In [1]:

```
import numpy as np
import pandas as pd
import time
from datetime import datetime
from tqdm import tqdm_notebook as tqdm
from matplotlib import pyplot as plt
from sklearn import preprocessing
from scipy import stats
from sklearn.ensemble import RandomForestRegressor
from sklearn.model_selection import train_test_split
from sklearn.metrics import auc, roc_curve, roc_auc_score, accuracy_score, precision_score, recall_score, f1_score
from sklearn.model_selection import cross_val_score
from sklearn.metrics import confusion_matrix
import datetime as dt
from sklearn import linear_model
from sklearn.metrics import mean_squared_error, r2_score
from sklearn.model_selection import RandomizedSearchCV
```

Data Reading:

In [2]:

```python
df_consumption = pd.read_csv("updated_new_consumption.csv")

print(df_consumption.shape)
df_consumption.head()
```

```
(17034, 50)
```

Out[2]:

	meter_id	date	T1	T2	T3	T4	T5	T6	T7	T8	...	T39	T40	T41	T42	T43	T44	T45	T46	T47	T4
0	0x3efe28fb93c72bebc9cfa41bea027f67ff26470f	2017-01-01	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	Na
1	0x3efe28fb93c72bebc9cfa41bea027f67ff26470f	2017-01-02	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	Na
2	0x3efe28fb93c72bebc9cfa41bea027f67ff26470f	2017-01-03	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	Na
3	0x3efe28fb93c72bebc9cfa41bea027f67ff26470f	2017-01-04	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	Na
4	0x3efe28fb93c72bebc9cfa41bea027f67ff26470f	2017-01-05	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	Na

5 rows × 50 columns

In [3]:

```python
df_weather_avg = pd.read_csv("new_weather_avg.csv")

print(df_weather_avg.shape)
df_weather_avg.head()
```

```
(51, 366)
```

Out[3]:

	meter_id	2017-01-01	2017-01-02	2017-01-03	2017-01-04	2017-01-05	2017-01-06	2017-01-07	2017-01-08	2017-01-09	...	2017-12-22	2017-
0	0x3370de120048d9de744f88357b61d1e8225b0ce5	5.370833	1.529167	3.045833	4.341667	0.670833	1.812500	6.745833	7.691667	6.841667	...	8.612500	7.9833
1	0xed796ea8cc6535eff1a9afa08a28a096b309b784	5.200000	1.670833	3.300000	5.354167	0.725000	1.450000	6.695833	7.566667	6.670833	...	8.620833	7.9833
2	0xb9c600842cb2d195d461d675f2758ddbf5bb45bb	4.729167	1.425000	3.475000	4.883333	1.366667	3.095833	7.016667	7.833333	6.891667	...	8.737500	7.9083
3	0x0a68e0f81509913d6b6bbfa3ad2fc63df28eca34	4.458333	1.795833	3.983333	5.070833	1.412500	2.570833	7.262500	7.462500	6.395833	...	8.862500	8.1666
4	0x78a812ecd87a4b945e0d262aec41e0eb2b59fe1e	4.458333	1.795833	3.983333	5.070833	1.412500	2.570833	7.262500	7.462500	6.395833	...	8.862500	8.1666

5 rows × 366 columns

In [4]:

```python
df_weather_max = pd.read_csv("new_weather_max.csv")

print(df_weather_max.shape)
df_weather_max.head()
```

```
(51, 366)
```

Out[4]:

	meter_id	2017-01-01	2017-01-02	2017-01-03	2017-01-04	2017-01-05	2017-01-06	2017-01-07	2017-01-08	2017-01-09	...	2017-12-22	2017-12-23	2017-12-24	2017-12-25	2017-12-26	2017-12-27	201 12-2
0	0x3370de120048d9de744f88357b61d1e8225b0ce5	7.3	3.8	5.9	6.6	4.7	4.8	8.0	9.2	8.9	...	10.3	8.8	10.2	10.7	6.1	3.6	3
1	0xed796ea8cc6535eff1a9afa08a28a096b309b784	7.4	3.9	6.9	7.2	4.1	5.3	8.1	9.1	9.0	...	10.3	9.0	11.1	11.1	6.4	3.6	4
2	0xb9c600842cb2d195d461d675f2758ddbf5bb45bb	7.7	3.6	6.9	7.1	4.3	5.0	8.5	8.5	9.1	...	10.8	8.8	11.0	10.9	5.3	2.8	4
3	0x0a68e0f81509913d6b6bbfa3ad2fc63df28eca34	7.5	4.4	7.0	7.0	5.8	5.3	9.3	8.8	8.6	...	11.2	9.2	11.2	10.8	5.6	2.7	4
4	0x78a812ecd87a4b945e0d262aec41e0eb2b59fe1e	7.5	4.4	7.0	7.0	5.8	5.3	9.3	8.8	8.6	...	11.2	9.2	11.2	10.8	5.6	2.7	4

5 rows × 366 columns

In [5]:

```
df_weather_min = pd.read_csv("new_weather_min.csv")

print(df_weather_min.shape)
df_weather_min.head()
```

```
(51, 366)
```

Out[5]:

	meter_id	2017-01-01	2017-01-02	2017-01-03	2017-01-04	2017-01-05	2017-01-06	2017-01-07	2017-01-08	2017-01-09	...	2017-12-22	2017-12-23	2017-12-24	2017-12-25	2017-12-26	2017-12-27	201 12-2
0	0x3370de120048d9de744f88357b61d1e8225b0ce5	1.3	-0.1	-0.2	1.0	-1.5	-0.7	5.0	6.6	3.1	...	7.2	7.1	7.3	8.7	2.7	0.6	-0
1	0xed796ea8cc6535eff1a9afa08a28a096b309b784	1.3	0.0	-2.0	1.9	-1.3	-2.1	5.3	5.7	3.0	...	4.7	5.4	8.3	6.2	2.9	0.1	-0
2	0xb9c600842cb2d195d461d675f2758ddbf5bb45bb	1.0	0.0	-0.4	1.9	-0.5	-0.6	5.0	7.4	3.5	...	7.2	7.1	8.2	4.8	2.5	-0.5	-2
3	0x0a68e0f81509913d6b6bbfa3ad2fc63df28eca34	2.0	-0.1	-0.6	1.4	-0.4	-0.8	4.6	5.6	3.6	...	7.7	7.2	8.0	4.0	2.2	-0.4	-0
4	0x78a812ecd87a4b945e0d262aec41e0eb2b59fe1e	2.0	-0.1	-0.6	1.4	-0.4	-0.8	4.6	5.6	3.6	...	7.7	7.2	8.0	4.0	2.2	-0.4	-0

5 rows × 366 columns

In [6]:

```
df_addInfo = pd.read_csv("new_addInfo.csv")

print(df_addInfo.shape)
df_addInfo.head()
```

```
(51, 24)
```

