```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns

contracts = pd.read_excel('Data contracts.xlsx')
```

Exploring Data

First, let's take a look a the head of data:

```
contracts.head()
```

	shop_id	package_order_id	package_name	contract_date	start_date	end_date	real_end_date	Listing_limit	industry	category	region	city
0	35120	57868	Car C	2021-08-22	2021-09-06	2022-10-06	NaT	80	re_auto	خودرو	تهران	تهران
1	73135	55723	Car B	2021-06-08	2021-06-08	2022-07-15	NaT	50	re_auto	خودرو	تهران	تهران
2	28746	49014	Car C	2021-01-16	2021-01-16	2021-05-17	NaT	500	re_auto	خودرو	فارس	شیراز
3	76180	63743	Car C	2022-08-09	NaN	2023-02-08	NaT	10	re_auto	خودرو	آذربایجان شرقی	مراغه
4	63157	46291	Car B	2020-11-23	2020-11-23	2021-03-23	NaT	10	re_auto	خودرو	قم	قم

It would be wise to change farsi columns into English, but becasue of time limit, I ignore this step.

Data Types

```
print(contracts.info())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 14419 entries, 0 to 14418
Data columns (total 12 columns):
 #   Column            Non-Null Count  Dtype         
---  ------            --------------  -----         
 0   shop_id           14419 non-null  int64         
 1   package_order_id  14419 non-null  int64         
 2   package_name      14419 non-null  object        
 3   contract_date     14417 non-null  object        
 4   start_date        14418 non-null  object        
 5   end_date          14419 non-null  object        
 6   real_end_date     8 non-null      datetime64[ns]
 7   Listing_limit     14419 non-null  int64         
 8   industry          14419 non-null  object        
 9   category          14419 non-null  object        
 10  region            14416 non-null  object        
 11  city              14419 non-null  object        
dtypes: datetime64[ns](1), int64(3), object(8)
memory usage: 1.3+ MB
None
```

`contract_date`, `start_date`, and `end_date` should be transformed into datatime objects.

NOTE: There are missing values in columns contract_date, start_date, and region.

```
contracts['contract_date'] = pd.to_datetime(contracts['contract_date'])
contracts['start_date'] = pd.to_datetime(contracts['start_date'])
contracts['end_date'] = pd.to_datetime(contracts['end_date'])
```

Checking date columns again:

```
print(contracts.info())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 14419 entries, 0 to 14418
Data columns (total 12 columns):
 #   Column            Non-Null Count  Dtype         
---  ------            --------------  -----         
 0   shop_id           14419 non-null  int64         
 1   package_order_id  14419 non-null  int64         
 2   package_name      14419 non-null  object        
 3   contract_date     14417 non-null  datetime64[ns]
 4   start_date        14418 non-null  datetime64[ns]
 5   end_date          14419 non-null  datetime64[ns]
 6   real_end_date     8 non-null      datetime64[ns]
 7   Listing_limit     14419 non-null  int64         
 8   industry          14419 non-null  object        
 9   category          14419 non-null  object        
 10  region            14416 non-null  object        
 11  city              14419 non-null  object        
dtypes: datetime64[ns](4), int64(3), object(5)
memory usage: 1.3+ MB
None
```

We have also categorical column like industry, category, region, and city. In case of necessity, those columns will be defined as categories later.

Unique values of each column

```
print(contracts.nunique())
```

```
shop_id             8123
package_order_id    14417
package_name            9
contract_date        1186
start_date           1130
end_date             1549
real_end_date           7
Listing_limit          48
industry                2
category               11
region                 29
city                  282
dtype: int64
```

There are 8123 unqiue values of `shop_id`. Also, we have rows with the same `package_order_id`, which doesn't make a sense.

```
contracts[contracts.duplicated(subset='package_order_id', keep=False)].\
    sort_values('package_order_id')
```

	shop_id	package_order_id	package_name	contract_date	start_date	end_date	real_end_date	Listing_limit	industry	category	region	city
9828	14546	5660	General C	2019-07-20	2019-07-20	2019-10-21	NaT	5	re_auto	املاک	مازندران	آمل
11579	14546	5660	General C	2019-07-20	2019-07-20	2019-10-21	NaT	5	general	خدمات و کسب و کار	مازندران	آمل
280	74876	60314	Car B	2022-01-08	2022-01-08	2022-07-09	NaT	10	re_auto	خودرو	همدان	همدان
11651	74876	60314	Car B	2022-02-07	2022-01-08	2022-07-09	NaT	10	general	وسایل نقلیه	همدان	همدان

According to `industry` and `category` columns, these two orders are different from each other; however, their `shop_id`, `package_name`, `start_date` and `end_date` and even their `city` and `region` are identical!

