In [124]:

```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import MinMaxScaler, PolynomialFeatures
from sklearn.metrics import r2_score,mean_absolute_error, mean_squared_error
import numpy as np
from datetime import datetime
from sklearn.linear_model import LinearRegression, Ridge, Lasso, ElasticNet, BayesianRid
ge
from sklearn.tree import DecisionTreeRegressor
from sklearn.ensemble import GradientBoostingRegressor
from sklearn.model_selection import cross_validate, ShuffleSplit, train_test_split

from tqdm import tqdm
from scipy.signal import periodogram
```

We begin by loading data and displaying some information about the data

In [125]:

```
data = pd.read_csv('data/SeoulBikeData.csv')
data.describe().T
```

Out[125]:

	count	mean	std	min	25%	50%	75%	max
Rented Bike Count	8760.0	704.602055	644.997468	0.0	191.00	504.50	1065.25	3556.00
Hour	8760.0	11.500000	6.922582	0.0	5.75	11.50	17.25	23.00
Temperature	8760.0	12.882922	11.944825	-17.8	3.50	13.70	22.50	39.40
Humidity(%)	8760.0	58.226256	20.362413	0.0	42.00	57.00	74.00	98.00
Wind speed (m/s)	8760.0	1.724909	1.036300	0.0	0.90	1.50	2.30	7.40
Visibility (10m)	8760.0	1436.825799	608.298712	27.0	940.00	1698.00	2000.00	2000.00
Dew point temperature	8760.0	4.073813	13.060369	-30.6	-4.70	5.10	14.80	27.20
Solar Radiation (MJ/m2)	8760.0	0.569111	0.868746	0.0	0.00	0.01	0.93	3.52
Rainfall(mm)	8760.0	0.148687	1.128193	0.0	0.00	0.00	0.00	35.00
Snowfall (cm)	8760.0	0.075068	0.436746	0.0	0.00	0.00	0.00	8.80

In [126]:

```
data.head()
```

Out[126]:

	Date	Rented Bike Count	Hour	Temperature	Humidity(%)	Wind speed (m/s)	Visibility (10m)	Dew point temperature	Solar Radiation (MJ/m2)	Rainfall(mm)	Snowfall (cm)	Sea
0	01/12/2017	254	0	-5.2	37	2.2	2000	-17.6	0.0	0.0	0.0	W
1	01/12/2017	204	1	-5.5	38	0.8	2000	-17.6	0.0	0.0	0.0	W
2	01/12/2017	173	2	-6.0	39	1.0	2000	-17.7	0.0	0.0	0.0	W
3	01/12/2017	107	3	-6.2	40	0.9	2000	-17.6	0.0	0.0	0.0	W
4	01/12/2017	78	4	-6.0	36	2.3	2000	-18.6	0.0	0.0	0.0	W

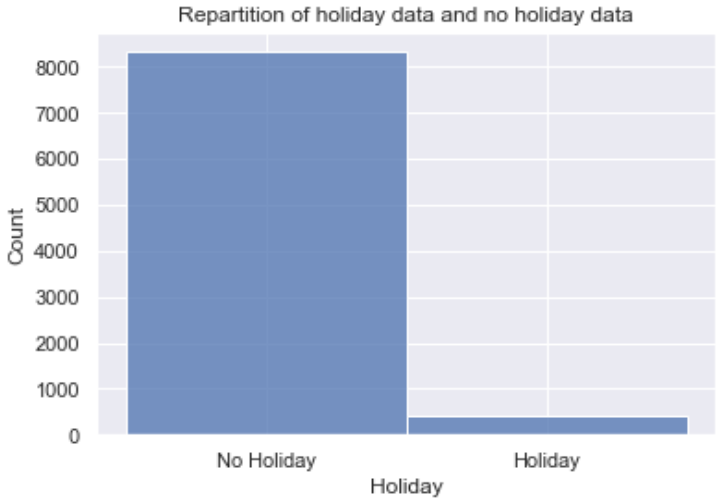
In [127]:

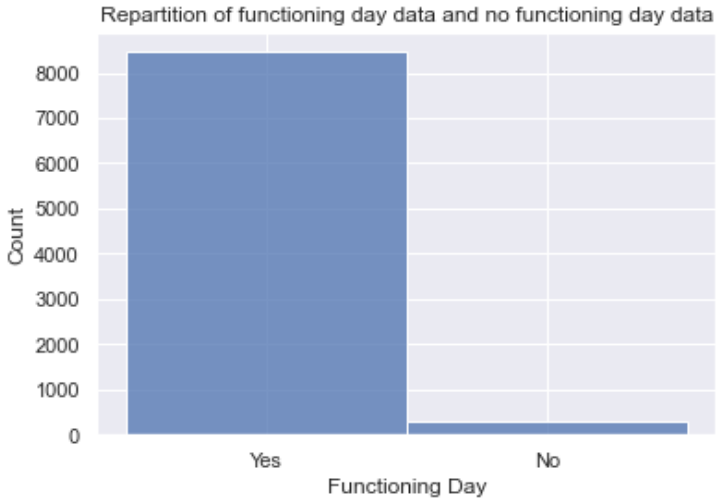
```
#No nan nor null values
nulls = data.isnull().sum()
nans = data.isna().sum()

print(nulls[nulls>0])
print(nans[nans>0])
```

```
Series([], dtype: int64)
Series([], dtype: int64)
```

In [128]:

```
sns.histplot(data=data, x='Holiday')
plt.title('Repartition of holiday data and no holiday data')
plt.show()
sns.histplot(data=data, x='Functioning Day')
plt.title('Repartition of functioning day data and no functioning day data')
plt.show()
```





We then display the correlation matrix in order to see correlation between input features et the number of rented bikes. To begin we pass the string data into numerical data

In [129]:

```
categories = ['Seasons', 'Holiday', 'Functioning Day']
for category in categories:
    data[category] = pd.Categorical(data[category]).codes
```

In [130]:

```
#We need to transform Date into features :
```

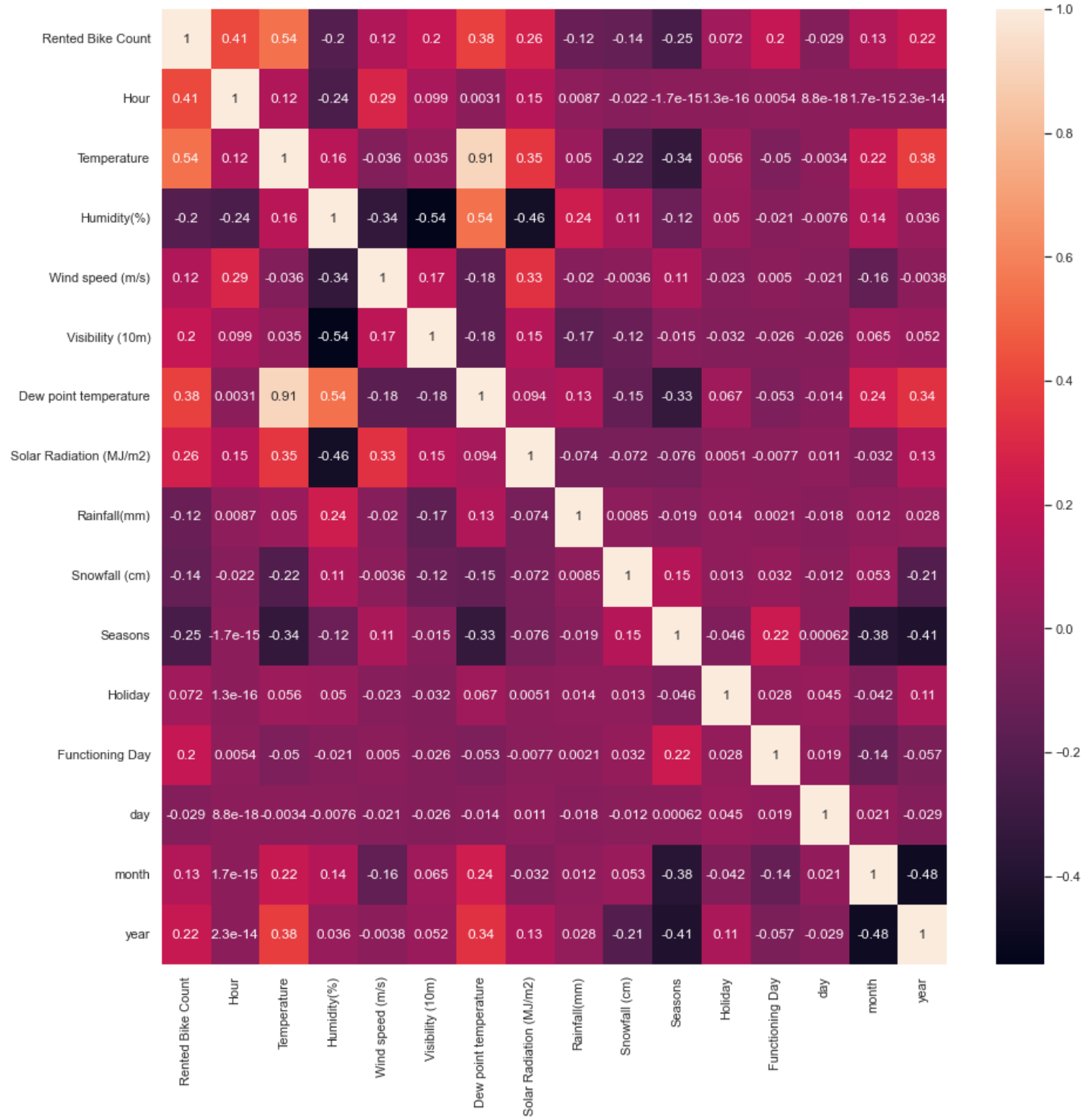
```
data['day'] = data['Date'].apply(lambda x : datetime.strptime(x,'%d/%m/%Y').weekday())
data['month'] = data['Date'].apply(lambda x : datetime.strptime(x,'%d/%m/%Y').month)
data['year'] = data['Date'].apply(lambda x : datetime.strptime(x,'%d/%m/%Y').year)
```