Out[6]:

	meter_id	dwelling_type	num_occupants	num_bedrooms	heating_fuel	hot_water_fuel	boiler_age	loft_insulatior
0	0xbae5a5527aff4b4b8035e960c5eaaf848e7c8c92	bungalow	2.0	3	gas	gas	new	y
1	0xd030a4ef9685df3c4c5188d6e74b6d90a7dbf166	semi_detached_house	2.0	3	gas	gas	new	y
2	0x748cad7867e108022b8692e6cf833b2e09efa5df	semi_detached_house	2.0	3	gas	gas	old	y
3	0xd1bc7d3545fda93a6a0bacd6c5b5a02005f3d8e1	flat	2.0	1	elec	elec	old	r
4	0x72ec271fda14656d74e0c2445b80e76f8d194e76	detached_house	2.0	4	gas	gas	new	y

5 rows × 24 columns

Remove missing from dataset

In [7]:

```
df_consumption.dropna(inplace=True)
df_weather_avg.dropna(inplace=True)
df_weather_min.dropna(inplace=True)
df_weather_max.dropna(inplace=True)
df_addInfo.dropna(inplace=True)
```

Join Datasets

In [8]:

```
#convert weather df to a joinable format

start = datetime(2017, 1, 1)
end = datetime(2017, 12, 31)
date_range = pd.date_range(start, end)

ed_df_weather_min = pd.DataFrame(columns=["meter_id", "date", "min_temper"])

for meter_idx in tqdm(df_weather_min["meter_id"].values):

    df_meter_idx = pd.DataFrame(columns=["meter_id", "date", "min_temper"])
    df_meter_idx["date"] = date_range
    df_meter_idx["meter_id"] = meter_idx
    #print(meter_idx)
    df_meter_idx["min_temper"] = df_weather_min[df_weather_min.meter_id == meter_idx].stack().values[1:].astype(float)

    ed_df_weather_min = pd.concat([ed_df_weather_min, df_meter_idx]).reset_index(drop=True)

ed_df_weather_min = ed_df_weather_min.sort_values(["meter_id", "date"]).reset_index(drop=True)
#df_train["meter_reading"] = df_train["min_temper"]
print(ed_df_weather_min.shape)
ed_df_weather_min.head()
```

```
100% 50/50 [00:00<00:00, 151.79it/s]
```

```
(18250, 3)
```

Out[8]:

	meter_id	date	min_temper
0	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-01	4.5
1	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-02	-0.7
2	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-03	-1.5
3	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-04	0.8
4	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-05	-2.5

In [9]:

```
ed_df_weather_min["date"] = pd.to_datetime(ed_df_weather_min["date"])
df_consumption["date"] = pd.to_datetime(df_consumption["date"])
df_consumption_min = df_consumption.merge(ed_df_weather_min, on=['meter_id', 'date'], how='left', indicator=False)
df_consumption_min.head()
```

Out[9]:

	meter_id	date	T1	T2	T3	T4	T5	T6	T7	T8	...	T40	T41	T42	T43	T44	T45	T46
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	0.327	0.494	0.364	0.437	0.434	0.420	0.375
1	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-03	0.149	0.145	0.133	0.128	0.145	0.148	0.131	0.149	...	0.292	0.260	0.239	0.239	0.238	0.245	0.276
2	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-04	0.150	0.133	0.145	0.138	0.124	0.150	0.129	0.152	...	0.977	0.540	0.385	0.351	0.914	0.393	1.119
3	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-05	0.165	0.185	0.204	0.177	0.170	0.184	0.174	0.185	...	0.360	0.299	0.295	0.332	0.318	0.369	0.378
4	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-06	0.151	0.148	0.148	0.139	0.131	0.148	0.144	0.140	...	1.079	0.751	0.571	0.320	0.326	0.321	0.293

5 rows × 51 columns

In [10]:

```
#convert weather df to a joinable format

start = datetime(2017, 1, 1)
end = datetime(2017, 12, 31)
date_range = pd.date_range(start, end)

ed_df_weather_max = pd.DataFrame(columns=["meter_id", "date", "max_temper"])

for meter_idx in tqdm(df_weather_max["meter_id"].values):

    df_meter_idx = pd.DataFrame(columns=["meter_id", "date", "max_temper"])
    df_meter_idx["date"] = date_range
    df_meter_idx["meter_id"] = meter_idx
    #print(meter_idx)
    df_meter_idx["max_temper"] = df_weather_max[df_weather_max.meter_id == meter_idx].stack().values[1:].astype(float)

    ed_df_weather_max = pd.concat([ed_df_weather_max, df_meter_idx]).reset_index(drop=True)

ed_df_weather_max = ed_df_weather_max.sort_values(["meter_id", "date"]).reset_index(drop=True)
#df_train["meter_reading"] = df_train["min_temper"]
print(ed_df_weather_max.shape)
ed_df_weather_max.head()
```

```
100% 50/50 [00:00<00:00, 156.76it/s]
```

```
(18250, 3)
```

Out[10]:

	meter_id	date	max_temper
0	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-01	9.7
1	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-02	5.4
2	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-03	5.5
3	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-04	7.8
4	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-05	5.3

In [11]:

```
ed_df_weather_max["date"] = pd.to_datetime(ed_df_weather_max["date"])
df_consumption_min["date"] = pd.to_datetime(df_consumption_min["date"])
df_consumption_min_max = df_consumption_min.merge(ed_df_weather_max, on=['meter_id', 'date'], how='left', indicator=False)
df_consumption_min_max.head()
```

Out[11]:

	meter_id	date	T1	T2	T3	T4	T5	T6	T7	T8	...	T41	T42	T43	T44	T45	T46	T47
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	0.494	0.364	0.437	0.434	0.420	0.375	0.288
1	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-03	0.149	0.145	0.133	0.128	0.145	0.148	0.131	0.149	...	0.260	0.239	0.239	0.238	0.245	0.276	0.278
2	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-04	0.150	0.133	0.145	0.138	0.124	0.150	0.129	0.152	...	0.540	0.385	0.351	0.914	0.393	1.119	0.707
3	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-05	0.165	0.185	0.204	0.177	0.170	0.184	0.174	0.185	...	0.299	0.295	0.332	0.318	0.369	0.378	0.272
4	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-06	0.151	0.148	0.148	0.139	0.131	0.148	0.144	0.140	...	0.751	0.571	0.320	0.326	0.321	0.293	0.176

5 rows × 52 columns

In [12]:

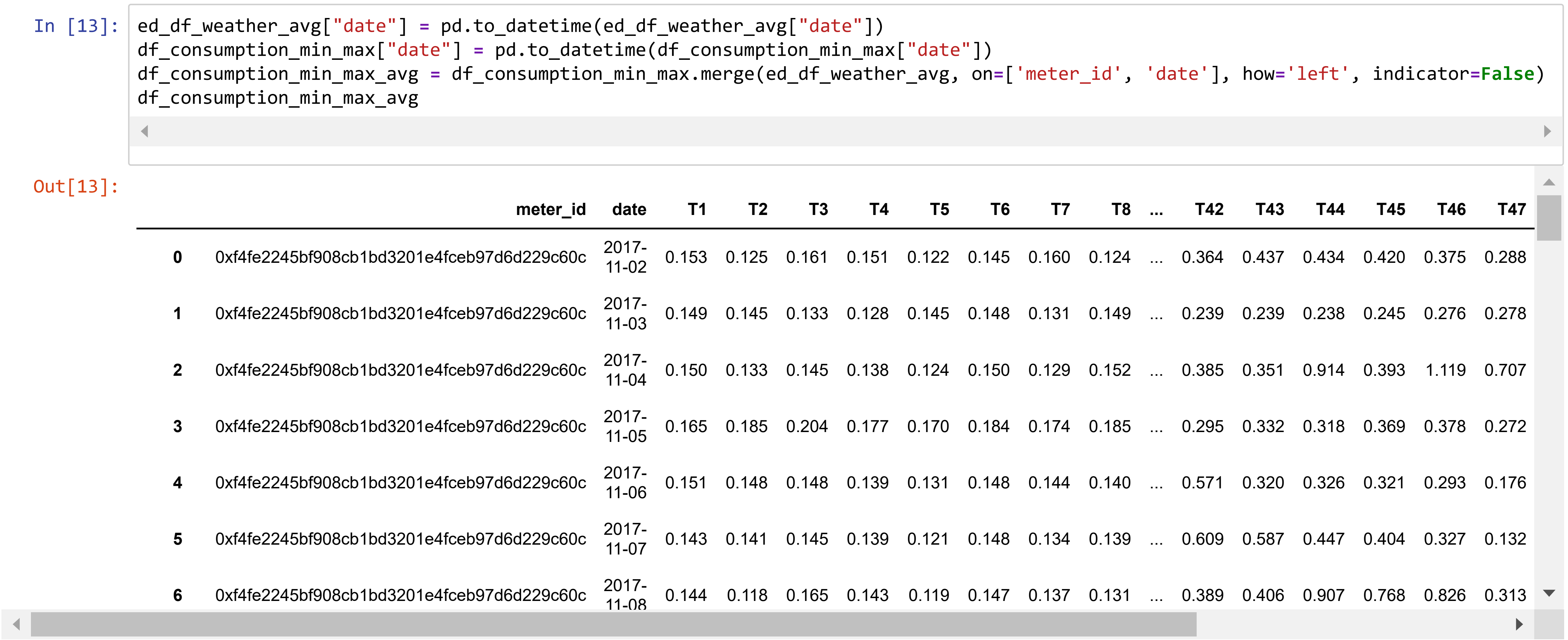
```
#convert weather df to a joinable format

start = datetime(2017, 1, 1)
end = datetime(2017, 12, 31)
date_range = pd.date_range(start, end)

ed_df_weather_avg = pd.DataFrame(columns=["meter_id", "date", "avg_temper"])

for meter_idx in tqdm(df_weather_avg["meter_id"].values):

    df_meter_idx = pd.DataFrame(columns=["meter_id", "date", "avg_temper"])
    df_meter_idx["date"] = date_range
    df_meter_idx["meter_id"] = meter_idx
    #print(meter_idx)
    df_meter_idx["avg_temper"] = df_weather_avg[df_weather_avg.meter_id == meter_idx].stack().values[1:].astype(float)

    ed_df_weather_avg = pd.concat([ed_df_weather_avg, df_meter_idx]).reset_index(drop=True)

ed_df_weather_avg = ed_df_weather_avg.sort_values(["meter_id", "date"]).reset_index(drop=True)
#df_train["meter_reading"] = df_train["min_temper"]
print(ed_df_weather_avg.shape)
ed_df_weather_avg.head()
```

```
100% 50/50 [00:00<00:00, 152.13it/s]
```

```
(18250, 3)
```

Out[12]:

	meter_id	date	avg_temper
0	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-01	6.350000
1	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-02	2.604167
2	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-03	1.704167
3	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-04	4.745833
4	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-05	0.145833



```python
ed_df_weather_avg["date"] = pd.to_datetime(ed_df_weather_avg["date"])
df_consumption_min_max["date"] = pd.to_datetime(df_consumption_min_max["date"])
df_consumption_min_max_avg = df_consumption_min_max.merge(ed_df_weather_avg, on=['meter_id', 'date'], how='left', indicator=False)
df_consumption_min_max_avg
```

	meter_id	date	T1	T2	T3	T4	T5	T6	T7	T8	...	T42	T43	T44	T45	T46	T47
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	0.364	0.437	0.434	0.420	0.375	0.288
1	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-03	0.149	0.145	0.133	0.128	0.145	0.148	0.131	0.149	...	0.239	0.239	0.238	0.245	0.276	0.278
2	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-04	0.150	0.133	0.145	0.138	0.124	0.150	0.129	0.152	...	0.385	0.351	0.914	0.393	1.119	0.707
3	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-05	0.165	0.185	0.204	0.177	0.170	0.184	0.174	0.185	...	0.295	0.332	0.318	0.369	0.378	0.272
4	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-06	0.151	0.148	0.148	0.139	0.131	0.148	0.144	0.140	...	0.571	0.320	0.326	0.321	0.293	0.176
5	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-07	0.143	0.141	0.145	0.139	0.121	0.148	0.134	0.139	...	0.609	0.587	0.447	0.404	0.327	0.132
6	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-08	0.144	0.118	0.165	0.143	0.119	0.147	0.137	0.131	...	0.389	0.406	0.907	0.768	0.826	0.313

```
In [14]: df_consumption_min_max_avg_info = df_consumption_min_max_avg.merge(df_addInfo, on=['meter_id'], how='left', indicator=False)
         df_consumption_min_max_avg_info.head()
```

Out[14]:

	meter_id	date	T1	T2	T3	T4	T5	T6	T7	T8	...	refrigerator	tumble_dryer	washing_machine	ga
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	1.0	0	1.0	
1	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-03	0.149	0.145	0.133	0.128	0.145	0.148	0.131	0.149	...	1.0	0	1.0	
2	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-04	0.150	0.133	0.145	0.138	0.124	0.150	0.129	0.152	...	1.0	0	1.0	
3	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-05	0.165	0.185	0.204	0.177	0.170	0.184	0.174	0.185	...	1.0	0	1.0	
4	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-06	0.151	0.148	0.148	0.139	0.131	0.148	0.144	0.140	...	1.0	0	1.0	

5 rows × 76 columns

Data cleaning

missing values (null_reading)

```
In [15]: df_consumption_min_max_avg_info.dropna(inplace=True)
```

discarding zero reading consumptions

```
In [16]: df_consumption_min_max_avg_info = df_consumption_min_max_avg_info.loc[~((df_consumption_min_max_avg_info['T1'] == 0) | (df_consumpti
```

In [17]:

```
df_consumption_min_max_avg_info.to_csv('df_consumption_min_max_avg_info.csv',index=False)
```

