Imports

In [ ]:
```
import numpy as np
import pandas as pd
import seaborn as sns
from matplotlib import pyplot as plt
from scipy import stats
```

Reading data

In [ ]:
```
data_path = "../data/lab_2/car_crashes.xlsx"
```

In [ ]:
```
df = pd.read_excel(data_path)
df
```

Out[ ]:

	ID	Source	TMC	Severity	Start_Time	End_Time	Distance(mi)	Description	Stree
0	A-1	MapQuest	201.0	3	2016-02-08 05:46:00	2016-02-08 11:00:00	0.01	Right lane blocked due to accident on I-70 Eas...	I-70
1	A-2	MapQuest	201.0	2	2016-02-08 06:07:59	2016-02-08 06:37:59	0.01	Accident on Brice Rd at Tussing Rd. Expect del...	Brice R
2	A-3	MapQuest	201.0	2	2016-02-08 06:49:27	2016-02-08 07:19:27	0.01	Accident on OH-32 State Route 32 Westbound at ...	State Rout 3
3	A-4	MapQuest	201.0	3	2016-02-08 07:23:34	2016-02-08 07:53:34	0.01	Accident on I-75 Southbound at Exits 52 52B US...	I-75
4	A-5	MapQuest	201.0	2	2016-02-08 07:39:07	2016-02-08 08:09:07	0.01	Accident on McEwen Rd at OH-725 Miamisburg Cen...	Miamisbur Centervill R
...	...	...	...	...	...	...	...	...	.
4995	A-4996	MapQuest	201.0	2	2016-08-01 11:35:41	2016-08-01 12:05:41	0.00	Accident on Cold Springs Rd at Middletown Rd.	Col Springs R
4996	A-4997	MapQuest	201.0	2	2016-08-01 11:41:23	2016-08-01 12:26:23	0.00	Accident on Travis Blvd at Holiday Ln.	Travis Blv

	ID	Source	TMC	Severity	Start_Time	End_Time	Distance(mi)	Description	Stree
4997	A-4998	MapQuest	201.0	2	2016-08-01 11:57:27	2016-08-01 12:42:27	0.00	Accident on River Rd at Orchard Rd.	River R
4998	A-4999	MapQuest	201.0	2	2016-08-01 12:00:54	2016-08-01 12:30:54	0.00	Accident on Marconi Ave at Bell St.	Bell S
4999	A-5000	MapQuest	201.0	2	2016-08-01 11:59:44	2016-08-01 12:29:44	0.00	Accident on Madison Ave Westbound at I-80.	I-80 W

5000 rows × 37 columns

In [ ]:
```
df.columns
```

Out[ ]:
```
Index(['ID', 'Source', 'TMC', 'Severity', 'Start_Time', 'End_Time',
       'Distance(mi)', 'Description', 'Street', 'Side', 'City', 'State',
       'Zipcode', 'Weather_Timestamp', 'Temperature(F)', 'Wind_Chill(F)',
       'Humidity(%)', 'Pressure(in)', 'Visibility(mi)', 'Wind_Direction',
       'Wind_Speed(mph)', 'Precipitation(in)', 'Weather_Condition', 'Bump',
       'Crossing', 'Give_Way', 'Junction', 'No_Exit', 'Railway', 'Roundabout',
       'Station', 'Stop', 'Traffic_Calming', 'Traffic_Signal', 'Turning_Loop',
       'Sunrise_Sunset', 'Civil_Twilight'],
      dtype='object')
```

In [ ]:
```
df = df.loc[:,["Severity", "Visibility(mi)", "Wind_Speed(mph)",
               "Humidity(%)", "Temperature(F)"]].dropna().copy()
df.describe()
```

Out[ ]:

	Severity	Visibility(mi)	Wind_Speed(mph)	Humidity(%)	Temperature(F)
count	4519.000000	4519.000000	4519.000000	4519.000000	4519.000000
mean	2.422439	9.469772	9.410246	51.027661	70.287586
std	0.497574	1.850890	4.314188	23.749484	18.501633
min	1.000000	0.200000	1.200000	8.000000	5.000000
25%	2.000000	10.000000	5.800000	32.000000	61.000000
50%	2.000000	10.000000	9.200000	50.000000	71.600000
75%	3.000000	10.000000	11.500000	69.000000	82.900000
max	4.000000	30.000000	31.100000	100.000000	106.000000

