Original data + encode all columns + select all columns for tranning

```
GB accuracy
0.648936170212766
GB CFmap
[[493  21  30  44  34  21]
 [  6  33  20  18  22   4]
 [  3   4   8   6   1   5]
 [  1   8   5   4   7   3]
 [  1   4   2   6   6   7]
 [  2   6   2   2   2   5]]
GB f1 score
0.2916397357168776
```

F class

F class max = 0.269

https://machinelearningmastery.com/feature-selection-machine-learning-python/

F_class 3 個 fea

```
15   Satisfication_Score
19   Tenure_in_Months
35   Contract
```

```
GB accuracy
0.5803782505910166
GB CFmap
[[443  49   8  41  22  80]
 [  6  28  20  16  15  18]
 [  1   7   5   6   3   5]
 [  2  10   3   6   3   4]
 [  2   3   3   5   5   8]
 [  1   6   2   3   3   4]]
GB f1 score
0.25465866969105316
```

F_class 5 個 fea

```
15   Satisfication_Score
18   Number_of_Referrals
19   Tenure_in_Months
35   Contract
42   Total_Long_Distance_Charges
```

```
GB accuracy
0.6122931442080378
GB CFmap
[[466  65  13  38  22  39]
 [  3  33  15   8  24  20]
 [  2   6   4   5   6   4]
 [  2   9   1   6   6   4]
 [  1   6   5   5   5   4]
 [  1   7   2   1   4   4]]
GB f1 score
0.26095757890384785
```

F_class 8 個 fea

```
7   Number_of_Dependents
15   Satisfication_Score
18   Number_of_Referrals
19   Tenure_in_Months
35   Contract
39   Total_Charges
42   Total_Long_Distance_Charges
43   Total_Revenue
```

```
GB accuracy
0.6252955082742316
GB CFmap
[[476  46  12  31  35  43]
 [  5  33  11  13  22  19]
 [  2   7   4   5   3   6]
 [  2   9   2   3   9   3]
 [  0   5   3   6   6   6]
 [  0   3   0   2   7   7]]
GB f1 score
0.2691947434082061
```

F_class 10 個 fea

```
4   Senior_Citizen
6   Dependents
7   Number_of_Dependents
15   Satisfication_Score
18   Number_of_Referrals
19   Tenure_in_Months
35   Contract
39   Total_Charges
42   Total_Long_Distance_Charges
43   Total_Revenue
```

```
GB accuracy
0.6158392434988179
GB CFmap
[[477  31  15  33  31  56]
 [  5  26  14  14  23  21]
 [  3   6   6   5   2   5]
 [  2   8   3   2   9   4]
 [  1   6   3   3   6   7]
 [  0   2   3   4   6   4]]
GB f1 score
0.25477398138605084
```

F_class 20 個 fea

```
2   Age
4   Senior_Citizen
6   Dependents
7   Number_of_Dependents
15   Satisfication_Score
17   Referred_a_Friend
18   Number_of_Referrals
19   Tenure_in_Months
20   Offer                          GB accuracy
21   Phone_Service                  0.6264775413711584
24   Internet_Service               GB CFmap
25   Internet_Type                  [[493  21  28  33  36  32]
27   Online_Security                 [  4  21  21  20  20  17]
30   Premium_Tech_Support            [  2   7   4   6   3   5]
35   Contract                        [  2   8   5   2   6   5]
36   Paperless_Billing               [  1   5   3   2   8   7]
38   Monthly_Charge                  [  1   2   5   4   5   2]]
39   Total_Charges                  GB f1 score
42   Total_Long_Distance_Charges    0.23997181400270784
43   Total_Revenue
```

LogisticRegression

---

sklearn.feature_selection.SelectFromModel

LogisticRegression max =0.155

https://scikit-learn.org/stable/modules/generated/sklearn.feature_selection.SelectFromModel.html

```
10   City
12   Lat_Long
14   Longitude
38   Monthly_Charge
39   Total_Charges
42   Total_Long_Distance_Charges
43   Total_Revenue
```

```
GB accuracy
0.34515366430260047
GB CFmap
[[260  68  88  79  72  76]
 [ 16  18  17  19  20  13]
 [  6   5   5   4   2   5]
 [  6   7   4   3   6   2]
 [ 10   4   4   1   3   4]
 [  0   3   3   5   5   3]]
GB f1 score
0.15506166978661637
```