There must be a mistake at data entry pipeline. Due to high uncertainty, all four rows are discarded from the following analysis.

```
contracts.drop_duplicates(subset='package_order_id', keep=False, inplace=True)
```

Missing Values

```
missing_conditions = contracts['contract_date'].isna()|contracts['start_date'].isna()|contracts['region'].isna()
contracts[missing_conditions]
```

	shop_id	package_order_id	package_name	contract_date	start_date	end_date	real_end_date	Listing_limit	industry	category	region	city
3	76180	63743	Car C	2022-08-09	NaT	2023-02-08	NaT	10	re_auto	خودرو	آذربایجان شرقی	مراغه
10600	71562	53139	General A	2021-03-13	2021-03-13	2021-09-26	NaT	15	general	ورزشی ، تفریحی ، سرگرمی	NaN	تهران
11147	68825	48980	General B	2021-01-13	2021-01-13	2021-04-14	NaT	5	general	خدمات و کسب و کار	NaN	تهران
12884	68392	48821	General C	2021-01-06	2021-01-06	2021-05-07	NaT	30	general	استخدام	NaN	تهران
12955	76557	64920	General C	NaT	2022-10-26	2023-01-24	NaT	5	general	استخدام	تهران	شهریار
13769	76554	64903	General A	NaT	2022-10-26	2023-10-25	NaT	5	general	صنعتی و اداری و تجاری	سمنان	سمنان

NaT for date columns and NaN for other types are both standard ways of missingness indications.

Month column

```
contracts['month'] = contracts['end_date'].dt.month
contracts['month'] = np.where(contracts['real_end_date'].notnull(),
                              contracts['real_end_date'].dt.month,
                              contracts['end_date'].dt.month)
```

Months found in this data set:

```
print(contracts['month'].unique())
```

```
    [10.  7.  5.  2.  3.  4.  8.  1. 11. 12.  6.  9.]
```

Let's do the calculation for the last three months of year (i.e. October, November, and December).

Renew and Return Rate Calculation

First, a new column represents any future `start_date` for a new contract:

```
contracts_sorted = contracts.sort_values(by = ['shop_id', 'start_date'])
contracts_sorted['start_date_next'] = contracts_sorted.groupby('shop_id')['start_date'].shift(-1)
```

Then, days between `end_date` of previous contract and `start_date` of new one is determined:

```
contracts_sorted['days_to_new'] = contracts_sorted['start_date_next'] - contracts_sorted['end_date']

# If real_end_date exists:
contracts_sorted['days_to_new'] = np.where(contracts_sorted['real_end_date'].notnull(), contracts_sorted['start_date_next'] - contracts_sorted['real_end_date'], contracts_s

contracts_sorted['days_to_new'] = contracts_sorted['days_to_new'].dt.days
```

A new column represents whether the conditions of renewal or return have been met:

```
# Renew
contracts_sorted['renew'] = contracts_sorted['days_to_new'] <= 30
# Return
contracts_sorted['return'] = contracts_sorted['days_to_new'] > 30
```

Let's filter only those rows that its `end_date` is within the last three months of year:

```
condition_months = contracts_sorted['month'].isin([10, 11, 12])
contracts_endseason = contracts_sorted[condition_months]
```

Last but not least, our interested rate are calculated:

```
renew_return_rates = contracts_endseason.groupby(['region', 'category', 'month'])['renew', 'return'].agg(lambda x: np.mean(x) * 100)
renew_return_rates = renew_return_rates.reset_index()
```

```
<ipython-input-41-3bcc78f42be6>:1: FutureWarning: Indexing with multiple keys (implicitly converted to a tuple of keys) will be deprecated, use a list instead.
  renew_return_rates = contracts_endseason.groupby(['region', 'category', 'month'])['renew', 'return'].agg(lambda x: np.mean(x) * 100)
```

Renaming columns:

```
renew_return_rates.rename(columns = {'renew':'renew_rate_perc', 'return':'return_rate_perc'},
                          inplace = True)
```