In [131]:

```
fig, ax = plt.subplots(figsize=(15,15))
sns.heatmap(data.corr(), annot=True,fmt=".2g", ax=ax)
```

Out[131]:

<AxesSubplot:>

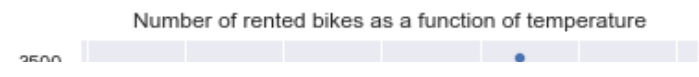


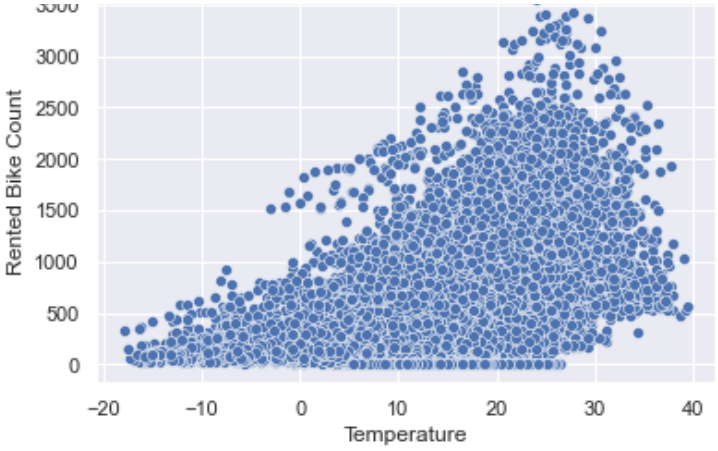
In [132]:

```
sns.scatterplot(data=data, y='Rented Bike Count', x='Temperature')
plt.title('Number of rented bikes as a function of temperature')
```

Out[132]:

Text(0.5, 1.0, 'Number of rented bikes as a function of temperature')



