sale_prediction_of_bulldozer

November 12, 2019

[ ]:
```
# Bulldozer sale prediciton is a regression task and for predicting te model , ␣
↪algorithm used is RandomForest
# The depedent variable is Sale Price and independent variable is rest all␣
↪attributes like machineID, Saledata etc.
# The evaluation metric used here is RMSLE (Root mean square Log Error).In this␣
↪We first take the mean of squared
# differences of log values. We take a square root of the result obtained.
# This is equivalent to calculating the root mean squared error (rmse) of log␣
↪of the values.
# The R^2 is a statistical measure of how close the data are to the fittest line
```

[63]:
```
%load_ext autoreload
%autoreload 2
%matplotlib inline
```

```
The autoreload extension is already loaded. To reload it, use:
  %reload_ext autoreload
```

[2]:
```
from fastai.imports import*
from fastai.tabular import *
from pandas_summary import DataFrameSummary
from sklearn.ensemble import RandomForestRegressor, RandomForestClassifier
from IPython.display import display
from sklearn import metrics
import numpy as np
from pandas.api.types import is_string_dtype, is_numeric_dtype,␣
↪is_categorical_dtype
from sklearn.preprocessing import LabelEncoder, Imputer, StandardScaler
```

[4]:
```
# Reaing the CSV data file(Train file)
```

[5]:
```
data_read=pd.read_csv('Train.csv', low_memory=False, parse_dates=["saledate"])
```

[66]:
```
data_read.head()
```

[66]:
```
   SalesID  SalePrice  MachineID  ModelID  datasource  auctioneerID  YearMade  \
0  1139246      66000     999089     3157         121           3.0      2004
```

```
1  1139248      57000     117657        77          121           3.0       1996
2  1139249      10000     434808      7009          121           3.0       2001
3  1139251      38500    1026470       332          121           3.0       2001
4  1139253      11000    1057373     17311          121           3.0       2007

   MachineHoursCurrentMeter UsageBand   saledate  … Undercarriage_Pad_Width  \
0                      68.0       Low 2006-11-16  …                     NaN
1                    4640.0       Low 2004-03-26  …                     NaN
2                    2838.0      High 2004-02-26  …                     NaN
3                    3486.0      High 2011-05-19  …                     NaN
4                     722.0    Medium 2009-07-23  …                     NaN

  Stick_Length Thumb Pattern_Changer Grouser_Type Backhoe_Mounting Blade_Type  \
0          NaN   NaN             NaN          NaN              NaN        NaN
1          NaN   NaN             NaN          NaN              NaN        NaN
2          NaN   NaN             NaN          NaN              NaN        NaN
3          NaN   NaN             NaN          NaN              NaN        NaN
4          NaN   NaN             NaN          NaN              NaN        NaN

  Travel_Controls Differential_Type Steering_Controls
0             NaN          Standard      Conventional
1             NaN          Standard      Conventional
2             NaN               NaN               NaN
3             NaN               NaN               NaN
4             NaN               NaN               NaN

[5 rows x 53 columns]
```

[6]:
```python
def display_alldata(df):
 with pd.option_context('display.max_rows', 1000, 'display.max_columns', 1000):
    display(df)
```

[69]:
```python
display_alldata(data_read.head().transpose())
```

```
                                                           0  \
SalesID                                              1139246
SalePrice                                              66000
MachineID                                             999089
ModelID                                                 3157
datasource                                               121
auctioneerID                                               3
YearMade                                                2004
MachineHoursCurrentMeter                                  68
UsageBand                                                Low
saledate                                 2006-11-16 00:00:00
fiModelDesc                                             521D
fiBaseModel                                              521
```

```
fiSecondaryDesc                                                      D
fiModelSeries                                                      NaN
fiModelDescriptor                                                  NaN
ProductSize                                                        NaN
fiProductClassDesc          Wheel Loader - 110.0 to 120.0 Horsepower
state                                                          Alabama
ProductGroup                                                        WL
ProductGroupDesc                                          Wheel Loader
Drive_System                                                       NaN
Enclosure                                                  EROPS w AC
Forks                                          None or Unspecified
Pad_Type                                                           NaN
Ride_Control                                   None or Unspecified
Stick                                                              NaN
Transmission                                                       NaN
Turbocharged                                                       NaN
Blade_Extension                                                    NaN
Blade_Width                                                        NaN
Enclosure_Type                                                     NaN
Engine_Horsepower                                                  NaN
Hydraulics                                                     2 Valve
Pushblock                                                          NaN
Ripper                                                             NaN
Scarifier                                                          NaN
Tip_Control                                                        NaN
Tire_Size                                      None or Unspecified
Coupler                                        None or Unspecified
Coupler_System                                                     NaN
Grouser_Tracks                                                     NaN
Hydraulics_Flow                                                    NaN
Track_Type                                                         NaN
Undercarriage_Pad_Width                                            NaN
Stick_Length                                                       NaN
Thumb                                                              NaN
Pattern_Changer                                                    NaN
Grouser_Type                                                       NaN
Backhoe_Mounting                                                   NaN
Blade_Type                                                         NaN
Travel_Controls                                                    NaN
Differential_Type                                             Standard
Steering_Controls                                         Conventional

                                                                     1  \
SalesID                                                        1139248
SalePrice                                                        57000
MachineID                                                       117657
ModelID                                                             77
datasource                                                         121
```