The dataframe is like the following:

```
renew_return_rates.head()
```

	region	category	month	renew_rate_perc	return_rate_perc
0	آذربایجان شرقی	املاک	10.0	40.0	20.0
1	آذربایجان شرقی	املاک	11.0	100.0	0.0
2	آذربایجان شرقی	املاک	12.0	20.0	10.0
3	آذربایجان شرقی	خدمات و کسب و کار	11.0	100.0	0.0
4	آذربایجان شرقی	خدمات و کسب و کار	12.0	50.0	0.0

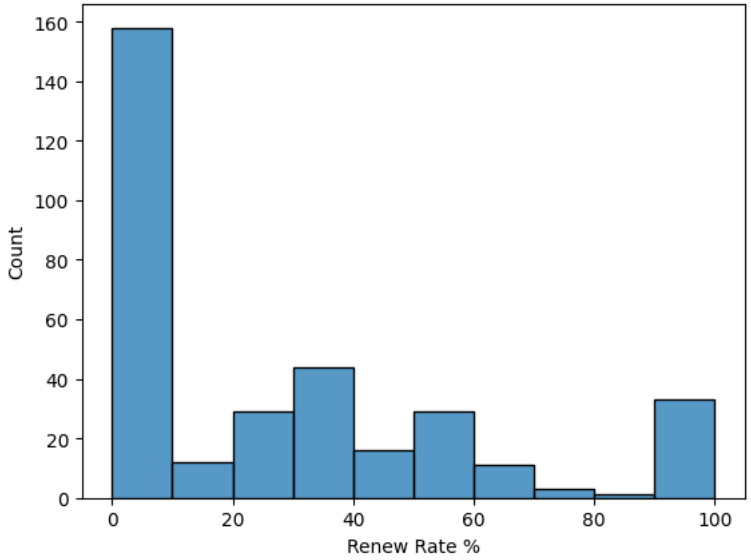
Renew and Return Rate Visualization

Renew Rate Histogram

```
sns.histplot(x = 'renew_rate_perc', data = renew_return_rates)
plt.xlabel('Renew Rate %')
plt.show()
```

Return Rate Histogram

```
sns.histplot(x = 'renew_rate_perc', data = renew_return_rates)
plt.xlabel('Renew Rate %')
plt.show()
```

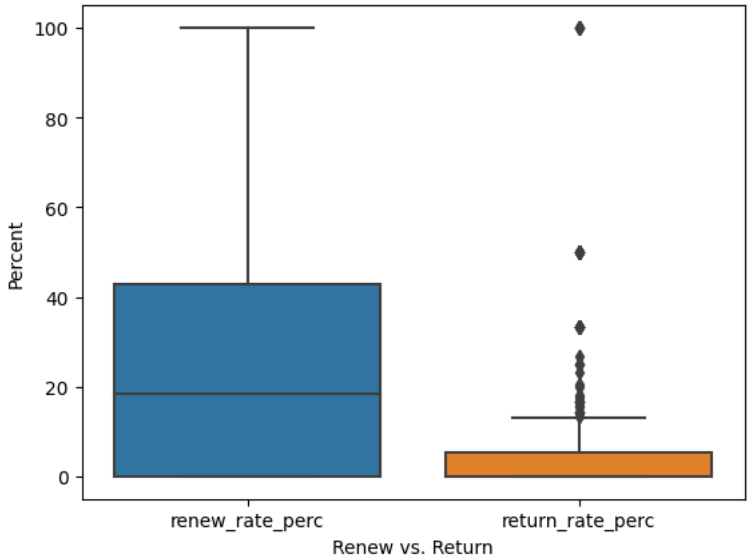


Difference Between Renew and Return Rates Distribution

```
pivoted_renew_return = pd.melt(renew_return_rates,
                               id_vars=['region', 'category', 'month'],
                               var_name = 'renew_return', value_name='percent')
```

```
sns.boxplot(x = 'renew_return', y = 'percent', data = pivoted_renew_return)
plt.xlabel('Renew vs. Return')
```

```
plt.ylabel('Percent')
plt.show()
```



Clearly, the longer it takes since the last contract, the higher the probability of customer churn.

