INTRODUCTION

Runda is a surburb in the heart of Nairobi. Its an estate of the who is who in the country. Due to the status quo of the class of citizens that live here, it is exepected that the price of land and houses are off the roof (well, from the common mwananchis perspective anyway). This notebook walks through investigating housing prices in Runda. The data has been scrapped from BuyRentKenya. Download the csv from here .Find a step by step tutorial for the webscrapping here.

LOAD THE DATA

First import the necessary libraries

```
# import necessary libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import re
```

```
/usr/local/lib/python3.6/dist-packages/statsmodels/tools/_testing.py:19: FutureWarning: pandas.util.testing is deprecated. Use the functions in the public API at pandas.testing instead.
  import pandas.util.testing as tm
```

We load the data from the csv file runda_houses.csv and convert it to a dataframe

```
df = pd.read_csv('/content/runda-houses.csv')
df.head(2)
```

	_id	url	__v	area	baths	beds	cars	description	externalFeatures	generalFeatures	internalFeatures	price
0	5f5d1a3e1e441dbaa36b1273	https://www.buyrentkenya.com/listings/6-bed-ho...	0	2428	8	6	0	\n6 bedroom houseAll rooms en-suiteSitting on ...	[' Built in Cupboards ', ' Ensuite ', ' Kitche...	[' Balcony ', ' Fence ', ' Garden ']	[]	85000000
1	5f5d1a3f1e441dbaa36b132c	https://www.buyrentkenya.com/listings/4-bed-ho...	0	6001	3	4	0	\nUnbelievable!!Yet a unique house with charac...	[' Fence ', ' Garden ']	[' Fibre Internet ', ' Pets Allowed ']	[' Alarm ', ' Built in Cupboards ', ' Ensuite ...	75000000

```
df.tail(2)
```

	_id	url	__v	area	baths	beds	cars	description	externalFeatures	generalFeatures	internalFeatures	price
140	5f5d202b1e441dbaa36e9b15	https://www.buyrentkenya.com/listings/5-bed-ho...	0	0	0	5	0	\nIts a magnificent 5bdrm unfurnished ambassad...	[]	[]	[]	140000000
141	5f5d202c1e441dbaa36e9b93	https://www.buyrentkenya.com/listings/6-bed-	0	0	7	6	0	\n6 Bedroom Ambassadorial House for saleAll	[]	[]	[]	0

DATA CLEANING

The data needs alot of cleaning inorder to be useful for analysis. Some values are NaN while others are None. The features are also in form of lists and some are also missing.

Drop unnecesaary columns

We do not need the url , _id, and the _v columns so we will drop them for they only add clutter to he data we have

```
# drop columns
# drop columns

df =df.drop(['_id', 'url', '__v'], axis=1)
df.head(2)
```

	area	baths	beds	cars	description	externalFeatures	generalFeatures	internalFeatures	price
0	2428	8	6	0	\n6 bedroom houseAll rooms en-suiteSitting on ...	[' Built in Cupboards ', ' Ensuite ', ' Kitche...	[' Balcony ', ' Fence ', ' Garden ']	[]	85000000
1	6001	3	4	0	\nUnbelievable!!Yet a unique house with charac...	[' Fence ', ' Garden ']	[' Fibre Internet ', ' Pets Allowed ']	[' Alarm ', ' Built in Cupboards ', ' Ensuite ...	75000000

```
df.isna().sum()
```

```
area                0
baths               0
beds                0
cars                0
description         0
externalFeatures    0
generalFeatures     0
internalFeatures    0
price               0
dtype: int64
```

```
df.describe()
```

	area	baths	beds	cars	price
count	142.000000	142.000000	142.000000	142.000000	1.420000e+02
mean	3313.683099	4.612676	4.964789	0.464789	1.106027e+08
std	25400.116125	2.172845	1.013469	1.335080	6.002568e+07
min	0.000000	0.000000	3.000000	0.000000	0.000000e+00
25%	0.000000	4.000000	4.000000	0.000000	7.500000e+07
50%	1113.000000	5.000000	5.000000	0.000000	9.500000e+07
75%	2024.000000	6.000000	5.000000	0.000000	1.500000e+08
max	303525.000000	9.000000	8.000000	10.000000	2.600000e+08

The dataset has a lot of missing values. We need to work with data that is complete or drop those that have few missing values. We check for zeros per column. In our webscraping we assigned a zero to any feature that was not listed. However, the missing data can be most likely found in the description.

```
# Get number if zeros per column
df.isin([0]).sum()
```

```
area                 56
baths                19
beds                  0
cars                120
description           0
externalFeatures      0
generalFeatures       0
internalFeatures      0
price                 3
dtype: int64
```

The cars column seems to have the most missing values. Followed by area. The price and beds are the most useable in the dataset. A look at the sixth home in the df . The area was not given by the agency but it can be found in the description.

```
# Make a df with only the sixth house
```

```
df1 = df.iloc[5,].copy()
df1
```

```
area                                                             2023
baths                                                               8
beds                                                                8
cars                                                                0
description         \nThis is a newly built prime property located...
externalFeatures    [' Balcony ', ' Bore Hole ', ' Electric Fence ...
generalFeatures     [' Backup Generator ', ' CCTV ', ' Electricity...
internalFeatures    [' Aircon ', ' Alarm ', ' Built in Cupboards '...
price                                                       150000000
Name: 5, dtype: object
```

```
# The area can be seen in the description

df1['description']
```

```
'\nThis is a newly built prime property located in Runda estate. It's eight bedrooms all ensuite house modern home. Situated on a half an acre. Spacious rooms and fitted with modern amenities and facilitie
s. Back up generator, locable garage, DSQ and swimming pool. Security systems enhanced and electrified fence all round. For more information kindly contact us.\n'
```

From the above, you can see that the area is in the description. As such it warrants extraction of missing values in the dataset.