auctioneerID	3
YearMade	1996
MachineHoursCurrentMeter	4640
UsageBand	Low
saledate	2004-03-26 00:00:00
fiModelDesc	950FII
fiBaseModel	950
fiSecondaryDesc	F
fiModelSeries	II
fiModelDescriptor	NaN
ProductSize	Medium
fiProductClassDesc	Wheel Loader - 150.0 to 175.0 Horsepower
state	North Carolina
ProductGroup	WL
ProductGroupDesc	Wheel Loader
Drive_System	NaN
Enclosure	EROPS w AC
Forks	None or Unspecified
Pad_Type	NaN
Ride_Control	None or Unspecified
Stick	NaN
Transmission	NaN
Turbocharged	NaN
Blade_Extension	NaN
Blade_Width	NaN
Enclosure_Type	NaN
Engine_Horsepower	NaN
Hydraulics	2 Valve
Pushblock	NaN
Ripper	NaN
Scarifier	NaN
Tip_Control	NaN
Tire_Size	23.5
Coupler	None or Unspecified
Coupler_System	NaN
Grouser_Tracks	NaN
Hydraulics_Flow	NaN
Track_Type	NaN
Undercarriage_Pad_Width	NaN
Stick_Length	NaN
Thumb	NaN
Pattern_Changer	NaN
Grouser_Type	NaN
Backhoe_Mounting	NaN
Blade_Type	NaN
Travel_Controls	NaN
Differential_Type	Standard
Steering_Controls	Conventional

```
                                                                  2  \
SalesID                                                     1139249
SalePrice                                                     10000
MachineID                                                    434808
ModelID                                                        7009
datasource                                                      121
auctioneerID                                                      3
YearMade                                                       2001
MachineHoursCurrentMeter                                       2838
UsageBand                                                      High
saledate                                        2004-02-26 00:00:00
fiModelDesc                                                     226
fiBaseModel                                                     226
fiSecondaryDesc                                                 NaN
fiModelSeries                                                   NaN
fiModelDescriptor                                               NaN
ProductSize                                                     NaN
fiProductClassDesc        Skid Steer Loader - 1351.0 to 1601.0 Lb Operat...
state                                                      New York
ProductGroup                                                    SSL
ProductGroupDesc                                Skid Steer Loaders
Drive_System                                                    NaN
Enclosure                                                     OROPS
Forks                                           None or Unspecified
Pad_Type                                                        NaN
Ride_Control                                                    NaN
Stick                                                           NaN
Transmission                                                    NaN
Turbocharged                                                    NaN
Blade_Extension                                                 NaN
Blade_Width                                                     NaN
Enclosure_Type                                                  NaN
Engine_Horsepower                                               NaN
Hydraulics                                                Auxiliary
Pushblock                                                       NaN
Ripper                                                          NaN
Scarifier                                                       NaN
Tip_Control                                                     NaN
Tire_Size                                                       NaN
Coupler                                         None or Unspecified
Coupler_System                                  None or Unspecified
Grouser_Tracks                                  None or Unspecified
Hydraulics_Flow                                            Standard
Track_Type                                                      NaN
Undercarriage_Pad_Width                                         NaN
Stick_Length                                                    NaN
Thumb                                                           NaN
```

```
Pattern_Changer                                                   NaN
Grouser_Type                                                      NaN
Backhoe_Mounting                                                  NaN
Blade_Type                                                        NaN
Travel_Controls                                                   NaN
Differential_Type                                                 NaN
Steering_Controls                                                 NaN

                                                                    3  \
SalesID                                                       1139251
SalePrice                                                       38500
MachineID                                                     1026470
ModelID                                                           332
datasource                                                        121
auctioneerID                                                        3
YearMade                                                         2001
MachineHoursCurrentMeter                                         3486
UsageBand                                                        High
saledate                                          2011-05-19 00:00:00
fiModelDesc                                                  PC120-6E
fiBaseModel                                                     PC120
fiSecondaryDesc                                                   NaN
fiModelSeries                                                     -6E
fiModelDescriptor                                                 NaN
ProductSize                                                     Small
fiProductClassDesc        Hydraulic Excavator, Track - 12.0 to 14.0 Metr...
state                                                           Texas
ProductGroup                                                      TEX
ProductGroupDesc                                     Track Excavators
Drive_System                                                      NaN
