projeto1_final

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https://www.kaggle.com/datasets/olistbr/brazilian-ecommerce

[1]:
```
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import seaborn as sns
plt.rcParams['figure.figsize'] = (15, 8)
```

[ ]:
```
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import pingouin as pg
import seaborn as sns
import scipy.stats as stats
from sklearn import datasets, svm, naive_bayes, metrics, model_selection, tree,␣
 ↪neighbors, ensemble
from sklearn.model_selection import train_test_split
from statsmodels.miscmodels.ordinal_model import OrderedModel
plt.rcParams['figure.figsize'] = (15, 8)
```

[2]:
```
df_reviews = pd.read_csv('./archive/olist_order_reviews_dataset.csv')
df_items = pd.read_csv('./archive/olist_order_items_dataset.csv')
df_payments = pd.read_csv('./archive/olist_order_payments_dataset.csv')
df_orders = pd.read_csv('./archive/olist_orders_dataset.csv')
df_customer = pd.read_csv('./archive/olist_customers_dataset.csv')
df_products = pd.read_csv('./archive/olist_products_dataset.csv')
df_geolocation = pd.read_csv('./archive/olist_geolocation_dataset.csv')
df_sellers = pd.read_csv('./archive/olist_sellers_dataset.csv')
```

0.1 Perguntas:

0.1.1 1 – Quantas categorias de produtos foram comercializadas e quais os atributos mais relevantes?

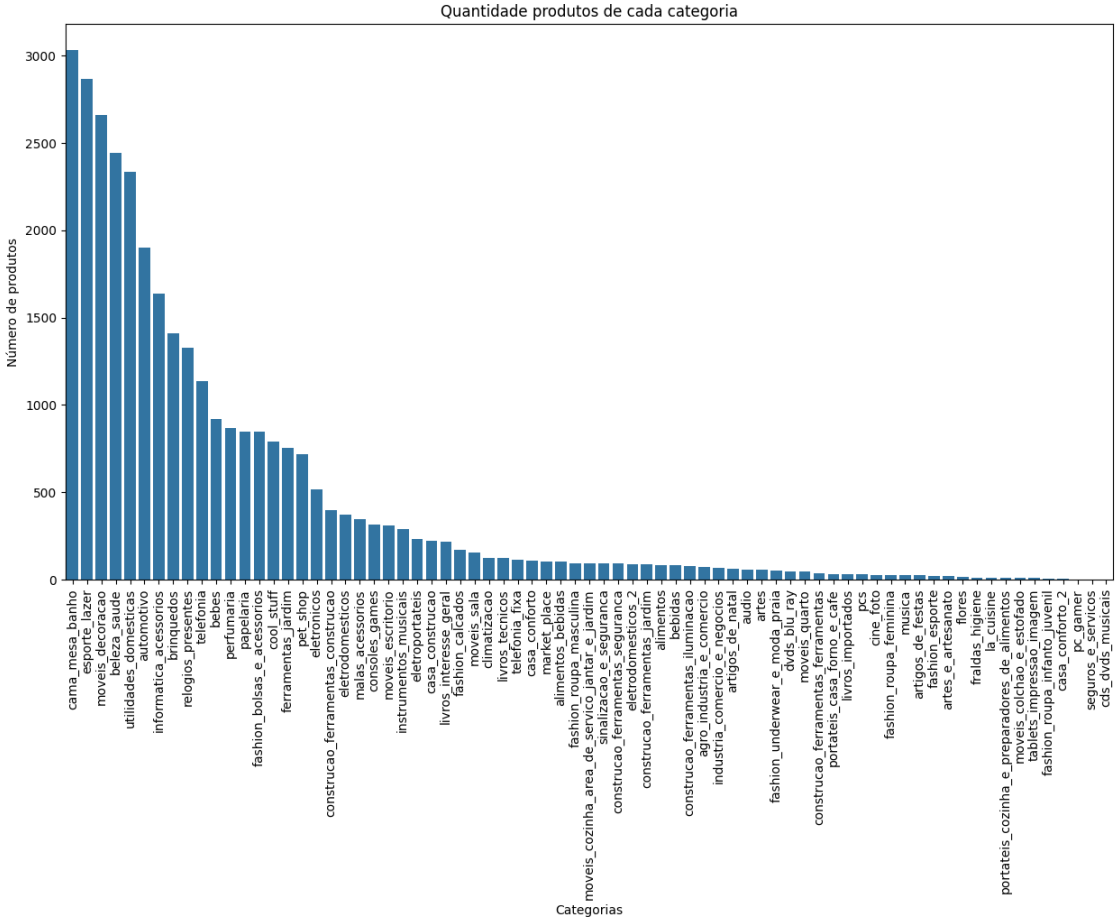
[ ]:
```
df_products['product_category_name'].nunique()
```

[ ]:
```
73
```

0.1.2 2 – Qual a categoria de produtos mais vendida?

[3]:
```
plt.xticks(rotation=90)
sns.countplot(df_products, x='product_category_name', order =␣
 ↪df_products['product_category_name'].value_counts().index)
plt.title("Quantidade produtos de cada categoria")
plt.xlabel("Categorias")
plt.ylabel("Número de produtos")
```

[3]:
```
Text(0, 0.5, 'Número de produtos')
```



[ ]:
```
df_order_products = (df_orders.merge(df_items, on='order_id')
                      .merge(df_products, on='product_id'))
df_order_products['product_category_name'].value_counts(dropna=False)
```

[ ]:
```
product_category_name
cama_mesa_banho                   11115
beleza_saude                       9670
esporte_lazer                      8641
moveis_decoracao                   8334
informatica_acessorios             7827
                                  …
cds_dvds_musicais                    14
la_cuisine                           14
pc_gamer                              9
fashion_roupa_infanto_juvenil         8
seguros_e_servicos                    2
Name: count, Length: 74, dtype: int64
```

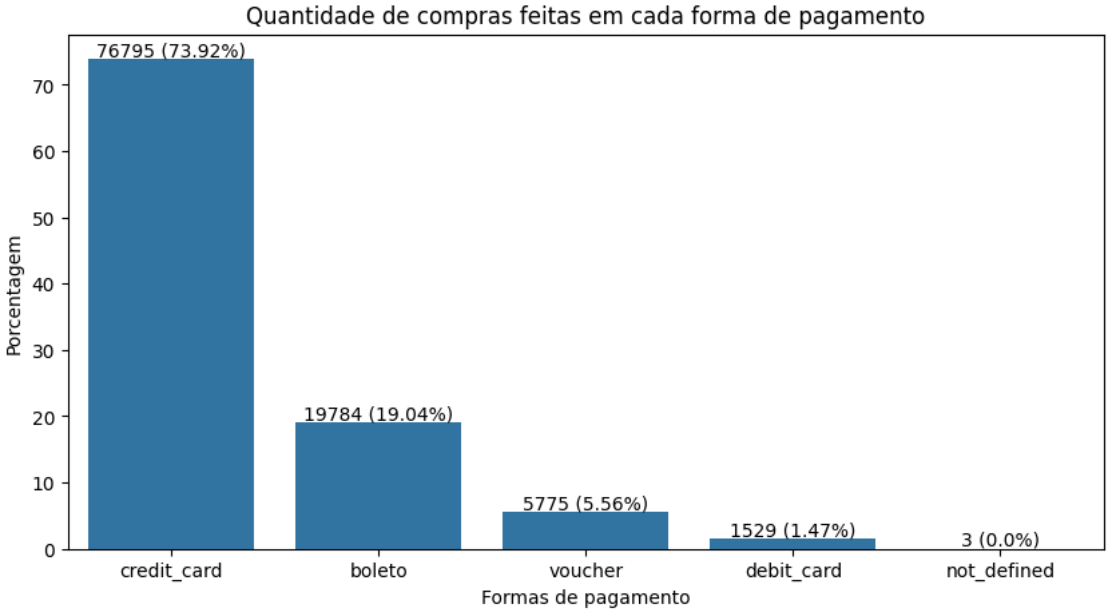
[ ]:
```
del df_order_products
```

0.1.3 3 – Qual a porcentagem de compras feitas com cartão de crédito? Neste caso, qual é o número médio de parcelas?

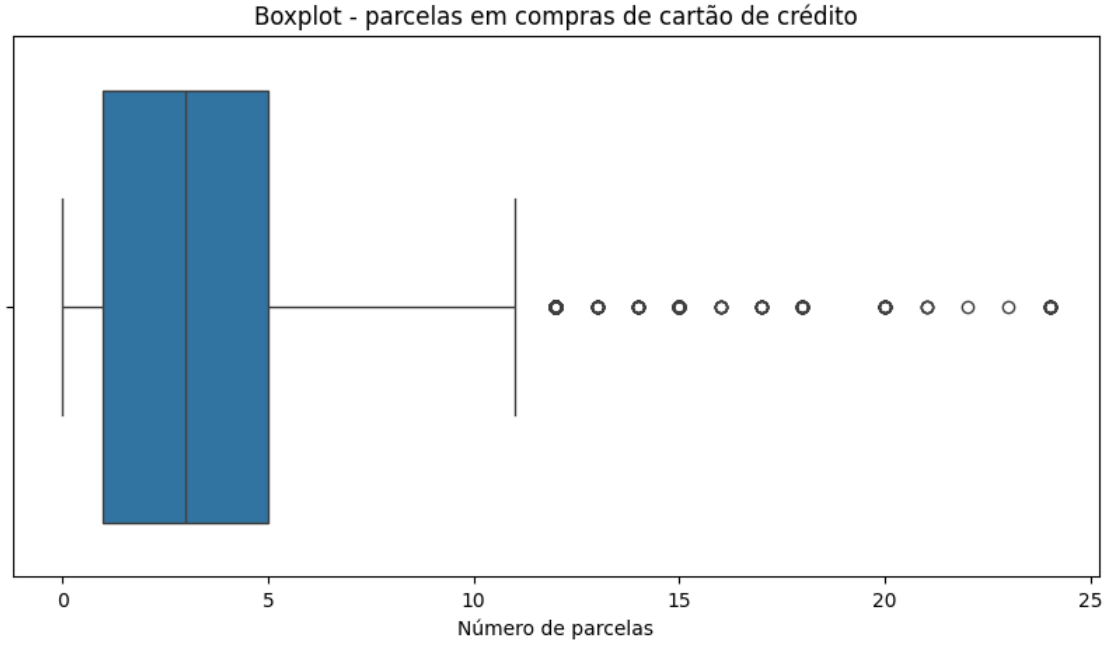
[4]:
```
plt.rcParams['figure.figsize'] = (10, 5)
```

[5]:
```
df_order_payments = df_orders.merge(df_payments, on='order_id')
df_pay = pd.DataFrame(df_order_payments['payment_type'].value_counts()).
 ↪reset_index()
```

[6]:
```
ax = sns.countplot(df_order_payments, x='payment_type', stat='percent', order =␣
 ↪df_order_payments['payment_type'].value_counts().index)
i = 0
for p in ax.patches:
  height = p.get_height()
  text = (str(df_pay['payment_type'][i]) + ' (' + str(p.get_height().round(2))␣
 ↪+ '%)')
  ax.text(p.get_x()+p.get_width()/2., height + 0.5, text, ha="center")
  i+=1
plt.title("Quantidade de compras feitas em cada forma de pagamento")
plt.xlabel("Formas de pagamento")
plt.ylabel("Porcentagem")
plt.show()
```



[7]:
```
sns.boxplot(df_order_payments[df_order_payments['payment_type'] ==␣
 ↪'credit_card'], x='payment_installments')
plt.title("Boxplot - parcelas em compras de cartão de crédito")
plt.xlabel("Número de parcelas")
plt.show()
```



[ ]:
```
df_order_payments[df_order_payments['payment_type'] ==␣
↪'credit_card']['payment_installments'].describe()
```

[ ]:
```
count    76795.000000
mean         3.507155
std          2.850990
min          0.000000
25%          1.000000
50%          3.000000
75%          5.000000
max         24.000000
Name: payment_installments, dtype: float64
```

0.1.4 4 – O valor das compras fica em média em torno de qual valor em reais?

[ ]:
```
df_order_payments['payment_value'].describe()
```

[ ]:
```
count    103886.000000
mean        154.100380
std         217.494064
min           0.000000
25%          56.790000
50%         100.000000
75%         171.837500
max       13664.080000
Name: payment_value, dtype: float64
```

[8]:
```
sns.histplot(df_order_payments, x='payment_value')
plt.title("Valor das compras")
plt.xlabel("Valor")
plt.ylabel('')
plt.show()
```

[9]:
```
del df_order_payments
```

0.1.5 5 – Qual a porcentagem de clientes satisfeitos com a realização da compra (review score = 4 ou 5)

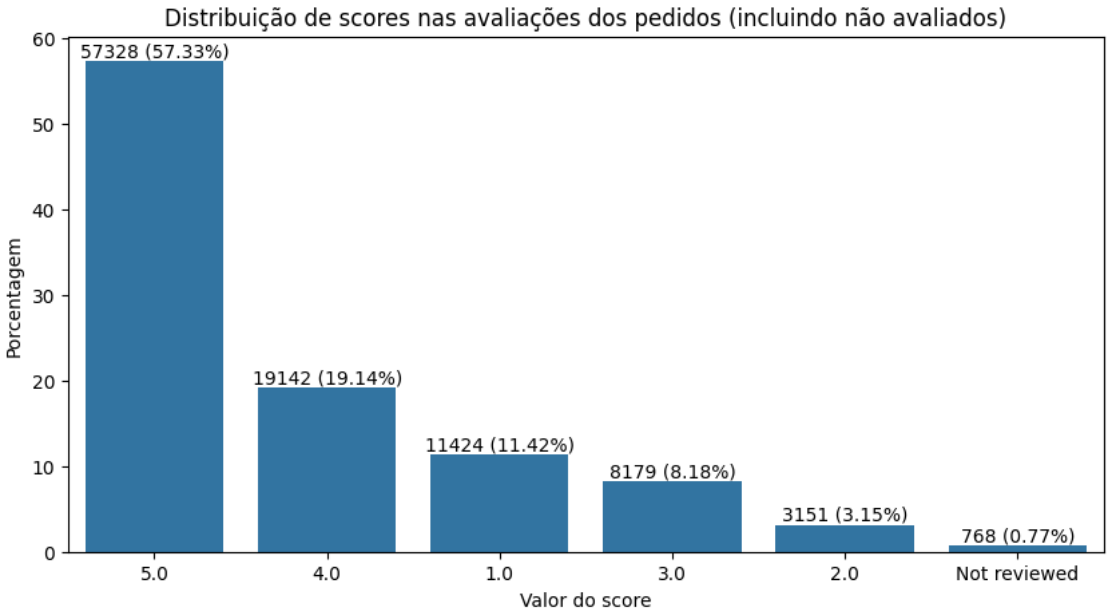
[10]:
```
df_order_reviews = df_orders.merge(df_reviews, on='order_id', how='left')
df_order_reviews['review_score'] = df_order_reviews['review_score'].astype(str)
df_order_reviews.loc[df_order_reviews['review_score'] == 'nan', 'review_score']␣
 ↪= 'Not reviewed'
df_ord = pd.DataFrame(df_order_reviews['review_score'].value_counts()).
 ↪reset_index()
```