Functions

In [ ]:
```
def momentum(arr, k: int):
    if k < 1:
        raise ValueError("K must be natural")
    sum = 0
    for elem in arr:
```

```
        sum += elem ** k
    return sum / len(arr)

def mean_1d(arr):
    return momentum(arr, 1)

def mean_2d(arr_2d):
    res = []
    for arr_1d in arr_2d:
        res.append(mean_1d(arr_1d))
    return res

def cov(arr1, arr2):
    if len(arr1) != len(arr2):
        raise ValueError("Array lenghts must be same")
    mean1 = mean_1d(arr1)
    mean2 = mean_1d(arr2)
    sum = 0
    for i in range(len(arr1)):
        sum += (arr1[i] - mean1) * (arr2[i] - mean2)
    return sum / len(arr1)

def cov_matrix(arrs):
    result = np.zeros((arrs.shape[0], arrs.shape[0]))
    for i in range(arrs.shape[0]):
        for j in range(arrs.shape[0]):
            result[i, j] = cov(arrs[i], arrs[j])
    return result

def variance(arr):
    return momentum(arr, 2) - mean_1d(arr) ** 2

def corr(arr1, arr2):
    return cov(arr1, arr2) / (variance(arr1) * variance(arr2)) ** 0.5

def corr_matrix(arrs):
    result = np.zeros((arrs.shape[0], arrs.shape[0]))
    for i in range(arrs.shape[0]):
        for j in range(arrs.shape[0]):
            result[i, j] = corr(arrs[i], arrs[j])
    return result
```

Comparison

In [ ]:

```
res1 = np.mean(df)
res2 = mean_2d(df.values.T)
print(f"Theirs: {res1}")
print(f"Ours {res2}")
np.allclose(res1, res2, atol=0.0001)
```

```
Theirs: Severity            2.422439
Visibility(mi)      9.469772
Wind_Speed(mph)     9.410246
Humidity(%)        51.027661
Temperature(F)     70.287586
dtype: float64
Ours [2.422438592608984, 9.469772073467581, 9.410245629564091, 51.027660986944014, 7
0.28758574905973]
```

Out[ ]:

```
True
```

In [ ]:

```
res1 = np.cov(df["Severity"].values, df["Visibility(mi)"].values)[0][1]
```

```
res2 = cov(df["Severity"].values, df["Visibility(mi)"].values)
print(f"Theirs: {res1}")
print(f"Ours {res2}")
np.allclose(res1, res2, atol=0.0001)
```

```
Theirs: 0.03829241074599107
Ours 0.038283937098997294
True
```

Out[ ]:

In [ ]:

```
res1 = np.cov(df.T)
res2 = cov_matrix(df.values.T)
print(f"Theirs: {res1}")
print(f"Ours {res2}")
np.allclose(res1, res2, atol=0.12)
```

```
Theirs: [[ 2.47579621e-01  3.82924107e-02  1.79756771e-01  4.48914382e-01
  -1.04471269e-01]
 [ 3.82924107e-02  3.42579258e+00  4.35475775e-01 -1.78702792e+01
   1.56500651e+01]
 [ 1.79756771e-01  4.35475775e-01  1.86122213e+01 -3.45145655e+00
  -1.40489713e+00]
 [ 4.48914382e-01 -1.78702792e+01 -3.45145655e+00  5.64037969e+02
  -3.71785181e+02]
 [-1.04471269e-01  1.56500651e+01 -1.40489713e+00 -3.71785181e+02
   3.42310441e+02]]
Ours [[ 2.47524834e-01  3.82839371e-02  1.79716993e-01  4.48815042e-01
  -1.04448151e-01]
 [ 3.82839371e-02  3.42503449e+00  4.35379410e-01 -1.78663247e+01
   1.56466020e+01]
 [ 1.79716993e-01  4.35379410e-01  1.86081026e+01 -3.45069279e+00
  -1.40458624e+00]
 [ 4.48815042e-01 -1.78663247e+01 -3.45069279e+00  5.63913154e+02
  -3.71702910e+02]
 [-1.04448151e-01  1.56466020e+01 -1.40458624e+00 -3.71702910e+02
   3.42234692e+02]]
True
```