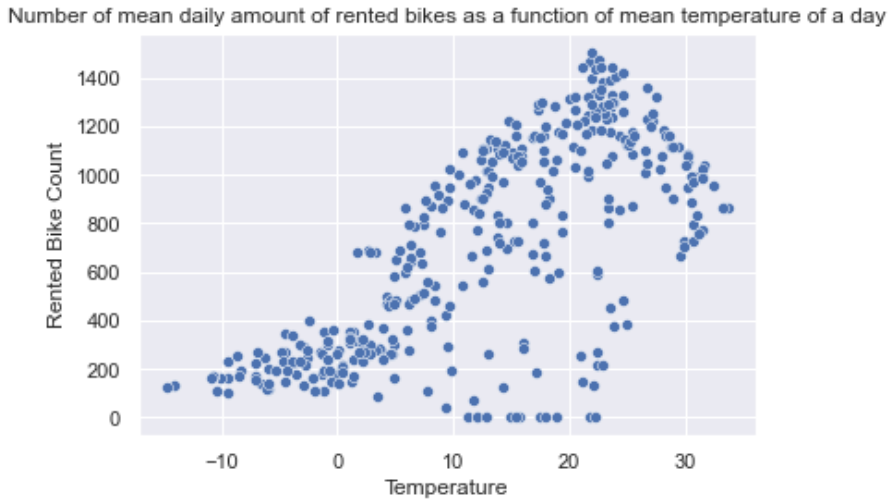


In [133]:

```
mean_per_day = data.groupby('Date').mean()
sns.scatterplot(data=mean_per_day, x="Temperature", y="Rented Bike Count")
plt.title('Number of mean daily amount of rented bikes as a function of mean temperature
of a day')
```

Out[133]:

```
Text(0.5, 1.0, 'Number of mean daily amount of rented bikes as a function of mean tempera
ture of a day')
```

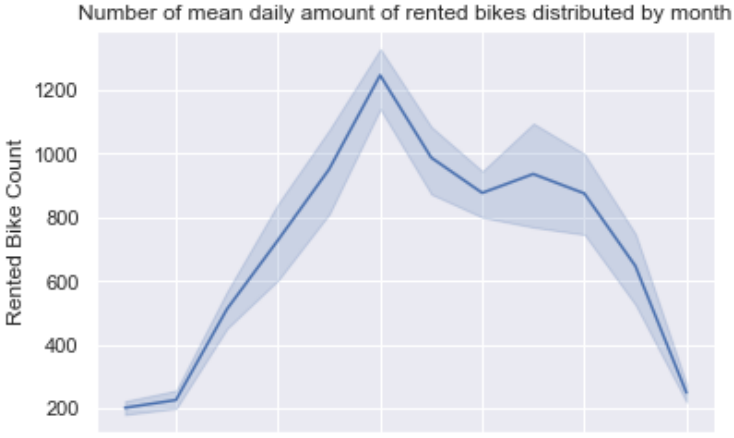


In [134]:

```
import seaborn as sns
sns.set_theme(style="darkgrid")
mean_per_day = data.groupby('Date').mean()
# Plot the responses for different events and regions
sns.lineplot(data=mean_per_day, x="month", y="Rented Bike Count")
plt.title('Number of mean daily amount of rented bikes distributed by month')
```

Out[134]:

```
Text(0.5, 1.0, 'Number of mean daily amount of rented bikes distributed by month')
```

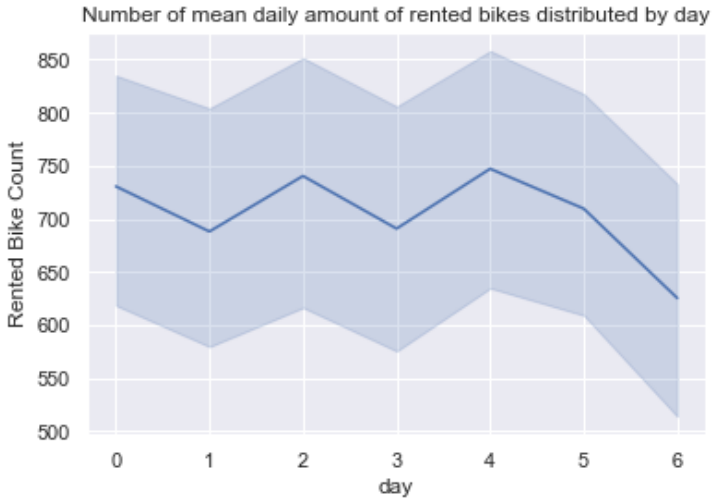


In [135]:

```
import seaborn as sns
sns.set_theme(style="darkgrid")
mean_per_day = data.groupby('Date').mean()
# Plot the responses for different events and regions
sns.lineplot(data=mean_per_day, x="day", y="Rented Bike Count")
plt.title('Number of mean daily amount of rented bikes distributed by day')
```