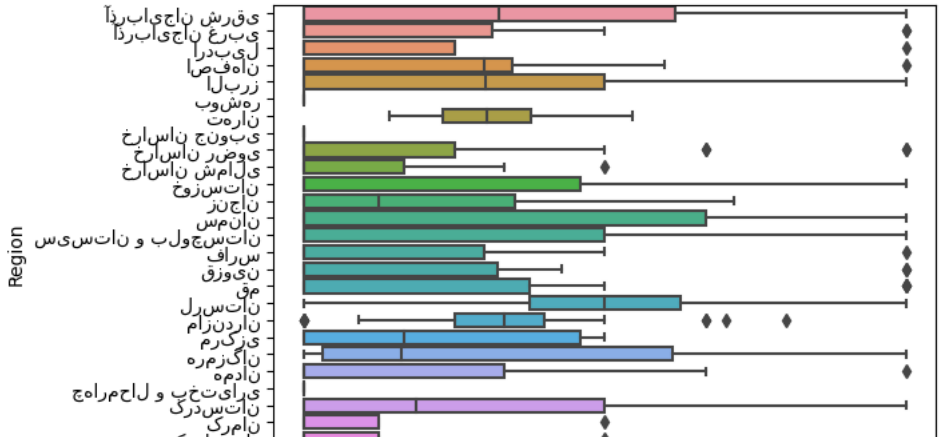
It's not implied what percentage rates should be considered low so a wise thing to do is to use quartiles of its distribution.

```
renew_quartiles = np.quantile(renew_return_rates['renew_rate_perc'], q = [0.25, 0.5, 0.75])

print(f'The first quartile of renew distribution is: {renew_quartiles[0]:.2f}')
print(f'The second quartile (median) of renew distribution is: {renew_quartiles[1]:.2f}')
print(f'The third quartile of renew distribution is: {renew_quartiles[2]:.2f}')
```

```
The first quartile of renew distribution is: 0.00
The second quartile (median) of renew distribution is: 18.47
The third quartile of renew distribution is: 42.98
```

Renew Across Regions

```
sns.boxplot(x = 'renew_rate_perc', y = 'region', data = renew_return_rates)
plt.xlabel('Percent')
plt.ylabel('Region')
plt.show()
```

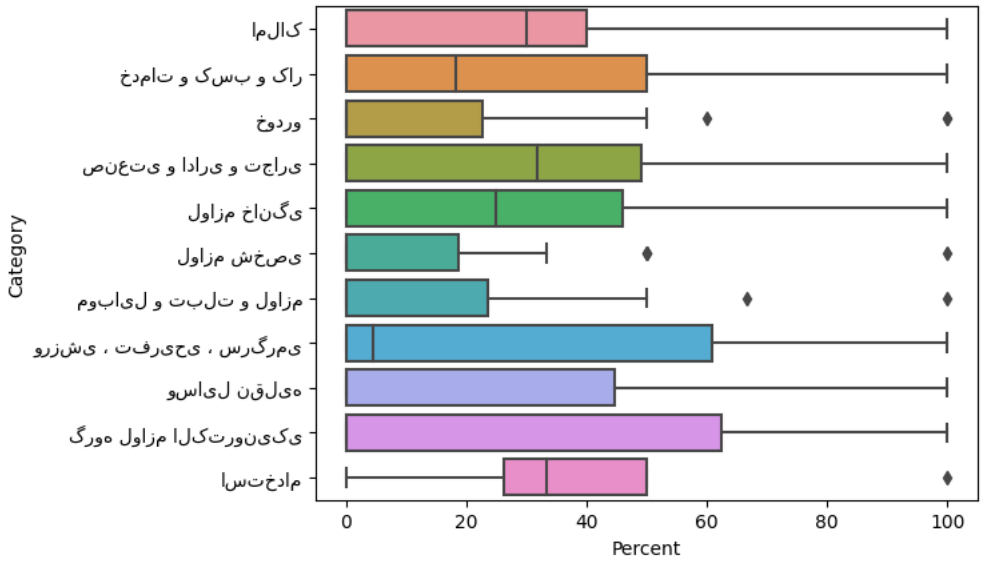


Regions with lowest renewal rates are:

Booshehr, Khorasan Jonubi, Charmahal Bakhtiari, Yazd, Kerman, Kermanshah, and Khorasan Shomali

Renew Across Category

```
sns.boxplot(x = 'renew_rate_perc', y = 'category', data = renew_return_rates)
plt.xlabel('Percent')
plt.ylabel('Category')
plt.show()
```