Out[ ]:

In [ ]:

```
res1 = np.corrcoef(df.T)
res2 = corr_matrix(df.values.T)
print(f"Theirs: {res1}")
print(f"Ours {res2}")
np.allclose(res1, res2, atol=0.0001)
```

```
Theirs: [[ 1.          0.04157907  0.08373918  0.03798848 -0.01134826]
 [ 0.04157907  1.          0.05453614 -0.40653378  0.45700983]
 [ 0.08373918  0.05453614  1.         -0.03368598 -0.01760092]
 [ 0.03798848 -0.40653378 -0.03368598  1.         -0.84611196]
 [-0.01134826  0.45700983 -0.01760092 -0.84611196  1.        ]]
Ours [[ 1.          0.04157907  0.08373918  0.03798848 -0.01134826]
 [ 0.04157907  1.          0.05453614 -0.40653378  0.45700983]
 [ 0.08373918  0.05453614  1.         -0.03368598 -0.01760092]
 [ 0.03798848 -0.40653378 -0.03368598  1.         -0.84611196]
 [-0.01134826  0.45700983 -0.01760092 -0.84611196  1.        ]]
True
```

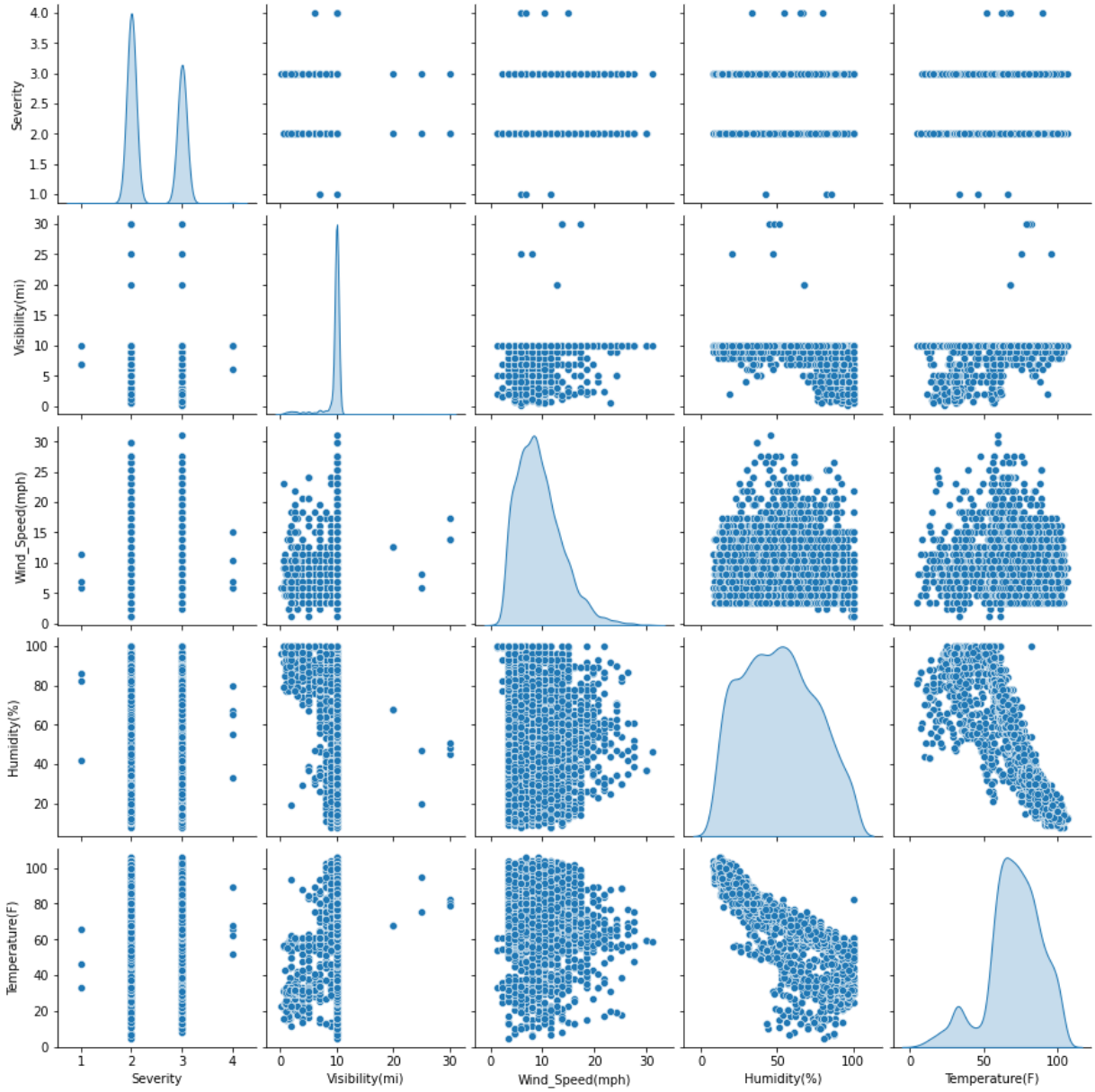
Out[ ]:

Graphs

In [ ]:

```
sns.pairplot(df, diag_kind="kde")
```

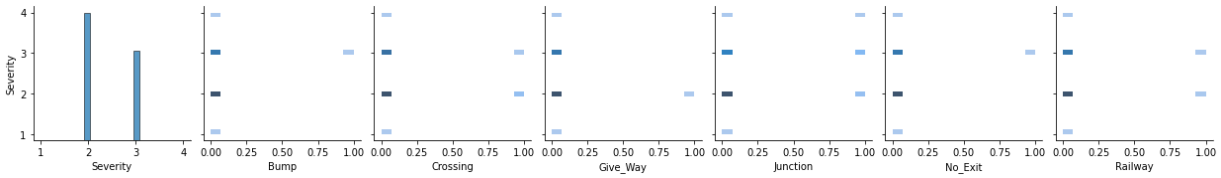
Out[ ]: <seaborn.axisgrid.PairGrid at 0x7fea56833850>



По графикам видно, что практически все аварии произошли при небольшой видимости (<10 миль), влажность имеет обратную зависимость от температуры, есть небольшая прямая зависимость между температурой и скоростью ветра

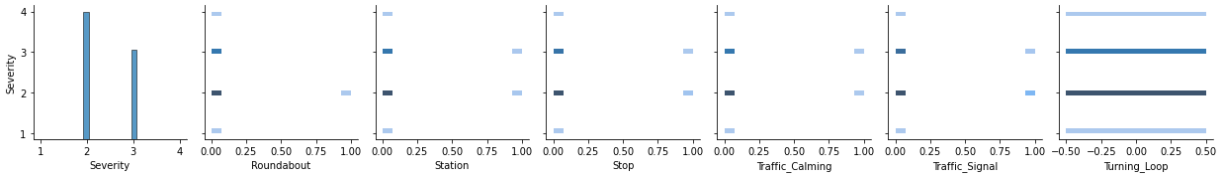
In [ ]:
```
new_df = pd.read_excel(data_path).loc[:,["Severity", "Bump", "Crossing",
                                         "Give_Way", "Junction",
                                         "No_Exit", "Railway"]] \
                                 .astype(int).dropna().copy()
sns.pairplot(new_df, y_vars=["Severity"], kind="hist")
```

Out[ ]: <seaborn.axisgrid.PairGrid at 0x7fea5d27d880>



In [ ]:
```
new_df = pd.read_excel(data_path).loc[:,["Severity", "Roundabout", "Station",
                                         "Stop", "Traffic_Calming",
                                         "Traffic_Signal", "Turning_Loop"]] \
                                 .astype(int).dropna().copy()
sns.pairplot(new_df, y_vars=["Severity"], kind="hist")
```

Out[ ]: <seaborn.axisgrid.PairGrid at 0x7fea4fdc6b50>



Лежачие полицейские и знаки "тупик" не сильно помогают в уменьшении серьезности аварий. В местах, где расположены знаки "Уступи дорогу" и на круговых перекрёстках серьезность аварий не очень высокая. Самые серьезные аварии происходят на транспортных развязках

In [ ]: