DMG2 Assignment Problem 2

Purity, Entropy, Information Gain

In [17]:
```
import numpy as np
import pandas as pd
import os
import matplotlib.pyplot as plt
import seaborn as sns

sns.set_style('white')
```

In [18]:
```
DATA_DIR = '/home/jishnu/Documents/ISB/Term3/dmg2/assignments/hw_assignment
1/dmg2/datasets/mushroom'
train = pd.read_csv(os.path.join(DATA_DIR,'train.csv'),usecols=['V{0}'.forma
t(i) for i in range(1,24)])
test = pd.read_csv(os.path.join(DATA_DIR,'test.csv'),usecols=
['V{0}'.format(i) for i in range(1,24)])

train.columns
```

Out[18]:
```
Index(['V1', 'V2', 'V3', 'V4', 'V5', 'V6', 'V7', 'V8', 'V9', 'V10', 'V11',
       'V12', 'V13', 'V14', 'V15', 'V16', 'V17', 'V18', 'V19', 'V20', 'V21',
       'V22', 'V23'],
      dtype='object')
```

In [19]:
```
train.head()
```

Out[19]:

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	...	V14	V15	V16	V17	V18	V19	V20	V21	V22	V23
0	p	x	s	n	t	p	f	c	n	k	...	s	w	w	p	w	o	p	k	s	u
1	e	x	s	y	t	a	f	c	b	k	...	s	w	w	p	w	o	p	n	n	g
2	e	x	s	g	f	n	f	w	b	k	...	s	w	w	p	w	o	e	n	a	g
3	p	x	y	w	t	p	f	c	n	p	...	s	w	w	p	w	o	p	k	v	g
4	e	x	y	y	t	a	f	c	b	n	...	s	w	w	p	w	o	p	k	s	m

5 rows × 23 columns

In [20]:
```
#for col_no in range(1,24):
    #print('V{0}'.format(col_no))
#    train['V{0}'.format(col_no)] =
train_cat = train.astype('category')
train_cat.dtypes
```

Out[20]:
```
V1     category
V2     category
V3     category
V4     category
V5     category
V6     category
V7     category
V8     category
V9     category
V10    category
V11    category
V12    category
V13    category
V14    category
V15    category
V16    category
V17    category
V18    category
V19    category
V20    category
V21    category
V22    category
V23    category
dtype: object
```

In [21]:
```
train_cat.describe().T
```

Out[21]:

	count	unique	top	freq
V1	4907	2	e	2535
V2	4907	6	x	2198
V3	4907	4	y	1998
V4	4907	10	n	1372
V5	4907	2	f	2862
V6	4907	9	n	2148
V7	4907	2	f	4772
V8	4907	2	c	4135
V9	4907	2	b	3419
V10	4907	12	b	1040
V11	4907	2	t	2783
V12	4907	4	b	3820
V13	4907	4	s	3098
V14	4907	4	s	2966
V15	4907	9	w	2651
V16	4907	9	w	2595
V17	4907	1	p	4907
V18	4907	4	w	4781
V19	4907	3	o	4506
V20	4907	5	p	2411
V21	4907	9	w	1449
V22	4907	6	v	2440
V23	4907	7	d	1938

In [22]:
```
pd.DataFrame(train_cat['V1'].value_counts()).reset_index()
```

Out[22]:

	index	V1
0	e	2535
1	p	2372

In [25]:
```
v2_grouped = train_cat.groupby(by='V2')

v2_v1_df = pd.DataFrame(v2_grouped.V1.value_counts()).rename(columns=
{'V1':'count'}).reset_index()

v2_v1_df
```

Out[25]:

	V2	V1	count
0	b	e	242
1	b	p	26
2	c	p	3
3	f	e	989
4	f	p	936
5	k	p	361
6	k	e	131
7	s	e	21
8	x	e	1152
9	x	p	1046

In [1]:
```
242/(242+26)
```

Out[1]:
```
0.9029850746268657
```

In [68]:
```
max_sum = 0
for sub_class in v2_v1_df['V2'].unique():
    e_count = v2_v1_df.loc[(v2_v1_df['V2'] == sub_class) & (v2_v1_df['V1'] =
= 'e')]['count']
    p_count = v2_v1_df.loc[(v2_v1_df['V2'] == sub_class) & (v2_v1_df['V1'] =
= 'p')]['count']
    try:
        e_count = int(e_count)
    except:
        e_count = 0
    try:
        p_count = int(p_count)
    except:
        p_count = 0
    print(e_count,p_count)
    max_sum += np.max([e_count,p_count])
    #print(np.max([e_count,p_count]))
print(max_sum/4907)
```

```
242 26
0 3
989 936
131 361
21 0
1152 1046
0.564092113308
```

In [63]:
```
v2_grouped.count()
```

Out[63]:

	V1	V3	V4	V5	V6	V7	V8	V9	V10	V11	...	V14	V15	V16	V17	V1
V2																
b	268	268	268	268	268	268	268	268	268	268	...	268	268	268	268	268
c	3	3	3	3	3	3	3	3	3	3	...	3	3	3	3	3
f	1925	1925	1925	1925	1925	1925	1925	1925	1925	1925	...	1925	1925	1925	1925	192
k	492	492	492	492	492	492	492	492	492	492	...	492	492	492	492	492
s	21	21	21	21	21	21	21	21	21	21	...	21	21	21	21	21
x	2198	2198	2198	2198	2198	2198	2198	2198	2198	2198	...	2198	2198	2198	2198	219

6 rows × 22 columns

In [69]:
```
np.sum(pd.DataFrame(train_cat['V1'].value_counts()).reset_index()['V1'])
```

Out[69]: 4907

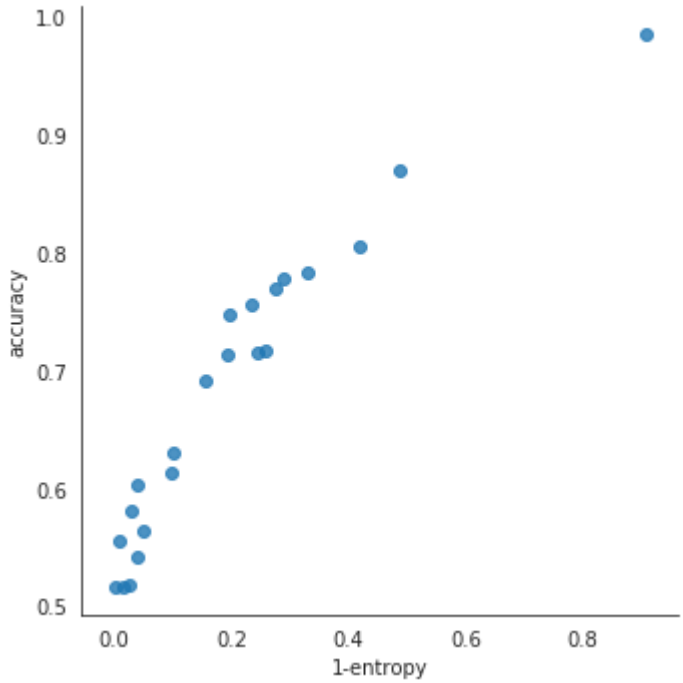
In [104]:
```
purity_table = pd.DataFrame(columns=['feature','accuracy','gini_index','1-en
tropy'])
record_count = np.sum(pd.DataFrame(train_cat['V1'].value_counts()).reset_ind
ex()['V1'])
for col_no in range(2,24):
    feature = 'V{0}'.format(col_no)
    feature_grouped = train_cat.groupby(by=feature)
    feature_v1_df = pd.DataFrame(feature_grouped.V1.value_counts()).rename(c
olumns={'V1':'count'}).reset_index()
    max_sum,gini_purity,entropy = 0,0,0
    for sub_class in feature_v1_df[feature].unique():
        e_count = feature_v1_df.loc[(feature_v1_df[feature] == sub_class) &
(feature_v1_df['V1'] == 'e')]['count']
        p_count = feature_v1_df.loc[(feature_v1_df[feature] == sub_class) &
(feature_v1_df['V1'] == 'p')]['count']
        try:
            e_count = int(e_count)
        except:
            e_count = 0
        try:
            p_count = int(p_count)
        except:
            p_count = 0
        max_sum += np.max([e_count,p_count])
        gini_purity += ((e_count/(e_count+p_count))**2 + (p_count/(e_count+p
_count))**2) * (e_count+p_count)
        e_prob = e_count / (e_count + p_count)
        p_prob = p_count / (e_count + p_count)
        if e_prob == 0.0:
            entropy += ( p_prob * np.log2(1 / p_prob) ) * (e_count +
p_count)
        elif p_prob == 0.0:
            entropy += ( e_prob * np.log2(1 / e_prob) ) * (e_count +
p_count)
        else:
            entropy += ( e_prob * np.log2(1 / e_prob) + p_prob * np.log2(1 /
 p_prob) ) * (e_count + p_count)

    accuracy = np.round(max_sum / record_count, 4)
    gini_purity = np.round(gini_purity / record_count, 4)
    entropy = np.round(entropy / record_count, 4)
    purity_table = purity_table.append({'feature' : feature, 'accuracy' : ac
curacy, 'gini_index' : gini_purity, '1-entropy' : np.round(1-entropy,4)},ign
ore_index=True)
purity_table
```

Out[104]:

	feature	accuracy	gini_index	1-entropy
0	V2	0.5641	0.5318	0.0518
1	V3	0.5816	0.5199	0.0293
2	V4	0.6028	0.5268	0.0402
3	V5	0.7473	0.6292	0.1979
4	V6	0.9851	0.9713	0.9063
5	V7	0.5166	0.5087	0.0144
6	V8	0.6138	0.5597	0.0992
7	V9	0.7559	0.6477	0.2347
8	V10	0.8046	0.7334	0.4204
9	V11	0.5561	0.5065	0.0094
10	V12	0.6303	0.5603	0.1000
11	V13	0.7771	0.6751	0.2877
12	V14	0.7687	0.6674	0.2749
13	V15	0.7171	0.6404	0.2598
14	V16	0.7149	0.6347	0.2460
15	V17	0.5166	0.5006	0.0008
16	V18	0.5176	0.5129	0.0257
17	V19	0.5417	0.5249	0.0415
18	V20	0.7824	0.6886	0.3295
19	V21	0.8686	0.7853	0.4867
20	V22	0.7131	0.6129	0.1930
21	V23	0.6913	0.5976	0.1578

Plotting Accuracy vs 1-Entropy

In [106]:
```
sns.lmplot(x='1-entropy',y='accuracy',data=purity_table,fit_reg=False)
plt.show();
```



It is observed that as the entropy decreases, the accuracy increases as the purity increases.

In [107]:
```
purity_table.loc[purity_table['accuracy'] ==
np.max(purity_table['accuracy'])]
```

Out[107]:

	feature	accuracy	gini_index	1-entropy
4	V6	0.9851	0.9713	0.9063

In [108]:
```
purity_table.loc[purity_table['1-entropy'] == np.max(purity_table['1-entrop
y'])]
```

Out[108]:

	feature	accuracy	gini_index	1-entropy
4	V6	0.9851	0.9713	0.9063

In [110]:
```
purity_table.loc[purity_table['gini_index'] == np.max(purity_table['gini_ind
ex'])]
```

Out[110]:

	feature	accuracy	gini_index	1-entropy
4	V6	0.9851	0.9713	0.9063

Google Form Answers

- Feature with highest accuracy : V6
- Accuracy of feature with highest accuracy : 0.9851
- Feature with lowest entropy : V6
- Lowest Entropy : 0.0937
- Feature with highest Gini Index : V6
- Highest Gini Index across all features : 0.9713