Enclosure                                                 EROPS w AC
Forks                                                             NaN
Pad_Type                                                          NaN
Ride_Control                                                      NaN
Stick                                                             NaN
Transmission                                                      NaN
Turbocharged                                                      NaN
Blade_Extension                                                   NaN
Blade_Width                                                       NaN
Enclosure_Type                                                    NaN
Engine_Horsepower                                                 NaN
Hydraulics                                                    2 Valve
Pushblock                                                         NaN
Ripper                                                            NaN
Scarifier                                                         NaN
Tip_Control                                                       NaN
Tire_Size                                                         NaN
Coupler                                           None or Unspecified
```

```
Coupler_System                                                         NaN
Grouser_Tracks                                                         NaN
Hydraulics_Flow                                                        NaN
Track_Type                                                             NaN
Undercarriage_Pad_Width                                                NaN
Stick_Length                                                           NaN
Thumb                                                                  NaN
Pattern_Changer                                                        NaN
Grouser_Type                                                           NaN
Backhoe_Mounting                                                       NaN
Blade_Type                                                             NaN
Travel_Controls                                                        NaN
Differential_Type                                                      NaN
Steering_Controls                                                      NaN

                                                                         4
SalesID                                                            1139253
SalePrice                                                            11000
MachineID                                                          1057373
ModelID                                                              17311
datasource                                                             121
auctioneerID                                                             3
YearMade                                                              2007
MachineHoursCurrentMeter                                               722
UsageBand                                                           Medium
saledate                                               2009-07-23 00:00:00
fiModelDesc                                                           S175
fiBaseModel                                                           S175
fiSecondaryDesc                                                        NaN
fiModelSeries                                                          NaN
fiModelDescriptor                                                      NaN
ProductSize                                                            NaN
fiProductClassDesc        Skid Steer Loader - 1601.0 to 1751.0 Lb Operat...
state                                                             New York
ProductGroup                                                           SSL
ProductGroupDesc                                        Skid Steer Loaders
Drive_System                                                           NaN
Enclosure                                                            EROPS
Forks                                                  None or Unspecified
Pad_Type                                                               NaN
Ride_Control                                                           NaN
Stick                                                                  NaN
Transmission                                                           NaN
Turbocharged                                                           NaN
Blade_Extension                                                        NaN
Blade_Width                                                            NaN
Enclosure_Type                                                         NaN
Engine_Horsepower                                                      NaN
```

```
Hydraulics                                              Auxiliary
Pushblock                                                     NaN
Ripper                                                        NaN
Scarifier                                                     NaN
Tip_Control                                                   NaN
Tire_Size                                                     NaN
Coupler                                       None or Unspecified
Coupler_System                                None or Unspecified
Grouser_Tracks                                None or Unspecified
Hydraulics_Flow                                          Standard
Track_Type                                                    NaN
Undercarriage_Pad_Width                                       NaN
Stick_Length                                                  NaN
Thumb                                                         NaN
Pattern_Changer                                               NaN
Grouser_Type                                                  NaN
Backhoe_Mounting                                              NaN
Blade_Type                                                    NaN
Travel_Controls                                               NaN
Differential_Type                                             NaN
Steering_Controls                                             NaN
```

