session-5

September 10, 2024

1 Working With Missing and Duplicate Data

```
[1]: import pandas as pd
```

- Check for errors in data cleaning/transformation
- Use data from additional sources to fill missing values
- Drop row/column
- Fill missing values with reasonable estimates computed from the available data

```
[2]: happiness2015 = pd.read_csv('wh_2015.csv')
     happiness2016 = pd.read_csv('wh_2016.csv')
     happiness2017 = pd.read_csv('wh_2017.csv')
```

```
[3]: shape_2015 = happiness2015.shape
     shape_2016 = happiness2016.shape
     shape_2017 = happiness2017.shape
```

```
[4]: shape_2015, shape_2016, shape_2017
```

```
[4]: ((164, 13), (164, 14), (164, 13))
```

```
[5]: happiness2015.head()
```

```
[5]:        Country          Region  Happiness Rank  Happiness Score  \
     0  Switzerland  Western Europe             1.0            7.587
     1      Iceland  Western Europe             2.0            7.561
     2      Denmark  Western Europe             3.0            7.527
     3       Norway  Western Europe             4.0            7.522
     4       Canada   North America             5.0            7.427

        Standard Error  Economy (GDP per Capita)   Family  \
     0         0.03411                   1.39651  1.34951
     1         0.04884                   1.30232  1.40223
     2         0.03328                   1.32548  1.36058
     3         0.03880                   1.45900  1.33095
     4         0.03553                   1.32629  1.32261
```

```
   Health (Life Expectancy)  Freedom  Trust (Government Corruption)  \
0                   0.94143  0.66557                        0.41978
1                   0.94784  0.62877                        0.14145
2                   0.87464  0.64938                        0.48357
3                   0.88521  0.66973                        0.36503
4                   0.90563  0.63297                        0.32957

   Generosity  Dystopia Residual  Year
0     0.29678            2.51738  2015
1     0.43630            2.70201  2015
2     0.34139            2.49204  2015
3     0.34699            2.46531  2015
4     0.45811            2.45176  2015
```

[6]:
```
happiness2015[happiness2015['Happiness Score'].isnull()]
```

[6]:
```
               Country Region  Happiness Rank  Happiness Score  \
158             Belize    NaN             NaN              NaN
159            Namibia    NaN             NaN              NaN
160        Puerto Rico    NaN             NaN              NaN
161            Somalia    NaN             NaN              NaN
162  Somaliland Region    NaN             NaN              NaN
163        South Sudan    NaN             NaN              NaN

     Standard Error  Economy (GDP per Capita)  Family  \
158             NaN                       NaN     NaN
159             NaN                       NaN     NaN
160             NaN                       NaN     NaN
161             NaN                       NaN     NaN
162             NaN                       NaN     NaN
163             NaN                       NaN     NaN

     Health (Life Expectancy)  Freedom  Trust (Government Corruption)  \
158                       NaN      NaN                            NaN
159                       NaN      NaN                            NaN
160                       NaN      NaN                            NaN
161                       NaN      NaN                            NaN
162                       NaN      NaN                            NaN
163                       NaN      NaN                            NaN

     Generosity  Dystopia Residual  Year
158         NaN                NaN  2015
159         NaN                NaN  2015
160         NaN                NaN  2015
161         NaN                NaN  2015
162         NaN                NaN  2015
163         NaN                NaN  2015
```

[7]:

```
happiness2015.isnull().sum()
```

[7]:

```
Country                          0
Region                           6
Happiness Rank                   6
Happiness Score                  6
Standard Error                   6
Economy (GDP per Capita)         6
Family                           6
Health (Life Expectancy)         6
Freedom                          6
Trust (Government Corruption)    6
Generosity                       6
Dystopia Residual                6
Year                             0
dtype: int64
```

[8]:

```
missing_2016 = happiness2016.isnull().sum()
missing_2017 = happiness2017.isnull().sum()
```

[9]:

```
missing_2016
```

[9]:

```
Country                          0
Region                           7
Happiness Rank                   7
Happiness Score                  7
Lower Confidence Interval        7
Upper Confidence Interval        7
Economy (GDP per Capita)         7
Family                           7
Health (Life Expectancy)         7
Freedom                          7
Trust (Government Corruption)    7
Generosity                       7
Dystopia Residual                7
Year                             0
dtype: int64
```

[10]:

```
missing_2017
```

[10]:

```
Country                          0
Happiness.Rank                   9
Happiness.Score                  9
Whisker.high                     9
Whisker.low                      9
Economy..GDP.per.Capita.         9
Family                           9
```

```
Health..Life.Expectancy.         9
Freedom                          9
Generosity                       9
Trust..Government.Corruption.    9
Dystopia.Residual                9
Year                             0
dtype: int64
```

[11]:

```
combined = pd.concat([happiness2015, happiness2016, happiness2017],␣
 ↪ignore_index=True)
combined.head()
```