RFE

sklearn.feature_selection.RFE¶

RFE max = 0.2848

https://scikit-learn.org/stable/modules/generated/sklearn.feature_selection.RFE.html#sklearn.feature_selection.RFE

n = 5

```
4    Senior_Citizen
7    Number_of_Dependents
15    Satisfication_Score
32    Streaming_Movies
35    Contract
```

```
GB accuracy
0.5874704491725768
GB CFmap
[[463  19  42  41  48  30]
 [  3  16  28  19  21  16]
 [  1   3   7   8   4   4]
 [  0   6   6   5   6   5]
 [  3   4   7   1   5   6]
 [  0   2   8   6   2   1]]
GB f1 score
0.22661760268980635
```

N = 10

```
4    Senior_Citizen
6    Dependents
7    Number_of_Dependents
9    State
15    Satisfication_Score
27    Online_Security
30    Premium_Tech_Support
32    Streaming_Movies
35    Contract
36    Paperless_Billing
```

```
GB accuracy
0.6382978723404256
GB CFmap
[[487  20  23  35  24  54]
 [  5  28  16  20  15  19]
 [  2   7   3   8   3   4]
 [  1   3   1   9   3  11]
 [  3   5   1   7   7   3]
 [  1   2   6   4   0   6]]
GB f1 score
0.2848737826695433
```

N = 12

```
4   Senior_Citizen
6   Dependents
7   Number_of_Dependents
9   State
15   Satisfication_Score
16   Quarter
23   Multiple_Lines
27   Online_Security
30   Premium_Tech_Support
32   Streaming_Movies
35   Contract
36   Paperless_Billing
GB accuracy
0.6158392434988179
GB CFmap
[[475  19  25  38  32  54]
 [  5  30  21  14  17  16]
 [  1   3   1   9   6   7]
 [  1   5   3   5   5   9]
 [  2   4   4   5   5   6]
 [  1   4   4   3   2   5]]
GB f1 score
0.2524406407377126
```

N = 15

```
4   Senior_Citizen
6   Dependents
7   Number_of_Dependents
9   State
15   Satisfication_Score
16   Quarter
21   Phone_Service
23   Multiple_Lines
27   Online_Security
30   Premium_Tech_Support
31   Streaming_TV
32   Streaming_Movies
34   Unlimited_Data
35   Contract
36   Paperless_Billing
GB accuracy
0.6170212765957447
GB CFmap
[[472  28  25  31  44  43]
 [  8  29  18  16  19  13]
 [  2   3   3  10   4   5]
 [  1   4   5   9   4   5]
 [  1   4   5   3   6   7]
 [  1   4   5   5   1   3]]
GB f1 score
0.2652504867652091
```

N = 20

```
4   Senior_Citizen
6   Dependents
7   Number_of_Dependents
9   State
15   Satisfication_Score
16   Quarter
17   Referred_a_Friend
18   Number_of_Referrals
21   Phone_Service
23   Multiple_Lines
25   Internet_Type
27   Online_Security
29   Device_Protection_Plan
30   Premium_Tech_Support
31   Streaming_TV
32   Streaming_Movies
33   Streaming_Music
34   Unlimited_Data
35   Contract
36   Paperless_Billing
GB accuracy
0.6323877068557919
GB CFmap
[[487  26  25  33  28  44]
 [  4  24  25  18  13  19]
 [  1   6   6   6   1   7]
 [  1  10   3   5   3   6]
 [  0   4   8   3   8   3]
 [  0   4   3   6   1   5]]
GB f1 score
0.27506493778870206
```

