simple Linear for 99% (Area) - Intervals

Simple Linear for 95% (distance)

```
||-=-=-=- Intercept Confidence Interval -=-=-=-||
 Intercept: -27,365
 Intercept Standard Error: 370,576
 Intercept Confidence Interval (95.0) -> ] -755,45; 700,721[

||-=-=-=- Slope Confidence Interval -=-=-=-||
 Slope : 5,991
 Slope Standard Error: 0,232
 Slope Confidence Interval (95.0) -> ] 5,535; 6,447[
```

Image 153 - Simple Linear for 95% (Distance) - Intervals

Simple Linear for 99% (distance)

```
||-=-=-=- Intercept Confidence Interval -=-=-=-||
 Intercept: -27,365
 Intercept Standard Error: 370,576
 Intercept Confidence Interval (99.0) -> ] -985,578; 930,848[

||-=-=-=- Slope Confidence Interval -=-=-=-||
 Slope : 5,991
 Slope Standard Error: 0,232
 Slope Confidence Interval (99.0) -> ] 5,391; 6,591[
```

Image 154 - Simple Linear for 99% (Distance) - Intervals

Simple Linear for 95% (bedrooms)

```
||-=-=-=- Intercept Confidence Interval -=-=-=-||
 Intercept: 6746,603
 Intercept Standard Error: 642,208
 Intercept Confidence Interval (95.0) -> ] 5484,833; 8008,373[

||-=-=-=- Slope Confidence Interval -=-=-=-||
 Slope : 816,363
 Slope Standard Error: 217,862
 Slope Confidence Interval (95.0) -> ] 388,319; 1244,407[
```

Image 155 - Simple Linear for 95% (Bedrooms) - Intervals

Simple Linear for 99% (bedrooms)

```
||-=-=-=- Intercept Confidence Interval -=-=-=-||
 Intercept: 6746,603
 Intercept Standard Error: 642,208
 Intercept Confidence Interval (99.0) -> ] 5086,023; 8407,183[

||-=-=-=- Slope Confidence Interval -=-=-=-||
 Slope : 816,363
 Slope Standard Error: 217,862
 Slope Confidence Interval (99.0) -> ] 253,025; 1379,701[
```

Image 156 - Simple Linear for 99% (Bedrooms) - Intervals

Simple Linear for 95% (bathrooms)

```
||-=-=-=- Intercept Confidence Interval -=-=-=-||
 Intercept: 2397,768
 Intercept Standard Error: 375,617
 Intercept Confidence Interval (95.0) -> ] 1659,779; 3135,756[

||-=-=-=- Slope Confidence Interval -=-=-=-||
 Slope : 2771,699
 Slope Standard Error: 145,886
 Slope Confidence Interval (95.0) -> ] 2485,071; 3058,328[
```

Image 157 - Simple Linear for 95% (Bathrooms) - Intervals

Simple Linear for 99% (bathrooms)

```
||-=-=-=- Intercept Confidence Interval -=-=-=-||
 Intercept: 2397,768
 Intercept Standard Error: 375,617
 Intercept Confidence Interval (99.0) -> ] 1426,522; 3369,013[

||-=-=-=- Slope Confidence Interval -=-=-=-||
 Slope : 2771,699
 Slope Standard Error: 145,886
 Slope Confidence Interval (99.0) -> ] 2394,475; 3148,924[
```

Image 158 - Simple Linear for 99% (Bathrooms) - Interval

Simple Linear for 95% (parking spaces)

```
||-=-=-=- Intercept Confidence Interval -=-=-=-||
 Intercept: 2776,47
 Intercept Standard Error: 316,812
 Intercept Confidence Interval (95.0) -> ] 2154,016; 3398,923[

||-=-=-=- Slope Confidence Interval -=-=-=-||
 Slope : 3622,479
 Slope Standard Error: 167,367
 Slope Confidence Interval (95.0) -> ] 3293,646; 3951,312[
```

Image 159 - Simple Linear for 95% (Parking Spaces) - Intervals

Simple Linear for 99% (parking spaces)

```
||-=-=-=- Intercept Confidence Interval -=-=-=-||
 Intercept: 2776,47
 Intercept Standard Error: 316,812
 Intercept Confidence Interval (99.0) -> ] 1957,276; 3595,663[

||-=-=-=- Slope Confidence Interval -=-=-=-||
 Slope : 3622,479
 Slope Standard Error: 167,367
 Slope Confidence Interval (99.0) -> ] 3189,71; 4055,248[
```

Image 160 - Simple Linear for 99% (Parking Spaces) - Intervals

Multi Linear Regression

Overview of Multi Linear Regression

In the regression analysis, we found situations with more than one independent variable. This regression model takes the multiple regression model (RLM) name. The dependent variable Y may be related to k independent variables.