[11]:

```
       Country          Region  Happiness Rank  Happiness Score  \
0  Switzerland  Western Europe             1.0            7.587
1      Iceland  Western Europe             2.0            7.561
2      Denmark  Western Europe             3.0            7.527
3       Norway  Western Europe             4.0            7.522
4       Canada   North America             5.0            7.427

   Standard Error  Economy (GDP per Capita)   Family  \
0         0.03411                   1.39651  1.34951
1         0.04884                   1.30232  1.40223
2         0.03328                   1.32548  1.36058
3         0.03880                   1.45900  1.33095
4         0.03553                   1.32629  1.32261

   Health (Life Expectancy)  Freedom  Trust (Government Corruption)  …  \
0                   0.94143  0.66557                        0.41978  …
1                   0.94784  0.62877                        0.14145  …
2                   0.87464  0.64938                        0.48357  …
3                   0.88521  0.66973                        0.36503  …
4                   0.90563  0.63297                        0.32957  …

   Lower Confidence Interval  Upper Confidence Interval  Happiness.Rank  \
0                        NaN                        NaN             NaN
1                        NaN                        NaN             NaN
2                        NaN                        NaN             NaN
3                        NaN                        NaN             NaN
4                        NaN                        NaN             NaN

   Happiness.Score  Whisker.high  Whisker.low  Economy..GDP.per.Capita.  \
0              NaN           NaN          NaN                       NaN
1              NaN           NaN          NaN                       NaN
2              NaN           NaN          NaN                       NaN
3              NaN           NaN          NaN                       NaN
4              NaN           NaN          NaN                       NaN
```

```
   Health..Life.Expectancy.  Trust..Government.Corruption.  Dystopia.Residual
0                       NaN                            NaN                NaN
1                       NaN                            NaN                NaN
2                       NaN                            NaN                NaN
3                       NaN                            NaN                NaN
4                       NaN                            NaN                NaN

[5 rows x 23 columns]
```

```
[12]: combined.isnull().sum()
```

```
[12]: Country                            0
Region                           177
Happiness Rank                   177
Happiness Score                  177
Standard Error                   334
Economy (GDP per Capita)         177
Family                            22
Health (Life Expectancy)         177
Freedom                           22
Trust (Government Corruption)    177
Generosity                        22
Dystopia Residual                177
Year                               0
Lower Confidence Interval        335
Upper Confidence Interval        335
Happiness.Rank                   337
Happiness.Score                  337
Whisker.high                     337
Whisker.low                      337
Economy..GDP.per.Capita.         337
Health..Life.Expectancy.         337
Trust..Government.Corruption.    337
Dystopia.Residual                337
dtype: int64
```

```
[13]: happiness2017.columns = happiness2017.columns.str.replace(".",' ').str.strip().
        ↪str.replace('  ',' ').str.upper()
```

```
C:\Users\dell\AppData\Local\Temp/ipykernel_14232/3693490500.py:1: FutureWarning:
The default value of regex will change from True to False in a future version.
In addition, single character regular expressions will *not* be treated as
literal strings when regex=True.
  happiness2017.columns = happiness2017.columns.str.replace(".",'
').str.strip().str.replace('  ',' ').str.upper()
```

```
[14]: happiness2017.columns
```

```
[14]: Index(['COUNTRY', 'HAPPINESS RANK', 'HAPPINESS SCORE', 'WHISKER HIGH',
             'WHISKER LOW', 'ECONOMY GDP PER CAPITA', 'FAMILY',
             'HEALTH LIFE EXPECTANCY', 'FREEDOM', 'GENEROSITY',
             'TRUST GOVERNMENT CORRUPTION', 'DYSTOPIA RESIDUAL', 'YEAR'],
            dtype='object')
```

```
[15]: happiness2015.columns = happiness2015.columns.str.replace('(','').str.
       ↪replace(')','').str.strip().str.upper()
```

```
C:\Users\dell\AppData\Local\Temp/ipykernel_14232/3458434633.py:1: FutureWarning:
The default value of regex will change from True to False in a future version.
In addition, single character regular expressions will *not* be treated as
literal strings when regex=True.
  happiness2015.columns = happiness2015.columns.str.replace('(','').str.replace(
')','').str.strip().str.upper()
```

```
[16]: happiness2016.columns = happiness2016.columns.str.replace('(','').str.
       ↪replace(')','').str.strip().str.upper()
```

```
C:\Users\dell\AppData\Local\Temp/ipykernel_14232/1949433483.py:1: FutureWarning:
The default value of regex will change from True to False in a future version.
In addition, single character regular expressions will *not* be treated as
literal strings when regex=True.
  happiness2016.columns = happiness2016.columns.str.replace('(','').str.replace(
')','').str.strip().str.upper()
```

```
[17]: combined = pd.concat([happiness2015,happiness2016,happiness2017],␣
       ↪ignore_index=True)
```

```
[18]: combined.head()
```

```
[18]:        COUNTRY          REGION  HAPPINESS RANK  HAPPINESS SCORE  \
      0  Switzerland  Western Europe             1.0            7.587
      1      Iceland  Western Europe             2.0            7.561
      2      Denmark  Western Europe             3.0            7.527
      3       Norway  Western Europe             4.0            7.522
      4       Canada   North America             5.0            7.427

         STANDARD ERROR  ECONOMY GDP PER CAPITA   FAMILY  HEALTH LIFE EXPECTANCY  \
      0         0.03411                 1.39651  1.34951                 0.94143
      1         0.04884                 1.30232  1.40223                 0.94784
      2         0.03328                 1.32548  1.36058                 0.87464
      3         0.03880                 1.45900  1.33095                 0.88521
      4         0.03553                 1.32629  1.32261                 0.90563

         FREEDOM  TRUST GOVERNMENT CORRUPTION  GENEROSITY  DYSTOPIA RESIDUAL  YEAR  \
      0  0.66557                      0.41978     0.29678            2.51738  2015
```

```
1  0.62877                      0.14145     0.43630            2.70201  2015
2  0.64938                      0.48357     0.34139            2.49204  2015
3  0.66973                      0.36503     0.34699            2.46531  2015
4  0.63297                      0.32957     0.45811            2.45176  2015

   LOWER CONFIDENCE INTERVAL  UPPER CONFIDENCE INTERVAL  WHISKER HIGH  \
0                        NaN                        NaN           NaN
1                        NaN                        NaN           NaN
2                        NaN                        NaN           NaN
3                        NaN                        NaN           NaN
4                        NaN                        NaN           NaN

   WHISKER LOW
0          NaN
1          NaN
2          NaN
3          NaN
4          NaN
```