Out[135]:

```
Text(0.5, 1.0, 'Number of mean daily amount of rented bikes distributed by day')
```



In [136]:

```
data.drop(['Date'], axis='columns', inplace = True)
#date non utilisée après dans les regressions
```

In [137]:

```
#We perform one hot encoding for categorical features
distinct = data.nunique()
print(distinct)
cat_col = list(distinct[distinct<=12].index)
non_cat_feat = list(distinct[distinct>12].index)
data = pd.get_dummies(data, columns = cat_col, drop_first = True)
```

```
Rented Bike Count          2166
Hour                         24
Temperature                 546
Humidity(%)                  90
Wind speed (m/s)             65
Visibility (10m)           1789
Dew point temperature       556
Solar Radiation (MJ/m2)     345
Rainfall(mm)                 61
Snowfall (cm)                51
Seasons                       4
Holiday                       2
Functioning Day               2
day                           7
month                        12
year                          2
dtype: int64
```

In [138]:

```
non_cat_feat.remove('Rented Bike Count')
```

We scale data :

In [139]:

```
scaler_feat = MinMaxScaler()
data[non_cat_feat] = scaler_feat.fit_transform(data[non_cat_feat])

scaler_out = MinMaxScaler()
data['Rented Bike Count'] = scaler_out.fit_transform(data[['Rented Bike Count']])
```

We prepare data for future regression :

In [140]:

```
features = list(data.columns)
features.remove('Rented Bike Count')
```

In [141]:

```
x_data = data[features].to_numpy(dtype=np.float32)
y_data = data['Rented Bike Count'].to_numpy(dtype=np.float32)
```

In [142]:

```
poly_2 = PolynomialFeatures(2,include_bias=False)
x_poly_2 = poly_2.fit_transform(x_data)

poly_3 = PolynomialFeatures(3,include_bias=False)
x_poly_3 = poly_3.fit_transform(x_data)
```

We then perform a grid search in order to search for the best model and the best hyperparameters :

In [143]:

```
def test_model(model, X, score):
    cv = ShuffleSplit(n_splits=5, test_size=0.2)
    cv_results = cross_validate(model, X, y_data, cv=cv, scoring=score, return_train_sco
re=True)['test_score']
    mean_cv = cv_results
    return mean_cv
```

In [144]:

```
print('Takes approximately 40 seconds')
results = []
models = {'Linear': LinearRegression, 'Ridge': Ridge, 'Lasso': Lasso, 'Elastic Net': Ela
sticNet, 'Decision tree' : DecisionTreeRegressor, 'Gradient Boosting' : GradientBoosting
Regressor}
x_values = {'Degree 1': x_data, 'Degree 2': x_poly_2, 'Degree 3' : x_poly_3}

for x in x_values:
    for model in models:
        new_model = models[model]
        if not (x=='Degree 3' and model=='Linear'):
            if (x=='Degree 3' and model=='Decision tree') or (x=='Degree 2' and model=='
Decision tree'):
                pass
            elif (x=='Degree 3' and model=='Gradient Boosting') or (x=='Degree 2' and mo
del=='Gradient Boosting'):
                pass
            else:
                mean= test_model(models[model](), x_values[x], 'neg_mean_squared_error')
                results += [[model, x, -el_mean] for el_mean in mean]

results = pd.DataFrame(results, columns = ['Model', 'Degree', 'MSE'])
```

```
Takes approximately 40 seconds
```

In [145]:

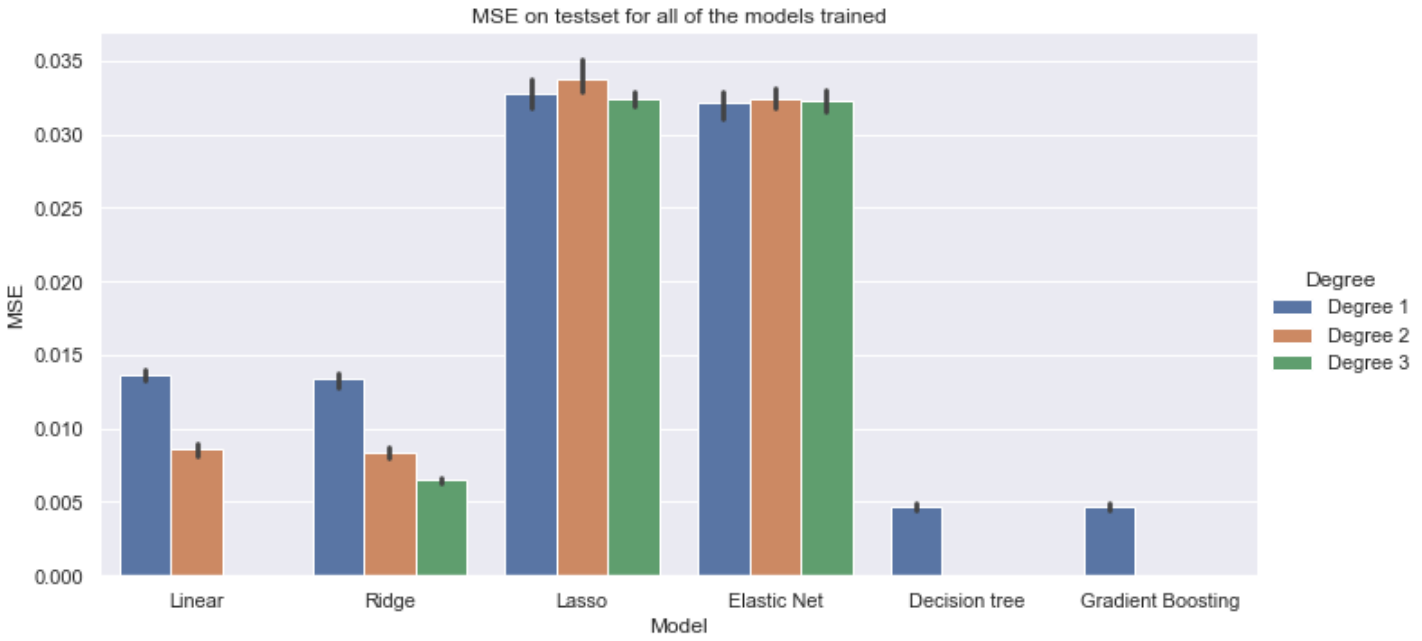
```
sns.catplot(x='Model', y="MSE", hue='Degree', kind="bar", size=5, aspect=2, data=results
```

```
)
plt.title('MSE on testset for all of the models trained')
```

```
C:\Users\nicol\AppData\Roaming\Python\Python37\site-packages\seaborn\categorical.py:3750:
UserWarning: The `size` parameter has been renamed to `height`; please update your code.
  warnings.warn(msg, UserWarning)
```

Out[145]:

```
Text(0.5, 1.0, 'MSE on testset for all of the models trained')
```

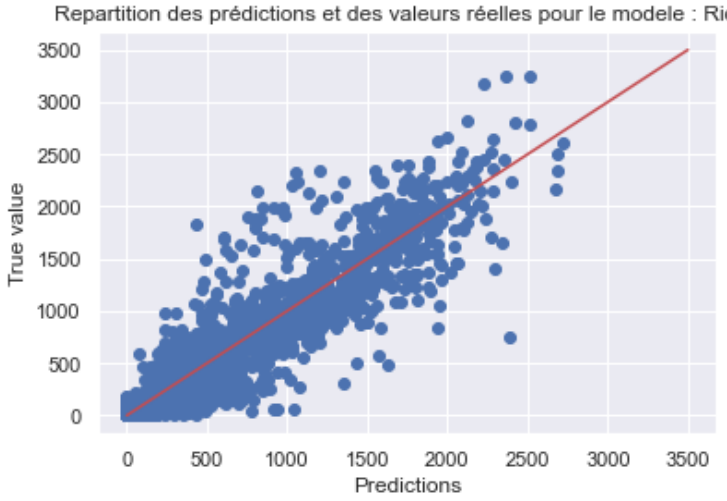


We study more in depth the three best models found :

