Prague University of Economics and Business

Faculty of Informatics and Statistics

****

Airbnb: Price prediction in Prague

4IT439 – Data-X – Applied data analytics models in real world tasks

Term paper

Team 3: Tomáš Mikulenka, Lukáš Kuthan, Adéla Smrčková, Jana Štolcová

Date: 6. 5. 2024

Content

[1 Data Understanding 4](#_Toc164002798)

[2 Data Preparation 5](#_Toc164002799)

[3 Data Visualization 6](#_Toc164002800)

[4 Modelling 7](#_Toc164002801)

[5 Model interpretation 8](#_Toc164002802)

[6 Bonus tasks 9](#_Toc164002803)

# Data Understanding

We used python to explore the data. At first we downloaded all three versions of everything from the website. Then we went and looked at it one by one.

* Neighbourhoods – the same, kept one for possible binning (already included in listings)
* Reviews – all reviews in one file, kept the newest one from December
* Calendars – the data from December seem strange, so we decided to use only the one from June and September
* Listings – also a bit strange data from December, so we used only June and September

Here are some insights from our data exploration of the listings:

* price – wrong currency, needs to be a float, but won´t need to use it, we will use the price from calendar (the same case)
* bathroom\_text – text, needs to be transformed, gives us information about the number of bathrooms and also if it is shared or not
* bathroom – empty column, will be dropped
* neighbourhood – can be dropped, cleaned data are already in the column neighbourhood\_cleansed
* amenities – all equipment of the accommodation, could be helpful in the model if properly handled
* price, room type, accommodates, beds, bedrooms, bathrooms, neighbourhood will be probably the most important parameters for the model
* multiple other empty columns, will be dropped
* true false columns will be also transformed into Boolean 1/0

For the purpose of this report we have used python to give us a table (on the following page), which describes all the columns in listings.

We decided not to include the grey columns in the model, because they don´t seem to us as relevant. The others we want in the model, the green ones will stay as they are and the orange ones need to be transformed. The transformations are described in the next chapter.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Column** | **Data Type** | **Non-null val** | **Missing val** | **Unique Count** | **Min Value** | **Max Value** | **Mean Value** | **SD** | **Outlier Count** |
| id | int64 | 8949 | 0 | 8949 |  |  |  |  |  |
| listing\_url | object | 8949 | 0 | 8949 |  |  |  |  |  |
| scrape\_id | int64 | 8949 | 0 | 1 |  |  |  |  |  |
| last\_scraped | object | 8949 | 0 | 1 |  |  |  |  |  |
| source | object | 8949 | 0 | 2 |  |  |  |  |  |
| name | object | 8949 | 0 | 6728 |  |  |  |  |  |
| description | object | 8785 | 164 | 7599 |  |  |  |  |  |
| neighborhood\_overview | object | 4904 | 4045 | 3126 |  |  |  |  |  |
| picture\_url | object | 8949 | 0 | 8627 |  |  |  |  |  |
| host\_id | int64 | 8949 | 0 | 3180 | 3128 | 537229454 | 167351187,56 | 176419788 | 0 |
| host\_url | object | 8949 | 0 | 3180 |  |  |  |  |  |
| host\_name | object | 8949 | 0 | 1383 |  |  |  |  |  |
| host\_since | object | 8949 | 0 | 2144 |  |  |  |  |  |
| host\_location | object | 7025 | 1924 | 191 |  |  |  |  |  |
| host\_about | object | 5259 | 3690 | 1479 |  |  |  |  |  |
| host\_response\_time | object | 7860 | 1089 | 4 |  |  |  |  |  |
| host\_response\_rate | object | 7860 | 1089 | 47 |  |  |  |  |  |
| host\_acceptance\_rate | object | 8284 | 665 | 92 |  |  |  |  |  |
| host\_is\_superhost | object | 8637 | 312 | 2 |  |  |  |  |  |
| host\_thumbnail\_url | object | 8949 | 0 | 3048 |  |  |  |  |  |
| host\_picture\_url | object | 8949 | 0 | 3048 |  |  |  |  |  |
| host\_neighbourhood | object | 8197 | 752 | 132 |  |  |  |  |  |
| host\_listings\_count | int64 | 8949 | 0 | 68 | 0 | 2562 | 21,96 | 72 | 27 |
| host\_total\_listings\_count | int64 | 8949 | 0 | 83 | 0 | 5324 | 36,50 | 219 | 15 |
| host\_verifications | object | 8949 | 0 | 6 |  |  |  |  |  |
| host\_has\_profile\_pic | object | 8949 | 0 | 2 |  |  |  |  |  |
| host\_identity\_verified | object | 8949 | 0 | 2 |  |  |  |  |  |
| neighbourhood | object | 4904 | 4045 | 236 |  |  |  |  |  |
| neighbourhood\_cleansed | object | 8949 | 0 | 52 |  |  |  |  |  |
| neighbourhood\_group\_cleansed | float64 | 0 | 8949 | 0 |  |  |  |  | 0 |
| latitude | float64 | 8949 | 0 | 5334 | 50 | 50 | 50,08 | 0 | 19 |
| longitude | float64 | 8949 | 0 | 6193 | 14 | 15 | 14,43 | 0 | 19 |
| property\_type | object | 8949 | 0 | 60 |  |  |  |  |  |
| room\_type | object | 8949 | 0 | 4 |  |  |  |  |  |
| accommodates | int64 | 8949 | 0 | 16 | 1 | 16 | 3,93 | 2 | 0 |
| bathrooms | float64 | 0 | 8949 | 0 |  |  |  |  | 0 |
| bathrooms\_text | object | 8933 | 16 | 34 |  |  |  |  |  |