[19]:

```
missing = combined.isnull().sum()
```

[20]:

```
combined.tail()
```

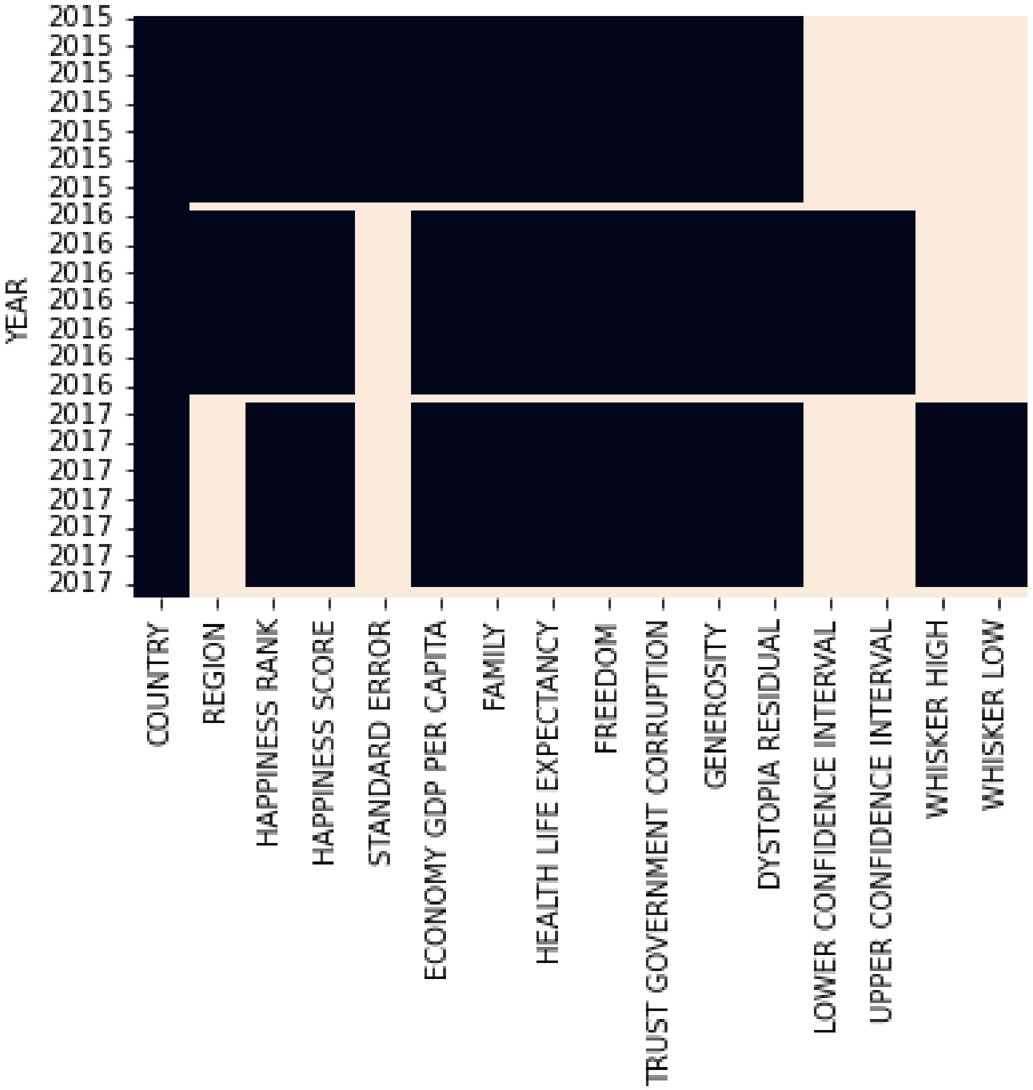
[20]:

```
               COUNTRY REGION  HAPPINESS RANK  HAPPINESS SCORE  \
487        Puerto Rico    NaN             NaN              NaN
488  Somaliland Region    NaN             NaN              NaN
489  Somaliland region    NaN             NaN              NaN
490           Suriname    NaN             NaN              NaN
491          Swaziland    NaN             NaN              NaN

     STANDARD ERROR  ECONOMY GDP PER CAPITA  FAMILY  HEALTH LIFE EXPECTANCY  \
487             NaN                     NaN     NaN                     NaN
488             NaN                     NaN     NaN                     NaN
489             NaN                     NaN     NaN                     NaN
490             NaN                     NaN     NaN                     NaN
491             NaN                     NaN     NaN                     NaN

     FREEDOM  TRUST GOVERNMENT CORRUPTION  GENEROSITY  DYSTOPIA RESIDUAL  \
487      NaN                          NaN         NaN                NaN
488      NaN                          NaN         NaN                NaN
489      NaN                          NaN         NaN                NaN
490      NaN                          NaN         NaN                NaN
491      NaN                          NaN         NaN                NaN

     YEAR  LOWER CONFIDENCE INTERVAL  UPPER CONFIDENCE INTERVAL  WHISKER HIGH  \
487  2017                        NaN                        NaN           NaN
488  2017                        NaN                        NaN           NaN
```

```
489  2017                        NaN                         NaN           NaN
490  2017                        NaN                         NaN           NaN
491  2017                        NaN                         NaN           NaN

     WHISKER LOW
487          NaN
488          NaN
489          NaN
490          NaN
491          NaN
```

[21]:
```python
import seaborn as sns
import matplotlib.pyplot as plt
```

[22]:
```python
combined_updated = combined.set_index('YEAR')
sns.heatmap(combined_updated.isnull(),cbar=False)
plt.show()
```



[23]:
```
region_2017 = combined[combined['YEAR'] == 2017]['REGION']
missing = region_2017.isnull().sum()
```

[24]:
```
missing
```

[24]:
```
164
```

- Check for errors in data cleaning/transformation
- `Use data from additional sources to fill missing values`
- Drop row/column
- Fill missing values with reasonable estimates computed from the available data

Recall once more that each year contains the same countries. Since the regions are fixed values - the region a country was assigned to in 2015 and 2016 won't change

```
[25]: happiness2015['COUNTRY'].isin(happiness2016['COUNTRY']).sum()
```

```
[25]: 164
```

```
[26]: regions = pd.read_csv('region.csv')
      regions.shape
```

```
[26]: (164, 2)
```

```
[27]: regions.head()
```

```
[27]:        COUNTRY          REGION
      0  Switzerland  Western Europe
      1      Iceland  Western Europe
      2      Denmark  Western Europe
      3       Norway  Western Europe
      4       Canada   North America
```

```
[28]: combined = pd.merge(left=combined, right = regions, on='COUNTRY',how = 'left')
```

```
[29]: combined.columns
```

```
[29]: Index(['COUNTRY', 'REGION_x', 'HAPPINESS RANK', 'HAPPINESS SCORE',
             'STANDARD ERROR', 'ECONOMY GDP PER CAPITA', 'FAMILY',
             'HEALTH LIFE EXPECTANCY', 'FREEDOM', 'TRUST GOVERNMENT CORRUPTION',
             'GENEROSITY', 'DYSTOPIA RESIDUAL', 'YEAR', 'LOWER CONFIDENCE INTERVAL',
             'UPPER CONFIDENCE INTERVAL', 'WHISKER HIGH', 'WHISKER LOW', 'REGION_y'],
            dtype='object')
```

```
[30]: combined[['REGION_x','REGION_y']]
```

```
[30]:            REGION_x                     REGION_y
      0    Western Europe               Western Europe
      1    Western Europe               Western Europe
      2    Western Europe               Western Europe
      3    Western Europe               Western Europe
      4     North America                North America
      ..              …                            …
      487             NaN  Latin America and Caribbean
      488             NaN           Sub-Saharan Africa
      489             NaN           Sub-Saharan Africa
      490             NaN  Latin America and Caribbean
      491             NaN           Sub-Saharan Africa

      [492 rows x 2 columns]
```

```
[31]: combined.isnull().sum()
```

[31]:
```
COUNTRY                          0
REGION_x                       177
HAPPINESS RANK                  22
HAPPINESS SCORE                 22
STANDARD ERROR                 334
ECONOMY GDP PER CAPITA          22
FAMILY                          22
HEALTH LIFE EXPECTANCY          22
FREEDOM                         22
TRUST GOVERNMENT CORRUPTION     22
GENEROSITY                      22
DYSTOPIA RESIDUAL               22
YEAR                             0
LOWER CONFIDENCE INTERVAL      335
UPPER CONFIDENCE INTERVAL      335
WHISKER HIGH                   337
WHISKER LOW                    337
REGION_y                         0
dtype: int64
```