[ ]:
```
# Data Preprocessing as we can see so many categorical values in data frame␣
 ↪like sale data Usage band .Its necessary to
# convert categorical value to numerical value to feed into tree.
```

[34]:
```
datavalue=np.log(data_read.SalePrice)
```

[37]:
```
print(datavalue)
```

```
0         11.097410
1         10.950807
2          9.210340
3         10.558414
4          9.305651
            …
401120     9.259131
401121     9.305651
401122     9.350102
401123     9.104980
401124     8.955448
Name: SalePrice, Length: 401125, dtype: float64
```

[70]:
```
def add_datepart(df, fldname, drop=True):
    fld = df[fldname]
    if not np.issubdtype(fld.dtype, np.datetime64):
        df[fldname] = fld = pd.to_datetime(fld,
```

```
                                            infer_datetime_format=True)
    targ_pre = re.sub('[Dd]ate$', '', fldname)
    for n in ('Year', 'Month', 'Week', 'Day', 'Dayofweek',
            'Dayofyear', 'Is_month_end', 'Is_month_start',
            'Is_quarter_end', 'Is_quarter_start', 'Is_year_end',
            'Is_year_start'):
        df[targ_pre+n] = getattr(fld.dt,n.lower())
    df[targ_pre+'Elapsed'] = fld.astype(np.int64) // 10**9
    if drop: df.drop(fldname, axis=1, inplace=True)
```

[71]:
```
fld = data_read.saledate
fld.dt.year
```

[71]:
```
0         2006
1         2004
2         2004
3         2011
4         2009
          …
401120    2011
401121    2011
401122    2011
401123    2011
401124    2011
Name: saledate, Length: 401125, dtype: int64
```

[72]:
```
add_datepart(data_read, 'saledate')
```

[74]:
```
data_read.saleYear.head()
```

[74]:
```
0    2006
1    2004
2    2004
3    2011
4    2009
Name: saleYear, dtype: int64
```

[77]:
```
def train_cats(df):
    for n,c in df.items():
        if is_string_dtype(c):  df[n] = c.astype('category').cat.as_ordered()
```

[83]:
```
train_cats(data_read)
```

[85]:
```
data_read.UsageBand.cat.set_categories(['High', 'Medium', 'Low'],
    ordered=True, inplace=True)
```

[ ]:
```
# The below code is used to find the null values in dataframe as we can seeeso␣
↪many nullvalues(NAN)
```

[86]:
```
display_alldata(data_read.isnull().sum().sort_index()/len(data_read))
```

```
Backhoe_Mounting            0.803872
Blade_Extension             0.937129
Blade_Type                  0.800977
Blade_Width                 0.937129
Coupler                     0.466620
Coupler_System              0.891660
Differential_Type           0.826959
Drive_System                0.739829
Enclosure                   0.000810
Enclosure_Type              0.937129
Engine_Horsepower           0.937129
Forks                       0.521154
Grouser_Tracks              0.891899
Grouser_Type                0.752813
Hydraulics                  0.200823
Hydraulics_Flow             0.891899
MachineHoursCurrentMeter    0.644089
MachineID                   0.000000
ModelID                     0.000000
Pad_Type                    0.802720
Pattern_Changer             0.752651
ProductGroup                0.000000
ProductGroupDesc            0.000000
ProductSize                 0.525460
Pushblock                   0.937129
Ride_Control                0.629527
Ripper                      0.740388
SalePrice                   0.000000
SalesID                     0.000000
Scarifier                   0.937102
Steering_Controls           0.827064
Stick                       0.802720
Stick_Length                0.752651
Thumb                       0.752476
Tip_Control                 0.937129
Tire_Size                   0.763869
Track_Type                  0.752813
Transmission                0.543210
Travel_Controls             0.800975
Turbocharged                0.802720
Undercarriage_Pad_Width     0.751020
UsageBand                   0.826391
```

```
YearMade                    0.000000
auctioneerID                0.050199
datasource                  0.000000
fiBaseModel                 0.000000
fiModelDesc                 0.000000
fiModelDescriptor           0.820707
fiModelSeries               0.858129
fiProductClassDesc          0.000000
fiSecondaryDesc             0.342016
saleDay                     0.000000
saleDayofweek               0.000000
saleDayofyear               0.000000
saleElapsed                 0.000000
saleIs_month_end            0.000000
saleIs_month_start          0.000000
saleIs_quarter_end          0.000000
saleIs_quarter_start        0.000000
saleIs_year_end             0.000000
saleIs_year_start           0.000000
saleMonth                   0.000000
saleWeek                    0.000000
saleYear                    0.000000
state                       0.000000
dtype: float64
```

