

In [1]:

```
1 import pandas as pd
2 import numpy as np
3 import matplotlib.pyplot as plt
4
5 from sklearn.ensemble import GradientBoostingClassifier
6 from sklearn.model_selection import train_test_split, GridSearchCV
7 from sklearn.metrics import recall_score, roc_curve, auc
8
9 import pickle
```

In [18]:

```
1 data = pd.read_csv('final_data_cleaned.csv')
2
3 infection_rate = data['INFECTION RATE']
4
5 data = data.drop('INFECTION RATE', axis = 1)
6 data.insert(101, "INFECTION RATE", infection_rate)
7 pred_set = data.loc[data['INFECTION RATE'] == 0.0]
8
9 data = data.drop(pred_set.index)
```

In [31]:

```
1 data.shape
```

Out[31]:

(2618, 102)

In [3]:

```
1 median = data["INFECTION RATE"].median()
```

In [4]:

```
1 def label_risk(num):
2     if num < median:
3         return -1 # low risk
4     else:
5         return 1 # high risk
```

In [5]:

```
1 data["risk"] = data["INFECTION RATE"].apply(label_risk)
```

In [30]:

```
1 data['INFECTION RATE'].describe()
```

Out[30]:

```
count      2618.000000
mean         0.071938
std          0.183478
min          0.001578
25%          0.017626
50%          0.034648
75%          0.068314
max          6.022003
Name: INFECTION RATE, dtype: float64
```

In [16]:

```
1 X = data.iloc[:, 4:101] # no total population
2 X = X.drop("LAND AREA(SQMI)", axis = 1)
3 y = data["risk"]
4
5 pred_X = pred_set.iloc[:, 4:101] # no total population
6 pred_X = pred_X.drop("LAND AREA(SQMI)", axis = 1)
```

In [7]:

```
1 X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.4, random_
```

In [8]:

```
1 clf = GradientBoostingClassifier(random_state=0)
2 clf.fit(X_train, y_train)
3 y_pred = clf.predict(X_test)
4 print(recall_score(y_test, y_pred, average='binary'))
```

0.6181474480151229

In [9]:

```
1 param_grid = {
2     'max_depth': [3, 5, 7],
3     'min_samples_split': [2, 4, 6],
4     'n_estimators': [100, 300, 500],
5     'learning_rate': [0.001, 0.01, 0.1]
6 }
7 clf = GradientBoostingClassifier(random_state=0)
8 grid = GridSearchCV(
9     clf,
10    param_grid,
11    scoring = 'recall',
12    return_train_score = True
13 )
14 grid.fit(X_train, y_train)
15
16 df = pd.DataFrame(grid.cv_results_)
17 df['mean_test_score']
18 df['mean_train_score']
19 cols_to_keep = ["param_learning_rate", "param_max_depth", "param_min_samples_split",
20                 "mean_test_score", "mean_train_score"]
21 df_toshow = df[cols_to_keep].fillna('-')
22 df_toshow = df_toshow.sort_values(by = ["mean_test_score"])
23 df_toshow.head()
```

Out[9]:

	param_learning_rate	param_max_depth	param_min_samples_split	param_n_estimators	mean
15	0.001	5	6	100	
12	0.001	5	4	100	
9	0.001	5	2	100	
0	0.001	3	2	100	
3	0.001	3	4	100	

In [10]:

```
1 df_toshow = df_toshow.sort_values(by = ["mean_test_score"], ascending = False)
2 df_toshow
```

Out[10]:

	param_learning_rate	param_max_depth	param_min_samples_split	param_n_estimators	mean
55	0.100	3	2	300	
61	0.100	3	6	300	
63	0.100	5	2	100	
68	0.100	5	4	500	
67	0.100	5	4	300	
...
0	0.001	3	2	100	
6	0.001	3	6	100	
9	0.001	5	2	100	
12	0.001	5	4	100	
15	0.001	5	6	100	

81 rows × 6 columns

In [11]:

```
1 best_params = df_toshow.head(1)
2
3 params = {
4     'n_estimators': best_params['param_n_estimators'].item(),
5     'max_depth': best_params['param_max_depth'].item(),
6     'min_samples_split': best_params['param_min_samples_split'].item(),
7     'learning_rate': best_params['param_learning_rate'].item(),
8 }
9 print(params)
10
11 clf = GradientBoostingClassifier(random_state = 0, **params)
12 clf.fit(X_train, y_train)
13 y_pred = clf.predict(X_test)
14 print(recall_score(y_test, y_pred, average='binary'))
```

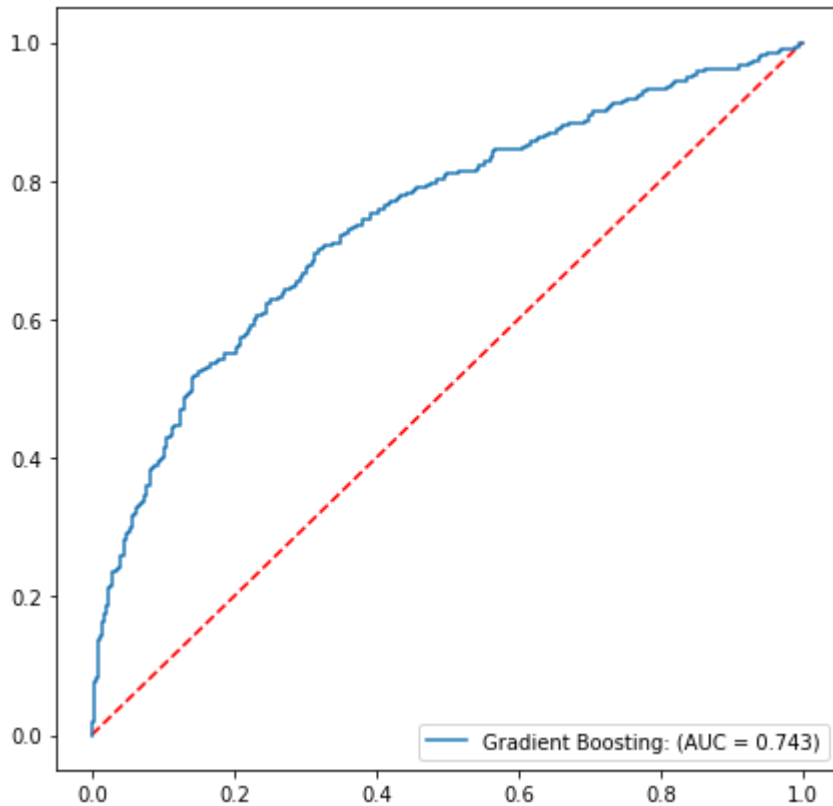
```
{'n_estimators': 300, 'max_depth': 3, 'min_samples_split': 2, 'learning_rate': 0.1}
0.6370510396975425
```

In [12]:

```
1 y_proba = clf.predict_proba(X_test)[:,-1]
2 fpr, tpr, thresholds = roc_curve(y_test, y_proba)
3 roc_auc = auc(fpr, tpr)
4
5 plt.figure(figsize=(7, 7))
6 plt.plot([0, 1], [0, 1], 'r--')
7 plt.plot(fpr, tpr, label = 'Gradient Boosting: (AUC = %0.3f)' % roc_auc)
8 plt.legend(loc = 'lower right')
```

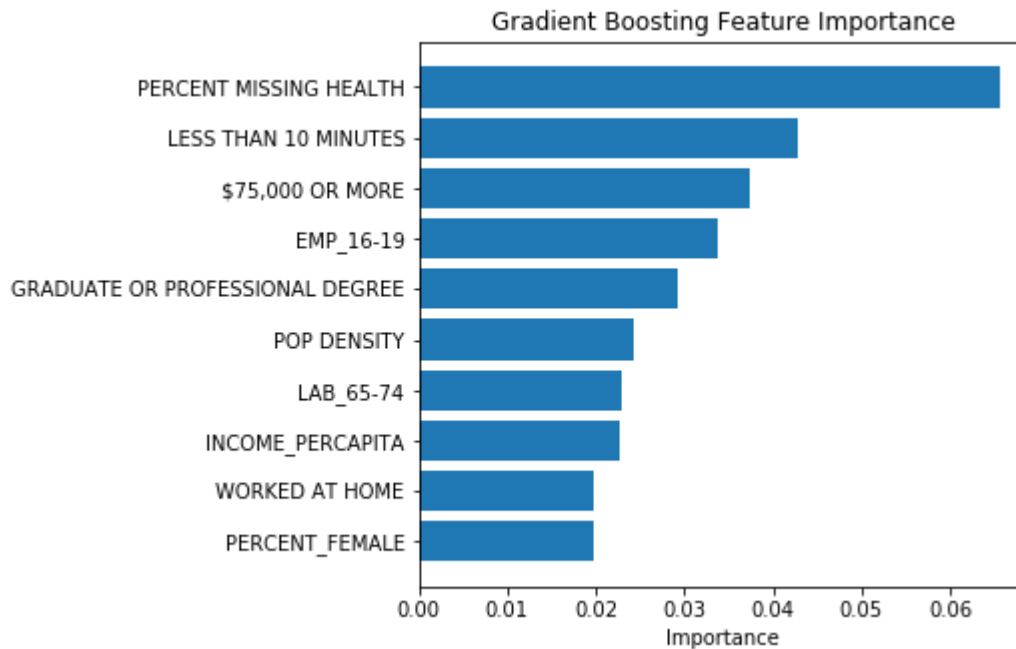
Out[12]:

<matplotlib.legend.Legend at 0x1a22134f90>



In [13]:

```
1 feature_importance = clf.feature_importances_  
2 sorted_idx = np.argsort(feature_importance)  
3 top_10 = sorted_idx[-10:]  
4 pos = np.arange(top_10.shape[0]) + .5  
5 plt.figure(figsize=(12, 5))  
6 plt.subplot(1, 2, 2)  
7 plt.barh(pos, feature_importance[top_10], align='center')  
8 plt.yticks(pos, X.columns[top_10])  
9 plt.xlabel('Importance')  
10 plt.title('Gradient Boosting Feature Importance')  
11 plt.show()
```



In [19]:

```
1 infection_rate_predictions = clf.predict(pred_X)
2 pred_set["RISK"] = infection_rate_predictions
3 pred_set
```

Out[19]:

E30_34	AGE55_59	AGE60_64	...	UNEMP_OVER75	PERCENT WITH PRIVATE HEALTH INSURANCE	PERCENT NO PRIVATE HEALTH INSURANCE	PERCENT WITH PUBLIC HEALTH INSURANCE	PE NO F F INSU
5.8	7.7	6.4	...	0.0	55.233853	41.312144	46.098675	50.
6.3	7.7	7.2	...	0.0	87.025355	38.863278	55.295402	70.
8.8	7.4	6.6	...	0.0	73.540479	45.684151	64.640821	54.
4.4	11.7	8.4	...	42.9	73.540479	45.684151	64.640821	54.
6.5	7.6	14.2	...	0.0	87.025355	38.863278	55.295402	70.
...
5.0	8.0	7.5	...	1.3	59.444226	40.339494	38.914012	60.
4.7	8.8	9.4	...	1.1	87.025355	38.863278	55.295402	70.
5.6	6.2	7.4	...	2.7	87.025355	38.863278	55.295402	70.
5.4	6.4	9.3	...	0.0	87.025355	38.863278	55.295402	70.
6.0	5.3	11.4	...	0.0	87.025355	38.863278	55.295402	70.

In [22]:

```
1 pred_set_toshow = pred_set[['COUNTY', 'STATE', 'RISK']]
2 pred_set_toshow
```

Out[22]:

	COUNTY	STATE	RISK
30	Geneva County	Alabama	1
67	Aleutians East Borough	Alaska	1
68	Aleutians West Census Area	Alaska	1
71	Bristol Bay Borough	Alaska	1
72	Denali Borough	Alaska	1
...
3114	Vernon County	Wisconsin	-1
3117	Washburn County	Wisconsin	-1
3125	Big Horn County	Wyoming	-1
3139	Platte County	Wyoming	-1
3146	Weston County	Wyoming	-1

529 rows × 3 columns

In [23]:

```
1 with pd.option_context('display.max_rows', None, 'display.max_columns', None):
2     display(pred_set_toshow)
```

	COUNTY	STATE	RISK
30	Geneva County	Alabama	1
67	Aleutians East Borough	Alaska	1
68	Aleutians West Census Area	Alaska	1
71	Bristol Bay Borough	Alaska	1
72	Denali Borough	Alaska	1
73	Dillingham Census Area	Alaska	-1
75	Haines Borough	Alaska	1
76	Hoonah-Angoon Census Area	Alaska	1
80	Kodiak Island Borough	Alaska	-1
81	Kusilvak Census Area	Alaska	-1
82	Lake and Peninsula Borough	Alaska	1
84	Nome Census Area	Alaska	-1
85	North Slope Borough	Alaska	1
86	Northwest Arctic Borough	Alaska	-1
89	Sitka City and Borough	Alaska	1
90	Skagway Municipality	Alaska	1
92	Valdez-Cordova Census Area	Alaska	1
93	Wrangell City and Borough	Alaska	-1
94	Yakutat City and Borough	Alaska	1
117	Calhoun County	Arkansas	1
135	Fulton County	Arkansas	-1
144	Jackson County	Arkansas	-1
151	Little River County	Arkansas	1
159	Montgomery County	Arkansas	-1
203	Lassen County	California	-1
207	Mariposa County	California	-1
210	Modoc County	California	-1
231	Sierra County	California	1
238	Trinity County	California	1
249	Bent County	Colorado	-1
253	Cheyenne County	Colorado	1
255	Conejos County	Colorado	-1
261	Dolores County	Colorado	1
273	Jackson County	Colorado	1

	COUNTY	STATE	RISK
275	Kiowa County	Colorado	1
300	San Juan County	Colorado	1
302	Sedgwick County	Colorado	1
440	Evans County	Georgia	1
448	Glascock County	Georgia	1
489	Montgomery County	Georgia	1
517	Taliaferro County	Georgia	1
548	Kalawao County	Hawaii	1
554	Bear Lake County	Idaho	-1
555	Benewah County	Idaho	-1
558	Boise County	Idaho	-1
561	Boundary County	Idaho	-1
562	Butte County	Idaho	1
567	Clark County	Idaho	1
568	Clearwater County	Idaho	-1
571	Franklin County	Idaho	-1
580	Lemhi County	Idaho	-1
581	Lewis County	Idaho	-1
586	Oneida County	Idaho	-1
590	Shoshone County	Idaho	-1
596	Alexander County	Illinois	1
599	Brown County	Illinois	-1
603	Cass County	Illinois	-1
607	Clay County	Illinois	-1
617	Edgar County	Illinois	-1
618	Edwards County	Illinois	-1
627	Hamilton County	Illinois	-1
629	Hardin County	Illinois	-1
630	Henderson County	Illinois	-1
638	Johnson County	Illinois	-1
670	Pope County	Illinois	1
672	Putnam County	Illinois	-1
680	Scott County	Illinois	-1
685	Union County	Illinois	-1
690	Wayne County	Illinois	-1
691	White County	Illinois	-1
700	Benton County	Indiana	-1

	COUNTY	STATE	RISK
759	Pike County	Indiana	-1
790	Adams County	Iowa	-1
801	Calhoun County	Iowa	-1
803	Cass County	Iowa	-1
806	Cherokee County	Iowa	-1
814	Davis County	Iowa	-1
815	Decatur County	Iowa	-1
820	Emmet County	Iowa	-1
822	Floyd County	Iowa	-1
824	Fremont County	Iowa	-1
834	Humboldt County	Iowa	-1
835	Ida County	Iowa	-1
847	Lucas County	Iowa	-1
856	Monroe County	Iowa	-1
862	Palo Alto County	Iowa	-1
864	Pocahontas County	Iowa	1
868	Ringgold County	Iowa	-1
869	Sac County	Iowa	-1
881	Wayne County	Iowa	1
888	Allen County	Kansas	-1
894	Brown County	Kansas	-1
896	Chase County	Kansas	1
899	Cheyenne County	Kansas	1
900	Clark County	Kansas	1
904	Comanche County	Kansas	1
907	Decatur County	Kansas	1
908	Dickinson County	Kansas	-1
911	Edwards County	Kansas	1
912	Elk County	Kansas	1
914	Ellsworth County	Kansas	-1
920	Graham County	Kansas	1
921	Grant County	Kansas	-1
922	Gray County	Kansas	-1
923	Greeley County	Kansas	1
926	Harper County	Kansas	-1
928	Haskell County	Kansas	-1
929	Hodgeman County	Kansas	1

	COUNTY	STATE	RISK
934	Kearny County	Kansas	-1
935	Kingman County	Kansas	-1
936	Kiowa County	Kansas	1
938	Lane County	Kansas	1
940	Lincoln County	Kansas	1
942	Logan County	Kansas	1
946	Marshall County	Kansas	-1
947	Meade County	Kansas	1
953	Nemaha County	Kansas	-1
955	Ness County	Kansas	1
956	Norton County	Kansas	-1
960	Pawnee County	Kansas	-1
964	Rawlins County	Kansas	1
967	Rice County	Kansas	-1
970	Rush County	Kansas	1
971	Russell County	Kansas	-1
977	Sheridan County	Kansas	1
978	Sherman County	Kansas	1
979	Smith County	Kansas	1
981	Stanton County	Kansas	1
984	Thomas County	Kansas	-1
985	Trego County	Kansas	1
987	Wallace County	Kansas	1
988	Washington County	Kansas	-1
989	Wichita County	Kansas	1
990	Wilson County	Kansas	-1
999	Bell County	Kentucky	-1
1012	Carlisle County	Kentucky	1
1015	Casey County	Kentucky	-1
1018	Clay County	Kentucky	-1
1024	Elliott County	Kentucky	1
1025	Estill County	Kentucky	-1
1027	Fleming County	Kentucky	-1
1028	Floyd County	Kentucky	-1
1030	Fulton County	Kentucky	-1
1031	Gallatin County	Kentucky	-1
1032	Garrard County	Kentucky	1

	COUNTY	STATE	RISK
1040	Harlan County	Kentucky	-1
1045	Hickman County	Kentucky	-1
1052	Knott County	Kentucky	-1
1053	Knox County	Kentucky	-1
1057	Lee County	Kentucky	-1
1061	Lincoln County	Kentucky	-1
1062	Livingston County	Kentucky	-1
1069	Magoffin County	Kentucky	-1
1077	Metcalfe County	Kentucky	-1
1080	Morgan County	Kentucky	-1
1086	Owen County	Kentucky	1
1087	Owsley County	Kentucky	1
1093	Robertson County	Kentucky	1
1095	Rowan County	Kentucky	-1
1103	Trigg County	Kentucky	-1
1104	Trimble County	Kentucky	-1
1111	Wolfe County	Kentucky	-1
1187	Piscataquis County	Maine	-1
1220	Dukes County	Massachusetts	-1
1226	Nantucket County	Massachusetts	1
1231	Alcona County	Michigan	-1
1232	Alger County	Michigan	-1
1237	Baraga County	Michigan	-1
1240	Benzie County	Michigan	-1
1247	Chippewa County	Michigan	-1
1266	Iron County	Michigan	-1
1272	Keweenaw County	Michigan	1
1290	Montmorency County	Michigan	-1
1296	Ontonagon County	Michigan	-1
1314	Aitkin County	Minnesota	-1
1316	Becker County	Minnesota	-1
1325	Chippewa County	Minnesota	-1
1329	Cook County	Minnesota	1
1339	Grant County	Minnesota	-1
1342	Hubbard County	Minnesota	-1
1346	Kanabec County	Minnesota	-1
1348	Kittson County	Minnesota	-1

	COUNTY	STATE	RISK
1351	Lake County	Minnesota	-1
1352	Lake of the Woods County	Minnesota	1
1358	Marshall County	Minnesota	1
1361	Mille Lacs County	Minnesota	-1
1362	Morrison County	Minnesota	-1
1367	Norman County	Minnesota	-1
1370	Pennington County	Minnesota	-1
1374	Pope County	Minnesota	-1
1376	Red Lake County	Minnesota	-1
1380	Rock County	Minnesota	-1
1388	Stevens County	Minnesota	-1
1390	Todd County	Minnesota	-1
1393	Wadena County	Minnesota	-1
1428	Issaquena County	Mississippi	1
1486	Audrain County	Missouri	-1
1488	Barton County	Missouri	-1
1499	Carroll County	Missouri	-1
1511	Dade County	Missouri	1
1513	Daviess County	Missouri	-1
1515	Dent County	Missouri	-1
1516	Douglas County	Missouri	-1
1522	Grundy County	Missouri	-1
1525	Hickory County	Missouri	-1
1526	Holt County	Missouri	-1
1534	Knox County	Missouri	-1
1535	Laclede County	Missouri	-1
1537	Lawrence County	Missouri	-1
1538	Lewis County	Missouri	-1
1546	Marion County	Missouri	-1
1547	Mercer County	Missouri	-1
1548	Miller County	Missouri	-1
1549	Mississippi County	Missouri	-1
1551	Monroe County	Missouri	-1
1559	Ozark County	Missouri	1
1568	Putnam County	Missouri	-1
1580	Schuyler County	Missouri	-1
1583	Shannon County	Missouri	-1

	COUNTY	STATE	RISK
1587	Sullivan County	Missouri	-1
1589	Texas County	Missouri	-1
1593	Wayne County	Missouri	-1
1600	Blaine County	Montana	1
1603	Carter County	Montana	1
1605	Chouteau County	Montana	1
1606	Custer County	Montana	-1
1607	Daniels County	Montana	1
1608	Dawson County	Montana	-1
1610	Fallon County	Montana	1
1611	Fergus County	Montana	-1
1614	Garfield County	Montana	1
1617	Granite County	Montana	1
1620	Judith Basin County	Montana	1
1625	McCone County	Montana	1
1628	Mineral County	Montana	-1
1632	Petroleum County	Montana	1
1633	Phillips County	Montana	-1
1634	Pondera County	Montana	-1
1635	Powder River County	Montana	1
1636	Powell County	Montana	-1
1637	Prairie County	Montana	1
1641	Rosebud County	Montana	-1
1642	Sanders County	Montana	-1
1643	Sheridan County	Montana	1
1646	Sweet Grass County	Montana	-1
1647	Teton County	Montana	1
1649	Treasure County	Montana	1
1650	Valley County	Montana	-1
1651	Wheatland County	Montana	1
1652	Wibaux County	Montana	1
1656	Arthur County	Nebraska	1
1657	Banner County	Nebraska	1
1658	Blaine County	Nebraska	1
1659	Boone County	Nebraska	-1
1661	Boyd County	Nebraska	1
1662	Brown County	Nebraska	1

	COUNTY	STATE	RISK
1665	Butler County	Nebraska	-1
1667	Cedar County	Nebraska	-1
1668	Chase County	Nebraska	-1
1675	Dakota County	Nebraska	-1
1676	Dawes County	Nebraska	-1
1678	Deuel County	Nebraska	1
1679	Dixon County	Nebraska	-1
1682	Dundy County	Nebraska	1
1683	Fillmore County	Nebraska	-1
1685	Frontier County	Nebraska	1
1686	Furnas County	Nebraska	-1
1688	Garden County	Nebraska	1
1689	Garfield County	Nebraska	1
1691	Grant County	Nebraska	1
1692	Greeley County	Nebraska	1
1695	Harlan County	Nebraska	-1
1696	Hayes County	Nebraska	1
1697	Hitchcock County	Nebraska	1
1698	Holt County	Nebraska	-1
1699	Hooker County	Nebraska	1
1700	Howard County	Nebraska	-1
1701	Jefferson County	Nebraska	-1
1704	Keith County	Nebraska	-1
1705	Keya Paha County	Nebraska	1
1710	Logan County	Nebraska	1
1711	Loup County	Nebraska	1
1712	McPherson County	Nebraska	1
1715	Morrill County	Nebraska	1
1716	Nance County	Nebraska	-1
1718	Nuckolls County	Nebraska	-1
1720	Pawnee County	Nebraska	1
1721	Perkins County	Nebraska	1
1726	Red Willow County	Nebraska	-1
1727	Richardson County	Nebraska	-1
1728	Rock County	Nebraska	1
1729	Saline County	Nebraska	-1
1734	Sheridan County	Nebraska	1

	COUNTY	STATE	RISK
1735	Sherman County	Nebraska	1
1736	Sioux County	Nebraska	1
1738	Thayer County	Nebraska	-1
1739	Thomas County	Nebraska	1
1740	Thurston County	Nebraska	-1
1741	Valley County	Nebraska	-1
1745	Wheeler County	Nebraska	1
1747	Churchill County	Nevada	-1
1751	Esmeralda County	Nevada	1
1752	Eureka County	Nevada	1
1754	Lander County	Nevada	-1
1757	Mineral County	Nevada	-1
1759	Pershing County	Nevada	-1
1760	Storey County	Nevada	1
1801	De Baca County	New Mexico	1
1805	Guadalupe County	New Mexico	-1
1806	Harding County	New Mexico	1
1813	Mora County	New Mexico	-1
1815	Quay County	New Mexico	-1
1822	Sierra County	New Mexico	-1
1826	Union County	New Mexico	1
1830	Bronx County	New York	1
1851	Kings County	New York	1
1868	Queens County	New York	1
1870	Richmond County	New York	1
1895	Avery County	North Carolina	-1
1904	Camden County	North Carolina	1
1927	Graham County	North Carolina	1
1937	Hyde County	North Carolina	-1
1947	Madison County	North Carolina	1
1976	Swain County	North Carolina	-1
1978	Tyrrell County	North Carolina	1
1989	Yancey County	North Carolina	-1
1990	Adams County	North Dakota	1
1992	Benson County	North Dakota	-1
1993	Billings County	North Dakota	1
1994	Bottineau County	North Dakota	-1

	COUNTY	STATE	RISK
1999	Cavalier County	North Dakota	1
2000	Dickey County	North Dakota	-1
2006	Golden Valley County	North Dakota	1
2009	Griggs County	North Dakota	1
2010	Hettinger County	North Dakota	1
2011	Kidder County	North Dakota	1
2012	LaMoure County	North Dakota	1
2013	Logan County	North Dakota	1
2018	Mercer County	North Dakota	-1
2021	Nelson County	North Dakota	1
2023	Pembina County	North Dakota	-1
2026	Ransom County	North Dakota	-1
2027	Renville County	North Dakota	1
2031	Sheridan County	North Dakota	1
2035	Steele County	North Dakota	1
2037	Towner County	North Dakota	1
2038	Traill County	North Dakota	-1
2041	Wells County	North Dakota	1
2076	Harrison County	Ohio	-1
2111	Putnam County	Ohio	-1
2124	Vinton County	Ohio	-1
2132	Alfalfa County	Oklahoma	-1
2136	Blaine County	Oklahoma	-1
2143	Cimarron County	Oklahoma	1
2145	Coal County	Oklahoma	-1
2153	Ellis County	Oklahoma	-1
2159	Harmon County	Oklahoma	1
2160	Harper County	Oklahoma	-1
2161	Haskell County	Oklahoma	-1
2162	Hughes County	Oklahoma	-1
2165	Johnston County	Oklahoma	-1
2180	Murray County	Oklahoma	-1
2194	Pushmataha County	Oklahoma	1
2195	Roger Mills County	Oklahoma	-1
2205	Washita County	Oklahoma	-1
2206	Woods County	Oklahoma	-1
2208	Baker County	Oregon	-1

	COUNTY	STATE	RISK
2213	Coos County	Oregon	-1
2218	Gilliam County	Oregon	1
2220	Harney County	Oregon	-1
2223	Jefferson County	Oregon	-1
2226	Lake County	Oregon	-1
2242	Wheeler County	Oregon	1
2364	Bennett County	South Dakota	1
2368	Brule County	South Dakota	1
2369	Buffalo County	South Dakota	1
2370	Butte County	South Dakota	-1
2371	Campbell County	South Dakota	1
2377	Custer County	South Dakota	1
2379	Day County	South Dakota	-1
2381	Dewey County	South Dakota	-1
2382	Douglas County	South Dakota	1
2383	Edmunds County	South Dakota	-1
2386	Grant County	South Dakota	-1
2387	Gregory County	South Dakota	-1
2388	Haakon County	South Dakota	1
2390	Hand County	South Dakota	1
2391	Hanson County	South Dakota	-1
2392	Harding County	South Dakota	1
2395	Hyde County	South Dakota	1
2396	Jackson County	South Dakota	1
2398	Jones County	South Dakota	1
2399	Kingsbury County	South Dakota	-1
2405	McPherson County	South Dakota	1
2408	Mellette County	South Dakota	1
2411	Moody County	South Dakota	-1
2414	Perkins County	South Dakota	1
2415	Potter County	South Dakota	1
2419	Stanley County	South Dakota	1
2420	Sully County	South Dakota	1
2422	Tripp County	South Dakota	-1
2425	Walworth County	South Dakota	1
2427	Ziebach County	South Dakota	1
2444	Crockett County	Tennessee	1

	COUNTY	STATE	RISK
2461	Hancock County	Tennessee	-1
2475	Lake County	Tennessee	-1
2491	Moore County	Tennessee	-1
2496	Pickett County	Tennessee	1
2499	Rhea County	Tennessee	-1
2515	Van Buren County	Tennessee	1
2527	Archer County	Texas	-1
2528	Armstrong County	Texas	1
2531	Bailey County	Texas	-1
2534	Baylor County	Texas	1
2539	Borden County	Texas	1
2540	Bosque County	Texas	-1
2544	Brewster County	Texas	-1
2545	Briscoe County	Texas	1
2546	Brooks County	Texas	-1
2555	Carson County	Texas	1
2560	Childress County	Texas	-1
2562	Cochran County	Texas	1
2563	Coke County	Texas	-1
2564	Coleman County	Texas	-1
2566	Collingsworth County	Texas	1
2573	Cottle County	Texas	1
2575	Crockett County	Texas	1
2577	Culberson County	Texas	1
2588	Duval County	Texas	-1
2591	Edwards County	Texas	1
2598	Fisher County	Texas	-1
2600	Foard County	Texas	1
2603	Freestone County	Texas	1
2607	Garza County	Texas	-1
2609	Glasscock County	Texas	1
2618	Hall County	Texas	1
2621	Hardeman County	Texas	1
2625	Hartley County	Texas	-1
2626	Haskell County	Texas	-1
2635	Houston County	Texas	-1
2637	Hudspeth County	Texas	-1

	COUNTY	STATE	RISK
2640	Irion County	Texas	1
2644	Jeff Davis County	Texas	1
2646	Jim Hogg County	Texas	-1
2653	Kenedy County	Texas	1
2654	Kent County	Texas	1
2656	Kimble County	Texas	-1
2657	King County	Texas	1
2658	Kinney County	Texas	1
2664	La Salle County	Texas	-1
2670	Lipscomb County	Texas	1
2673	Loving County	Texas	1
2678	McMullen County	Texas	1
2680	Marion County	Texas	1
2686	Menard County	Texas	1
2689	Mills County	Texas	-1
2695	Motley County	Texas	1
2699	Nolan County	Texas	1
2701	Ochiltree County	Texas	-1
2707	Parmer County	Texas	1
2711	Presidio County	Texas	1
2714	Reagan County	Texas	-1
2715	Real County	Texas	1
2716	Red River County	Texas	-1
2718	Refugio County	Texas	1
2719	Roberts County	Texas	1
2722	Runnels County	Texas	-1
2724	Sabine County	Texas	1
2728	San Saba County	Texas	-1
2729	Schleicher County	Texas	1
2730	Scurry County	Texas	-1
2731	Shackelford County	Texas	-1
2733	Sherman County	Texas	1
2735	Somervell County	Texas	1
2738	Sterling County	Texas	1
2739	Stonewall County	Texas	1
2740	Sutton County	Texas	-1
2744	Terrell County	Texas	1

	COUNTY	STATE	RISK
2746	Throckmorton County	Texas	1
2753	Upton County	Texas	-1
2760	Ward County	Texas	-1
2764	Wheeler County	Texas	-1
2766	Wilbarger County	Texas	-1
2773	Yoakum County	Texas	-1
2776	Zavala County	Texas	-1
2777	Beaver County	Utah	-1
2781	Daggett County	Utah	1
2788	Juab County	Utah	-1
2790	Millard County	Utah	-1
2791	Morgan County	Utah	1
2792	Piute County	Utah	1
2793	Rich County	Utah	1
2796	Sanpete County	Utah	-1
2797	Sevier County	Utah	-1
2804	Wayne County	Utah	1
2828	Bath County	Virginia	-1
2831	Bland County	Virginia	-1
2846	Dickenson County	Virginia	-1
2848	Essex County	Virginia	1
2860	Grayson County	Virginia	-1
2867	Highland County	Virginia	1
2890	Patrick County	Virginia	-1
2930	Falls Church city	Virginia	1
2941	Martinsville city	Virginia	-1
2944	Norton city	Virginia	1
2969	Garfield County	Washington	1
3003	Calhoun County	West Virginia	-1
3004	Clay County	West Virginia	-1
3005	Doddridge County	West Virginia	1
3007	Gilmer County	West Virginia	1
3008	Grant County	West Virginia	-1
3018	Lincoln County	West Virginia	-1
3026	Mingo County	West Virginia	-1
3034	Pocahontas County	West Virginia	-1
3039	Ritchie County	West Virginia	-1

	COUNTY	STATE	RISK
3041	Summers County	West Virginia	-1
3047	Webster County	West Virginia	1
3058	Burnett County	Wisconsin	-1
3072	Forest County	Wisconsin	-1
3075	Green Lake County	Wisconsin	-1
3085	Langlade County	Wisconsin	-1
3086	Lincoln County	Wisconsin	-1
3098	Pepin County	Wisconsin	-1
3112	Taylor County	Wisconsin	-1
3114	Vernon County	Wisconsin	-1
3117	Washburn County	Wisconsin	-1
3125	Big Horn County	Wyoming	-1
3139	Platte County	Wyoming	-1
3146	Weston County	Wyoming	-1

In [26]:

```
1 #y_proba_pd = pd.DataFrame(y_proba)
```

In [27]:

```
1 #y_proba_pd.to_csv(r'gBoosting_y_proba.csv', index = True)
```

In [29]:

```
1 pred_set['RISK'].value_counts(ascending=True)
```

Out[29]:

```
1      230
-1     299
Name: RISK, dtype: int64
```

In []:

```
1
```