[32]:
```
combined = combined.drop('REGION_x',axis=1)
```

[33]:
```
combined.isnull().sum()
```

[33]:
```
COUNTRY                          0
HAPPINESS RANK                  22
HAPPINESS SCORE                 22
STANDARD ERROR                 334
ECONOMY GDP PER CAPITA          22
FAMILY                          22
HEALTH LIFE EXPECTANCY          22
FREEDOM                         22
TRUST GOVERNMENT CORRUPTION     22
GENEROSITY                      22
DYSTOPIA RESIDUAL               22
YEAR                             0
LOWER CONFIDENCE INTERVAL      335
UPPER CONFIDENCE INTERVAL      335
WHISKER HIGH                   337
WHISKER LOW                    337
REGION_y                         0
dtype: int64
```

[34]:
```
combined.rename({'REGION_y':'REGION'}, axis=1,inplace=True)
```

[35]:
```
combined.head()
```

[35]:

```
       COUNTRY  HAPPINESS RANK  HAPPINESS SCORE  STANDARD ERROR  \
0  Switzerland             1.0            7.587         0.03411
1      Iceland             2.0            7.561         0.04884
2      Denmark             3.0            7.527         0.03328
3       Norway             4.0            7.522         0.03880
4       Canada             5.0            7.427         0.03553

   ECONOMY GDP PER CAPITA   FAMILY  HEALTH LIFE EXPECTANCY  FREEDOM  \
0                 1.39651  1.34951                 0.94143  0.66557
1                 1.30232  1.40223                 0.94784  0.62877
2                 1.32548  1.36058                 0.87464  0.64938
3                 1.45900  1.33095                 0.88521  0.66973
4                 1.32629  1.32261                 0.90563  0.63297

   TRUST GOVERNMENT CORRUPTION  GENEROSITY  DYSTOPIA RESIDUAL  YEAR  \
0                      0.41978     0.29678            2.51738  2015
1                      0.14145     0.43630            2.70201  2015
2                      0.48357     0.34139            2.49204  2015
3                      0.36503     0.34699            2.46531  2015
4                      0.32957     0.45811            2.45176  2015

   LOWER CONFIDENCE INTERVAL  UPPER CONFIDENCE INTERVAL  WHISKER HIGH  \
0                        NaN                        NaN           NaN
1                        NaN                        NaN           NaN
2                        NaN                        NaN           NaN
3                        NaN                        NaN           NaN
4                        NaN                        NaN           NaN

   WHISKER LOW          REGION
0          NaN  Western Europe
1          NaN  Western Europe
2          NaN  Western Europe
3          NaN  Western Europe
4          NaN   North America
```

[36]:

```
regions_columns = combined.iloc[:,-1]
```

[37]:

```
combined.pop('REGION')
```

[37]:

```
0                   Western Europe
1                   Western Europe
2                   Western Europe
3                   Western Europe
4                    North America
                  …
487    Latin America and Caribbean
488             Sub-Saharan Africa
```

```
489             Sub-Saharan Africa
490    Latin America and Caribbean
491             Sub-Saharan Africa
Name: REGION, Length: 492, dtype: object
```

[38]:

```
combined.insert(1, regions_columns.name, regions_columns)
```

[39]:

```
combined
```

[39]:

```
               COUNTRY                       REGION  HAPPINESS RANK  \
0          Switzerland               Western Europe             1.0
1              Iceland               Western Europe             2.0
2              Denmark               Western Europe             3.0
3               Norway               Western Europe             4.0
4               Canada                North America             5.0
..                 …                          …             …
487        Puerto Rico  Latin America and Caribbean             NaN
488  Somaliland Region           Sub-Saharan Africa             NaN
489  Somaliland region           Sub-Saharan Africa             NaN
490           Suriname  Latin America and Caribbean             NaN
491          Swaziland           Sub-Saharan Africa             NaN

     HAPPINESS SCORE  STANDARD ERROR  ECONOMY GDP PER CAPITA   FAMILY  \
0              7.587         0.03411                 1.39651  1.34951
1              7.561         0.04884                 1.30232  1.40223
2              7.527         0.03328                 1.32548  1.36058
3              7.522         0.03880                 1.45900  1.33095
4              7.427         0.03553                 1.32629  1.32261
..               …             …                       …      …
487              NaN             NaN                     NaN      NaN
488              NaN             NaN                     NaN      NaN
489              NaN             NaN                     NaN      NaN
490              NaN             NaN                     NaN      NaN
491              NaN             NaN                     NaN      NaN

     HEALTH LIFE EXPECTANCY  FREEDOM  TRUST GOVERNMENT CORRUPTION  GENEROSITY  \
0                   0.94143  0.66557                      0.41978     0.29678
1                   0.94784  0.62877                      0.14145     0.43630
2                   0.87464  0.64938                      0.48357     0.34139
3                   0.88521  0.66973                      0.36503     0.34699
4                   0.90563  0.63297                      0.32957     0.45811
..                      …       …                           …          …
487                     NaN      NaN                          NaN         NaN
488                     NaN      NaN                          NaN         NaN
489                     NaN      NaN                          NaN         NaN
490                     NaN      NaN                          NaN         NaN
491                     NaN      NaN                          NaN         NaN
```

```
     DYSTOPIA RESIDUAL  YEAR  LOWER CONFIDENCE INTERVAL  \
0              2.51738  2015                        NaN
1              2.70201  2015                        NaN
2              2.49204  2015                        NaN
3              2.46531  2015                        NaN
4              2.45176  2015                        NaN
..                 …   …                         …
487                NaN  2017                        NaN
488                NaN  2017                        NaN
489                NaN  2017                        NaN
490                NaN  2017                        NaN
491                NaN  2017                        NaN

     UPPER CONFIDENCE INTERVAL  WHISKER HIGH  WHISKER LOW
0                          NaN           NaN          NaN
1                          NaN           NaN          NaN
2                          NaN           NaN          NaN
3                          NaN           NaN          NaN
4                          NaN           NaN          NaN
..                         …           …           …
487                        NaN           NaN          NaN
488                        NaN           NaN          NaN
489                        NaN           NaN          NaN
490                        NaN           NaN          NaN
491                        NaN           NaN          NaN

[492 rows x 17 columns]
```

2 duplicated()

[40]:

```
combined[combined.duplicated()]
```

[40]:

```
Empty DataFrame
Columns: [COUNTRY, REGION, HAPPINESS RANK, HAPPINESS SCORE, STANDARD ERROR,
ECONOMY GDP PER CAPITA, FAMILY, HEALTH LIFE EXPECTANCY, FREEDOM, TRUST
GOVERNMENT CORRUPTION, GENEROSITY, DYSTOPIA RESIDUAL, YEAR, LOWER CONFIDENCE
INTERVAL, UPPER CONFIDENCE INTERVAL, WHISKER HIGH, WHISKER LOW]
Index: []
```