[89]:
```
os.makedirs('featherformat', exist_ok=True)
data_read.to_feather('tmp/featherfile')
```

[90]:
```
data_read = pd.read_feather('tmp/featherfile')
```

[ ]:
```
# The below functions viz fix_missing, numericalize , cat_to_numeric three␣
↪function is used to remove null values and to
# convert categorical values to numerical value
```

[7]:
```
def fix_missing(df, col, name, na_dict):
    if is_numeric_dtype(col):
        if pd.isnull(col).sum() or (name in na_dict):
            df[name+'_na'] = pd.isnull(col)
            filler = na_dict[name] if name in na_dict else col.median()
            df[name] = col.fillna(filler)
            na_dict[name] = filler
    return na_dict
```

[8]:
```
def numericalize(df, col, name, max_n_cat):
     if not is_numeric_dtype(col) and ( max_n_cat is None or len(col.cat.
↪categories)>max_n_cat):
```

```
        df[name] = pd.Categorical(col).codes+1
```

```
[9]: def cat_to_numeric(df, y_fld=None, skip_flds=None, ignore_flds=None,␣
     ↪do_scale=False, na_dict=None,
                 preproc_fn=None, max_n_cat=None, subset=None, mapper=None):
         if not ignore_flds: ignore_flds=[]
         if not skip_flds: skip_flds=[]
         if subset: df = get_sample(df,subset)
         else: df = df.copy()
         ignored_flds = df.loc[:, ignore_flds]
         df.drop(ignore_flds, axis=1, inplace=True)
         if preproc_fn: preproc_fn(df)
         if y_fld is None: y = None
         else:
             if not is_numeric_dtype(df[y_fld]): df[y_fld] = pd.
     ↪Categorical(df[y_fld]).codes
             y = df[y_fld].values
             skip_flds += [y_fld]
         df.drop(skip_flds, axis=1, inplace=True)

         if na_dict is None: na_dict = {}
         else: na_dict = na_dict.copy()
         na_dict_initial = na_dict.copy()
         for n,c in df.items(): na_dict = fix_missing(df, c, n, na_dict)
         if len(na_dict_initial.keys()) > 0:
             df.drop([a + '_na' for a in list(set(na_dict.keys()) -␣
     ↪set(na_dict_initial.keys()))], axis=1, inplace=True)
         if do_scale: mapper = scale_vars(df, mapper)
         for n,c in df.items(): numericalize(df, c, n, max_n_cat)
         df = pd.get_dummies(df, dummy_na=True)
         df = pd.concat([ignored_flds, df], axis=1)
         res = [df, y, na_dict]
         if do_scale: res = res + [mapper]
         return res
```

```
[12]: df, y, nas = cat_to_numeric(data_read, 'SalePrice')
```

```
[11]: df.head().transpose()
```

```
[11]:                                 0        1        2        3        4
      SalesID                   1139246  1139248  1139249  1139251  1139253
      MachineID                  999089   117657   434808  1026470  1057373
      ModelID                      3157       77     7009      332    17311
      datasource                    121      121      121      121      121
      auctioneerID                    3        3        3        3        3
      YearMade                     2004     1996     2001     2001     2007
      MachineHoursCurrentMeter       68     4640     2838     3486      722
```

