DSBA Hackathon 2023

ESSEC & Centrale Supélec

'The Right Price'

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Introduction

Problem Statement:
How can I make real estate investment decisions accurately, reliably and quickly?

Proposal:
Build an interactive customer interface based on a powerful price predicting model

Methodology:

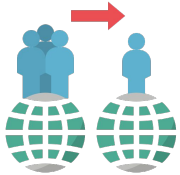
1. Key Insights of Property Market in Ile de France
2. Price Prediction Modelling
3. Use insights obtained to develop further value add for clients

Conclusion:
Access model results, explain how results were arrived at, and provide future application and recommendations

Further Ideas to Explore:
What are the other potential use cases for our model and applications?

What have the purchase trends been in Paris in recent years?

- Sales continue as per previous trends:
  - 144,350 second-hand and 21,000 new homes were sold in 2020;
  - 155,400 and 27,300 were the 10-year average previously



- Post health-crisis spending behavior. Clients now search for:
  - More room;
  - Change in setting - greater appetite for single family homes in Inner and Outer Suburbs, away from Greater Paris Region

- Nevertheless, prices remain on an upward trend in Parisas of end-2020
  - 5.9% increase in single-family home prices
  - 6.5% increase in second-hand apartments

- Institutional investors are an important clientele:
  - 5.2 billion Euros worth of investments; a clientele that should always be observed

What influences property prices in Paris?

Macroeconomic Conditions

1. Stable economic conditions and favourable borrowing conditions
   - ~1.20% mortgage rate (5.07% during Financial Crisis)
   - Average Mortgage Term: 233 months (20 years)
2. Low unemployment: 4Q 2022 - 7.2% unemployment, lowest since Q1 2008
3. High savings rate resultant from the pandemic, with increase in property purchases when lockdowns were lifted
4. Trends indicate property purchases will likely continue

Micro-Factors

Main Factors in Paris

- Location of Property
- Type of Property
- Surface Area (m2)
- Year of Construction
- Year of Last Renovation
- Number of Rooms

Other Factors:

- Amenities
- Presence of Construction Nearby
- Proximity to Transport Links
- Presence of Crime
- Tax Rate on Properties

- 1er arrondissement : 13.445 €/m2
- 2eme arrondissement : 12.570 €/m2
- 3eme arrondissement : 12.982 €/m2
- 4eme arrondissement : 13.928 €/m2
- 5eme arrondissement : 13.186 €/m2
- 6eme arrondissement : 15.367 €/m2
- 7eme arrondissement : 14.827 €/m2
- 8eme arrondissement : 12.510 €/m2
- 9eme arrondissement : 11.872 €/m2
- 10eme arrondissement : 11.065 €/m2
- 11eme arrondissement : 11.305 €/m2
- 12eme arrondissement : 10.355 €/m2
- 13eme arrondissement : 9.916 €/m2
- 14eme arrondissement : 10.805 €/m2
- 15eme arrondissement : 10.976 €/m2
- 16eme arrondissement : 12.086 €/m2
- 17eme arrondissement : 11.767 €/m2
- 18eme arrondissement : 10.855 €/m2
- 19eme arrondissement : 9.475 €/m2
- 20eme arrondissement : 9.874 €/m2

Who are the buyers of properties in France?

64% of French nationals own their own home
(EU average: 69.7%)

Within Paris, only 33% of Parisians own their own homes

17% of all homes in Paris are houses

Most purchase their homes in their 30s or later

Immigrant populations more likely to rent than to own properties

Lower income households typically purchase in rural areas and small towns, contingent on state aid

Our Price Prediction Model

Premise:

Predictive model for Apartments sold in first-hand market in Ile de France

Features:

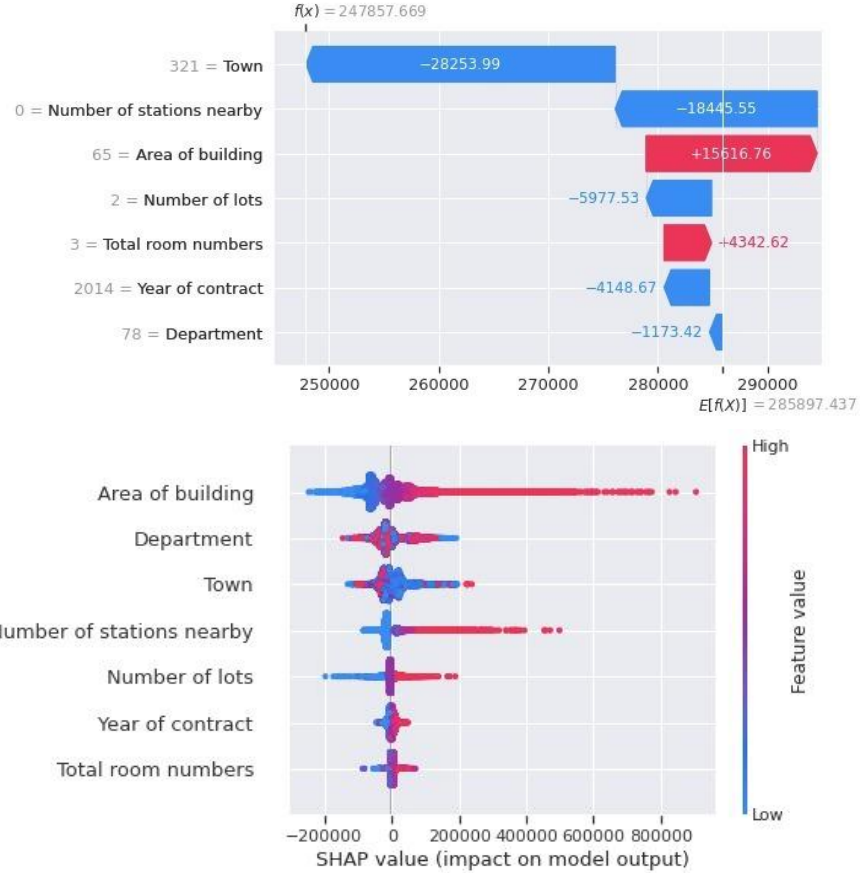
- Year of mutation
- Location information: *department*, *commune*, *stations nearby*
- Housing conditions: *number of lots*, *total number of main rooms*

Model Performance:

With **LightGBM**, we achieved this:

RMSE Prediction: 51 331€

R2 Prediction: 83.2%



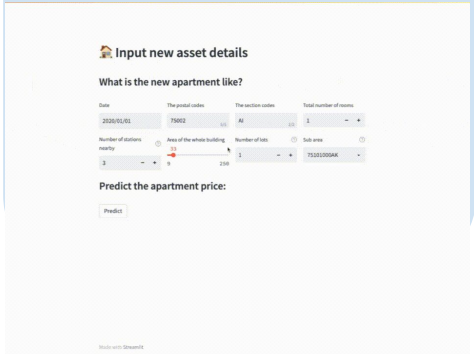
Value Creation

We wanted to give info to clients guided by *3 principles*:

1. **Convenient** - Clients can easily obtain information
2. **Intuitive** - Clients can make informed decisions from the information given
3. **Reliable** - Clients feel confident to reuse the product in the future

Convenient

Easy and quick to request and obtain information with no hassle, paperwork or delay

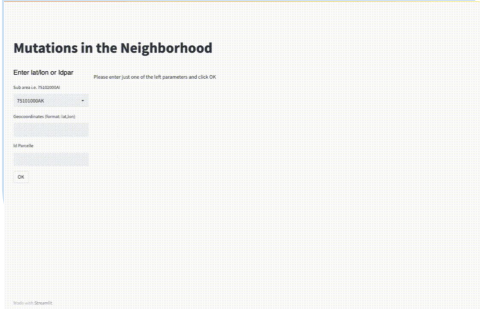


Intuitive

Understand the information quickly with little technical jargon

Reliable

Rely on the authenticity and integrity of information without second-guessing in the future



Dashboards: Visualization Tools for our models

We want to illustrate our work in an intuitive, interactive and instant manner. A Dashboard is designed for values created. Just by enter and click, clients can obtain further insights on the apartment neighborhood.

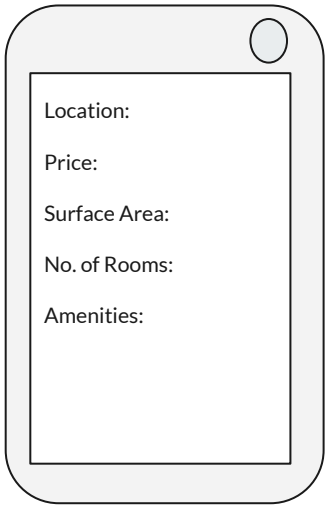
Intuitive, **I**nteractive, **I**nstant

How much is the apartment whose features suit my situations? What is price trend of a similar apartment?