| bedrooms | float64 | 7030 | 1919 | 15 | 1 | 34 | 1,57 | 1 | 33 |
| beds | float64 | 8833 | 116 | 26 | 1 | 50 | 2,61 | 2 | 83 |
| amenities | object | 8949 | 0 | 8040 |  |  |  |  |  |
| price | object | 8949 | 0 | 3121 |  |  |  |  |  |
| minimum\_nights | int64 | 8949 | 0 | 63 | 1 | 1115 | 4,97 | 32 | 295 |
| maximum\_nights | int64 | 8949 | 0 | 128 | 1 | 9000 | 590,46 | 464 | 2 |
| minimum\_minimum\_nights | int64 | 8949 | 0 | 61 | 1 | 1115 | 4,43 | 29 | 269 |
| maximum\_minimum\_nights | int64 | 8949 | 0 | 66 | 1 | 1115 | 9,64 | 41 | 285 |
| minimum\_maximum\_nights | int64 | 8949 | 0 | 97 | 1 | 3333 | 693,11 | 472 | 1 |
| maximum\_maximum\_nights | int64 | 8949 | 0 | 97 | 1 | 3333 | 751,94 | 451 | 1 |
| minimum\_nights\_avg\_ntm | float64 | 8949 | 0 | 231 | 1 | 1115 | 6,16 | 32 | 218 |
| maximum\_nights\_avg\_ntm | float64 | 8949 | 0 | 298 | 1 | 3333 | 734,00 | 451 | 1 |
| calendar\_updated | float64 | 0 | 8949 | 0 |  |  |  |  | 0 |
| has\_availability | object | 8949 | 0 | 2 |  |  |  |  |  |
| availability\_30 | int64 | 8949 | 0 | 31 | 0 | 30 | 9,90 | 9 | 0 |
| availability\_60 | int64 | 8949 | 0 | 61 | 0 | 60 | 25,93 | 20 | 0 |
| availability\_90 | int64 | 8949 | 0 | 91 | 0 | 90 | 43,06 | 31 | 0 |
| availability\_365 | int64 | 8949 | 0 | 366 | 0 | 365 | 159,07 | 133 | 0 |
| calendar\_last\_scraped | object | 8949 | 0 | 1 |  |  |  |  |  |
| number\_of\_reviews | int64 | 8949 | 0 | 499 | 0 | 1693 | 63,26 | 100 | 6 |
| number\_of\_reviews\_ltm | int64 | 8949 | 0 | 121 | 0 | 385 | 17,72 | 23 | 6 |
| number\_of\_reviews\_l30d | int64 | 8949 | 0 | 19 | 0 | 23 | 1,50 | 2 | 4 |
| first\_review | object | 8066 | 883 | 2585 |  |  |  |  |  |
| last\_review | object | 8066 | 883 | 932 |  |  |  |  |  |
| review\_scores\_rating | float64 | 8066 | 883 | 146 | 0 | 5 | 4,69 | 0 | 49 |
| review\_scores\_accuracy | float64 | 8050 | 899 | 132 | 1 | 5 | 4,74 | 0 | 42 |
| review\_scores\_cleanliness | float64 | 8050 | 899 | 164 | 1 | 5 | 4,68 | 0 | 36 |
| review\_scores\_checkin | float64 | 8050 | 899 | 133 | 1 | 5 | 4,79 | 0 | 73 |
| review\_scores\_communication | float64 | 8051 | 898 | 129 | 1 | 5 | 4,79 | 0 | 79 |
| review\_scores\_location | float64 | 8050 | 899 | 124 | 1 | 5 | 4,77 | 0 | 55 |
| review\_scores\_value | float64 | 8050 | 899 | 136 | 1 | 5 | 4,66 | 0 | 35 |
| license | float64 | 0 | 8949 | 0 |  |  |  |  | 0 |
| instant\_bookable | object | 8949 | 0 | 2 |  |  |  |  |  |
| calculated\_host\_listings\_count | int64 | 8949 | 0 | 53 | 1 | 96 | 17,06 | 24 | 0 |
| calculated\_host\_listings\_count\_entire\_homes | int64 | 8949 | 0 | 50 | 0 | 96 | 14,30 | 23 | 0 |
| calculated\_host\_listings\_count\_private\_rooms | int64 | 8949 | 0 | 22 | 0 | 59 | 1,82 | 7 | 112 |
| calculated\_host\_listings\_count\_shared\_rooms | int64 | 8949 | 0 | 7 | 0 | 77 | 0,78 | 7 | 186 |
| reviews\_per\_month | float64 | 8066 | 883 | 782 | 0 | 27 | 2,00 | 2 | 5 |

Legend

|  |
| --- |
| not for model |
| adjust |
| keep |

# Data Preparation

Here is the next version of the previous table, where each parameter is reasoned with why keep it or not and what changes we did.

Specifics can be found in the code.

|  |  |  |  |
| --- | --- | --- | --- |
| **Column** | **Keep** | **Change** | **Reason** |
| id | No |  | Not relevant, could be misleading |
| listing\_url | No |  | Not relevant, could be misleading |
| scrape\_id | No |  | Not relevant, could be misleading |
| last\_scraped | No |  | Not relevant, could be misleading |
| source | No |  | Not relevant, could be misleading |
| name | No |  | Not relevant, could be misleading |
| description | Yes, but | Count number of signs | Could be relevant |
| neighborhood\_overview | Yes, but | Is or not - boolean | Could be relevant |
| picture\_url | No |  | Not relevant, could be misleading |
| host\_id | No |  | Not relevant, could be misleading |
| host\_url | No |  | Not relevant, could be misleading |
| host\_name | No |  | Not relevant, could be misleading |
| host\_since | Yes, but | Difference from today and in bins (less than year, more than year) | Could be relevant |
| host\_location | No |  | Not relevant, could be misleading |
| host\_about | Yes, but | Is or not - boolean | Could be relevant |
| host\_response\_time | No |  | Not relevant, could be misleading |
| host\_response\_rate | Yes, but | Edit N/A to 0, make bins | Could be relevant |
| host\_acceptance\_rate | No |  | Not relevant, could be misleading |
| host\_is\_superhost | Yes, but | 1/0 boolean | Could be relevant |
| host\_thumbnail\_url | No |  | Not relevant, could be misleading |
| host\_picture\_url | No |  | Not relevant, could be misleading |
| host\_neighbourhood | No |  | Not relevant, could be misleading |
| host\_listings\_count | No |  | Not relevant, could be misleading |
| host\_total\_listings\_count | No |  | Not relevant, could be misleading |
| host\_verifications | No |  | Not relevant, could be misleading |
| host\_has\_profile\_pic | Yes, but | 1/0 boolean | Could be relevant |
| host\_identity\_verified | Yes, but | 1/0 boolean | Could be relevant |
| neighbourhood | No |  | Not relevant, could be misleading |
| neighbourhood\_cleansed | Yes, but | Make bins | Relevant |
| neighbourhood\_group\_cleansed | No |  | Empty |
| latitude | No |  | Not relevant, could be misleading |
| longitude | No |  | Not relevant, could be misleading |
| property\_type | No |  | Not relevant, could be misleading |
| room\_type | Yes |  | Relevant |
| accommodates | Yes |  | Relevant |
| bathrooms | No |  | Empty |
| bathrooms\_text | Yes, but | Convert to number and create a new column boolean shared\_bathroom | Relevant |
| bedrooms | Yes, but | Replace blanks with 1 | Relevant |
| beds | Yes, but | Replace blanks with 1 | Relevant |
| amenities | Yes, but | Give score | Relevant |
| price | No |  | Not relevant, could be misleading |
| minimum\_nights | No |  | Not relevant, could be misleading |
| maximum\_nights | No |  | Not relevant, could be misleading |
| minimum\_minimum\_nights | No |  | Not relevant, could be misleading |
| maximum\_minimum\_nights | No |  | Not relevant, could be misleading |
| minimum\_maximum\_nights | No |  | Not relevant, could be misleading |
| maximum\_maximum\_nights | No |  | Not relevant, could be misleading |
| minimum\_nights\_avg\_ntm | No |  | Not relevant, could be misleading |
| maximum\_nights\_avg\_ntm | No |  | Not relevant, could be misleading |
| calendar\_updated | No |  | Empty |
| has\_availability | No |  | Not relevant, could be misleading |
| availability\_30 | No |  | Not relevant, could be misleading |
| availability\_60 | No |  | Not relevant, could be misleading |
| availability\_90 | No |  | Not relevant, could be misleading |
| availability\_365 | No |  | Not relevant, could be misleading |
| calendar\_last\_scraped | No |  | Not relevant, could be misleading |
| number\_of\_reviews | Yes |  | Could be relevant |
| number\_of\_reviews\_ltm | No |  | Not relevant, could be misleading |
| number\_of\_reviews\_l30d | No |  | Not relevant, could be misleading |
| first\_review | No |  | Not relevant, could be misleading |
| last\_review | No |  | Not relevant, could be misleading |
| review\_scores\_rating | Yes |  | Could be relevant |
| review\_scores\_accuracy | No |  | Not relevant, could be misleading |
| review\_scores\_cleanliness | No |  | Not relevant, could be misleading |
| review\_scores\_checkin | No |  | Not relevant, could be misleading |
| review\_scores\_communication | No |  | Not relevant, could be misleading |
| review\_scores\_location | No |  | Not relevant, could be misleading |
| review\_scores\_value | No |  | Not relevant, could be misleading |
| license | No |  | Empty |
| instant\_bookable | Yes, but | 1/0 boolean | Could be relevant |
| calculated\_host\_listings\_count | No |  | Not relevant, could be misleading |
| calculated\_host\_listings\_count\_entire\_homes | No |  | Not relevant, could be misleading |
| calculated\_host\_listings\_count\_private\_rooms | No |  | Not relevant, could be misleading |
| calculated\_host\_listings\_count\_shared\_rooms | No |  | Not relevant, could be misleading |
| reviews\_per\_month | No |  | Not relevant, could be misleading |

# Data Visualization

* Ceny bych udělala – jak jsme odebrali outliers

# Modelling

* + Try different models and provide a rationale for your selected model choice and architecture. Describe your validation process. Your model report must include the following:n
* Model limitations and considerations
* Ideas to improve the model
* Explain how you chose the values for the hyper-parameters of your model

# Model interpretation

* + Use appropriate methods to interpret the impact of your features on the predictions.
  + Try to interpret main interactions of the most influential features.

# Bonus tasks

* + Analyse the relation between the sentiment and price. Were people who paid more also more satisfied?
  + What high seasons did you identify? How do the seasons differ for different locations and estate types?