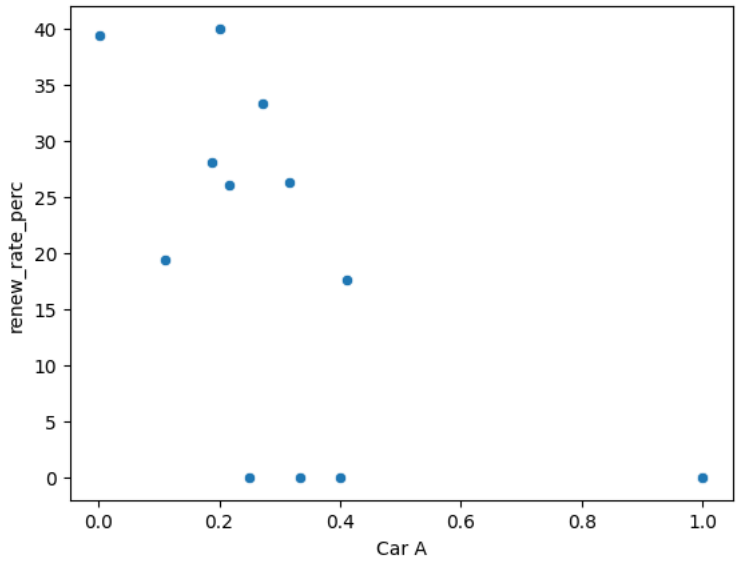
Categories with lowest renewal rates are:
Khodro, Lavazem shakhsi, and Mobile-tablet.

Let's use the remaining information from the initial data set.

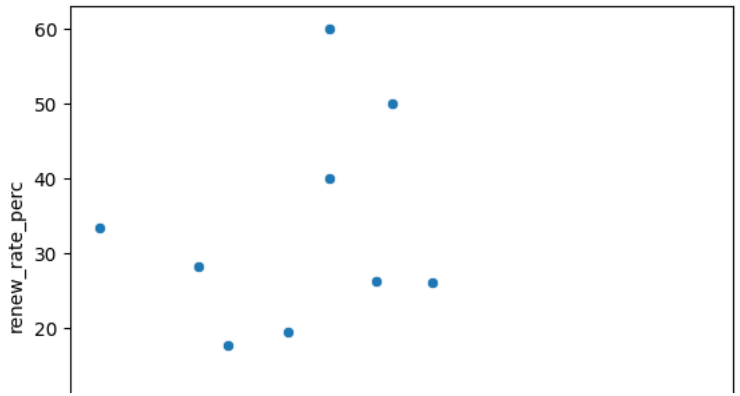
```
# package_name, listing_limit, and industry table
contracts_dummies = pd.concat([contracts[['region', 'category', 'month','Listing_limit']], pd.get_dummies(contracts['package_name']), pd.get_dummies(contracts['industry'])],

contracts_dummies = contracts_dummies.groupby(['region', 'category', 'month']).mean().reset_index()
contracts_dummies = contracts_dummies[contracts_dummies['month'].isin([10, 11, 12])]

merged_df = renew_return_rates.merge(contracts_dummies, how='inner', on = ['region', 'category', 'month'])
```

Renew vs. Car Industry Packages

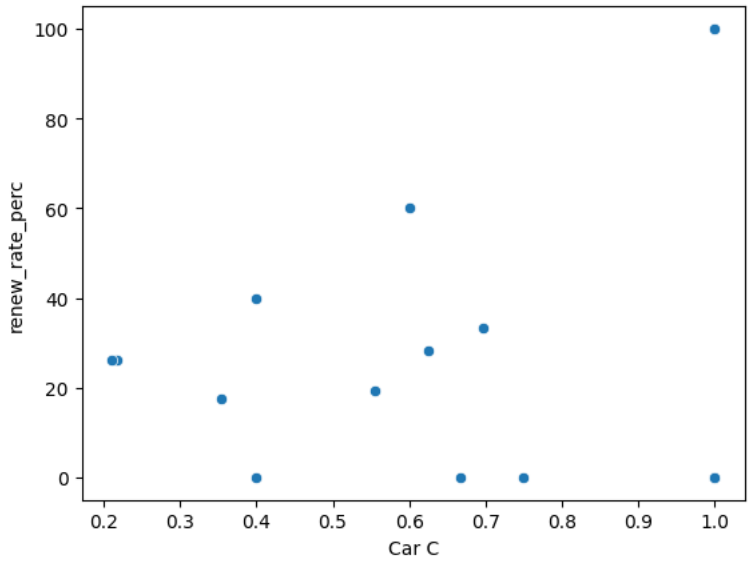
```
sns.scatterplot(x = 'Car A', y = 'renew_rate_perc', data = merged_df[merged_df['Car A'] != 0])
plt.show()
```




```
sns.scatterplot(x = 'Car B', y = 'renew_rate_perc', data = merged_df[merged_df['Car B'] != 0])
plt.show()
```



