Importing Libraries and Dataset

```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import accuracy_score, classification_report
from sklearn.ensemble import GradientBoostingClassifier,
RandomForestClassifier, AdaBoostClassifier
from sklearn.svm import SVC, LinearSVC
from sklearn.neighbors import KNeighborsClassifier
from sklearn.naive_bayes import GaussianNB
from sklearn.tree import DecisionTreeClassifier
from sklearn.linear_model import LogisticRegression, SGDClassifier
from sklearn.neural_network import MLPClassifier
from xgboost import XGBClassifier

import warnings
warnings.filterwarnings("ignore")

df = pd.read_csv("Data\pokemon.csv")

df.head()
```

```
                     abilities  against_bug  against_dark
against_dragon  \
0  ['Overgrow', 'Chlorophyll']          1.0           1.0
1.0
1  ['Overgrow', 'Chlorophyll']          1.0           1.0
1.0
2  ['Overgrow', 'Chlorophyll']          1.0           1.0
1.0
3     ['Blaze', 'Solar Power']          0.5           1.0
1.0
4     ['Blaze', 'Solar Power']          0.5           1.0
1.0

   against_electric  against_fairy  against_fight  against_fire  \
0               0.5            0.5            0.5           2.0
1               0.5            0.5            0.5           2.0
2               0.5            0.5            0.5           2.0
3               1.0            0.5            1.0           0.5
4               1.0            0.5            1.0           0.5

   against_flying  against_ghost  ...  percentage_male  pokedex_number
\
```

```
0              2.0           1.0  ...           88.1              1

1              2.0           1.0  ...           88.1              2

2              2.0           1.0  ...           88.1              3

3              1.0           1.0  ...           88.1              4

4              1.0           1.0  ...           88.1              5


   sp_attack  sp_defense  speed  type1   type2  weight_kg  generation
\
0         65          65     45  grass  poison        6.9           1

1         80          80     60  grass  poison       13.0           1

2        122         120     80  grass  poison      100.0           1

3         60          50     65   fire     NaN        8.5           1

4         80          65     80   fire     NaN       19.0           1


   is_legendary
0             0
1             0
2             0
3             0
4             0

[5 rows x 41 columns]
```

Descriptive Statistics

```
df.shape     # 801 pokemons, 41 attributes

(801, 41)

df.columns.values   # columns

array(['abilities', 'against_bug', 'against_dark', 'against_dragon',
       'against_electric', 'against_fairy', 'against_fight',
       'against_fire', 'against_flying', 'against_ghost',
'against_grass',
       'against_ground', 'against_ice', 'against_normal',
       'against_poison', 'against_psychic', 'against_rock',
       'against_steel', 'against_water', 'attack', 'base_egg_steps',
       'base_happiness', 'base_total', 'capture_rate',
```

```
'classfication',
       'defense', 'experience_growth', 'height_m', 'hp',
'japanese_name',
       'name', 'percentage_male', 'pokedex_number', 'sp_attack',
       'sp_defense', 'speed', 'type1', 'type2', 'weight_kg',
'generation',
       'is_legendary'], dtype=object)
```

```
df.sample(5).T
```

```
                                              24                    680  \
abilities           ['Static', 'Lightningrod']    ['Stance Change']
against_bug                                  1.0                   0.25
against_dark                                 1.0                    2.0
against_dragon                               1.0                    0.5
against_electric                             0.5                    1.0
against_fairy                                1.0                    0.5
against_fight                                1.0                    0.0
against_fire                                 1.0                    2.0
against_flying                               0.5                    0.5
against_ghost                                1.0                    2.0
against_grass                                1.0                    0.5
against_ground                               2.0                    2.0
against_ice                                  1.0                    0.5
against_normal                               1.0                    0.0
against_poison                               1.0                    0.0
against_psychic                              1.0                    0.5
against_rock                                 1.0                    0.5
against_steel                                0.5                    0.5
against_water                                1.0                    1.0
attack                                        55                    150
base_egg_steps                              2560                   5120
base_happiness                                70                     70
base_total                                   320                    520
capture_rate                                 190                     45
classfication                      Mouse Pokémon  Royal Sword Pokémon
defense                                       40                     50
experience_growth                        1000000                1000000
height_m                                     0.4                    1.7
hp                                            35                     60
japanese_name                       Pikachu ピカチュウ   Gillgard ギルガルド
name                                     Pikachu              Aegislash
percentage_male                             50.0                   50.0
pokedex_number                                25                    681
sp_attack                                     50                    150
sp_defense                                    50                     50
speed                                         90                     60
type1                                   electric                  steel
type2                                        NaN                  ghost
weight_kg                                    6.0                   53.0
```

```
generation                                     1                    6
is_legendary                                   0                    0

                                          230  \
abilities          ['Pickup', 'Sand Veil']
against_bug                               1.0
against_dark                              1.0
against_dragon                            1.0
against_electric                          0.0
against_fairy                             1.0
against_fight                             1.0
against_fire                              1.0
against_flying                            1.0
against_ghost                             1.0
against_grass                             2.0
against_ground                            1.0
against_ice                               2.0
against_normal                            1.0
against_poison                            0.5
against_psychic                           1.0
against_rock                              0.5
against_steel                             1.0
against_water                             2.0
attack                                     60
base_egg_steps                           5120
base_happiness                             70
base_total                                330
capture_rate                              120
classfication               Long Nose Pokémon
defense                                    60
experience_growth                     1000000
height_m                                  0.5
hp                                         90
japanese_name                  Gomazou ゴマゾウ
name                                   Phanpy
percentage_male                          50.0
pokedex_number                            231
sp_attack                                  40
sp_defense                                 40
speed                                      40
type1                                  ground
type2                                     NaN
weight_kg                                33.5
generation                                  2
is_legendary                                0

                                                     46   \
abilities          ['Effect Spore', 'Dry Skin', 'Damp']
against_bug                                          2.0
```

```
against_dark                                                     1.0
against_dragon                                                   1.0
against_electric                                                 0.5
against_fairy                                                    1.0
against_fight                                                    0.5
against_fire                                                     4.0
against_flying                                                   4.0
against_ghost                                                    1.0
against_grass                                                   0.25
against_ground                                                  0.25
against_ice                                                      2.0
against_normal                                                   1.0
against_poison                                                   2.0
against_psychic                                                  1.0
against_rock                                                     2.0
against_steel                                                    1.0
against_water                                                    0.5
attack                                                            95
base_egg_steps                                                  5120
base_happiness                                                    70
base_total                                                       405
capture_rate                                                      75
classfication                                       Mushroom Pokémon
defense                                                           80
experience_growth                                            1000000
height_m                                                         1.0
hp                                                                60
japanese_name                                           Parasectパラセクト
name                                                        Parasect
percentage_male                                                 50.0
pokedex_number                                                    47
sp_attack                                                         60
sp_defense                                                        80
speed                                                             30
type1                                                            bug
type2                                                          grass
weight_kg                                                       29.5
generation                                                         1
is_legendary                                                       0

                                                         574
abilities          ['Frisk', 'Competitive', 'Shadow Tag']
against_bug                                              2.0
against_dark                                             2.0
against_dragon                                           1.0
against_electric                                         1.0
against_fairy                                            1.0
against_fight                                            0.5
against_fire                                             1.0
```

```
against_flying                                         1.0
against_ghost                                          2.0
against_grass                                          1.0
against_ground                                         1.0
against_ice                                            1.0
against_normal                                         1.0
against_poison                                         1.0
against_psychic                                        0.5
against_rock                                           1.0
against_steel                                          1.0
against_water                                          1.0
attack                                                  45
base_egg_steps                                        5120
base_happiness                                          70
base_total                                             390
capture_rate                                           100
classfication                           Manipulate Pokémon
defense                                                 70
experience_growth                                  1059860
height_m                                               0.7
hp                                                      60
japanese_name                                Gothimiru ゴチミル
name                                             Gothorita
percentage_male                                       24.6
pokedex_number                                         575
sp_attack                                               75
sp_defense                                              85
speed                                                   55
type1                                              psychic
type2                                                  NaN
weight_kg                                             18.0
generation                                               5
is_legendary                                             0
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 801 entries, 0 to 800
Data columns (total 41 columns):
 #   Column             Non-Null Count  Dtype  
---  ------             --------------  -----  
 0   abilities          801 non-null    object 
 1   against_bug        801 non-null    float64
 2   against_dark       801 non-null    float64
 3   against_dragon     801 non-null    float64
 4   against_electric   801 non-null    float64
 5   against_fairy      801 non-null    float64
 6   against_fight      801 non-null    float64
 7   against_fire       801 non-null    float64
 8   against_flying     801 non-null    float64
```

```
 9   against_ghost      801 non-null    float64
 10  against_grass      801 non-null    float64
 11  against_ground     801 non-null    float64
 12  against_ice        801 non-null    float64
 13  against_normal     801 non-null    float64
 14  against_poison     801 non-null    float64
 15  against_psychic    801 non-null    float64
 16  against_rock       801 non-null    float64
 17  against_steel      801 non-null    float64
 18  against_water      801 non-null    float64
 19  attack             801 non-null    int64
 20  base_egg_steps     801 non-null    int64
 21  base_happiness     801 non-null    int64
 22  base_total         801 non-null    int64
 23  capture_rate       801 non-null    object
 24  classfication      801 non-null    object
 25  defense            801 non-null    int64
 26  experience_growth  801 non-null    int64
 27  height_m           781 non-null    float64
 28  hp                 801 non-null    int64
 29  japanese_name      801 non-null    object
 30  name               801 non-null    object
 31  percentage_male    703 non-null    float64
 32  pokedex_number     801 non-null    int64
 33  sp_attack          801 non-null    int64
 34  sp_defense         801 non-null    int64
 35  speed              801 non-null    int64
 36  type1              801 non-null    object
 37  type2              417 non-null    object
 38  weight_kg          781 non-null    float64
 39  generation         801 non-null    int64
 40  is_legendary       801 non-null    int64
dtypes: float64(21), int64(13), object(7)
memory usage: 256.7+ KB
```

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

```
                   count          mean           std        min
25%  \
against_bug        801.0  9.962547e-01       0.597248       0.25
0.5
against_dark       801.0  1.057116e+00       0.438142       0.25
1.0
against_dragon     801.0  9.687890e-01       0.353058       0.00
1.0
against_electric   801.0  1.073970e+00       0.654962       0.00
0.5
against_fairy      801.0  1.068976e+00       0.522167       0.25
1.0
against_fight      801.0  1.065543e+00       0.717251       0.00
```

```
0.5
against_fire       801.0  1.135456e+00       0.691853       0.25
0.5
against_flying     801.0  1.192884e+00       0.604488       0.25
1.0
against_ghost      801.0  9.850187e-01       0.558256       0.00
1.0
against_grass      801.0  1.034020e+00       0.788896       0.25
0.5
against_ground     801.0  1.098002e+00       0.738818       0.00
1.0
against_ice        801.0  1.208177e+00       0.735356       0.25
0.5
against_normal     801.0  8.870162e-01       0.266106       0.00
1.0
against_poison     801.0  9.753433e-01       0.549375       0.00
0.5
against_psychic    801.0  1.005306e+00       0.495183       0.00
1.0
against_rock       801.0  1.250312e+00       0.697148       0.25
1.0
against_steel      801.0  9.834582e-01       0.500117       0.25
0.5
against_water      801.0  1.058365e+00       0.606562       0.25
0.5
attack             801.0  7.785768e+01      32.158820       5.00
55.0
base_egg_steps     801.0  7.191011e+03    6558.220422    1280.00
5120.0
base_happiness     801.0  6.536205e+01      19.598948       0.00
70.0
base_total         801.0  4.283770e+02     119.203577     180.00
320.0
defense            801.0  7.300874e+01      30.769159       5.00
50.0
experience_growth  801.0  1.054996e+06  160255.835096  600000.00
1000000.0
height_m           781.0  1.163892e+00       1.080326       0.10
0.6
hp                 801.0  6.895880e+01      26.576015       1.00
50.0
percentage_male    703.0  5.515576e+01      20.261623       0.00
50.0
pokedex_number     801.0  4.010000e+02     231.373075       1.00
201.0
sp_attack          801.0  7.130587e+01      32.353826      10.00
45.0
sp_defense         801.0  7.091136e+01      27.942501      20.00
50.0
```

```
speed                 801.0  6.633458e+01      28.907662       5.00
45.0
weight_kg             781.0  6.137810e+01     109.354766       0.10
9.0
generation            801.0  3.690387e+00       1.930420       1.00
2.0
is_legendary          801.0  8.739076e-02       0.282583       0.00
0.0

                         50%        75%        max
against_bug              1.0        1.0        4.0
against_dark             1.0        1.0        4.0
against_dragon           1.0        1.0        2.0
against_electric         1.0        1.0        4.0
against_fairy            1.0        1.0        4.0
against_fight            1.0        1.0        4.0
against_fire             1.0        2.0        4.0
against_flying           1.0        1.0        4.0
against_ghost            1.0        1.0        4.0
against_grass            1.0        1.0        4.0
against_ground           1.0        1.0        4.0
against_ice              1.0        2.0        4.0
against_normal           1.0        1.0        1.0
against_poison           1.0        1.0        4.0
against_psychic          1.0        1.0        4.0
against_rock             1.0        2.0        4.0
against_steel            1.0        1.0        4.0
against_water            1.0        1.0        4.0
attack                  75.0      100.0      185.0
base_egg_steps        5120.0     6400.0    30720.0
base_happiness          70.0       70.0      140.0
base_total             435.0      505.0      780.0
defense                 70.0       90.0      230.0
experience_growth  1000000.0  1059860.0  1640000.0
height_m                 1.0        1.5       14.5
hp                      65.0       80.0      255.0
percentage_male         50.0       50.0      100.0
pokedex_number         401.0      601.0      801.0
sp_attack               65.0       91.0      194.0
sp_defense              66.0       90.0      230.0
speed                   65.0       85.0      180.0
weight_kg               27.3       64.8      999.9
generation               4.0        5.0        7.0
is_legendary             0.0        0.0        1.0
```

Data Preprocessing

Reordering name attribute

```
df.insert(0, 'name', df.pop('name'))   # done to easily identify names

df.head()

         name                    abilities  against_bug  against_dark  
\
0   Bulbasaur  ['Overgrow', 'Chlorophyll']          1.0           1.0   

1     Ivysaur  ['Overgrow', 'Chlorophyll']          1.0           1.0   

2    Venusaur  ['Overgrow', 'Chlorophyll']          1.0           1.0   

3  Charmander     ['Blaze', 'Solar Power']          0.5           1.0   

4  Charmeleon     ['Blaze', 'Solar Power']          0.5           1.0   


   against_dragon  against_electric  against_fairy  against_fight  \
0             1.0               0.5            0.5            0.5   
1             1.0               0.5            0.5            0.5   
2             1.0               0.5            0.5            0.5   
3             1.0               1.0            0.5            1.0   
4             1.0               1.0            0.5            1.0   

   against_fire  against_flying  ...  percentage_male  pokedex_number  
\
0           2.0             2.0  ...             88.1               1   

1           2.0             2.0  ...             88.1               2   

2           2.0             2.0  ...             88.1               3   

3           0.5             1.0  ...             88.1               4   

4           0.5             1.0  ...             88.1               5   


   sp_attack  sp_defense  speed  type1   type2  weight_kg  generation  
\
0         65          65     45  grass  poison        6.9           1   

1         80          80     60  grass  poison       13.0           1   

2        122         120     80  grass  poison      100.0           1   

3         60          50     65   fire     NaN        8.5           1   
```

```
4          80           65      80    fire      NaN        19.0             1


   is_legendary
0             0
1             0
2             0
3             0
4             0

[5 rows x 41 columns]
```

Null Values

```
df.isnull().sum()
```

```
name                  0
abilities             0
against_bug           0
against_dark          0
against_dragon        0
against_electric      0
against_fairy         0
against_fight         0
against_fire          0
against_flying        0
against_ghost         0
against_grass         0
against_ground        0
against_ice           0
against_normal        0
against_poison        0
against_psychic       0
against_rock          0
against_steel         0
against_water         0
attack                0
base_egg_steps        0
base_happiness        0
base_total            0
capture_rate          0
classfication         0
defense               0
experience_growth     0
height_m             20
hp                    0
japanese_name         0
percentage_male      98
pokedex_number        0
sp_attack             0
```

```
sp_defense              0
speed                   0
type1                   0
type2                 384
weight_kg              20
generation              0
is_legendary            0
dtype: int64
```

"height_m" and "weight_kg has 20-20 Null Values each. "percentage_male" has 98 Null Values "type2" has 384 missing values

Data Imputation

```python
# Replacing missing height_m and weight_kg values with mode of them
df["height_m"].fillna(df["height_m"].mean(), inplace=True)
df["weight_kg"].fillna(df["weight_kg"].mean(), inplace=True)

# Replacing the missing values in percentage_male with None
df["percentage_male"].fillna('None', inplace=True)

# Replacing the missing values in type 2 with NUll
df["type2"].fillna('None', inplace=True)

df.isnull().sum()
```

```
name                   0
abilities              0
against_bug            0
against_dark           0
against_dragon         0
against_electric       0
against_fairy          0
against_fight          0
against_fire           0
against_flying         0
against_ghost          0
against_grass          0
against_ground         0
against_ice            0
against_normal         0
against_poison         0
against_psychic        0
against_rock           0
against_steel          0
against_water          0
attack                 0
base_egg_steps         0
base_happiness         0
base_total             0
```

```
capture_rate         0
classfication        0
defense              0
experience_growth    0
height_m             0
hp                   0
japanese_name        0
percentage_male      0
pokedex_number       0
sp_attack            0
sp_defense           0
speed                0
type1                0
type2                0
weight_kg            0
generation           0
is_legendary         0
dtype: int64
```

capture_rate attribute

capture_rate is an object attribute but has numerical values. Now, lets check the capture_rate attribute.

```
for i in df.capture_rate:
    print(i, end=", ")
```

```
45, 45, 45, 45, 45, 45, 45, 45, 45, 255, 120, 45, 255, 120, 45, 255,
120, 45, 255, 127, 255, 90, 255, 90, 190, 75, 255, 90, 235, 120, 45,
235, 120, 45, 150, 25, 190, 75, 170, 50, 255, 90, 255, 120, 45, 190,
75, 190, 75, 255, 50, 255, 90, 190, 75, 190, 75, 190, 75, 255, 120,
45, 200, 100, 50, 180, 90, 45, 255, 120, 45, 190, 60, 255, 120, 45,
190, 60, 190, 75, 190, 60, 45, 190, 45, 190, 75, 190, 75, 190, 60,
190, 90, 45, 45, 190, 75, 225, 60, 190, 60, 90, 45, 190, 75, 45, 45,
45, 190, 60, 120, 60, 30, 45, 45, 225, 75, 225, 60, 225, 60, 45, 45,
45, 45, 45, 45, 45, 255, 45, 45, 35, 45, 45, 45, 45, 45, 45, 45, 45,
45, 45, 25, 3, 3, 3, 45, 45, 45, 3, 45, 45, 45, 45, 45, 45, 45, 45,
45, 45, 255, 90, 255, 90, 255, 90, 255, 90, 90, 190, 75, 190, 150,
170, 190, 75, 190, 75, 235, 120, 45, 45, 190, 75, 65, 45, 255, 120,
45, 45, 235, 120, 75, 255, 90, 45, 45, 30, 70, 45, 225, 45, 60, 190,
75, 190, 60, 25, 190, 75, 45, 25, 190, 45, 60, 120, 60, 190, 75, 225,
75, 60, 190, 75, 45, 25, 25, 120, 45, 45, 120, 60, 45, 45, 45, 75, 45,
45, 45, 45, 45, 30, 3, 3, 3, 45, 45, 45, 3, 3, 45, 45, 45, 45, 45, 45,
45, 45, 45, 45, 255, 127, 255, 90, 255, 120, 45, 120, 45, 255, 120,
45, 255, 120, 45, 200, 45, 190, 45, 235, 120, 45, 200, 75, 255, 90,
255, 120, 45, 255, 120, 45, 190, 120, 45, 180, 200, 150, 255, 255, 60,
45, 45, 180, 90, 45, 180, 90, 120, 45, 200, 200, 150, 150, 150, 225,
75, 225, 60, 125, 60, 255, 150, 90, 255, 60, 255, 255, 120, 45, 190,
60, 255, 45, 90, 90, 45, 45, 190, 75, 205, 155, 255, 90, 45, 45, 45,
```

```
45, 255, 60, 45, 200, 225, 45, 190, 90, 200, 45, 30, 125, 190, 75,
255, 120, 45, 255, 60, 60, 25, 225, 45, 45, 45, 3, 3, 3, 3, 3, 3, 3,
3, 3, 3, 45, 3, 3, 45, 45, 45, 45, 45, 45, 45, 45, 45, 255, 120, 45,
255, 127, 255, 45, 235, 120, 45, 255, 75, 45, 45, 45, 45, 120, 45, 45,
120, 45, 200, 190, 75, 190, 75, 190, 75, 45, 125, 60, 190, 60, 45, 30,
190, 75, 120, 225, 60, 255, 90, 255, 145, 130, 30, 100, 45, 45, 45,
50, 75, 45, 140, 60, 120, 45, 140, 75, 200, 190, 75, 25, 120, 60, 45,
30, 30, 30, 30, 30, 30, 30, 30, 45, 45, 30, 50, 30, 45, 60, 45, 75,
45, 3, 3, 3, 3, 3, 3, 3, 3, 3, 30, 3, 3, 45, 3, 3, 45, 45, 45, 45, 45,
45, 45, 45, 45, 255, 255, 255, 120, 45, 255, 90, 190, 75, 190, 75,
190, 75, 190, 75, 255, 120, 45, 190, 75, 255, 120, 45, 190, 45, 120,
60, 255, 180, 90, 45, 255, 120, 45, 45, 45, 255, 120, 45, 255, 120,
45, 190, 75, 190, 75, 25, 180, 90, 45, 120, 60, 255, 190, 75, 180, 90,
45, 190, 90, 45, 45, 45, 45, 190, 60, 75, 45, 255, 60, 200, 100, 50,
200, 100, 50, 190, 45, 255, 120, 45, 190, 75, 200, 200, 75, 190, 75,
190, 60, 75, 190, 75, 255, 90, 130, 60, 30, 190, 60, 30, 255, 90, 190,
90, 45, 75, 60, 45, 120, 60, 25, 200, 75, 75, 180, 45, 45, 190, 90,
120, 45, 45, 190, 60, 190, 60, 90, 90, 45, 45, 45, 45, 15, 3, 3, 3, 3,
3, 3, 3, 3, 3, 3, 3, 3, 45, 45, 45, 45, 45, 45, 45, 45, 45, 255, 127,
255, 120, 45, 255, 120, 45, 220, 65, 225, 120, 45, 200, 45, 220, 65,
160, 190, 75, 180, 90, 45, 200, 140, 200, 140, 190, 80, 120, 45, 225,
55, 225, 55, 190, 75, 45, 45, 45, 45, 45, 100, 180, 60, 45, 45, 45,
75, 120, 60, 120, 60, 190, 55, 190, 45, 45, 45, 3, 3, 3, 3, 45, 45,
45, 45, 45, 45, 45, 45, 45, 255, 120, 45, 255, 127, 255, 120, 45, 225,
60, 45, 190, 75, 190, 90, 60, 190, 75, 190, 60, 200, 100, 190, 75,
190, 75, 120, 45, 140, 70, 235, 120, 45, 60, 45, 45, 90, 45, 140, 60,
60, 3, 3, 30 (Meteorite)255 (Core), 45, 70, 180, 45, 80, 70, 25, 45,
45, 45, 3, 3, 3, 3, 45, 45, 45, 45, 45, 25, 255, 30, 25, 255, 15, 3,
3,
```

```
df[df["capture_rate"]=="30 (Meteorite)255 (Core)"]
```

```
       name         abilities  against_bug  against_dark
against_dragon  \
773  Minior  ['Shields Down']          0.5           1.0
1.0

     against_electric  against_fairy  against_fight  against_fire  \
773               2.0            1.0            1.0           0.5

     against_flying  ...  percentage_male  pokedex_number
sp_attack  \
773             0.5  ...             None             774        100


     sp_defense  speed  type1   type2  weight_kg  generation
is_legendary
773          60    120   rock  flying       40.0           7
0
```

```
[1 rows x 41 columns]
```

As we can see in the output values there is one value "30 (Meteorite)255 (Core)". We know its a rock/fly type pokemon, therefore, we will replace it with "Meteorite" capture_rate of 30.

```
# replacing with 30
df["capture_rate"].replace({"30 (Meteorite)255 (Core)": "30"},
inplace=True)

# converting into integer type attribute
df["capture_rate"] = df["capture_rate"].astype('int')
df["capture_rate"].dtype
```

```
dtype('int64')
```

Dropping unncessary attributes

We will drop off 3 unncessary columns:

1. japenese_name
2. pokedex_number
3. percentage_male

```
df.drop(columns=['japanese_name', 'pokedex_number',
'percentage_male'], axis=1, inplace=True)
```

Combining number of abilities and type1 & type2

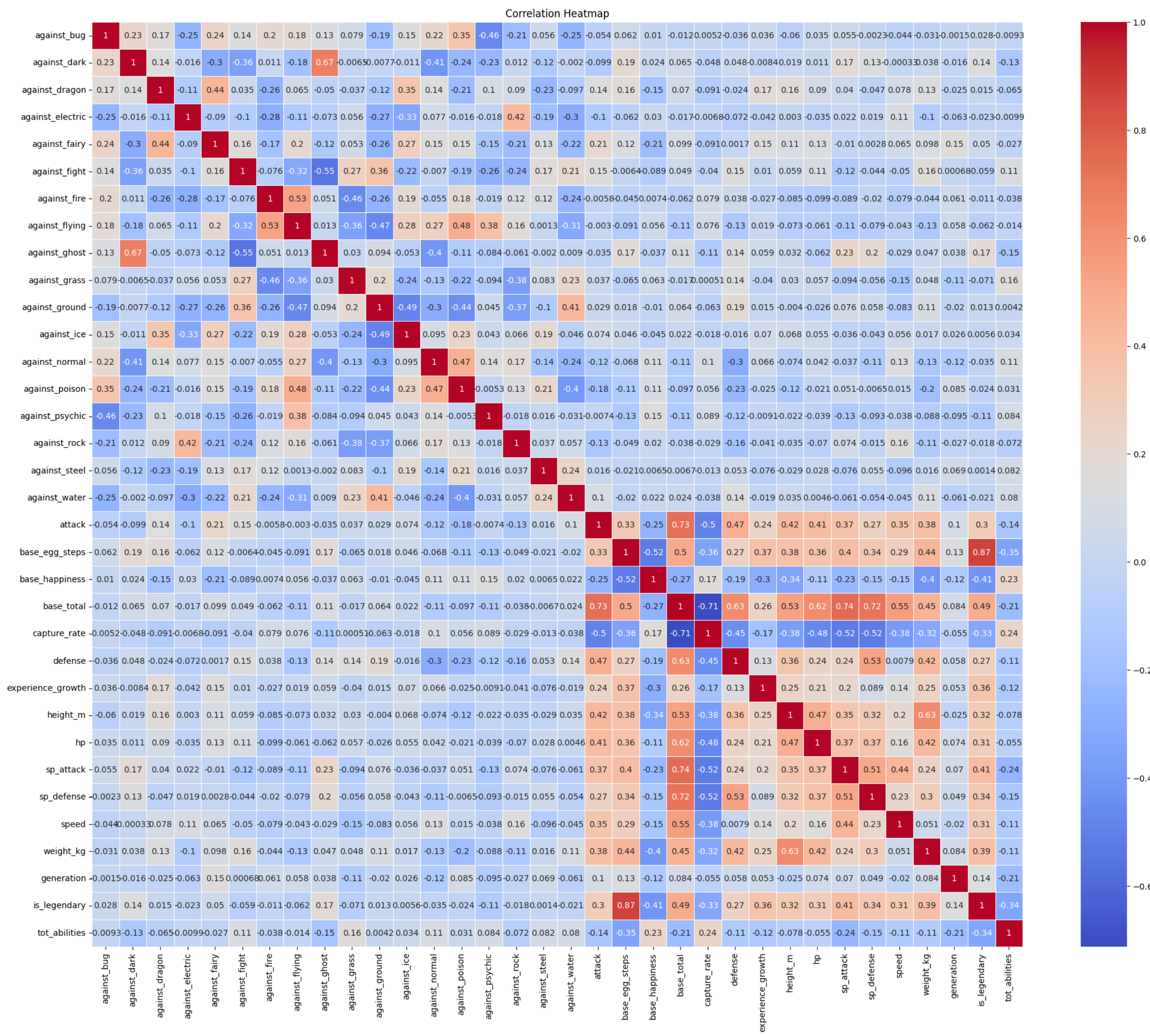
```
# adding total abilities that a pokemon has
df["tot_abilities"] = df.apply(lambda x: len(x["abilities"]), axis=1)

# merging type1 and type2 and adding into new column=> type,
# and renaming type1 to primary and type2 to secondary
df['type'] =  df.apply(lambda x: x['type1'] if pd.isnull(x['type2'])
else f'{x["type1"]}_{x["type2"]}', axis=1)
df.rename(columns = {'type1':'primary type', 'type2':'secondary
type'}, inplace = True)

# Checking the final shape of df before moving into visualizations
df.shape
```

```
(801, 40)
```

Data Analysis

```
plt.figure(figsize=(25, 20))
sns.heatmap(df.corr(numeric_only=True), annot=True,  cmap='coolwarm',
```

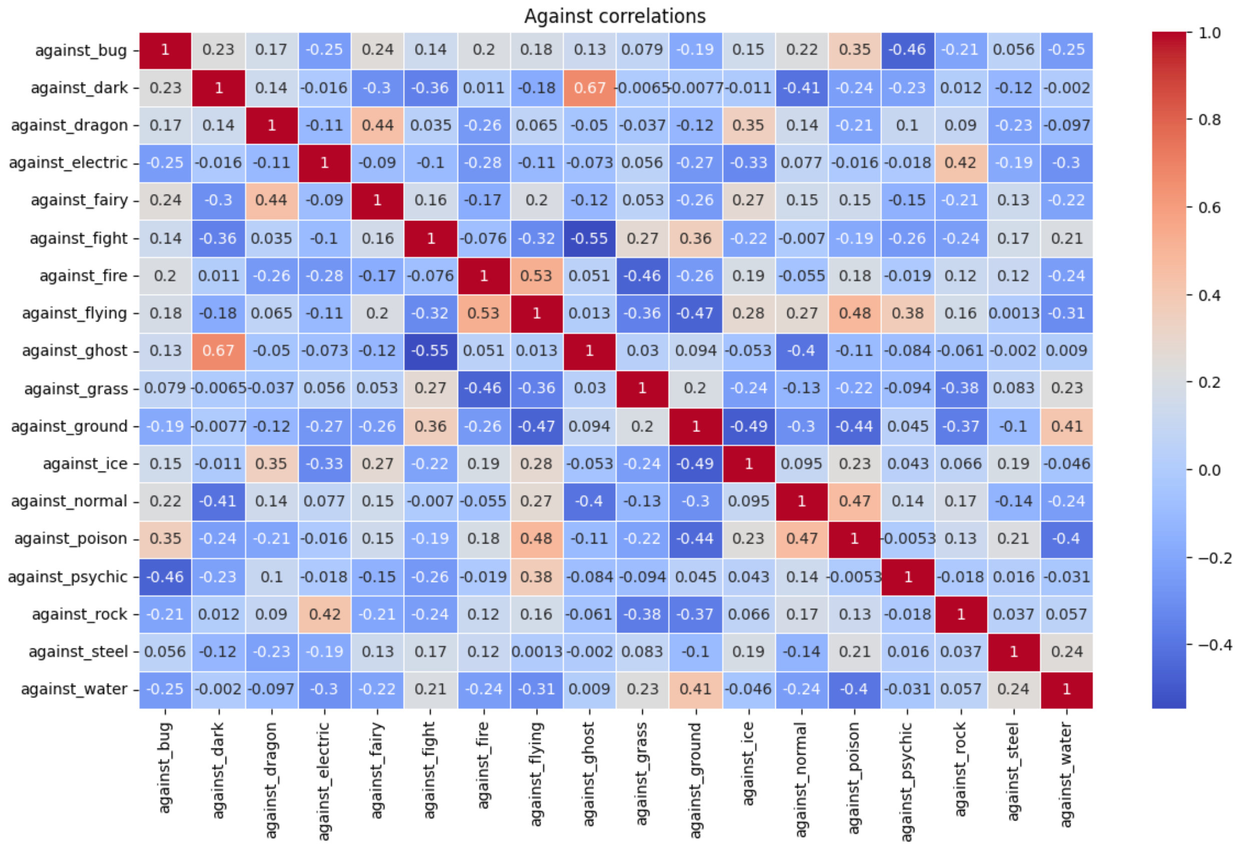
```
linewidths=0.5).set_title("Correlation Heatmap")
plt.show()
```



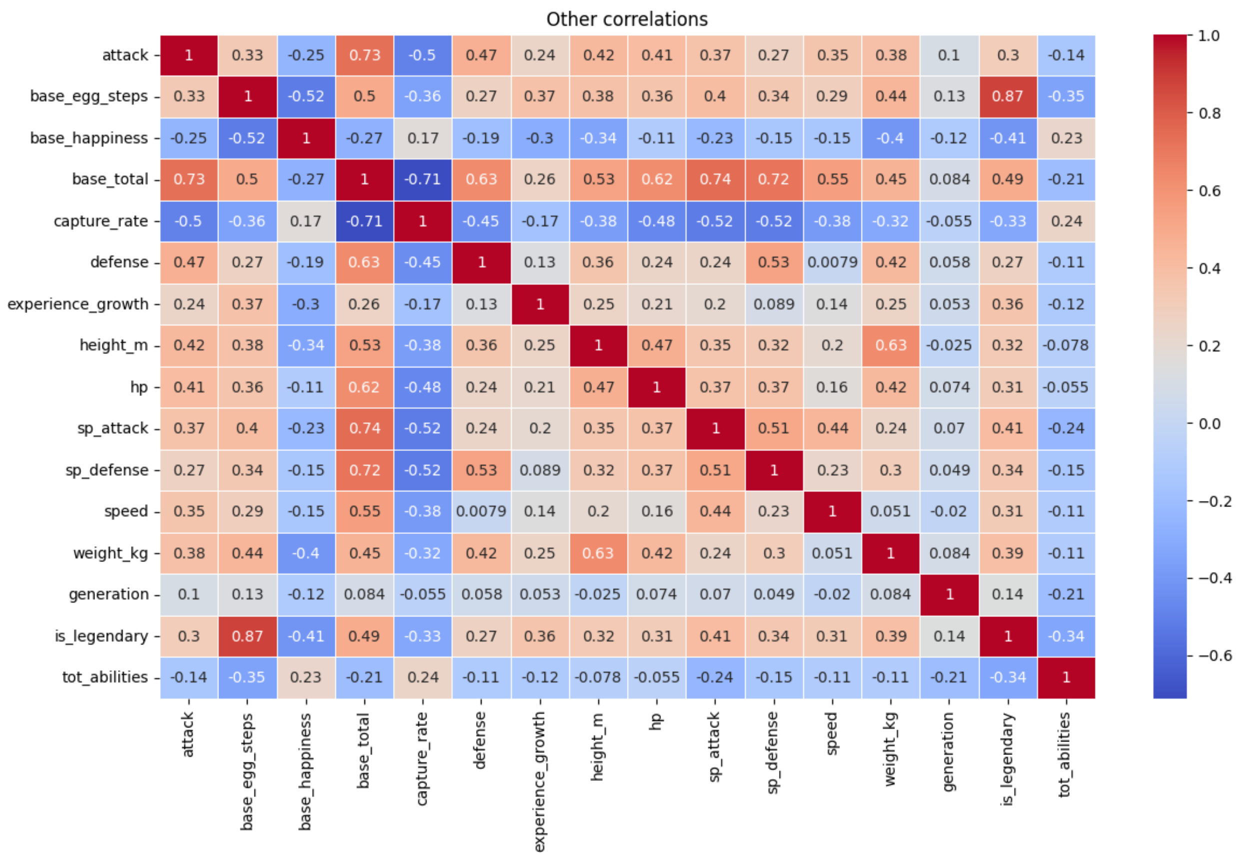
Lets distribute the correlation into two main parts for proper understanding =>

```
against=[]
rest=[]
for i in df.columns:
    if 'against' in i:
        against.append(i)
    else:
        rest.append(i)

plt.figure(figsize=(14, 8))
sns.heatmap(df[against].corr(), annot=True, cmap='coolwarm',
```

```
linewidths=0.5).set_title("Against correlations")
plt.show()
```




```
plt.figure(figsize=(14, 8))
sns.heatmap(df[rest].corr(numeric_only=True), annot=True,
cmap='coolwarm', linewidths=0.5).set_title("Other correlations")
plt.show()
```



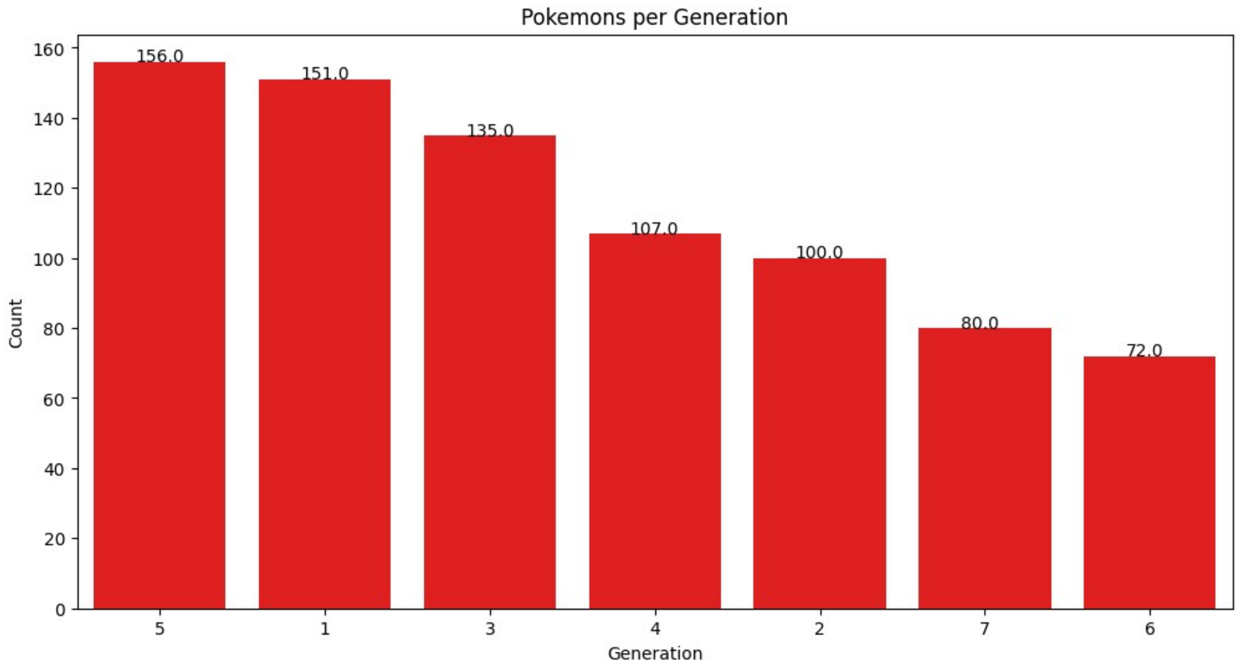
Now we can see from the above heatmap, following relations:

- base_total has good correlation with attack, defense, sp_attack, and sp_defense.
- base_egg_steps have a huge correlation with is_legendary attribute.
- weight_kg is also very correlated with height_m

Visualizations

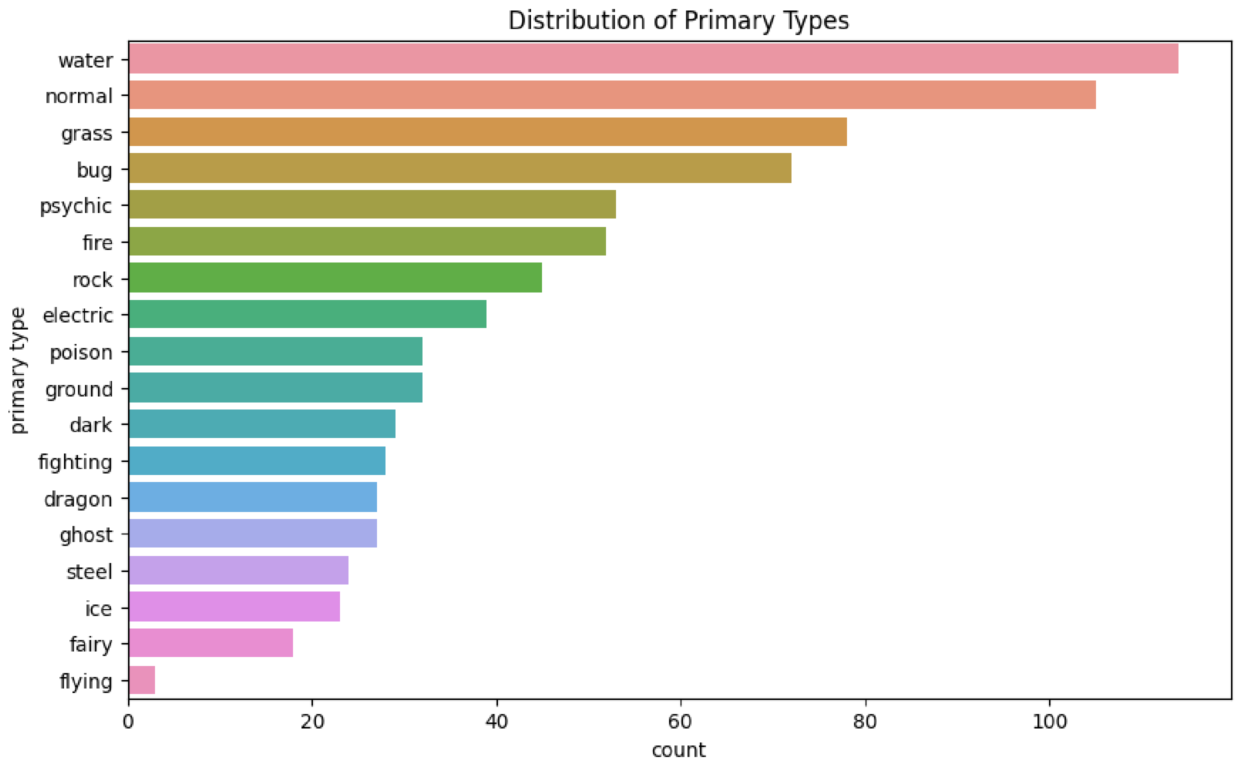
1. Count of Pokemons per generation

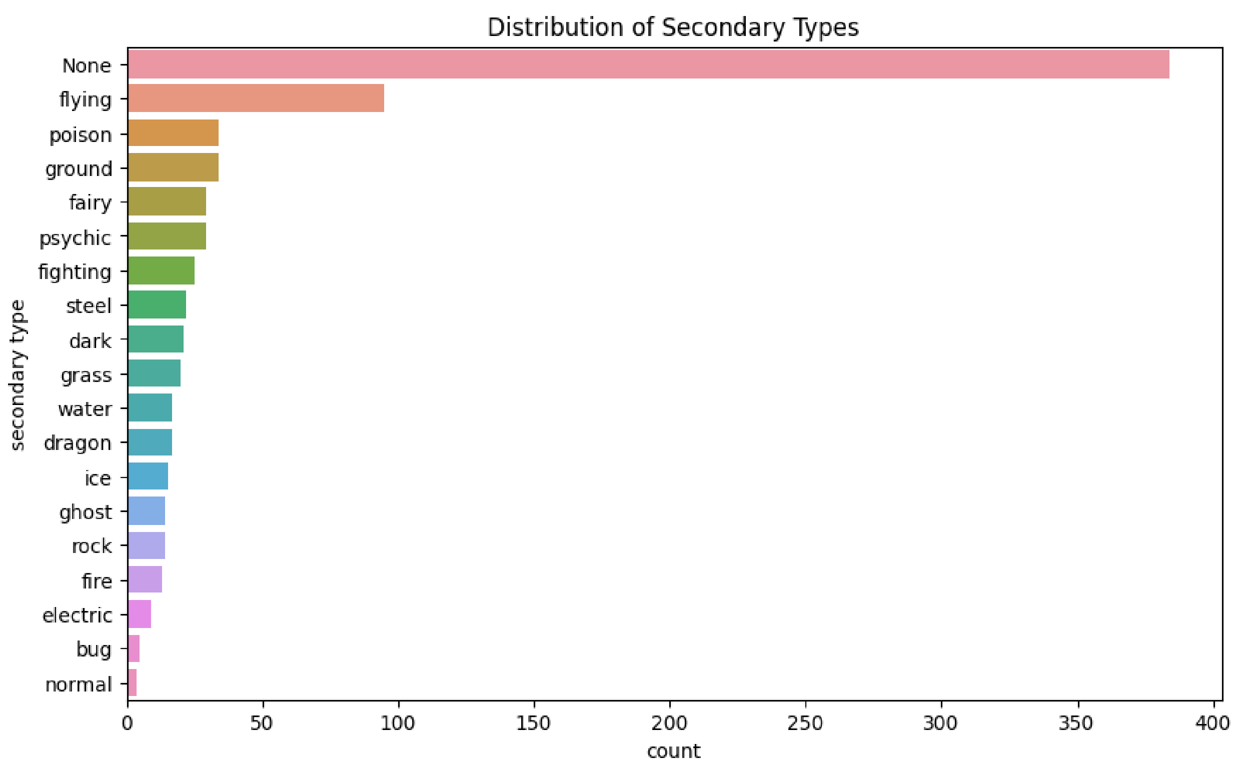
```
plt.figure(figsize=(12,6))
ax =
sns.countplot(x='generation',data=df,order=df['generation'].value_coun
ts().index,color='red')
ax.set_title('Pokemons per Generation')
ax.set(xlabel='Generation',ylabel='Count')
for p in ax.patches:
    ax.annotate('{:.1f}'.format(p.get_height()), (p.get_x()+0.25,
p.get_height()+0.01))
plt.show()
```



2. Distribution of Primary and Secondary Types of pokemon

```
# Bar charts for primary type
plt.figure(figsize=(10, 6))
sns.countplot(y='primary type', data=df, order=df['primary
type'].value_counts().index)
plt.title('Distribution of Primary Types')
plt.show()

# Bar charts for secondary type
plt.figure(figsize=(10, 6))
sns.countplot(y='secondary type', data=df, order=df['secondary
type'].value_counts().index)
plt.title('Distribution of Secondary Types')
plt.show()
```





From the above plot, we can derive following conclusions:

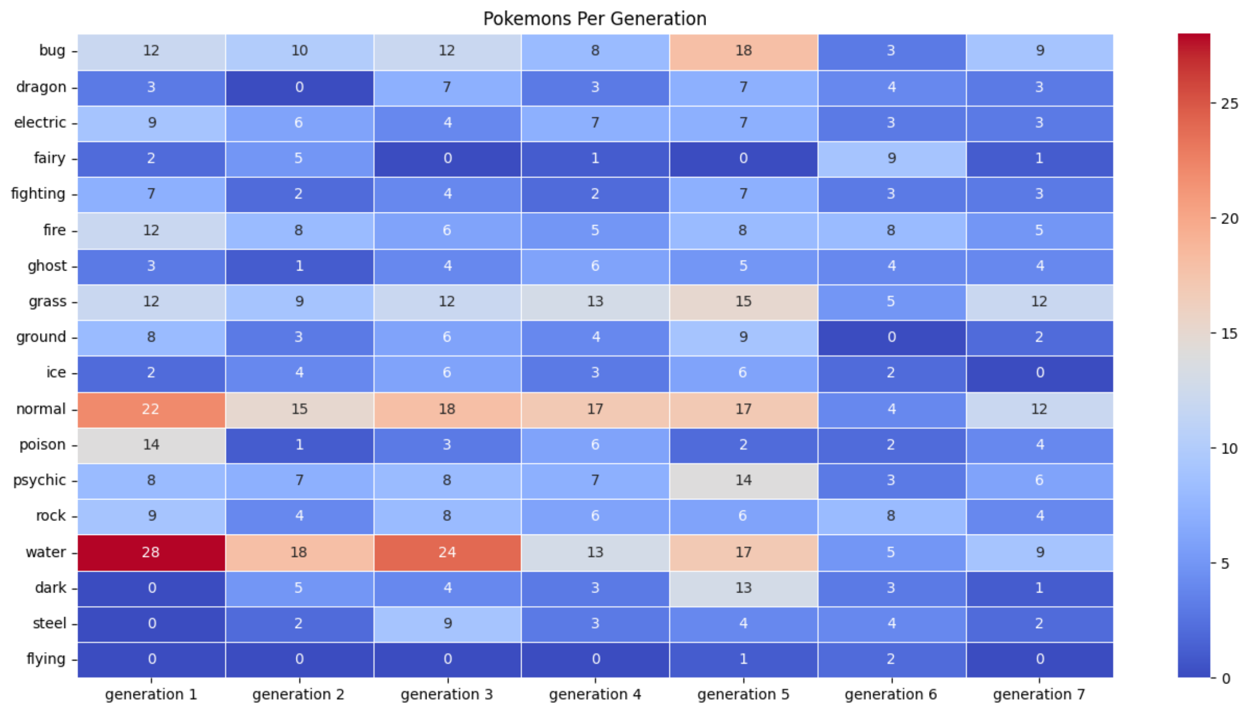
- Most occured pokemon type

- Primary type = Water Type
- Secondary type = None; followed by flying type

- Least occured pokemon type
  - Primary type = flying
  - Secondary type = normal

3. Types of Pokemons in each Generation

```
primary_type_generation_group = df.groupby(['generation', 'primary
type'])['name'].count().to_frame().reset_index()
primary_type_generation_group.rename(columns={'name' : 'name_count'},
inplace=True)
primary_type_generation_dict  = {}
for generation in
list(primary_type_generation_group['generation'].unique()):
    current_generation = []
    for p_type in primary_type_generation_group['primary
type'].unique():
        try:
            current_generation.append(

primary_type_generation_group.loc[(primary_type_generation_group['gene
ration']==generation)
                                        &
(primary_type_generation_group['primary type'] == p_type)]
['name_count'].values[0])
        except IndexError:
            current_generation.append(0)
    primary_type_generation_dict[f'generation {generation}'] =
current_generation

p_type_by_generation = pd.DataFrame(primary_type_generation_dict,
index= primary_type_generation_group['primary type'].unique())
fig,axes = plt.subplots(figsize=(16,8))
sns.heatmap(p_type_by_generation, annot=True, cmap='coolwarm',
linewidths=0.5).set_title('Pokemons Per Generation')
plt.show()
```



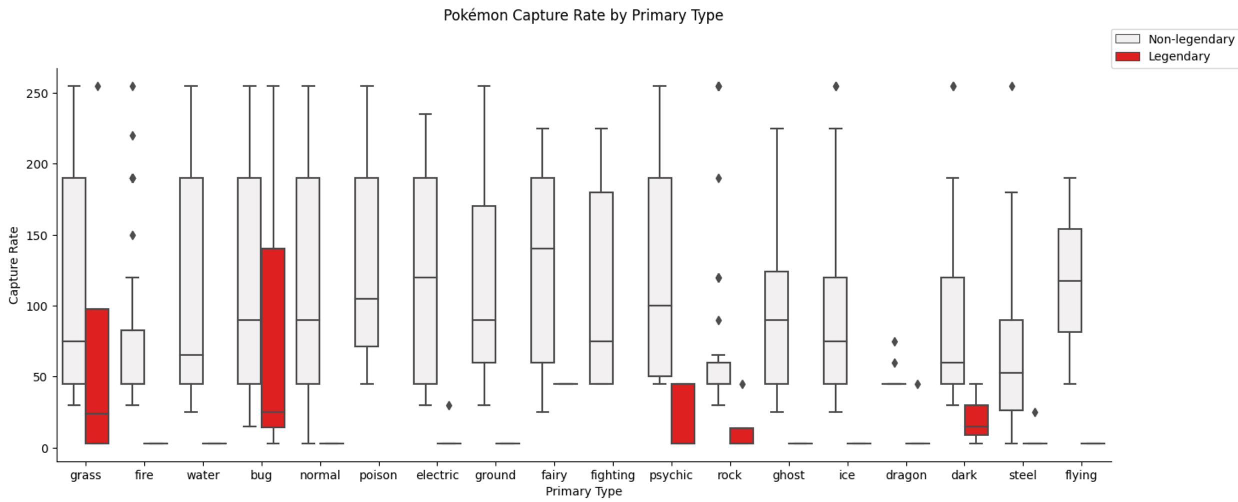
As we can see that, not each generation have all types of pokemons: And we can derive following conlusions from above::

- Only Gen 5 & 6 have flying type pokemons
- In Gen 1, there is no dark, steel & flying type pokemons
- In Gen 1, 2, & 3, water type pokemons are most common
- In Gen 4, normal type pokemons are most common
- In Gen 5, bug type pokemons are most common
- In Gen 6, fairy type pokemons are most common
- In Gen 7, normal & grass type pokemons are most common

4. Easiest / Hardest Pokemon Type to catch

```
plt.figure(figsize=(16,6))
ax = sns.boxplot(x='primary type',y='capture_rate',
hue='is_legendary', data = df, color="red")

ax.set_xlabel(xlabel='Primary Type')
ax.set_ylabel(ylabel='Capture Rate')
ax.set_title('Pokémon Capture Rate by Primary Type', pad=40)

sns.despine(top=True, right=True)

handles, labels = ax.get_legend_handles_labels()
ax.legend(handles, ['Non-legendary', 'Legendary'], loc=(1,1))
```

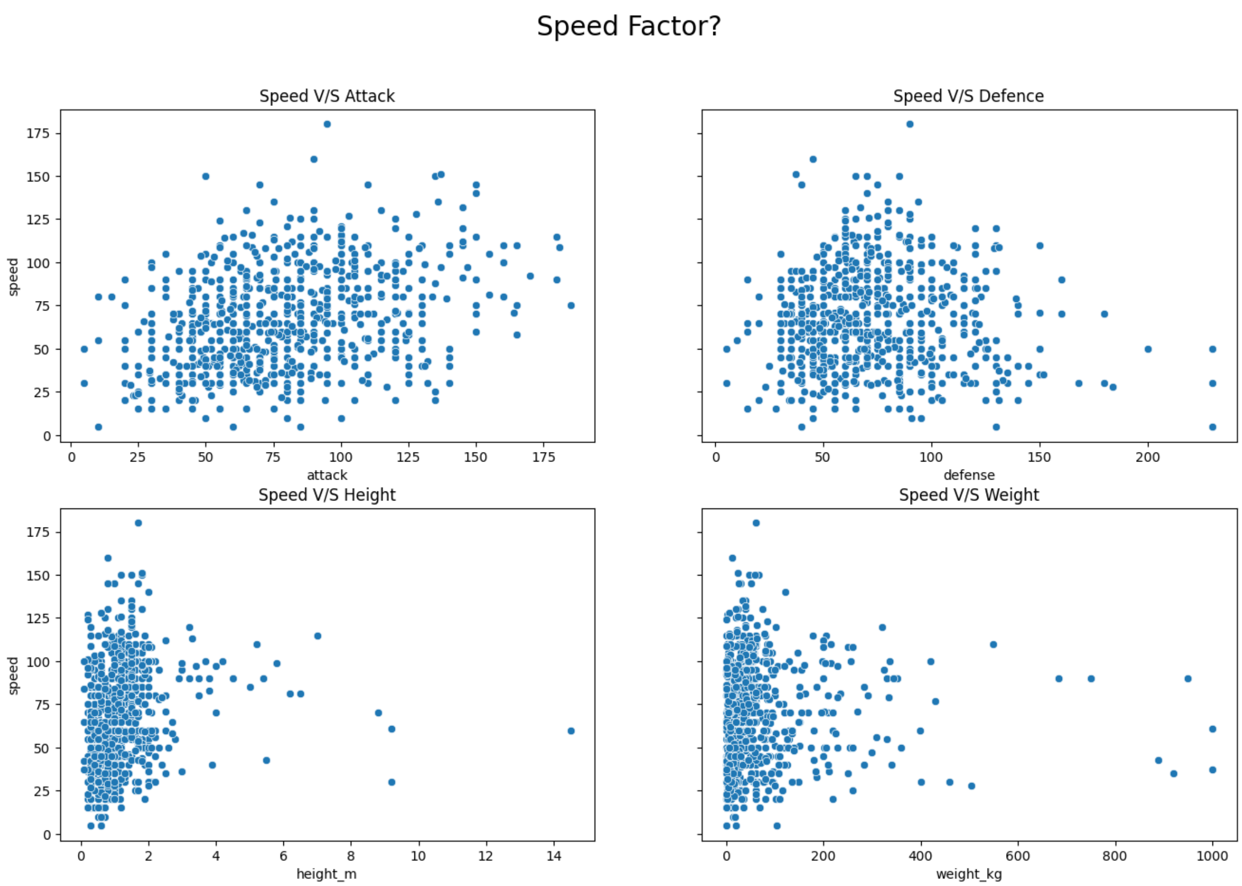
```
<matplotlib.legend.Legend at 0x7cee17d88850>
```



The easiest pokemon type to catch is "fairy" and hardest to catch is "dragon" type. It is also hard to catch "rock" and "fire" type pokemons. In legendary pokemons, easiest to catch are from "bug" and "grass" types.

5. How Speed correlate with various base stats?

```
fig,axes = plt.subplots(2,2,figsize=(16,10),sharey=True)
sns.scatterplot(x='attack', y='speed', data=df,ax=axes[0,0])
axes[0,0].set_title("Speed V/S Attack")
sns.scatterplot(x='defense', y='speed', data=df, ax=axes[0, 1])
axes[0,1].set_title("Speed V/S Defence")
sns.scatterplot(x='height_m', y='speed', data=df, ax=axes[1, 0])
axes[1,0].set_title("Speed V/S Height")
sns.scatterplot(x='weight_kg', y='speed', data=df, ax=axes[1, 1])
axes[1,1].set_title("Speed V/S Weight")
fig.suptitle("Speed Factor?", size=20)
plt.show()
```

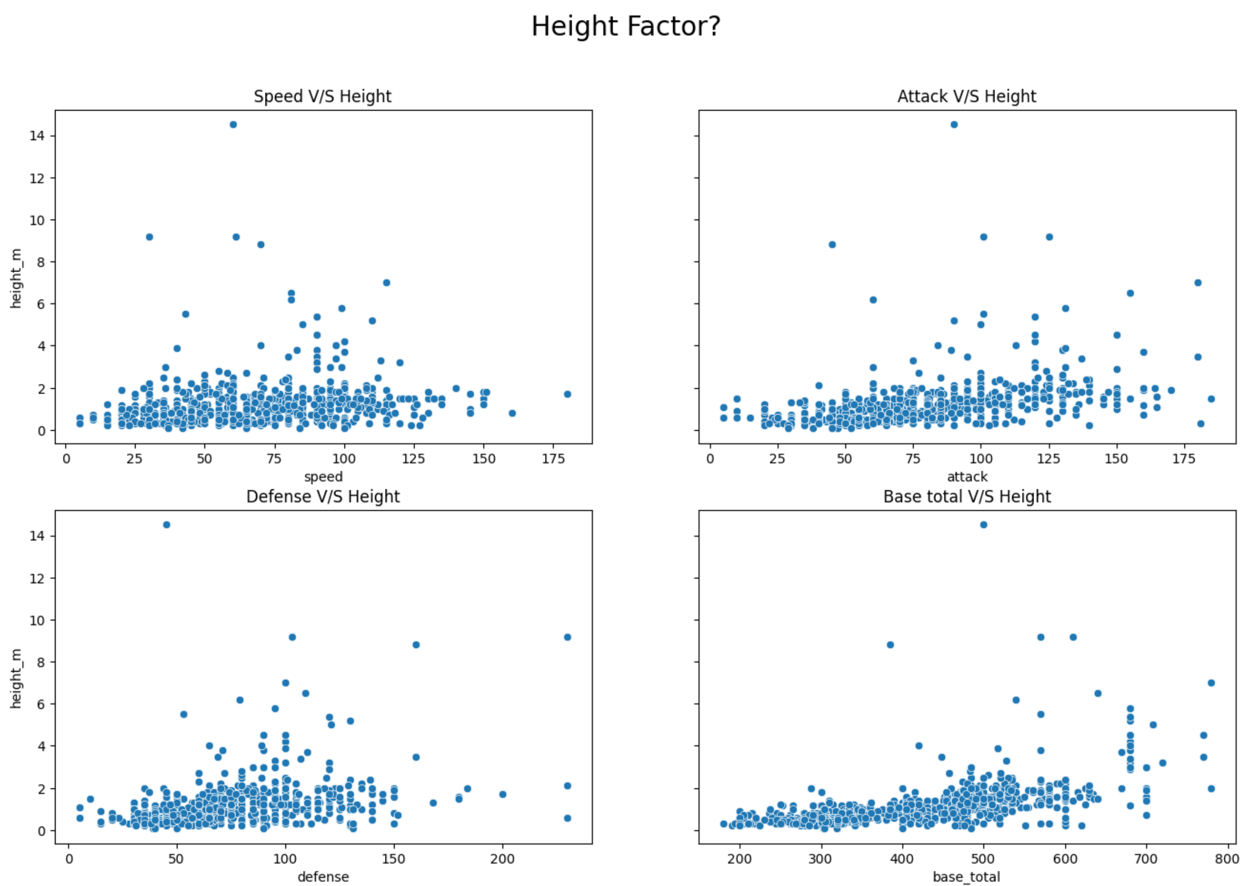


Insights from the above plots:

- For most pokemons, Attack capacity slightly depends on its speed
- For most pokemons, Defense also slightly depends on its speed
- Height of pokemons highly affects the speed (Less Height --> High speed)
- Weight of pokemons also affects the speed (Less Weight --> High speed)

6. How Height correlate with various base stats?

```
fig,axes = plt.subplots(2,2,figsize=(16,10),sharey=True)
sns.scatterplot(x='speed', y='height_m', data=df,ax=axes[0,0])
axes[0,0].set_title("Speed V/S Height")
sns.scatterplot(x='attack', y='height_m', data=df, ax=axes[0, 1])
axes[0,1].set_title("Attack V/S Height")
sns.scatterplot(x='defense', y='height_m', data=df, ax=axes[1, 0])
axes[1,0].set_title("Defense V/S Height")
sns.scatterplot(x='base_total', y='height_m', data=df, ax=axes[1, 1])
axes[1,1].set_title("Base total V/S Height")
fig.suptitle("Height Factor?", size=20)
plt.show()
```

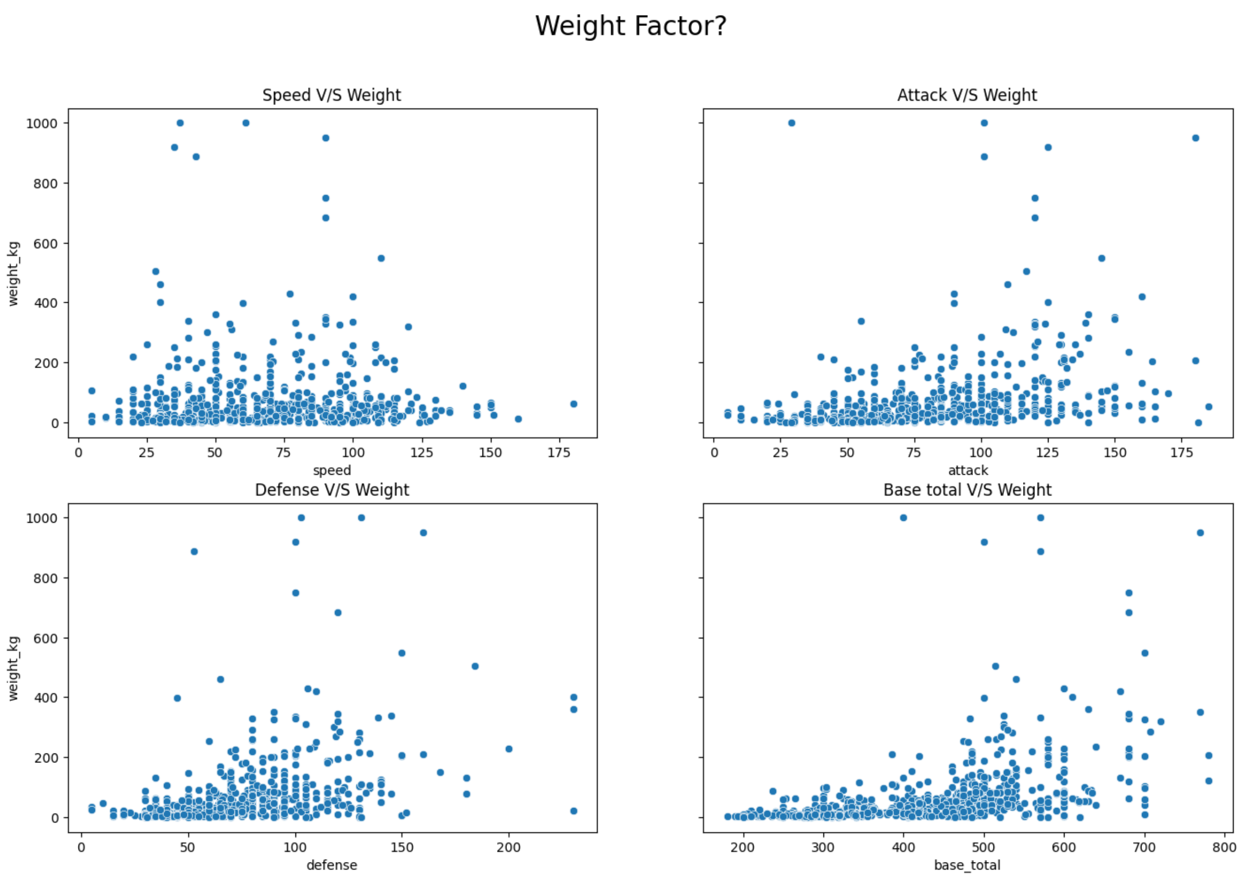


Insights from the above plots:

- Height of pokemons highly affects the speed (Less Height --> High speed)
- Height also highly affects attack capacity (less height --> high attack power)
- For most pokemons, Defense moderately correlates to Height
- Also, we can see that some pokemons with moderate height have high base total

7. How Weight correlate with various base stats?

```
fig,axes = plt.subplots(2,2,figsize=(16,10),sharey=True)
sns.scatterplot(x='speed', y='weight_kg', data=df,ax=axes[0,0])
axes[0,0].set_title("Speed V/S Weight")
sns.scatterplot(x='attack', y='weight_kg', data=df, ax=axes[0, 1])
axes[0,1].set_title("Attack V/S Weight")
sns.scatterplot(x='defense', y='weight_kg', data=df, ax=axes[1, 0])
axes[1,0].set_title("Defense V/S Weight")
sns.scatterplot(x='base_total', y='weight_kg', data=df, ax=axes[1, 1])
axes[1,1].set_title("Base total V/S Weight")
fig.suptitle("Weight Factor?", size=20)
plt.show()
```

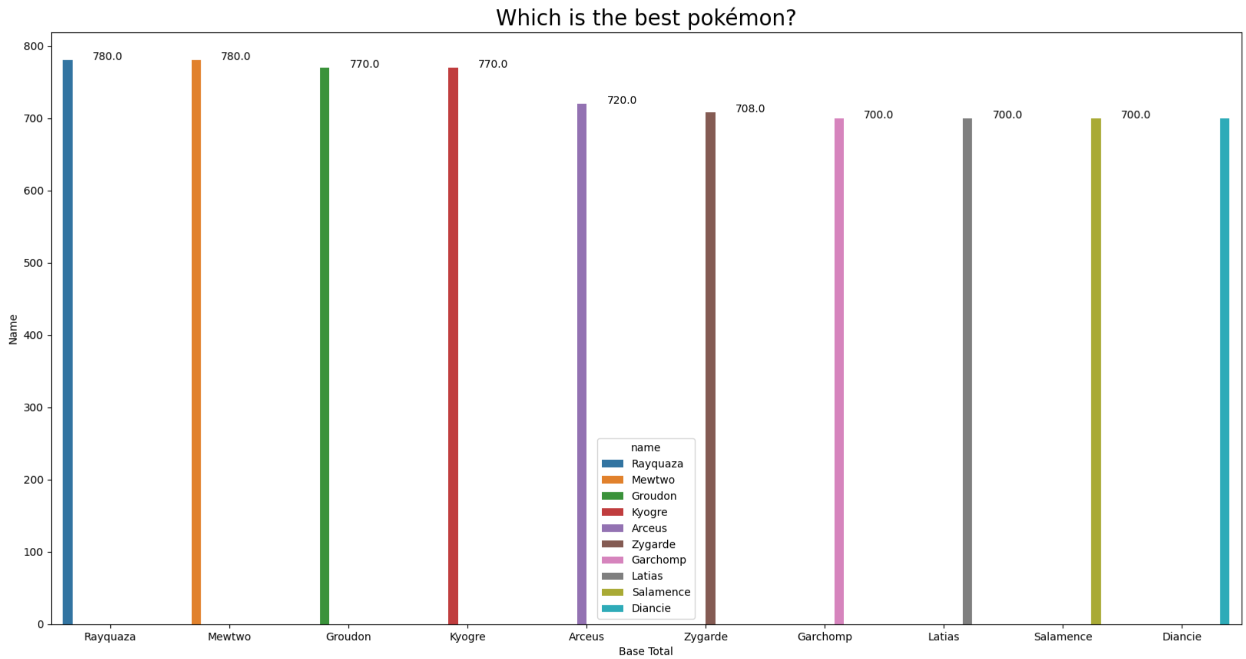


Insights from the above plots:

- High-weight pokemons are slower, while low-weight ones are faster. Some high-weight Pokemon have more speed, likely flying types.
- Heavyweight pokemons have better attack power,
- Moderate weight can increase defense strength
- A strong base total, weighing 100-200kgs, signifies a pokemon's strength.

8. Strongest Pokemon

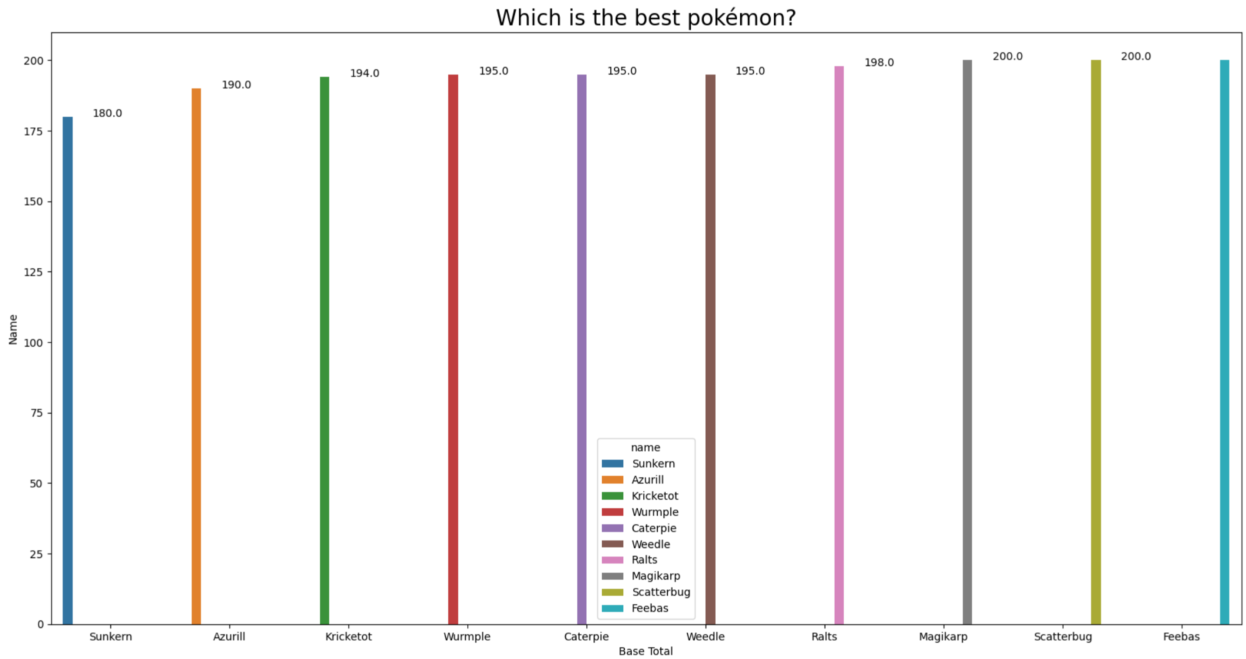
```
top10_pokemon_base_total = df.sort_values(by="base_total",
ascending=False).reset_index()[:10]
plt.figure(figsize=(20,10))
ax = sns.barplot(x=top10_pokemon_base_total["name"],
y=top10_pokemon_base_total["base_total"], orient='v',
hue=top10_pokemon_base_total["name"])
ax.set_title("Which is the best pokémon?", size=20)
ax.set(xlabel="Base Total", ylabel="Name")
for p in ax.patches:
    ax.annotate('{:.1f}'.format( p.get_height()), (p.get_x()+0.25,
p.get_height()+0.01))
```



SO, the strongest pokemons being Mewtwo, Rayquaza, followed by Groudon, Kyogre, and others.

9. Weakest Pokemon

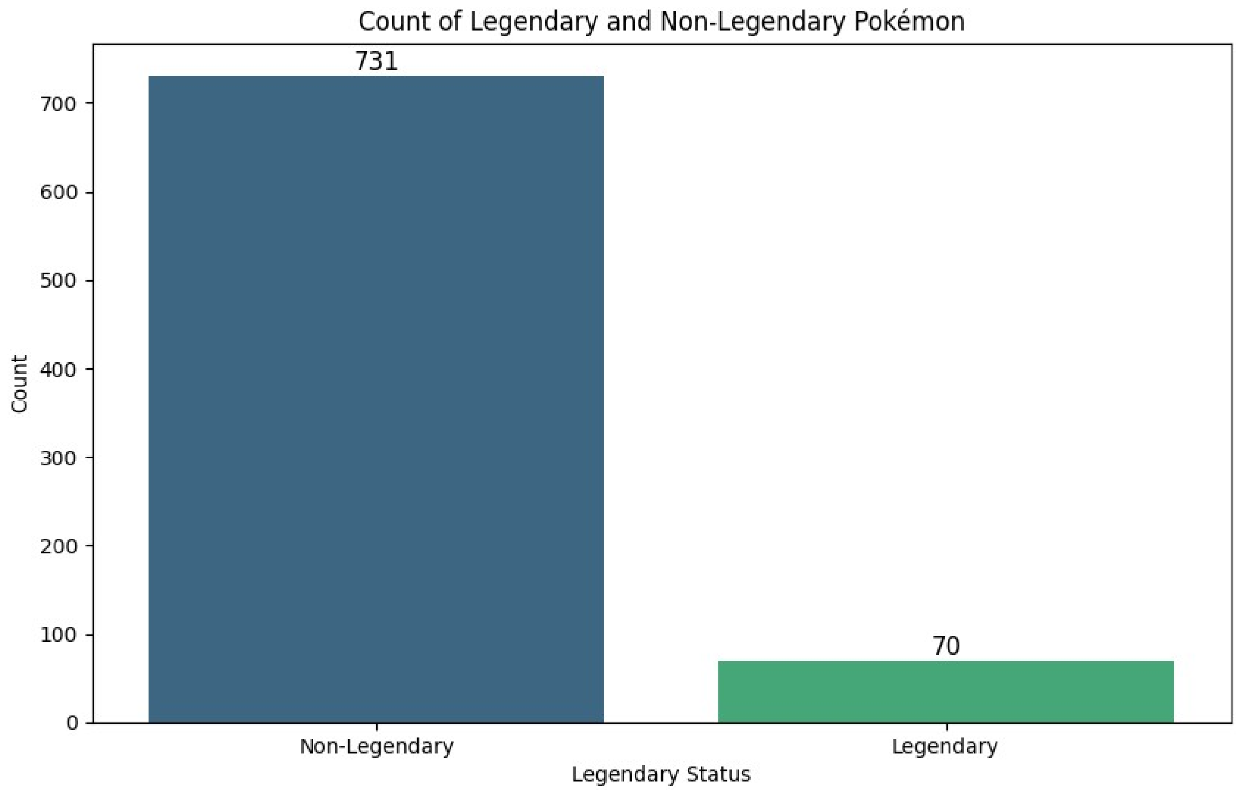
```
top10_pokemon_base_total = df.sort_values(by="base_total",
ascending=True).reset_index()[:10]
plt.figure(figsize=(20,10))
ax = sns.barplot(x=top10_pokemon_base_total["name"],
y=top10_pokemon_base_total["base_total"], orient='v',
hue=top10_pokemon_base_total["name"])
ax.set_title("Which is the best pokémon?", size=20)
ax.set(xlabel="Base Total", ylabel="Name")
for p in ax.patches:
    ax.annotate('{:.1f}'.format( p.get_height()), (p.get_x()+0.25,
p.get_height()+0.01))
```



So, the weakest pokemon is Sunkern, followed by Azurill, Kricketot, and others.

10. Count of legendary pokemons

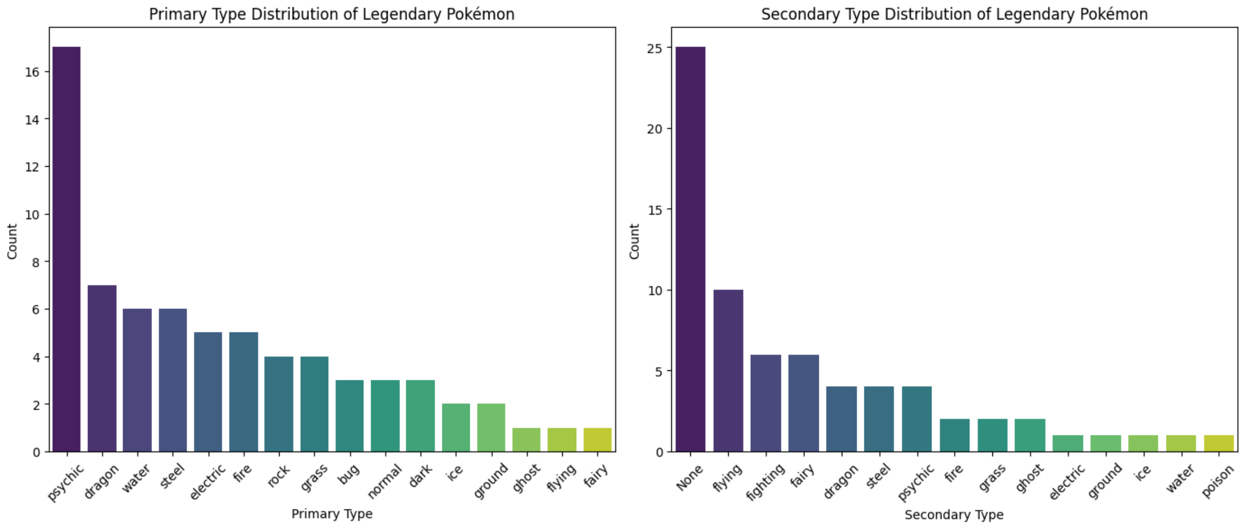
```
legendary_counts = df['is_legendary'].value_counts()

plt.figure(figsize=(10, 6))
bar = sns.barplot(x=legendary_counts.index, y=legendary_counts.values,
palette="viridis")
plt.xlabel('Legendary Status')
plt.ylabel('Count')
plt.title('Count of Legendary and Non-Legendary Pokémon')
plt.xticks(ticks=[0, 1], labels=['Non-Legendary', 'Legendary'])

for i in range(len(legendary_counts)):
    bar.text(i, legendary_counts.values[i] + 0.1,
legendary_counts.values[i], ha='center', va='bottom', fontsize=12)

plt.show()
```



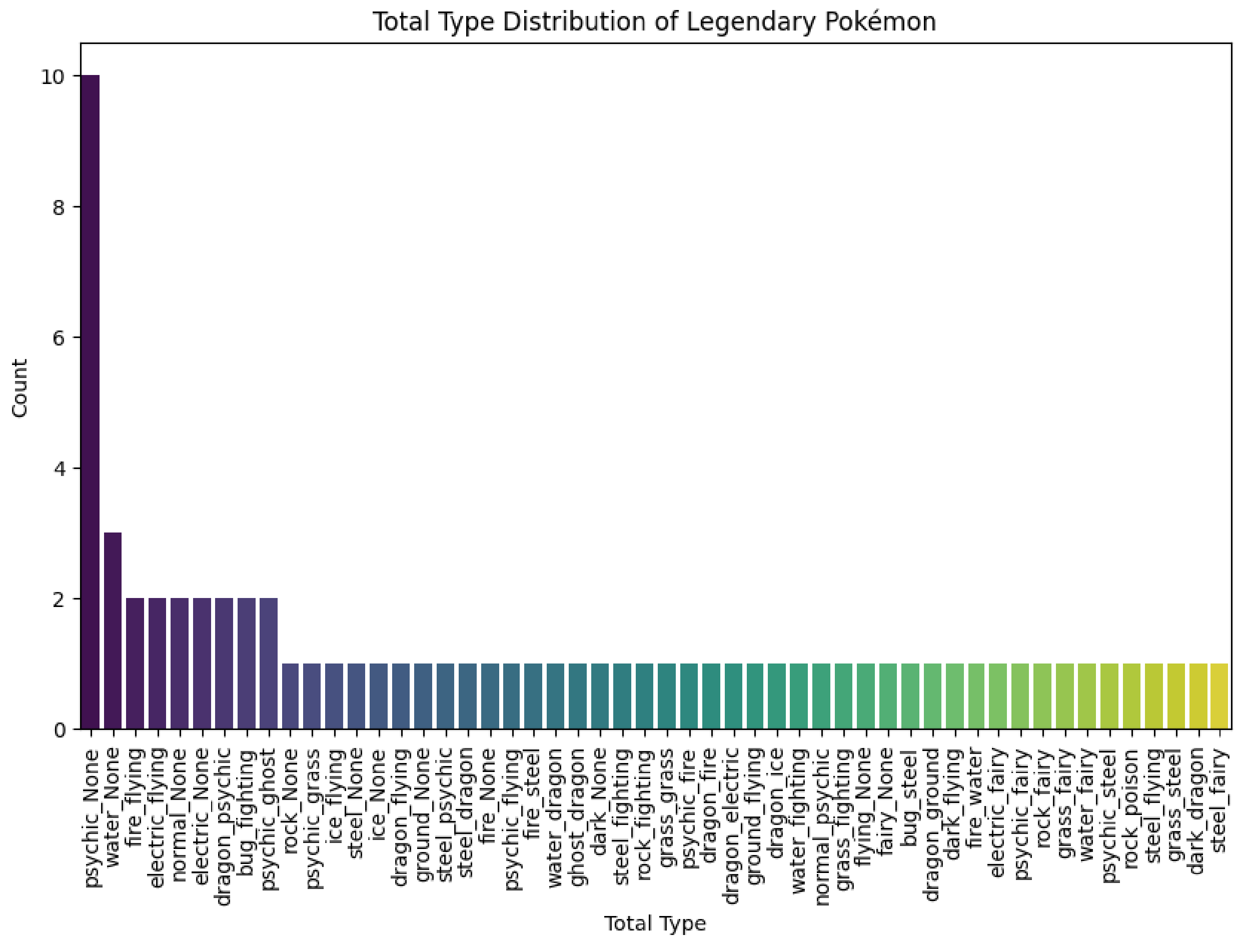
11. What is the most common type among legendary pokemons?

```
# Filter for legendary Pokémon
legendary_pokemon = df[df['is_legendary']==1]

# Count primary and secondary types
primary_type_counts = legendary_pokemon['primary type'].value_counts()
secondary_type_counts = legendary_pokemon['secondary
type'].value_counts(dropna=False)

# Plot the distribution of primary types
plt.figure(figsize=(14, 6))

plt.subplot(1, 2, 1)
sns.barplot(x=primary_type_counts.index, y=primary_type_counts.values,
palette="viridis")
plt.xlabel('Primary Type')
plt.ylabel('Count')
plt.title('Primary Type Distribution of Legendary Pokémon')
plt.xticks(rotation=45)

# Plot the distribution of secondary types
plt.subplot(1, 2, 2)
sns.barplot(x=secondary_type_counts.index,
y=secondary_type_counts.values, palette="viridis")
plt.xlabel('Secondary Type')
```

```
plt.ylabel('Count')
plt.title('Secondary Type Distribution of Legendary Pokémon')
plt.xticks(rotation=45)

# Adjust layout
plt.tight_layout()
plt.show()
```




```
# Filter for legendary Pokémon
legendary_pokemon = df[df['is_legendary'] == 1]

# Count occurrences of each total type
total_type_counts = legendary_pokemon['type'].value_counts()

# Plot the distribution of total types
plt.figure(figsize=(10, 6))
sns.barplot(x=total_type_counts.index, y=total_type_counts.values,
palette="viridis")
plt.xlabel('Total Type')
plt.ylabel('Count')
plt.title('Total Type Distribution of Legendary Pokémon')
plt.xticks(rotation=90)

# Display the plot
plt.show()
```



From above plots, we can derive multiple conclusions:

- If a pokemon have primary type as "psychic" then it has a very high chance of being a legendary pokemon.
- If a pokemon have secondary type as "flying" then it has a very high chance of being a legendary pokemon.
- If a pokemon have primary and secondary type as follows then it has a good chance of being a legendary pokemon as well:
  - Dragon and Psychic type
  - Fire and Flying type
  - Electric and Flying type
  - Psychic and Ghost type
  - Bug anf Fighting type

Classifying Legendary or not?

Selecting Features

```
featured_df = df[['attack', 'base_egg_steps', 'base_total','defense',
'experience_growth',
                  'height_m','hp',
'weight_kg','sp_attack','sp_defense','speed','tot_abilities',
                  'is_legendary']]
featured_df.head()
```

```
   attack  base_egg_steps  base_total  defense  experience_growth
height_m  \
0      49            5120         318       49            1059860
0.7
1      62            5120         405       63            1059860
1.0
2     100            5120         625      123            1059860
2.0
3      52            5120         309       43            1059860
0.6
4      64            5120         405       58            1059860
1.1

   hp  weight_kg  sp_attack  sp_defense  speed  tot_abilities
is_legendary
0  45        6.9         65          65     45             27
0
1  60       13.0         80          80     60             27
0
2  80      100.0        122         120     80             27
0
3  39        8.5         60          50     65             24
0
4  58       19.0         80          65     80             24
0
```

Splitting the data into train & test sets

```
X = featured_df.drop("is_legendary", axis=1)    # predictors
y = featured_df["is_legendary"]                 # target

# splitting the data
X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=42)

print(f"Train set:\t{len(y_train)}")
print(f"Test set:\t{len(y_test)}")
```

```
Train set: 640
Test set:  161
```

Standardize features

```python
# Standardize features
scaler = StandardScaler()

# Fit on training data
X_train = scaler.fit_transform(X_train)

# Apply transform to validation and test data
X_test = scaler.transform(X_test)
```

Model fitting and testing

```python
# Initialize models
classifiers = {
    'Gradient Boosting': GradientBoostingClassifier(),
    'Random Forest': RandomForestClassifier(),
    'AdaBoost': AdaBoostClassifier(),
    'Support Vector Machine': SVC(),
    'Linear SVM': LinearSVC(),
    'K-Nearest Neighbors': KNeighborsClassifier(),
    'Gaussian Naive Bayes': GaussianNB(),
    'Decision Tree': DecisionTreeClassifier(),
    'Logistic Regression': LogisticRegression(),
    'Stochastic Gradient Descent': SGDClassifier(),
    'Neural Network': MLPClassifier(hidden_layer_sizes=(100, 100),
max_iter=1000),
    'XGBoost': XGBClassifier()
}


# Loop through each classifier
for name, clf in classifiers.items():
    # Fit the model on the training set
    clf.fit(X_train, y_train)

    # Predict on the test set for final evaluation
    y_test_pred = clf.predict(X_test)

    # Evaluate performance on test set
    test_accuracy = accuracy_score(y_test, y_test_pred)
    test_report = classification_report(y_test, y_test_pred)

    # Print results
    print(f"Algorithm: {name}")
    print("Test Set Results:")
    print(f"Accuracy: {test_accuracy:.2f}")
    print(test_report)
    print("="*55)
```

```
Algorithm: Gradient Boosting
Test Set Results:
```

```
Accuracy: 0.99
              precision    recall  f1-score   support

           0       1.00      0.99      1.00       143
           1       0.95      1.00      0.97        18

    accuracy                           0.99       161
   macro avg       0.97      1.00      0.98       161
weighted avg       0.99      0.99      0.99       161

=======================================================
Algorithm: Random Forest
Test Set Results:
Accuracy: 0.99
              precision    recall  f1-score   support

           0       0.99      1.00      0.99       143
           1       1.00      0.89      0.94        18

    accuracy                           0.99       161
   macro avg       0.99      0.94      0.97       161
weighted avg       0.99      0.99      0.99       161

=======================================================
Algorithm: AdaBoost
Test Set Results:
Accuracy: 0.99
              precision    recall  f1-score   support

           0       1.00      0.99      1.00       143
           1       0.95      1.00      0.97        18

    accuracy                           0.99       161
   macro avg       0.97      1.00      0.98       161
weighted avg       0.99      0.99      0.99       161

=======================================================
Algorithm: Support Vector Machine
Test Set Results:
Accuracy: 0.98
              precision    recall  f1-score   support

           0       0.97      1.00      0.99       143
           1       1.00      0.78      0.88        18

    accuracy                           0.98       161
   macro avg       0.99      0.89      0.93       161
weighted avg       0.98      0.98      0.97       161

=======================================================
```

```
Algorithm: Linear SVM
Test Set Results:
Accuracy: 0.98
              precision    recall  f1-score   support

           0       0.98      1.00      0.99       143
           1       1.00      0.83      0.91        18

    accuracy                           0.98       161
   macro avg       0.99      0.92      0.95       161
weighted avg       0.98      0.98      0.98       161

=======================================================
Algorithm: K-Nearest Neighbors
Test Set Results:
Accuracy: 0.98
              precision    recall  f1-score   support

           0       0.98      1.00      0.99       143
           1       1.00      0.83      0.91        18

    accuracy                           0.98       161
   macro avg       0.99      0.92      0.95       161
weighted avg       0.98      0.98      0.98       161

=======================================================
Algorithm: Gaussian Naive Bayes
Test Set Results:
Accuracy: 0.98
              precision    recall  f1-score   support

           0       0.99      0.99      0.99       143
           1       0.89      0.89      0.89        18

    accuracy                           0.98       161
   macro avg       0.94      0.94      0.94       161
weighted avg       0.98      0.98      0.98       161

=======================================================
Algorithm: Decision Tree
Test Set Results:
Accuracy: 0.98
              precision    recall  f1-score   support

           0       0.99      0.99      0.99       143
           1       0.89      0.94      0.92        18

    accuracy                           0.98       161
   macro avg       0.94      0.97      0.95       161
weighted avg       0.98      0.98      0.98       161
```

```
=======================================================
Algorithm: Logistic Regression
Test Set Results:
Accuracy: 0.98
              precision    recall  f1-score   support

           0       0.98      1.00      0.99       143
           1       1.00      0.83      0.91        18

    accuracy                           0.98       161
   macro avg       0.99      0.92      0.95       161
weighted avg       0.98      0.98      0.98       161

=======================================================
Algorithm: Stochastic Gradient Descent
Test Set Results:
Accuracy: 0.96
              precision    recall  f1-score   support

           0       0.97      0.98      0.98       143
           1       0.82      0.78      0.80        18

    accuracy                           0.96       161
   macro avg       0.90      0.88      0.89       161
weighted avg       0.96      0.96      0.96       161

=======================================================
Algorithm: Neural Network
Test Set Results:
Accuracy: 0.98
              precision    recall  f1-score   support

           0       0.99      0.99      0.99       143
           1       0.89      0.89      0.89        18

    accuracy                           0.98       161
   macro avg       0.94      0.94      0.94       161
weighted avg       0.98      0.98      0.98       161

=======================================================
Algorithm: XGBoost
Test Set Results:
Accuracy: 0.98
              precision    recall  f1-score   support

           0       0.99      0.99      0.99       143
           1       0.94      0.89      0.91        18

    accuracy                           0.98       161
```

```
   macro avg       0.96      0.94      0.95       161
weighted avg       0.98      0.98      0.98       161

=======================================================
```

FOllowing is the comparison of models and their metrics such as accuracy, precision, recall, and F1-score.   Algorithm Accuracy Precision Recall F1-score   Class 0 Class 1 Class 0 Class 1 Class 0 Class 1   Gradient Boosting 0.99 1.00 0.95 0.99 1.00 1.00 0.97   Random Forest 0.99 0.99 1.00 1.00 0.89 0.99 0.94   AdaBoost 0.99 1.00 0.95 0.99 1.00 1.00 0.97   Support Vector Machine 0.98 0.97 1.00 1.00 0.78 0.99 0.88   Linear SVM 0.98 0.98 1.00 1.00 0.83 0.99 0.91   K-Nearest Neighbors 0.98 0.98 1.00 1.00 0.83 0.99 0.91   Gaussian Naive Bayes 0.98 0.99 0.89 0.99 0.89 0.99 0.89   Decision Tree 0.98 0.99 0.89 0.99 0.94 0.99 0.92   Logistic Regression 0.98 0.98 1.00 1.00 0.83 0.99 0.91   Stochastic Gradient Descent 0.96 0.97 0.82 0.98 0.78 0.98 0.80   Neural Network 0.98 0.99 0.89 0.99 0.89 0.99 0.89   XGBoost 0.98 0.99 0.94 0.99 0.89 0.99 0.91

END of Notebook