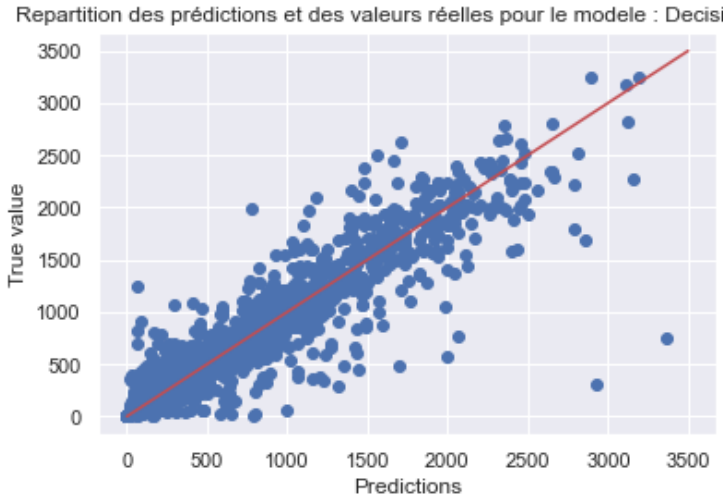
In [146]:

```
x_train, x_test, y_train, y_test = train_test_split(x_data,y_data,test_size=0.2)
models = {'Ridge' : Ridge, 'Decision Tree' : DecisionTreeRegressor, 'GradientBoosting' :
GradientBoostingRegressor}

def test_model(model, model_name, degree=1):
    if degree!=1:
        poly = PolynomialFeatures(degree, include_bias=False)
        x_tr = poly.fit_transform(x_train)
        x_te = poly.fit_transform(x_test)
    else:
        x_tr = x_train
        x_te = x_test

    model.fit(x_tr, y_train)
    pred = model.predict(x_te).reshape(-1,1)
    true = y_test.reshape(-1,1)

    real_pred = scaler_out.inverse_transform(pred).clip(min=0)
    real_true = scaler_out.inverse_transform(true)

    plt.scatter(real_pred,real_true)
    plt.xlabel('Predictions')
    plt.ylabel('True value')

    plt.plot([0,3500],[0,3500], color='r')
    plt.title('Repartition des prédictions et des valeurs réelles pour le modele : ' + mo
del_name)
    plt.show()
    print('MAE : ', mean_absolute_error(real_pred, real_true))
    print('MSE : ', mean_squared_error(real_pred, real_true))

for model in models:
    if model=='Ridge':
        test_model(models[model](), degree=3, model_name = model)
    else:
```

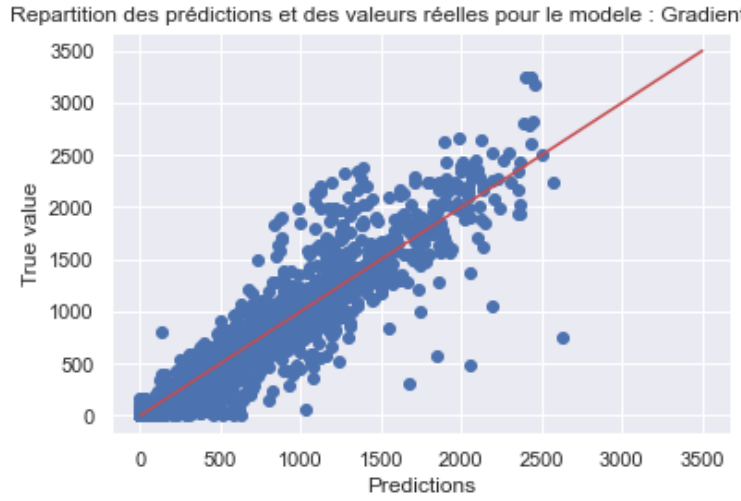
```
test_model(models[model](), degree=1, model_name = model)
```




```
MAE :  186.22029
MSE :  77083.25
```




```
MAE :  129.9874430394687
MSE :  54158.65406505413
```




```
MAE :  158.1855717831683
MSE :  58809.840246185646
```