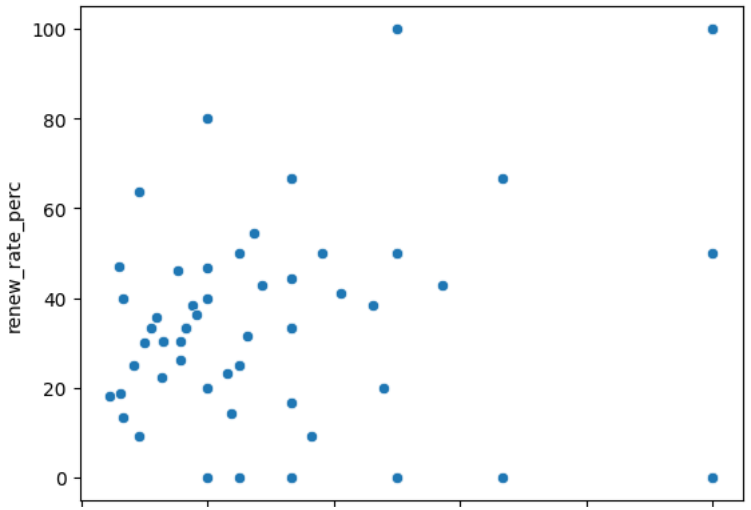

```
sns.scatterplot(x = 'Car C', y = 'renew_rate_perc', data = merged_df[merged_df['Car C'] != 0])
plt.show()
```



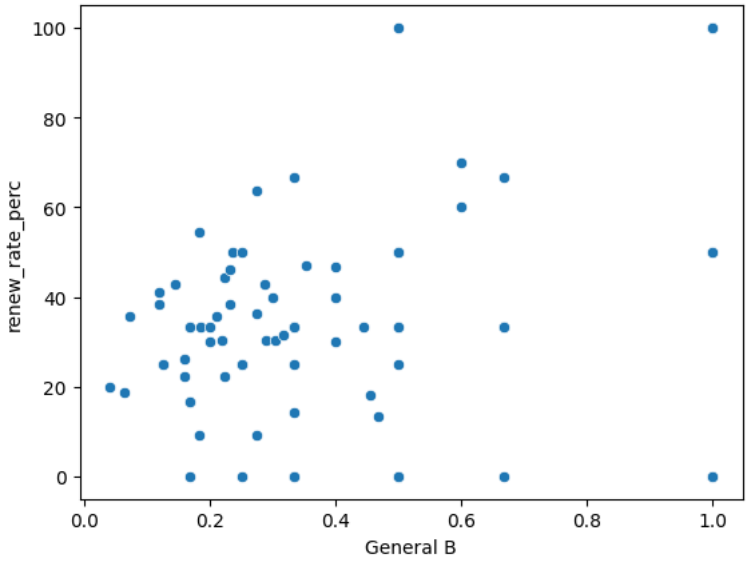
It seems those regions and categories with higher A package offerings have slightly higher rates. In Package C type, the relationship is reversed.

Renew vs. General Industry

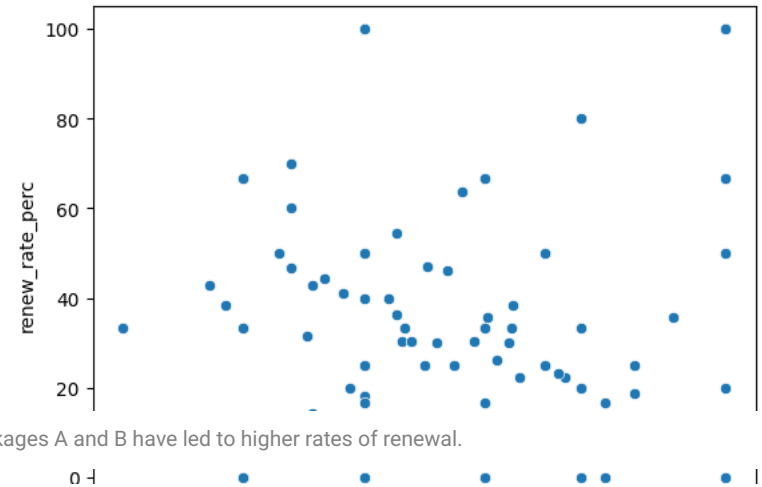
```
sns.scatterplot(x = 'General A', y = 'renew_rate_perc', data = merged_df[merged_df['General A'] != 0])
plt.show()
```




```
sns.scatterplot(x = 'General B', y = 'renew_rate_perc', data = merged_df[merged_df['General B'] != 0])
plt.show()
```