In [18]:

```
df_consumption_min_max_avg_info.columns
```

Out[18]:

```
Index(['meter_id', 'date', 'T1', 'T2', 'T3', 'T4', 'T5', 'T6', 'T7', 'T8',
       'T9', 'T10', 'T11', 'T12', 'T13', 'T14', 'T15', 'T16', 'T17', 'T18',
       'T19', 'T20', 'T21', 'T22', 'T23', 'T24', 'T25', 'T26', 'T27', 'T28',
       'T29', 'T30', 'T31', 'T32', 'T33', 'T34', 'T35', 'T36', 'T37', 'T38',
       'T39', 'T40', 'T41', 'T42', 'T43', 'T44', 'T45', 'T46', 'T47', 'T48',
       'min_temper', 'max_temper', 'avg_temper', 'dwelling_type',
       'num_occupants', 'num_bedrooms', 'heating_fuel', 'hot_water_fuel',
       'boiler_age', 'loft_insulation', 'wall_insulation',
       'heating_temperature', 'efficient_lighting_percentage', 'dishwasher',
       'freezer', 'fridge_freezer', 'refrigerator', 'tumble_dryer',
       'washing_machine', 'game_console', 'laptop', 'pc', 'router',
       'set_top_box', 'tablet', 'tv'],
      dtype='object')
```

Outliers

There are different methods for finding outliers: 1-box plot 2-z-score

1-box plot

In [19]:

```
#####1- box plot: (method1)

#####for each column (e.g T1-T48), example here for T1

#q_low = df_consumption_min_max_avg_info['T1'].quantile(0.01)
#q_hi = df_consumption_min_max_avg_info['T1'].quantile(0.99)


#df_consumption_min_max_avg_info = df_consumption_min_max_avg_info[(df_consumption_min_max_avg_info['T1'] < q_hi)
# & (df_consumption_min_max_avg_info['T1'] > q_low)]
```

In [20]:

```
#####1- box plot: (method2)

#####for each column (e.g T1-T48), example here for T1

#Q1 =  df['T1'].quantile(0.25)
#Q3 = df['T1'].quantile(0.75)
#IQR = Q3 - Q1

#df[(df['T1'] < Q1-1.5*IQR ) | (df['T1'] > Q3+1.5*IQR)]['T1']
```

2- z-score

In [21]:

```
df_consumption_min_max_avg_info[(np.abs(stats.zscore(df_consumption_min_max_avg_info.iloc[:,2:51])) < 3)]
```

Out[21]:

	meter_id	date	T1	T2	T3	T4	T5	T6	T7	T8	...	refrigerator	tumble_dryer	washing_mach
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	1.0	0	
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	1.0	0	
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	1.0	0	
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	1.0	0	
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	1.0	0	
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	1.0	0	
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	1.0	0	

Transofrmation (Catagorization)

```
In [22]: df_consumption_min_max_avg_info= pd.get_dummies(df_consumption_min_max_avg_info, columns=['dwelling_type', 'heating_fuel', 'hot_wate
```

```
In [23]: df_consumption_min_max_avg_info.columns.values
```

```
Out[23]: array(['meter_id', 'date', 'T1', 'T2', 'T3', 'T4', 'T5', 'T6', 'T7', 'T8',
                'T9', 'T10', 'T11', 'T12', 'T13', 'T14', 'T15', 'T16', 'T17',
                'T18', 'T19', 'T20', 'T21', 'T22', 'T23', 'T24', 'T25', 'T26',
                'T27', 'T28', 'T29', 'T30', 'T31', 'T32', 'T33', 'T34', 'T35',
                'T36', 'T37', 'T38', 'T39', 'T40', 'T41', 'T42', 'T43', 'T44',
                'T45', 'T46', 'T47', 'T48', 'min_temper', 'max_temper',
                'avg_temper', 'num_occupants', 'num_bedrooms', 'dishwasher',
                'freezer', 'fridge_freezer', 'refrigerator', 'tumble_dryer',
                'washing_machine', 'game_console', 'laptop', 'pc', 'router',
                'set_top_box', 'tablet', 'tv', 'dwelling_type_detached_house',
                'dwelling_type_flat', 'dwelling_type_semi_detached_house',
                'dwelling_type_terraced_house', 'heating_fuel_gas',
                'heating_fuel_lpg_oil', 'heating_fuel_other', 'hot_water_fuel_gas',
                'hot_water_fuel_other', 'boiler_age_old', 'loft_insulation_y',
                'wall_insulation_not_sure', 'wall_insulation_y_cavity',
                'wall_insulation_y_external', 'wall_insulation_y_internal',
                'heating_temperature_above_20', 'heating_temperature_below_18',
                'heating_temperature_not_sure',
                'efficient_lighting_percentage_25_to_50',
                'efficient_lighting_percentage_50_to_75',
                'efficient_lighting_percentage_75_to_100'], dtype=object)
```

Feature Engineering

Creating New Features : Max/Avg/Min of daily consumption

In [24]:
```
col = df_consumption_min_max_avg_info.loc[: , "T1":"T48"]
df_consumption_min_max_avg_info['T_mean'] = col.mean(axis=1)
df_consumption_min_max_avg_info['T_max'] = col.max(axis=1)
df_consumption_min_max_avg_info['T_min'] = col.min(axis=1)
```

In [25]:
```
df_consumption_min_max_avg_info.head()
```

Out[25]:

	meter_id	date	T1	T2	T3	T4	T5	T6	T7	T8	...	wall_insulation_y_internal	heating_temperature_a
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	0	
1	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-03	0.149	0.145	0.133	0.128	0.145	0.148	0.131	0.149	...	0	
2	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-04	0.150	0.133	0.145	0.138	0.124	0.150	0.129	0.152	...	0	
3	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-05	0.165	0.185	0.204	0.177	0.170	0.184	0.174	0.185	...	0	
4	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-06	0.151	0.148	0.148	0.139	0.131	0.148	0.144	0.140	...	0	

5 rows × 92 columns

Adding Next-day Avg/Min/Max Tempreature

In [26]:

```
#formatting the weathers df

next_ed_df_weather_min = pd.DataFrame(columns=["meter_id", "date", "min_temper", "next_day_min_tempr"])
#18249
for i in tqdm(range(18249)):
    next_ed_df_weather_min.at[i,'meter_id']= ed_df_weather_min.iloc[i][0]
    next_ed_df_weather_min.at[i,'date']= ed_df_weather_min.iloc[i][1]
    next_ed_df_weather_min.at[i,'min_temper']= ed_df_weather_min.iloc[i][2]

    if(ed_df_weather_min.iloc[i][0] == ed_df_weather_min.iloc[i+1][0]):
        next_ed_df_weather_min.at[i,'next_day_min_tempr']= ed_df_weather_min.iloc[i+1][2]
    else:
        next_ed_df_weather_min.at[i,'next_day_min_tempr']= None


    #print(next_ed_df_weather_min)


next_ed_df_weather_min.head()
```

```
100% 18249/18249 [01:09<00:00, 261.93it/s]
```

Out[26]:

	meter_id	date	min_temper	next_day_min_tempr
0	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-01 00:00:00	4.5	-0.7
1	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-02 00:00:00	-0.7	-1.5
2	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-03 00:00:00	-1.5	0.8
3	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-04 00:00:00	0.8	-2.5
4	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-05 00:00:00	-2.5	-2.4

In [27]:

```
del next_ed_df_weather_min['min_temper']
next_ed_df_weather_min["date"] = pd.to_datetime(next_ed_df_weather_min["date"])
df_consumption_min_max_avg_info["date"] = pd.to_datetime(df_consumption_min_max_avg_info["date"])
df_consumption_min_max_avg_info_1 = df_consumption_min_max_avg_info.merge(next_ed_df_weather_min, on=['meter_id', 'date'], how='left
```

In [28]:

```
next_ed_df_weather_max = pd.DataFrame(columns=["meter_id", "date", "max_temper", "next_day_max_tempr"])
#18249
for i in tqdm(range(18249)):
    next_ed_df_weather_max.at[i,'meter_id']= ed_df_weather_max.iloc[i][0]
    next_ed_df_weather_max.at[i,'date']= ed_df_weather_max.iloc[i][1]
    next_ed_df_weather_max.at[i,'max_temper']= ed_df_weather_max.iloc[i][2]

    if(ed_df_weather_max.iloc[i][0] == ed_df_weather_max.iloc[i+1][0]):
        next_ed_df_weather_max.at[i,'next_day_max_tempr']= ed_df_weather_max.iloc[i+1][2]
    else:
        next_ed_df_weather_max.at[i,'next_day_max_tempr']= None


    #print(next_ed_df_weather_max)


next_ed_df_weather_max.head()
```

```
100% 18249/18249 [01:10<00:00, 257.51it/s]
```

Out[28]:

	meter_id	date	max_temper	next_day_max_tempr
0	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-01 00:00:00	9.7	5.4
1	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-02 00:00:00	5.4	5.5
2	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-03 00:00:00	5.5	7.8
3	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-04 00:00:00	7.8	5.3
4	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-05 00:00:00	5.3	6.7

In [29]:

```
del next_ed_df_weather_max['max_temper']
next_ed_df_weather_max["date"] = pd.to_datetime(next_ed_df_weather_max["date"])
df_consumption_min_max_avg_info_1["date"] = pd.to_datetime(df_consumption_min_max_avg_info_1["date"])
df_consumption_min_max_avg_info_12 = df_consumption_min_max_avg_info_1.merge(next_ed_df_weather_max, on=['meter_id', 'date'], how='
```

In [30]:

```
next_ed_df_weather_avg = pd.DataFrame(columns=["meter_id", "date", "avg_temper", "next_day_avg_tempr"])
#18249
for i in tqdm(range(18249)):
    next_ed_df_weather_avg.at[i,'meter_id']= ed_df_weather_avg.iloc[i][0]
    next_ed_df_weather_avg.at[i,'date']= ed_df_weather_avg.iloc[i][1]
    next_ed_df_weather_avg.at[i,'avg_temper']= ed_df_weather_avg.iloc[i][2]

    if(ed_df_weather_avg.iloc[i][0] == ed_df_weather_avg.iloc[i+1][0]):
        next_ed_df_weather_avg.at[i,'next_day_avg_tempr']= ed_df_weather_avg.iloc[i+1][2]
    else:
        next_ed_df_weather_avg.at[i,'next_day_avg_tempr']= None


    #print(next_ed_df_weather_avg)


next_ed_df_weather_avg.head()
```

```
100% 18249/18249 [01:10<00:00, 258.20it/s]
```

Out[30]:

	meter_id	date	avg_temper	next_day_avg_tempr
0	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-01 00:00:00	6.35	2.60417
1	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-02 00:00:00	2.60417	1.70417
2	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-03 00:00:00	1.70417	4.74583
3	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-04 00:00:00	4.74583	0.145833
4	0x067ae210f71a5fe0e54032b3506fc4b37e44e622	2017-01-05 00:00:00	0.145833	2.25833

In [31]:

```
del next_ed_df_weather_avg['avg_temper']
next_ed_df_weather_avg["date"] = pd.to_datetime(next_ed_df_weather_avg["date"])
df_consumption_min_max_avg_info_12["date"] = pd.to_datetime(df_consumption_min_max_avg_info_12["date"])
df_consumption_min_max_avg_info_123 = df_consumption_min_max_avg_info_12.merge(next_ed_df_weather_avg, on=['meter_id', 'date'], how=
df_consumption_min_max_avg_info_123.head()
```

Out[31]:

	meter_id	date	T1	T2	T3	T4	T5	T6	T7	T8	...	heating_temperature_not_sure	efficient_lighti
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	0	
1	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-03	0.149	0.145	0.133	0.128	0.145	0.148	0.131	0.149	...	0	
2	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-04	0.150	0.133	0.145	0.138	0.124	0.150	0.129	0.152	...	0	
3	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-05	0.165	0.185	0.204	0.177	0.170	0.184	0.174	0.185	...	0	
4	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-06	0.151	0.148	0.148	0.139	0.131	0.148	0.144	0.140	...	0	

5 rows × 95 columns

Adding Y class (next_day_max_consumption)

In [32]:

```
df_consumption_min_max_avg_info_123_Y = df_consumption_min_max_avg_info_123
df_consumption_min_max_avg_info_123_Y ["Y_next_day_max_consumption"]=None
#df_consumption_min_max_avg_info_123_Y
```

In [33]:

```
df_consumption_min_max_avg_info_123.shape
```

Out[33]:

```
(6803, 96)
```

In [34]:

```
#df_consumption_min_max_avg_info_123.columns
```

In [35]:

```
for i in tqdm(range(6801)):

    if(df_consumption_min_max_avg_info_123.iloc[i][0] == df_consumption_min_max_avg_info_123.iloc[i+1][0]):
        print(df_consumption_min_max_avg_info_123.iloc[i][0])
        #print("yes")
                #print("yes")

        df_consumption_min_max_avg_info_123_Y.at[i,'Y_next_day_max_consumption']= df_consumption_min_max_avg_info_123.iloc[i+1][90]

df_consumption_min_max_avg_info_123_Y.head()
```

```
100% 6801/6801 [00:22<00:00, 298.60it/s]
```

In [36]:

```
#df_consumption_min_max_avg_info_123_Y.to_csv('df_consumption_min_max_avg_info_123_Y.csv',index=False)
```

In [ ]:

```

```

Outliers

In [37]:
```python
df_consumption_min_max_avg_info_123_Y[(np.abs(stats.zscore(df_consumption_min_max_avg_info_123_Y.iloc[:,2:51])) < 3)]
```

Out[37]:

	meter_id	date	T1	T2	T3	T4	T5	T6	T7	T8	...	efficient_lighting_percentage_25_to_50	eff
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	0	
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	0	
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	0	
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	0	
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	0	
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	0	
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	0	

In [38]:
```python
#df_consumption_min_max_avg_info_123_Y = np.array(df_consumption_min_max_avg_info_123_Y.iloc[:,89:95], dtype=np.float64) # can use n


df_consumption_min_max_avg_info_123_Y.iloc[:, 89] = pd.to_numeric(df_consumption_min_max_avg_info_123_Y.iloc[:, 89])
df_consumption_min_max_avg_info_123_Y.iloc[:, 90] = pd.to_numeric(df_consumption_min_max_avg_info_123_Y.iloc[:, 90])
df_consumption_min_max_avg_info_123_Y.iloc[:, 91] = pd.to_numeric(df_consumption_min_max_avg_info_123_Y.iloc[:, 91])
df_consumption_min_max_avg_info_123_Y.iloc[:, 92] = pd.to_numeric(df_consumption_min_max_avg_info_123_Y.iloc[:, 92])
df_consumption_min_max_avg_info_123_Y.iloc[:, 93] = pd.to_numeric(df_consumption_min_max_avg_info_123_Y.iloc[:, 93])
df_consumption_min_max_avg_info_123_Y.iloc[:, 94] = pd.to_numeric(df_consumption_min_max_avg_info_123_Y.iloc[:, 94])
df_consumption_min_max_avg_info_123_Y.iloc[:, 95] = pd.to_numeric(df_consumption_min_max_avg_info_123_Y.iloc[:, 95])


#df_consumption_min_max_avg_info_123_Y.iloc[:,89:95] = pd.to_numeric(df_consumption_min_max_avg_info_123_Y.iloc[:,89:95])
```

In [39]:
```
df_consumption_min_max_avg_info_123_Y[(np.abs(stats.zscore(df_consumption_min_max_avg_info_123_Y.iloc[:,89:95])) < 3)]
```

Out[39]:

	meter_id	date	T1	T2	T3	T4	T5	T6	T7	T8	...	efficient_lighting_percentage_25_to_50	eff
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	0	
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	0	
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	0	
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	0	
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	0	
0	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-02	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	...	0	
1	0xf4fe2245bf908cb1bd3201e4fceb97d6d229c60c	2017-11-03	0.149	0.145	0.133	0.128	0.145	0.148	0.131	0.149	...	0	

```
In [40]: df_consumption_min_max_avg_info_123_Y.columns
```

```
Out[40]: Index(['meter_id', 'date', 'T1', 'T2', 'T3', 'T4', 'T5', 'T6', 'T7', 'T8',
               'T9', 'T10', 'T11', 'T12', 'T13', 'T14', 'T15', 'T16', 'T17', 'T18',
               'T19', 'T20', 'T21', 'T22', 'T23', 'T24', 'T25', 'T26', 'T27', 'T28',
               'T29', 'T30', 'T31', 'T32', 'T33', 'T34', 'T35', 'T36', 'T37', 'T38',
               'T39', 'T40', 'T41', 'T42', 'T43', 'T44', 'T45', 'T46', 'T47', 'T48',
               'min_temper', 'max_temper', 'avg_temper', 'num_occupants',
               'num_bedrooms', 'dishwasher', 'freezer', 'fridge_freezer',
               'refrigerator', 'tumble_dryer', 'washing_machine', 'game_console',
               'laptop', 'pc', 'router', 'set_top_box', 'tablet', 'tv',
               'dwelling_type_detached_house', 'dwelling_type_flat',
               'dwelling_type_semi_detached_house', 'dwelling_type_terraced_house',
               'heating_fuel_gas', 'heating_fuel_lpg_oil', 'heating_fuel_other',
               'hot_water_fuel_gas', 'hot_water_fuel_other', 'boiler_age_old',
               'loft_insulation_y', 'wall_insulation_not_sure',
               'wall_insulation_y_cavity', 'wall_insulation_y_external',
               'wall_insulation_y_internal', 'heating_temperature_above_20',
               'heating_temperature_below_18', 'heating_temperature_not_sure',
               'efficient_lighting_percentage_25_to_50',
               'efficient_lighting_percentage_50_to_75',
               'efficient_lighting_percentage_75_to_100', 'T_mean', 'T_max', 'T_min',
               'next_day_min_tempr', 'next_day_max_tempr', 'next_day_avg_tempr',
               'Y_next_day_max_consumption'],
              dtype='object')
```

Normalize

In [41]:

```
#Consumptions
preprocessing.normalize(df_consumption_min_max_avg_info_123_Y.iloc[:,2:51])
preprocessing.normalize(df_consumption_min_max_avg_info_123_Y.iloc[:,89:95])
```

Out[41]:

```
array([[ 0.01789155,  0.13674855,  0.00665173,  0.49888   ,  0.66517334,
         0.53814371],
       [ 0.0176938 ,  0.13248341,  0.00798254,  0.33540104,  0.73788228,
         0.57018176],
       [ 0.03860989,  0.21707957,  0.01073418,  0.        ,  0.86256784,
         0.45524414],
       ...,
       [ 0.02532356,  0.15829699,  0.00745725,  0.06779314,  0.86436256,
         0.47172728],
       [ 0.03962207,  0.26846998,  0.01075979, -0.393651  ,  0.8397888 ,
         0.25696663],
       [ 0.02524641,  0.23073896,  0.00656979,  0.05972536,  0.85606343,
         0.45789439]])
```

In [ ]:

```
```

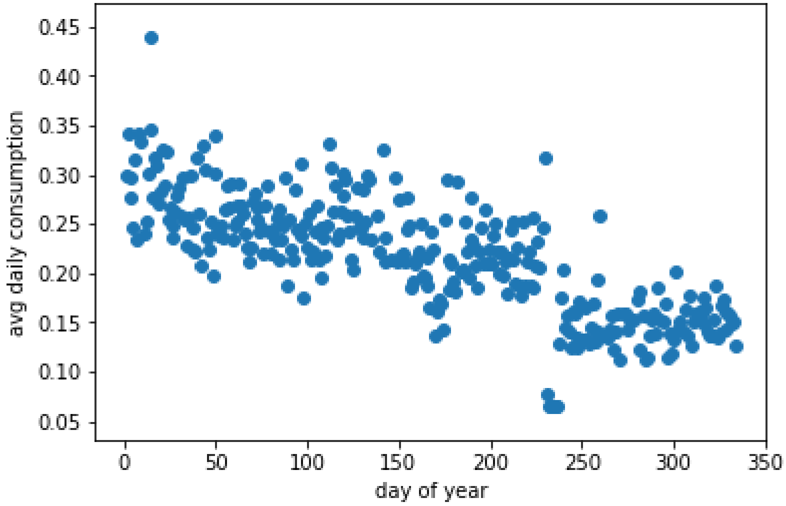
Visualization

Avg daily consumption for a specific customer (meter_id) 0xcd61d0e2f496d81ddb7d7bd4eab4b1ceb87d2b68

In [42]:

```
x_cons= df_consumption_min_max_avg_info_123_Y[df_consumption_min_max_avg_info_123_Y.meter_id=='0xcd61d0e2f496d81ddb7d7bd4eab4b1ceb87
x = list()


for i in x_cons:
    day=i.timetuple().tm_yday
    x.append(day)


print(len(x))

y= df_consumption_min_max_avg_info_123_Y[df_consumption_min_max_avg_info_123_Y.meter_id=='0xcd61d0e2f496d81ddb7d7bd4eab4b1ceb87d2b68
y=list(y)
print(len(y))

plt.xlabel("day of year")
plt.ylabel("avg daily consumption")

plt.scatter(x, y)
plt.show()
```

```
314
314
```



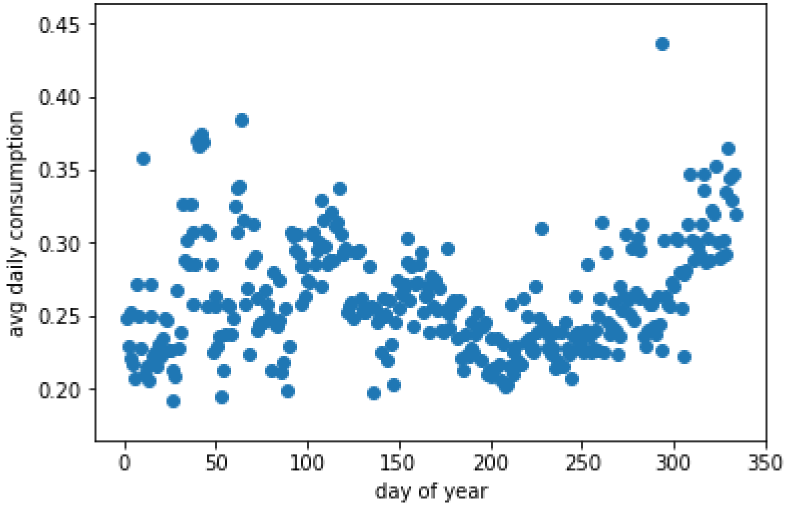
Avg daily consumption for all customers during a year

```
In [43]: #Calculate Avg
         dft=df_consumption_min_max_avg_info_123_Y.groupby(['date']).mean()
         dft.shape
```

```
Out[43]: (334, 94)
```

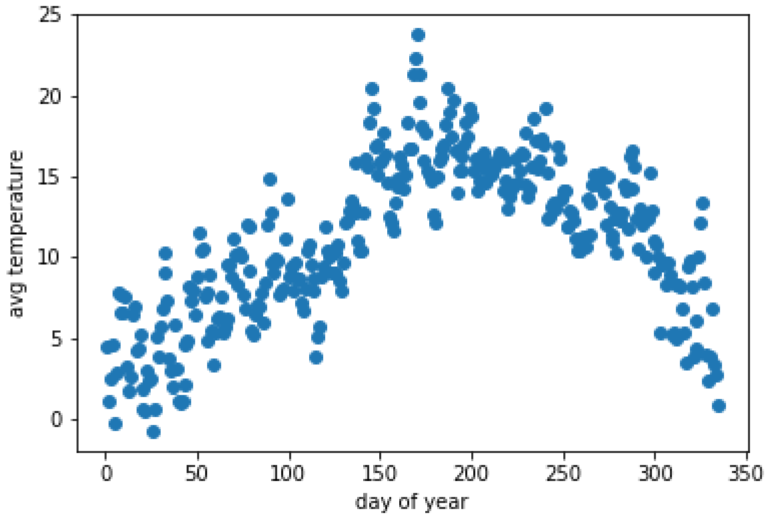
In [44]:

```
x_cons= dft.index

x= list()
y= list()
for i in x_cons:
    day=i.timetuple().tm_yday
    x.append(day)
    mc=dft.iloc[dft.index==i]['T_mean']
    y.append(mc)

plt.xlabel("day of year")
plt.ylabel("avg daily consumption")

plt.scatter(x, y)
plt.show()
```



In [45]:

```
x_cons= dft.index

x= list()
y= list()
for i in x_cons:
    day=i.timetuple().tm_yday
    x.append(day)
    mc=dft.iloc[dft.index==i]['avg_temper']
    y.append(mc)

plt.xlabel("day of year")
plt.ylabel("avg temperature")

plt.scatter(x, y)
plt.show()
```



omitting missing data for the Y

```
In [46]: df_consumption_min_max_avg_info_123_Y.shape
```

```
Out[46]: (6803, 96)
```

```
In [47]: df_consumption_min_max_avg_info_123_Y.dropna(inplace=True)
```

```
In [48]: df_consumption_min_max_avg_info_123_Y.shape
```

```
Out[48]: (6755, 96)
```

```
In [49]: df_consumption_min_max_avg_info_123_Y.to_csv('fin_df_consumption_min_max_avg_info_123_Y.csv',index=False)
```

Experimental setup

number of features : 94

```
In [50]: df_consumption_min_max_avg_info_123_Y.shape
```

```
Out[50]: (6755, 96)
```

```
In [51]: #df_consumption_min_max_avg_info_123_Y.columns
```

```
In [52]: #df_consumption_min_max_avg_info_123_Y
         df_consumption_min_max_avg_info_123_Y['date'] = pd.to_datetime(df_consumption_min_max_avg_info_123_Y['date'])
         df_consumption_min_max_avg_info_123_Y['date']=df_consumption_min_max_avg_info_123_Y['date'].map(dt.datetime.toordinal)
```

In [53]:

```
X= df_consumption_min_max_avg_info_123_Y.iloc[:, 1:94]
X.head()
```

Out[53]:

	date	T1	T2	T3	T4	T5	T6	T7	T8	T9	...	heating_temperature_below_18	heating_temperature_not_sure	efficient_lighting_perce
0	736635	0.153	0.125	0.161	0.151	0.122	0.145	0.160	0.124	0.154	...	0	0	
1	736636	0.149	0.145	0.133	0.128	0.145	0.148	0.131	0.149	0.130	...	0	0	
2	736637	0.150	0.133	0.145	0.138	0.124	0.150	0.129	0.152	0.138	...	0	0	
3	736638	0.165	0.185	0.204	0.177	0.170	0.184	0.174	0.185	0.191	...	0	0	
4	736639	0.151	0.148	0.148	0.139	0.131	0.148	0.144	0.140	0.147	...	0	0	

5 rows × 93 columns

In [54]:

```
Y= df_consumption_min_max_avg_info_123_Y['Y_next_day_max_consumption']
Y.head()
```

Out[54]:

```
0    1.975
1    2.265
2    1.253
3    1.612
4    2.254
Name: Y_next_day_max_consumption, dtype: float64
```

In [55]:

```
X_train, X_test, y_train, y_test = train_test_split(X, Y, test_size=.3, random_state=0)
```

Random Forest

In [56]:

```
rf = RandomForestRegressor(n_estimators = 1000, random_state = 42)
```

In [57]:

```
# Number of trees in random forest
n_estimators = [int(x) for x in np.linspace(start = 200, stop = 2000, num = 10)]
# Number of features to consider at every split
max_features = ['auto', 'sqrt']
# Maximum number of levels in tree
max_depth = [int(x) for x in np.linspace(10, 110, num = 11)]
max_depth.append(None)
# Minimum number of samples required to split a node
min_samples_split = [2, 5, 10]
# Minimum number of samples required at each leaf node
min_samples_leaf = [1, 2, 4]
# Method of selecting samples for training each tree
bootstrap = [True, False]
# Create the random grid
random_grid = {'n_estimators': n_estimators,
               'max_features': max_features,
               'max_depth': max_depth,
               'min_samples_split': min_samples_split,
               'min_samples_leaf': min_samples_leaf,
               'bootstrap': bootstrap}
print(random_grid)
```

```
{'max_depth': [10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, None], 'min_samples_leaf': [1, 2, 4], 'bootstrap': [True, False],
'n_estimators': [200, 400, 600, 800, 1000, 1200, 1400, 1600, 1800, 2000], 'max_features': ['auto', 'sqrt'], 'min_samples_split':
[2, 5, 10]}
```

In [58]:

```
# Random search of parameters, using 3 fold cross validation,
# search across 100 different combinations, and use all available cores
rf_random = RandomizedSearchCV(estimator = rf, param_distributions = random_grid, n_iter = 5, cv = 3, verbose=2, random_state=42, n_
```

In [59]:

```
rf_random.fit(X_train, y_train)

#rf.fit(X_train, y_train)
```

```
Fitting 3 folds for each of 5 candidates, totalling 15 fits

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done   8 out of  15 | elapsed:   45.3s remaining:   39.7s
[Parallel(n_jobs=-1)]: Done  15 out of  15 | elapsed:  4.7min finished
```

Out[59]:

```
RandomizedSearchCV(cv=3, error_score=nan,
                   estimator=RandomForestRegressor(bootstrap=True,
                                                   ccp_alpha=0.0,
                                                   criterion='mse',
                                                   max_depth=None,
                                                   max_features='auto',
                                                   max_leaf_nodes=None,
                                                   max_samples=None,
                                                   min_impurity_decrease=0.0,
                                                   min_impurity_split=None,
                                                   min_samples_leaf=1,
                                                   min_samples_split=2,
                                                   min_weight_fraction_leaf=0.0,
                                                   n_estimators=1000,
                                                   n_jobs=None, oob_score=Fal...
                   param_distributions={'bootstrap': [True, False],
                                        'max_depth': [10, 20, 30, 40, 50, 60,
                                                      70, 80, 90, 100, 110,
                                                      None],
                                        'max_features': ['auto', 'sqrt'],
                                        'min_samples_leaf': [1, 2, 4],
                                        'min_samples_split': [2, 5, 10],
                                        'n_estimators': [200, 400, 600, 800,
                                                         1000, 1200, 1400, 1600,
                                                         1800, 2000]},
                   pre_dispatch='2*n_jobs', random_state=42, refit=True,
                   return_train_score=False, scoring=None, verbose=2)
```

In [60]:
```
#best parameters from fitting the random search

rf_random.best_params_
```

Out[60]:
```
{'bootstrap': False,
 'max_depth': 90,
 'max_features': 'sqrt',
 'min_samples_leaf': 4,
 'min_samples_split': 10,
 'n_estimators': 600}
```

In [61]:
```
def evaluate(model, test_features, test_labels):
    predictions = model.predict(test_features)
    errors = abs(predictions - test_labels)
    mape = 100 * np.mean(errors / test_labels)
    accuracy = 100 - mape
    print('Model Performance')
    print('Average Error: {:0.4f} degrees.'.format(np.mean(errors)))
    print('Accuracy = {:0.2f}%.'.format(accuracy))

    return accuracy
```

Parametes and performance

In [62]:
```
base_model = RandomForestRegressor(n_estimators = 10, random_state = 42)
base_model.fit(X_train, y_train)
base_accuracy = evaluate(base_model, X_test, y_test)
```

```
Model Performance
Average Error: 0.2977 degrees.
Accuracy = 53.26%.
```

```
In [63]: best_random = rf_random.best_estimator_
         random_accuracy = evaluate(best_random, X_test, y_test)
```

```
Model Performance
Average Error: 0.2738 degrees.
Accuracy = 55.48%.
```

```
In [64]: print('Improvement of {:0.2f}%.'.format( 100 * (random_accuracy - base_accuracy) / base_accuracy))
```

```
Improvement of 4.16%.
```

```
In [65]: #df_consumption_min_max_avg_info_123_Y.to_csv('My_Final_Preprocessed.csv',index=False)
```

Regression ¶

```
In [66]: regr = linear_model.LinearRegression()
```

```
In [67]: regr.fit(X_train, y_train)
```

```
Out[67]: LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None, normalize=False)
```

```
In [68]: y_pred = regr.predict(X_test)
```

Parametes and performance

In [69]:

```
print('Coefficients: \n', regr.coef_)
```

```
Coefficients: 
 [-1.99360961e-04 -1.86536564e-01  1.67643430e-01 -6.20086507e-02
  1.24767961e-01  9.08259859e-02  1.04358511e-01  6.97708053e-02
 -1.00151925e-03 -4.47458353e-02 -2.93537480e-02 -4.26482838e-02
  4.97269110e-03  3.43196636e-02  2.12360102e-02  8.16312954e-02
 -2.05158965e-02  3.00164063e-02  7.40968332e-03 -1.74171087e-02
 -3.36597500e-02 -1.38546104e-02  8.15600535e-02 -1.67005325e-03
 -1.04938711e-02  4.22509177e-02 -6.84042935e-02 -1.61000473e-03
  7.55217205e-02 -9.06816835e-03 -8.05893625e-03 -2.77050471e-02
  1.94180203e-02  2.28182207e-02 -1.18069002e-02  3.88452242e-02
  7.75349204e-02 -3.31740599e-02  3.17258647e-02 -3.97168178e-02
 -8.42055447e-03  8.62482551e-02  5.39945651e-02  5.65701296e-02
  4.66639911e-02  6.85385101e-02  1.14561776e-01  4.43184660e-02
  2.20713991e-01 -3.02076752e-03 -1.81945383e-03  3.65547455e-03
  2.21017893e-01 -2.37678293e-01 -9.65220813e-02  1.67238245e-01
  2.33509783e-01  8.16683547e-02 -2.06277245e-02  8.32667268e-17
  1.27793704e-01 -7.33667536e-02 -1.03276138e-01 -5.54732766e-02
 -8.57534302e-02 -5.92576062e-02  5.71874338e-02  1.05733253e-01
 -5.48737209e-01  2.72789822e-02  9.26102497e-02  5.41344225e-01
 -8.91262806e-02 -5.05188882e-01 -8.18465459e-01 -8.91262806e-02
 -1.66149313e-01 -1.40934204e-01  9.08832365e-02  2.27131746e-01
 -1.83670559e-01  1.95016562e-02 -1.19405450e-01 -2.57240831e-01
 -2.64894191e-01 -1.52575076e-01 -4.66052829e-02 -1.16348003e-01
  2.38826333e-02  1.88799630e-01 -6.48819955e-02 -7.05916728e-05
 -4.37770518e-03]
```

In [70]:

```
print('Mean squared error: %.2f'
      % mean_squared_error(y_test, y_pred))
# The coefficient of determination: 1 is perfect prediction
print('Coefficient of determination: %.2f'
      % r2_score(y_test, y_pred))
```

```
Mean squared error: 0.18
Coefficient of determination: 0.61
```

In [71]:

```
cv_4_results = cross_val_score(regr, X_train, y_train, cv=3, scoring='neg_mean_squared_error')
```

```
In [72]: cv_4_results

Out[72]: array([-0.18716957, -0.17933958, -0.18296154])

In [ ]:

In [ ]:

In [64]:
```