What is the spatial price distribution in Ile de France? Which part has reasonable price?

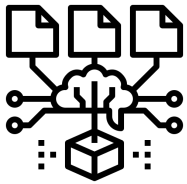
Which apartments were dealt and how do the price tend in the neighborhood of my selected one?

Future improvements of the app



Inputs from Clients

+



Pricing Model

(what we are proposing today)

Add-on A:
Give range of options based on Price

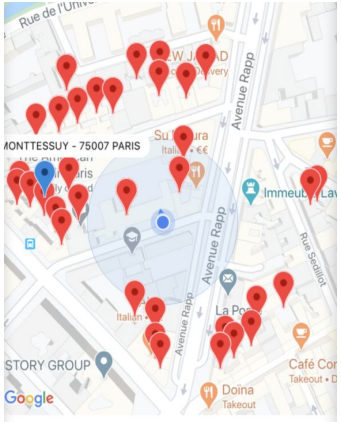
"My budget is 500k, what options do I have right now?"

List alternatives within +/- 5/10/15% of price Indicated by client

Add-on B:
Give range of options based on Location

"What options are in the same area?"

List price ranges <u>within same vicinity</u> of result found for the client by the model



Conclusions

What did we set out to do?
Determine if prices of apartments in Paris can be modeled based on selected features.

How did we accomplish this goal?
First, we extracted features from publicly available data. Other features were engineered where if no direct sources were present. The model makes on average an error of ~ 50 000€ and it is able to capture more than 83% of the features that contribute to the apartment prices in l'Ile de France.

What else did we do?
We designed dashboard to represent features used in our model to make it easy for client how our model predicted the prices of apartments. These dashboards were:
1. Price Prediction Interface
2. Apartment Price Heatmap
3. Neighbour Market Explorer.

Can we further leverage insights learned to benefit clients?
Our next step is to enable comparison functions by being able to:
1. Compare prices with surrounding properties with the property predicted by our model;
2. Provide alternatives of other properties within a price band in other locations.

Thank You!

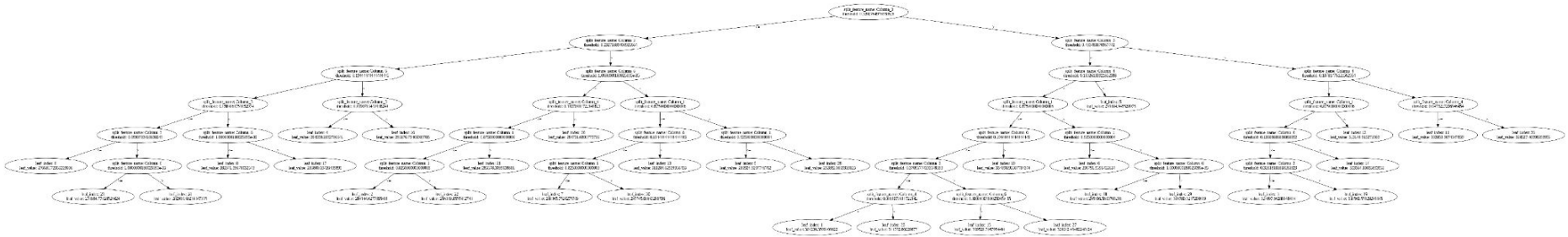
Appendix

Comparison of performances among models:

Model	Linear Regression	XGBoost	LightGBM
RMSE (Validation)	104557.357	65696.789	63310.076
RMSE (Test)	105596.887	57784.661	55814.324
RMSE (Prediction)	84441.000	51321.379	51330.950
R2 (Validation)	0.597	0.840	0.851
STD of R2 (Validation)	0.018	0.030	0.028
R2 (Test)	0.635	0.891	0.898
R2 (Prediction)	0.545	0.832	0.832

Appendix

LightGBM Regression Tree:



References

Slide 3: “The Residential Property Market.” *Knightfrank.com/Research*, Knight Frank, Nov. 2020, https://content.knightfrank.com/research/2185/documents/en/the-residential-property-market-feb-2021-7869.pdf.

Slide 4: “Property Valuation in Paris.” *RealAdvisor.fr,* RealAdvisor, Property-valuation-city-paris

Slide 5: Una Dimitrijevic, “Buying Property in France,” *Expatica.com,* 30 January 2023, https://www.expatica.com/fr/housing/buying/buying-property-in-france-101126/