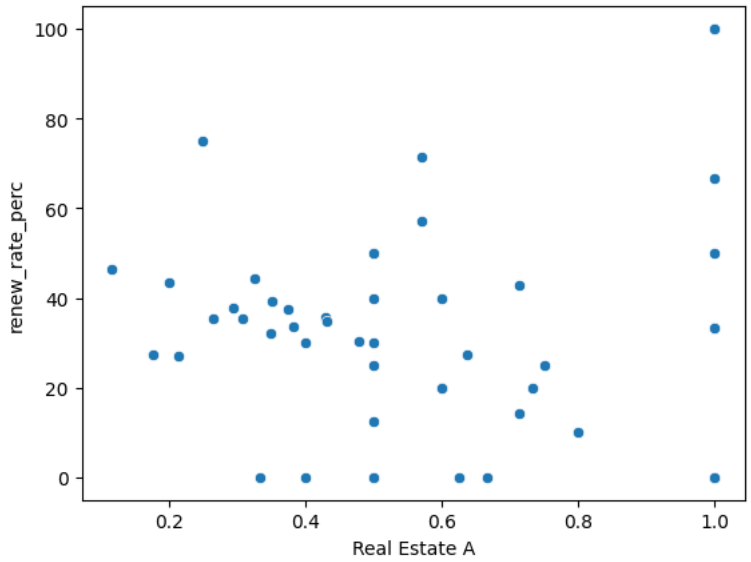

```
sns.scatterplot(x = 'General C', y = 'renew_rate_perc', data = merged_df[merged_df['General C'] != 0])
plt.show()
```



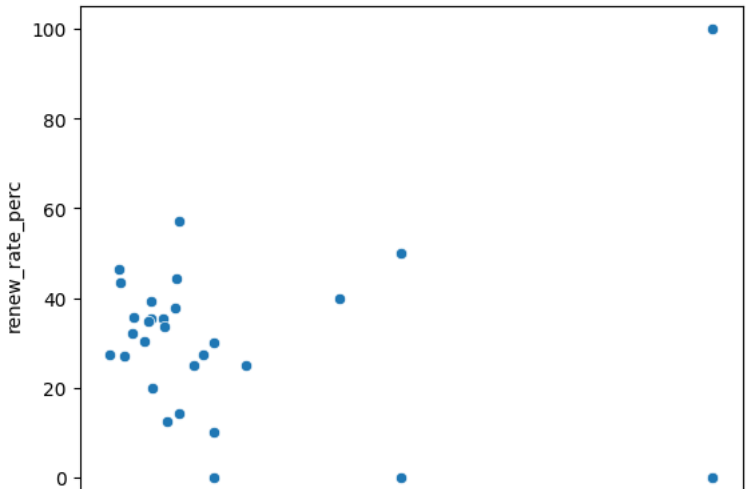
Packages A and B have led to higher rates of renewal.