[ ]:
```
df_order_reviews.shape, df_orders.shape
```

[ ]:
```
((99992, 14), (99441, 8))
```

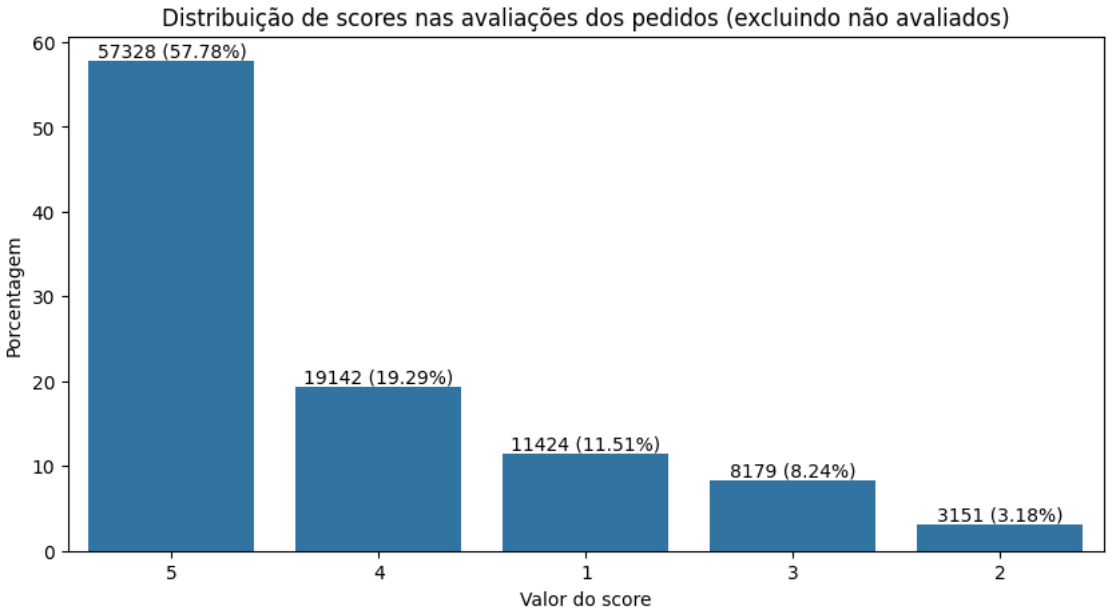
[11]:
```
ax = sns.countplot(df_order_reviews.sort_values('review_score'),␣
 ↪x='review_score', stat='percent', order = df_order_reviews['review_score'].
 ↪value_counts().index)

i = 0
for p in ax.patches:
  height = p.get_height()
  text = (str(df_ord['review_score'][i]) + ' (' + str(p.get_height().round(2))␣
 ↪+ '%)')
  ax.text(p.get_x()+p.get_width()/2., height + 0.5, text,ha="center")
```

```
  i+=1

plt.title("Distribuição de scores nas avaliações dos pedidos (incluindo não␣
 ↪avaliados)")
plt.xlabel("Valor do score")
plt.ylabel('Porcentagem')
plt.show()
```



[13]:
```
df_rev = pd.DataFrame(df_reviews['review_score'].value_counts()).reset_index()
```

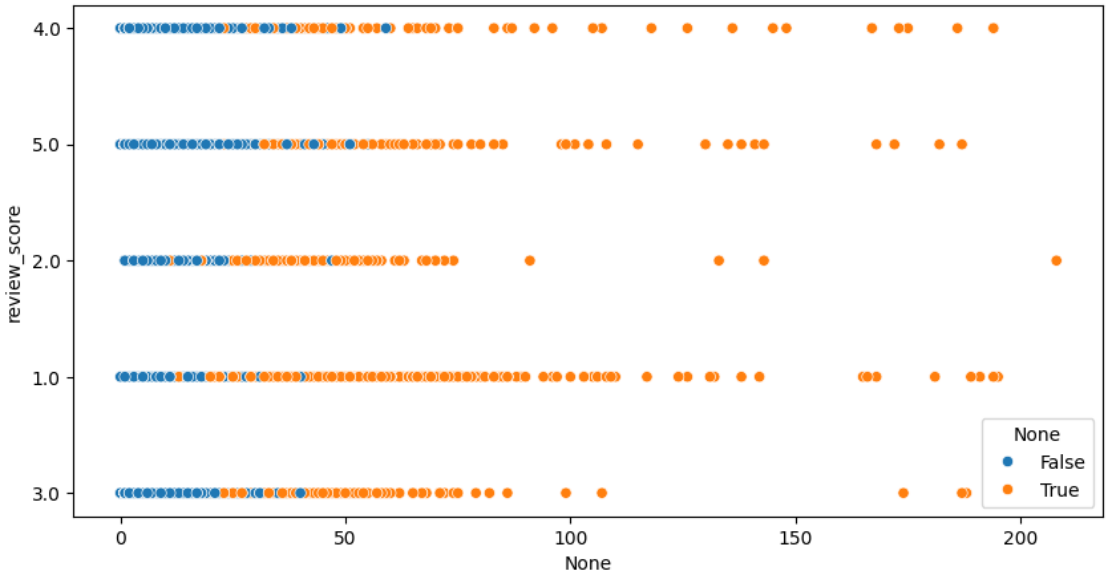
[14]:
```
ax = sns.countplot(df_reviews.sort_values('review_score'), x='review_score',␣
 ↪stat='percent', order = df_reviews['review_score'].value_counts().index)

i = 0
for p in ax.patches:
  height = p.get_height()
  text = (str(df_rev['review_score'][i]) + ' (' + str(p.get_height().round(2))␣
 ↪+ '%)')
  ax.text(p.get_x()+p.get_width()/2., height + 0.5, text,ha="center")
  i+=1

plt.title("Distribuição de scores nas avaliações dos pedidos (excluindo não␣
 ↪avaliados)")
plt.xlabel("Valor do score")
plt.ylabel('Porcentagem')
plt.show()
```



0.1.6 6 – Existe relação entre o tempo de entrega e avaliação feita pelo cliente?

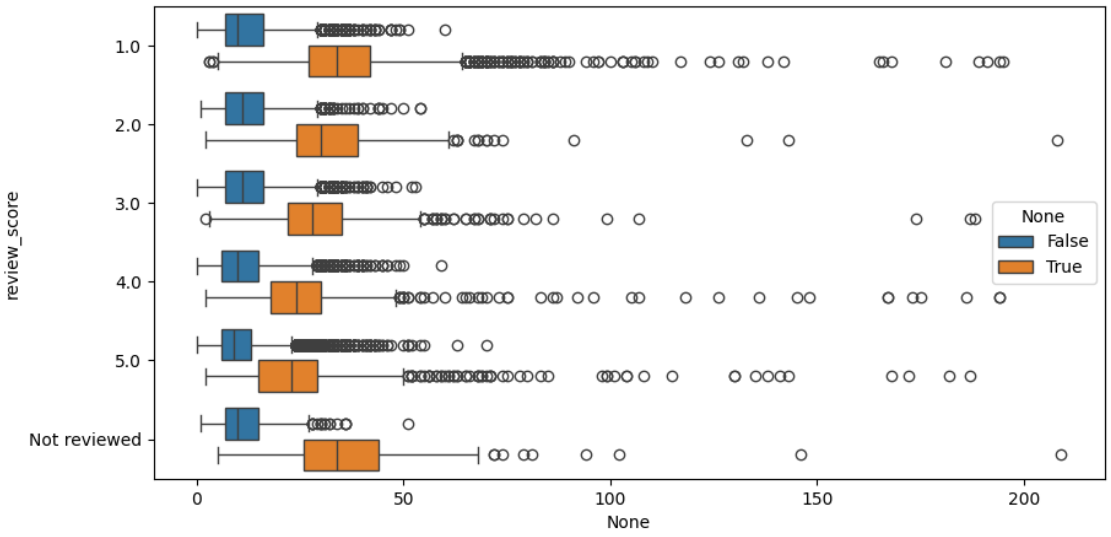
[ ]:
```
sns.scatterplot(x=((pd.
↪to_datetime(df_order_reviews['order_delivered_customer_date']) - pd.
↪to_datetime(df_order_reviews['order_purchase_timestamp']))).dt.
↪days[df_order_reviews['review_score'] != 'Not reviewed'] ,␣
↪y=df_order_reviews['review_score'][df_order_reviews['review_score'] != 'Not␣
↪reviewed'], hue=pd.
↪to_datetime(df_order_reviews['order_delivered_customer_date'])[df_order_reviews['review_sco
↪!= 'Not reviewed'] > pd.
↪to_datetime(df_order_reviews['order_estimated_delivery_date'])[df_order_reviews['review_sco
↪!= 'Not reviewed'])
```

[ ]:
```
<Axes: xlabel='None', ylabel='review_score'>
```



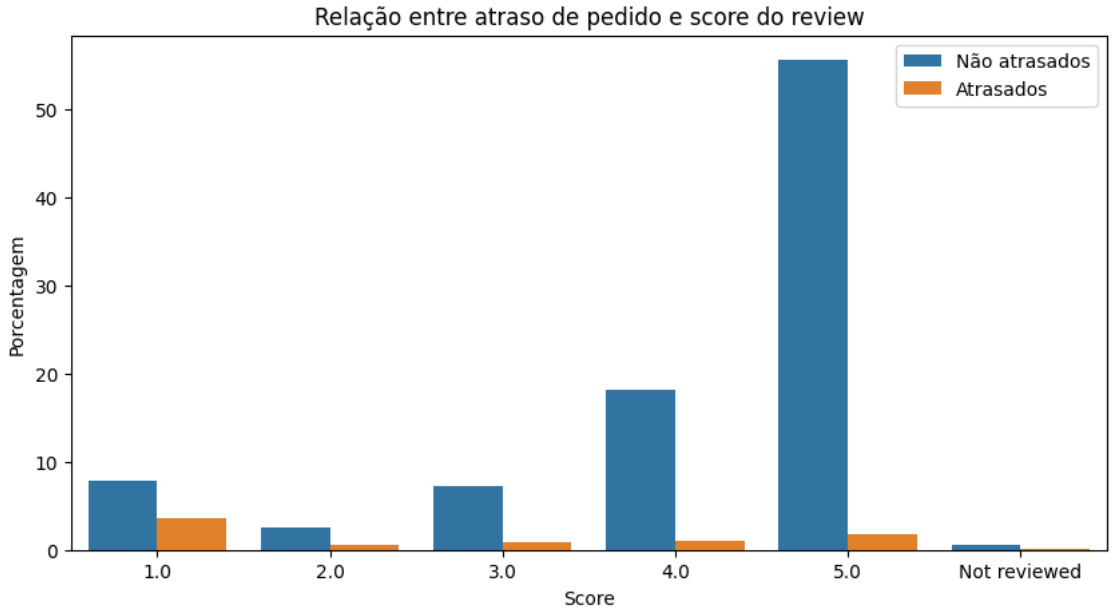
[ ]:
```
sns.boxplot(x=((pd.to_datetime(df_order_reviews.
↪sort_values('review_score')['order_delivered_customer_date']) - pd.
↪to_datetime(df_order_reviews.
↪sort_values('review_score')['order_purchase_timestamp']))).dt.days,␣
↪y=df_order_reviews.sort_values('review_score')['review_score'], orient='h',␣
↪hue=pd.to_datetime(df_order_reviews.
↪sort_values('review_score')['order_delivered_customer_date']) > pd.
↪to_datetime(df_order_reviews.
↪sort_values('review_score')['order_estimated_delivery_date']))
```

[ ]:
```
<Axes: xlabel='None', ylabel='review_score'>
```



[15]:
```
sns.countplot(df_order_reviews.sort_values('review_score'), x='review_score',␣
 ↪stat='percent', hue=pd.to_datetime(df_order_reviews.
 ↪sort_values('review_score')['order_delivered_customer_date']) > pd.
 ↪to_datetime(df_order_reviews.
 ↪sort_values('review_score')['order_estimated_delivery_date']))
plt.legend(labels=['Não atrasados', 'Atrasados'])
plt.title('Relação entre atraso de pedido e score do review')
plt.xlabel('Score')
plt.ylabel('Porcentagem')
```

[15]:
```
Text(0, 0.5, 'Porcentagem')
```



0.1.7 7 – Quais estados do Brasil que possuem mais clientes insatisfeitos?

[16]:
```
df_geo_reviews = (df_reviews.merge(df_orders, on='order_id'))
df_geo_reviews = df_geo_reviews.merge(df_customer, on='customer_id')
df_geo_reviews_low = df_geo_reviews[df_geo_reviews.review_score < 4]
df_geo_reviews_low['customer_state'].value_counts()
```

[16]:
```
SP    8564
RJ    3697
MG    2515
RS    1181
PR    1010
```

```
BA     971
SC     853
DF     493
GO     491
ES     482
PE     405
CE     395
PA     286
MA     236
MT     202
MS     158
PB     136
PI     132
AL     128
RN     107
SE     105
RO      66
TO      61
AM      28
AC      21
RR      18
AP      13
Name: customer_state, dtype: int64
```

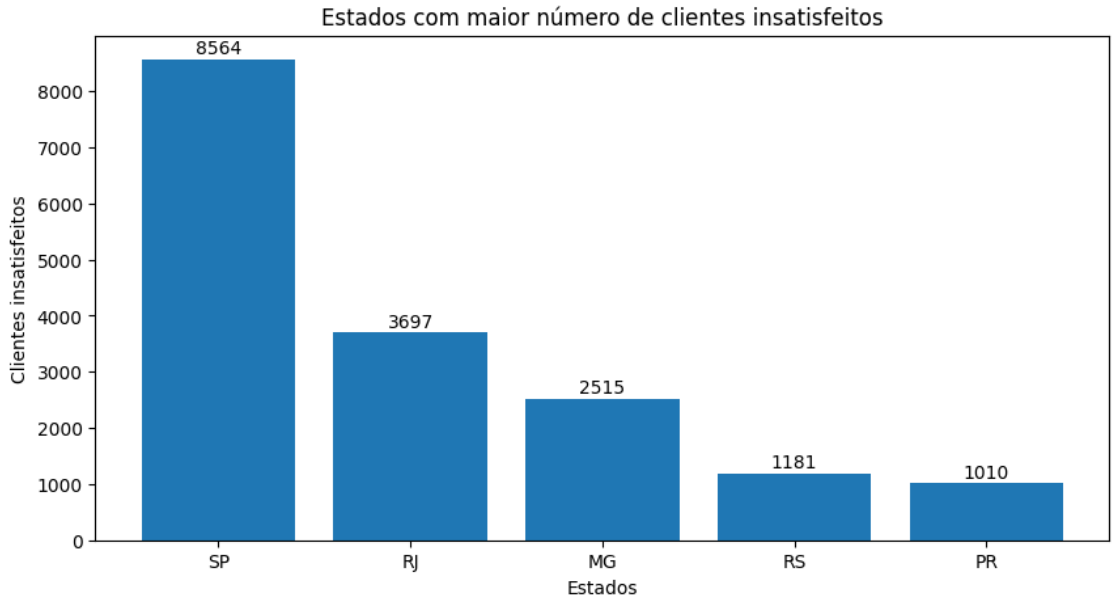
[17]:
```
df = pd.DataFrame(df_geo_reviews_low['customer_state'].value_counts()).
 ↪reset_index()
df = df[df['customer_state'] > 1000]
df
```

[17]:

	index	customer_state
0	SP	8564
1	RJ	3697
2	MG	2515
3	RS	1181
4	PR	1010

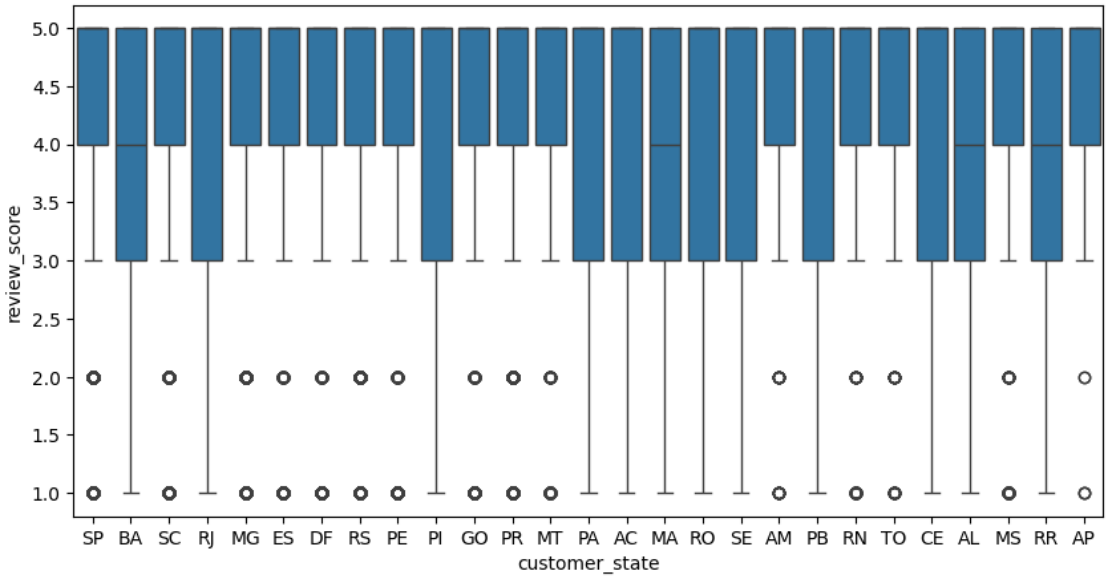
[18]:
```
ax = plt.bar(df['index'], df['customer_state'])

i = 0
for p in ax:
    width = p.get_width()
    height = p.get_height()
    text = (str(df['customer_state'][i]))
    x, y = p.get_xy()
    plt.text(x+width/2,
             y+height+100,
             text,
```

```
            ha='center')
    i+=1


plt.xlabel("Estados")
plt.ylabel("Clientes insatisfeitos")
plt.title("Estados com maior número de clientes insatisfeitos")
plt.show()
```