Cleaning the description

The description has some elements that do not add to the importance of the tesxt. We will remove the following as part of our preprocessing:

- paragraph numbers
- trailing new line (\n).
- apostrophes
- commas
- hyphens
- add space between words with caps

```
# cleaning
def clean_description(text):
  """
  args text {String} the description of the current house
  return text {String} returns a string of the preprocessed description

  """
  pattern = re.compile(r'((?<=[^\W[A-Z])[A-Z]|(?<=\S)[A-Z](?=[a-z]))')
  # removing paragraph numbers
  text = re.sub('[0-9]+.\t','',str(text))
  # removing new line
  text = re.sub('\n ','',str(text))

  text = re.sub('\\n',' ',str(text))
  # removing apostrophes
  text = re.sub("'s",'',str(text))
  # removing commas
  text = re.sub(",",'',str(text))
  # remove astreisk
  # text = re.sub("*",'',str(text))
  # removing hyphens
  text = re.sub("-",' ',str(text))
  text = re.sub("– ",'',str(text))
  # add space between words with caps
  text = pattern.sub(r' \1', str(text))
  return text
```

Clean the description in the dataframe and store it as clean_description

```
df['clean_description'] = df['description'].apply(clean_description)
```

```
df.head(2)
```

	area	baths	beds	cars	description	externalFeatures	generalFeatures	internalFeatures	price	clean_description
0	2428	8	6	0	\n6 bedroom houseAll rooms en-suiteSitting on ...	[' Built in Cupboards ', ' Ensuite ', ' Kitche...	[' Balcony ', ' Fence ', ' Garden ']	[]	85000000	6 bedroom house All rooms en suite Sitting on...
1	6001	3	4	0	\nUnbelievable!!Yet a unique house with	[' Fence ', ' Garden ']	[' Fibre Internet ', ' Pets	[' Alarm ', ' Built in Cupboards ', '	75000000	Unbelievable!! Yet a unique house with

```
df['clean_description'][15]
```

```
' RUNDA Selling this magnificent 6 bedroom Palatial home with all bedrooms ensuite plus Servant quarter brand new has TV roomfamily room gymwalk in closet for the master bedroom steam bathsauna in the Quiet
and Leafy heart of Runda. Sitting on half acre with swimming pool Asking price is kes 210million slightly negotiable. Contact us on show me or show me for more information. '
```

The clean description also contains text in shortform such as No. to mean number, we need to replace this so as to have a consistent and correct parts of speech tag.

```
def replace_shortforms(text):
  """
  args text {String} the description of the current house
  return text {String} returns a string of the preprocessed description after shortforms have been replaced

  """
  text = text.replace('N0.', ' ')
  text = text.replace("No.", " ")
  text = text.replace('no.', ' ')
  text = text.replace('NO.', '')

  return text
```

```
df['clean_description'] = df['clean_description'].apply(replace_shortforms)
```

```
df['clean_description'][1]
```

```
' Unbelievable!! Yet a unique house with character in the after lush of Runda area. It comes with 4   bedrooms 2  ensuite in a quiet neighborhood. Salient features include: Entrance Lounge with functional f
ire place Dining area  Common cloak room Guest ensuite bedroom with ample ward robesshowersink basin and dressing mirror FIRST FLOOR LEVEL: 2 sharing bedrooms with ample wardrobesshowersink basin and dressi
ng mirror Master ensuite bedroom with ample walk in closetscubicle showersink basin and dressing mirror EXTERNAL FEATURES: Dhobi area Manicured lawn with talk trees and branches  Secured by perimeter wall S
ufficient water tanks for storage This is a gold minea place to be for few investors with high value returns.GRAB OPPORTUNITY!! '
```

We split the description into sentences

```
def split_to_sentence(text):
  # split sentences and questions
    text = re.split('[.?]', text)
    clean_sent = []
    for sent in text:
        clean_sent.append(sent)
    return clean_sent
```

```
df['clean_description'] = df['clean_description'].apply(split_to_sentence)
```

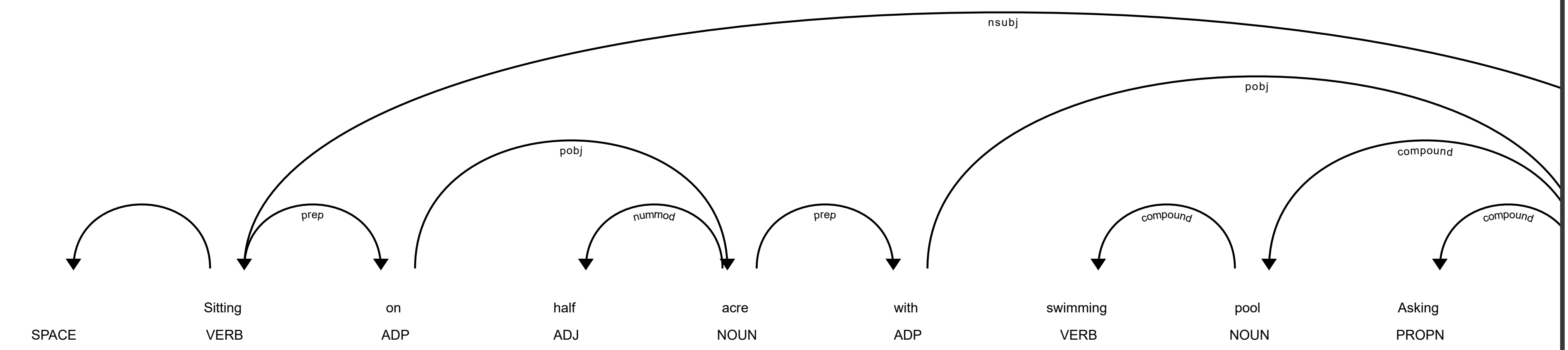
```
df['clean_description'][6]
```

```
[' 5 Bedroom Home For Sale This gorgeous property located in the heart of Runda along Runda Drive sits on 1',
 '2 acres   a short driving distance from the UN',
 ' The property features 5 bedrooms which are all en suite with built in wardrobes',
 ' The master bedroom features a large fireplace with an adjoining Jacuzzi Room',
 ' The property boasts a fully fitted kitchen with two large pantries in addition to a safe room',
 ' The living room features a fireplace which opens onto an outdoor terrace which is spacious and ideal for entertaining guests',
 ' The mature garden area has a solar heated swimming pool',
 ' The house also has an additional 2 bedroom self contained guesthouse',
 ' This house is the perfect place to call home! Call us to arrange a viewing today! ']
```

```
!pip install visualise_spacy_tree
import spacy
from spacy.matcher import Matcher

from spacy import displacy
import visualise_spacy_tree
from IPython.display import Image, display

# load english language model
nlp = spacy.load('en_core_web_sm',disable=['ner','textcat'])
```

```
Requirement already satisfied: visualise_spacy_tree in /usr/local/lib/python3.6/dist-packages (0.0.6)
Requirement already satisfied: pydot==1.4.1 in /usr/local/lib/python3.6/dist-packages (from visualise_spacy_tree) (1.4.1)
Requirement already satisfied: pyparsing>=2.1.4 in /usr/local/lib/python3.6/dist-packages (from pydot==1.4.1->visualise_spacy_tree) (2.4.7)
```

```
# create spacy

text = df['clean_description'][15]
doc = nlp(text[1])

displacy.render(doc, style='dep',jupyter=True)
```