[41]:

```
combined[combined.duplicated(["COUNTRY",'YEAR'])]
```

[41]:

```
Empty DataFrame
Columns: [COUNTRY, REGION, HAPPINESS RANK, HAPPINESS SCORE, STANDARD ERROR,
ECONOMY GDP PER CAPITA, FAMILY, HEALTH LIFE EXPECTANCY, FREEDOM, TRUST
GOVERNMENT CORRUPTION, GENEROSITY, DYSTOPIA RESIDUAL, YEAR, LOWER CONFIDENCE
INTERVAL, UPPER CONFIDENCE INTERVAL, WHISKER HIGH, WHISKER LOW]
Index: []
```

Since the dataframe is empty, we can tell that there are no rows with exactly the same country AND year

‘India’ AND ‘INDIA’

```
[42]: combined['COUNTRY'] = combined["COUNTRY"].str.upper()
```

```
[43]: combined[combined.duplicated(["COUNTRY",'YEAR'])]
```

```
[43]:                COUNTRY              REGION  HAPPINESS RANK  HAPPINESS SCORE  \
162  SOMALILAND REGION  Sub-Saharan Africa             NaN              NaN
326  SOMALILAND REGION  Sub-Saharan Africa             NaN              NaN
489  SOMALILAND REGION  Sub-Saharan Africa             NaN              NaN

     STANDARD ERROR  ECONOMY GDP PER CAPITA  FAMILY  HEALTH LIFE EXPECTANCY  \
162             NaN                     NaN     NaN                     NaN
326             NaN                     NaN     NaN                     NaN
489             NaN                     NaN     NaN                     NaN

     FREEDOM  TRUST GOVERNMENT CORRUPTION  GENEROSITY  DYSTOPIA RESIDUAL  \
162      NaN                          NaN         NaN                NaN
326      NaN                          NaN         NaN                NaN
489      NaN                          NaN         NaN                NaN

     YEAR  LOWER CONFIDENCE INTERVAL  UPPER CONFIDENCE INTERVAL  WHISKER HIGH  \
162  2015                        NaN                        NaN           NaN
326  2016                        NaN                        NaN           NaN
489  2017                        NaN                        NaN           NaN

     WHISKER LOW
162          NaN
326          NaN
489          NaN
```

```
[44]: combined[combined['COUNTRY'] == 'SOMALILAND REGION']
```

```
[44]:                COUNTRY              REGION  HAPPINESS RANK  HAPPINESS SCORE  \
90   SOMALILAND REGION  Sub-Saharan Africa            91.0            5.057
162  SOMALILAND REGION  Sub-Saharan Africa             NaN              NaN
260  SOMALILAND REGION  Sub-Saharan Africa            97.0            5.057
326  SOMALILAND REGION  Sub-Saharan Africa             NaN              NaN
488  SOMALILAND REGION  Sub-Saharan Africa             NaN              NaN
489  SOMALILAND REGION  Sub-Saharan Africa             NaN              NaN

     STANDARD ERROR  ECONOMY GDP PER CAPITA   FAMILY  HEALTH LIFE EXPECTANCY  \
90          0.06161                 0.18847  0.95152                 0.43873
162             NaN                     NaN      NaN                     NaN
260             NaN                 0.25558  0.75862                 0.33108
326             NaN                     NaN      NaN                     NaN
488             NaN                     NaN      NaN                     NaN
489             NaN                     NaN      NaN                     NaN

     FREEDOM  TRUST GOVERNMENT CORRUPTION  GENEROSITY  DYSTOPIA RESIDUAL  \
90   0.46582                      0.39928     0.50318            2.11032
162      NaN                          NaN         NaN                NaN
260  0.39130                      0.36794     0.51479            2.43801
326      NaN                          NaN         NaN                NaN
488      NaN                          NaN         NaN                NaN
489      NaN                          NaN         NaN                NaN

     YEAR  LOWER CONFIDENCE INTERVAL  UPPER CONFIDENCE INTERVAL  WHISKER HIGH  \
90   2015                        NaN                        NaN           NaN
162  2015                        NaN                        NaN           NaN
260  2016                      4.934                       5.18           NaN
326  2016                        NaN                        NaN           NaN
488  2017                        NaN                        NaN           NaN
489  2017                        NaN                        NaN           NaN

     WHISKER LOW
90           NaN
162          NaN
260          NaN
326          NaN
488          NaN
489          NaN
```

3 drop_duplicates()

[45]:
```
combined = combined.drop_duplicates(['COUNTRY','YEAR'])
```

[46]:
```
combined.shape
```

[46]:
```
(489, 17)
```

[47]:
```
combined[combined.duplicated(["COUNTRY",'YEAR'])]
```

[47]:
```
Empty DataFrame
Columns: [COUNTRY, REGION, HAPPINESS RANK, HAPPINESS SCORE, STANDARD ERROR,
ECONOMY GDP PER CAPITA, FAMILY, HEALTH LIFE EXPECTANCY, FREEDOM, TRUST
GOVERNMENT CORRUPTION, GENEROSITY, DYSTOPIA RESIDUAL, YEAR, LOWER CONFIDENCE
INTERVAL, UPPER CONFIDENCE INTERVAL, WHISKER HIGH, WHISKER LOW]
```

```
Index: []
```

```
[48]: combined[combined['COUNTRY'] == 'SOMALILAND REGION']
```

```
[48]:
               COUNTRY              REGION  HAPPINESS RANK  HAPPINESS SCORE  \
90   SOMALILAND REGION  Sub-Saharan Africa            91.0            5.057
260  SOMALILAND REGION  Sub-Saharan Africa            97.0            5.057
488  SOMALILAND REGION  Sub-Saharan Africa             NaN              NaN

     STANDARD ERROR  ECONOMY GDP PER CAPITA   FAMILY  HEALTH LIFE EXPECTANCY  \
90          0.06161                 0.18847  0.95152                 0.43873
260             NaN                 0.25558  0.75862                 0.33108
488             NaN                     NaN      NaN                     NaN

     FREEDOM  TRUST GOVERNMENT CORRUPTION  GENEROSITY  DYSTOPIA RESIDUAL  \
90   0.46582                      0.39928     0.50318            2.11032
260  0.39130                      0.36794     0.51479            2.43801
488      NaN                          NaN         NaN                NaN

     YEAR  LOWER CONFIDENCE INTERVAL  UPPER CONFIDENCE INTERVAL  WHISKER HIGH  \
90   2015                        NaN                        NaN           NaN
260  2016                      4.934                       5.18           NaN
488  2017                        NaN                        NaN           NaN

     WHISKER LOW
90           NaN
260          NaN
488          NaN
```

- Check for errors in data cleaning/transformation
- Use data from additional sources to fill missing values
- Drop row/column
- Fill missing values with reasonable estimates computed from the available data

Since missing values make up more than half of the following columns and we don't need them to accomplish our end goal, we will drop them.

- STANDARD ERROR
- LOWER CONFIDENCE INTERVAL
- UPPER CONFIDENCE INTERVAL
- WHISKER HIGH
- WHISKER LOW

```
[49]: # columns_to_drop = ['STANDARD ERROR','LOWER CONFIDENCE INTERVAL','UPPER␣
       ↪CONFIDENCE INTERVAL','WHISKER HIGH','WHISKER LOW']

      # combined = combined.drop(columns_to_drop, axis=1)
```

4 dropna()

[50]:

```
combined.notnull().sum().sort_values()
```

[50]:

```
WHISKER LOW                      155
WHISKER HIGH                     155
UPPER CONFIDENCE INTERVAL        157
LOWER CONFIDENCE INTERVAL        157
STANDARD ERROR                   158
DYSTOPIA RESIDUAL                470
GENEROSITY                       470
TRUST GOVERNMENT CORRUPTION      470
FREEDOM                          470
FAMILY                           470
ECONOMY GDP PER CAPITA           470
HAPPINESS SCORE                  470
HAPPINESS RANK                   470
HEALTH LIFE EXPECTANCY           470
YEAR                             489
REGION                           489
COUNTRY                          489
dtype: int64
```

[51]:

```
combined.dropna(thresh=159, axis = 1).head()
```

[51]:

```
       COUNTRY          REGION  HAPPINESS RANK  HAPPINESS SCORE  \
0  SWITZERLAND  Western Europe             1.0            7.587
1      ICELAND  Western Europe             2.0            7.561
2      DENMARK  Western Europe             3.0            7.527
3       NORWAY  Western Europe             4.0            7.522
4       CANADA   North America             5.0            7.427

   ECONOMY GDP PER CAPITA   FAMILY  HEALTH LIFE EXPECTANCY  FREEDOM  \
0                 1.39651  1.34951                 0.94143  0.66557
1                 1.30232  1.40223                 0.94784  0.62877
2                 1.32548  1.36058                 0.87464  0.64938
3                 1.45900  1.33095                 0.88521  0.66973
4                 1.32629  1.32261                 0.90563  0.63297

   TRUST GOVERNMENT CORRUPTION  GENEROSITY  DYSTOPIA RESIDUAL  YEAR
0                      0.41978     0.29678            2.51738  2015
1                      0.14145     0.43630            2.70201  2015
2                      0.48357     0.34139            2.49204  2015
3                      0.36503     0.34699            2.46531  2015
4                      0.32957     0.45811            2.45176  2015
```

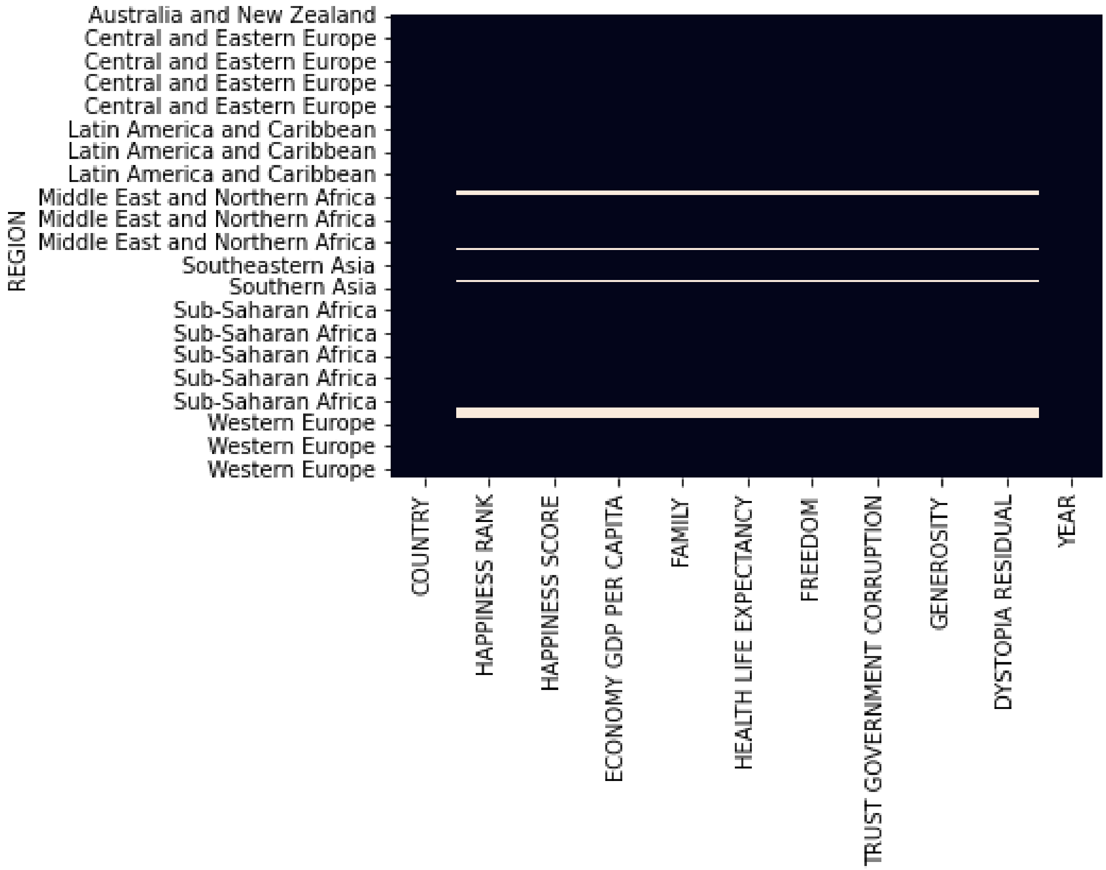
[52]:
```
combined  = combined.dropna(thresh=159, axis = 1)
combined.isnull().sum()
```

[52]:
```
COUNTRY                         0
REGION                          0
HAPPINESS RANK                 19
HAPPINESS SCORE                19
ECONOMY GDP PER CAPITA         19
FAMILY                         19
HEALTH LIFE EXPECTANCY         19
FREEDOM                        19
TRUST GOVERNMENT CORRUPTION    19
GENEROSITY                     19
DYSTOPIA RESIDUAL              19
YEAR                            0
dtype: int64
```

[53]:
```
combined.set_index("REGION").sort_values(['REGION','HAPPINESS SCORE']).head()
```

[53]:
```
                               COUNTRY  HAPPINESS RANK  HAPPINESS SCORE  \
REGION
Australia and New Zealand    AUSTRALIA            10.0            7.284
Australia and New Zealand    AUSTRALIA            10.0            7.284
Australia and New Zealand  NEW ZEALAND             9.0            7.286
Australia and New Zealand    AUSTRALIA             9.0            7.313
Australia and New Zealand  NEW ZEALAND             8.0            7.314

                           ECONOMY GDP PER CAPITA    FAMILY  \
REGION
Australia and New Zealand                1.484415  1.510042
Australia and New Zealand                1.333580  1.309230
Australia and New Zealand                1.250180  1.319670
Australia and New Zealand                1.444430  1.104760
Australia and New Zealand                1.405706  1.548195

                           HEALTH LIFE EXPECTANCY   FREEDOM  \
REGION
Australia and New Zealand                0.843887  0.601607
Australia and New Zealand                0.931560  0.651240
Australia and New Zealand                0.908370  0.639380
Australia and New Zealand                0.851200  0.568370
Australia and New Zealand                0.816760  0.614062

                           TRUST GOVERNMENT CORRUPTION  GENEROSITY  \
REGION
Australia and New Zealand                     0.301184    0.477699
Australia and New Zealand                     0.356370    0.435620
Australia and New Zealand                     0.429220    0.475010
Australia and New Zealand                     0.323310    0.474070
Australia and New Zealand                     0.382817    0.500005

                           DYSTOPIA RESIDUAL  YEAR
REGION
Australia and New Zealand           2.065211  2017
Australia and New Zealand           2.266460  2015
Australia and New Zealand           2.264250  2015
Australia and New Zealand           2.546500  2016
Australia and New Zealand           2.046456  2017
```

[54]:
```
sorted_combined = combined.set_index("REGION").sort_values(['REGION','HAPPINESS␣
 ↪SCORE'])
sns.heatmap(sorted_combined.isnull(), cbar=False)
plt.show()
```



[55]:
```
combined.head()
```

```
[55]:        COUNTRY          REGION  HAPPINESS RANK  HAPPINESS SCORE  \
      0  SWITZERLAND  Western Europe             1.0            7.587
      1      ICELAND  Western Europe             2.0            7.561
      2      DENMARK  Western Europe             3.0            7.527
      3       NORWAY  Western Europe             4.0            7.522
      4       CANADA   North America             5.0            7.427

         ECONOMY GDP PER CAPITA   FAMILY  HEALTH LIFE EXPECTANCY  FREEDOM  \
      0                 1.39651  1.34951                 0.94143  0.66557
      1                 1.30232  1.40223                 0.94784  0.62877
      2                 1.32548  1.36058                 0.87464  0.64938
      3                 1.45900  1.33095                 0.88521  0.66973
      4                 1.32629  1.32261                 0.90563  0.63297

         TRUST GOVERNMENT CORRUPTION  GENEROSITY  DYSTOPIA RESIDUAL  YEAR
      0                      0.41978     0.29678            2.51738  2015
      1                      0.14145     0.43630            2.70201  2015
      2                      0.48357     0.34139            2.49204  2015
      3                      0.36503     0.34699            2.46531  2015
      4                      0.32957     0.45811            2.45176  2015
```

5 fillna()

- Check for errors in data cleaning/transformation
- Use data from additional sources to fill missing values
- Drop row/column
- Fill missing values with reasonable estimates computed from the available data

```
[56]: (6+7+8+9+75)/5
```

```
[56]: 21.0
```

```
[57]: (6+7+8+9+75+21)/6
```

```
[57]: 21.0
```

```
[58]: combined['HAPPINESS SCORE'].mean()
```

```
[58]: 5.370727659882893
```

```
[59]: score_mean = combined['HAPPINESS SCORE'].mean()
```

```
[60]: combined['HAPPINESS SCORE'] = combined['HAPPINESS SCORE'].fillna(score_mean)
```

```
[61]: combined['HAPPINESS SCORE'].mean()
```

```
[61]: 5.370727659882894
```

```
[62]: combined.isnull().sum()
```

```
[62]: COUNTRY                         0
      REGION                          0
      HAPPINESS RANK                 19
      HAPPINESS SCORE                 0
      ECONOMY GDP PER CAPITA         19
      FAMILY                         19
      HEALTH LIFE EXPECTANCY         19
      FREEDOM                        19
      TRUST GOVERNMENT CORRUPTION    19
      GENEROSITY                     19
      DYSTOPIA RESIDUAL              19
      YEAR                            0
      dtype: int64
```

6 Task

- Fill all other remaining columns with mean.
- FOR HAPPINESS RANKING, since this is an ordinal value, find out how can you fill the null values in an ordinal/rank/positional value.

```
[63]: combined['ECONOMY GDP PER CAPITA'].mean()
```

```
[63]: 0.9278300665993268
```

```
[64]: combined.columns[3:11]
```

```
[64]: Index(['HAPPINESS SCORE', 'ECONOMY GDP PER CAPITA', 'FAMILY',
             'HEALTH LIFE EXPECTANCY', 'FREEDOM', 'TRUST GOVERNMENT CORRUPTION',
             'GENEROSITY', 'DYSTOPIA RESIDUAL'],
            dtype='object')
```

```
[65]: counter = 0
      column_name = combined.columns[3:11]
      for i in column_name:
          counter += 1
          mean = str(combined[i].mean())
          mean_list = mean.split()
          for j in mean_list:
              combined[i] = combined[i].fillna(float(j))
              print(combined[i])
```

```
0       7.587000
1       7.561000
```

```
2      7.527000
3      7.522000
4      7.427000
         …
486    5.370728
487    5.370728
488    5.370728
490    5.370728
491    5.370728
Name: HAPPINESS SCORE, Length: 489, dtype: float64
0      1.39651
1      1.30232
2      1.32548
3      1.45900
4      1.32629
        …
486    0.92783
487    0.92783
488    0.92783
490    0.92783
491    0.92783
Name: ECONOMY GDP PER CAPITA, Length: 489, dtype: float64
0      1.349510
1      1.402230
2      1.360580
3      1.330950
4      1.322610
         …
486    0.990347
487    0.990347
488    0.990347
490    0.990347
491    0.990347
Name: FAMILY, Length: 489, dtype: float64
0      0.941430
1      0.947840
2      0.874640
3      0.885210
4      0.905630
         …
486    0.579968
487    0.579968
488    0.579968
490    0.579968
491    0.579968
Name: HEALTH LIFE EXPECTANCY, Length: 489, dtype: float64
0      0.665570
1      0.628770
```

```
2      0.649380
3      0.669730
4      0.632970
         …
486    0.402828
487    0.402828
488    0.402828
490    0.402828
491    0.402828
Name: FREEDOM, Length: 489, dtype: float64
0      0.41978
1      0.14145
2      0.48357
3      0.36503
4      0.32957
        …
486    0.13479
487    0.13479
488    0.13479
490    0.13479
491    0.13479
Name: TRUST GOVERNMENT CORRUPTION, Length: 489, dtype: float64
0      0.296780
1      0.436300
2      0.341390
3      0.346990
4      0.458110
         …
486    0.242241
487    0.242241
488    0.242241
490    0.242241
491    0.242241
Name: GENEROSITY, Length: 489, dtype: float64
0      2.517380
1      2.702010
2      2.492040
3      2.465310
4      2.451760
         …
486    2.092717
487    2.092717
488    2.092717
490    2.092717
491    2.092717
Name: DYSTOPIA RESIDUAL, Length: 489, dtype: float64
```