[ ]:
```
sns.boxplot(df_geo_reviews, x='customer_state', y='review_score')
```

[ ]:
```
<Axes: xlabel='customer_state', ylabel='review_score'>
```



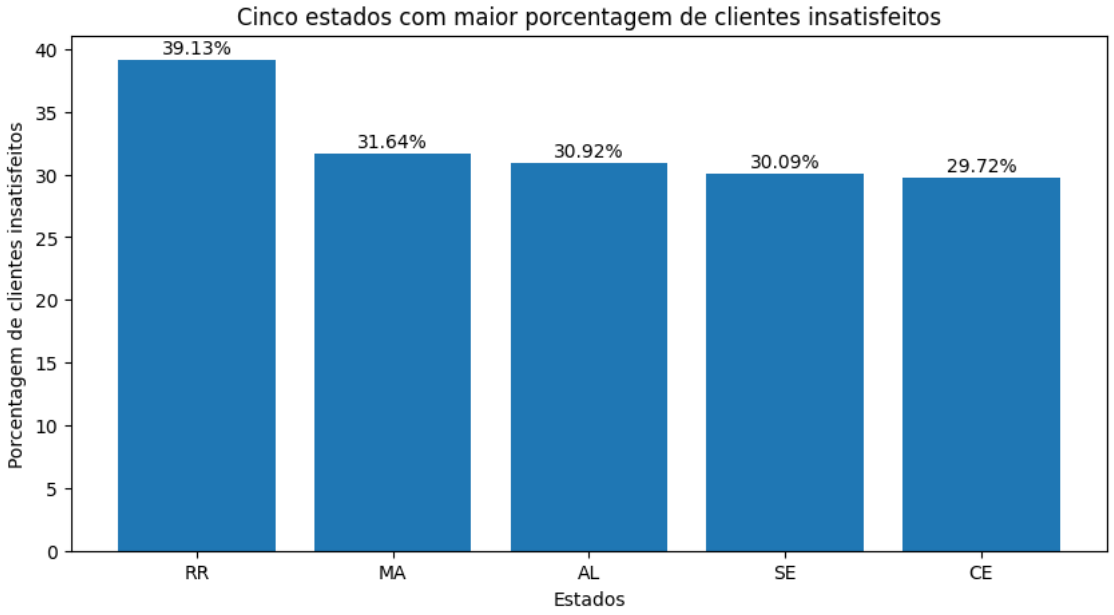
[19]:
```
df2 = pd.DataFrame(((df_geo_reviews_low['customer_state'].value_counts())/
 ↪(df_geo_reviews['customer_state'].value_counts())) *100)
df2 = df2.sort_values(by=['customer_state'], ascending=False).reset_index()
df2
```

[19]:

	index	customer_state
0	RR	39.130435
1	MA	31.635389
2	AL	30.917874
3	SE	30.085960
4	CE	29.721595
5	PA	29.545455
6	RJ	28.962005
7	BA	28.924635
8	PI	26.883910
9	RO	26.190476
10	AC	25.925926
11	PB	25.612053
12	PE	24.605103
13	GO	24.258893
14	ES	23.908730
15	SC	23.544024
16	DF	22.951583
17	MT	22.369878
18	RN	22.199170
19	TO	21.863799
20	MS	21.823204

```
21    MG        21.634409
22    RS        21.539303
23    SP        20.542096
24    PR        20.047638
25    AP        19.402985
26    AM        19.047619
```

[20]:
```
df2 = df2[df2['customer_state'] > 29.72]
ax = plt.bar(df2['index'], df2['customer_state'])

i = 0
for p in ax:
    width = p.get_width()
    height = p.get_height()
    text = (str(round(df2['customer_state'][i],2)) + "%")
    x, y = p.get_xy()
    plt.text(x+width/2,
             y+height+0.5,
             text,
             ha='center')
    i+=1


plt.xlabel("Estados")
plt.ylabel("Porcentagem de clientes insatisfeitos")
plt.title("Cinco estados com maior porcentagem de clientes insatisfeitos")
plt.figure(figsize=(8,6))
plt.show()
```



```
<Figure size 800x600 with 0 Axes>
```

0.1.8 Média do preço do pedido por categoria de produtos vendidos

[21]:
```
df_item_order = df_items.merge(df_products, on='product_id')
categorias_mais_vendidas = pd.DataFrame(df_item_order['product_category_name'].
 ↪value_counts())
categorias_mais_vendidas =␣
 ↪categorias_mais_vendidas[categorias_mais_vendidas['product_category_name'] >␣
 ↪7800]
categorias_mais_vendidas
```

[21]:

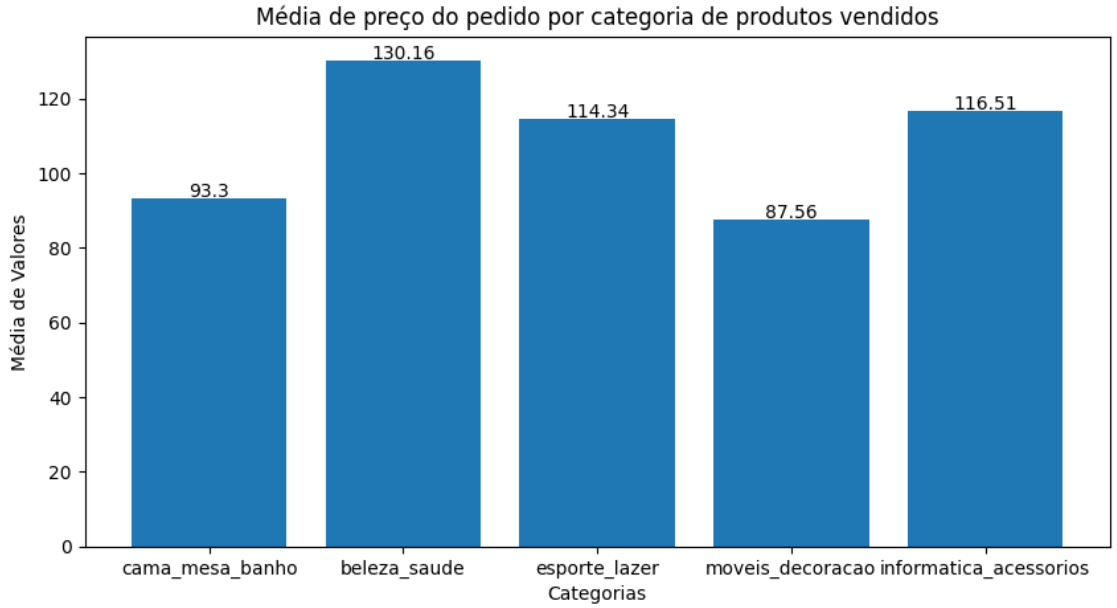
	product_category_name
cama_mesa_banho	11115
beleza_saude	9670
esporte_lazer	8641
moveis_decoracao	8334
informatica_acessorios	7827

[22]:
```
lista_valores = []
for i in categorias_mais_vendidas.index.to_list():
  media = round(df_item_order[df_item_order['product_category_name'] ==␣
 ↪i]['price'].mean(),2)
  lista_valores.append(media)
  print(i, media)
```

```
cama_mesa_banho 93.3
beleza_saude 130.16
esporte_lazer 114.34
moveis_decoracao 87.56
informatica_acessorios 116.51
```

[23]:
```
ax = plt.bar(categorias_mais_vendidas.index.to_list(), lista_valores)

i = 0
for p in ax:
    width = p.get_width()
    height = p.get_height()
    text = (str(lista_valores[i]))
    x, y = p.get_xy()
    plt.text(x+width/2,
             y+height+0.5,
             text,
             ha='center')
    i+=1
```

```
plt.xlabel("Categorias")
plt.ylabel("Média de Valores")
plt.title("Média de preço do pedido por categoria de produtos vendidos")
plt.show()
```



1 Ajuste dos modelos:

1.1 Tratamento das covariáveis

[ ]:
```
df_payments = pd.get_dummies(df_payments, columns=['payment_type'])
df_products = pd.get_dummies(df_products, columns=['product_category_name'])
```

[ ]:
```
df_items['total_price'] = df_items['price'] * df_items['order_item_id']
df_items['total_freight'] = df_items['freight_value'] *␣
 ↪df_items['order_item_id']
df_sellers_customers = (df_orders.merge(df_customer, on='customer_id',␣
 ↪validate='many_to_one')
                                  .merge(df_items, on='order_id',␣
 ↪validate='one_to_many')
                                  .merge(df_sellers, on='seller_id',␣
 ↪validate='many_to_one')
                                  .merge(df_products, on='product_id',␣
 ↪validate='many_to_one')
                        )
```

```
df_sellers_customers['same_state'] = df_sellers_customers['customer_state'] ==␣
↪df_sellers_customers['seller_state']
df_sellers_customers.head()
```

[ ]:
```
                           order_id                       customer_id  \
0  e481f51cbdc54678b7cc49136f2d6af7  9ef432eb6251297304e76186b10a928d
1  53cdb2fc8bc7dce0b6741e2150273451  b0830fb4747a6c6d20dea0b8c802d7ef
2  47770eb9100c2d0c44946d9cf07ec65d  41ce2a54c0b03bf3443c3d931a367089
3  949d5b44dbf5de918fe9c16f97b45f8a  f88197465ea7920adcdbec7375364d82
4  ad21c59c0840e6cb83a9ceb5573f8159  8ab97904e6daea8866dbdbc4fb7aad2c

  order_status order_purchase_timestamp    order_approved_at  \
0    delivered      2017-10-02 10:56:33  2017-10-02 11:07:15
1    delivered      2018-07-24 20:41:37  2018-07-26 03:24:27
2    delivered      2018-08-08 08:38:49  2018-08-08 08:55:23
3    delivered      2017-11-18 19:28:06  2017-11-18 19:45:59
4    delivered      2018-02-13 21:18:39  2018-02-13 22:20:29

  order_delivered_carrier_date order_delivered_customer_date  \
0          2017-10-04 19:55:00           2017-10-10 21:25:13
1          2018-07-26 14:31:00           2018-08-07 15:27:45
2          2018-08-08 13:50:00           2018-08-17 18:06:29
3          2017-11-22 13:39:59           2017-12-02 00:28:42
4          2018-02-14 19:46:34           2018-02-16 18:17:02

  order_estimated_delivery_date                customer_unique_id  \
0           2017-10-18 00:00:00  7c396fd4830fd04220f754e42b4e5bff
1           2018-08-13 00:00:00  af07308b275d755c9edb36a90c618231
2           2018-09-04 00:00:00  3a653a41f6f9fc3d2a113cf8398680e8
3           2017-12-15 00:00:00  7c142cf63193a1473d2e66489a9ae977
4           2018-02-26 00:00:00  72632f0f9dd73dfee390c9b22eb56dd6

   customer_zip_code_prefix  …  \
0                      3149  …
1                     47813  …
2                     75265  …
3                     59296  …
4                      9195  …

  product_category_name_portateis_casa_forno_e_cafe  \
0                                             False
1                                             False
2                                             False
3                                             False
4                                             False

  product_category_name_portateis_cozinha_e_preparadores_de_alimentos  \
```

```
0                                          False
1                                          False
2                                          False
3                                          False
4                                          False

   product_category_name_relogios_presentes  \
0                                     False
1                                     False
2                                     False
3                                     False
4                                     False

  product_category_name_seguros_e_servicos  \
0                                    False
1                                    False
2                                    False
3                                    False
4                                    False

  product_category_name_sinalizacao_e_seguranca  \
0                                         False
1                                         False
2                                         False
3                                         False
4                                         False

  product_category_name_tablets_impressao_imagem  \
0                                          False
1                                          False
2                                          False
3                                          False
4                                          False

   product_category_name_telefonia  product_category_name_telefonia_fixa  \
0                            False                                 False
1                            False                                 False
2                            False                                 False
3                            False                                 False
4                            False                                 False

   product_category_name_utilidades_domesticas  same_state
0                                         True        True
1                                        False       False
2                                        False       False
3                                        False       False
4                                        False        True
```

```
[5 rows x 104 columns]
```

[ ]:
```
df_payments_unique = df_payments.groupby('order_id').agg({
    'payment_sequential': 'count',
    'payment_value': 'sum',
    'payment_type_boleto': 'mean',
    'payment_type_credit_card': 'mean',
    'payment_type_debit_card': 'mean',
    'payment_type_not_defined': 'mean',
    'payment_type_voucher': 'mean',
    'payment_installments': 'mean'
}).reset_index()
df_sellers_unique = df_sellers_customers.groupby('order_id').agg(dict({
    'product_id': 'nunique',
    'seller_id': 'nunique',
    'same_state': 'mean',
    'total_price': 'mean',
    'total_freight': 'mean'
}, **{
    nome: 'mean' for nome in df_sellers_customers.columns if 'product' in nome␣
 ↪and nome != 'product_id'
})).reset_index()
df_reg = (df_reviews.merge(df_orders, on='order_id', validate='many_to_one')
                    .merge(df_customer, on='customer_id',␣
 ↪validate='many_to_one')
                    .merge(df_payments_unique, on='order_id',␣
 ↪validate='many_to_one')
                    .merge(df_sellers_unique, on='order_id',␣
 ↪validate='many_to_one')
          )
df_reg.head()
```

[ ]:
```
                          review_id                          order_id  \
0  7bc2406110b926393aa56f80a40eba40  73fc7af87114b39712e6da79b0a377eb
1  80e641a11e56f04c1ad469d5645fdfde  a548910a1c6147796b98fdf73dbeba33
2  228ce5500dc1d8e020d8d1322874b6f0  f9e4b658b201a9f2ecdecbb34bed034b
3  e64fb393e7b32834bb789ff8bb30750e  658677c97b385a9be170737859d3511b
4  f7c4243c7fe1938f181bec41a392bdeb  8e6bfb81e283fa7e4f11123a3fb894f1

   review_score review_comment_title  \
0             4                  NaN
1             5                  NaN
2             5                  NaN
3             5                  NaN
4             5                  NaN
```

```
                            review_comment_message review_creation_date  \
0                                              NaN  2018-01-18 00:00:00
1                                              NaN  2018-03-10 00:00:00
2                                              NaN  2018-02-17 00:00:00
3              Recebi bem antes do prazo estipulado.  2017-04-21 00:00:00
4  Parabéns lojas lannister adorei comprar pela I…  2018-03-01 00:00:00

  review_answer_timestamp                       customer_id order_status  \
0     2018-01-18 21:46:59  41dcb106f807e993532d446263290104    delivered
1     2018-03-11 03:05:13  8a2e7ef9053dea531e4dc76bd6d853e6    delivered
2     2018-02-18 14:36:24  e226dfed6544df5b7b87a48208690feb    delivered
3     2017-04-21 22:02:06  de6dff97e5f1ba84a3cd9a3bc97df5f6    delivered
4     2018-03-02 10:26:53  5986b333ca0d44534a156a52a8e33a83    delivered

  order_purchase_timestamp  … product_category_name_pet_shop  \
0      2018-01-11 15:30:49  …                            0.0
1      2018-02-28 12:25:19  …                            0.0
2      2018-02-03 09:56:22  …                            0.0
3      2017-04-09 17:41:13  …                            0.0
4      2018-02-10 10:59:03  …                            0.0

  product_category_name_portateis_casa_forno_e_cafe  \
0                                               0.0
1                                               0.0
2                                               0.0
3                                               0.0
4                                               0.0

  product_category_name_portateis_cozinha_e_preparadores_de_alimentos  \
0                                                0.0
1                                                0.0
2                                                0.0
3                                                0.0
4                                                0.0

  product_category_name_relogios_presentes  \
0                                      0.0
1                                      0.0
2                                      0.0
3                                      0.0
4                                      0.0

  product_category_name_seguros_e_servicos  \
0                                      0.0
1                                      0.0
2                                      0.0
3                                      0.0
```

```
4                                     0.0

   product_category_name_sinalizacao_e_seguranca  \
0                                            0.0
1                                            0.0
2                                            0.0
3                                            0.0
4                                            0.0

  product_category_name_tablets_impressao_imagem  \
0                                            0.0
1                                            0.0
2                                            0.0
3                                            0.0
4                                            0.0

  product_category_name_telefonia  product_category_name_telefonia_fixa  \
0                             0.0                                   0.0
1                             0.0                                   0.0
2                             0.0                                   0.0
3                             0.0                                   0.0
4                             0.0                                   0.0

   product_category_name_utilidades_domesticas
0                                          0.0
1                                          0.0
2                                          0.0
3                                          0.0
4                                          0.0

[5 rows x 111 columns]
```