嵌入式（embedded）Max = 0.269

SelectFromModel 選取特征

https://www.itread01.com/content/1527535241.html

```
1   Gender
2   Age
3   Under_30
4   Senior_Citizen
5   Married
6   Dependents
7   Number_of_Dependents
10   City
12   Lat_Long
13   Latitude
14   Longitude
15   Satisfication_Score
16   Quarter
17   Referred_a_Friend
18   Number_of_Referrals
19   Tenure_in_Months
20   Offer
21   Phone_Service
22   Avg_Monthly_Long_Distance_Charges
23   Multiple_Lines
24   Internet_Service
25   Internet_Type
26   Avg_Monthly_GB_Download
27   Online_Security
28   Online_Backup
30   Premium_Tech_Support
32   Streaming_Movies
34   Unlimited_Data
35   Contract
36   Paperless_Billing
37   Payment_Method
38   Monthly_Charge
39   Total_Charges
40   Total_Refunds
41   Total_Extra_Data_Charges
42   Total_Long_Distance_Charges
43   Total_Revenue
```

```
GB accuracy
0.6252955082742316
GB CFmap
[[477  34  28  44  39  21]
 [  2  31  16  16  19  19]
 [  0   5   6  11   3   2]
 [  1   9   4   6   5   3]
 [  1   5   4   5   6   5]
 [  0   4   2   4   6   3]]
GB f1 score
0.2692123198894921
```

KNeighbors

---

sklearn.feature_selection.SequentialFeatureSelector¶

KNeighbors max = 0.30 -> kaggle:0.27

– K = 10

https://scikit-learn.org/stable/modules/generated/sklearn.feature_selection.SequentialFeatureSelector.html#sklearn.feature_selection.SequentialFeatureSelector

```
0   Count
3   Under_30
7   Number_of_Dependents
9   State
15   Satisfication_Score
16   Quarter
21   Phone_Service
25   Internet_Type
35   Contract
40   Total_Refunds
```

```
GB accuracy
0.6028368794326241
GB CFmap
[[461  34  24  47  22  55]
 [  4  28  25  16  16  14]
 [  0   7   6   6   4   4]
 [  2   7   0   6   4   9]
 [  3   4   5   4   6   4]
 [  0   6   3   7   0   3]]
GB f1 score
0.26211437182969793
```

– K = 15

```
0   Count
4   Senior_Citizen
6   Dependents
7   Number_of_Dependents
15   Satisfication_Score
16   Quarter
17   Referred_a_Friend
18   Number_of_Referrals
27   Online_Security
30   Premium_Tech_Support
31   Streaming_TV
34   Unlimited_Data
35   Contract
36   Paperless_Billing
40   Total_Refunds
```

```
GB accuracy
0.6288416075650118
GB CFmap
[[479  17  32  42  27  46]
 [  3  23  23  16  19  19]
 [  2   4   5   8   6   2]
 [  1   4   3   9   4   7]
 [  1   1   5   2  12   5]
 [  0   3   3   7   2   4]]
GB f1 score
0.2894165329684166
```

K = 18 //pred(4)

```
0   Count
4   Senior_Citizen
6   Dependents
7   Number_of_Dependents
8   Country
9   State
15   Satisfication_Score
16   Quarter
17   Referred_a_Friend
24   Internet_Service
27   Online_Security
28   Online_Backup
29   Device_Protection_Plan
30   Premium_Tech_Support
32   Streaming_Movies
35   Contract
36   Paperless_Billing
40   Total_Refunds
```

```
GB accuracy
0.6382978723404256
GB CFmap
[[483  28  20  37  32  43]
 [  5  26  24  11  12  25]
 [  3   8   5   5   2   4]
 [  1   3   3  12   6   3]
 [  3   4   7   1   8   3]
 [  1   2   4   4   2   6]]
GB f1 score
0.3002158434124354
```

Name	Submitted	Wait time	Execution time	Score
pred (4).csv	just now	1 seconds	0 seconds	0.27477

Complete

K = 20

```
0   Count
3   Under_30
7   Number_of_Dependents
8   Country
9   State
15   Satisfication_Score
16   Quarter
17   Referred_a_Friend
18   Number_of_Referrals
23   Multiple_Lines
27   Online_Security
28   Online_Backup
29   Device_Protection_Plan
30   Premium_Tech_Support
31   Streaming_TV
32   Streaming_Movies
33   Streaming_Music
35   Contract
36   Paperless_Billing
40   Total_Refunds
```

```
GB accuracy
0.6323877068557919
GB CFmap
[[494  34  17  32  29  37]
 [  6  19  25  14  23  16]
 [  1   5   4   6   4   7]
 [  1   8   2   8   4   5]
 [  1   5   6   1   5   8]
 [  1   2   4   5   2   5]]
GB f1 score
0.25870611261495713
```

