In [24]:
```
%load_ext autoreload
%autoreload 2

%matplotlib inline
```

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

In [25]:
```
from fastai.imports import *
from fastai.structured import *
import numpy as np
import pandas as pd
from pandas_summary import DataFrameSummary
import sklearn.model_selection
from IPython.display import display
import math
import random
from sklearn import metrics
from sklearn.ensemble import RandomForestClassifier
from sklearn.svm import SVC
import collections
```

In [26]:
```
PATH = "data/Cristano_Ronaldo_Final_v1/"
```

In [27]:
```
!ls {PATH}
```

```
amit_dubey_190199_code_4.csv  data.csv  sample_submission.csv
amit_dubey_190199_code_5.csv  __MACOSX
```

Required Functions

In [28]:
```
def imae(x,y):
    return 1/(1+(abs(x-y)).mean())
```

In [29]:
```
def print_score(m):
    res = [
        imae(m.predict(X_train.drop(['Unnamed: 0'],axis=1)), y_train),
        imae(m.predict(X_valid.drop(['Unnamed: 0'],axis=1)), y_valid),
        m.score(X_train.drop(['Unnamed: 0'],axis=1), y_train),
        m.score(X_valid.drop(['Unnamed: 0'],axis=1), y_valid),
          ]
    if hasattr(m, 'oob_score_'): res.append(m.oob_score_)
    print(res)
```

In [30]:
```
def display_all(df):
    with pd.option_context("display.max_rows", 1000, "display.max_columns",
1000):
        display(df)
```

Data Pre-processing

In [31]:
```
df_i = pd.read_csv(f'{PATH}sample_submission.csv')
df_i.shot_id_number = df_i.shot_id_number-1
df_i=df_i.drop(['is_goal'], axis=1)
```

In [32]:
```
df_raw = pd.read_csv(f'{PATH}data.csv', low_memory=False, parse_dates=['date_of_game'])
```

In [33]:
```
df_raw.is_goal.value_counts()
```

Out[33]:
```
0.0    13550
1.0    10879
Name: is_goal, dtype: int64
```

In [34]:
```
display_all(df_raw.T)
```

	0	1	2	3	4	5	
Unnamed: 0	0	1	2	3	4	5	
match_event_id	10	12	35	43	155	244	
location_x	167	-157	-101	138	0	-145	
location_y	72	0	135	175	0	-11	
remaining_min	10	10	7	6	NaN	9	
power_of_shot	1	1	1	1	2	3	
knockout_match	0	0	0	0	0	0	
game_season	2000-01	2000-01	2000-01	2000-01	2000-01	NaN	2
remaining_sec	27	22	45	52	19	32	
distance_of_shot	38	35	36	42	20	34	
is_goal	NaN	0	1	0	1	0	
area_of_shot	Right Side(R)	Left Side(L)	Left Side Center(LC)	Right Side Center(RC)	Center(C)	Left Side(L)	C
shot_basics	Mid Range	Mid Range	Mid Range	Mid Range	Goal Area	Mid Range	G
range_of_shot	16-24 ft.	8-16 ft.	16-24 ft.	16-24 ft.	Less Than 8 ft.	8-16 ft.	Less
team_name	Manchester United	Manchester United	Manchester United	Manchester United	NaN	Manchester United	Mar
date_of_game	2000-10-31 00:00:00	2000-10-31 00:00:00	2000-10-31 00:00:00	2000-10-31 00:00:00	2000-10-31 00:00:00	2000-10-31 00:00:00	200 0
home/away	MANU @ POR	MANU @ POR	NaN	MANU @ POR	MANU @ POR	MANU @ POR	M
shot_id_number	1	2	3	4	5	6	
lat/lng	45.539131, -122.651648	45.539131, -122.651648	45.539131, -122.651648	45.539131, -122.651648	45.539131, -122.651648	45.539131, -122.651648	45. -122
type_of_shot	shot - 30	shot - 45	shot - 25	NaN	NaN	shot - 17	
type_of_combined_shot	NaN	NaN	NaN	shot - 3	shot - 1	NaN	
match_id	20000012	20000012	20000012	20000012	20000012	20000012	20
team_id	1610612747	1610612747	1610612747	1610612747	1610612747	1610612747	1610
remaining_min.1	10	10	92.64	NaN	42.64	9	
power_of_shot.1	1	1	1	1	2	3	
knockout_match.1	50.608	28.8	0	122.608	0	0	
remaining_sec.1	54.2	22	63.7216	52	19	NaN	
distance_of_shot.1	38	35	54.4	42	20	34	