[ ]:
```
df_reg.columns.values
```

[ ]:
```
array(['review_id', 'order_id', 'review_score', 'review_comment_title',
       'review_comment_message', 'review_creation_date',
       'review_answer_timestamp', 'customer_id', 'order_status',
       'order_purchase_timestamp', 'order_approved_at',
       'order_delivered_carrier_date', 'order_delivered_customer_date',
       'order_estimated_delivery_date', 'customer_unique_id',
       'customer_zip_code_prefix', 'customer_city', 'customer_state',
       'payment_sequential', 'payment_value', 'payment_type_boleto',
       'payment_type_credit_card', 'payment_type_debit_card',
       'payment_type_not_defined', 'payment_type_voucher',
       'payment_installments', 'product_id', 'seller_id', 'same_state',
       'total_price', 'total_freight', 'product_name_lenght',
       'product_description_lenght', 'product_photos_qty',
```

```
'product_weight_g', 'product_length_cm', 'product_height_cm',
'product_width_cm',
'product_category_name_agro_industria_e_comercio',
'product_category_name_alimentos',
'product_category_name_alimentos_bebidas',
'product_category_name_artes',
'product_category_name_artes_e_artesanato',
'product_category_name_artigos_de_festas',
'product_category_name_artigos_de_natal',
'product_category_name_audio', 'product_category_name_automotivo',
'product_category_name_bebes', 'product_category_name_bebidas',
'product_category_name_beleza_saude',
'product_category_name_brinquedos',
'product_category_name_cama_mesa_banho',
'product_category_name_casa_conforto',
'product_category_name_casa_conforto_2',
'product_category_name_casa_construcao',
'product_category_name_cds_dvds_musicais',
'product_category_name_cine_foto',
'product_category_name_climatizacao',
'product_category_name_consoles_games',
'product_category_name_construcao_ferramentas_construcao',
'product_category_name_construcao_ferramentas_ferramentas',
'product_category_name_construcao_ferramentas_iluminacao',
'product_category_name_construcao_ferramentas_jardim',
'product_category_name_construcao_ferramentas_seguranca',
'product_category_name_cool_stuff',
'product_category_name_dvds_blu_ray',
'product_category_name_eletrodomesticos',
'product_category_name_eletrodomesticos_2',
'product_category_name_eletronicos',
'product_category_name_eletroportateis',
'product_category_name_esporte_lazer',
'product_category_name_fashion_bolsas_e_acessorios',
'product_category_name_fashion_calcados',
'product_category_name_fashion_esporte',
'product_category_name_fashion_roupa_feminina',
'product_category_name_fashion_roupa_infanto_juvenil',
'product_category_name_fashion_roupa_masculina',
'product_category_name_fashion_underwear_e_moda_praia',
'product_category_name_ferramentas_jardim',
'product_category_name_flores',
'product_category_name_fraldas_higiene',
'product_category_name_industria_comercio_e_negocios',
'product_category_name_informatica_acessorios',
'product_category_name_instrumentos_musicais',
'product_category_name_la_cuisine',
```

```
        'product_category_name_livros_importados',
        'product_category_name_livros_interesse_geral',
        'product_category_name_livros_tecnicos',
        'product_category_name_malas_acessorios',
        'product_category_name_market_place',
        'product_category_name_moveis_colchao_e_estofado',
        'product_category_name_moveis_cozinha_area_de_servico_jantar_e_jardim',
        'product_category_name_moveis_decoracao',
        'product_category_name_moveis_escritorio',
        'product_category_name_moveis_quarto',
        'product_category_name_moveis_sala',
        'product_category_name_musica', 'product_category_name_papelaria',
        'product_category_name_pc_gamer', 'product_category_name_pcs',
        'product_category_name_perfumaria',
        'product_category_name_pet_shop',
        'product_category_name_portateis_casa_forno_e_cafe',
        'product_category_name_portateis_cozinha_e_preparadores_de_alimentos',
        'product_category_name_relogios_presentes',
        'product_category_name_seguros_e_servicos',
        'product_category_name_sinalizacao_e_seguranca',
        'product_category_name_tablets_impressao_imagem',
        'product_category_name_telefonia',
        'product_category_name_telefonia_fixa',
        'product_category_name_utilidades_domesticas'], dtype=object)
```

[ ]:
```
del df_reg['review_id'], df_reg['order_id'], df_reg['review_comment_title'],␣
 ↪df_reg['review_comment_message'], df_reg['review_creation_date']
del df_reg['review_answer_timestamp'], df_reg['customer_id'],␣
 ↪df_reg['order_approved_at'], df_reg['order_delivered_carrier_date']
del df_reg['customer_unique_id'], df_reg['customer_zip_code_prefix'],␣
 ↪df_reg['customer_city']
```

[ ]:
```
df_reg['delayed_order'] = pd.
 ↪to_datetime(df_reg['order_estimated_delivery_date']) < pd.
 ↪to_datetime(df_reg['order_delivered_customer_date'])
df_reg['delayed_days'] = (pd.
 ↪to_datetime(df_reg['order_estimated_delivery_date']) - pd.
 ↪to_datetime(df_reg['order_delivered_customer_date'])).dt.days
df_reg.loc[df_reg['delayed_days'] < 0, 'delayed_days'] = 0
df_reg['delivery_time'] = (pd.
 ↪to_datetime(df_reg['order_delivered_customer_date']) - pd.
 ↪to_datetime(df_reg['order_purchase_timestamp'])).dt.days
df_reg['delivery_interaction'] = df_reg['delayed_order'] *␣
 ↪df_reg['delivery_time']
df_reg['installment_value'] = df_reg['payment_value'] /␣
 ↪df_reg['payment_installments']
```

```
df_reg.loc[df_reg['payment_installments'] == 0, 'installment_value'] =␣
 ↪df_reg['payment_value'][df_reg['payment_installments'] == 0]
df_reg['cancelado'] = df_reg['order_status'] == 'canceled'
del df_reg['order_delivered_customer_date'], df_reg['order_status'],␣
 ↪df_reg['order_estimated_delivery_date'], df_reg['order_purchase_timestamp']
df_reg = df_reg.dropna()
df_reg = pd.get_dummies(df_reg, columns=['customer_state'])
df_reg_train, df_reg_test = train_test_split(df_reg, test_size=0.1)
df_reg_train.shape
```

[ ]:
```
(85522, 127)
```

[ ]:
```
pd.set_option('display.max_columns',504)
df_reg_train.describe()
```

[ ]:
```
       review_score  payment_sequential  payment_value  payment_type_boleto  \
count  85522.000000        85522.000000   85522.000000         85522.000000
mean       4.157679            1.044223     159.572037             0.198756
std        1.283116            0.366713     216.487454             0.399066
min        1.000000            1.000000       9.590000             0.000000
25%        4.000000            1.000000      62.000000             0.000000
50%        5.000000            1.000000     105.010000             0.000000
75%        5.000000            1.000000     176.590000             0.000000
max        5.000000           22.000000   13664.080000             1.000000

       payment_type_credit_card  payment_type_debit_card  \
count              85522.000000             85522.000000
mean                   0.758129                 0.015376
std                    0.421907                 0.123044
min                    0.000000                 0.000000
25%                    0.500000                 0.000000
50%                    1.000000                 0.000000
75%                    1.000000                 0.000000
max                    1.000000                 1.000000

       payment_type_not_defined  payment_type_voucher  payment_installments  \
count                   85522.0          85522.000000          85522.000000
mean                        0.0              0.027739              2.913241
std                         0.0              0.146981              2.696494
min                         0.0              0.000000              0.000000
25%                         0.0              0.000000              1.000000
50%                         0.0              0.000000              2.000000
75%                         0.0              0.000000              4.000000
max                         0.0              1.000000             24.000000

         product_id     seller_id    same_state   total_price  total_freight  \
count  85522.000000  85522.000000  85522.000000  85522.000000   85522.000000
```

```
mean       1.038750      1.013961      0.359724    130.830951      21.491757
std        0.227842      0.124111      0.479295    193.477697      17.761463
min        1.000000      1.000000      0.000000      0.850000       0.000000
25%        1.000000      1.000000      0.000000     45.000000      13.670000
50%        1.000000      1.000000      0.000000     82.000000      17.060000
75%        1.000000      1.000000      1.000000    146.990000      23.080000
max        8.000000      5.000000      1.000000   7560.000000    1047.060000

       product_name_lenght  product_description_lenght  product_photos_qty  \
count         85522.000000                85522.000000        85522.000000
mean             48.870271                  792.150914            2.248688
std               9.951641                  651.219561            1.737791
min               5.000000                    4.000000            1.000000
25%              43.000000                  351.000000            1.000000
50%              52.000000                  606.000000            2.000000
75%              57.000000                  995.000000            3.000000
max              72.000000                 3992.000000           20.000000

       product_weight_g  product_length_cm  product_height_cm  \
count      85522.000000       85522.000000       85522.000000
mean        2097.142935          30.108422          16.446137
std         3743.873358          16.064317          13.249087
min            0.000000           7.000000           2.000000
25%          300.000000          18.000000           8.000000
50%          700.000000          25.000000          13.000000
75%         1813.000000          38.000000          20.000000
max        40425.000000         105.000000         105.000000

       product_width_cm  product_category_name_agro_industria_e_comercio  \
count      85522.000000                                       85522.000000
mean          23.061284                                           0.001847
std           11.704761                                           0.042943
min            6.000000                                           0.000000
25%           15.000000                                           0.000000
50%           20.000000                                           0.000000
75%           30.000000                                           0.000000
max          118.000000                                           1.000000

       product_category_name_alimentos  \
count                     85522.000000
mean                          0.004541
std                           0.067087
min                           0.000000
25%                           0.000000
50%                           0.000000
75%                           0.000000
max                           1.000000
```

```
       product_category_name_alimentos_bebidas  product_category_name_artes  \
count                              85522.000000                 85522.000000
mean                                   0.002383                     0.001944
std                                    0.048645                     0.043890
min                                    0.000000                     0.000000
25%                                    0.000000                     0.000000
50%                                    0.000000                     0.000000
75%                                    0.000000                     0.000000
max                                    1.000000                     1.000000

       product_category_name_artes_e_artesanato  \
count                              85522.000000
mean                                   0.000246
std                                    0.015481
min                                    0.000000
25%                                    0.000000
50%                                    0.000000
75%                                    0.000000
max                                    1.000000

       product_category_name_artigos_de_festas  \
count                              85522.000000
mean                                   0.000357
std                                    0.018804
min                                    0.000000
25%                                    0.000000
50%                                    0.000000
75%                                    0.000000
max                                    1.000000

       product_category_name_artigos_de_natal  product_category_name_audio  \
count                            85522.000000                 85522.000000
mean                                 0.001317                     0.003672
std                                  0.036236                     0.060337
min                                  0.000000                     0.000000
25%                                  0.000000                     0.000000
50%                                  0.000000                     0.000000
75%                                  0.000000                     0.000000
max                                  1.000000                     1.000000

       product_category_name_automotivo  product_category_name_bebes  \
count                      85522.000000                 85522.000000
mean                           0.039647                     0.029171
std                            0.194886                     0.167603
min                            0.000000                     0.000000
25%                            0.000000                     0.000000
```

```
50%                              0.000000                      0.000000
75%                              0.000000                      0.000000
max                              1.000000                      1.000000

       product_category_name_bebidas  product_category_name_beleza_saude  \
count                   85522.000000                        85522.000000
mean                        0.002895                            0.090926
std                         0.053574                            0.287207
min                         0.000000                            0.000000
25%                         0.000000                            0.000000
50%                         0.000000                            0.000000
75%                         0.000000                            0.000000
max                         1.000000                            1.000000

       product_category_name_brinquedos  \
count                      85522.000000
mean                           0.039475
std                            0.194385
min                            0.000000
25%                            0.000000
50%                            0.000000
75%                            0.000000
max                            1.000000

       product_category_name_cama_mesa_banho  \
count                           85522.000000
mean                               0.097356
std                                0.295560
min                                0.000000
25%                                0.000000
50%                                0.000000
75%                                0.000000
max                                1.000000

       product_category_name_casa_conforto  \
count                         85522.000000
mean                              0.003740
std                               0.059871
min                               0.000000
25%                               0.000000
50%                               0.000000
75%                               0.000000
max                               1.000000

       product_category_name_casa_conforto_2  \
count                           85522.000000
mean                               0.000234
```

```
std                                   0.015098
min                                   0.000000
25%                                   0.000000
50%                                   0.000000
75%                                   0.000000
max                                   1.000000

       product_category_name_casa_construcao  \
count                           85522.000000
mean                                0.004895
std                                 0.069305
min                                 0.000000
25%                                 0.000000
50%                                 0.000000
75%                                 0.000000
max                                 1.000000

       product_category_name_cds_dvds_musicais  \
count                             85522.000000
mean                                  0.000117
std                                   0.010813
min                                   0.000000
25%                                   0.000000
50%                                   0.000000
75%                                   0.000000
max                                   1.000000

       product_category_name_cine_foto  product_category_name_climatizacao  \
count                     85522.000000                        85522.000000
mean                          0.000702                            0.002467
std                           0.026367                            0.049551
min                           0.000000                            0.000000
25%                           0.000000                            0.000000
50%                           0.000000                            0.000000
75%                           0.000000                            0.000000
max                           1.000000                            1.000000

       product_category_name_consoles_games  \
count                          85522.000000
mean                               0.010522
std                                0.101922
min                                0.000000
25%                                0.000000
50%                                0.000000
75%                                0.000000
max                                1.000000
```

```
       product_category_name_construcao_ferramentas_construcao  \
count                                        85522.000000
mean                                             0.007728
std                                              0.087328
min                                              0.000000
25%                                              0.000000
50%                                              0.000000
75%                                              0.000000
max                                              1.000000

       product_category_name_construcao_ferramentas_ferramentas  \
count                                        85522.000000
mean                                             0.000935
std                                              0.030571
min                                              0.000000
25%                                              0.000000
50%                                              0.000000
75%                                              0.000000
max                                              1.000000

       product_category_name_construcao_ferramentas_iluminacao  \
count                                        85522.000000
mean                                             0.002363
std                                              0.048119
min                                              0.000000
25%                                              0.000000
50%                                              0.000000
75%                                              0.000000
max                                              1.000000

       product_category_name_construcao_ferramentas_jardim  \
count                                        85522.000000
mean                                             0.002021
std                                              0.044565
min                                              0.000000
25%                                              0.000000
50%                                              0.000000
75%                                              0.000000
max                                              1.000000

       product_category_name_construcao_ferramentas_seguranca  \
count                                        85522.000000
mean                                             0.001640
std                                              0.040218
min                                              0.000000
25%                                              0.000000
50%                                              0.000000
```

```
75%                                                0.000000
max                                                1.000000

       product_category_name_cool_stuff  product_category_name_dvds_blu_ray  \
count                      85522.000000                        85522.000000
mean                           0.036933                            0.000575
std                            0.188163                            0.023855
min                            0.000000                            0.000000
25%                            0.000000                            0.000000
50%                            0.000000                            0.000000
75%                            0.000000                            0.000000
max                            1.000000                            1.000000

       product_category_name_eletrodomesticos  \
count                            85522.000000
mean                                 0.008302
std                                  0.090737
min                                  0.000000
25%                                  0.000000
50%                                  0.000000
75%                                  0.000000
max                                  1.000000

       product_category_name_eletrodomesticos_2  \
count                              85522.000000
mean                                   0.002438
std                                    0.049286
min                                    0.000000
25%                                    0.000000
50%                                    0.000000
75%                                    0.000000
max                                    1.000000

       product_category_name_eletronicos  \
count                       85522.000000
mean                            0.026134
std                             0.159378
min                             0.000000
25%                             0.000000
50%                             0.000000
75%                             0.000000
max                             1.000000

       product_category_name_eletroportateis  \
count                            85522.000000
mean                                 0.006315
std                                  0.079135
```

```
min                                  0.000000
25%                                  0.000000
50%                                  0.000000
75%                                  0.000000
max                                  1.000000

       product_category_name_esporte_lazer  \
count                         85522.000000
mean                              0.078828
std                               0.269138
min                               0.000000
25%                               0.000000
50%                               0.000000
75%                               0.000000
max                               1.000000

       product_category_name_fashion_bolsas_e_acessorios  \
count                                       85522.000000
mean                                            0.019371
std                                             0.137652
min                                             0.000000
25%                                             0.000000
50%                                             0.000000
75%                                             0.000000
max                                             1.000000

       product_category_name_fashion_calcados  \
count                            85522.000000
mean                                 0.002444
std                                  0.049316
min                                  0.000000
25%                                  0.000000
50%                                  0.000000
75%                                  0.000000
max                                  1.000000

       product_category_name_fashion_esporte  \
count                           85522.000000
mean                                0.000281
std                                 0.016574
min                                 0.000000
25%                                 0.000000
50%                                 0.000000
75%                                 0.000000
max                                 1.000000

       product_category_name_fashion_roupa_feminina  \
```

```
count                                    85522.000000
mean                                         0.000403
std                                          0.020008
min                                          0.000000
25%                                          0.000000
50%                                          0.000000
75%                                          0.000000
max                                          1.000000

       product_category_name_fashion_roupa_infanto_juvenil  \
count                                        85522.000000
mean                                             0.000070
std                                              0.008019
min                                              0.000000
25%                                              0.000000
50%                                              0.000000
75%                                              0.000000
max                                              1.000000

       product_category_name_fashion_roupa_masculina  \
count                                      85522.000000
mean                                           0.001111
std                                            0.033311
min                                            0.000000
25%                                            0.000000
50%                                            0.000000
75%                                            0.000000
max                                            1.000000

       product_category_name_fashion_underwear_e_moda_praia  \
count                                        85522.000000
mean                                             0.001193
std                                              0.034515
min                                              0.000000
25%                                              0.000000
50%                                              0.000000
75%                                              0.000000
max                                              1.000000

       product_category_name_ferramentas_jardim  product_category_name_flores  \
count                              85522.000000                  85522.000000
mean                                   0.035660                      0.000288
std                                    0.184987                      0.016844
min                                    0.000000                      0.000000
25%                                    0.000000                      0.000000
50%                                    0.000000                      0.000000
75%                                    0.000000                      0.000000
```

```
max                                    1.000000                        1.000000

       product_category_name_fraldas_higiene  \
count                          85522.000000
mean                               0.000292
std                                0.017095
min                                0.000000
25%                                0.000000
50%                                0.000000
75%                                0.000000
max                                1.000000

       product_category_name_industria_comercio_e_negocios  \
count                                        85522.000000
mean                                             0.002360
std                                              0.048466
min                                              0.000000
25%                                              0.000000
50%                                              0.000000
75%                                              0.000000
max                                              1.000000

       product_category_name_informatica_acessorios  \
count                                  85522.000000
mean                                       0.068988
std                                        0.253172
min                                        0.000000
25%                                        0.000000
50%                                        0.000000
75%                                        0.000000
max                                        1.000000

       product_category_name_instrumentos_musicais  \
count                                 85522.000000
mean                                      0.006287
std                                       0.078901
min                                       0.000000
25%                                       0.000000
50%                                       0.000000
75%                                       0.000000
max                                       1.000000

       product_category_name_la_cuisine  \
count                      85522.000000
mean                           0.000117
std                            0.010813
min                            0.000000
```

```
25%                              0.000000
50%                              0.000000
75%                              0.000000
max                              1.000000

       product_category_name_livros_importados  \
count                             85522.000000
mean                                  0.000544
std                                   0.023249
min                                   0.000000
25%                                   0.000000
50%                                   0.000000
75%                                   0.000000
max                                   1.000000

       product_category_name_livros_interesse_geral  \
count                                   85522.000000
mean                                        0.005010
std                                         0.070504
min                                         0.000000
25%                                         0.000000
50%                                         0.000000
75%                                         0.000000
max                                         1.000000

       product_category_name_livros_tecnicos  \
count                            85522.000000
mean                                0.002812
std                                 0.052872
min                                 0.000000
25%                                 0.000000
50%                                 0.000000
75%                                 0.000000
max                                 1.000000

       product_category_name_malas_acessorios  \
count                              85522.000000
mean                                   0.010625
std                                    0.102374
min                                    0.000000
25%                                    0.000000
50%                                    0.000000
75%                                    0.000000
max                                    1.000000

       product_category_name_market_place  \
count                        85522.000000
```

```
mean                                0.002734
std                                 0.051887
min                                 0.000000
25%                                 0.000000
50%                                 0.000000
75%                                 0.000000
max                                 1.000000

       product_category_name_moveis_colchao_e_estofado  \
count                                     85522.000000
mean                                          0.000362
std                                           0.019036
min                                           0.000000
25%                                           0.000000
50%                                           0.000000
75%                                           0.000000
max                                           1.000000

       product_category_name_moveis_cozinha_area_de_servico_jantar_e_jardim  \
count                                          85522.000000
mean                                               0.002324
std                                                0.047977
min                                                0.000000
25%                                                0.000000
50%                                                0.000000
75%                                                0.000000
max                                                1.000000

       product_category_name_moveis_decoracao  \
count                            85522.000000
mean                                 0.065657
std                                  0.246648
min                                  0.000000
25%                                  0.000000
50%                                  0.000000
75%                                  0.000000
max                                  1.000000

       product_category_name_moveis_escritorio  \
count                             85522.000000
mean                                  0.012915
std                                   0.112743
min                                   0.000000
25%                                   0.000000
50%                                   0.000000
75%                                   0.000000
max                                   1.000000
```

```
       product_category_name_moveis_quarto  product_category_name_moveis_sala  \
count                          85522.000000                       85522.000000
mean                               0.000871                           0.004249
std                                0.029353                           0.064727
min                                0.000000                           0.000000
25%                                0.000000                           0.000000
50%                                0.000000                           0.000000
75%                                0.000000                           0.000000
max                                1.000000                           1.000000

       product_category_name_musica  product_category_name_papelaria  \
count                  85522.000000                      85522.000000
mean                       0.000421                          0.023472
std                        0.020370                          0.151132
min                        0.000000                          0.000000
25%                        0.000000                          0.000000
50%                        0.000000                          0.000000
75%                        0.000000                          0.000000
max                        1.000000                          1.000000

       product_category_name_pc_gamer  product_category_name_pcs  \
count                    85522.000000               85522.000000
mean                         0.000076                   0.001746
std                          0.008548                   0.041719
min                          0.000000                   0.000000
25%                          0.000000                   0.000000
50%                          0.000000                   0.000000
75%                          0.000000                   0.000000
max                          1.000000                   1.000000

       product_category_name_perfumaria  product_category_name_pet_shop  \
count                      85522.000000                    85522.000000
mean                           0.032356                        0.017466
std                            0.176735                        0.130895
min                            0.000000                        0.000000
25%                            0.000000                        0.000000
50%                            0.000000                        0.000000
75%                            0.000000                        0.000000
max                            1.000000                        1.000000

       product_category_name_portateis_casa_forno_e_cafe  \
count                                       85522.000000
mean                                            0.000748
std                                             0.027346
min                                             0.000000
25%                                             0.000000
```

```
50%                                                 0.000000
75%                                                 0.000000
max                                                 1.000000

       product_category_name_portateis_cozinha_e_preparadores_de_alimentos  \
count                                        85522.000000
mean                                             0.000140
std                                              0.011845
min                                              0.000000
25%                                              0.000000
50%                                              0.000000
75%                                              0.000000
max                                              1.000000

       product_category_name_relogios_presentes  \
count                             85522.000000
mean                                  0.057144
std                                   0.231888
min                                   0.000000
25%                                   0.000000
50%                                   0.000000
75%                                   0.000000
max                                   1.000000

       product_category_name_seguros_e_servicos  \
count                             85522.000000
mean                                  0.000012
std                                   0.003419
min                                   0.000000
25%                                   0.000000
50%                                   0.000000
75%                                   0.000000
max                                   1.000000

       product_category_name_sinalizacao_e_seguranca  \
count                                   85522.000000
mean                                        0.001386
std                                         0.037159
min                                         0.000000
25%                                         0.000000
50%                                         0.000000
75%                                         0.000000
max                                         1.000000

       product_category_name_tablets_impressao_imagem  \
count                                    85522.000000
mean                                         0.000813
```

```
std                                          0.028341
min                                          0.000000
25%                                          0.000000
50%                                          0.000000
75%                                          0.000000
max                                          1.000000

       product_category_name_telefonia  product_category_name_telefonia_fixa  \
count                     85522.000000                          85522.000000
mean                          0.042656                              0.002210
std                           0.201907                              0.046896
min                           0.000000                              0.000000
25%                           0.000000                              0.000000
50%                           0.000000                              0.000000
75%                           0.000000                              0.000000
max                           1.000000                              1.000000

       product_category_name_utilidades_domesticas  delayed_days  \
count                                 85522.000000  85522.000000
mean                                      0.059458     11.701094
std                                       0.235877      7.863212
min                                       0.000000      0.000000
25%                                       0.000000      6.000000
50%                                       0.000000     11.000000
75%                                       0.000000     16.000000
max                                       1.000000    146.000000

       delivery_time  delivery_interaction  installment_value
count   85522.000000          85522.000000       85522.000000
mean       12.054851              2.459812          82.549056
std         9.474367              9.676172         136.155726
min         0.000000              0.000000           3.767000
25%         6.000000              0.000000          28.610000
50%        10.000000              0.000000          53.730000
75%        15.000000              0.000000          93.370000
max       208.000000            208.000000       13664.080000
```

[ ]:
```
q,r = np.linalg.qr(np.asarray(df_reg_train.loc[:, df_reg_train.columns !=␣
↪'review_score'], dtype='float'))

df_reg_train = df_reg_train.iloc[:, np.insert(np.abs(np.diag(r))>=1e-8, 0,␣
↪True)]
np.insert(np.abs(np.diag(r))>=1e-8, 0, True)
```

[ ]:
```
df_reg_train.shape
```

[ ]:
```
(85522, 125)
```

[ ]:
```
payment_type = [
    i for i in df_reg_train.columns if 'payment_type' in i
]
payment_type.pop()


product_category_name = [
    i for i in df_reg_train.columns if 'product_category_name' in i
]
product_category_name.pop()


customer_state = [
    i for i in df_reg_train.columns if 'customer_state' in i
]
customer_state.pop()

covariaveis_unicas = [
    'payment_sequential',
    'payment_installments',
    'payment_value',
    'delayed_order',
    'delivery_interaction',
    'delivery_time',
    'delayed_days',
    'installment_value',
    'cancelado',
    'product_id',
    'seller_id',
    'same_state',
    'product_name_lenght',
    'product_description_lenght',
    'product_photos_qty',
    'product_weight_g',
    'product_length_cm',
    'product_height_cm',
    'product_width_cm',
    'total_price',
    'total_freight'
]
covariaveis = covariaveis_unicas + payment_type + product_category_name +␣
 ↪customer_state
```

1.2 Regressão ordinal logistica

[ ]:
```
modf_logit = OrderedModel(df_reg_train['review_score'],␣
 ↪df_reg_train[covariaveis].astype(float),
                                      distr='logit')
resf_logit = modf_logit.fit(method='bfgs')
resf_logit.summary()
```

```
/home/lucas/.cache/pypoetry/virtualenvs/ecommerce-classification-xG4A-NiM-
py3.10/lib/python3.10/site-packages/scipy/optimize/_optimize.py:1397:
OptimizeWarning: Maximum number of iterations has been exceeded.
  res = _minimize_bfgs(f, x0, args, fprime, callback=callback, **opts)

        Current function value: 1.094213
        Iterations: 500
        Function evaluations: 509
        Gradient evaluations: 509

/home/lucas/.cache/pypoetry/virtualenvs/ecommerce-classification-xG4A-NiM-
py3.10/lib/python3.10/site-packages/statsmodels/base/model.py:607:
ConvergenceWarning: Maximum Likelihood optimization failed to converge. Check
mle_retvals
  warnings.warn("Maximum Likelihood optimization failed to "
```

[ ]:

Dep. Variable:	review_score	**Log-Likelihood:**	-93579.
Model:	OrderedModel	**AIC:**	1.874e+05
Method:	Maximum Likelihood	**BIC:**	1.886e+05
Date:	Tue, 02 Apr 2024		
Time:	02:01:26		
No. Observations:	85522		
Df Residuals:	85397		
Df Model:	121		

	coef	std
payment_sequential	0.0148	0.0
payment_installments	0.0039	0.0
payment_value	-0.0036	0.0
delayed_order	-1.0429	0.0
delivery_interaction	-0.0116	0.0
delivery_time	-0.0498	0.0
delayed_days	0.0022	0.0
installment_value	0.0001	9.39e
cancelado	-5.0389	1.9
product_id	-0.2745	0.0
seller_id	-1.3501	0.0
same_state	-0.0173	0.0
product_name_lenght	-0.0035	0.0
product_description_lenght	7.811e-06	1.18e
product_photos_qty	-0.0087	0.0
product_weight_g	-7.52e-07	3.12e
product_length_cm	-7.337e-06	0.0
product_height_cm	-0.0007	0.0
product_width_cm	0.0004	0.0
total_price	0.0037	0.0
total_freight	0.0041	0.0
payment_type_boleto	0.1589	0.0
payment_type_credit_card	0.1100	0.0
payment_type_debit_card	0.2071	0.0
product_category_name_agro_industria_e_comercio	-0.3613	0.1
product_category_name_alimentos	0.2644	0.1
product_category_name_alimentos_bebidas	0.2854	0.1
product_category_name_artes	-0.2740	0.1
product_category_name_artes_e_artesanato	0.0523	0.4
product_category_name_artigos_de_festas	-0.3906	0.3
product_category_name_artigos_de_natal	-0.1439	0.1
product_category_name_audio	-0.3082	0.1
product_category_name_automotivo	-0.0340	0.0
product_category_name_bebes	-0.0216	0.0
product_category_name_bebidas	0.0809	0.1
product_category_name_beleza_saude	0.1311	0.0
product_category_name_brinquedos	0.0953	0.0
product_category_name_cama_mesa_banho	-0.1384	0.0
product_category_name_casa_conforto	-0.0595	0.1
product_category_name_casa_conforto_2	0.1837	0.4
product_category_name_casa_construcao	-0.1132	0.1
product_category_name_cds_dvds_musicais	0.5736	0.7
product_category_name_cine_foto	0.5406	0.3
product_category_name_climatizacao	-0.0150	0.1
product_category_name_consoles_games	0.0547	0.0
product_category_name_construcao_ferramentas_construcao	-0.0640	0.0
product_category_name_construcao_ferramentas_ferramentas	0.5602	0.2
product_category_name_construcao_ferramentas_iluminacao	-0.1080	0.1
product_category_name_construcao_ferramentas_jardim	0.3294	0.1
product_category_name_construcao_ferramentas_seguranca	-0.3074	0.1
product_category_name_cool_stuff	0.0456	0.0
product_category_name_dvds_blu_ray	0.0995	0.2

[ ]:
```
modf_logit.transform_threshold_params(resf_logit.params[-4:])
```

[ ]:
```
array([       -inf, -4.7793653 , -4.4080766 , -3.69273392, -2.62656841,
        inf])
```

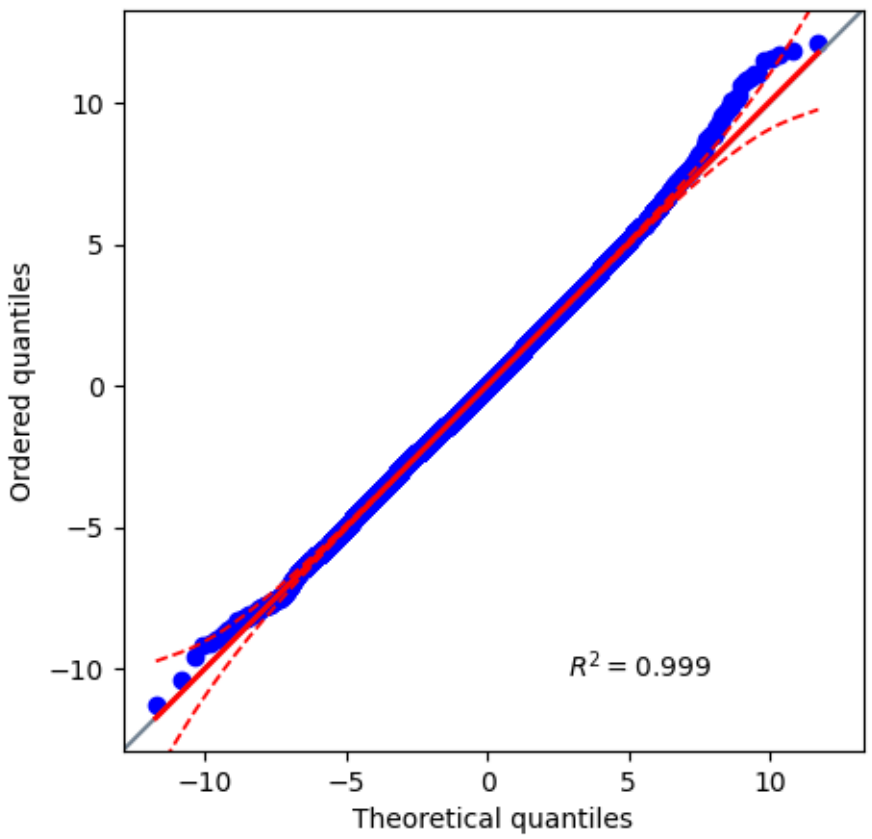
[ ]:
```
def amostra_dist_truncada(dist, a, b, loc, scale):
  u = np.random.uniform()
  return dist.ppf(
      u * (dist.cdf(b, loc=loc, scale=scale) - dist.cdf(a, loc=loc,␣
 ↪scale=scale)) +
      dist.cdf(a, loc=loc, scale=scale),
      loc=loc, scale=scale
      )


def residuo_substituto(modelo, y, dist, new_data=None, y_min=1):
    """Calcula o resíduo substituo proposto por Liu and Zhang (2017)."""
    response_values = np.sort(np.unique(y))
    classes = len(response_values)
    media = modelo.model.predict(modelo.params, exog=new_data, which="linpred")
    cut_points = modelo.model.transform_threshold_params(modelo.
 ↪params[1-classes:])
    deslocamento = 0
    if dist is stats.gumbel_r:
        deslocamento = np.euler_gamma
    s = [amostra_dist_truncada(dist, cut_points[y[i] - y_min],␣
 ↪cut_points[y[i]+1 - y_min], media[i] - deslocamento, 1) for i in␣
 ↪range(len(y))] # Currently assuming that y takes sequential integer values
    return s - media
```

[ ]:
```
def plota_residuos(data, y_name, features_names, dist, size=100):
    import math
    plot_size=7
    num_plots_x=5   # No. of plots in every row
    num_plots_y = math.ceil(len(features_names)/num_plots_x)   # No. of plots␣
 ↪in y direction

    '''
    for i in range(num_plots_y):
        start = i * num_plots_x
        end = start + num_plots_x
        sns.pairplot(x_vars=features_names[start:end], y_vars=y_name, data=data)
    '''

    g = sns.FacetGrid(pd.DataFrame(features_names), col=0, col_wrap=4,␣
 ↪sharey=False, sharex=False)
    for ax, x_var in zip(g.axes, features_names):
```

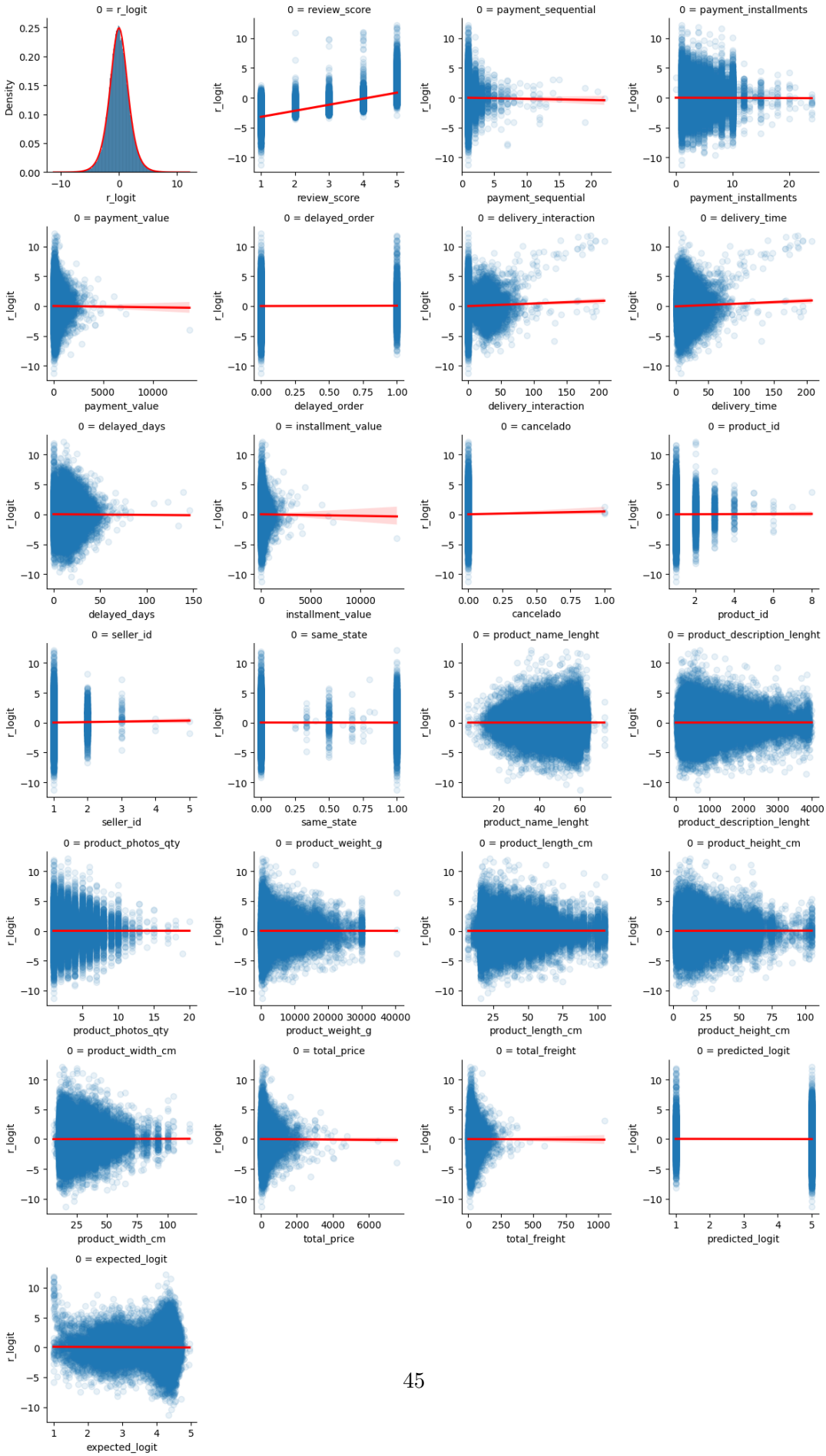
```
        if x_var == y_name:
            params = dist.fit(data[y_name])
            arg = params[:-2]
            loc = params[-2]
            scale = params[-1]
            x = np.linspace(data[y_name].min(), data[y_name].max(), num=size)
            if arg:
                pdf_fitted = dist.pdf(x, *arg, loc=loc, scale=scale)
            else:
                pdf_fitted = dist.pdf(x, loc=loc, scale=scale)
            sns.histplot(data=data, x=y_name, ax=ax, stat='density')
            sns.lineplot(x=x, y=pdf_fitted, ax=ax, color='r')
        else:
            sns.regplot(data=data, x=x_var, y=y_name, ax=ax,␣
 ↪line_kws=dict(color="r"), scatter_kws={'alpha': 0.1})
    g.tight_layout()

    plt.show()

def reporta_predicoes(modelo, endog, exog=None):
    mult = np.diag(np.sort(endog.unique()))
    probs = modelo.model.predict(modelo.params, exog=exog)
    predicted = np.argmax(probs, axis=1) + 1
    expected = np.sum(probs @ mult, axis=1)
    mse_expected = ((endog - expected)** 2).mean()
    mse_predicted = ((endog - predicted)** 2).mean()
    accuracy = (endog == predicted).mean()
    print(f'MSE de acordo com os valores esperados: {mse_expected:.2f}')
    print(f'MSE de acordo com a nota mais provável: {mse_predicted:.2f}')
    print(f'Acurácia das notas mais provaveis: {100*accuracy:.2f}%')
```

[ ]:
```
r_logit = residuo_substituto(resf_logit, df_reg_train.review_score.values,␣
 ↪stats.logistic)
df_reg_train['r_logit'] = r_logit
df_reg_train['predicted_logit'] = np.argmax(resf_logit.model.predict(resf_logit.
 ↪params), axis=1) + 1
mult = np.diag(np.sort(df_reg_train.review_score.unique()))
df_reg_train['expected_logit'] = np.sum(resf_logit.model.predict(resf_logit.
 ↪params) @ mult, axis=1)
pg.qqplot(r_logit, dist=stats.logistic, confidence=.95)
```

[ ]:
```
<Axes: xlabel='Theoretical quantiles', ylabel='Ordered quantiles'>
```



[ ]:
```
plota_residuos(df_reg_train, 'r_logit', ['r_logit', 'review_score'] +␣
↪covariaveis_unicas + ['predicted_logit', 'expected_logit'], stats.logistic)
```


0 = r_logit
Density
r_logit
0 = review_score
r_logit
review_score
0 = payment_sequential
r_logit
payment_sequential
0 = payment_installments
r_logit
payment_installments
0 = payment_value
r_logit
payment_value
0 = delayed_order
r_logit
delayed_order
0 = delivery_interaction
r_logit
delivery_interaction
0 = delivery_time
r_logit
delivery_time
0 = delayed_days
r_logit
delayed_days
0 = installment_value
r_logit
installment_value
0 = cancelado
r_logit
cancelado
0 = product_id
r_logit
product_id
0 = seller_id
r_logit
seller_id
0 = same_state
r_logit
same_state
0 = product_name_lenght
r_logit
product_name_lenght
0 = product_description_lenght
r_logit
product_description_lenght
0 = product_photos_qty
r_logit
product_photos_qty
0 = product_weight_g
r_logit
product_weight_g
0 = product_length_cm
r_logit
product_length_cm
0 = product_height_cm
r_logit
product_height_cm
0 = product_width_cm
r_logit
product_width_cm
0 = total_price
r_logit
total_price
0 = total_freight
r_logit
total_freight
0 = predicted_logit
r_logit
predicted_logit
0 = expected_logit
r_logit
expected_logit

[ ]:
```
reporta_predicoes(resf_logit, df_reg_train.review_score)
```

```
MSE de acordo com os valores esperados: 1.33
MSE de acordo com a nota mais provável: 2.00
Acurácia das notas mais provaveis: 61.63%
```

1.3 Regressão ordinal probit

[ ]:
```
modf_probit = OrderedModel(df_reg_train['review_score'],␣
 ↪df_reg_train[covariaveis].astype(float),
                                    distr='probit')
resf_probit = modf_probit.fit(method='bfgs')
resf_probit.summary()
```

```
/home/lucas/.cache/pypoetry/virtualenvs/ecommerce-classification-xG4A-NiM-
py3.10/lib/python3.10/site-packages/scipy/optimize/_optimize.py:1397:
OptimizeWarning: Maximum number of iterations has been exceeded.
  res = _minimize_bfgs(f, x0, args, fprime, callback=callback, **opts)

        Current function value: 1.095150
        Iterations: 500
        Function evaluations: 510
        Gradient evaluations: 510

/home/lucas/.cache/pypoetry/virtualenvs/ecommerce-classification-xG4A-NiM-
py3.10/lib/python3.10/site-packages/statsmodels/base/model.py:607:
ConvergenceWarning: Maximum Likelihood optimization failed to converge. Check
mle_retvals
  warnings.warn("Maximum Likelihood optimization failed to "
```

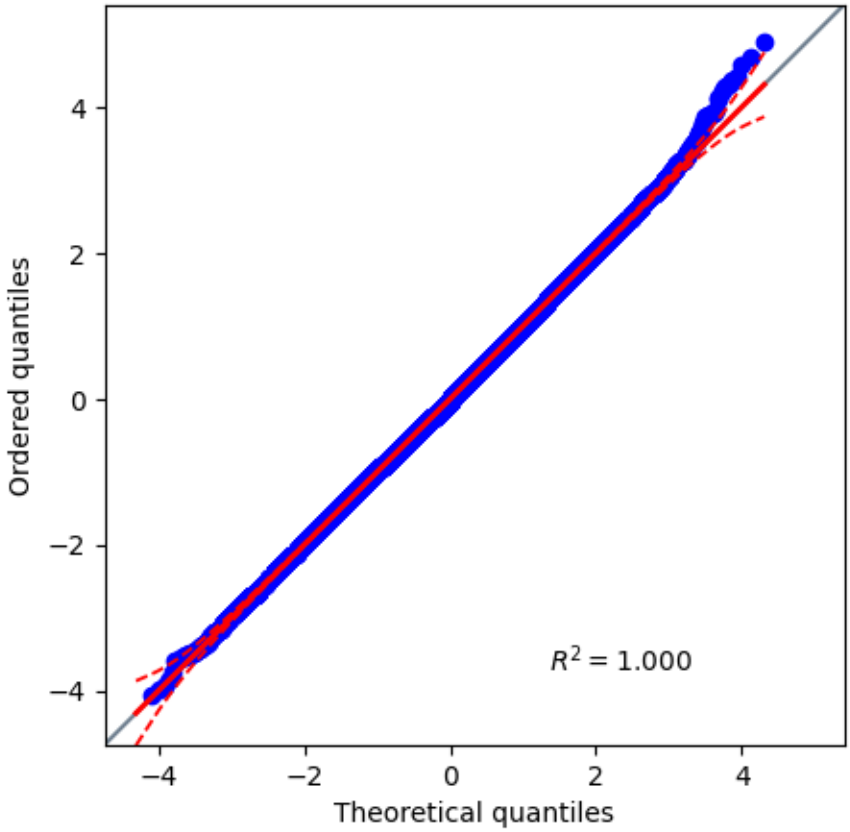
[ ]:

Dep. Variable:	review_score	**Log-Likelihood:**	-93659.
Model:	OrderedModel	**AIC:**	1.876e+05
Method:	Maximum Likelihood	**BIC:**	1.887e+05
Date:	Tue, 02 Apr 2024		
Time:	03:23:40		
No. Observations:	85522		
Df Residuals:	85397		
Df Model:	121		

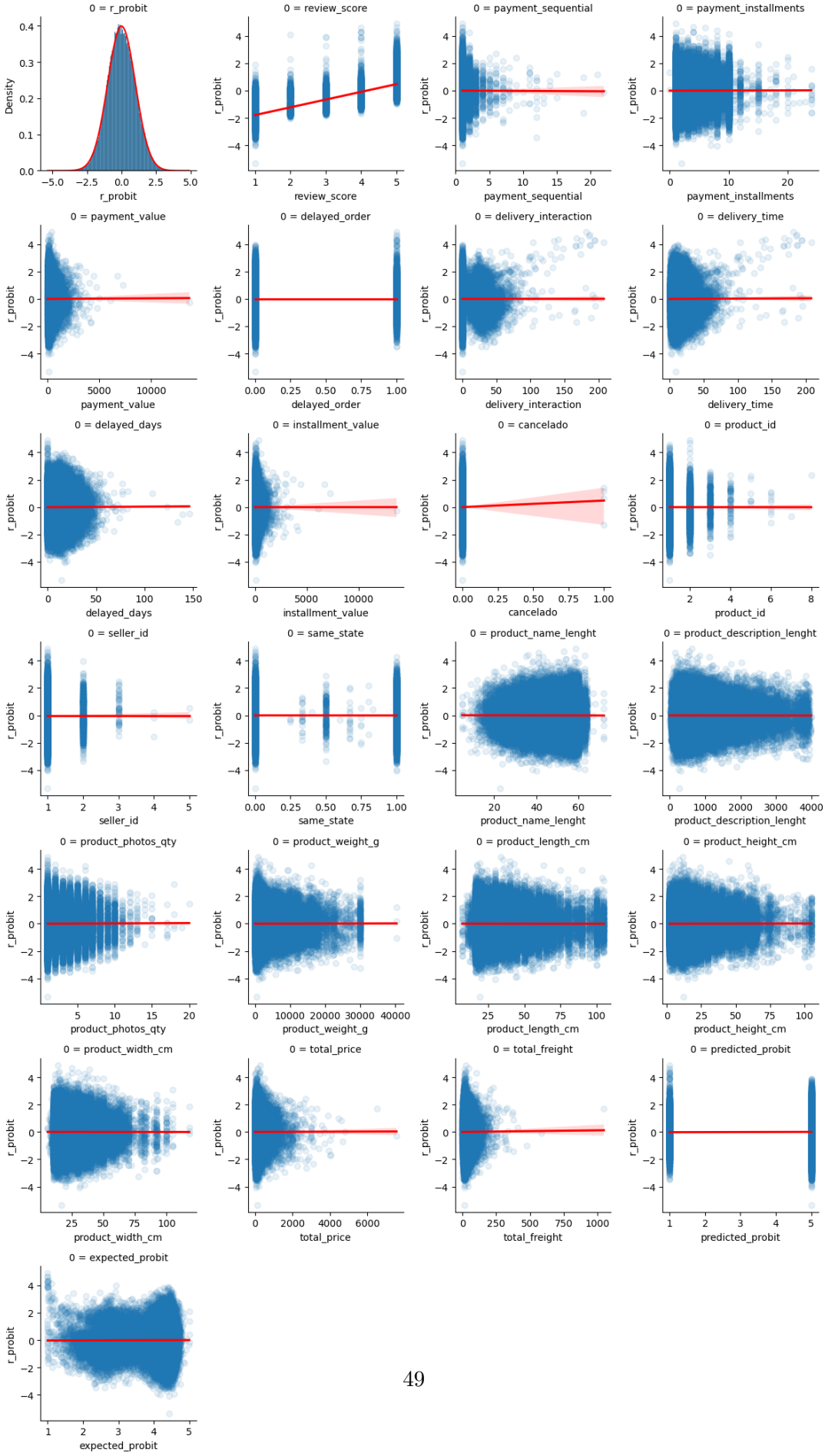
	coef	std
payment_sequential	0.0065	0.0
payment_installments	0.0009	0.0
payment_value	-0.0021	0.0
delayed_order	-0.9224	0.0
delivery_interaction	0.0044	0.0
delivery_time	-0.0278	0.0
delayed_days	0.0014	0.0
installment_value	7.889e-05	5.29e
cancelado	-4.6376	5.2
product_id	-0.1707	0.0
seller_id	-0.7411	0.0
same_state	0.0005	0.0
product_name_lenght	-0.0020	0.0
product_description_lenght	5.788e-06	7e-0
product_photos_qty	-0.0042	0.0
product_weight_g	-7.383e-07	1.82e
product_length_cm	9.526e-05	0.0
product_height_cm	-0.0005	0.0
product_width_cm	0.0003	0.0
total_price	0.0022	0.0
total_freight	0.0023	0.0
payment_type_boleto	0.0965	0.0
payment_type_credit_card	0.0739	0.0
payment_type_debit_card	0.1278	0.0
product_category_name_agro_industria_e_comercio	-0.2304	0.0
product_category_name_alimentos	0.1480	0.0
product_category_name_alimentos_bebidas	0.1906	0.0
product_category_name_artes	-0.1805	0.0
product_category_name_artes_e_artesanato	0.0697	0.2
product_category_name_artigos_de_festas	-0.3175	0.2
product_category_name_artigos_de_natal	-0.0961	0.1
product_category_name_audio	-0.2167	0.0
product_category_name_automotivo	-0.0256	0.0
product_category_name_bebes	-0.0185	0.0
product_category_name_bebidas	0.0512	0.0
product_category_name_beleza_saude	0.0649	0.0
product_category_name_brinquedos	0.0471	0.0
product_category_name_cama_mesa_banho	-0.0953	0.0
product_category_name_casa_conforto	-0.0642	0.0
product_category_name_casa_conforto_2	0.0705	0.2
product_category_name_casa_construcao	-0.0766	0.0
product_category_name_cds_dvds_musicais	0.3043	0.4
product_category_name_cine_foto	0.2626	0.1
product_category_name_climatizacao	-0.0481	0.0
product_category_name_consoles_games	0.0244	0.0
product_category_name_construcao_ferramentas_construcao	-0.0416	0.0
product_category_name_construcao_ferramentas_ferramentas	0.2932	0.1
product_category_name_construcao_ferramentas_iluminacao	-0.0342	0.0
product_category_name_construcao_ferramentas_jardim	0.1813	0.0
product_category_name_construcao_ferramentas_seguranca	-0.2010	0.1
product_category_name_cool_stuff	0.0247	0.0
product_category_name_dvds_blu_ray	0.0457	0.1

[ ]:
```
r_probit = residuo_substituto(resf_probit, df_reg_train.review_score.values,␣
↪stats.norm)
df_reg_train['r_probit'] = r_probit
df_reg_train['predicted_probit'] = np.argmax(resf_probit.model.
↪predict(resf_probit.params), axis=1) + 1
df_reg_train['expected_probit'] = np.sum(resf_probit.model.predict(resf_probit.
↪params) @ mult, axis=1)
pg.qqplot(r_probit, dist=stats.norm, confidence=.95)
```

[ ]:
```
<Axes: xlabel='Theoretical quantiles', ylabel='Ordered quantiles'>
```



[ ]:
```
plota_residuos(df_reg_train, 'r_probit', ['r_probit', 'review_score'] +␣
↪covariaveis_unicas + ['predicted_probit', 'expected_probit'], stats.norm)
```


0 = r_probit
Density
r_probit
0 = review_score
r_probit
review_score
0 = payment_sequential
r_probit
payment_sequential
0 = payment_installments
r_probit
payment_installments
0 = payment_value
r_probit
payment_value
0 = delayed_order
r_probit
delayed_order
0 = delivery_interaction
r_probit
delivery_interaction
0 = delivery_time
r_probit
delivery_time
0 = delayed_days
r_probit
delayed_days
0 = installment_value
r_probit
installment_value
0 = cancelado
r_probit
cancelado
0 = product_id
r_probit
product_id
0 = seller_id
r_probit
seller_id
0 = same_state
r_probit
same_state
0 = product_name_lenght
r_probit
product_name_lenght
0 = product_description_lenght
r_probit
product_description_lenght
0 = product_photos_qty
r_probit
product_photos_qty
0 = product_weight_g
r_probit
product_weight_g
0 = product_length_cm
r_probit
product_length_cm
0 = product_height_cm
r_probit
product_height_cm
0 = product_width_cm
r_probit
product_width_cm
0 = total_price
r_probit
total_price
0 = total_freight
r_probit
total_freight
0 = predicted_probit
r_probit
predicted_probit
0 = expected_probit
r_probit
expected_probit

[ ]:
```
reporta_predicoes(resf_probit, df_reg_train.review_score)
```

```
MSE de acordo com os valores esperados: 1.33
MSE de acordo com a nota mais provável: 2.01
Acurácia das notas mais provaveis: 61.58%
```

1.4 Regressão ordinal LogLog

[ ]:
```
modf_loglog = OrderedModel(df_reg_train['review_score'],␣
 ↪df_reg_train[covariaveis].astype(float),
                                    distr=stats.gumbel_r)
resf_loglog = modf_loglog.fit(method='bfgs')
resf_loglog.summary()
```

```
/home/lucas/.cache/pypoetry/virtualenvs/ecommerce-classification-xG4A-NiM-
py3.10/lib/python3.10/site-packages/scipy/optimize/_optimize.py:1397:
OptimizeWarning: Maximum number of iterations has been exceeded.
  res = _minimize_bfgs(f, x0, args, fprime, callback=callback, **opts)

        Current function value: 1.092161
        Iterations: 500
        Function evaluations: 510
        Gradient evaluations: 510

/home/lucas/.cache/pypoetry/virtualenvs/ecommerce-classification-xG4A-NiM-
py3.10/lib/python3.10/site-packages/statsmodels/base/model.py:607:
ConvergenceWarning: Maximum Likelihood optimization failed to converge. Check
mle_retvals
  warnings.warn("Maximum Likelihood optimization failed to "
```

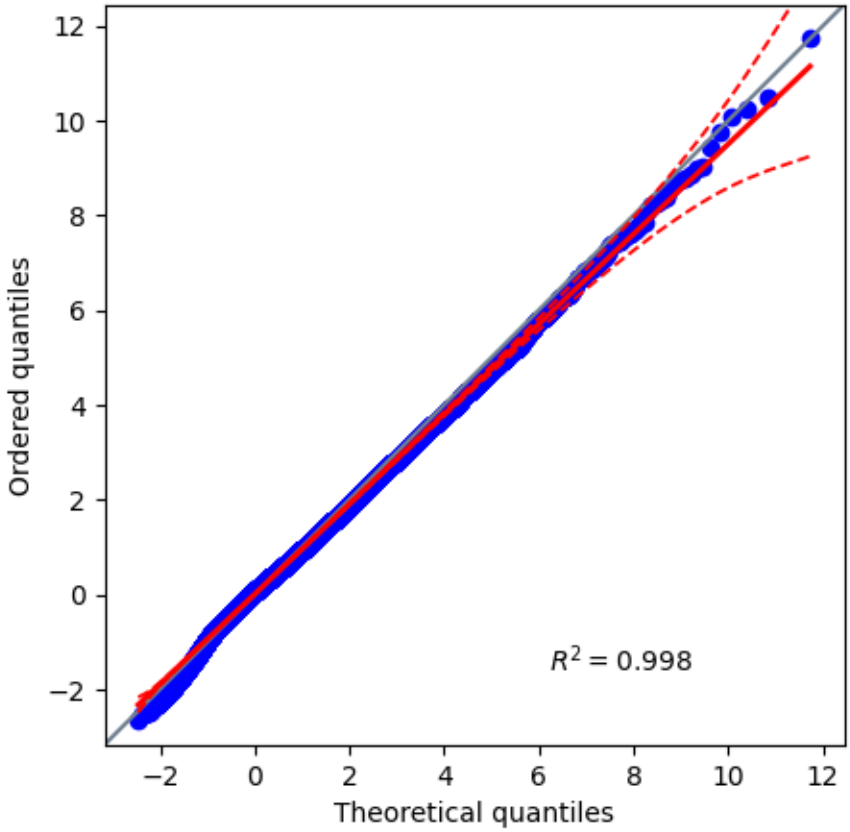
[ ]:

Dep. Variable:	review_score	**Log-Likelihood:**	-93404.
Model:	OrderedModel	**AIC:**	1.871e+05
Method:	Maximum Likelihood	**BIC:**	1.882e+05
Date:	Tue, 02 Apr 2024		
Time:	10:18:21		
No. Observations:	85522		
Df Residuals:	85397		
Df Model:	121		

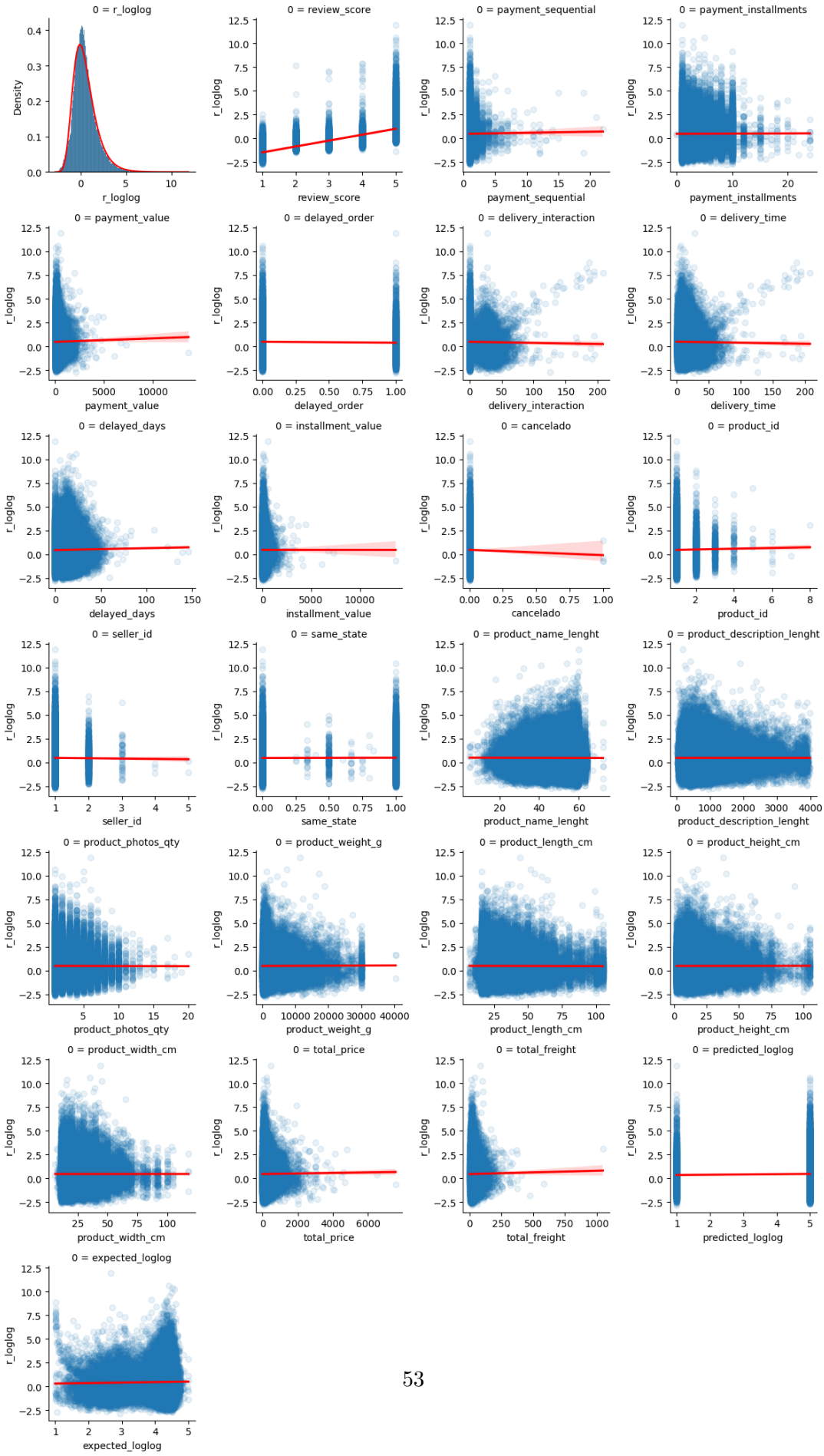
	coef	std
payment_sequential	0.0032	0.0
payment_installments	-0.0008	0.0
payment_value	-0.0028	0.0
delayed_order	-0.4265	0.0
delivery_interaction	-0.0157	0.0
delivery_time	-0.0252	0.0
delayed_days	-0.0001	0.0
installment_value	8.042e-05	4.87e
cancelado	-4.9147	3.6
product_id	-0.1968	0.0
seller_id	-0.6743	0.0
same_state	-0.0288	0.0
product_name_lenght	-0.0017	0.0
product_description_lenght	6.975e-06	6.38e
product_photos_qty	-0.0041	0.0
product_weight_g	-1.276e-06	1.68e
product_length_cm	0.0004	0.0
product_height_cm	-0.0004	0.0
product_width_cm	0.0004	0.0
total_price	0.0029	0.0
total_freight	0.0029	0.0
payment_type_boleto	0.0958	0.0
payment_type_credit_card	0.0849	0.0
payment_type_debit_card	0.1090	0.0
product_category_name_agro_industria_e_comercio	-0.1926	0.0
product_category_name_alimentos	0.1098	0.0
product_category_name_alimentos_bebidas	0.2090	0.0
product_category_name_artes	-0.1973	0.0
product_category_name_artes_e_artesanato	0.1379	0.2
product_category_name_artigos_de_festas	-0.2937	0.1
product_category_name_artigos_de_natal	-0.0604	0.1
product_category_name_audio	-0.2159	0.0
product_category_name_automotivo	-0.0249	0.0
product_category_name_bebes	-0.0166	0.0
product_category_name_bebidas	0.0762	0.0
product_category_name_beleza_saude	0.0528	0.0
product_category_name_brinquedos	0.0398	0.0
product_category_name_cama_mesa_banho	-0.0862	0.0
product_category_name_casa_conforto	-0.0924	0.0
product_category_name_casa_conforto_2	0.0981	0.2
product_category_name_casa_construcao	-0.0617	0.0
product_category_name_cds_dvds_musicais	0.2839	0.3
product_category_name_cine_foto	0.2202	0.1
product_category_name_climatizacao	-0.0618	0.0
product_category_name_consoles_games	0.0402	0.0
product_category_name_construcao_ferramentas_construcao	-0.0373	0.0
product_category_name_construcao_ferramentas_ferramentas	0.2163	0.1
product_category_name_construcao_ferramentas_iluminacao	0.0168	0.0
product_category_name_construcao_ferramentas_jardim	0.2059	0.0
product_category_name_construcao_ferramentas_seguranca	-0.2373	0.0
product_category_name_cool_stuff	0.0195	0.0
product_category_name_dvds_blu_ray	0.0479	0.1

[ ]:
```
r_loglog = residuo_substituto(resf_loglog, df_reg_train.review_score.values,␣
↪stats.gumbel_r)
df_reg_train['r_loglog'] = r_loglog
df_reg_train['predicted_loglog'] = np.argmax(resf_loglog.model.
↪predict(resf_loglog.params), axis=1) + 1
df_reg_train['expected_loglog'] = np.sum(resf_loglog.model.predict(resf_loglog.
↪params) @ mult, axis=1)
pg.qqplot(r_loglog, dist=stats.gumbel_r, confidence=.95)
```

[ ]:
```
<Axes: xlabel='Theoretical quantiles', ylabel='Ordered quantiles'>
```



[ ]:
```
plota_residuos(df_reg_train, 'r_loglog', ['r_loglog', 'review_score'] +␣
↪covariaveis_unicas + ['predicted_loglog', 'expected_loglog'], stats.gumbel_r)
```


0 = r_loglog
Density
r_loglog
0 = review_score
r_loglog
review_score
0 = payment_sequential
r_loglog
payment_sequential
0 = payment_installments
r_loglog
payment_installments
0 = payment_value
r_loglog
payment_value
0 = delayed_order
r_loglog
delayed_order
0 = delivery_interaction
r_loglog
delivery_interaction
0 = delivery_time
r_loglog
delivery_time
0 = delayed_days
r_loglog
delayed_days
0 = installment_value
r_loglog
installment_value
0 = cancelado
r_loglog
cancelado
0 = product_id
r_loglog
product_id
0 = seller_id
r_loglog
seller_id
0 = same_state
r_loglog
same_state
0 = product_name_lenght
r_loglog
product_name_lenght
0 = product_description_lenght
r_loglog
product_description_lenght
0 = product_photos_qty
r_loglog
product_photos_qty
0 = product_weight_g
r_loglog
product_weight_g
0 = product_length_cm
r_loglog
product_length_cm
0 = product_height_cm
r_loglog
product_height_cm
0 = product_width_cm
r_loglog
product_width_cm
0 = total_price
r_loglog
total_price
0 = total_freight
r_loglog
total_freight
0 = predicted_loglog
r_loglog
predicted_loglog
0 = expected_loglog
r_loglog
expected_loglog

[ ]:
```
reporta_predicoes(resf_loglog, df_reg_train.review_score)
```

```
MSE de acordo com os valores esperados: 1.32
MSE de acordo com a nota mais provável: 1.99
Acurácia das notas mais provaveis: 61.64%
```

[ ]:
```
r_probit.mean(), r_logit.mean(), r_loglog.mean()
```

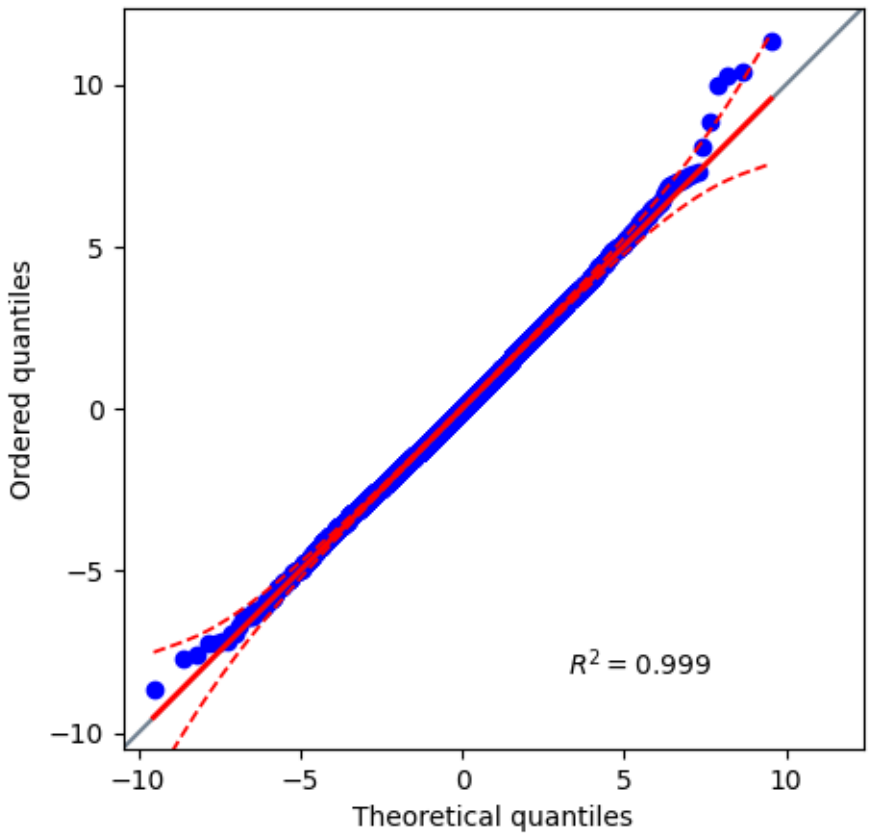
[ ]:
```
(-0.0007963687629919248, 0.015365549142877034, 0.475517297550056)
```

Apesar das métricas de previsão melhores para a regressão loglog, o seu resíduo tem valor distante de 0, indicando um ajuste não tão bom

1.5 Teste Regressão ordinal logit

[ ]:
```
probs_preditas_logit = resf_logit.model.predict(resf_logit.params,␣
 ↪exog=df_reg_test[covariaveis].astype(float))
df_reg_test['predicted_logit'] = np.argmax(probs_preditas_logit, axis=1) + 1
df_reg_test['expected_logit'] = np.sum(probs_preditas_logit @ mult, axis=1)
r_probit = residuo_substituto(resf_probit, df_reg_test.review_score.values,␣
 ↪stats.logistic, new_data=df_reg_test[covariaveis].astype(float))
df_reg_test['r_logit'] = r_logit
pg.qqplot(r_logit, dist=stats.logistic, confidence=.95)
```

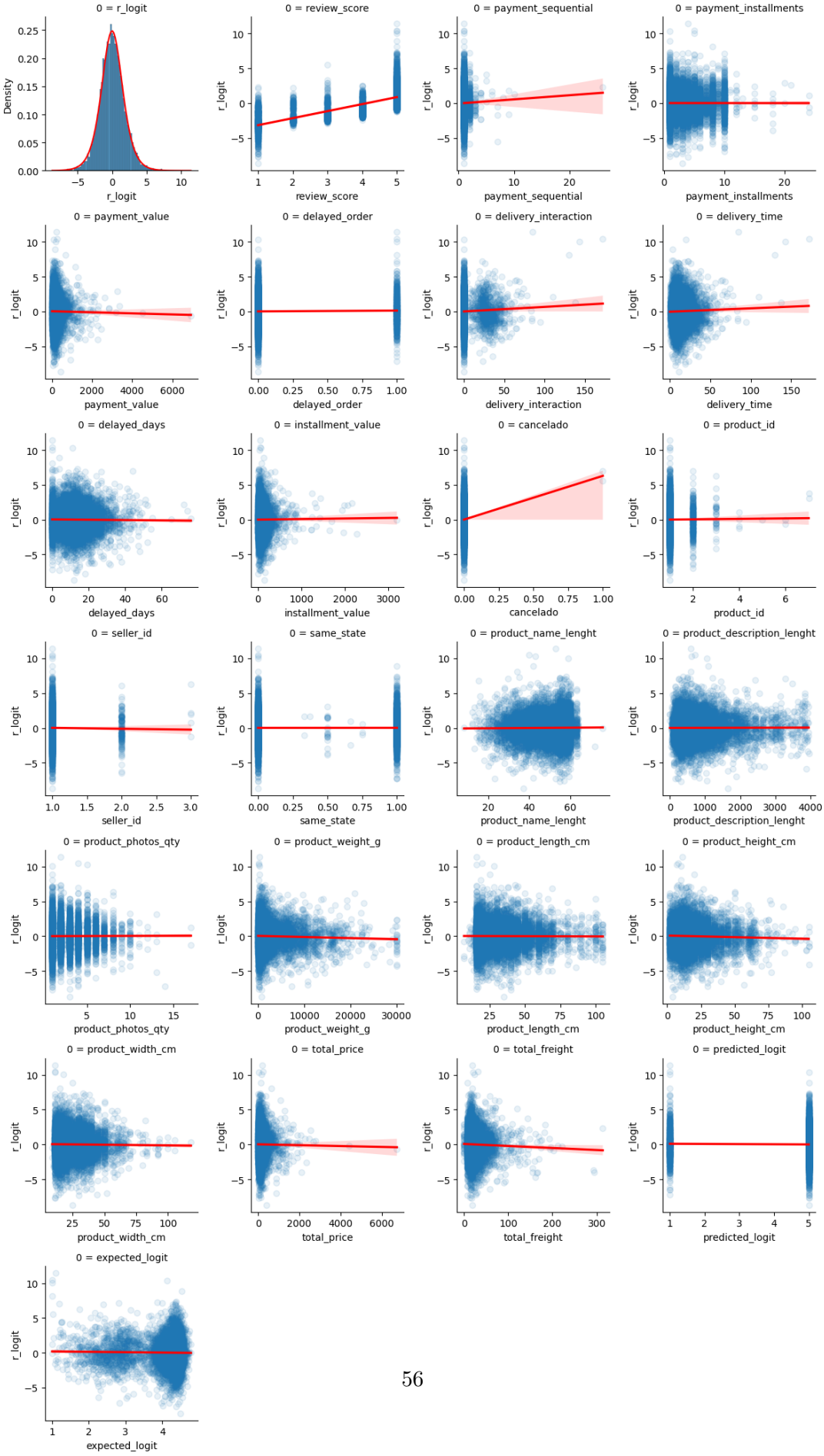
[ ]:
```
<Axes: xlabel='Theoretical quantiles', ylabel='Ordered quantiles'>
```



[ ]:
```
reporta_predicoes(resf_logit, df_reg_test.review_score,␣
↪exog=df_reg_test[covariaveis].astype(float))
```

```
MSE de acordo com os valores esperados: 1.35
MSE de acordo com a nota mais provável: 2.05
Acurácia das notas mais provaveis: 61.09%
```

[ ]:
```
plota_residuos(df_reg_test, 'r_logit', ['r_logit', 'review_score'] +␣
↪covariaveis_unicas + ['predicted_logit', 'expected_logit'], stats.logistic)
```


0 = r_logit
Density
r_logit
0 = review_score
r_logit
review_score
0 = payment_sequential
r_logit
payment_sequential
0 = payment_installments
r_logit
payment_installments
0 = payment_value
r_logit
payment_value
0 = delayed_order
r_logit
delayed_order
0 = delivery_interaction
r_logit
delivery_interaction
0 = delivery_time
r_logit
delivery_time
0 = delayed_days
r_logit
delayed_days
0 = installment_value
r_logit
installment_value
0 = cancelado
r_logit
cancelado
0 = product_id
r_logit
product_id
0 = seller_id
r_logit
seller_id
0 = same_state
r_logit
same_state
0 = product_name_lenght
r_logit
product_name_lenght
0 = product_description_lenght
r_logit
product_description_lenght
0 = product_photos_qty
r_logit
product_photos_qty
0 = product_weight_g
r_logit
product_weight_g
0 = product_length_cm
r_logit
product_length_cm
0 = product_height_cm
r_logit
product_height_cm
0 = product_width_cm
r_logit
product_width_cm
0 = total_price
r_logit
total_price
0 = total_freight
r_logit
total_freight
0 = predicted_logit
r_logit
predicted_logit
0 = expected_logit
r_logit
expected_logit

1.6 Random Forest

[ ]:
```
clf = ensemble.RandomForestClassifier()
param_grid = {
    'max_depth': range(1, 11),
    'min_samples_split': range(2, 5),
    'min_samples_leaf': range(1, 5),
    'n_estimators': range(150, 200, 20)
}

grid = model_selection.GridSearchCV(clf, param_grid)
grid.fit(df_reg_train[covariaveis], df_reg_train['review_score'])

# Obtém predições para a base de teste
predito = grid.predict(df_reg_test[covariaveis])
print(f'melhores parametros: {grid.best_params_}')
print(f"Acurácia do modelo de floresta aleatória: {metrics.
 ↪accuracy_score(df_reg_test['review_score'], predito):.2f}")
```

```
melhores parametros: {'max_depth': 10, 'min_damples_leaf': 1,
'min_samples_split': 2, 'n_estimators': 150}
Acurácia do modelo de floresta aleatória: 0.62
```

1.7 Naive-Bayes

[ ]:
```
# Cria um classificador Bayes ingênuo (Naive Bayes)
gnb = naive_bayes.GaussianNB()

# Treina o classificador na base de treinamento
gnb.fit(df_reg_train[covariaveis], df_reg_train['review_score'])

# Predição dos rótulos na base de teste
predito = gnb.predict(df_reg_test[covariaveis])


print(f"Acurácia do modelo de Naive-Bayes: {metrics.
 ↪accuracy_score(df_reg_test['review_score'], predito):.2f}")
```

```
Acurácia do modelo de Naive-Bayes: 0.57
```

1.8 KNN

[ ]:
```
classifier = model_selection.GridSearchCV(neighbors.KNeighborsClassifier(),
                                          {'n_neighbors': range(3, 10)},
                                          scoring='accuracy')

# treina o classificador com os dados de treinameto
classifier.fit(df_reg_train[covariaveis], df_reg_train['review_score'])

# Obtém predições para a base de teste
predito = classifier.predict(df_reg_test[covariaveis])
print(f'melhores parametros: {classifier.best_params_}')
print(f"Acurácia do modelo de KNN {metrics.
 ↪accuracy_score(df_reg_test['review_score'], predito):.2f}")
```

```
melhores parametros: {'n_neighbors': 9}
Acurácia do modelo de KNN 0.55
```