UsageBand	2	2	1	1	3
saledate	2647	2148	2131	3753	3281
fiModelDesc	950	1725	331	3674	4208
fiBaseModel	296	527	110	1375	1529
fiSecondaryDesc	41	55	0	0	0
fiModelSeries	0	98	0	45	0
fiModelDescriptor	0	0	0	0	0
ProductSize	0	4	0	6	0
fiProductClassDesc	59	62	39	8	40
state	1	33	32	44	32
ProductGroup	6	6	3	4	3
ProductGroupDesc	6	6	3	4	3
Drive_System	0	0	0	0	0
Enclosure	3	3	6	3	1
Forks	1	1	1	0	1
Pad_Type	0	0	0	0	0
Ride_Control	2	2	0	0	0
Stick	0	0	0	0	0
Transmission	0	0	0	0	0
Turbocharged	0	0	0	0	0
Blade_Extension	0	0	0	0	0
Blade_Width	0	0	0	0	0
Enclosure_Type	0	0	0	0	0
Engine_Horsepower	0	0	0	0	0
Hydraulics	1	1	4	1	4
Pushblock	0	0	0	0	0
Ripper	0	0	0	0	0
Scarifier	0	0	0	0	0
Tip_Control	0	0	0	0	0
Tire_Size	17	12	0	0	0
Coupler	3	3	3	3	3
Coupler_System	0	0	1	0	1
Grouser_Tracks	0	0	1	0	1
Hydraulics_Flow	0	0	3	0	3
Track_Type	0	0	0	0	0
Undercarriage_Pad_Width	0	0	0	0	0
Stick_Length	0	0	0	0	0
Thumb	0	0	0	0	0
Pattern_Changer	0	0	0	0	0
Grouser_Type	0	0	0	0	0
Backhoe_Mounting	0	0	0	0	0
Blade_Type	0	0	0	0	0
Travel_Controls	0	0	0	0	0
Differential_Type	4	4	0	0	0
Steering_Controls	2	2	0	0	0
auctioneerID_na	False	False	False	False	False
MachineHoursCurrentMeter_na	False	False	False	False	False

[ ]:
```
# Now we will train the model using dataset in which dependent variable is␣
↪SalePrice and rest all are independent variable. Here as this is a
# regression task so we use random forest regressor
```

[13]:
```
m = RandomForestRegressor(n_jobs=-1)
m.fit(df, y)
m.score(df,y)
```

```
/home/abdul/anaconda3/envs/fastai/lib/python3.6/site-
packages/sklearn/ensemble/forest.py:245: FutureWarning: The default value of
n_estimators will change from 10 in version 0.20 to 100 in 0.22.
  "10 in version 0.20 to 100 in 0.22.", FutureWarning)
```

[13]:
```
0.982506543468755
```

[ ]:
```
# We have split tha dataset into train and valid in which training data shape␣
↪as 389125-rows and 54-columns and valid data
# set contents 12000-rows and 54 columns
```

[16]:
```
def split_vals(a,n):
    return a[:n].copy(), a[n:].copy()
n_valid = 12000
n_trn = len(df)-n_valid
raw_train, raw_valid = split_vals(data_read, n_trn)
X_train, X_valid = split_vals(df, n_trn)
y_train, y_valid = split_vals(y, n_trn)
X_train.shape, y_train.shape, X_valid.shape
```

[16]:
```
((389125, 54), (389125,), (12000, 54))
```

[22]:
```
def rmse(x,y): return math.sqrt(((x-y)**2).mean())
def print_score(m):
    res = [rmse(m.predict(X_train), y_train),
           rmse(m.predict(X_valid), y_valid),
           m.score(X_train, y_train), m.score(X_valid, y_valid)]
    if hasattr(m, 'oob_score_'): res.append(m.oob_score_)
    print(res)
m=RandomForestRegressor(n_jobs=-1)
%time m.fit(X_train, y_train)
print_score(m)
```

```
/home/abdul/anaconda3/envs/fastai/lib/python3.6/site-
packages/sklearn/ensemble/forest.py:245: FutureWarning: The default value of
n_estimators will change from 10 in version 0.20 to 100 in 0.22.
  "10 in version 0.20 to 100 in 0.22.", FutureWarning)
```

```
CPU times: user 1min 13s, sys: 274 ms, total: 1min 13s
Wall time: 23.3 s
```

```
[3053.999092533897, 8615.798772796306, 0.9823652537442809, 0.8737567902681392]
```

[ ]:
```
# From above reult we can say that -
# the training rmse is 0.3053 and validation rmse is 0.86. The r(square) value␣
↪for training is 0.98 and r(saquare) for
# valiadtion is 0.87.
```

[25]:
```
preds = np.stack([t.predict(X_valid) for t in m.estimators_])
preds[:,0], np.mean(preds[:,0]), y_valid[0]
```

[25]:
```
(array([ 9000., 10000.,  9000., 10000.,  9000.,  9000., 16000.,  9000., 10000.,
10000.]),
 10100.0,
 9000)
```

