06_worksheet_answers

November 16, 2022

1 Week 6 worksheet - GB cycling accidents

In the `data` folder of the course materials you should find a `CSV` file called `gb_cycling_accidents.csv` which contains data on bicycle accidents in Great Britain from 1970 to 2018. I retrieved the data set from kaggle, which cites data.world as the original source. Each row holds information about a specific accident, and each column holds information about the accident, such as the date, time of day, day of week, number of vehicles involved, weather conditions, severity, etc. Here is the full explanation of the columns in the data set.

Variable	Definition
Accident_Index	Unique identifier for the accident. This may be thought of as the accident "case number".
Number_of_Vehicles	Number of vehicles that were involved in the accident
Number_of_Casualties	Number of casualties resulting from the accident
Date	Date when the accident happened
Time	Time when the accident happened
Speed_limit	Speed limit on the part of the road where the accident took place
Road_conditions	Road condition (e.g., "frost") at the time and place of the accident
Weather_conditions	Whether condition (e.g., "rain") at time and place of the accident
Day	Day of the week when the accident occurred
Road_type	Type of road (e.g., "Dual carriageway") where the accident happened
Light_conditions	Light conditions (e.g., "Daylight") at time of accident
Gender	Whether the accident victim was Male or Female
Severity	How severe (e.g., "Serious") the accident was
Age_Grp	Age group of the accident victim

Let's explore the frequency of accidents with respect to the different variables.

[1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
plt.style.use('bmh')
```

1.0.1 1. Import pandas and read data/gb_cycling_accidents.csv into a DataFrame

[2]:
```
df = pd.read_csv('../data/gb_cycling_accidents.csv')
df
```

[2]:

	Accident_Index	Number_of_Vehicles	Number_of_Casualties	Date	\
0	197901A1SEE71	2	1	1979-01-01	
1	197901A2JDW40	1	1	1979-02-01	
2	197901A4IJV90	2	1	1979-04-01	
3	197901A4NIE33	2	1	1979-04-01	
4	197901A4SKO47	2	1	1979-04-01	
…	…	…	…	…	
827856	2018983118818	2	1	2018-02-07	
827857	2018983119218	2	1	2018-07-24	
827858	2018983120618	2	1	2018-10-08	
827859	2018983121918	2	1	2018-07-18	
827860	2018983133818	2	1	2018-12-20	

	Time	Speed_limit	Road_conditions	Weather_conditions	Day	\
0	18:20	50.0	Snow	Unknown	Monday	
1	09:15	30.0	Snow	Unknown	Tuesday	
2	08:45	30.0	Snow	Unknown	Thursday	
3	13:40	30.0	Wet	Unknown	Thursday	
4	18:50	30.0	Wet	Unknown	Thursday	
…	…	…	…	…	…	
827856	14:55	30.0	Dry	Clear	Monday	
827857	07:45	30.0	Dry	Clear	Tuesday	
827858	13:25	20.0	Dry	Clear	Friday	
827859	21:10	30.0	Dry	Clear	Wednesday	
827860	15:14	30.0	Wet	Rain	Thursday	

	Road_type	Light_conditions	Gender	Severity	Age_Grp
0	Dual carriageway	Darkness lights lit	Male	Serious	36 to 45
1	Unknown	Daylight	Male	Slight	46 to 55
2	Unknown	Daylight	Male	Slight	46 to 55
3	Unknown	Daylight	Male	Slight	36 to 45
4	Unknown	Darkness lights lit	Male	Slight	46 to 55
…	…	…	…	…	…
827856	Single carriageway	Daylight	Male	Slight	6 to 10
827857	Single carriageway	Daylight	Male	Serious	56 to 65
827858	Single carriageway	Daylight	Male	Serious	11 to 15
827859	Single carriageway	Daylight	Male	Serious	46 to 55
827860	Single carriageway	Daylight	Male	Serious	6 to 10

[827861 rows x 14 columns]

1.0.2 2. How many unique values are in the following columns?

- Speed_limit
- Road_conditions
- Weather_conditions
- Road_type
- Light_conditions
- Gender
- Severity
- Age_Grp

[3]:
```
cols = [
    'Road_conditions',
    'Weather_conditions',
    'Road_type',
    'Light_conditions',
    'Gender',
    'Severity',
    'Age_Grp'
]

