Sheet

Прогнозирование цен на жилье с помощью нейросетевой регрессионной модели

Работа выполнена: Осининой Татьяной, студентом R3237

Задание:

Необходимо по имеющимся данным о ценах на жильё предсказать окончательную цену каждого дома с учетом характеристик домов с использованием нейронной сети. Описание набора данных содержит 80 классов (набор переменых) классификации оценки типа жилья, и находится в файле `data_description.txt`.

В работе требуется дополнить раздел «Моделирование» в подразделе «Построение и обучение модели» создать и инициализировать последовательную модель нейронной сети с помощью фрэймворков тренировки нейронных сетей как: Torch или Tensorflow. Скомпилировать нейронную сеть выбрав функцию потерь и оптимизатор соответственно. Оценить точность полученных результатов. Вывести предсказанные данные о продаже.

Импорт библиотек

Импортируем необходимые библиотеки:

```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
from sklearn.model_selection import train_test_split
#for work with model
import tensorflow as tf
from keras.models import Sequential
from keras.layers import Dense
from hyperopt import fmin,tpe,hp,partial
```

Считываем набор данных

Загрузим набор данных и присвоим следующими переменные:

- `train_data`: данные, используемые для обучения модели
- `test_data`: данные, используемые для проверки модели

```
train_data = pd.read_csv('/data/notebook_files/train.csv')
test_data = pd.read_csv('/data/notebook_files/test.csv')
```

Подготовка данных

Отобразим обучающие и проверочные данные:

```
train_data.head()
```

	Id	MSSubClass	MSZoning	LotFrontage	LotArea	Street	Alley	LotShape	LandContour	Utilities	...	PoolArea	PoolQC	Fence	Mis
0	1	60	RL	65.0	8450	Pave	NaN	Reg	Lvl	AllPub	...	0	NaN	NaN	NaN
1	2	20	RL	80.0	9600	Pave	NaN	Reg	Lvl	AllPub	...	0	NaN	NaN	NaN
2	3	60	RL	68.0	11250	Pave	NaN	IR1	Lvl	AllPub	...	0	NaN	NaN	NaN
3	4	70	RL	60.0	9550	Pave	NaN	IR1	Lvl	AllPub	...	0	NaN	NaN	NaN
4	5	60	RL	84.0	14260	Pave	NaN	IR1	Lvl	AllPub	...	0	NaN	NaN	NaN

5 rows × 81 columns

```
test_data.head()
```

	Id	MSSubClass	MSZoning	LotFrontage	LotArea	Street	Alley	LotShape	LandContour	Utilities	...	ScreenPorch	PoolArea	PoolQ
0	1461	20	RH	80.0	11622	Pave	NaN	Reg	Lvl	AllPub	...	120	0	NaN
1	1462	20	RL	81.0	14267	Pave	NaN	IR1	Lvl	AllPub	...	0	0	NaN
2	1463	60	RL	74.0	13830	Pave	NaN	IR1	Lvl	AllPub	...	0	0	NaN
3	1464	60	RL	78.0	9978	Pave	NaN	IR1	Lvl	AllPub	...	0	0	NaN
4	1465	120	RL	43.0	5005	Pave	NaN	IR1	HLS	AllPub	...	144	0	NaN

5 rows × 80 columns

Как можно видеть, `train_data` имеет на один столбец больше, чем `test_data`, это столбец `SalePrice`, для обучения модели перед применением ее для предсказания меток в test_data.

Проверяем нет ли тестовые данные пустых значений значений (Nan)

Построим функцию `def missing_value_checker` для проверки и подсчёта пропущеных значений в test_data. А также выведем тип данных этих значений.

```
def missing_value_checker(data):
    list = []
    for feature, content in data.items():
        if data[feature].isnull().values.any():

            sum = data[feature].isna().sum()

            type = data[feature].dtype

            print (f'{feature}: {sum}, type: {type}')

            list.append(feature)
    print(list)

    print(len(list))

missing_value_checker(test_data)
```

```
MSZoning: 4, type: object
LotFrontage: 227, type: float64
Alley: 1352, type: object
Utilities: 2, type: object
Exterior1st: 1, type: object
Exterior2nd: 1, type: object
MasVnrType: 16, type: object
MasVnrArea: 15, type: float64
BsmtQual: 44, type: object
BsmtCond: 45, type: object
BsmtExposure: 44, type: object
BsmtFinType1: 42, type: object
BsmtFinSF1: 1, type: float64
BsmtFinType2: 42, type: object
BsmtFinSF2: 1, type: float64
BsmtUnfSF: 1, type: float64
TotalBsmtSF: 1, type: float64
BsmtFullBath: 2, type: float64
BsmtHalfBath: 2, type: float64
KitchenQual: 1, type: object
Functional: 2, type: object
FireplaceQu: 730, type: object
GarageType: 76, type: object
GarageYrBlt: 78, type: float64
GarageFinish: 78, type: object
GarageCars: 1, type: float64
GarageArea: 1, type: float64
GarageQual: 78, type: object
GarageCond: 78, type: object
PoolQC: 1456, type: object
Fence: 1169, type: object
MiscFeature: 1408, type: object
SaleType: 1, type: object
['MSZoning', 'LotFrontage', 'Alley', 'Utilities', 'Exterior1st', 'Exterior2nd', 'MasVnrType', 'MasVnr
33
```

Проверяем какие признаки в таблице можно оставить, а какие удалить. Если пропущенных значений слишком много, то удалим признак. Если их небольшое количество, то заполним `mean` или `median` для чисел, новая категория `missing` для строковых объектов.

В соответствии с этим:

– удалим ['Alley', 'FireplaceQu', 'PoolQC', 'Fence', 'MiscFeature'];

– заполним числовое отсутствующее значение значением `mean`;

– заполним строковое отсутствующее значение значением `missing`.

```
test_edited = test_data.drop(['Alley','FireplaceQu','PoolQC', 'Fence', 'MiscFeature'], axis=1)
train_edited = train_data.drop(['Alley','FireplaceQu','PoolQC', 'Fence', 'MiscFeature'], axis=1)

def nan_filler(data):
    for label, content in data.items():
        if pd.api.types.is_numeric_dtype(content):
            data[label] = content.fillna(content.median())
        else:
            data[label] = content.astype("category").cat.as_ordered()
            data[label] = pd.Categorical(content).codes+1

nan_filler(test_edited)
nan_filler(train_edited)
```

Перепроверим наши данные:

```
missing_value_checker(test_edited)
```

```
[]
0
```

```
missing_value_checker(train_edited)
```

```
[]
0
```

```
train_edited.shape, test_edited.shape
```

```
((1460, 76), (1459, 75))
```

```
test_edited.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1459 entries, 0 to 1458
Data columns (total 75 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   Id             1459 non-null   int64
 1   MSSubClass     1459 non-null   int64
```

```
2   MSZoning       1459 non-null   int8
3   LotFrontage    1459 non-null   float64
4   LotArea        1459 non-null   int64
5   Street         1459 non-null   int8
6   LotShape       1459 non-null   int8
7   LandContour    1459 non-null   int8
8   Utilities      1459 non-null   int8
9   LotConfig      1459 non-null   int8
10  LandSlope      1459 non-null   int8
11  Neighborhood   1459 non-null   int8
12  Condition1     1459 non-null   int8
13  Condition2     1459 non-null   int8
14  BldgType       1459 non-null   int8
15  HouseStyle     1459 non-null   int8
16  OverallQual    1459 non-null   int64
17  OverallCond    1459 non-null   int64
18  YearBuilt      1459 non-null   int64
19  YearRemodAdd   1459 non-null   int64
20  RoofStyle      1459 non-null   int8
21  RoofMatl       1459 non-null   int8
22  Exterior1st    1459 non-null   int8
23  Exterior2nd    1459 non-null   int8
24  MasVnrType     1459 non-null   int8
25  MasVnrArea     1459 non-null   float64
26  ExterQual      1459 non-null   int8
27  ExterCond      1459 non-null   int8
28  Foundation     1459 non-null   int8
29  BsmtQual       1459 non-null   int8
30  BsmtCond       1459 non-null   int8
31  BsmtExposure   1459 non-null   int8
32  BsmtFinType1   1459 non-null   int8
33  BsmtFinSF1     1459 non-null   float64
34  BsmtFinType2   1459 non-null   int8
35  BsmtFinSF2     1459 non-null   float64
36  BsmtUnfSF      1459 non-null   float64
37  TotalBsmtSF    1459 non-null   float64
38  Heating        1459 non-null   int8
39  HeatingQC      1459 non-null   int8
40  CentralAir     1459 non-null   int8
41  Electrical     1459 non-null   int8
42  1stFlrSF       1459 non-null   int64
43  2ndFlrSF       1459 non-null   int64
44  LowQualFinSF   1459 non-null   int64
45  GrLivArea      1459 non-null   int64
46  BsmtFullBath   1459 non-null   float64
47  BsmtHalfBath   1459 non-null   float64
48  FullBath       1459 non-null   int64
49  HalfBath       1459 non-null   int64
50  BedroomAbvGr   1459 non-null   int64
51  KitchenAbvGr   1459 non-null   int64
52  KitchenQual    1459 non-null   int8
53  TotRmsAbvGrd   1459 non-null   int64
54  Functional     1459 non-null   int8
55  Fireplaces     1459 non-null   int64
56  GarageType     1459 non-null   int8
57  GarageYrBlt    1459 non-null   float64
58  GarageFinish   1459 non-null   int8
59  GarageCars     1459 non-null   float64
60  GarageArea     1459 non-null   float64
61  GarageQual     1459 non-null   int8
62  GarageCond     1459 non-null   int8
63  PavedDrive     1459 non-null   int8
64  WoodDeckSF     1459 non-null   int64
```

```
 65  OpenPorchSF    1459 non-null   int64
 66  EnclosedPorch  1459 non-null   int64
 67  3SsnPorch      1459 non-null   int64
 68  ScreenPorch    1459 non-null   int64
 69  PoolArea       1459 non-null   int64
 70  MiscVal        1459 non-null   int64
 71  MoSold         1459 non-null   int64
 72  YrSold         1459 non-null   int64
 73  SaleType       1459 non-null   int8
 74  SaleCondition  1459 non-null   int8
dtypes: float64(11), int64(26), int8(38)
memory usage: 476.0 KB
```

```
train_edited.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1460 entries, 0 to 1459
Data columns (total 76 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   Id             1460 non-null   int64
 1   MSSubClass     1460 non-null   int64
 2   MSZoning       1460 non-null   int8
 3   LotFrontage    1460 non-null   float64
 4   LotArea        1460 non-null   int64
 5   Street         1460 non-null   int8
 6   LotShape       1460 non-null   int8
 7   LandContour    1460 non-null   int8
 8   Utilities      1460 non-null   int8
 9   LotConfig      1460 non-null   int8
 10  LandSlope      1460 non-null   int8
 11  Neighborhood   1460 non-null   int8
 12  Condition1     1460 non-null   int8
 13  Condition2     1460 non-null   int8
 14  BldgType       1460 non-null   int8
 15  HouseStyle     1460 non-null   int8
 16  OverallQual    1460 non-null   int64
 17  OverallCond    1460 non-null   int64
 18  YearBuilt      1460 non-null   int64
 19  YearRemodAdd   1460 non-null   int64
 20  RoofStyle      1460 non-null   int8
 21  RoofMatl       1460 non-null   int8
 22  Exterior1st    1460 non-null   int8
 23  Exterior2nd    1460 non-null   int8
 24  MasVnrType     1460 non-null   int8
 25  MasVnrArea     1460 non-null   float64
 26  ExterQual      1460 non-null   int8
 27  ExterCond      1460 non-null   int8
 28  Foundation     1460 non-null   int8
 29  BsmtQual       1460 non-null   int8
 30  BsmtCond       1460 non-null   int8
 31  BsmtExposure   1460 non-null   int8
 32  BsmtFinType1   1460 non-null   int8
 33  BsmtFinSF1     1460 non-null   int64
 34  BsmtFinType2   1460 non-null   int8
 35  BsmtFinSF2     1460 non-null   int64
 36  BsmtUnfSF      1460 non-null   int64
 37  TotalBsmtSF    1460 non-null   int64
 38  Heating        1460 non-null   int8
 39  HeatingQC      1460 non-null   int8
```

```
 40  CentralAir     1460 non-null   int8
 41  Electrical     1460 non-null   int8
 42  1stFlrSF       1460 non-null   int64
 43  2ndFlrSF       1460 non-null   int64
 44  LowQualFinSF   1460 non-null   int64
 45  GrLivArea      1460 non-null   int64
 46  BsmtFullBath   1460 non-null   int64
 47  BsmtHalfBath   1460 non-null   int64
 48  FullBath       1460 non-null   int64
 49  HalfBath       1460 non-null   int64
 50  BedroomAbvGr   1460 non-null   int64
 51  KitchenAbvGr   1460 non-null   int64
 52  KitchenQual    1460 non-null   int8
 53  TotRmsAbvGrd   1460 non-null   int64
 54  Functional     1460 non-null   int8
 55  Fireplaces     1460 non-null   int64
 56  GarageType     1460 non-null   int8
 57  GarageYrBlt    1460 non-null   float64
 58  GarageFinish   1460 non-null   int8
 59  GarageCars     1460 non-null   int64
 60  GarageArea     1460 non-null   int64
 61  GarageQual     1460 non-null   int8
 62  GarageCond     1460 non-null   int8
 63  PavedDrive     1460 non-null   int8
 64  WoodDeckSF     1460 non-null   int64
 65  OpenPorchSF    1460 non-null   int64
 66  EnclosedPorch  1460 non-null   int64
 67  3SsnPorch      1460 non-null   int64
 68  ScreenPorch    1460 non-null   int64
 69  PoolArea       1460 non-null   int64
 70  MiscVal        1460 non-null   int64
 71  MoSold         1460 non-null   int64
 72  YrSold         1460 non-null   int64
 73  SaleType       1460 non-null   int8
 74  SaleCondition  1460 non-null   int8
 75  SalePrice      1460 non-null   int64
dtypes: float64(3), int64(35), int8(38)
memory usage: 487.7 KB
```