28 rows × 30697 columns

In [35]:
```
df_raw['date_of_game'] = pd.to_datetime(df_raw.date_of_game)
df_raw=df_raw.sort_values('date_of_game')
display_all(df_raw.T)
```

	22901	22903	22904	22905	22906	22907	
Unnamed: 0	22901	22903	22904	22905	22906	22907	
match_event_id	102	124	144	151	157	226	
location_x	-140	-142	NaN	-10	75	-64	
location_y	116	181	0	138	177	223	
remaining_min	0	8	6	5	7	2	
power_of_shot	1	2	2	2	2	2	
knockout_match	0	0	0	0	0	0	
game_season	1996-97	1996-97	1996-97	1996-97	1996-97	NaN	1
remaining_sec	42	37	34	27	18	16	
distance_of_shot	38	43	20	33	39	43	
is_goal	0	1	0	1	NaN	1	
area_of_shot	Left Side Center(LC)	Left Side Center(LC)	Center(C)	Center(C)	Right Side Center(RC)	Center(C)	Ce
shot_basics	Mid Range	Mid Range	Goal Area	Goal Line	Mid Range	Mid Range	Go
range_of_shot	16-24 ft.	16-24 ft.	Less Than 8 ft.	8-16 ft.	16-24 ft.	16-24 ft.	Less
team_name	Manchester United	Manchester United	Manchester United	Manchester United	Manchester United	Manchester United	Man
date_of_game	1996-11-03 00:00:00	1996-11-06 00:00:00	1996-11-06 00:00:00	1996-11-06 00:00:00	1996-11-08 00:00:00	1996-11-08 00:00:00	1996 0(
home/away	MANU vs. MIN	MANU @ CHH	MANU @ CHH	MANU @ CHH	MANU @ TOR	MANU @ TOR	MA
shot_id_number	22902	22904	22905	22906	NaN	22908	
lat/lng	42.982923, -71.446094	35.205878, -80.841194	35.205878, -80.841194	NaN	43.717098, -79.395917	43.717098, -79.395917	43.7 -79.3
type_of_shot	shot - 18	shot - 9	NaN	NaN	NaN	NaN	sh
type_of_combined_shot	NaN	NaN	shot - 3	shot - 3	shot - 3	shot - 3	
match_id	29600027	29600044	29600044	29600044	29600057	29600057	296
team_id	1610612747	1610612747	1610612747	1610612747	1610612747	1610612747	1610
remaining_min.1	0	8	39.64	5	31.64	35.64	
power_of_shot.1	1	2	2	2	2	50.36	
knockout_match.1	0	0	0	100.928	0	0	
remaining_sec.1	48.2	37	34	NaN	18	16	
distance_of_shot.1	38	43	20	33	39	43	

28 rows × 30697 columns

In [72]:
```
"""
I tried this but it lead to worse r^2 score :/ so its commented now
lst = [
    'is_goal',
    'knockout_match',
    'game_season',
    'shot_basics',
    'team_name',
    'home/away',
    'lat/lng',
    'type_of_combined_shot',
    'match_id',
    'team_id',
    'knockout_match.1',
]
for col in lst:
    df_raw[col].interpolate(method='nearest',inplace=True)
    """;
```

In [22]:
```
?train_cats
```

train_cats

It change any columns of strings in a panda's dataframe to a column of categorical values. This applies the changes inplace.

In [37]:
```
train_cats(df_raw)
```

In [38]:
```
cols = ['knockout_match','match_event_id', 'game_season', 'area_of_shot','sh
ot_basics', 'range_of_shot', 'lat/lng', 'team_name',
       'home/away', 'shot_id_number',  'type_of_shot', 'type_of_combined_sho
t','match_id','team_id']
```

In [39]:
```
for col in cols:
    df_raw[col] = df_raw[col].astype('category').cat.codes
```

In [40]:
```
df_raw['year'] = df_raw['date_of_game'].dt.year
df_raw['month']=df_raw['date_of_game'].dt.month
df_raw=df_raw.drop(['date_of_game'],axis=1)
```

In [41]:
```
df_raw, __, ___ = proc_df(df_raw)
```

proc_df

It takes a data frame df and splits off the response variable, and changes the df into an entirely numeric dataframe. For each column of df which is not in skip_flds nor in ignore_flds, na values are replaced by the median value of the column.