Tree-based

1.13.4.2. Tree-based feature selection

https://scikit-learn.org/stable/modules/feature_selection.html#univariate-feature-selection

n_estimator = 50

```
2   Age
10   City                    GB accuracy
11   Zip_Code                0.5957446808510638
12   Lat_Long                GB CFmap
13   Latitude                [[455  34  35  44  45  30]
14   Longitude                [  7  23  16  18  20  19]
15   Satisfication_Score      [  1   3   8   9   2   4]
19   Tenure_in_Months         [  2   8   4   4   6   4]
25   Internet_Type            [  1   2   6   3  10   4]
35   Contract                 [  1   4   3   3   4   4]]
38   Monthly_Charge          GB f1 score
43   Total_Revenue           0.264491121363186
```

n_estimator = 40

```
2   Age
6   Dependents
10   City                    GB accuracy
11   Zip_Code                0.607565011820331
12   Lat_Long                GB CFmap
13   Latitude                [[463  28  39  51  36  26]
14   Longitude                [  7  27  16  17  18  18]
15   Satisfication_Score      [  2   5   8   7   2   3]
19   Tenure_in_Months         [  3   7   5   5   5   3]
35   Contract                 [  0   3   6   6   7   4]
38   Monthly_Charge           [  0   4   4   5   2   4]]
39   Total_Charges           GB f1 score
43   Total_Revenue           0.2699155845526327
```

n_estimator = 30

```
2   Age
10   City
11   Zip_Code                GB accuracy
12   Lat_Long                0.607565011820331
13   Latitude                GB CFmap
14   Longitude               [[465  30  35  37  43  33]
15   Satisfication_Score      [  6  26  16  18  19  18]
18   Number_of_Referrals      [  0   3   8   9   3   4]
19   Tenure_in_Months         [  2   9   4   3   5   5]
25   Internet_Type            [  0   3   6   4   8   5]
35   Contract                 [  1   6   1   3   4   4]]
38   Monthly_Charge          GB f1 score
43   Total_Revenue           0.2640508997238404
```

n_estimator = 20

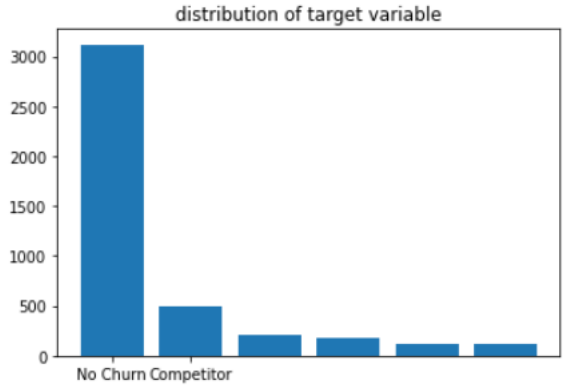
```
2   Age
4   Senior_Citizen
10   City
11   Zip_Code
12   Lat_Long
13   Latitude
14   Longitude
15   Satisfication_Score
19   Tenure_in_Months
35   Contract
38   Monthly_Charge
39   Total_Charges
42   Total_Long_Distance_Charges
43   Total_Revenue
```

```
GB accuracy
0.5756501182033097
GB CFmap
[[440  30  47  54  41  31]
 [  8  23  15  21  20  16]
 [  1   6   6  10   3   1]
 [  3  11   5   4   4   1]
 [  2   3   3   4   9   5]
 [  0   4   3   3   4   5]]
GB f1 score
0.2553160739826658
```

n_estimator = 10

```
2   Age
4   Senior_Citizen
10   City
11   Zip_Code
12   Lat_Long
13   Latitude
14   Longitude
15   Satisfication_Score
18   Number_of_Referrals
19   Tenure_in_Months
35   Contract
38   Monthly_Charge
43   Total_Revenue
```

```
GB accuracy
0.6182033096926713
GB CFmap
[[472  28  36  35  39  33]
 [  6  25  14  17  21  20]
 [  2   4   7  10   2   2]
 [  2  11   4   3   4   4]
 [  0   3   5   4  11   3]
 [  0   6   1   4   3   5]]
GB f1 score
0.2748428732124128
```


distribution of target variable
3000
2500
2000
1500
1000
500
0
No Churn Competitor