Information extraction

We need to extract mentions of area, cars and bathrooms. Spacy has a matcher class that matches a specified pattern to a given string. From the above visualisation, we can identify that spaCy identifies numbers as num and has a built in method of returning tokens with a number. First we filter through sentences in the description that have a number then from there we can decide if the number describes a bedroom a bathroom, land size etc.

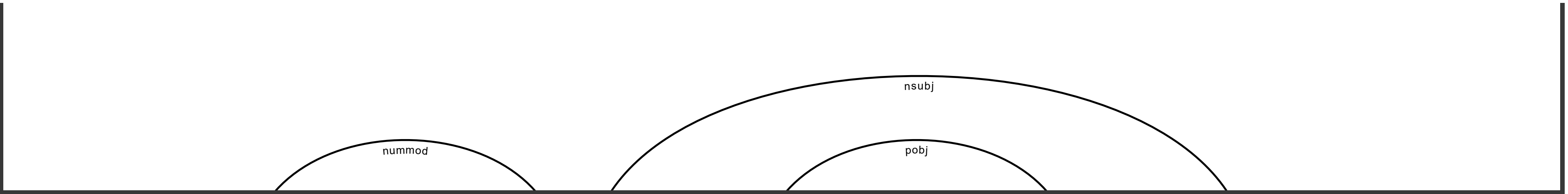
```
def extract_sentences_with_numbers(text):
  """  Takes in a sentence and returns the sentence if it contains a number
    Arguments:
        text {str} -- string sequence to have keywords extracted from


    Returns:
        text {str} -- string of the text with numbers
    """
  doc = nlp(text)
  for token in doc:
    if token.like_num:
       if token.like_num:
          return text
```

```
# TODO :
# Find a method that doesnt assume all descriptions have atleast one sentence with a number

list_of_sentences_with_numbers = []

for j in range(len(df)):
  has_num = []
  sentences = df['clean_description'][j]
  for i in range(len(sentences)):
      has_num.append(extract_sentences_with_numbers(sentences[i]))
  removed_none = []
  for sent in has_num:
      if sent != None :
          removed_none.append(sent)
  list_of_sentences_with_numbers.append(removed_none)
df['num_sent']= list_of_sentences_with_numbers
```

```
df['num_sent'][1]
```

```
[' It comes with 4   bedrooms 2  ensuite in a quiet neighborhood',
 ' Salient features include: Entrance Lounge with functional fire place Dining area  Common cloak room Guest ensuite bedroom with ample ward robesshowersink basin and dressing mirror FIRST FLOOR LEVEL: 2 sha
```

```
text = df['num_sent'][11]
doc = nlp(text[0])
displacy.render(doc, style='dep',jupyter=True)
```



Now that we have sentences with a number, we need to figure out if the number referes to a bedroom or something else. Also note that some descriptions with all ensuite mean that the baths are equal to the number of bedrooms.

```
# TODO :
# - Find a way to clean this data with spacy
```

USING MANUALLY CLEANED DATA

We first load the manually cleaned data

```
df = pd.read_csv('/content/manually_cleaned_runda-houses.csv')
df.head(2)
```

	_id	url	__v	area	baths	beds	cars	description	externalFeatures	generalFeatures	internalFeatures	price
0	5f5d1a3e1e441dbaa36b1273	https://www.buyrentkenya.com/listings/6-bed-ho...	0	2428	8	6	0	\n6 bedroom houseAll rooms en-suiteSitting on ...	[' Built in Cupboards ', ' Ensuite ', ' Kitche...	[' Balcony ', ' Fence ', ' Garden ']	[]	85000000
1	5f5d1a3f1e441dbaa36b132c	https://www.buyrentkenya.com/listings/4-bed-ho...	0	6001	3	4	0	\nUnbelievable!!Yet a unique house with charac...	[' Fence ', ' Garden ']	[' Fibre Internet ', ' Pets Allowed ']	[' Alarm ', ' Built in Cupboards ', ' Ensuite ...	75000000

Use area, price and baths of the houses with this three figures. Drop unecessary columns

```
# drop columns

df =df.drop(['_id', 'url', '__v', 'cars','description'], axis=1)
df.head(2)
```

	area	baths	beds	externalFeatures	generalFeatures	internalFeatures	price
0	2428	8	6	[' Built in Cupboards ', ' Ensuite ', ' Kitche...	[' Balcony ', ' Fence ', ' Garden ']	[]	85000000
1	6001	3	4	[' Fence ', ' Garden ']	[' Fibre Internet ', ' Pets Allowed ']	[' Alarm ', ' Built in Cupboards ', ' Ensuite ...	75000000

```
# Get number if zeros per column
df.isin([0]).sum()
```

```
area                37
baths               16
beds                 0
externalFeatures     0
generalFeatures      0
internalFeatures     0
price                3
dtype: int64
```

```
# drop columns where price is 0
df = df[df.price != 0]
```

```
# Get number if zeros per column
df.isin([0]).sum()
```

```
area                35
baths               16
beds                 0
externalFeatures     0
generalFeatures      0
internalFeatures     0
price                0
dtype: int64
```

```
# drop columns where area is 0
df = df[df.area != 0]
```

```
# Get number if zeros per column
df.isin([0]).sum()
```

```
area                 0
baths               10
beds                 0
externalFeatures     0
generalFeatures      0
internalFeatures     0
price                0
dtype: int64
```

```
# drop columns where baths is 0
df = df[df.baths != 0]
```

```
# Get number if zeros per column
df.isin([0]).sum()
```

```
area                0
baths               0
beds                0
externalFeatures    0
generalFeatures     0
internalFeatures    0
price               0
dtype: int64
```

```
len(df)
```

```
94
```

This takes care of the numerical values but doesnt sort the issue of missing features.

```
df.head(10)
```

	area	baths	beds	externalFeatures	generalFeatures	internalFeatures	price
0	2428	8	6	[' Built in Cupboards ', ' Ensuite ', ' Kitche...	[' Balcony ', ' Fence ', ' Garden ']	[]	85000000
1	6001	3	4	[' Fence ', ' Garden ']	[' Fibre Internet ', ' Pets Allowed ']	[' Alarm ', ' Built in Cupboards ', ' Ensuite ...	75000000
3	800	5	5	[' Balcony ', ' Bore Hole ', ' Electric Fence ...	[' Backup Generator ', ' CCTV ', ' Pets Allowe...	[' Aircon ', ' Alarm ', ' Built in Cupboards '...	340000
4	2833	5	5	[' Balcony ', ' Bore Hole ', ' Electric Fence ...	[' CCTV ', ' Electricity Included ', ' Fibre I...	[' Alarm ', ' Built in Cupboards ', ' Ensuite ...	150000000

```
length_of_df = len(df)

df.reset_index(drop=True, inplace=True)
```

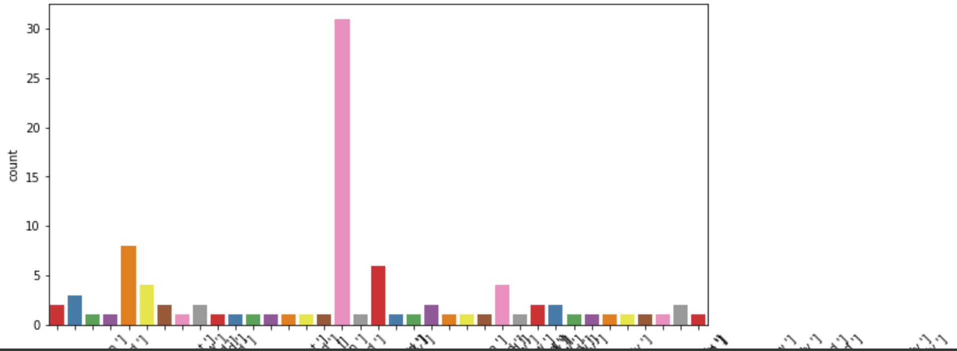
Dropping so many columns has significantly reduced our original dataset of 146 to 56. However inorder to make correct prediction based on actual housing data without making assumptions, we'll let the dataset remain as is. Our model analysis will help in making a decision on whether the data is enough to generalise on unseen data.