In [42]:
```
df_raw.match_event_id.value_counts()
```

Out[42]:
```
-1      1563
 0       128
 2       102
 9        92
 276      88
 6        87
 15       86
 10       85
 4        85
 316      83
 247      82
 265      82
 335      82
 7        81
 24       81
 255      80
 22       80
 311      79
 100      79
 254      79
 11       79
 237      79
 86       79
 25       78
 71       78
 236      78
 240      78
 301      77
 14       77
 269      77
        ...
 572       2
 581       2
 612       2
 596       2
 595       2
 579       2
 604       2
 594       2
 573       2
 577       2
 586       2
 588       1
 617       1
 603       1
 587       1
 606       1
 602       1
 592       1
 585       1
 616       1
 615       1
 599       1
 608       1
 614       1
 597       1
 611       1
 610       1
 609       1
 593       1
 607       1
Name: match_event_id, Length: 619, dtype: int64
```

In [43]:
```
df_tst = df_raw[df_raw['Unnamed: 0'].isin(df_i['shot_id_number'])]
df_trn = df_raw[~df_raw['Unnamed: 0'].isin(df_i['shot_id_number'])]
```

In [44]:
```
display_all(df_trn.T)
```

	22901	22903	22904	22905	22907	22909	22910	22911	22912	22913	22914
Unnamed: 0	22901	22903	22904	22905	22907	22909	22910	22911	22912	22913	22914
match_event_id	100	122	142	149	224	332	335	350	378	382	105
location_x	-140	-142	0	-10	-64	-79	-103	0	-155	0	0
location_y	116	181	0	138	223	177	207	0	175	0	0
remaining_min	0	8	6	5	2	1	1	0	9	8	1
power_of_shot	1	2	2	2	2	3	3	3	4	4	1
knockout_match	0	0	0	0	0	-1	0	0	0	0	0
game_season	0	0	0	0	-1	0	0	0	-1	0	-1
remaining_sec	42	37	34	27	16	53	14	2	9	36	10
distance_of_shot	38	43	20	33	43	39	43	20	43	20	20
is_goal	0	1	0	1	1	0	1	0	0	0	0
area_of_shot	1	1	0	0	0	1	1	0	1	0	0
shot_basics	4	4	0	1	4	4	4	0	4	0	0
range_of_shot	0	0	4	2	0	0	0	4	0	4	4
team_name	0	0	0	0	0	0	0	0	0	0	0
home/away	54	4	4	4	32	32	32	32	32	32	-1
shot_id_number	21701	21703	21704	21705	21706	21708	21709	21710	21711	21712	21713
lat/lng	31	13	13	-1	33	33	33	33	33	33	31
type_of_shot	10	56	-1	-1	-1	20	-1	34	13	34	34
type_of_combined_shot	-1	-1	3	3	3	-1	3	-1	-1	-1	-1
match_id	1079	1081	1081	1081	1082	1082	1082	1082	1082	1082	1083
team_id	0	0	0	0	0	0	0	0	0	0	0
remaining_min.1	0	8	39.64	5	35.64	1	1	0	9	8	75.2
power_of_shot.1	1	2	2	2	50.36	3	3	3	92.36	112.36	1
knockout_match.1	0	0	0	100.928	0	23.8	0	0	97.928	0	0
remaining_sec.1	48.2	37	34	35	16	53	14	2	9	36	35
distance_of_shot.1	38	43	20	33	43	39	31.4	20	99.4	51.4	20
year	1996	1996	1996	1996	1996	1996	1996	1996	1996	1996	1996
month	11	11	11	11	11	11	11	11	11	11	11
location_x_na	False	False	True	False	False	False	False	False	False	False	False
location_y_na	False	False	False	False	False	False	False	False	False	False	False
remaining_min_na	False	False	False	False	False	False	False	False	False	False	False
power_of_shot_na	False	False	False	False	False	False	True	False	False	False	False
remaining_sec_na	False	False	False	False	False	False	False	False	False	False	False
distance_of_shot_na	False	False	False	False	False	False	False	False	False	False	False
is_goal_na	False	False	False	False	False	False	False	False	False	False	False
remaining_min.1_na	False	False	False	False	False	False	False	False	False	False	False
power_of_shot.1_na	False	False	False	False	False	False	False	False	False	False	False
knockout_match.1_na	False	False	False	False	False	False	False	False	False	False	False
remaining_sec.1_na	False	False	False	True	False	False	False	False	False	False	True
distance_of_shot.1_na	False	False	False	False	False	False	False	False	False	False	False
year_na	False	False	False	False	False	False	False	False	False	False	False