for col in cols:
    print(f'{col}: {df[col].unique()}')
```

```
Road_conditions: ['Snow' 'Wet' 'Dry' 'Frost' 'Flood' 'Missing Data']
Weather_conditions: ['Unknown' 'Rain' 'Snow' 'Fog' 'Clear' 'Clear and windy'
'Other'
 'Rain and windy' 'Snow and windy' 'Missing data']
Road_type: ['Dual carriageway' 'Unknown' 'Single carriageway' 'Roundabout'
 'One way sreet' 'Slip road']
Light_conditions: ['Darkness lights lit' 'Daylight' 'Darkness no lights']
Gender: ['Male' 'Female' 'Other']
Severity: ['Serious' 'Slight' 'Fatal']
Age_Grp: ['36 to 45' '46 to 55' '16 to 20' '21 to 25' '26 to 35' '11 to 15'
 '56 to 65' '6 to 10' '66 to 75']
```

1.0.3 3. What road conditions were associated with the most and least accidents?

[4]:
```
df.Road_conditions.value_counts()
```

[4]:
```
Dry             633936
Wet             184279
Frost             6020
Snow              1710
Missing Data      1648
Flood              268
Name: Road_conditions, dtype: int64
```

1.0.4 4. What weather conditions were associated with the most and least accidents?

[5]:
```
df.Weather_conditions.value_counts()
```

[5]:
```
Clear              683162
Rain                82007
Unknown             24081
Clear and windy     11891
Other               11820
Rain and windy       8808
Fog                  3369
Snow                 2086
Snow and windy        483
Missing data          154
Name: Weather_conditions, dtype: int64
```

1.0.5 5. What road type was associated with the most and least accidents?

[6]:
```
df.Road_type.value_counts()
```

[6]:
```
Single carriageway    656703
Roundabout             75066
Dual carriageway       59037
Unknown                30647
One way sreet           5562
Slip road                846
Name: Road_type, dtype: int64
```

1.0.6 6. What light conditions were associated with the most and least accidents?

[7]:
```
df.Light_conditions.value_counts()
```

[7]:
```
Daylight               660657
Darkness lights lit    142039
Darkness no lights      25165
Name: Light_conditions, dtype: int64
```

1.0.7 7. What speed limit was associated with the most and least accidents?

[8]:
```
df.Speed_limit.value_counts()
```

[8]:
```
30.0    686784
60.0     58557
40.0     53337
70.0     11363
20.0     10836
50.0      6676
```