Working with the features

The features are in a list and as such are hard to use so we need to convert them to individual features

```

plt.figure(figsize=(10,5))
chart = sns.countplot(

    x=df['generalFeatures'],
    palette='Set1'
)
chart.set_xticklabels(chart.get_xticklabels(), rotation=45)
```

```
[Text(0, 0, "[' Balcony ', ' Fence ', ' Garden ']"),
 Text(0, 0, "[' Fibre Internet ', ' Pets Allowed ']"),
 Text(0, 0, "[' Backup Generator ', ' CCTV ', ' Pets Allowed ', ' Scenic View ']"),
 Text(0, 0, "[' CCTV ', ' Electricity Included ', ' Fibre Internet ']"),
 Text(0, 0, "[' Backup Generator ', ' CCTV ', ' Electricity Included ', ' Fibre Internet ', ' Pets Allowed ', ' Scenic View ', ' Water Included ', ' Wheel Chair Friendly ']"),
 Text(0, 0, "[' Backup Generator ', ' CCTV ', ' Pets Allowed ']"),
 Text(0, 0, "[' CCTV ', ' Fibre Internet ', ' Pets Allowed ']"),
 Text(0, 0, "[' CCTV ', ' Pets Allowed ']"),
 Text(0, 0, "[' CCTV ', ' Electricity Included ', ' Fibre Internet ', ' Pets Allowed ', ' Water Included ', ' Wheel Chair Friendly ']"),
 Text(0, 0, "[' Electricity Included ', ' Scenic View ', ' Water Included ']"),
 Text(0, 0, "[' Backup Generator ', ' Fibre Internet ', ' Golf Course ', ' Pets Allowed ']"),
 Text(0, 0, "[' Balcony ', ' Bore Hole ', ' Electric Fence ', ' Garden ']"),
 Text(0, 0, "[' Electricity Included ', ' Pets Allowed ', ' Scenic View ', ' Water Included ']"),
 Text(0, 0, "[' Fibre Internet ']"),
 Text(0, 0, "[' Backup Generator ', ' CCTV ', ' Electricity Included ', ' Fibre Internet ', ' Golf Course ', ' Pets Allowed ', ' Scenic View ']"),
 Text(0, 0, "[' Backup Generator ', ' Electricity Included ', ' Pets Allowed ', ' Scenic View ', ' Water Included ']"),
 Text(0, 0, '[]'),
 Text(0, 0, "[' CCTV ', ' Electricity Included ', ' Fibre Internet ', ' Pets Allowed ', ' Scenic View ', ' Water Included ']"),
 Text(0, 0, "[' Backup Generator ', ' CCTV ', ' Electricity Included ', ' Fibre Internet ', ' Pets Allowed ', ' Water Included ', ' Wheel Chair Friendly ']"),
 Text(0, 0, "[' Bore Hole ', ' Electric Fence ', ' Fence ', ' Garden ']"),
 Text(0, 0, "[' Backup Generator ', ' Fibre Internet ', ' Pets Allowed ']"),
 Text(0, 0, "[' Backup Generator ', ' CCTV ', ' Fibre Internet ', ' Pets Allowed ']"),
 Text(0, 0, "[' Backup Generator ', ' Fibre Internet ', ' Pets Allowed ', ' Scenic View ']"),
 Text(0, 0, "[' Fibre Internet ', ' Pets Allowed ', ' Scenic View ']"),
 Text(0, 0, "[' Backup Generator ', ' CCTV ', ' Scenic View ']"),
 Text(0, 0, "[' Scenic View ']"),
 Text(0, 0, "[' Pets Allowed ', ' Wheel Chair Friendly ']"),
 Text(0, 0, "[' Backup Generator ', ' CCTV ', ' Fibre Internet ', ' Pets Allowed ', ' Wheel Chair Friendly ']"),
 Text(0, 0, "[' Pets Allowed ']"),
 Text(0, 0, "[' Backup Generator ', ' CCTV ', ' Electricity Included ', ' Fibre Internet ', ' Lift Elevator ', ' Pets Allowed ', ' Scenic View ', ' Water Included ']"),
 Text(0, 0, "[' Backup Generator ', ' CCTV ', ' Electricity Included ', ' Fibre Internet ', ' Lift Elevator ', ' Pets Allowed ', ' Scenic View ', ' Water Included ', ' Wheel Chair Friendly ']"),
 Text(0, 0, "[' Backup Generator ', ' CCTV ', ' Electricity Included ', ' Fibre Internet ', ' Golf Course ', ' Pets Allowed ', ' Scenic View ', ' Water Included ', ' Wheel Chair Friendly ']"),
 Text(0, 0, "[' Backup Generator ', ' CCTV ', ' Fibre Internet ', ' Pets Allowed ', ' Scenic View ']"),
 Text(0, 0, "[' Electric Fence ', ' Fence ', ' Garden ']"),
 Text(0, 0, "[' Pets Allowed ', ' Scenic View ', ' Water Included ', ' Wheel Chair Friendly ']"),
 Text(0, 0, "[' Fence ', ' Garden ']"),
 Text(0, 0, "[' Electricity Included ', ' Pets Allowed ', ' Sea View ', ' Water Included ']")]
```



The features as they are do not provide the needed value and as such we will split them into distinct columns and indicate whether or not the house has the said features. It is for this reason we did not drop the columns with no features. This also solves the problem of having features mixed up during webscrapping. Also, the lists have been stored as strings instead of lists. We need to first convert them to lists

```
# convert to lists
from ast import literal_eval
df.loc[:,'generalFeatures'] = df.loc[:,'generalFeatures'].apply(lambda x: literal_eval(x))
df.loc[:,'internalFeatures'] = df.loc[:,'internalFeatures'].apply(lambda x: literal_eval(x))
df.loc[:,'externalFeatures'] = df.loc[:,'externalFeatures'].apply(lambda x: literal_eval(x))
```

```
all_features =set([])

def get_all_features(text):
  for i in range(len(text)):
   all_features.add(text[i].strip())


for i in range(length_of_df):
  get_all_features(df['generalFeatures'][i])
  get_all_features(df['internalFeatures'][i])
  get_all_features(df['externalFeatures'][i])


print("All features ", type(all_features),  all_features)
```

```
All features  <class 'set'> {'Electric Fence', 'Built in Cupboards', 'Pets Allowed', 'Fence', 'CCTV', 'Sea View', 'Golf Course', 'Backup Generator', 'Lift Elevator', 'Walk In Closet', 'Water Included', 'Kitc
```

We first need to turn the features to individual column names with intial values of zero. Then iterate trhough the df giving a 1 to a house that has a feature.

```
# turn all features to column names
for feature in all_features:
  df[feature] = [0] * length_of_df

df.head(2)
```

	area	baths	beds	externalFeatures	generalFeatures	internalFeatures	price	Electric Fence	Built in Cupboards	Pets Allowed	Fence	CCTV	Sea View	Golf Course	Backup Generator	Lift Elevator	Walk In Closet	Water Included	Kitchen	Aircon	Electricit Include
0	2428	8	6	[Built in Cupboards , Ensuite , Kitchen]	[Balcony , Fence , Garden]	[]	85000000	0	0	0	0	0	0	0	0	0	0	0	0	0	
1	6001	3	4	[Fence , Garden]	[Fibre Internet , Pets Allowed]	[Alarm , Built in Cupboards , Ensuite , Ki...	75000000	0	0	0	0	0	0	0	0	0	0	0	0	0	

```
def populate_feature( j, text):
   for i in range(len(text)):
     a = text[i].strip()

     df[a][j] = 1

for i in range(length_of_df):
  populate_feature(i ,df['generalFeatures'][i])
  populate_feature(i , df['internalFeatures'][i])
  populate_feature(i ,df['externalFeatures'][i])

df.head(2)
```

```
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:5: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame
```

We can now drop the lists columns

```
df.drop(['generalFeatures','externalFeatures', 'internalFeatures'],axis=1)
```

	area	baths	beds	price	Electric Fence	Built in Cupboards	Pets Allowed	Fence	CCTV	Sea View	Golf Course	Backup Generator	Lift Elevator	Walk In Closet	Water Included	Kitchen	Aircon	Electricity Included	Bore Hole	Wheel Chair Friendly	Balcony	Fibre Internet	Alarm	Garden
0	2428	8	6	85000000	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1
1	6001	3	4	75000000	0	1	1	1	0	0	0	0	0	1	0	1	0	0	0	0	0	1	1	1
2	800	5	5	340000	1	1	1	1	1	0	0	1	0	1	0	1	1	0	1	0	1	0	1	1
3	2833	5	5	150000000	1	1	0	1	1	0	0	0	0	1	0	1	0	1	1	0	1	1	1	1
4	2023	8	8	150000000	1	1	1	1	1	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
89	2000	6	5	150000000	1	1	1	1	1	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1
90	2023	8	6	200000000	1	1	1	1	1	0	0	1	0	1	0	1	0	0	1	0	1	0	1	1
91	2023	7	7	150000000	1	1	1	0	0	1	0	0	0	1	1	1	1	1	0	0	0	0	1	0
92	2023	4	4	83000000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
93	2023	7	7	90000000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

94 rows × 26 columns

Our price being the target variable needs to be at the end

```
df1 = df.pop('price')
df['price']  = df1
df.head(2)
```

	area	baths	beds	externalFeatures	generalFeatures	internalFeatures	Electric Fence	Built in Cupboards	Pets Allowed	Fence	CCTV	Sea View	Golf Course	Backup Generator	Lift Elevator	Walk In Closet	Water Included	Kitchen	Aircon	Electricity Included	Bore Hole
0	2428	8	6	[Built in Cupboards , Ensuite , Kitchen]	[Balcony , Fence , Garden]	[]	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0
1	6001	3	4	[Fence , Garden]	[Fibre Internet , Pets Allowed]	[Alarm , Built in Cupboards , Ensuite , Ki...	0	1	1	1	0	0	0	0	0	1	0	1	0	0	0

EXPLORATORY DATA ANALYSIS

We need to make sure that our data is now cleaned

```
df.info()
```

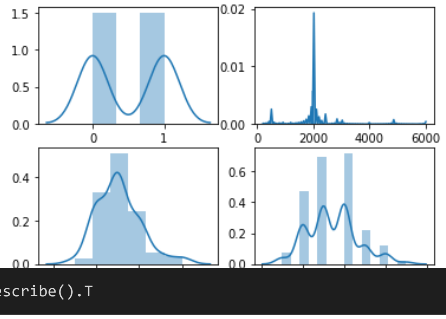
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 94 entries, 0 to 93
Data columns (total 29 columns):
 #   Column                Non-Null Count  Dtype 
---  ------                --------------  ----- 
 0   area                  94 non-null     int64 
 1   baths                 94 non-null     int64 
 2   beds                  94 non-null     int64 
 3   externalFeatures      94 non-null     object
 4   generalFeatures       94 non-null     object
 5   internalFeatures      94 non-null     object
 6   Electric Fence        94 non-null     int64 
 7   Built in Cupboards    94 non-null     int64 
 8   Pets Allowed          94 non-null     int64 
 9   Fence                 94 non-null     int64 
 10  CCTV                  94 non-null     int64 
 11  Sea View              94 non-null     int64 
 12  Golf Course           94 non-null     int64 
 13  Backup Generator      94 non-null     int64 
 14  Lift Elevator         94 non-null     int64 
 15  Walk In Closet        94 non-null     int64 
 16  Water Included        94 non-null     int64 
 17  Kitchen               94 non-null     int64 
 18  Aircon                94 non-null     int64 
 19  Electricity Included  94 non-null     int64 
 20  Bore Hole             94 non-null     int64 
 21  Wheel Chair Friendly  94 non-null     int64 
 22  Balcony               94 non-null     int64 
 23  Fibre Internet        94 non-null     int64 
 24  Alarm                 94 non-null     int64 
```

```
df.shape
```

```
(94, 29)
```

Our dataset has 94 data points with 29 columns. We have 28 features and on target variable the price .

```
import math
# all_numerical = ['Sea View', 'Kitchen', 'Lift Elevator', 'Water Included', 'Balcony', 'Garden', 'Wheel Chair Friendly', 'Fence', 'Golf Course', 'Scenic View', 'CCTV', 'Walk In Closet', 'Alarm', 'Backup Generator
all_numerical = [ 'Balcony','area','beds','baths']

# this plots multiple seaborn histograms on different subplots.
#
def plot_multiple_histograms(df, cols):
    num_plots = len(cols)
    num_cols = math.ceil(np.sqrt(num_plots))
    num_rows = math.ceil(num_plots/num_cols)

    fig, axs = plt.subplots(num_rows, num_cols)

    for ind, col in enumerate(cols):
        i = math.floor(ind/num_cols)
        j = ind - i*num_cols

        if num_rows == 1:
            if num_cols == 1:
                sns.distplot(df[col], kde=True, ax=axs)
            else:
                sns.distplot(df[col], kde=True, ax=axs[j])
        else:
            sns.distplot(df[col], kde=True, ax=axs[i, j])


plot_multiple_histograms(df,all_numerical)
```

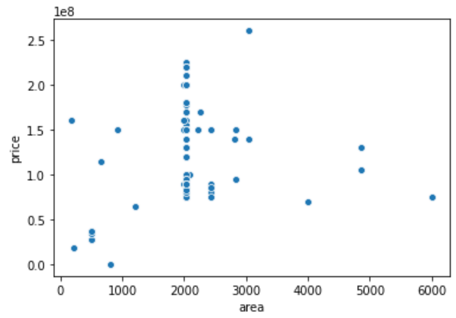


```
df.describe().T
```

	count	mean	std	min	25%	50%	75%	max
area	94.0	2.024862e+03	8.604055e+02	186.0	2023.0	2024.0	2.024000e+03	6001.0
baths	94.0	5.436170e+00	1.223063e+00	3.0	5.0	5.0	6.000000e+00	9.0
beds	94.0	5.063830e+00	1.013972e+00	3.0	4.0	5.0	6.000000e+00	8.0
Electric Fence	94.0	5.638298e-01	4.985681e-01	0.0	0.0	1.0	1.000000e+00	1.0
Built in Cupboards	94.0	6.489362e-01	4.798621e-01	0.0	0.0	1.0	1.000000e+00	1.0
Pets Allowed	94.0	5.106383e-01	5.025672e-01	0.0	0.0	1.0	1.000000e+00	1.0
Fence	94.0	5.638298e-01	4.985681e-01	0.0	0.0	1.0	1.000000e+00	1.0
CCTV	94.0	3.829787e-01	4.887197e-01	0.0	0.0	0.0	1.000000e+00	1.0
Sea View	94.0	1.063830e-02	1.031421e-01	0.0	0.0	0.0	0.000000e+00	1.0
Golf Course	94.0	3.191489e-02	1.767160e-01	0.0	0.0	0.0	0.000000e+00	1.0
Backup Generator	94.0	3.510638e-01	4.798621e-01	0.0	0.0	0.0	1.000000e+00	1.0
Lift Elevator	94.0	2.127660e-02	1.450787e-01	0.0	0.0	0.0	0.000000e+00	1.0
Walk In Closet	94.0	5.106383e-01	5.025672e-01	0.0	0.0	1.0	1.000000e+00	1.0
Water Included	94.0	2.659574e-01	4.442108e-01	0.0	0.0	0.0	1.000000e+00	1.0
Kitchen	94.0	6.702128e-01	4.726566e-01	0.0	0.0	1.0	1.000000e+00	1.0
Aircon	94.0	2.553191e-01	4.383785e-01	0.0	0.0	0.0	7.500000e-01	1.0
Electricity Included	94.0	2.765957e-01	4.497133e-01	0.0	0.0	0.0	1.000000e+00	1.0
Bore Hole	94.0	3.936170e-01	4.911712e-01	0.0	0.0	0.0	1.000000e+00	1.0
Wheel Chair Friendly	94.0	2.340426e-01	4.256692e-01	0.0	0.0	0.0	0.000000e+00	1.0
Balcony	94.0	5.000000e-01	5.026810e-01	0.0	0.0	0.5	1.000000e+00	1.0
Fibre Internet	94.0	3.936170e-01	4.911712e-01	0.0	0.0	0.0	1.000000e+00	1.0
Alarm	94.0	4.361702e-01	4.985681e-01	0.0	0.0	0.0	1.000000e+00	1.0
Garden	94.0	6.382979e-01	4.830696e-01	0.0	0.0	1.0	1.000000e+00	1.0
Scenic View	94.0	2.765957e-01	4.497133e-01	0.0	0.0	0.0	1.000000e+00	1.0
Ensuite	94.0	6.702128e-01	4.726566e-01	0.0	0.0	1.0	1.000000e+00	1.0
price	94.0	1.232536e+08	5.631485e+07	340000.0	85000000.0	120000000.0	1.587500e+08	260000000.0

What is the relationship between area and price?

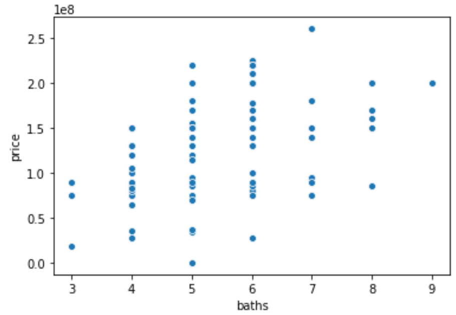
```
sns.scatterplot(x=df['area'], y=df['price']);
```



from the above, most houses are within the same area. From skiming throught the data one can see that most of the houses are on half an acre as can be shown on the scatterplot.

What is the relationship between number of bathrooms and price?

```
sns.scatterplot(x=df['baths'], y=df['price']);
```



Naturally the more the bathrooms the pricier the house.

MODEL BUILDING

In this task we will use linear regression and neural networks to determine the price of a house in runda.

1 . SPLIT DATA INTO TEST AND TRAINING SET

Data needs to be split in testing and training sets to avoid overfitting

```
from sklearn.model_selection import train_test_split
```

The data needs to be split into the features and the target variable. We are using all features to describe the price of a house.

```
all_numerical = ['Sea View', 'Kitchen', 'Lift Elevator', 'Water Included', 'Balcony', 'Garden', 'Wheel Chair Friendly', 'Fence', 'Golf Course', 'Scenic View', 'CCTV', 'Walk In Closet', 'Alarm', 'Backup Generator',
# X - features
num_of_columns = len(df.columns)
a =num_of_columns-1
X = df[['Sea View', 'Kitchen', 'Lift Elevator', 'Water Included', 'Balcony', 'Garden', 'Wheel Chair Friendly', 'Fence', 'Golf Course', 'Scenic View', 'CCTV', 'Walk In Closet', 'Alarm', 'Backup Generator', 'Electri
```

```
print("X shape" , X.shape)
# y price
y = df['price']
print("y shape" , y.shape)
```

```
X shape (94, 25)
y shape (94,)
```

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=42)
```