In [45]:
```
df_trn.describe()
```

Out[45]:

	Unnamed: 0	match_event_id	location_x	location_y	remaining_min	power_of_shot	knocko
count	25697.000000	25697.000000	25697.000000	25697.000000	25697.000000	25697.000000	2569
mean	15327.166946	235.127602	7.105421	90.453438	4.891116	2.545122	
std	8860.462397	155.817575	107.559386	85.810451	3.365993	1.128151	
min	1.000000	-1.000000	-250.000000	-44.000000	0.000000	1.000000	
25%	7645.000000	90.000000	-59.000000	7.000000	2.000000	2.000000	
50%	15335.000000	241.000000	0.000000	74.000000	5.000000	3.000000	
75%	22975.000000	358.000000	90.000000	156.000000	8.000000	3.000000	
max	30696.000000	616.000000	248.000000	791.000000	11.000000	7.000000	

8 rows × 29 columns

In [46]:
```
 X_train, X_valid, y_train, y_valid  = sklearn.model_selection.train_test_sp
lit(df_trn.drop(['is_goal'],axis=1), df_trn['is_goal'], test_size=0.20, rand
om_state=42)
```

In [47]:
```
X_train.shape, X_valid.shape, y_train.shape, y_valid.shape
```

Out[47]:
```
((20557, 42), (5140, 42), (20557,), (5140,))
```

Model Selection & Analysis

set_rf_samples(n)

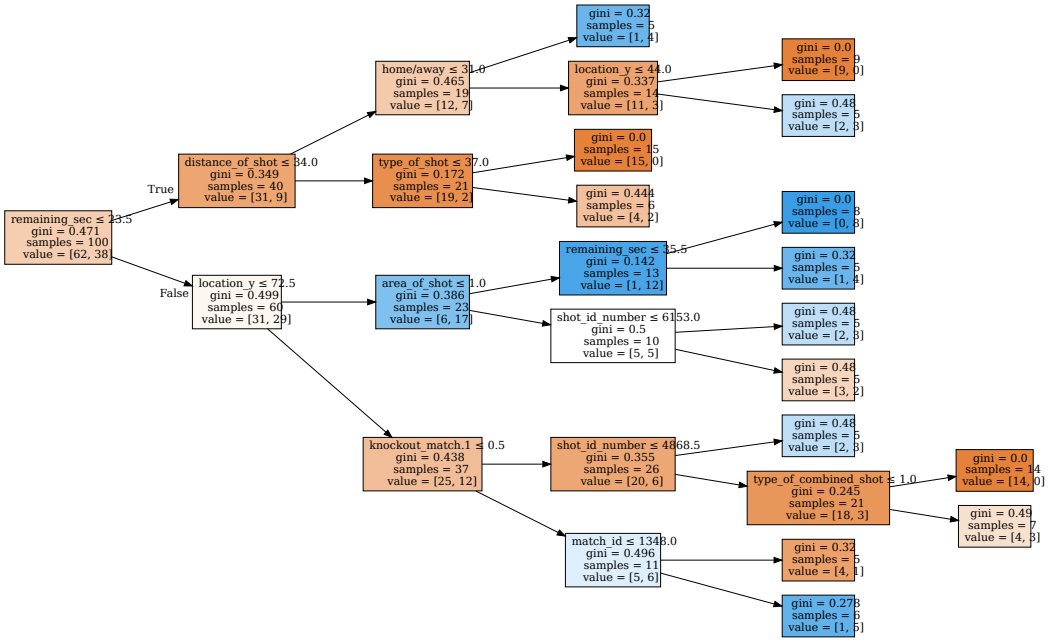
Changes Scikit learn's random forests to give each tree a random sample of n random rows.

In [67]:
```
set_rf_samples(100)
```

In [68]:
```
clf = RandomForestClassifier(n_estimators=1000, max_depth=10, max_features=
0.5, min_samples_leaf=5)
clf.fit(X_train.drop(['Unnamed: 0'],axis=1), y_train)
print_score(clf)
```

```
[0.7244502396391317, 0.7206954570947841, 0.6196429440093398, 0.61245136186770
43]
```

In [50]:
```
draw_tree(clf.estimators_[0], X_train.drop(['Unnamed: 0'],axis=1), precisio
n=3)
```

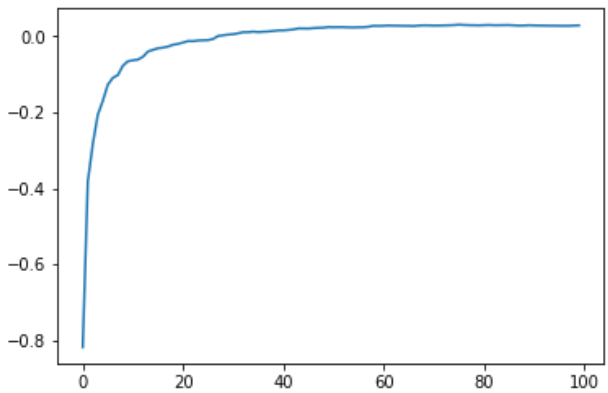


In [51]:
```
pred_valid =  clf.predict(X_train.drop(['Unnamed: 0'],axis=1))
collections.Counter(pred_valid)
```

Out[51]:
```
Counter({0.0: 15933, 1.0: 4624})
```

In [52]:
```
preds = np.stack([t.predict(X_valid.drop(['Unnamed: 0'],axis=1)) for t in cl
f.estimators_])
#preds[:,0], np.mean(preds[:,0]), y_valid[0]
```

In [65]:
```
plt.plot([metrics.r2_score(y_valid, np.mean(preds[:i+1], axis=0)) for i in r
ange(100)]);
```



In [54]:
```
fi = rf_feat_importance(clf, X_valid.drop(['Unnamed: 0'],axis=1))
fi[:]
```

Out[54]:

	cols	imp
2	location_y	0.068470
0	match_event_id	0.068415
8	distance_of_shot	0.065186
13	home/away	0.063609
23	remaining_sec.1	0.059963
1	location_x	0.057858
24	distance_of_shot.1	0.057441
7	remaining_sec	0.054528
18	match_id	0.051288
14	shot_id_number	0.049876
20	remaining_min.1	0.042990
6	game_season	0.040110
16	type_of_shot	0.036658
3	remaining_min	0.036567
25	year	0.036102
15	lat/lng	0.035925
26	month	0.035921
21	power_of_shot.1	0.026117
10	shot_basics	0.019469
9	area_of_shot	0.018344
22	knockout_match.1	0.016383
11	range_of_shot	0.015479
4	power_of_shot	0.013549
17	type_of_combined_shot	0.012213
33	is_goal_na	0.008094
5	knockout_match	0.001652
29	remaining_min_na	0.000874
38	distance_of_shot.1_na	0.000782
36	knockout_match.1_na	0.000740
31	remaining_sec_na	0.000680
12	team_name	0.000657
35	power_of_shot.1_na	0.000637
32	distance_of_shot_na	0.000617
30	power_of_shot_na	0.000574
39	year_na	0.000561
27	location_x_na	0.000492
34	remaining_min.1_na	0.000358
28	location_y_na	0.000307
37	remaining_sec.1_na	0.000280
40	month_na	0.000235
19	team_id	0.000000

In [55]:
```
clf.fit(df_trn.drop(['Unnamed: 0','is_goal'],axis=1), df_trn['is_goal'])
```

Out[55]:
```
RandomForestClassifier(bootstrap=True, class_weight=None, criterion='gini',
                       max_depth=10, max_features=0.5, max_leaf_nodes=None,
                       min_impurity_decrease=0.0, min_impurity_split=None,
                       min_samples_leaf=5, min_samples_split=2,
                       min_weight_fraction_leaf=0.0, n_estimators=1000,
                       n_jobs=None, oob_score=False, random_state=None,
                       verbose=0, warm_start=False)
```

In [56]:
```
df_tst = df_tst.drop(['is_goal'],axis=1)
```

In [57]:
```
df_trn.T
```

Out[57]:

	22901	22903	22904	22905	22907	22909	22910	22911	22912	22913	...	3(
Unnamed: 0	22901	22903	22904	22905	22907	22909	22910	22911	22912	22913	...	3(
match_event_id	100	122	142	149	224	332	335	350	378	382	...	
location_x	-140	-142	0	-10	-64	-79	-103	0	-155	0	...	
location_y	116	181	0	138	223	177	207	0	175	0	...	
remaining_min	0	8	6	5	2	1	1	0	9	8	...	
power_of_shot	1	2	2	2	2	3	3	3	4	4	...	
knockout_match	0	0	0	0	0	-1	0	0	0	0	...	
game_season	0	0	0	0	-1	0	0	0	-1	0	...	
remaining_sec	42	37	34	27	16	53	14	2	9	36	...	
distance_of_shot	38	43	20	33	43	39	43	20	43	20	...	
is_goal	0	1	0	1	1	0	1	0	0	0	...	
area_of_shot	1	1	0	0	0	1	1	0	1	0	...	
shot_basics	4	4	0	1	4	4	4	0	4	0	...	
range_of_shot	0	0	4	2	0	0	0	4	0	4	...	
team_name	0	0	0	0	0	0	0	0	0	0	...	
home/away	54	4	4	4	32	32	32	32	32	32	...	
shot_id_number	21701	21703	21704	21705	21706	21708	21709	21710	21711	21712	...	2(
lat/lng	31	13	13	-1	33	33	33	33	33	33	...	
type_of_shot	10	56	-1	-1	-1	20	-1	34	13	34	...	
type_of_combined_shot	-1	-1	3	3	3	-1	3	-1	-1	-1	...	
match_id	1079	1081	1081	1081	1082	1082	1082	1082	1082	1082	...	1
team_id	0	0	0	0	0	0	0	0	0	0	...	
remaining_min.1	0	8	39.64	5	35.64	1	1	0	9	8	...	
power_of_shot.1	1	2	2	2	50.36	3	3	3	92.36	112.36	...	
knockout_match.1	0	0	0	100.928	0	23.8	0	0	97.928	0	...	
remaining_sec.1	48.2	37	34	35	16	53	14	2	9	36	...	
distance_of_shot.1	38	43	20	33	43	39	31.4	20	99.4	51.4	...	
year	1996	1996	1996	1996	1996	1996	1996	1996	1996	1996	...	2
month	11	11	11	11	11	11	11	11	11	11	...	
location_x_na	False	False	True	False	False	False	False	False	False	False	...	F
location_y_na	False	False	False	False	False	False	False	False	False	False	...	F
remaining_min_na	False	False	False	False	False	False	False	False	False	False	...	F
power_of_shot_na	False	False	False	False	False	False	True	False	False	False	...	F
remaining_sec_na	False	False	False	False	False	False	False	False	False	False	...	F
distance_of_shot_na	False	False	False	False	False	False	False	False	False	False	...	
is_goal_na	False	False	False	False	False	False	False	False	False	False	...	
remaining_min.1_na	False	False	False	False	False	False	False	False	False	False	...	F
power_of_shot.1_na	False	False	False	False	False	False	False	False	False	False	...	F
knockout_match.1_na	False	False	False	False	False	False	False	False	False	False	...	F
remaining_sec.1_na	False	False	False	True	False	False	False	False	False	False	...	F
distance_of_shot.1_na	False	False	False	False	False	False	False	False	False	False	...	F
year_na	False	False	False	False	False	False	False	False	False	False	...	

In [58]:
```
pred_tst = clf.predict(df_tst.drop(['Unnamed: 0'],axis=1))
```

In [59]:
```
pred_tst
```

Out[59]:
```
array([0., 1., 0., ..., 0., 0., 1.])
```

In [60]:
```
df_ans=pd.DataFrame()
df_ans['id']=df_tst['Unnamed: 0']+1
```

In [61]:
```
df_ans['prediction']=pred_tst.astype('int')
```

In [62]:
```
df_ans=df_ans.sort_values('id')
```

In [63]:
```
#df_ans.prediction = df_ans.prediction.astype('int')
df_ans.to_csv(f'{PATH}/amit_dubey_190199_code_5.csv', index=False)
```

In [64]:
```
df_ans.T
```

Out[64]:

	0	7	16	19	32	33	34	35	36	37	...	30646	30648	30655	30659	30664	30668	30680	
id	1	8	17	20	33	34	35	36	37	38	...	30647	30649	30656	30660	30665	30669	30681	
prediction	0	0	1	1	0	0	1	0	0	0	...	0	0	0	0	0	0	1	

2 rows × 5000 columns