Multiple linear regression is used to estimate the relationship between two or more independent variables and one dependent variable. So, multiple linear regression is used when you want to know:

1. How strong the relationship is between the two or more independent variables and one dependent variable.
2. The value of the dependent variable at a certain value of the independent variables (Bevans, 2020b)

Multiple Linear Regression Model

The formula for a multiple linear regression is (Bevans, 2020b):

$$Y = \beta_0 + \beta_1 X_1 + \cdots + \beta_n X_n + \varepsilon$$

Image 161 - Method_25_MATCP_Theorical_8_Slide_4

- Y - predicted value of the dependent variable.
- $\beta 0$ – y-intercept, the predicted value of y when all other parameters are set to 0.
- $\beta 1 X1$– regression coefficient.
- $X1$, Xn– independent variable.
- cursive εi – model error of the estimate or how much variation there is in our estimate of Y.

The model of the multiple linear regression presented is a system of n equations with the matrix representation:

$$Y = X\beta + \varepsilon$$

$$Y = \begin{bmatrix} y_1 \\ y_2 \\ \dots \\ y_n \end{bmatrix}, X = \begin{bmatrix} 1 & x_{11} & x_{1k} \\ \dots & \dots & \dots \\ 1 & x_{n1} & x_{nk} \end{bmatrix}, \beta = \begin{bmatrix} \beta_0 \\ \beta_1 \\ \dots \\ \beta_n \end{bmatrix}, \varepsilon = \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \dots \\ \varepsilon_n \end{bmatrix}$$

Image 162 - Method_26_MATCP_Theorical_8_Slide_6

However, to obtain the matrix representation it is necessary to calculate the following matrix of X and Y variables: $X, X^T, X^T X, (X^T X)^{-1}, Y, Y^T, Y^T Y, X^T Y, X^T X . X^T Y = \widehat{\beta}, \beta^T$

Model Significance

Anova

The Anova calculations for multiple regression are nearly identical to the calculations for simple linear regression, except that the degrees of freedom are adjusted to reflect the number of independent variables in the model.

$$SQ_T = SQ_R + SQ_E$$

Image 163 - Method_26_MATCP_Theorical_8_Slide_14

- SQT - measures the total variation of observations around the mean.
- SQR - measures the variation of the dependent variable.
- SQE - measures the variation of the independent variable.

$$SQ_T = Y^T Y - n\overline{y}^2 \qquad SQ_R = \beta^T X^T Y - n\overline{y}^2 \qquad SQ_E = Y^T Y - \beta^T X^T Y$$

Image 164 - Method_27_28_29_MATCP_Theorical_8_Slide_14

The calculations are synthesized in the table:

Source of variation	Sum of squares	Degrees of freedom	Root mean square	F test stats
Regression	SQ_R	k	$MQ_R = \frac{SR}{k}$	$F = \frac{MSR}{MSE}$
Error	SQ_E	$n-(k+1)$	$MQ_E = \frac{SE}{n-(k+1)}$	
Total	SQ_T	$n-1$		

Image 165 - Table_2_MATCP_Theorical_8_Slide_16

Coefficient determination

The coefficient determination is a measure of the proportion of change in response variable Y that is explained by the regression equation.

$$R^2 = \frac{SQ_R}{SQ_T} = 1 - \frac{SQ_E}{SQ_T} \qquad R^2_{adj} = \frac{(1-R^2)(n-1)}{n-(k+1)}$$

Image 166 - Method_30_31_MATCP_Theorical_8_Slide_17

Outputs:

Multilinear for 95%:

```
SIGNIFICANCE_LEVEL=0.05
n=499,0000
SQT=7709791182,4507
SQR=5746112120,8091
SQE=1963679061,6416
R Squared =0,7453
R Squared Adjusted =0,7427
```

Image 167 - Multilinear for 95% - Part_1_ANOVA

```
||-=-=-=- Significance Model With ANOVA -=-=-=-||
 MQR:1149222424,1618
 MQE:3983121,8289
 F0 :288,5230
 F de Snedecor : 2,1170
-=-=-=-=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=-=-=-=-
F0 > F de Snedecor
H0 is rejected -> regression model is significant
 -=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=
```

Image 168 - Multilinear for 95% - Part_2_ANOVA

The mean squares for regression (MQR) is 1149222424,1618, and the mean squares for error (MQE) is 3983121,8289. The F-statistic is calculated as 288.5230, and the critical F-value at a significance level of 0.05 is 2,1170. Since the calculated F-statistic is greater than the critical F-value, we reject the null hypothesis (H0) and conclude that the regression model is significant.

Multilinear for 99%:

```
SIGNIFICANCE_LEVEL=0.01
n=499,0000
SQT=7709791182,4507
SQR=5746112120,8091
SQE=1963679061,6416
R Squared =0,7453
R Squared Adjusted =0,7427
```

Image 169 - Multilinear for 99% - Part_1_ANOVA

```
||-=-=-=- Significance Model With ANOVA -=-=-=-||
 MQR:1149222424,1618
 MQE:3983121,8289
 F0 :288,5230
 F de Snedecor : 2,8386
-=-=-=-=-=-=-
H0 : b = b0
H1 : b != b0
-=-=-=-=-=-=-
F0 > F de Snedecor
H0 is rejected -> regression model is significant
 -=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=
```

Image 170 - Multilinear for 99% - Part_2_ANOVA

To understand the values on this output, we only need to follow the same line of thought that we used in the previous output.

Hypothesis tests for model coefficients

The hypothesis tests are a statistical procedure that is used to claim the data of the table of values. The hypothesis tests for all the regression coefficients follow a five-step procedure (Kumar, 2022):

- Formulate null and alternate hypotheses:

$$H_0: \beta_j = 0 \ \ v.s. \ \ \beta_j: a \neq 0$$

Image 171 - Method_32_MATCP_Theorical_8_Slide_21

- Determine the test statistics:

$$T_0 = \frac{\widehat{\beta_j}}{\sqrt{\hat{\sigma}^2 C_{jj}}} \qquad \hat{\sigma}^2 = \frac{SQ_E}{n-(k+1)} = MQ_E$$

Image 172 - Method_33_34_MATCP_Theorical_8_Slide_18_21

$$Cjj - element\ j\ of\ the\ main\ diagonal\ of\ matriz\ C = (X^T X)^{-1}$$

- Determine the critical region:

$$t_c = t_{1-\frac{\alpha}{2}}[n-(k+1)] \qquad RC =]-\infty, -t_c[U]t_c, +\infty[$$

Image 173 - Method_35_36_MATCP_Theorical_8_Slide_21

- Calculate the statistics.
- Make decisions:
    - The rejection of $H0$ allows us to conclude that the regressor xj has explanatory power. The non-rejection of $H0$ allows us to conclude that the regressor xj can be “deleted”.

Outputs:

Multilinear for 95%:

```
-=-=-=-=-=- Hypothesis Tests (95.0%) -=-=-=-=-=-
Test : H0 : B = 0
       H1 : B =|= 0
-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=
Parameter 0: 809,2582
observed t -> 1,9800
tc ->1,9647
|observed t| > tc, Rejects H0
-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=
Parameter 1: -11,0780
observed t -> -2,5921
tc ->1,9647
|observed t| > tc, Rejects H0
-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=
Parameter 2: 4,8278
observed t -> 16,9583
tc ->1,9647
|observed t| > tc, Rejects H0
-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=
Parameter 3: -1072,8759
observed t -> -7,9843
tc ->1,9647
|observed t| > tc, Rejects H0
-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=
Parameter 4: 592,7870
observed t -> 4,3914
tc ->1,9647
|observed t| > tc, Rejects H0
-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=
Parameter 5: 1695,6582
observed t -> 11,4305
tc ->1,9647
|observed t| > tc, Rejects H0
-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=
```

Image 174 - Multilinear for 95% - Tests

For each parameter, the null hypothesis (H0) states that the coefficient is equal to zero, and the alternative hypothesis (H1) states that the coefficient is not equal to zero. The t-statistic is calculated for each parameter, and the critical t-value at a significance level of 0.05 is 1,9647. If the absolute value of the observed t-statistic is greater than the critical t-value, we reject the null hypothesis. Based on the hypothesis tests, all the parameters in the model are significant at a 5% significance level.

Multilinear for 99%:

```
-=-=-=-=-=- Hypothesis Tests (99.0%) -=-=-=-=-=-
Test : H0 : B = 0
       H1 : B =|= 0
-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-
Parameter 0: 809,2582
observed t -> 1,9800
tc ->2,5858
|observed t| <= tc, Accepts H0
-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-
Parameter 1: -11,0780
observed t -> -2,5921
tc ->2,5858
|observed t| > tc, Rejects H0
-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-
Parameter 2: 4,8278
observed t -> 16,9583
tc ->2,5858
|observed t| > tc, Rejects H0
-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-
Parameter 3: -1072,8759
observed t -> -7,9843
tc ->2,5858
|observed t| > tc, Rejects H0
-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-
Parameter 4: 592,7870
observed t -> 4,3914
tc ->2,5858
|observed t| > tc, Rejects H0
-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-
Parameter 5: 1695,6582
observed t -> 11,4305
tc ->2,5858
|observed t| > tc, Rejects H0
-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-
```

Image 175 - Multilinear for 99% - Tests

To test the significance of each individual independent variable, hypothesis tests are performed. The significance level is set at 0.01 (1%). The results of the tests are as follows:

- Parameter 0: The coefficient is 809,2582. The observed t-value is 1.9800, which is less than the critical t-value of 2.5858. Therefore, the null hypothesis (H0: B = 0) is accepted, indicating that the parameter is not statistically significant.
- Parameter 1: The coefficient is -11,0780. The observed t-value is -2.5921, which is greater than the critical t-value of -2.5858. Thus, the null hypothesis is rejected, indicating that the parameter is statistically significant.
- Parameter 2: The coefficient is 4,8278. The observed t-value is 16.9583, which is greater than the critical t-value of 2.5858. Hence, the null

hypothesis is rejected, indicating that the parameter is statistically significant.

- Parameter 3: The coefficient is -1072,8759. The observed t-value is -7.9843, which is greater than the critical t-value of -2.5858. Therefore, the null hypothesis is rejected, suggesting that the parameter is statistically significant.
- Parameter 4: The coefficient is 592,7870. The observed t-value is 4.3914, which is greater than the critical t-value of 2.5858. Thus, the null hypothesis is rejected, indicating that the parameter is statistically significant.
- Parameter 5: The coefficient is 1695,6582. The observed t-value is 11.4305, which is greater than the critical t-value of 2.5858. Hence, the null hypothesis is rejected, suggesting that the parameter is statistically significant.

Confidence intervals for prediction values

The confidence intervals for prediction values can be used to find the average answer of a variable of their true value. The confidence interval at (1 − α) x 100% for all regression coefficients are given by:

$$]\widehat{\beta_j} - t_c S\sqrt{\hat{\sigma}^2 C_{jj}}\,, \widehat{\beta_j} + t_c S\sqrt{\hat{\sigma}^2 C_{jj}}\,[$$

Image 176 - Method_37_MATCP_Theorical_8_Slide_18

Outputs:

Multilinear for 95%:

```
[-=-=-=-=-=-= Confidence Intervals (95.0%) -=-=-=-=-=-=]



Parameter 0 Confidence Interval (95.0%): ]6,2313, 1612,2851[
Parameter 0 =809,2582
Standard Error: 408,7174
 -=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=

Parameter 1 Confidence Interval (95.0%): ]-19,4748, -2,6812[
Parameter 1 =-11,0780
Standard Error: 4,2737
 -=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=

Parameter 2 Confidence Interval (95.0%): ]4,2685, 5,3872[
Parameter 2 =4,8278
Standard Error: 0,2847
 -=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=

Parameter 3 Confidence Interval (95.0%): ]-1336,8855, -808,8663[
Parameter 3 =-1072,8759
Standard Error: 134,3732
 -=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=

Parameter 4 Confidence Interval (95.0%): ]327,5682, 858,0057[
Parameter 4 =592,7870
Standard Error: 134,9887
 -=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=

Parameter 5 Confidence Interval (95.0%): ]1404,1978, 1987,1185[
Parameter 5 =1695,6582
Standard Error: 148,3448
 -=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=
```

Image 177 - Multilinear for 95% - Intervals

Multilinear for 99%:

```
[-=-=-=-=-=-= Confidence Intervals (99.0%) -=-=-=-=-=-=]



Parameter 0 Confidence Interval (99.0%): ]-247,5859, 1866,1023[
Parameter 0 =809,2582
Standard Error: 408,7174
 -=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=

Parameter 1 Confidence Interval (99.0%): ]-22,1288, -0,0271[
Parameter 1 =-11,0780
Standard Error: 4,2737
 -=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=

Parameter 2 Confidence Interval (99.0%): ]4,0917, 5,5640[
Parameter 2 =4,8278
Standard Error: 0,2847
 -=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=

Parameter 3 Confidence Interval (99.0%): ]-1420,3325, -725,4193[
Parameter 3 =-1072,8759
Standard Error: 134,3732
 -=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=

Parameter 4 Confidence Interval (99.0%): ]243,7390, 941,8349[
Parameter 4 =592,7870
Standard Error: 134,9887
 -=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=

Parameter 5 Confidence Interval (99.0%): ]1312,0743, 2079,2420[
Parameter 5 =1695,6582
Standard Error: 148,3448
 -=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=
```

Image 178 - Multilinear for 99% - Intervals

Annex C. MDISC

Sorting Algorithms

Introduction

The project establishes the use of concepts taught on Discrete Mathematics to ensure that the required features are implemented correctly.

One of the functionalities that requires the use of discrete math concepts is US17 (“As a network manager, I want to list all deals made.”) that consists on the user having the option to choose manually the two algorithms implemented, and those are about sorting in an ascending or descending order the deals made related to real estate, so to sort all the deals made we implemented the bubble sort algorithm and the sort selection algorithm.

The bubble sort algorithm is a simple sorting algorithm that sorts the elements simply by comparing adjacent values two by two and placing them in ascending order in case they aren’t. The algorithm continues to pass through the list until no more swaps are needed, indicating that the list is sorted.

```
procedure bubble_sort(a[1],a[2],...,a[n]:real)
for i:= 1 to n-1
    for j:= 1 to n-i
        if a[j] > a[j+1] then swap a[j] and a[j+1]
```

Image 179 - Bubble Sort Pseudocode Ascending

```
for (int i = 0; i < resultList.size() - 1; i++) {
    for (int j = 0; j < resultList.size() - i - 1; j++) {
        if
(resultList.get(j).getPublishedAnnouncement().getProperty().getArea() >
resultList.get(j +
1).getPublishedAnnouncement().getProperty().getArea()) {
            aux = resultList.get(j);
            resultList.set(j, resultList.get(j + 1));
            resultList.set(j + 1, aux);
        }
    }
}
return resultList;
```

Image 180 - Bubble Sort Code Ascending

```
procedure bubble_sort(a[1],a[2],...,a[n]:real)
for i:= 1 to n-1
    for j:= 1 to n-i
        if a[j] < a[j+1] then swap a[j] and a[j+1]
```

Image 181 - Bubble Sort Pseudocode Descending

```
for (int i = 0; i < resultList.size() - 1; i++) {
    for (int j = 0; j < resultList.size() - i - 1; j++) {
        if
(resultList.get(j).getPublishedAnnouncement().getProperty().getArea() <
resultList.get(j +
1).getPublishedAnnouncement().getProperty().getArea()) {
            aux = resultList.get(j);
            resultList.set(j, resultList.get(j + 1));
            resultList.set(j + 1, aux);
        }
    }
}
return resultList;
```

Image 182 - Bubble Sort Code Descending

This algorithm goes through the following steps:

1. Takes an array a of real numbers as input. The array has elements a[1] through a[n], where n is the total number of elements.
2. The outer loop for i := 1 to n-1 controls the number of passes that need to be made over the array. Since each pass will move the largest unsorted element to its correct position, n-1 passes are sufficient to sort the entire array.
3. The inner loop for j := 1 to n-i iterates through the unsorted portion of the array. In each pass, the largest unsorted element will "bubble up" to the end of the unsorted portion. Therefore, the loop range decreases by i in each pass to exclude the already sorted elements at the end of the array.
4. Inside the inner loop, there is an if statement that compares a[j] with a[j+1]. If the element at index j is greater than the element at index j+1, it means they are in the wrong order and need to be swapped.
5. The swap operation exchanges the values of a[j] and a[j+1], effectively moving the larger element towards the end of the unsorted portion.
6. After completing both loops, the array will be sorted in ascending order.

The sort selection algorithm is a simple and efficient sorting algorithm that is described as an in-place comparison-based algorithm that divides the list into two parts, the sorted part on the left and the unsorted part on the right and works by repeatedly selecting the smallest (or largest) element from the unsorted portion of the list and moving it to the sorted portion of the list.

```
procedure sort_selection(a[1],a[2],...,a[n]:real)
for i:= 1 to n
max_Index:= i
  for j:= i+1 to n
           if a[j] > a[max_Index] then max_Index := j

aux = a[max_Index]
a[max_Index] = a[i]
a[i] = aux
```

Image 183 - Sort Selection Pseudocode Ascending

```
Offer aux;
int max_Index;

for (int i = 0; i < resultList.size() - 1; i++) {
    max_Index = i;
    for (int j = i + 1; j < resultList.size(); j++) {
        if
(resultList.get(j).getPublishedAnnouncement().getProperty().
getArea() >
resultList.get(max_Index).getPublishedAnnouncement().getProp
erty().getArea()) {
            max_Index = j;
        }
    }
    aux = resultList.get(max_Index);
    resultList.set(max_Index, resultList.get(i));
    resultList.set(i, aux);
}
return resultList;
```

Image 184 - Sort Selection Code Ascending

```
procedure sort_selection(a[1],a[2],...,a[n]:real)
for i:= 1 to n
max_Index:= i
  for j:= i+1 to n
           if a[j] < a[max_Index] then max_Index := j

aux = a[max_Index]
a[max_Index] = a[i]
a[i] = aux
```

Image 185 - Sort Selection Pseudocode Descending

```
Offer aux;
int max_Index;

for (int i = 0; i < resultList.size() - 1; i++) {
    max_Index = i;
    for (int j = i + 1; j < resultList.size(); j++) {
        if
(resultList.get(j).getPublishedAnnouncement().getProperty().
getArea() <
resultList.get(max_Index).getPublishedAnnouncement().getProp
erty().getArea()) {
            max_Index = j;
        }
    }
    aux = resultList.get(max_Index);
    resultList.set(max_Index, resultList.get(i));
    resultList.set(i, aux);
}
return resultList;
```

Image 186 - Sort Selection Code Descending

This algorithm goes through the following steps:

1. Set the first element as maximum.
2. Compare minimum with the second element. If the second element is smaller than minimum, assign the second element as minimum. The process goes on until the last element.
3. After each iteration, minimum is placed in the front of the unsorted list.
4. For each iteration, indexing starts from the first unsorted element. Step 1 to 3 are repeated until all elements are placed at their correct positions.

Worst-case time complexity analysis

As we saw earlier, the bubble sort algorithm repeatedly compares adjacent elements and swaps them if they are in the wrong order and this process continues until the entire list is completed sorted and the sort of selection algorithm repeatedly selects the smallest or largest from the unsorted portion of the list and moves it to the sorted portion of the list.

In the worst-case scenario, we consider an input where the list is already sorted in descending order, and we want to sort it in ascending order. This input configuration maximizes the number of comparisons and swaps required by bubble sort.

Bubble Sort

The first line it will be performed n times. For each interaction it will be done n compartions and n increments and for each iteration in the first cycle for there will be n – i interaction in the second cycle for and also it will be done n comparations and n increments. Thus, the total number of comparations performed, the total number of interactions and the maximum number of trades it described as:

$$\sum_{i=1}^{n-1}(n-i) = \sum_{i=1}^{n-1} n \; - \sum_{i=1}^{n-1} i \; = n\,(\,n\,-\,1\,) - \frac{1\,+\,(n\,-\,1)}{2}\,(n\,-\,1) \;=\; \frac{n(n\,-\,1)}{2}$$

Lines		Bubble Sort Algorithm
1st	`for i := 1 to n - 1`	$\mathrm{nC} + \mathrm{nA}$
2nd	`for j := 1 to n - i`	$\frac{n(n-1)}{2}A + \frac{n(n-1)}{2}C$
3rd	`if a[j] > a[j + 1] then swap a[j] and a[j + 1]`	$\frac{n(n-1)}{2}A + \frac{n(n-1)}{2}Op$
Total		
Complexity O		$O(n^2)$

Sort Selection

The first line it will be performed n + 1 times. For each interaction i it will be done n + 1 compartions and n + 1 increments and for each iteration in the first cycle for there will be I + 1 interaction in the second cycle for and it will be done n comparations and n increments. Thus, the total number of comparations performed, the total number of interactions and the maximum number of trades it described as:

$$\sum_{i=1}^{n-1}(n-i) = \sum_{i=1}^{n-1} n \; - \sum_{i=1}^{n-1} i \; = n\,(\,n\,-\,1\,) - \frac{1\,+\,(n\,-\,1)}{2}\,(n\,-\,1) \;=\; \frac{n(n\,-\,1)}{2}$$

Lines		Sort Selection Algorithm
1st	`for i:= 1 to n`	$\mathrm{n{+}1C + n{+}1A}$
2nd	`max_Index:= i`	$\frac{n(n-1)}{2}A + \frac{n(n-1)}{2}C$
3rd	`for j:= i+1 to n`	$\frac{n(n-1)}{2}A + \frac{n(n-1)}{2}Op$
4th	`if a[j] > a[max_Index] then max_Index := j`	nA
5th	`aux = a[max_Index]`	nA
6th	`a[max_Index] = a[i]`	nA
total	`a[i] = aux`	
Complexity O		$O(n^2)$

Balanced Partition Problem

Introduction

One of the functionalities that requires the use of discrete math concepts is US19 (“As a network manager, I want to divide a set of all stores into two subsets, so that the total number of properties of the stores between the two subsets is the closest possible.”) which lead to the Balanced Partition Problem. This problem consists in determining whether a given set can be partitioned into two subsets such that the sum of elements in both subsets is the same, and to solve this problem you need to implement a brute force algorithm. A brute force algorithm is a straightforward method of solving a problem through exhaustion that rely on sheer computing power and trying every possibility rather than advanced techniques to improve efficiency, they are simple and consistent, but very low.

```
int stores = stores.size
int n = 2^size - 1
int sum1 = 0
int sum2 = 0
int minDifference = 9999
int difference String auxBinary = ""
int[] storeListings = new int[size]

for i := 1 to size
      storeListings[i] = stores.get(i).getListing()
      for i := 1 to totalSubsets
            String binary = Integer.toBinaryString(i);
            for j := 1 to n
                  if (j < binary.length) then
                        if(binary.charAt(i)==”1”)      then      sum1      =
storeListings[i] + sum1
                        else sum2 = storeListings[i] + sum2
                  else sum2 = storeListings[i] + sum2
            difference = |sum1 - sum2|;
            if (difference < minDifference) then minDifference = difference
&& auxBinary = binary

            sum1 = 0;
            sum2 = 0;

      List<String> l1 = new ArrayList<>()
      List<String> l2 = new ArrayList<>()

      for j := 1 to size
            if (i < auxBinary.length())
                  if  (binary.charAt(i)  ==  “1”)  then  l1.add("ID:  "  +
stores.get(i).getId() + " Number Properties: " + stores.get(i).getListing())
                  else  l2.add("ID:  "  +  stores.get(i).getId()  +  "  Number
Properties: " + stores.get(i).getListing())
            else l2.add("ID:" + stores.get(i).getId() + " Number Properties:
" + stores.get(i).getListing())

      List<List<String>> result = new ArrayList<>()
      String minDifferenceString = "" + minDifference

      List<String> minDifferencelist = new ArrayList<>()
      minDifferencelist.add(minDifferenceString)

      result.add(l1)
      result.add(l2)
      result.add(minDifferencelist)

return result
```

Image 187 - Brute Force Pseudocode

```
int size = stores.size();
int totalSubsets = (int)Math.pow(2, size) - 1;
int sum1 = 0;
int sum2 = 0;
int minDifference = 9999;
int difference;
String auxBinary = "";
int[] storeListings = new int[size];
for (int i = 0; i < size; i++) {
    storeListings[i] = stores.get(i).getListing();
}
for (int i = 0; i < totalSubsets; i++) {
    String binary = Integer.toBinaryString(i);
    for (int j = 0; j < size; j++) {
        if (j < binary.length()) {
            if
(Character.toString(binary.charAt(j)).equals("1")) {

                sum1 = storeListings[j] + sum1;
            } else {
                sum2 = storeListings[j] + sum2;
            }
        } else {
            sum2 = storeListings[j] + sum2;
        }
    }
    difference = Math.abs(sum1 - sum2);
    if (difference < minDifference) {
        minDifference = difference;
        auxBinary = binary;
    }
    sum2 = 0;
    sum1 = 0;
}
List<String> l1 = new ArrayList<>();
List<String> l2 = new ArrayList<>();
for (int i = 0; i < stores.size(); i++) {
    if (i < auxBinary.length()) {
        if
(Character.toString(auxBinary.charAt(i)).equals("1")) {
            l1.add("ID: " + stores.get(i).getId() + "   Number
Properties: " + stores.get(i).getListing());
        } else {
            l2.add("ID: " + stores.get(i).getId() + "   Number
Properties: " + stores.get(i).getListing());
        }
```

Image 188 - Brute Force Code (pt.1)

```
} else {
        l2.add("ID:" + stores.get(i).getId() + "   Number
Properties: " + stores.get(i).getListing());
    }
}
List<List<String>> result = new ArrayList<>();
String minDifferenceString = "" + minDifference;
List<String> minDifferencelist = new ArrayList<>();
minDifferencelist.add(minDifferenceString);
result.add(l1);
result.add(l2);
result.add(minDifferencelist);
return result;
```

Image 189 - Brute Force Code (pt.2)

Runtime tests for inputs of various sizes

n = 3	
0.0000297033	0.000031775
0.000029145	0.0000587799
Average = 0.0000373508	

n = 6	
0.0000352867	0.0000693188
0.0000349767	0.0000432826
Average = 0.0000457162	

n = 9	
0.0000500567	0.0000672951
0.0000616567	0.0000829792
Average = 0.00006	

n = 12	
0.0001717517	0.0002099993
0.0001587083	0.000191809
Average = 0.00018	

n = 15

0.0004532517	0.0004554049
0.00040573	0.0004126923
Average = 0.00043	

n = 18	
0.001167975	0.0011929979
0.0012344117	0.0010826549
Average = 0.001169509875	

n = 21	
0.00616138	0.0066971306
0.0061633667	0.0069105083
Average = 0.0064830964	

n = 24	
0.045738215	0.051408082
0.044082845	0.0540142403
Average = 0.048810845575	

n = 27	
0.3687313967	0.3802427799
0.36942178	0.3529977347
Average = 0.367848422825	

n = 30	
3.2040580517	2.5107936889
3.1694024033	2.4754850083
Average = 2.83993478805	

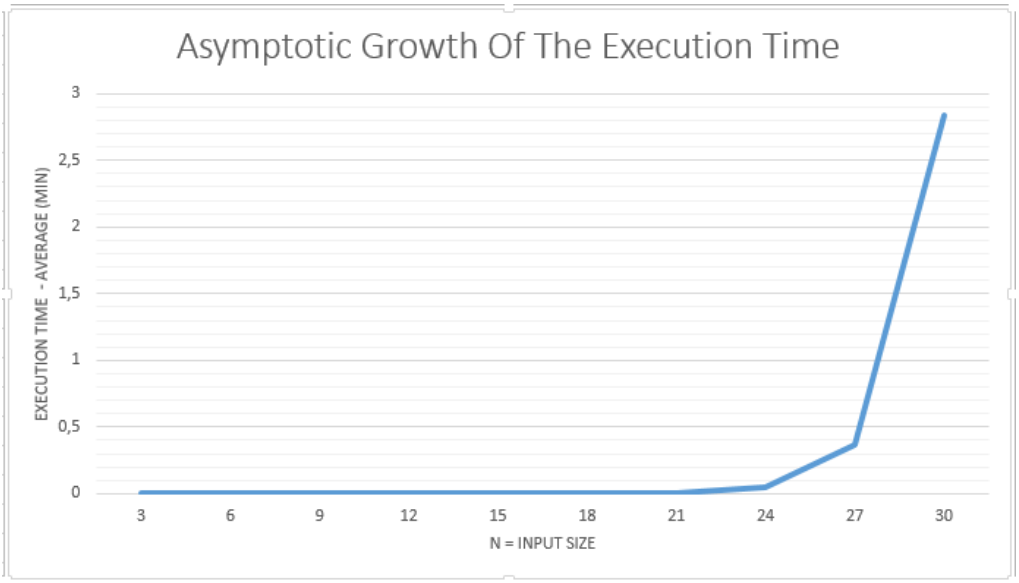


Image 190 - Asymptotic Growth Of Execution Time

Worst-case time complexity analysis

1	`int stores = stores.size`	1A
2	`int n = 2^size - 1`	1A +1Op
3	`int sum1 = 0`	1A
4	`int sum2 = 0`	1A
5	`int minDifference = 9999`	1A
6	`int difference String auxBinary = ""`	1A
7	`int[] storeListings = new int[size]`	1A
8	`for i := 1 to size`	size+1A+ size+1C
9	`storeListings[i] = stores.get(i).getListing()`	sizeA
10	`for i := 1 to n`	n+1A + n+1C
11	`String binary = Integer.toBinaryString(i);`	nA
12	`for j := 1 to size`	(size+1)*nA+ (size+1)*nC
13	`if (j < binary.length) then`	size*nC
14	`if(binary.charAt(i) == "1")`	nC
15	`then sum1 = storeListings[i] + sum1`	nA + nOp
16	`else sum2 = storeListings[i] + sum2`	size*nA + size*nOp
17	`else sum2 = storeListings[i] + sum2`	size*nC

18	`difference = |sum1 - sum2|;`	nA+nOp
19	`if (difference < minDifference) then minDifference = difference && auxBinary = binary`	nC
20	`sum1 = 0;`	nA
21	`sum2 = 0;`	nA
22	`List<String> l1 = new ArrayList<>()`	1A
23	`List<String> l2 = new ArrayList<>()`	1A
24	`for i := 1 to size`	size+1A + size+1C
25	`if (i < auxBinary.length())`	size
26	`if (binary.charAt(i) == "1") then l1.add("ID: " + stores.get(i).getId() + " Number Properties: " + stores.get(i).getListing())`	auxbinary.lengthA + auxbinary.lengthC
27	`else l2.add("ID: " + stores.get(i).getId() + " Number Properties: " + stores.get(i).getListing())`	auxbinary.lengthA + auxbinary.lengthC
28	`else l2.add("ID:" + stores.get(i).getId() + " Number Properties: " + stores.get(i).getListing())`	sizeA+sizeOp
29	`List<List<String>> result = new ArrayList<>()`	1A
30	`String minDifferenceString = "" + minDifference`	1A+1Op
31	`List<String> minDifferencelist = new ArrayList<>()`	1A
32	`minDifferencelist.add(minDifferenceString)`	1A+1Op
33	`result.add(l1)`	1A+1Op
34	`result.add(l2)`	1A+1Op
35	`result.add(minDifferencelist)`	1A+1Op
36	`return result`	1R
Total		
ComplexityO		O(n)