[24]:
```
preds.shape
```

[24]:
```
(10, 12000)
```

[26]:
```
# Each tree is stored in an attribute called estimators_ .
# For each tree, we will  predict with our validation set.
# np.stack concatenates them together on a new axis,
# so the resulting preds has the shape of (10, 12000) (10 trees, 12000␣
↪validation set).
# The mean of 10 predictions for the first data is 10, and the actual value is␣
↪9.
```

[ ]:
```
# now lets tune the hyperparameter and see the result.Here the hyperparameter␣
↪is estimators.
```

[27]:
```
m=RandomForestRegressor(n_estimators=20,n_jobs=-1)
%time m.fit(X_train, y_train)
print_score(m)
```

```
CPU times: user 2min 36s, sys: 695 ms, total: 2min 36s
Wall time: 43.6 s
[2775.4709165699182, 8241.811514463157, 0.9854351918180747, 0.8844786408164632]
```

[28]:
```
m=RandomForestRegressor(n_estimators=40,n_jobs=-1)
%time m.fit(X_train, y_train)
print_score(m)
```

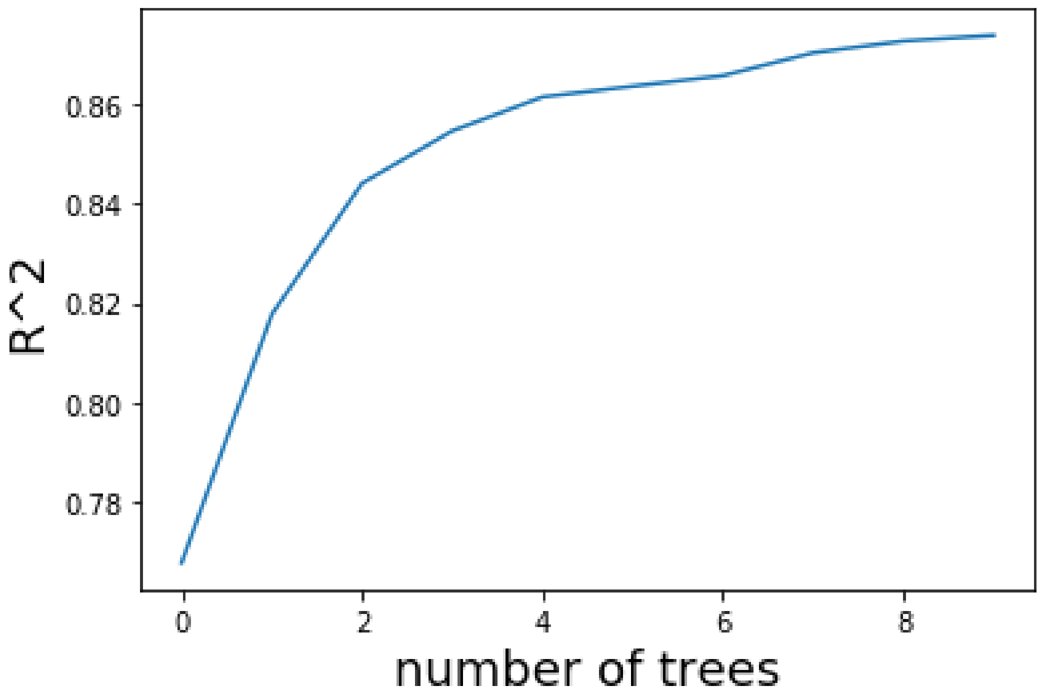
```
CPU times: user 5min 10s, sys: 927 ms, total: 5min 11s
Wall time: 1min 21s
[2632.942989539121, 8130.479245490734, 0.9868926674324792, 0.8875785390919012]
```

[ ]:
```
# Increasing the number of trees or estimators doesn't make much difference in␣
↪the predicted value and actual value.
# Adding more trees slows it down, but with less trees you can still draw some␣
↪conclusion.
```

[ ]:
```
# plot of R^2 vs Numer of trees . As we increase the number of trees the curve␣
↪becomes almost flat
```

[30]:
```
plt.plot([metrics.r2_score(y_valid, np.mean(preds[:i+1], axis=0)) for i in␣
↪range(10)]);
plt.xlabel('number of trees', fontsize=18)
plt.ylabel('R^2', fontsize=18)
```

[30]:
```
Text(0, 0.5, 'R^2')
```



[ ]:
```

```