Linear Regression

```
from sklearn.linear_model import LinearRegression
from sklearn import metrics
%matplotlib inline
```

```
regressor = LinearRegression()
regressor.fit(X_train, y_train)
```

```
LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None, normalize=False)
```

```
coeff_df = pd.DataFrame(regressor.coef_, X.columns, columns=['Coefficient'])
coeff_df
```

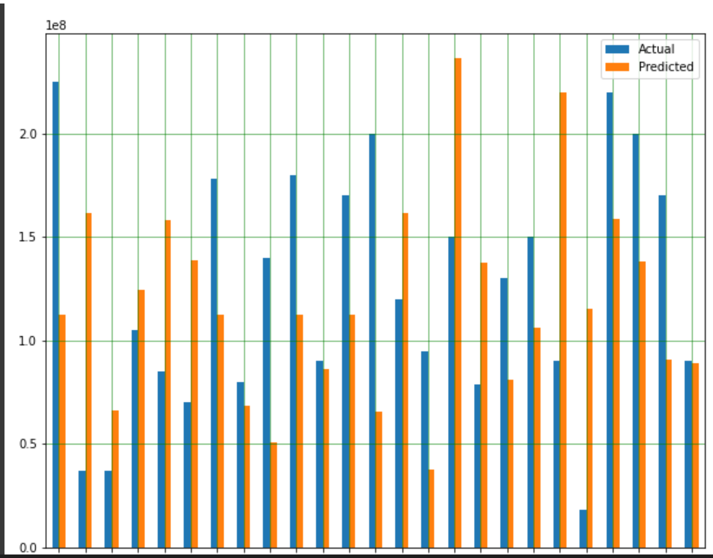
	Coefficient
Sea View	8.371216e+07
Kitchen	3.026551e+07
Lift Elevator	5.529048e+07
Water Included	4.408421e+07

```
y_pred = regressor.predict(X_test)
```

```
df0 = pd.DataFrame({'Actual': y_test, 'Predicted': y_pred})
df1 = df0.head(25)
df1
```

	Actual	Predicted
40	225000000	1.124441e+08
22	37000000	1.617482e+08
55	37000000	6.601671e+07
72	105000000	1.246503e+08
0	85000000	1.579052e+08
26	70000000	1.390082e+08
39	178000000	1.124441e+08
67	80000000	6.826347e+07
10	140000000	5.071335e+07
44	180000000	1.124341e+08
83	90000000	8.647283e+07
35	170000000	1.124476e+08
90	200000000	6.593738e+07
62	120000000	1.615492e+08
12	95000000	3.769712e+07
4	150000000	2.364302e+08
18	79000000	1.374720e+08
28	130000000	8.127015e+07
49	150000000	1.064624e+08
65	90000000	2.196192e+08
15	18500000	1.152678e+08
68	220000000	1.584994e+08
78	200000000	1.384323e+08
30	170000000	9.094777e+07
33	90000000	8.910255e+07

```
df1.plot(kind='bar',figsize=(10,8))
plt.grid(which='major', linestyle='-', linewidth='0.5', color='green')
plt.grid(which='minor', linestyle=':', linewidth='0.5', color='black')
plt.show()
```



```
print('Mean Absolute Error:', metrics.mean_absolute_error(y_test, y_pred))
print('Mean Squared Error:', metrics.mean_squared_error(y_test, y_pred))
print('Root Mean Squared Error:', np.sqrt(metrics.mean_squared_error(y_test, y_pred)))
```

```
Mean Absolute Error: 64197566.56853049
Mean Squared Error: 5450239966979054.0
Root Mean Squared Error: 73825740.54473856
```

Neural Networks

```
# Import required libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import sklearn
from sklearn.neural_network import MLPClassifier
from sklearn.neural_network import MLPRegressor

# Import necessary modules
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_squared_error
from math import sqrt
from sklearn.metrics import r2_score
```

```
from sklearn.neural_network import MLPClassifier

mlp = MLPClassifier(hidden_layer_sizes=(8,8,8), activation='relu', solver='adam', max_iter=500)
mlp.fit(X_train,y_train)

predict_train = mlp.predict(X_train)
predict_test = mlp.predict(X_test)
```

```
/usr/local/lib/python3.6/dist-packages/sklearn/neural_network/_multilayer_perceptron.py:571: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (500) reached and the optimization hasn't converged y
  % self.max_iter, ConvergenceWarning)
```

```
from sklearn.metrics import classification_report,confusion_matrix
print(confusion_matrix(y_train,predict_train))
print(classification_report(y_train,predict_train))
print(classification_report(y_train,predict_train))
```

```
[[ 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0
   0  0]
 [ 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  2  0  0  0  0  0  0
   0  0]
 [ 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0
   0  0]
 [ 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0
   0  0]
 [ 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0
   0  0]
 [ 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0
   0  0]
 [ 0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  6  0  0  0  0  0  0
   0  0]
 [ 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  2  0  0  0  0  0  0
   0  0]
 [ 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0
```

```
print(confusion_matrix(y_test,predict_test))
print(classification_report(y_test,predict_test))
```

```
[[0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0]
 [0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
```

MODEL ANALYSIS

```
 [0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0]
```

CONCLUSION

```
 [0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0]]
              precision    recall  f1-score   support

    18500000       0.00      0.00      0.00         1
    37000000       0.00      0.00      0.00         2
    70000000       0.00      0.00      0.00         1
    75000000       0.00      0.00      0.00         0
    79000000       0.00      0.00      0.00         1
    80000000       0.00      0.00      0.00         1
    85000000       0.00      0.00      0.00         1
    90000000       0.00      0.00      0.00         3
    95000000       0.00      0.00      0.00         1
   105000000       0.00      0.00      0.00         1
   120000000       0.00      0.00      0.00         1
   130000000       0.00      0.00      0.00         2
   140000000       0.00      0.00      0.00         1
```