Разделим данные

Поскольку мы не знаем метку (Цена) тестовых данных, для оценки модели, чтобы получить лучшую модель перед прогнозированием тестовых данных, разделим данные в файле train.scv на обучающие и проверочные данные, соотношение составляет 20%.

```
X = train_edited.drop('SalePrice', axis=1)
y = train_edited['SalePrice']

X_train, X_val, y_train, y_val = train_test_split(X, y, test_size = 0.2)
```

```
X_train.shape, test_edited.shape
```

```
((1168, 75), (1459, 75))
```

Моделирование

Подбор гиперпарметров (количество узлов)

С помощью цикла пытаемся подобрать количество узлов или входные значения (a), для выхода будем использовать пока 10. Проанализировав данные, нашли, что ошибка уменьшается стремительно до разумных размеро (хотя бы меньше 1) при a=92, a=69. Замечу, что мы рассматривали только в промежутке от 0 до 100. Дальше поработаем с этими значениями

```
# from tensorflow import keras или import torch
values_loss=[]
for a in range(65,100):
    model = Sequential()
    model.add(Dense(a, activation='relu'))
    model.add(Dense(10, activation='relu'))
    tf.random.set_seed(40) #Для обеспечения воспроизводимости результатов устанавливается функция see
    model.compile(loss='msle', optimizer='adam', metrics=['mae'])
    #Для оценки потерь рекомендую использовать MSLE(MeanSquaredLogarithmicError), а также метрику MAE
    history = model.fit(X_train, y_train, epochs=10) #замените None на гиперпараметры вашей модели не
    print("/n","epocha - ",a,"/n")
```

```
Epoch 1/10
 1/37 [..............................] - ETA: 3:09 - loss: 69.2252 - mae: 154717.1406
Epoch 2/10
 1/37 [..............................] - ETA: 1s - loss: 29.0326 - mae: 173572.2969
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 23.3141 - mae: 148921.7344
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 20.8151 - mae: 165776.5312
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 18.7444 - mae: 179079.5000
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 17.6970 - mae: 154320.3125
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 16.8527 - mae: 149441.6406
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 16.1819 - mae: 149861.0625
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 15.4622 - mae: 122673.6406
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 14.8921 - mae: 102368.6406
/n epocha -  65 /n
Epoch 1/10
 1/37 [..............................] - ETA: 27s - loss: 104.0149 - mae: 154980.8594
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 55.0476 - mae: 174422.3438
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 38.4383 - mae: 151028.9219
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 36.9645 - mae: 170886.5938
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 34.9009 - mae: 188586.5938
Epoch 6/10
```

```
 1/37 [..............................] - ETA: 0s - loss: 33.2633 - mae: 164677.6875
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 18.6867 - mae: 159761.1719
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 17.8794 - mae: 168784.7812
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 17.0935 - mae: 151600.0000
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 16.3534 - mae: 142150.5312
/n epocha -  66 /n
Epoch 1/10
 1/37 [..............................] - ETA: 29s - loss: 89.7612 - mae: 154902.9844
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 31.0771 - mae: 174126.2812
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 25.6019 - mae: 150618.2500
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 22.2369 - mae: 168428.6875
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 19.2471 - mae: 181541.2656
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 17.5686 - mae: 153514.0938
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 16.3767 - mae: 143406.1875
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 15.7968 - mae: 140330.8438
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 15.2444 - mae: 113279.5156
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 14.8196 - mae: 97185.5625
/n epocha -  67 /n
Epoch 1/10
 1/37 [..............................] - ETA: 24s - loss: 92.8780 - mae: 154933.0625
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 55.2598 - mae: 174485.3125
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 38.6421 - mae: 151160.0312
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 35.9476 - mae: 169514.0938
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 33.2239 - mae: 183392.4375
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 31.8541 - mae: 157539.5938
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 31.0876 - mae: 152824.8125
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 30.7741 - mae: 158208.1562
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 30.2142 - mae: 138372.7344
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 15.9098 - mae: 129062.0469
/n epocha -  68 /n
Epoch 1/10
 1/37 [..............................] - ETA: 23s - loss: 55.8874 - mae: 154549.7969
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 17.6023 - mae: 173584.5625
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 12.1974 - mae: 149718.7969
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 8.3202 - mae: 166927.4062
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 4.8183 - mae: 177444.5938
Epoch 6/10
```

```
 1/37 [..............................] - ETA: 0s - loss: 3.1186 - mae: 147792.4375
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 2.1268 - mae: 140448.0625
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 1.5828 - mae: 140549.5312
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 1.0337 - mae: 117052.9688
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 0.7136 - mae: 103582.1406
/n epocha -  69 /n
Epoch 1/10
 1/37 [..............................] - ETA: 25s - loss: 96.4425 - mae: 154782.7031
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 33.9003 - mae: 174252.6875
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 26.5011 - mae: 151036.8281
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 23.6729 - mae: 170356.3438
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 20.4366 - mae: 185710.7969
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 18.6225 - mae: 159984.5312
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 17.5182 - mae: 154508.7812
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 16.9744 - mae: 162068.3125
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 16.2575 - mae: 142672.4219
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 15.6430 - mae: 131889.8750
/n epocha -  70 /n
Epoch 1/10
 1/37 [..............................] - ETA: 27s - loss: 53.3576 - mae: 154527.5000
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 29.4040 - mae: 173704.6250
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 23.4139 - mae: 148988.6875
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 20.6825 - mae: 165333.0156
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 18.3745 - mae: 176947.5000
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 17.1781 - mae: 150066.0000
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 16.4635 - mae: 144969.5469
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 16.0353 - mae: 146255.4062
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 15.4717 - mae: 122316.8594
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 14.9897 - mae: 107592.2969
/n epocha -  71 /n
Epoch 1/10
 1/37 [..............................] - ETA: 23s - loss: 107.2608 - mae: 154754.5625
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 77.9468 - mae: 173949.4219
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 50.1013 - mae: 150271.2969
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 49.6751 - mae: 170210.3594
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 47.9265 - mae: 187480.1875
Epoch 6/10
```

```
 1/37 [..............................] - ETA: 0s - loss: 33.3257 - mae: 164081.9844
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 32.1428 - mae: 160886.4062
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 31.3778 - mae: 165625.7812
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 30.5119 - mae: 143636.6406
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 16.1520 - mae: 129630.5156
/n epocha -  72 /n
Epoch 1/10
 1/37 [..............................] - ETA: 38s - loss: 100.3278 - mae: 154957.7656
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 54.6173 - mae: 174326.7812
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 49.6833 - mae: 150465.4375
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 48.6251 - mae: 168868.2500
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 46.8171 - mae: 183481.1250
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 18.4458 - mae: 156077.7969
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 17.5842 - mae: 153231.2969
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 17.2470 - mae: 162136.8438
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 16.6321 - mae: 145111.3750
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 16.0350 - mae: 136435.7500
/n epocha -  73 /n
Epoch 1/10
 1/37 [..............................] - ETA: 27s - loss: 73.7042 - mae: 154645.9688
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 16.9963 - mae: 173455.6094
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 11.7946 - mae: 149545.4062
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 7.5791 - mae: 165531.2500
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 4.1905 - mae: 174282.0000
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 2.5683 - mae: 142426.3438
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 1.6596 - mae: 131543.1094
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 1.2007 - mae: 130155.7500
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 0.7357 - mae: 103925.7812
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 0.4916 - mae: 89205.5938
/n epocha -  74 /n
Epoch 1/10
 1/37 [..............................] - ETA: 29s - loss: 97.5698 - mae: 154826.5000
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 55.1393 - mae: 174702.5000
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 26.3831 - mae: 150985.2656
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 24.2361 - mae: 170881.5625
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 21.0034 - mae: 187236.6875
Epoch 6/10
```

```
 1/37 [..............................] - ETA: 0s - loss: 18.8860 - mae: 161180.5625
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 17.6093 - mae: 156278.0312
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 17.0048 - mae: 162435.6250
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 16.2596 - mae: 142263.0625
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 15.6218 - mae: 130899.8125
/n epocha -  75 /n
Epoch 1/10
 1/37 [..............................] - ETA: 26s - loss: 77.1982 - mae: 154803.4219
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 28.3486 - mae: 173327.8125
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 22.5462 - mae: 148172.6875
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 19.5799 - mae: 162238.1250
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 17.3987 - mae: 170118.8125
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 16.3071 - mae: 139950.1250
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 15.6401 - mae: 132595.0000
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 15.3547 - mae: 124383.6250
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 14.9644 - mae: 96686.0781
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 14.6472 - mae: 81219.8750
/n epocha -  76 /n
Epoch 1/10
 1/37 [..............................] - ETA: 26s - loss: 66.4565 - mae: 154651.6250
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 18.4328 - mae: 173817.9062
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 11.6984 - mae: 149370.1406
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 7.5557 - mae: 165542.2500
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 4.6404 - mae: 176327.5938
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 3.3853 - mae: 149644.5312
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 2.4949 - mae: 144628.0000
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 1.8924 - mae: 146747.7188
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 1.2251 - mae: 122775.4844
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 0.8024 - mae: 107077.9766
/n epocha -  77 /n
Epoch 1/10
 1/37 [..............................] - ETA: 16s - loss: 76.4207 - mae: 154600.5000
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 51.6549 - mae: 173728.4844
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 25.4432 - mae: 150322.8750
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 23.0232 - mae: 169429.7812
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 19.7474 - mae: 183303.3438
Epoch 6/10
```

```
 1/37 [..............................] - ETA: 0s - loss: 17.5548 - mae: 153049.7500
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 16.2065 - mae: 140578.1094
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 15.6772 - mae: 135497.7344
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 15.1736 - mae: 108017.3125
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 14.7851 - mae: 92309.7344
/n epocha -  78 /n
Epoch 1/10
 1/37 [..............................] - ETA: 16s - loss: 81.9401 - mae: 154921.9531
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 53.0126 - mae: 173637.3125
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 24.8501 - mae: 149995.9844
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 23.2049 - mae: 169578.1250
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 20.5424 - mae: 185640.5312
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 18.2164 - mae: 157417.8438
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 16.6570 - mae: 146286.7344
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 15.9887 - mae: 145179.2188
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 15.3794 - mae: 118963.0156
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 14.9036 - mae: 102866.9531
/n epocha -  79 /n
Epoch 1/10
 1/37 [..............................] - ETA: 16s - loss: 97.4639 - mae: 154895.5312
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 41.7049 - mae: 173878.1875
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 36.9645 - mae: 150078.2031
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 34.2700 - mae: 166211.2812
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 31.8450 - mae: 175321.5000
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 17.2501 - mae: 147175.4062
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 16.7051 - mae: 145172.5625
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 16.3029 - mae: 148599.3125
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 15.6955 - mae: 126221.1172
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 15.1446 - mae: 111776.1562
/n epocha -  80 /n
Epoch 1/10
 1/37 [..............................] - ETA: 16s - loss: 98.4334 - mae: 154938.0938
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 68.0132 - mae: 174846.9688
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 62.3439 - mae: 150695.2500
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 51.5184 - mae: 166974.7500
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 46.5951 - mae: 181176.9844
Epoch 6/10
```

```
 1/37 [..............................] - ETA: 0s - loss: 45.3438 - mae: 154330.4531
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 44.8572 - mae: 150482.6250
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 44.7912 - mae: 154264.3594
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 44.2863 - mae: 131492.7656
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 43.5424 - mae: 116128.9219
/n epocha -  81 /n
Epoch 1/10
 1/37 [..............................] - ETA: 16s - loss: 73.3522 - mae: 154600.7500
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 38.2197 - mae: 172068.1875
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 34.6749 - mae: 147502.5938
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 33.3722 - mae: 163223.2500
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 31.3807 - mae: 170802.2969
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 30.2648 - mae: 138107.2188
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 29.7981 - mae: 131260.1875
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 29.7257 - mae: 123477.8125
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 29.4134 - mae: 98251.2656
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 28.9878 - mae: 85655.9922
/n epocha -  82 /n
Epoch 1/10
 1/37 [..............................] - ETA: 16s - loss: 75.3537 - mae: 154621.0312
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 39.7698 - mae: 173066.0938
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 23.3967 - mae: 148930.2344
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 21.6178 - mae: 167303.8438
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 19.4869 - mae: 182290.5938
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 18.1719 - mae: 157314.4688
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 17.2877 - mae: 152497.8438
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 16.8062 - mae: 159591.3125
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 16.1470 - mae: 139884.4688
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 15.4992 - mae: 127003.7969
/n epocha -  83 /n
Epoch 1/10
 1/37 [..............................] - ETA: 16s - loss: 88.8643 - mae: 154735.4375
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 64.8395 - mae: 173128.7500
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 61.2046 - mae: 149258.6250
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 35.5396 - mae: 167322.0938
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 33.5226 - mae: 182946.7500
Epoch 6/10
```

```
 1/37 [..............................] - ETA: 0s - loss: 31.7845 - mae: 155084.9688
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 30.6462 - mae: 147811.9219
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 30.2896 - mae: 144780.0312
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 29.7583 - mae: 119927.7969
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 29.1678 - mae: 103250.9922
/n epocha -  84 /n
Epoch 1/10
 1/37 [..............................] - ETA: 16s - loss: 95.7347 - mae: 154920.5156
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 41.2840 - mae: 173669.9062
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 36.0360 - mae: 149200.2031
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 33.8001 - mae: 164808.5156
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 31.7564 - mae: 174371.9531
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 30.7000 - mae: 145916.0312
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 30.1644 - mae: 141596.2344
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 30.0348 - mae: 139022.0938
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 29.6431 - mae: 116329.8984
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 29.1237 - mae: 102355.6719
/n epocha -  85 /n
Epoch 1/10
 1/37 [..............................] - ETA: 17s - loss: 83.9666 - mae: 154807.7812
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 28.8953 - mae: 173491.8750
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 22.8280 - mae: 148339.9375
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 19.4159 - mae: 161385.0000
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 17.2213 - mae: 168013.3281
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 16.0822 - mae: 135708.2188
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 15.5312 - mae: 129804.6562
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 15.2903 - mae: 121322.0078
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 14.9245 - mae: 93061.7188
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 14.6228 - mae: 78172.0078
/n epocha -  86 /n
Epoch 1/10
 1/37 [..............................] - ETA: 17s - loss: 72.3067 - mae: 154526.6094
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 26.7414 - mae: 172557.8438
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 21.4205 - mae: 146580.2656
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 18.5608 - mae: 157844.5156
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 16.5813 - mae: 160358.5625
Epoch 6/10
```

```
 1/37 [..............................] - ETA: 0s - loss: 15.5455 - mae: 123135.8047
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 15.0566 - mae: 115444.1875
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 14.9307 - mae: 97063.1953
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 14.7151 - mae: 70558.0547
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 14.5199 - mae: 65871.7422
/n epocha -  87 /n
Epoch 1/10
 1/37 [..............................] - ETA: 17s - loss: 69.6006 - mae: 154603.5469
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 49.4803 - mae: 170824.7656
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 32.8113 - mae: 143164.1875
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 19.0709 - mae: 158869.0938
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 17.8573 - mae: 172394.0938
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 16.9100 - mae: 146544.6875
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 16.1074 - mae: 139382.4531
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 15.7117 - mae: 136402.0625
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 15.2189 - mae: 110161.9688
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 14.8108 - mae: 94321.2188
/n epocha -  88 /n
Epoch 1/10
 1/37 [..............................] - ETA: 19s - loss: 85.9726 - mae: 154770.9688
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 53.3798 - mae: 173764.8125
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 24.3015 - mae: 149507.5312
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 21.9968 - mae: 167791.7812
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 19.5012 - mae: 181793.3281
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 17.7055 - mae: 153776.0469
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 16.2210 - mae: 142348.1562
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 15.5184 - mae: 130240.3594
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 15.0009 - mae: 98467.0781
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 14.6478 - mae: 80481.4531
/n epocha -  89 /n
Epoch 1/10
 1/37 [..............................] - ETA: 19s - loss: 94.3039 - mae: 154858.5938
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 41.7154 - mae: 173915.9375
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 36.2999 - mae: 149486.0469
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 33.8771 - mae: 165022.3750
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 31.7744 - mae: 174443.5156
Epoch 6/10
```

```
 1/37 [..............................] - ETA: 0s - loss: 30.7125 - mae: 146005.8594
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 16.7394 - mae: 141943.8594
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 16.1781 - mae: 142207.5312
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 15.6587 - mae: 121680.5547
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 15.0740 - mae: 106896.8359
/n epocha -  90 /n
Epoch 1/10
 1/37 [..............................] - ETA: 1:02 - loss: 73.1732 - mae: 154550.0938
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 49.7477 - mae: 171815.5469
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 33.9206 - mae: 146063.8750
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 32.4032 - mae: 158689.1719
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 30.8074 - mae: 162857.9688
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 29.9687 - mae: 130720.0781
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 29.6368 - mae: 127928.2969
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 29.6028 - mae: 115738.2969
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 29.3320 - mae: 89916.2969
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 28.9408 - mae: 81552.0547
/n epocha -  91 /n
Epoch 1/10
 1/37 [..............................] - ETA: 51s - loss: 77.5341 - mae: 154719.2812
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 65.3772 - mae: 173640.8438
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 26.3029 - mae: 149344.0000
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 21.8615 - mae: 167439.3750
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 19.6793 - mae: 182311.8438
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 17.5639 - mae: 152185.2656
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 16.0649 - mae: 140658.2656
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 15.3601 - mae: 122716.9219
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 14.8626 - mae: 87250.3750
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 14.5665 - mae: 71288.0547
/n epocha -  92 /n
Epoch 1/10
 1/37 [..............................] - ETA: 50s - loss: 88.7277 - mae: 154910.5312
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 55.3904 - mae: 174080.6562
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 49.6563 - mae: 150257.0938
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 48.1497 - mae: 167437.5781
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 46.3393 - mae: 179729.2031
Epoch 6/10
```

```
 1/37 [..............................] - ETA: 0s - loss: 31.9209 - mae: 154965.7500
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 31.2998 - mae: 155403.7969
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 17.0957 - mae: 158445.9062
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 2.3637 - mae: 135471.3438
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 1.6514 - mae: 122310.5703
/n epocha -  93 /n
Epoch 1/10
 1/37 [..............................] - ETA: 50s - loss: 92.2489 - mae: 154834.8438
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 40.6719 - mae: 173500.1875
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 22.7710 - mae: 148274.8750
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 19.9992 - mae: 163274.1562
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 17.4116 - mae: 169522.7812
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 16.1195 - mae: 136008.6406
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 15.5242 - mae: 130834.4375
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 15.2458 - mae: 118544.4844
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 14.8916 - mae: 89911.1562
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 14.6014 - mae: 75440.3750
/n epocha -  94 /n
Epoch 1/10
 1/37 [..............................] - ETA: 49s - loss: 81.4325 - mae: 154870.5312
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 16.1444 - mae: 173074.0312
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 11.5213 - mae: 149258.9062
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 7.8741 - mae: 166224.7812
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 4.7621 - mae: 176932.3125
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 3.3176 - mae: 149164.4688
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 2.3442 - mae: 143483.6094
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 1.7759 - mae: 144284.8906
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 1.1804 - mae: 121472.0078
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 0.8298 - mae: 108346.3281
/n epocha -  95 /n
Epoch 1/10
 1/37 [..............................] - ETA: 51s - loss: 74.5987 - mae: 154781.5625
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 28.4495 - mae: 173120.8906
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 23.9984 - mae: 149426.0781
Epoch 4/10
 1/37 [..............................] - ETA: 1s - loss: 20.5582 - mae: 164888.1250
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 17.3892 - mae: 168904.8906
Epoch 6/10
```

```
 1/37 [..............................] - ETA: 0s - loss: 16.0788 - mae: 134779.3750
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 15.4549 - mae: 131831.4688
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 15.1990 - mae: 115580.9141
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 14.8627 - mae: 88584.6875
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 14.5886 - mae: 73365.1875
/n epocha -  96 /n
Epoch 1/10
 1/37 [..............................] - ETA: 49s - loss: 90.2354 - mae: 154908.4219
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 28.2861 - mae: 173326.3438
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 22.6719 - mae: 148334.7500
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 19.4715 - mae: 162028.4219
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 17.1542 - mae: 167890.7812
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 15.9368 - mae: 133509.0938
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 15.3208 - mae: 125882.9531
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 15.1229 - mae: 112270.4766
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 14.8285 - mae: 85298.9453
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 14.5675 - mae: 70855.1016
/n epocha -  97 /n
Epoch 1/10
 1/37 [..............................] - ETA: 52s - loss: 91.9620 - mae: 154840.9531
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 29.5603 - mae: 173397.2500
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 23.0614 - mae: 148568.1875
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 20.7516 - mae: 165435.3906
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 18.3224 - mae: 176450.9219
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 16.5207 - mae: 142918.5469
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 15.5243 - mae: 129981.0703
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 15.1714 - mae: 115389.5391
Epoch 9/10
 1/37 [..............................] - ETA: 1s - loss: 14.8333 - mae: 85349.7812
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 14.5665 - mae: 70839.7812
/n epocha -  98 /n
Epoch 1/10
 1/37 [..............................] - ETA: 48s - loss: 87.2786 - mae: 154729.1719
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 50.8543 - mae: 173088.0938
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 35.2896 - mae: 148308.9062
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 19.7319 - mae: 162250.6562
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 17.5226 - mae: 170796.7500
Epoch 6/10
```

```
 1/37 [..............................] - ETA: 0s - loss: 16.3428 - mae: 140055.0000
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 15.7084 - mae: 133286.3281
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 15.4388 - mae: 127968.8125
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 15.0421 - mae: 101652.2969
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 14.6767 - mae: 83659.9375
/n epocha -  99 /n
```

Добавив скрытый слой, показатели loss и mae стремительнее уменьшается, чем без использования скрытого слоя, что более эффективно.

Проверим входные значения равные 100, 150, 200, 300:

```
values_loss=[]
for a in range(100,350,50):
    model = Sequential()
    model.add(Dense(a, activation='relu'))
    model.add(Dense(a, activation='relu'))
    model.add(Dense(1, activation='relu'))
    tf.random.set_seed(40) #Для обеспечения воспроизводимости результатов устанавливается функция see
    model.compile(loss='msle', optimizer='adam', metrics=['mae'])
    #Для оценки потерь рекомендую использовать MSLE(MeanSquaredLogarithmicError), а также метрику MAE
    history = model.fit(X_train, y_train, epochs=10) #замените None на гиперпараметры вашей модели не
    print("/n","epocha - ",a,"/n")
```

```
Epoch 1/10
 1/37 [..............................] - ETA: 2:19 - loss: 141.4704 - mae: 155148.9688
Epoch 2/10
 1/37 [..............................] - ETA: 1s - loss: 142.7265 - mae: 176255.7188
Epoch 3/10
 1/37 [..............................] - ETA: 2s - loss: 140.6069 - mae: 154380.1562
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 144.9063 - mae: 176966.5625
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 145.3690 - mae: 199268.7500
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 144.7490 - mae: 179331.0312
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 145.0701 - mae: 185554.1250
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 146.0608 - mae: 197065.9375
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 145.7385 - mae: 185929.5938
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 144.0663 - mae: 181825.8125
/n epocha -  100 /n
Epoch 1/10
 1/37 [..............................] - ETA: 17s - loss: 126.0462 - mae: 155133.8750
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 6.3944 - mae: 162869.9688
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 2.3427 - mae: 122127.9375
```

```
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 0.8027 - mae: 104640.4297
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 0.3073 - mae: 86096.9375
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 0.1313 - mae: 46949.4922
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 0.1609 - mae: 74713.1953
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 0.1537 - mae: 60456.7148
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 0.0825 - mae: 45219.3164
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 0.1012 - mae: 51719.6172
/n epocha -  150 /n
Epoch 1/10
 1/37 [..............................] - ETA: 16s - loss: 141.4704 - mae: 155148.9688
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 9.7377 - mae: 168619.9844
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 4.0445 - mae: 134148.3125
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 1.6526 - mae: 127743.0547
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 0.5910 - mae: 107776.6406
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 0.2743 - mae: 64202.6250
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 0.2422 - mae: 93705.1094
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 0.2037 - mae: 66749.0156
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 0.0984 - mae: 47512.2461
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 0.1079 - mae: 53828.7734
/n epocha -  200 /n
Epoch 1/10
 1/37 [..............................] - ETA: 16s - loss: 25.5693 - mae: 154132.7500
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 2.3035 - mae: 138592.1719
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 0.3635 - mae: 68688.5469
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 0.0969 - mae: 39524.8555
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 0.1456 - mae: 60231.6172
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 0.0883 - mae: 42432.5898
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 0.1580 - mae: 73362.6172
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 0.1547 - mae: 60269.1953
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 0.0803 - mae: 44612.0703
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 0.0987 - mae: 51192.4805
/n epocha -  250 /n
Epoch 1/10
 1/37 [..............................] - ETA: 30s - loss: 141.4704 - mae: 155148.9688
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 142.7265 - mae: 176255.7188
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 140.6069 - mae: 154380.1562
```

```
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 144.9063 - mae: 176966.5625
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 145.3690 - mae: 199268.7500
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 144.7490 - mae: 179331.0312
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 145.0701 - mae: 185554.1250
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 146.0608 - mae: 197065.9375
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 145.7385 - mae: 185929.5938
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 144.0663 - mae: 181825.8125
/n epocha -  300 /n
```

Дальше разберемся с выходными значениями. Заметим, что при увеличении выходного значения, ошибка растет, следовательно возьмем i=1.

```
for i in range (1,10):
    model = Sequential()
    model.add(Dense(92, activation='relu'))
    model.add(Dense(92, activation='relu'))
    model.add(Dense(1, activation='relu'))
    tf.random.set_seed(40) #Для обеспечения воспроизводимости результатов устанавливается функция see
    model.compile(loss='msle', optimizer='adam', metrics=['mae'])
    #Для оценки потерь рекомендую использовать MSLE(MeanSquaredLogarithmicError), а также метрику MAE
    history = model.fit(X_train, y_train, epochs=10)
    print("/n","epocha - ",i,"/n")
```

```
Epoch 1/10
 1/37 [..............................] - ETA: 17s - loss: 43.6718 - mae: 154839.0938
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 8.6254 - mae: 167090.1719
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 4.0893 - mae: 134427.9688
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 1.8974 - mae: 132266.6250
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 0.8646 - mae: 120470.3516
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 0.4868 - mae: 85490.0078
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 0.3765 - mae: 101001.0703
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 0.2966 - mae: 79373.7188
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 0.1430 - mae: 55826.2148
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 0.1230 - mae: 52408.2656
/n epocha -  1 /n
Epoch 1/10
 1/37 [..............................] - ETA: 16s - loss: 43.6718 - mae: 154839.0938
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 8.6254 - mae: 167090.1719
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 4.0893 - mae: 134427.9688
```

```
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 1.8974 - mae: 132266.6250
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 0.8646 - mae: 120470.3516
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 0.4868 - mae: 85490.0078
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 0.3765 - mae: 101001.0703
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 0.2966 - mae: 79373.7188
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 0.1430 - mae: 55826.2148
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 0.1230 - mae: 52408.2656
/n epocha -  2 /n
Epoch 1/10
 1/37 [..............................] - ETA: 16s - loss: 43.6718 - mae: 154839.0938
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 8.6254 - mae: 167090.1719
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 4.0893 - mae: 134427.9688
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 1.8974 - mae: 132266.6250
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 0.8646 - mae: 120470.3516
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 0.4868 - mae: 85490.0078
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 0.3765 - mae: 101001.0703
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 0.2966 - mae: 79373.7188
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 0.1430 - mae: 55826.2148
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 0.1230 - mae: 52408.2656
/n epocha -  3 /n
Epoch 1/10
 1/37 [..............................] - ETA: 16s - loss: 43.6718 - mae: 154839.0938
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 8.6254 - mae: 167090.1719
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 4.0893 - mae: 134427.9688
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 1.8974 - mae: 132266.6250
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 0.8646 - mae: 120470.3516
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 0.4868 - mae: 85490.0078
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 0.3765 - mae: 101001.0703
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 0.2966 - mae: 79373.7188
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 0.1430 - mae: 55826.2148
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 0.1230 - mae: 52408.2656
/n epocha -  4 /n
Epoch 1/10
 1/37 [..............................] - ETA: 16s - loss: 43.6718 - mae: 154839.0938
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 8.6254 - mae: 167090.1719
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 4.0893 - mae: 134427.9688
```

```
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 1.8974 - mae: 132266.6250
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 0.8646 - mae: 120470.3516
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 0.4868 - mae: 85490.0078
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 0.3765 - mae: 101001.0703
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 0.2966 - mae: 79373.7188
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 0.1430 - mae: 55826.2148
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 0.1230 - mae: 52408.2656
/n epocha -  5 /n
Epoch 1/10
 1/37 [..............................] - ETA: 16s - loss: 43.6718 - mae: 154839.0938
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 8.6254 - mae: 167090.1719
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 4.0893 - mae: 134427.9688
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 1.8974 - mae: 132266.6250
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 0.8646 - mae: 120470.3516
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 0.4868 - mae: 85490.0078
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 0.3765 - mae: 101001.0703
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 0.2966 - mae: 79373.7188
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 0.1430 - mae: 55826.2148
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 0.1230 - mae: 52408.2656
/n epocha -  6 /n
Epoch 1/10
 1/37 [..............................] - ETA: 16s - loss: 43.6718 - mae: 154839.0938
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 8.6254 - mae: 167090.1719
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 4.0893 - mae: 134427.9688
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 1.8974 - mae: 132266.6250
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 0.8646 - mae: 120470.3516
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 0.4868 - mae: 85490.0078
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 0.3765 - mae: 101001.0703
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 0.2966 - mae: 79373.7188
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 0.1430 - mae: 55826.2148
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 0.1230 - mae: 52408.2656
/n epocha -  7 /n
Epoch 1/10
 1/37 [..............................] - ETA: 16s - loss: 43.6718 - mae: 154839.0938
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 8.6254 - mae: 167090.1719
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 4.0893 - mae: 134427.9688
```

```
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 1.8974 - mae: 132266.6250
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 0.8646 - mae: 120470.3516
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 0.4868 - mae: 85490.0078
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 0.3765 - mae: 101001.0703
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 0.2966 - mae: 79373.7188
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 0.1430 - mae: 55826.2148
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 0.1230 - mae: 52408.2656
/n epocha -  8 /n
Epoch 1/10
 1/37 [..............................] - ETA: 16s - loss: 43.6718 - mae: 154839.0938
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 8.6254 - mae: 167090.1719
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 4.0893 - mae: 134427.9688
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 1.8974 - mae: 132266.6250
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 0.8646 - mae: 120470.3516
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 0.4868 - mae: 85490.0078
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 0.3765 - mae: 101001.0703
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 0.2966 - mae: 79373.7188
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 0.1430 - mae: 55826.2148
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 0.1230 - mae: 52408.2656
/n epocha -  9 /n
```

```
model = Sequential()
model.add(Dense(92, activation='relu'))
model.add(Dense(92, activation='relu'))
model.add(Dense(1, activation='relu'))
tf.random.set_seed(40) #Для обеспечения воспроизводимости результатов устанавливается функция seed
model.compile(loss='msle', optimizer='adam', metrics=['mae'])
#Для оценки потерь рекомендую использовать MSLE(MeanSquaredLogarithmicError), а также метрику MAE(Mea
history = model.fit(X_train, y_train, epochs=10)
```

```
Epoch 1/300
 1/37 [..............................] - ETA: 16s - loss: 43.6718 - mae: 154839.0938
Epoch 2/300
 1/37 [..............................] - ETA: 0s - loss: 8.6254 - mae: 167090.1719
Epoch 3/300
 1/37 [..............................] - ETA: 0s - loss: 4.0893 - mae: 134427.9688
Epoch 4/300
 1/37 [..............................] - ETA: 0s - loss: 1.8974 - mae: 132266.6250
Epoch 5/300
 1/37 [..............................] - ETA: 0s - loss: 0.8646 - mae: 120470.3516
Epoch 6/300
 1/37 [..............................] - ETA: 0s - loss: 0.4868 - mae: 85490.0078
Epoch 7/300
```

```
 1/37 [..............................] - ETA: 0s - loss: 0.3765 - mae: 101001.0703
Epoch 8/300
 1/37 [..............................] - ETA: 0s - loss: 0.2966 - mae: 79373.7188
Epoch 9/300
 1/37 [..............................] - ETA: 0s - loss: 0.1430 - mae: 55826.2148
Epoch 10/300
 1/37 [..............................] - ETA: 0s - loss: 0.1230 - mae: 52408.2656
Epoch 11/300
 1/37 [..............................] - ETA: 0s - loss: 0.0959 - mae: 41163.1719
Epoch 12/300
 1/37 [..............................] - ETA: 0s - loss: 0.1306 - mae: 53673.6953
Epoch 13/300
 1/37 [..............................] - ETA: 0s - loss: 0.1599 - mae: 50368.0078
Epoch 14/300
 1/37 [..............................] - ETA: 0s - loss: 0.1244 - mae: 45742.5039
Epoch 15/300
 1/37 [..............................] - ETA: 0s - loss: 0.2074 - mae: 74541.1484
Epoch 16/300
 1/37 [..............................] - ETA: 0s - loss: 0.1132 - mae: 43930.8438
Epoch 17/300
 1/37 [..............................] - ETA: 0s - loss: 0.0862 - mae: 46749.0898
Epoch 18/300
 1/37 [..............................] - ETA: 0s - loss: 0.0707 - mae: 43383.1797
Epoch 19/300
 1/37 [..............................] - ETA: 0s - loss: 0.0915 - mae: 45004.9805
Epoch 20/300
 1/37 [..............................] - ETA: 0s - loss: 0.0971 - mae: 36766.2188
Epoch 21/300
 1/37 [..............................] - ETA: 0s - loss: 0.0749 - mae: 41503.9961
Epoch 22/300
 1/37 [..............................] - ETA: 0s - loss: 0.1637 - mae: 75606.6250
Epoch 23/300
 1/37 [..............................] - ETA: 0s - loss: 0.1789 - mae: 46119.3398
Epoch 24/300
 1/37 [..............................] - ETA: 0s - loss: 0.1025 - mae: 45742.0234
Epoch 25/300
 1/37 [..............................] - ETA: 0s - loss: 0.0637 - mae: 39421.8320
Epoch 26/300
 1/37 [..............................] - ETA: 0s - loss: 0.0675 - mae: 37921.3984
Epoch 27/300
 1/37 [..............................] - ETA: 0s - loss: 0.1225 - mae: 40911.6953
Epoch 28/300
 1/37 [..............................] - ETA: 0s - loss: 0.0680 - mae: 32856.4883
Epoch 29/300
 1/37 [..............................] - ETA: 0s - loss: 0.0862 - mae: 38762.8047
Epoch 30/300
 1/37 [..............................] - ETA: 0s - loss: 0.0757 - mae: 46414.6875
Epoch 31/300
 1/37 [..............................] - ETA: 0s - loss: 0.1209 - mae: 60256.1328
Epoch 32/300
 1/37 [..............................] - ETA: 0s - loss: 0.1544 - mae: 36279.1719
Epoch 33/300
 1/37 [..............................] - ETA: 0s - loss: 0.1484 - mae: 48742.6953
Epoch 34/300
 1/37 [..............................] - ETA: 0s - loss: 0.0933 - mae: 40820.2500
Epoch 35/300
 1/37 [..............................] - ETA: 0s - loss: 0.1095 - mae: 55101.6406
Epoch 36/300
 1/37 [..............................] - ETA: 0s - loss: 0.1540 - mae: 69706.8594
Epoch 37/300
 1/37 [..............................] - ETA: 0s - loss: 0.0568 - mae: 36110.9453
Epoch 38/300
 1/37 [..............................] - ETA: 0s - loss: 0.0501 - mae: 34778.9453
```

```
Epoch 39/300
 1/37 [..............................] - ETA: 0s - loss: 0.1007 - mae: 53809.8359
Epoch 40/300
 1/37 [..............................] - ETA: 0s - loss: 0.0514 - mae: 31794.5801
Epoch 41/300
 1/37 [..............................] - ETA: 0s - loss: 0.0473 - mae: 33632.5703
Epoch 42/300
 1/37 [..............................] - ETA: 0s - loss: 0.0599 - mae: 46334.8125
Epoch 43/300
 1/37 [..............................] - ETA: 0s - loss: 0.1207 - mae: 38232.7969
Epoch 44/300
 1/37 [..............................] - ETA: 0s - loss: 0.0569 - mae: 39045.8750
Epoch 45/300
 1/37 [..............................] - ETA: 0s - loss: 0.0546 - mae: 34852.5859
Epoch 46/300
 1/37 [..............................] - ETA: 0s - loss: 0.0350 - mae: 28408.7461
Epoch 47/300
 1/37 [..............................] - ETA: 0s - loss: 0.0514 - mae: 38572.8281
Epoch 48/300
 1/37 [..............................] - ETA: 0s - loss: 0.0161 - mae: 19389.0508
Epoch 49/300
 1/37 [..............................] - ETA: 0s - loss: 0.0574 - mae: 36046.8242
Epoch 50/300
 1/37 [..............................] - ETA: 0s - loss: 0.0294 - mae: 19904.3105
Epoch 51/300
 1/37 [..............................] - ETA: 0s - loss: 0.0399 - mae: 33722.7500
Epoch 52/300
 1/37 [..............................] - ETA: 0s - loss: 0.0393 - mae: 30167.5234
Epoch 53/300
 1/37 [..............................] - ETA: 0s - loss: 0.0935 - mae: 27045.8906
Epoch 54/300
 1/37 [..............................] - ETA: 0s - loss: 0.0533 - mae: 36654.8359
Epoch 55/300
 1/37 [..............................] - ETA: 0s - loss: 0.0398 - mae: 25998.8711
Epoch 56/300
 1/37 [..............................] - ETA: 0s - loss: 0.0455 - mae: 33680.3750
Epoch 57/300
 1/37 [..............................] - ETA: 0s - loss: 0.0702 - mae: 26864.8945
Epoch 58/300
 1/37 [..............................] - ETA: 0s - loss: 0.0394 - mae: 26068.6602
Epoch 59/300
 1/37 [..............................] - ETA: 0s - loss: 0.0316 - mae: 28058.1973
Epoch 60/300
 1/37 [..............................] - ETA: 0s - loss: 0.0477 - mae: 31802.2910
Epoch 61/300
 1/37 [..............................] - ETA: 0s - loss: 0.0320 - mae: 21681.0664
Epoch 62/300
 1/37 [..............................] - ETA: 0s - loss: 0.0354 - mae: 26926.9004
Epoch 63/300
 1/37 [..............................] - ETA: 0s - loss: 0.0161 - mae: 17166.5547
Epoch 64/300
 1/37 [..............................] - ETA: 0s - loss: 0.0345 - mae: 26069.4570
Epoch 65/300
 1/37 [..............................] - ETA: 0s - loss: 0.0298 - mae: 26659.0723
Epoch 66/300
 1/37 [..............................] - ETA: 0s - loss: 0.0610 - mae: 26901.8145
Epoch 67/300
 1/37 [..............................] - ETA: 0s - loss: 0.0413 - mae: 34834.8984
Epoch 68/300
 1/37 [..............................] - ETA: 0s - loss: 0.0398 - mae: 28622.1094
Epoch 69/300
 1/37 [..............................] - ETA: 0s - loss: 0.0346 - mae: 27554.6094
Epoch 70/300
```

```
 1/37 [..............................] - ETA: 0s - loss: 0.0895 - mae: 32737.6016
Epoch 71/300
 1/37 [..............................] - ETA: 0s - loss: 0.0541 - mae: 32530.6270
Epoch 72/300
 1/37 [..............................] - ETA: 0s - loss: 0.0253 - mae: 20401.8379
Epoch 73/300
 1/37 [..............................] - ETA: 0s - loss: 0.0360 - mae: 24187.7363
Epoch 74/300
 1/37 [..............................] - ETA: 0s - loss: 0.0493 - mae: 28363.3438
Epoch 75/300
 1/37 [..............................] - ETA: 0s - loss: 0.0262 - mae: 16338.4199
Epoch 76/300
 1/37 [..............................] - ETA: 0s - loss: 0.0202 - mae: 16957.0078
Epoch 77/300
 1/37 [..............................] - ETA: 0s - loss: 0.0231 - mae: 28190.4785
Epoch 78/300
 1/37 [..............................] - ETA: 0s - loss: 0.0214 - mae: 20572.0547
Epoch 79/300
 1/37 [..............................] - ETA: 0s - loss: 0.0266 - mae: 27003.3945
Epoch 80/300
 1/37 [..............................] - ETA: 0s - loss: 0.0313 - mae: 22024.2461
Epoch 81/300
 1/37 [..............................] - ETA: 0s - loss: 0.0408 - mae: 25891.6328
Epoch 82/300
 1/37 [..............................] - ETA: 0s - loss: 0.0234 - mae: 22069.1719
Epoch 83/300
 1/37 [..............................] - ETA: 0s - loss: 0.0501 - mae: 29649.0195
Epoch 84/300
 1/37 [..............................] - ETA: 0s - loss: 0.0726 - mae: 26643.2461
Epoch 85/300
 1/37 [..............................] - ETA: 0s - loss: 0.0299 - mae: 26047.3125
Epoch 86/300
 1/37 [..............................] - ETA: 0s - loss: 0.0410 - mae: 30893.0664
Epoch 87/300
 1/37 [..............................] - ETA: 0s - loss: 0.0467 - mae: 26001.4648
Epoch 88/300
 1/37 [..............................] - ETA: 0s - loss: 0.0474 - mae: 36837.5938
Epoch 89/300
 1/37 [..............................] - ETA: 0s - loss: 0.0269 - mae: 20224.5586
Epoch 90/300
 1/37 [..............................] - ETA: 0s - loss: 0.0699 - mae: 29737.9219
Epoch 91/300
 1/37 [..............................] - ETA: 0s - loss: 0.0247 - mae: 22056.5312
Epoch 92/300
 1/37 [..............................] - ETA: 0s - loss: 0.0225 - mae: 19546.8027
Epoch 93/300
 1/37 [..............................] - ETA: 0s - loss: 0.0391 - mae: 27776.1484
Epoch 94/300
 1/37 [..............................] - ETA: 0s - loss: 0.0460 - mae: 31096.0723
Epoch 95/300
 1/37 [..............................] - ETA: 0s - loss: 0.0409 - mae: 31345.8750
Epoch 96/300
 1/37 [..............................] - ETA: 0s - loss: 0.0194 - mae: 18710.0703
Epoch 97/300
 1/37 [..............................] - ETA: 0s - loss: 0.0315 - mae: 26332.5195
Epoch 98/300
 1/37 [..............................] - ETA: 0s - loss: 0.0417 - mae: 31851.9375
Epoch 99/300
 1/37 [..............................] - ETA: 0s - loss: 0.0766 - mae: 31117.4180
Epoch 100/300
 1/37 [..............................] - ETA: 0s - loss: 0.0362 - mae: 25341.9258
Epoch 101/300
 1/37 [..............................] - ETA: 0s - loss: 0.0404 - mae: 27350.5098
```

```
Epoch 102/300
 1/37 [..............................] - ETA: 0s - loss: 0.0422 - mae: 26813.9180
Epoch 103/300
 1/37 [..............................] - ETA: 0s - loss: 0.0231 - mae: 24887.2285
Epoch 104/300
 1/37 [..............................] - ETA: 0s - loss: 0.0216 - mae: 19941.8203
Epoch 105/300
 1/37 [..............................] - ETA: 0s - loss: 0.0516 - mae: 28468.1172
Epoch 106/300
 1/37 [..............................] - ETA: 0s - loss: 0.0377 - mae: 28534.2148
Epoch 107/300
 1/37 [..............................] - ETA: 0s - loss: 0.0326 - mae: 22393.2578
Epoch 108/300
 1/37 [..............................] - ETA: 0s - loss: 0.0336 - mae: 18620.5234
Epoch 109/300
 1/37 [..............................] - ETA: 0s - loss: 0.0199 - mae: 18824.9160
Epoch 110/300
 1/37 [..............................] - ETA: 0s - loss: 0.0414 - mae: 27030.5820
Epoch 111/300
 1/37 [..............................] - ETA: 0s - loss: 0.0319 - mae: 25686.6914
Epoch 112/300
 1/37 [..............................] - ETA: 0s - loss: 0.0284 - mae: 25229.9336
Epoch 113/300
 1/37 [..............................] - ETA: 0s - loss: 0.0330 - mae: 21491.9688
Epoch 114/300
 1/37 [..............................] - ETA: 0s - loss: 0.0336 - mae: 28814.1172
Epoch 115/300
 1/37 [..............................] - ETA: 0s - loss: 0.0261 - mae: 25268.6973
Epoch 116/300
 1/37 [..............................] - ETA: 0s - loss: 0.0537 - mae: 41462.6250
Epoch 117/300
 1/37 [..............................] - ETA: 0s - loss: 0.0278 - mae: 22819.9531
Epoch 118/300
 1/37 [..............................] - ETA: 0s - loss: 0.0340 - mae: 28073.1973
Epoch 119/300
 1/37 [..............................] - ETA: 0s - loss: 0.0316 - mae: 24228.3359
Epoch 120/300
 1/37 [..............................] - ETA: 0s - loss: 0.0339 - mae: 19946.8438
Epoch 121/300
 1/37 [..............................] - ETA: 0s - loss: 0.0138 - mae: 16902.7344
Epoch 122/300
 1/37 [..............................] - ETA: 0s - loss: 0.0347 - mae: 29967.1328
Epoch 123/300
 1/37 [..............................] - ETA: 0s - loss: 0.0350 - mae: 22416.5723
Epoch 124/300
 1/37 [..............................] - ETA: 0s - loss: 0.0264 - mae: 20188.2695
Epoch 125/300
 1/37 [..............................] - ETA: 0s - loss: 0.0700 - mae: 29814.6016
Epoch 126/300
 1/37 [..............................] - ETA: 0s - loss: 0.0278 - mae: 26344.5039
Epoch 127/300
 1/37 [..............................] - ETA: 0s - loss: 0.0421 - mae: 32467.4199
Epoch 128/300
 1/37 [..............................] - ETA: 0s - loss: 0.0275 - mae: 25176.8398
Epoch 129/300
 1/37 [..............................] - ETA: 0s - loss: 0.0365 - mae: 24929.3906
Epoch 130/300
 1/37 [..............................] - ETA: 0s - loss: 0.0338 - mae: 28293.2734
Epoch 131/300
 1/37 [..............................] - ETA: 0s - loss: 0.0306 - mae: 24030.4785
Epoch 132/300
 1/37 [..............................] - ETA: 0s - loss: 0.0351 - mae: 29041.4727
Epoch 133/300
```

```
 1/37 [..............................] - ETA: 0s - loss: 0.0462 - mae: 28693.1133
Epoch 134/300
 1/37 [..............................] - ETA: 0s - loss: 0.0314 - mae: 20112.4512
Epoch 135/300
 1/37 [..............................] - ETA: 0s - loss: 0.0209 - mae: 15543.8633
Epoch 136/300
 1/37 [..............................] - ETA: 0s - loss: 0.0493 - mae: 33070.8828
Epoch 137/300
 1/37 [..............................] - ETA: 0s - loss: 0.0479 - mae: 30742.7969
Epoch 138/300
 1/37 [..............................] - ETA: 0s - loss: 0.0276 - mae: 24322.8750
Epoch 139/300
 1/37 [..............................] - ETA: 0s - loss: 0.0364 - mae: 29631.7500
Epoch 140/300
 1/37 [..............................] - ETA: 0s - loss: 0.0433 - mae: 26986.6641
Epoch 141/300
 1/37 [..............................] - ETA: 0s - loss: 0.0343 - mae: 23025.7266
Epoch 142/300
 1/37 [..............................] - ETA: 0s - loss: 0.0268 - mae: 21529.9258
Epoch 143/300
 1/37 [..............................] - ETA: 0s - loss: 0.0323 - mae: 26612.0195
Epoch 144/300
 1/37 [..............................] - ETA: 0s - loss: 0.0330 - mae: 20605.2246
Epoch 145/300
 1/37 [..............................] - ETA: 0s - loss: 0.0353 - mae: 25308.7812
Epoch 146/300
 1/37 [..............................] - ETA: 0s - loss: 0.0339 - mae: 22771.3691
Epoch 147/300
 1/37 [..............................] - ETA: 0s - loss: 0.0242 - mae: 22938.4336
Epoch 148/300
 1/37 [..............................] - ETA: 0s - loss: 0.0526 - mae: 27677.8789
Epoch 149/300
 1/37 [..............................] - ETA: 0s - loss: 0.0410 - mae: 20352.1250
Epoch 150/300
 1/37 [..............................] - ETA: 0s - loss: 0.0179 - mae: 17535.2559
Epoch 151/300
 1/37 [..............................] - ETA: 0s - loss: 0.0423 - mae: 32358.6035
Epoch 152/300
 1/37 [..............................] - ETA: 0s - loss: 0.0364 - mae: 26428.3906
Epoch 153/300
 1/37 [..............................] - ETA: 0s - loss: 0.0405 - mae: 29081.0234
Epoch 154/300
 1/37 [..............................] - ETA: 0s - loss: 0.0334 - mae: 24067.1074
Epoch 155/300
 1/37 [..............................] - ETA: 0s - loss: 0.0408 - mae: 25479.0273
Epoch 156/300
 1/37 [..............................] - ETA: 0s - loss: 0.0232 - mae: 24324.5215
Epoch 157/300
 1/37 [..............................] - ETA: 0s - loss: 0.0365 - mae: 27297.0254
Epoch 158/300
 1/37 [..............................] - ETA: 0s - loss: 0.0701 - mae: 26522.4160
Epoch 159/300
 1/37 [..............................] - ETA: 0s - loss: 0.0372 - mae: 30144.5312
Epoch 160/300
 1/37 [..............................] - ETA: 0s - loss: 0.0238 - mae: 28600.0527
Epoch 161/300
 1/37 [..............................] - ETA: 0s - loss: 0.0355 - mae: 30718.6133
Epoch 162/300
 1/37 [..............................] - ETA: 0s - loss: 0.0335 - mae: 24782.7441
Epoch 163/300
 1/37 [..............................] - ETA: 0s - loss: 0.0790 - mae: 38730.8242
Epoch 164/300
 1/37 [..............................] - ETA: 0s - loss: 0.0637 - mae: 25314.3242
```

```
Epoch 165/300
 1/37 [..............................] - ETA: 0s - loss: 0.0698 - mae: 29477.6250
Epoch 166/300
 1/37 [..............................] - ETA: 0s - loss: 0.0295 - mae: 20210.2461
Epoch 167/300
 1/37 [..............................] - ETA: 0s - loss: 0.0427 - mae: 24544.0195
Epoch 168/300
 1/37 [..............................] - ETA: 0s - loss: 0.0217 - mae: 24919.5273
Epoch 169/300
 1/37 [..............................] - ETA: 0s - loss: 0.0360 - mae: 29156.2461
Epoch 170/300
 1/37 [..............................] - ETA: 0s - loss: 0.0284 - mae: 26348.5547
Epoch 171/300
 1/37 [..............................] - ETA: 0s - loss: 0.0241 - mae: 23153.0645
Epoch 172/300
 1/37 [..............................] - ETA: 0s - loss: 0.0361 - mae: 29907.5430
Epoch 173/300
 1/37 [..............................] - ETA: 0s - loss: 0.0539 - mae: 30904.7480
Epoch 174/300
 1/37 [..............................] - ETA: 0s - loss: 0.0182 - mae: 18113.0859
Epoch 175/300
 1/37 [..............................] - ETA: 0s - loss: 0.0277 - mae: 23175.2676
Epoch 176/300
 1/37 [..............................] - ETA: 0s - loss: 0.0238 - mae: 17049.3906
Epoch 177/300
 1/37 [..............................] - ETA: 0s - loss: 0.0258 - mae: 23474.1836
Epoch 178/300
 1/37 [..............................] - ETA: 0s - loss: 0.0270 - mae: 19339.1914
Epoch 179/300
 1/37 [..............................] - ETA: 0s - loss: 0.0239 - mae: 23493.5586
Epoch 180/300
 1/37 [..............................] - ETA: 0s - loss: 0.0302 - mae: 28566.3594
Epoch 181/300
 1/37 [..............................] - ETA: 0s - loss: 0.0380 - mae: 22723.8359
Epoch 182/300
 1/37 [..............................] - ETA: 0s - loss: 0.0263 - mae: 23068.7305
Epoch 183/300
 1/37 [..............................] - ETA: 0s - loss: 0.0309 - mae: 20928.0234
Epoch 184/300
 1/37 [..............................] - ETA: 0s - loss: 0.0383 - mae: 21767.2285
Epoch 185/300
 1/37 [..............................] - ETA: 0s - loss: 0.0301 - mae: 21742.0801
Epoch 186/300
 1/37 [..............................] - ETA: 0s - loss: 0.0167 - mae: 21766.1328
Epoch 187/300
 1/37 [..............................] - ETA: 0s - loss: 0.0208 - mae: 20575.0156
Epoch 188/300
 1/37 [..............................] - ETA: 0s - loss: 0.0140 - mae: 18303.9512
Epoch 189/300
 1/37 [..............................] - ETA: 0s - loss: 0.0204 - mae: 19970.8848
Epoch 190/300
 1/37 [..............................] - ETA: 0s - loss: 0.0337 - mae: 21809.1953
Epoch 191/300
 1/37 [..............................] - ETA: 0s - loss: 0.0455 - mae: 29162.6719
Epoch 192/300
 1/37 [..............................] - ETA: 0s - loss: 0.0241 - mae: 21433.6250
Epoch 193/300
 1/37 [..............................] - ETA: 0s - loss: 0.0292 - mae: 25147.5156
Epoch 194/300
 1/37 [..............................] - ETA: 0s - loss: 0.0199 - mae: 21578.2578
Epoch 195/300
 1/37 [..............................] - ETA: 0s - loss: 0.0160 - mae: 14880.5898
Epoch 196/300
```

```
 1/37 [..............................] - ETA: 0s - loss: 0.0298 - mae: 29224.2383
Epoch 197/300
 1/37 [..............................] - ETA: 0s - loss: 0.0149 - mae: 17461.0898
Epoch 198/300
 1/37 [..............................] - ETA: 0s - loss: 0.0297 - mae: 26202.6289
Epoch 199/300
 1/37 [..............................] - ETA: 0s - loss: 0.0309 - mae: 22583.3105
Epoch 200/300
 1/37 [..............................] - ETA: 0s - loss: 0.0243 - mae: 19680.0391
Epoch 201/300
 1/37 [..............................] - ETA: 0s - loss: 0.0142 - mae: 19222.3672
Epoch 202/300
 1/37 [..............................] - ETA: 0s - loss: 0.0397 - mae: 26245.8320
Epoch 203/300
 1/37 [..............................] - ETA: 0s - loss: 0.0265 - mae: 17085.6406
Epoch 204/300
 1/37 [..............................] - ETA: 0s - loss: 0.0234 - mae: 21965.3281
Epoch 205/300
 1/37 [..............................] - ETA: 0s - loss: 0.0470 - mae: 22286.6348
Epoch 206/300
 1/37 [..............................] - ETA: 0s - loss: 0.0278 - mae: 20915.9805
Epoch 207/300
 1/37 [..............................] - ETA: 0s - loss: 0.0155 - mae: 16013.3311
Epoch 208/300
 1/37 [..............................] - ETA: 0s - loss: 0.0546 - mae: 27769.3223
Epoch 209/300
 1/37 [..............................] - ETA: 0s - loss: 0.0352 - mae: 27264.1230
Epoch 210/300
 1/37 [..............................] - ETA: 0s - loss: 0.0567 - mae: 23929.6758
Epoch 211/300
 1/37 [..............................] - ETA: 1s - loss: 0.0149 - mae: 17440.6250
Epoch 212/300
 1/37 [..............................] - ETA: 0s - loss: 0.0415 - mae: 25954.7988
Epoch 213/300
 1/37 [..............................] - ETA: 0s - loss: 0.0402 - mae: 21891.2227
Epoch 214/300
 1/37 [..............................] - ETA: 0s - loss: 0.0432 - mae: 23459.9160
Epoch 215/300
 1/37 [..............................] - ETA: 0s - loss: 0.0239 - mae: 24574.2520
Epoch 216/300
 1/37 [..............................] - ETA: 0s - loss: 0.0347 - mae: 22467.7695
Epoch 217/300
 1/37 [..............................] - ETA: 0s - loss: 0.0270 - mae: 19344.9102
Epoch 218/300
 1/37 [..............................] - ETA: 0s - loss: 0.0525 - mae: 24603.3789
Epoch 219/300
 1/37 [..............................] - ETA: 0s - loss: 0.0238 - mae: 26874.8555
Epoch 220/300
 1/37 [..............................] - ETA: 0s - loss: 0.0536 - mae: 22656.4414
Epoch 221/300
 1/37 [..............................] - ETA: 0s - loss: 0.0286 - mae: 26752.7402
Epoch 222/300
 1/37 [..............................] - ETA: 0s - loss: 0.0325 - mae: 20021.6289
Epoch 223/300
 1/37 [..............................] - ETA: 0s - loss: 0.0476 - mae: 30348.9668
Epoch 224/300
 1/37 [..............................] - ETA: 0s - loss: 0.0455 - mae: 29290.3945
Epoch 225/300
 1/37 [..............................] - ETA: 0s - loss: 0.0259 - mae: 29284.7812
Epoch 226/300
 1/37 [..............................] - ETA: 0s - loss: 0.0352 - mae: 23989.7129
Epoch 227/300
 1/37 [..............................] - ETA: 0s - loss: 0.0152 - mae: 15510.8779
```

```
Epoch 228/300
 1/37 [..............................] - ETA: 0s - loss: 0.0363 - mae: 21285.8516
Epoch 229/300
 1/37 [..............................] - ETA: 0s - loss: 0.0548 - mae: 39118.8242
Epoch 230/300
 1/37 [..............................] - ETA: 0s - loss: 0.0207 - mae: 21805.5430
Epoch 231/300
 1/37 [..............................] - ETA: 0s - loss: 0.0659 - mae: 24016.3125
Epoch 232/300
 1/37 [..............................] - ETA: 0s - loss: 0.0267 - mae: 24794.6191
Epoch 233/300
 1/37 [..............................] - ETA: 0s - loss: 0.0212 - mae: 20979.0273
Epoch 234/300
 1/37 [..............................] - ETA: 0s - loss: 0.0261 - mae: 23678.9297
Epoch 235/300
 1/37 [..............................] - ETA: 0s - loss: 0.0292 - mae: 22054.0156
Epoch 236/300
 1/37 [..............................] - ETA: 0s - loss: 0.0228 - mae: 20792.9473
Epoch 237/300
 1/37 [..............................] - ETA: 0s - loss: 0.0122 - mae: 14320.4834
Epoch 238/300
 1/37 [..............................] - ETA: 1s - loss: 0.0380 - mae: 18878.5312
Epoch 239/300
 1/37 [..............................] - ETA: 0s - loss: 0.0269 - mae: 20268.3594
Epoch 240/300
 1/37 [..............................] - ETA: 0s - loss: 0.0378 - mae: 29240.3066
Epoch 241/300
 1/37 [..............................] - ETA: 0s - loss: 0.0366 - mae: 21282.1953
Epoch 242/300
 1/37 [..............................] - ETA: 0s - loss: 0.0173 - mae: 17658.8340
Epoch 243/300
 1/37 [..............................] - ETA: 0s - loss: 0.0306 - mae: 32811.7305
Epoch 244/300
 1/37 [..............................] - ETA: 0s - loss: 0.0281 - mae: 20699.0020
Epoch 245/300
 1/37 [..............................] - ETA: 0s - loss: 0.0552 - mae: 27556.5000
Epoch 246/300
 1/37 [..............................] - ETA: 0s - loss: 0.0267 - mae: 26948.6953
Epoch 247/300
 1/37 [..............................] - ETA: 0s - loss: 0.0351 - mae: 23349.2852
Epoch 248/300
 1/37 [..............................] - ETA: 0s - loss: 0.0432 - mae: 23524.6797
Epoch 249/300
 1/37 [..............................] - ETA: 0s - loss: 0.0345 - mae: 24475.8438
Epoch 250/300
 1/37 [..............................] - ETA: 0s - loss: 0.0644 - mae: 21538.5547
Epoch 251/300
 1/37 [..............................] - ETA: 0s - loss: 0.0252 - mae: 26672.8555
Epoch 252/300
 1/37 [..............................] - ETA: 0s - loss: 0.0237 - mae: 20201.1523
Epoch 253/300
 1/37 [..............................] - ETA: 0s - loss: 0.0670 - mae: 23599.5625
Epoch 254/300
 1/37 [..............................] - ETA: 0s - loss: 0.0508 - mae: 29043.6406
Epoch 255/300
 1/37 [..............................] - ETA: 0s - loss: 0.0500 - mae: 29097.5625
Epoch 256/300
 1/37 [..............................] - ETA: 0s - loss: 0.0138 - mae: 17353.0684
Epoch 257/300
 1/37 [..............................] - ETA: 0s - loss: 0.0335 - mae: 25369.5938
Epoch 258/300
 1/37 [..............................] - ETA: 0s - loss: 0.0230 - mae: 21299.1406
Epoch 259/300
```

```
 1/37 [..............................] - ETA: 0s - loss: 0.0424 - mae: 22075.9102
Epoch 260/300
 1/37 [..............................] - ETA: 0s - loss: 0.0298 - mae: 20412.4375
Epoch 261/300
 1/37 [..............................] - ETA: 0s - loss: 0.0364 - mae: 16992.0098
Epoch 262/300
 1/37 [..............................] - ETA: 0s - loss: 0.0452 - mae: 30255.3477
Epoch 263/300
 1/37 [..............................] - ETA: 0s - loss: 0.0289 - mae: 20632.5820
Epoch 264/300
 1/37 [..............................] - ETA: 0s - loss: 0.0134 - mae: 17054.3594
Epoch 265/300
 1/37 [..............................] - ETA: 0s - loss: 0.0219 - mae: 19996.7598
Epoch 266/300
 1/37 [..............................] - ETA: 0s - loss: 0.0551 - mae: 29962.1426
Epoch 267/300
 1/37 [..............................] - ETA: 0s - loss: 0.0201 - mae: 21111.1875
Epoch 268/300
 1/37 [..............................] - ETA: 0s - loss: 0.0157 - mae: 20382.0820
Epoch 269/300
 1/37 [..............................] - ETA: 0s - loss: 0.0245 - mae: 21211.8066
Epoch 270/300
 1/37 [..............................] - ETA: 0s - loss: 0.0215 - mae: 20310.6348
Epoch 271/300
 1/37 [..............................] - ETA: 0s - loss: 0.0234 - mae: 23362.6289
Epoch 272/300
 1/37 [..............................] - ETA: 0s - loss: 0.0259 - mae: 24870.3711
Epoch 273/300
 1/37 [..............................] - ETA: 0s - loss: 0.0157 - mae: 18651.6914
Epoch 274/300
 1/37 [..............................] - ETA: 0s - loss: 0.0315 - mae: 20592.3828
Epoch 275/300
 1/37 [..............................] - ETA: 0s - loss: 0.0105 - mae: 15435.1572
Epoch 276/300
 1/37 [..............................] - ETA: 0s - loss: 0.0333 - mae: 31565.0078
Epoch 277/300
 1/37 [..............................] - ETA: 0s - loss: 0.0420 - mae: 21465.2266
Epoch 278/300
 1/37 [..............................] - ETA: 0s - loss: 0.0314 - mae: 27674.8301
Epoch 279/300
 1/37 [..............................] - ETA: 0s - loss: 0.0248 - mae: 25716.6738
Epoch 280/300
 1/37 [..............................] - ETA: 0s - loss: 0.0397 - mae: 21847.0137
Epoch 281/300
 1/37 [..............................] - ETA: 0s - loss: 0.0356 - mae: 24831.0664
Epoch 282/300
 1/37 [..............................] - ETA: 0s - loss: 0.0229 - mae: 21408.8398
Epoch 283/300
 1/37 [..............................] - ETA: 0s - loss: 0.0308 - mae: 17162.9238
Epoch 284/300
 1/37 [..............................] - ETA: 0s - loss: 0.0379 - mae: 16200.9893
Epoch 285/300
 1/37 [..............................] - ETA: 0s - loss: 0.0197 - mae: 19033.2793
Epoch 286/300
 1/37 [..............................] - ETA: 0s - loss: 0.0506 - mae: 24820.1055
Epoch 287/300
 1/37 [..............................] - ETA: 0s - loss: 0.0549 - mae: 25092.2090
Epoch 288/300
 1/37 [..............................] - ETA: 0s - loss: 0.0262 - mae: 24247.9883
Epoch 289/300
 1/37 [..............................] - ETA: 0s - loss: 0.0511 - mae: 25079.5684
Epoch 290/300
 1/37 [..............................] - ETA: 0s - loss: 0.0176 - mae: 18387.1172
```

```
Epoch 291/300
 1/37 [..............................] - ETA: 0s - loss: 0.0322 - mae: 20849.5508
Epoch 292/300
 1/37 [..............................] - ETA: 0s - loss: 0.0205 - mae: 19008.1191
Epoch 293/300
 1/37 [..............................] - ETA: 0s - loss: 0.0242 - mae: 18758.3906
Epoch 294/300
 1/37 [..............................] - ETA: 0s - loss: 0.0336 - mae: 17971.4375
Epoch 295/300
 1/37 [..............................] - ETA: 0s - loss: 0.0371 - mae: 22886.9688
Epoch 296/300
 1/37 [..............................] - ETA: 0s - loss: 0.0257 - mae: 27924.7461
Epoch 297/300
 1/37 [..............................] - ETA: 0s - loss: 0.0200 - mae: 20429.4941
Epoch 298/300
 1/37 [..............................] - ETA: 0s - loss: 0.0195 - mae: 21706.0156
Epoch 299/300
 1/37 [..............................] - ETA: 0s - loss: 0.0232 - mae: 20751.2324
Epoch 300/300
 1/37 [..............................] - ETA: 0s - loss: 0.0413 - mae: 26557.3691
```

```
model = Sequential()
model.add(Dense(250, activation='relu'))
model.add(Dense(250, activation='relu'))
model.add(Dense(1, activation='relu'))
tf.random.set_seed(40) #Для обеспечения воспроизводимости результатов устанавливается функция seed
model.compile(loss='msle', optimizer='adam', metrics=['mae'])
#Для оценки потерь рекомендую использовать MSLE(MeanSquaredLogarithmicError), а также метрику MAE(Mea
history = model.fit(X_train, y_train, epochs=10 )#замените None на гиперпараметры вашей модели нейрон
```

```
Epoch 1/10
 1/37 [..............................] - ETA: 17s - loss: 25.5693 - mae: 154132.7500
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 2.3035 - mae: 138592.1719
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 0.3635 - mae: 68688.5469
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 0.0969 - mae: 39524.8555
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 0.1456 - mae: 60231.6172
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 0.0883 - mae: 42432.5898
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 0.1580 - mae: 73362.6172
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 0.1547 - mae: 60269.1953
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 0.0803 - mae: 44612.0703
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 0.0987 - mae: 51192.4805
```

Можем сделать вывод, что loss и mae наименьшие при входном значение 250 и выходном значении = 1

Подбор функции и оптимизатора

Определились с гиперпараметрами, точнее с количеством узлов и выходным значением. Теперь сможем поэкспериментировать с функцией и оптимизатором.

Функция Sigmoid

```
model = Sequential()
model.add(Dense(250, activation='sigmoid'))
model.add(Dense(250, activation='sigmoid'))
model.add(Dense(1, activation='sigmoid'))
tf.random.set_seed(40) #Для обеспечения воспроизводимости результатов устанавливается функция seed
model.compile(loss='msle', optimizer='sgd', metrics=['mae'])
#Для оценки потерь рекомендую использовать MSLE(MeanSquaredLogarithmicError), а также метрику MAE(Mea
history = model.fit(X_train, y_train, epochs=10)
```

```
Epoch 1/10
 1/37 [..............................] - ETA: 14s - loss: 130.4938 - mae: 155148.3750
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 126.6899 - mae: 176254.7188
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 124.6752 - mae: 154379.1562
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 128.7142 - mae: 176965.5625
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 129.1587 - mae: 199267.7500
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 128.5655 - mae: 179330.0312
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 128.8681 - mae: 185553.1250
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 129.8042 - mae: 197064.9375
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 129.4945 - mae: 185928.5938
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 127.9226 - mae: 181824.8125
```

Функция Tanh

```
model = Sequential()
model.add(Dense(250, activation='tanh'))
model.add(Dense(250, activation='tanh'))
model.add(Dense(1, activation='tanh'))
tf.random.set_seed(40) #Для обеспечения воспроизводимости результатов устанавливается функция seed
model.compile(loss='msle', optimizer='sgd', metrics=['mae'])
#Для оценки потерь рекомендую использовать MSLE(MeanSquaredLogarithmicError), а также метрику MAE(Mea
history = model.fit(X_train, y_train, epochs=10)
```

```
Epoch 1/10
 1/37 [..............................] - ETA: 14s - loss: 140.4357 - mae: 155149.1875
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 126.6618 - mae: 176254.7188
```

```
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 124.6611 - mae: 154379.1562
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 128.7052 - mae: 176965.5625
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 129.1516 - mae: 199267.7500
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 128.5595 - mae: 179330.0312
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 128.8632 - mae: 185553.1250
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 129.8000 - mae: 197064.9375
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 129.4909 - mae: 185928.5938
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 127.9194 - mae: 181824.8125
```

Заметим, что замена оптимизатора не сильно влияет на результаты (хотя при оптимизаторе "adam" ошибка ниже), в отличии от функции активации. Так, наименьшее значение ошибки при функции активации "relu".

Функция Linear

```
model = Sequential()
model.add(Dense(250, activation='linear'))
model.add(Dense(250, activation='linear'))
model.add(Dense(1, activation='linear'))
tf.random.set_seed(40) #Для обеспечения воспроизводимости результатов устанавливается функция seed
model.compile(loss='msle', optimizer='adam', metrics=['mae'])
#Для оценки потерь рекомендую использовать MSLE(MeanSquaredLogarithmicError), а также метрику MAE(Mea
history = model.fit(X_train, y_train, epochs=10)
```

```
Epoch 1/10
 1/37 [..............................] - ETA: 27s - loss: 49.8469 - mae: 154777.1562
Epoch 2/10
 1/37 [..............................] - ETA: 0s - loss: 7.7646 - mae: 165550.3438
Epoch 3/10
 1/37 [..............................] - ETA: 0s - loss: 6.3390 - mae: 142190.6875
Epoch 4/10
 1/37 [..............................] - ETA: 0s - loss: 5.0109 - mae: 158181.8594
Epoch 5/10
 1/37 [..............................] - ETA: 0s - loss: 3.5468 - mae: 169641.9062
Epoch 6/10
 1/37 [..............................] - ETA: 0s - loss: 2.9377 - mae: 146275.6719
Epoch 7/10
 1/37 [..............................] - ETA: 0s - loss: 2.3549 - mae: 143774.2188
Epoch 8/10
 1/37 [..............................] - ETA: 0s - loss: 1.9644 - mae: 148957.7344
Epoch 9/10
 1/37 [..............................] - ETA: 0s - loss: 1.4441 - mae: 130010.1562
Epoch 10/10
 1/37 [..............................] - ETA: 0s - loss: 1.0720 - mae: 119317.6250
```

Гиперпараметры нейронной сети (количество эпох, размер мини-выборки)

Для обучения модели на обучающих данных `X_train` и `y_train` , зададим гиперпараметры нашей модели нейронной сети, количество эпох (epochs), размер мини-выборки (batch_size).

Размер мини-выборки

```
batch_size=[1,2,3,5,10,15,50,100,200]
for batch in  batch_size:
    model = Sequential()
    model.add(Dense(250, activation='linear'))
    model.add(Dense(250, activation='linear'))
    model.add(Dense(1, activation='linear'))
    tf.random.set_seed(40)
    model.compile(loss='msle', optimizer='adam', metrics=['mae'])
    #Для оценки потерь рекомендую использовать MSLE(MeanSquaredLogarithmicError), а также метрику MAE
    history = model.fit(X_train, y_train, epochs=10,batch_size=batch)
    print("Размер мини-выборки=",batch)
```

```
Epoch 1/10
   1/1168 [..............................] - ETA: 8:08 - loss: 20.8451 - mae: 100741.9531
Epoch 2/10
   1/1168 [..............................] - ETA: 2s - loss: 0.3745 - mae: 80191.1406
Epoch 3/10
   1/1168 [..............................] - ETA: 2s - loss: 1.4436e-05 - mae: 502.3750
Epoch 4/10
   1/1168 [..............................] - ETA: 2s - loss: 0.0047 - mae: 22287.1562
Epoch 5/10
   1/1168 [..............................] - ETA: 2s - loss: 0.0298 - mae: 25354.7500
Epoch 6/10
   1/1168 [..............................] - ETA: 2s - loss: 0.1371 - mae: 103676.9844
Epoch 7/10
   1/1168 [..............................] - ETA: 2s - loss: 5.5564e-04 - mae: 3238.2500
Epoch 8/10
   1/1168 [..............................] - ETA: 2s - loss: 6.6686e-04 - mae: 3543.4844
Epoch 9/10
   1/1168 [..............................] - ETA: 2s - loss: 0.0220 - mae: 19649.0000
Epoch 10/10
   1/1168 [..............................] - ETA: 2s - loss: 0.1083 - mae: 95256.4375
Размер мини-выборки= 1
Epoch 1/10
  1/584 [..............................] - ETA: 3:55 - loss: 23.5675 - mae: 138090.5000
Epoch 2/10
  1/584 [..............................] - ETA: 1s - loss: 0.3498 - mae: 77329.5156
Epoch 3/10
  1/584 [..............................] - ETA: 1s - loss: 0.0764 - mae: 28719.4844
Epoch 4/10
  1/584 [..............................] - ETA: 1s - loss: 0.0192 - mae: 32741.0156
Epoch 5/10
  1/584 [..............................] - ETA: 1s - loss: 0.0371 - mae: 23645.7188
Epoch 6/10
  1/584 [..............................] - ETA: 1s - loss: 0.0463 - mae: 45820.3906
```

```
Epoch 7/10
  1/584 [..............................] - ETA: 1s - loss: 0.0201 - mae: 31512.4062
Epoch 8/10
  1/584 [..............................] - ETA: 1s - loss: 0.0266 - mae: 32821.9062
Epoch 9/10
  1/584 [..............................] - ETA: 1s - loss: 0.0169 - mae: 16163.4297
Epoch 10/10
  1/584 [..............................] - ETA: 1s - loss: 0.1130 - mae: 78565.0078
Размер мини-выборки= 2
Epoch 1/10
  1/390 [..............................] - ETA: 2:53 - loss: 22.3208 - mae: 136349.4688
Epoch 2/10
  1/390 [..............................] - ETA: 0s - loss: 0.2953 - mae: 69666.2734
Epoch 3/10
  1/390 [..............................] - ETA: 0s - loss: 0.1676 - mae: 42863.2227
Epoch 4/10
  1/390 [..............................] - ETA: 0s - loss: 0.2403 - mae: 55410.1133
Epoch 5/10
  1/390 [..............................] - ETA: 0s - loss: 0.2080 - mae: 144497.9219
Epoch 6/10
  1/390 [..............................] - ETA: 0s - loss: 0.0469 - mae: 37574.2344
Epoch 7/10
  1/390 [..............................] - ETA: 0s - loss: 0.0154 - mae: 26055.6504
Epoch 8/10
  1/390 [..............................] - ETA: 0s - loss: 0.0316 - mae: 41261.9336
Epoch 9/10
  1/390 [..............................] - ETA: 0s - loss: 0.0139 - mae: 14764.9766
Epoch 10/10
  1/390 [..............................] - ETA: 0s - loss: 0.0786 - mae: 65734.2734
Размер мини-выборки= 3
Epoch 1/10
  1/234 [..............................] - ETA: 1:44 - loss: 22.9341 - mae: 137022.4219
Epoch 2/10
  1/234 [..............................] - ETA: 0s - loss: 0.1789 - mae: 67358.2969
Epoch 3/10
  1/234 [..............................] - ETA: 0s - loss: 0.1569 - mae: 43869.4453
Epoch 4/10
  1/234 [..............................] - ETA: 0s - loss: 0.2837 - mae: 62270.4375
Epoch 5/10
  1/234 [..............................] - ETA: 0s - loss: 0.2104 - mae: 115392.0000
Epoch 6/10
  1/234 [..............................] - ETA: 1s - loss: 0.0491 - mae: 36150.3867
Epoch 7/10
  1/234 [..............................] - ETA: 0s - loss: 0.1761 - mae: 93180.1719
Epoch 8/10
  1/234 [..............................] - ETA: 0s - loss: 0.0478 - mae: 39873.6484
Epoch 9/10
  1/234 [..............................] - ETA: 0s - loss: 0.0260 - mae: 23914.8281
Epoch 10/10
  1/234 [..............................] - ETA: 0s - loss: 0.0615 - mae: 53155.3008
Размер мини-выборки= 5
Epoch 1/10
  1/117 [..............................] - ETA: 1:51 - loss: 23.5871 - mae: 140289.0938
Epoch 2/10
  1/117 [..............................] - ETA: 0s - loss: 0.3846 - mae: 83409.5547
Epoch 3/10
  1/117 [..............................] - ETA: 0s - loss: 0.0834 - mae: 32080.3594
Epoch 4/10
  1/117 [..............................] - ETA: 0s - loss: 0.1749 - mae: 46890.5312
Epoch 5/10
  1/117 [..............................] - ETA: 0s - loss: 0.1622 - mae: 80791.6328
Epoch 6/10
  1/117 [..............................] - ETA: 0s - loss: 0.0606 - mae: 36190.8867
```

```
Epoch 7/10
  1/117 [..............................] - ETA: 0s - loss: 0.3420 - mae: 150995.2188
Epoch 8/10
  1/117 [..............................] - ETA: 0s - loss: 0.1878 - mae: 68562.2031
Epoch 9/10
  1/117 [..............................] - ETA: 0s - loss: 0.0653 - mae: 46781.9141
Epoch 10/10
  1/117 [..............................] - ETA: 0s - loss: 0.0787 - mae: 47675.6641
Размер мини-выборки= 10
Epoch 1/10
 1/78 [..............................] - ETA: 34s - loss: 24.0921 - mae: 149061.0938
Epoch 2/10
 1/78 [..............................] - ETA: 0s - loss: 0.4738 - mae: 77602.9219
Epoch 3/10
 1/78 [..............................] - ETA: 0s - loss: 0.0612 - mae: 28659.6660
Epoch 4/10
 1/78 [..............................] - ETA: 0s - loss: 0.1323 - mae: 37605.6992
Epoch 5/10
 1/78 [..............................] - ETA: 0s - loss: 0.1895 - mae: 86658.2969
Epoch 6/10
 1/78 [..............................] - ETA: 0s - loss: 0.0908 - mae: 44433.1133
Epoch 7/10
 1/78 [..............................] - ETA: 0s - loss: 0.3283 - mae: 144540.2500
Epoch 8/10
 1/78 [..............................] - ETA: 0s - loss: 0.1918 - mae: 76614.3281
Epoch 9/10
 1/78 [..............................] - ETA: 0s - loss: 0.0585 - mae: 39236.1094
Epoch 10/10
 1/78 [..............................] - ETA: 0s - loss: 0.0836 - mae: 48308.0898
Размер мини-выборки= 15
Epoch 1/10
 1/24 [>.............................] - ETA: 10s - loss: 24.8487 - mae: 152411.8906
Epoch 2/10
 1/24 [>.............................] - ETA: 0s - loss: 2.2279 - mae: 140711.3125
Epoch 3/10
 1/24 [>.............................] - ETA: 0s - loss: 1.0611 - mae: 100914.6562
Epoch 4/10
 1/24 [>.............................] - ETA: 0s - loss: 0.5873 - mae: 104864.7031
Epoch 5/10
 1/24 [>.............................] - ETA: 0s - loss: 0.3117 - mae: 80089.3750
Epoch 6/10
 1/24 [>.............................] - ETA: 0s - loss: 0.2021 - mae: 51894.6758
Epoch 7/10
 1/24 [>.............................] - ETA: 0s - loss: 0.2086 - mae: 80978.0859
Epoch 8/10
 1/24 [>.............................] - ETA: 0s - loss: 0.1882 - mae: 60612.6055
Epoch 9/10
 1/24 [>.............................] - ETA: 0s - loss: 0.1296 - mae: 58019.6016
Epoch 10/10
 1/24 [>.............................] - ETA: 0s - loss: 0.1343 - mae: 60403.9219
Размер мини-выборки= 50
Epoch 1/10
 1/12 [=>............................] - ETA: 4s - loss: 24.9047 - mae: 163296.1250
Epoch 2/10
 1/12 [=>............................] - ETA: 0s - loss: 3.6119 - mae: 150218.3438
Epoch 3/10
 1/12 [=>............................] - ETA: 0s - loss: 2.0502 - mae: 125115.9922
Epoch 4/10
 1/12 [=>............................] - ETA: 0s - loss: 1.5545 - mae: 133397.7656
Epoch 5/10
 1/12 [=>............................] - ETA: 0s - loss: 1.0703 - mae: 118713.3438
Epoch 6/10
 1/12 [=>............................] - ETA: 0s - loss: 0.7399 - mae: 92748.6094
```

```
Epoch 7/10
 1/12 [=>............................] - ETA: 0s - loss: 0.6004 - mae: 107462.0781
Epoch 8/10
 1/12 [=>............................] - ETA: 0s - loss: 0.4692 - mae: 81860.6797
Epoch 9/10
 1/12 [=>............................] - ETA: 0s - loss: 0.3467 - mae: 78644.2734
Epoch 10/10
 1/12 [=>............................] - ETA: 0s - loss: 0.2858 - mae: 76774.3594
Размер мини-выборки= 100
Epoch 1/10
1/6 [====>.........................] - ETA: 2s - loss: 24.8690 - mae: 175572.4844
Epoch 2/10
1/6 [====>.........................] - ETA: 0s - loss: 5.5316 - mae: 160790.6875
Epoch 3/10
1/6 [====>.........................] - ETA: 0s - loss: 3.4535 - mae: 144236.5312
Epoch 4/10
1/6 [====>.........................] - ETA: 0s - loss: 2.6539 - mae: 139819.5469
Epoch 5/10
1/6 [====>.........................] - ETA: 0s - loss: 2.2356 - mae: 147520.1719
Epoch 6/10
1/6 [====>.........................] - ETA: 0s - loss: 1.7520 - mae: 128468.5000
Epoch 7/10
1/6 [====>.........................] - ETA: 0s - loss: 1.4461 - mae: 128471.6016
Epoch 8/10
1/6 [====>.........................] - ETA: 0s - loss: 1.2753 - mae: 118985.6562
Epoch 9/10
1/6 [====>.........................] - ETA: 0s - loss: 1.0589 - mae: 111345.1016
Epoch 10/10
1/6 [====>.........................] - ETA: 0s - loss: 0.9547 - mae: 114651.8203
Размер мини-выборки= 200
```

Видим, что наименьшее значение ошибки при batch_size = 3

Количество эпох

```
model = Sequential()
model.add(Dense(250, activation='linear'))
model.add(Dense(250, activation='linear'))
model.add(Dense(1, activation='linear'))
tf.random.set_seed(40)
model.compile(loss='msle', optimizer='adam', metrics=['mae'])
#Для оценки потерь рекомендую использовать MSLE(MeanSquaredLogarithmicError), а также метрику MAE(Mea
history = model.fit(X_train, y_train, epochs=35)
```

При увеличении количества эпох - ошибки уменьшаются, что и логично, ведь эпоха - это количество итераций, это количество растет, а значит веса нейронной сети изменяются все большее количество раз. Сразу появляется предположение, что чем больше количество эпох, тем меньше ошибка, проверим эту гипотезу.

```
model = Sequential()
model.add(Dense(250, activation='linear'))
model.add(Dense(250, activation='linear'))
model.add(Dense(1, activation='linear'))
tf.random.set_seed(40)
model.compile(loss='msle', optimizer='adam', metrics=['mae'])
#Для оценки потерь рекомендую использовать MSLE(MeanSquaredLogarithmicError), а также метрику MAE(Mea
history = model.fit(X_train, y_train, epochs=350)
```

Нет, наше предположене неверно, оптимальное количество эпох = 65, при большем количестве не происходит зависимого уменьшение ошибки, появляются выбросы

Построение и обучение модели с подобранными гиперпараметрами

```
model = Sequential()
model.add(Dense(250, activation='linear'))
model.add(Dense(250, activation='linear'))
model.add(Dense(1, activation='linear'))
tf.random.set_seed(40)
model.compile(loss='msle', optimizer='adam', metrics=['mae'])
#Для оценки потерь рекомендую использовать MSLE(MeanSquaredLogarithmicError), а также метрику MAE(Mea
history = model.fit(X_train, y_train, epochs=65 ,batch_size=3)
```

```
Epoch 1/65
  1/390 [..............................] - ETA: 2:56 - loss: 22.3208 - mae: 136349.4688
Epoch 2/65
  1/390 [..............................] - ETA: 0s - loss: 0.2953 - mae: 69666.2734
Epoch 3/65
  1/390 [..............................] - ETA: 0s - loss: 0.1676 - mae: 42863.2227
Epoch 4/65
  1/390 [..............................] - ETA: 0s - loss: 0.2403 - mae: 55410.1133
Epoch 5/65
  1/390 [..............................] - ETA: 0s - loss: 0.2080 - mae: 144497.9219
Epoch 6/65
  1/390 [..............................] - ETA: 0s - loss: 0.0469 - mae: 37574.2344
Epoch 7/65
  1/390 [..............................] - ETA: 0s - loss: 0.0154 - mae: 26055.6504
Epoch 8/65
  1/390 [..............................] - ETA: 0s - loss: 0.0316 - mae: 41261.9336
Epoch 9/65
  1/390 [..............................] - ETA: 0s - loss: 0.0139 - mae: 14764.9766
Epoch 10/65
  1/390 [..............................] - ETA: 0s - loss: 0.0786 - mae: 65734.2734
Epoch 11/65
  1/390 [..............................] - ETA: 0s - loss: 0.0322 - mae: 10957.0547
Epoch 12/65
  1/390 [..............................] - ETA: 0s - loss: 0.0590 - mae: 45267.8320
Epoch 13/65
  1/390 [..............................] - ETA: 0s - loss: 0.1093 - mae: 39320.7812
Epoch 14/65
  1/390 [..............................] - ETA: 0s - loss: 0.0253 - mae: 15686.0498
Epoch 15/65
  1/390 [..............................] - ETA: 0s - loss: 0.1344 - mae: 30710.8594
Epoch 16/65
```

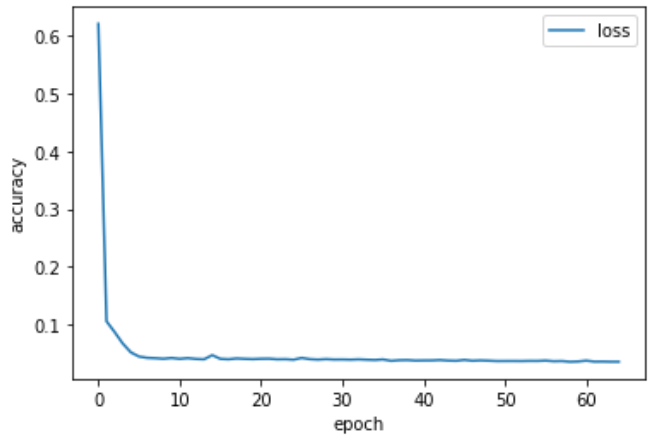
```
  1/390 [..............................] - ETA: 0s - loss: 0.0146 - mae: 18163.3848
Epoch 17/65
  1/390 [..............................] - ETA: 0s - loss: 0.0160 - mae: 18317.1504
Epoch 18/65
  1/390 [..............................] - ETA: 0s - loss: 0.0086 - mae: 17943.7949
Epoch 19/65
  1/390 [..............................] - ETA: 0s - loss: 0.0716 - mae: 75755.0078
Epoch 20/65
  1/390 [..............................] - ETA: 0s - loss: 0.0206 - mae: 18486.8750
Epoch 21/65
  1/390 [..............................] - ETA: 0s - loss: 0.0191 - mae: 25355.7188
Epoch 22/65
  1/390 [..............................] - ETA: 0s - loss: 0.0340 - mae: 14210.3096
Epoch 23/65
  1/390 [..............................] - ETA: 0s - loss: 0.0092 - mae: 15200.3564
Epoch 24/65
  1/390 [..............................] - ETA: 1s - loss: 0.0620 - mae: 60438.8711
Epoch 25/65
  1/390 [..............................] - ETA: 0s - loss: 0.0175 - mae: 18923.8340
Epoch 26/65
  1/390 [..............................] - ETA: 0s - loss: 0.0014 - mae: 4820.4375
Epoch 27/65
  1/390 [..............................] - ETA: 0s - loss: 0.0024 - mae: 7269.4478
Epoch 28/65
  1/390 [..............................] - ETA: 0s - loss: 0.0525 - mae: 27502.0801
Epoch 29/65
  1/390 [..............................] - ETA: 1s - loss: 0.0026 - mae: 7340.4453
Epoch 30/65
  1/390 [..............................] - ETA: 0s - loss: 0.0094 - mae: 25916.7129
Epoch 31/65
  1/390 [..............................] - ETA: 1s - loss: 0.0046 - mae: 8348.8721
Epoch 32/65
  1/390 [..............................] - ETA: 0s - loss: 0.0916 - mae: 38273.2578
Epoch 33/65
  1/390 [..............................] - ETA: 1s - loss: 0.0013 - mae: 4306.1641
Epoch 34/65
  1/390 [..............................] - ETA: 0s - loss: 0.0335 - mae: 26772.8027
Epoch 35/65
  1/390 [..............................] - ETA: 2s - loss: 0.0115 - mae: 12181.2969
Epoch 36/65
  1/390 [..............................] - ETA: 0s - loss: 0.0270 - mae: 15481.8076
Epoch 37/65
  1/390 [..............................] - ETA: 1s - loss: 0.0188 - mae: 20756.5078
Epoch 38/65
  1/390 [..............................] - ETA: 0s - loss: 0.0220 - mae: 12703.1641
Epoch 39/65
  1/390 [..............................] - ETA: 1s - loss: 0.0928 - mae: 74284.8828
Epoch 40/65
  1/390 [..............................] - ETA: 0s - loss: 0.0441 - mae: 35245.1562
Epoch 41/65
  1/390 [..............................] - ETA: 1s - loss: 0.0225 - mae: 18573.1875
Epoch 42/65
  1/390 [..............................] - ETA: 0s - loss: 0.0626 - mae: 43536.7461
Epoch 43/65
  1/390 [..............................] - ETA: 0s - loss: 0.0325 - mae: 39244.4375
Epoch 44/65
  1/390 [..............................] - ETA: 0s - loss: 0.0421 - mae: 62980.1289
Epoch 45/65
  1/390 [..............................] - ETA: 0s - loss: 0.0417 - mae: 44335.4062
Epoch 46/65
  1/390 [..............................] - ETA: 1s - loss: 0.0948 - mae: 61262.3633
Epoch 47/65
  1/390 [..............................] - ETA: 1s - loss: 0.0060 - mae: 14029.7656
```

```
Epoch 48/65
  1/390 [..............................] - ETA: 0s - loss: 0.0036 - mae: 7979.1069
Epoch 49/65
  1/390 [..............................] - ETA: 0s - loss: 0.0297 - mae: 39348.3008
Epoch 50/65
  1/390 [..............................] - ETA: 1s - loss: 0.0115 - mae: 16383.0576
Epoch 51/65
  1/390 [..............................] - ETA: 0s - loss: 0.0114 - mae: 13067.9502
Epoch 52/65
  1/390 [..............................] - ETA: 0s - loss: 0.0569 - mae: 50962.4727
Epoch 53/65
  1/390 [..............................] - ETA: 0s - loss: 0.0282 - mae: 17416.9844
Epoch 54/65
  1/390 [..............................] - ETA: 0s - loss: 0.0384 - mae: 44279.1523
Epoch 55/65
  1/390 [..............................] - ETA: 0s - loss: 0.0939 - mae: 21666.6230
Epoch 56/65
  1/390 [..............................] - ETA: 1s - loss: 0.0015 - mae: 9009.9482
Epoch 57/65
  1/390 [..............................] - ETA: 0s - loss: 0.0145 - mae: 18335.9219
Epoch 58/65
  1/390 [..............................] - ETA: 1s - loss: 0.0319 - mae: 22681.5000
Epoch 59/65
  1/390 [..............................] - ETA: 1s - loss: 0.0432 - mae: 38213.7539
Epoch 60/65
  1/390 [..............................] - ETA: 0s - loss: 0.1119 - mae: 58267.6445
Epoch 61/65
  1/390 [..............................] - ETA: 1s - loss: 0.0073 - mae: 15588.0781
Epoch 62/65
  1/390 [..............................] - ETA: 0s - loss: 0.0101 - mae: 16355.2451
Epoch 63/65
  1/390 [..............................] - ETA: 0s - loss: 0.0511 - mae: 28052.5527
Epoch 64/65
  1/390 [..............................] - ETA: 0s - loss: 0.0423 - mae: 25354.7891
Epoch 65/65
  1/390 [..............................] - ETA: 0s - loss: 0.0424 - mae: 36280.4766
```

Оценка результатов

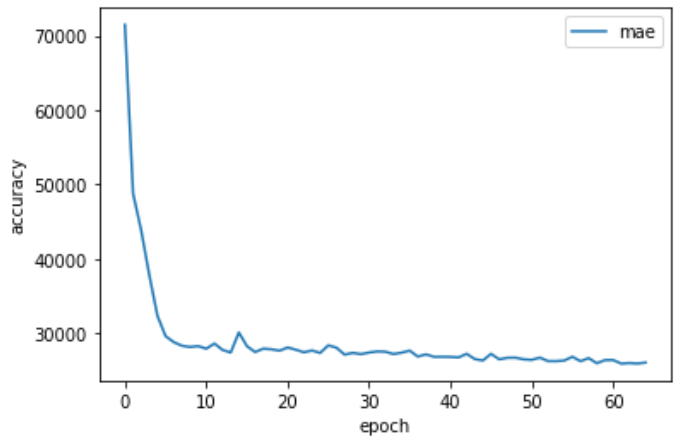
```
pd.DataFrame(history.history['loss']).plot()
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['loss'], loc='upper right')
print(history.history)
```

```
{'loss': [0.6207742094993591, 0.10598524659872055, 0.08729230612516403, 0.06741280108690262, 0.052126
```




```
pd.DataFrame(history.history['mae']).plot()
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['mae'], loc='upper right')
print(history.history)
```

```
{'loss': [0.6207742094993591, 0.10598524659872055, 0.08729230612516403, 0.06741280108690262, 0.052126
```




```
scores = model.evaluate(X_val, y_val, verbose=1)
```

```
 1/10 [==>.....................] - ETA: 1s - loss: 0.0282 - mae: 22594.8457
```

Предсказание

```
preds = model.predict(test_edited)
preds
```

```
[[147281.75]
 [229918.39]
 [190980.77]
```

```
 ...
 [200372.84]
 [105185.7 ]
 [223305.34]]
```

```
output=pd.DataFrame(
{
    'Id':train_edited['Id'],
    'SalePriceReal': train_edited['SalePrice'],
    'SalePricePred': np.squeeze(model.predict(train_edited.drop('SalePrice', axis=1)))
})
print(output)
```

```
        Id  SalePriceReal  SalePricePred
0        1         208500  193227.250000
1        2         181500  182581.812500
2        3         223500  200987.812500
3        4         140000  163173.328125
4        5         250000  265873.687500
...    ...            ...            ...
1455  1456         175000  163883.171875
1456  1457         210000  238559.109375
1457  1458         266500  213785.609375
1458  1459         142125  128300.875000
1459  1460         147500  182260.015625

[1460 rows x 3 columns]
```

При выполнении:

Выведите отчет нейросетевой регрессионной модели, для прогнозирование цен на жилье.

Подберить разные комбинации гиперпараметров таким образом, чтобы получить лучший результат на тестовом наборе данных.

Попробуйте использовать разное количество нейронов на входном слое, например 100, 150, 200 300.+

Добавьте в нейронную сеть скрытый слой с разным количеством нейронов.+

Используйте разное количество эпох: 10, 15, 20, 25, 30.+

Используйте разные размеры мини-выборки (batch_size): 10, 50, 100, 200.

Попробуйте использовать разные значения оптимизатора `optimizers` и функции потерь `loss`. Сравните полученые результаты.+

Вопросы:

Как выше перечисленные параметры влияют на полученный вами результат?

Что такое эпоха (Epoch)? В чем отличие от итерации (Iteration)?

Что такое функция активации? Какие вам известны?

Что такое MSE(Mean Squared Error) - Средняя квадратичная ошибка? Что такое MAE(Mean Absolute Error)? Для чего используются.