Renew vs. Real Estate

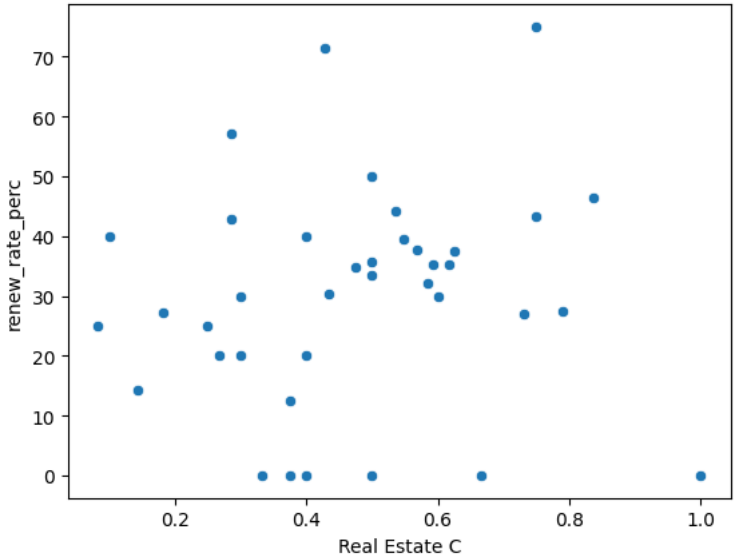
```
sns.scatterplot(x = 'Real Estate A', y = 'renew_rate_perc', data = merged_df[merged_df['Real Estate A'] != 0])
plt.show()
```




```
sns.scatterplot(x = 'Real Estate B', y = 'renew_rate_perc', data = merged_df[merged_df['Real Estate B'] != 0])
plt.show()
```




```
sns.scatterplot(x = 'Real Estate C', y = 'renew_rate_perc', data = merged_df[merged_df['Real Estate C'] != 0])
plt.show()
```



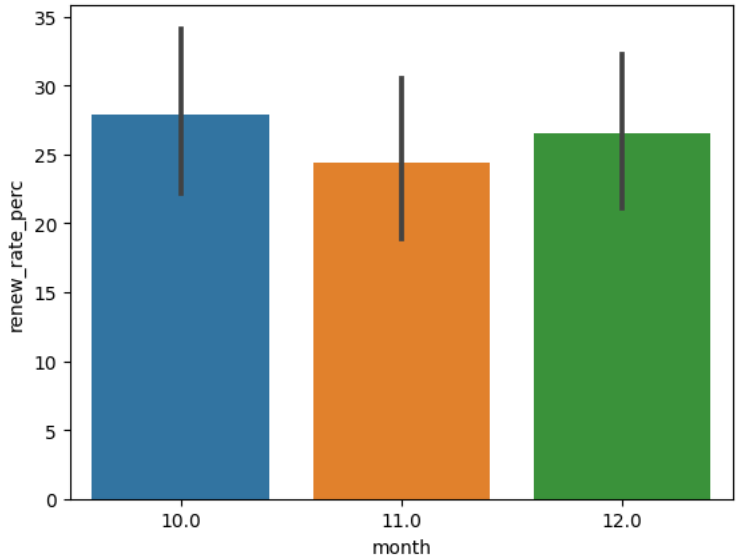
Here, package B doesn't perfom well!

Renew throughout Months

```
renew_return_rates
```

	region	category	month	renew_rate_perc	return_rate_perc
0	آذربایجان شرقی	املاک	10.0	40.0	20.0
1	آذربایجان شرقی	املاک	11.0	100.0	0.0
2	آذربایجان شرقی	املاک	12.0	20.0	10.0
3	آذربایجان شرقی	خدمات و کسب و کار	11.0	100.0	0.0
4	آذربایجان شرقی	خدمات و کسب و کار	12.0	50.0	0.0
...	...	...	...	...	...
331	گیلان	وسایل نقلیه	11.0	0.0	0.0
332	گیلان	وسایل نقلیه	12.0	0.0	0.0
333	گیلان	گروه لوازم الکترونیکی	12.0	0.0	0.0
334	یزد	خودرو	12.0	0.0	0.0
335	یزد	وسایل نقلیه	10.0	0.0	0.0

```
sns.barplot(x = 'month', y = 'renew_rate_perc', data = renew_return_rates)
plt.show()
```



Renew rates are not so different from each other throughout months.

Practical Suggestions

More Customized Packages

It's likely that packages offered to customers in specific regions are not attractive enough and they decide not to continue. Features can be reconsidered, especially in those regions with low economic power, more economical packages should be designed.

Changing Underperformed Packages

Some packages that have been detected before are not doing a decent job. Making a survey and sending to those who have used packages and decided not to continue let us know their problems.

Pay More Attention to Category

Our company has some issues in some categories like Khodro, Lavazem shakhsi, and Mobile-tablet. One way to improve offerings at these categories is to conduct in-depth interviews or even just making a short contact to get more insights what are the critical factors for they managers.

Retention Programs

The company should attempt to persuade its customers within 30 days. If it takes more than that, the probability of churning rises significantly. Sending emails to remind the manager what are the benefits of working with us and its costs could be beneficial.