[66]:

```
combined.isnull().sum()
```

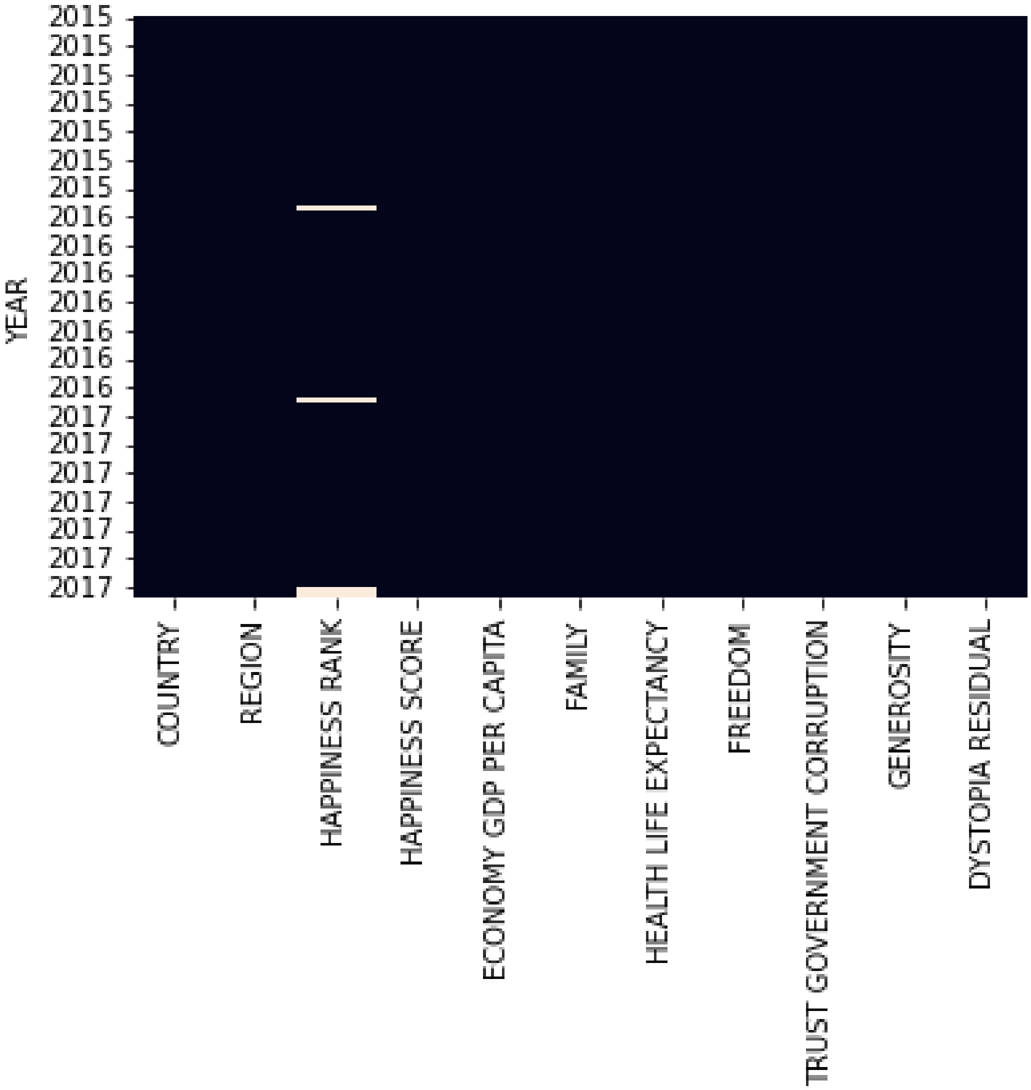
[66]:

```
COUNTRY                          0
REGION                           0
HAPPINESS RANK                  19
HAPPINESS SCORE                  0
ECONOMY GDP PER CAPITA           0
FAMILY                           0
HEALTH LIFE EXPECTANCY           0
FREEDOM                          0
TRUST GOVERNMENT CORRUPTION      0
GENEROSITY                       0
DYSTOPIA RESIDUAL                0
YEAR                             0
dtype: int64
```

- Fill all other remaining columns with mean.
- `FOR HAPPINESS RANKING, since this is an ordinal value, find out how can you fill the null values in an ordinal/rank/positional value.`

[67]:

```
combined_updated = combined.set_index('YEAR')
sns.heatmap(combined_updated.isnull(),cbar=False)
plt.show()
```



[68]:
```
year2015 = combined[combined['YEAR'] == 2015]
year2016 = combined[combined['YEAR'] == 2016]
year2017 = combined[combined['YEAR'] == 2017]
```

[69]:
```
filled_2015 = year2015['HAPPINESS RANK'].interpolate(method='linear')
filled_2016 = year2016['HAPPINESS RANK'].interpolate(method='linear')
filled_2017 = year2017['HAPPINESS RANK'].interpolate(method='linear')
```

[70]:
```
combined.loc[158:163, 'HAPPINESS RANK'] = filled_2015.loc[158:]
combined.loc[321:327, 'HAPPINESS RANK'] = filled_2016.loc[321:]
combined.loc[482:490, 'HAPPINESS RANK'] = filled_2017.loc[482:]
```

[71]:
```
combined['HAPPINESS RANK'] = combined['HAPPINESS RANK'].interpolate(method =␣
 ↪'linear')
```

[72]:
```
combined['HAPPINESS RANK'].isnull().sum()
```

[72]:
```
0
```

[73]:
```
combined.to_csv( 'Cleaning_updated.csv', index=False)
```