```
10.0        105
0.0          68
15.0         53
36.0         11
5.0          10
51.0          7
31.0          7
38.0          6
25.0          6
61.0          6
41.0          4
39.0          4
66.0          2
32.0          2
27.0          2
33.0          1
26.0          1
3.0           1
660.0         1
59.0          1
45.0          1
13.0          1
21.0          1
22.0          1
16.0          1
34.0          1
55.0          1
35.0          1
46.0          1
62.0          1
Name: Speed_limit, dtype: int64
```

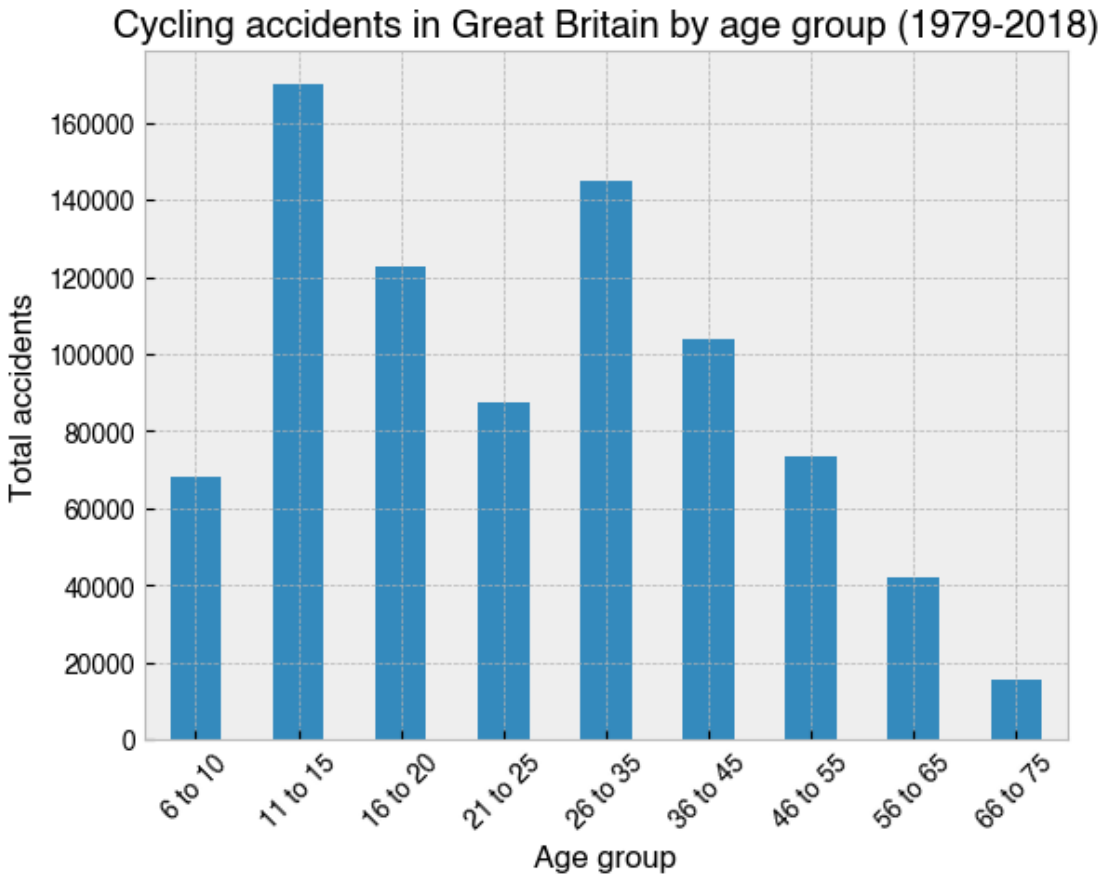
1.0.8 8. Based on the above, write a single sentence that summarises the conditions in which most accidents appeared to occur.

Most accidents occurred on single carriageway roads with a 30-MPH speed limit, in clear and dry daylight conditions.

1.0.9 9. Create a bar chart showing how accidents were distributed by `Age_Grp`

[9]:
```
group_order = [
    '6 to 10',
    '11 to 15',
    '16 to 20',
    '21 to 25',
    '26 to 35',
    '36 to 45',
```

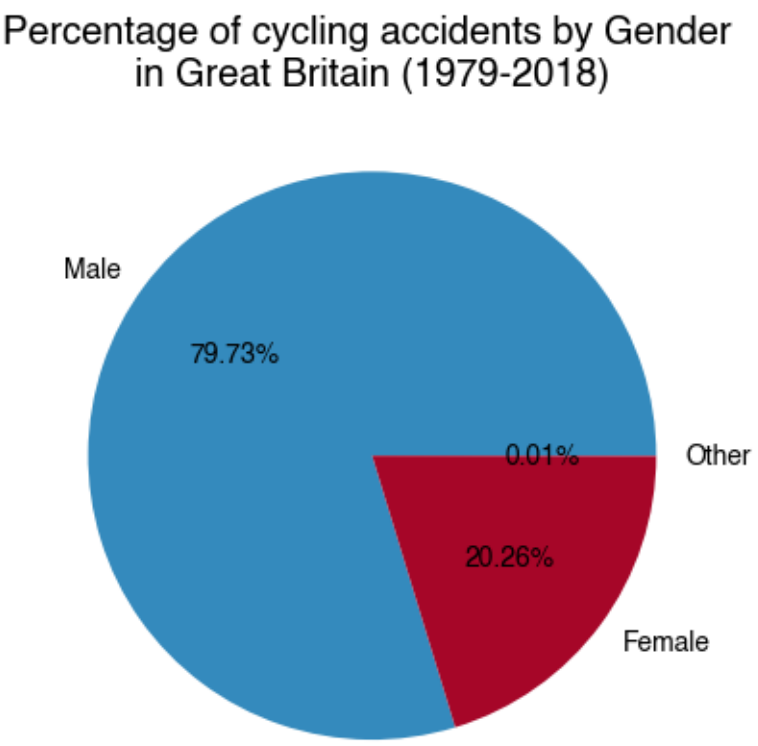
```
    '46 to 55',
    '56 to 65',
    '66 to 75'
]
ax = (
    df.groupby('Age_Grp')['Accident_Index']
    .count()[group_order]
    .plot(kind='bar', rot=45)
)
ax.set_xlabel('Age group')
ax.set_ylabel('Total accidents')
ax.set_title('Cycling accidents in Great Britain by age group (1979-2018)');
```



1.0.10 10. Across all accidents, what percentage involved Males, what percentage involved Females, and what percentage involved people identifying as 'Other'? Show the results in a pie chart.

[10]:
```
print(df.Gender.value_counts(normalize=True))
ax = (
    df.Gender.value_counts(normalize=True)
    .mul(100)
    .plot
    .pie(autopct='%1.2f%%')
)
ax.set_title('Percentage of cycling accidents by Gender \nin Great Britain␣
 ↪(1979-2018)')
ax.set_ylabel('');
```

```
Male      0.797265
Female    0.202591
Other     0.000144
Name: Gender, dtype: float64
```



1.0.11 11. What was the highest number of vehicles involved in a single accident?

[11]:
```
df.Number_of_Vehicles.value_counts()
```

[11]:
```
2     758784
1      41786
3      24955
4       1861
5        343
6         72
7         30
8         21
9          4
10         3
12         1
13         1
Name: Number_of_Vehicles, dtype: int64
```

1.0.12 12. What was the highest number of casualties involved in a single accident?

[12]:
```
df.Number_of_Casualties.value_counts()
```

[12]:
```
1     792685
2      32367
3       2227
4        357
5        123
6         54
7         23
8          9
13         5
9          5
10         3
60         1
12         1
34         1
Name: Number_of_Casualties, dtype: int64
```

1.0.13 13. On which day of the week did the accident with Accident_Index 201443N027074 occur?

[13]:
```
df.loc[df.Accident_Index=='201443N027074']
```

[13]:
```
       Accident_Index  Number_of_Vehicles  Number_of_Casualties        Date  \
751599  201443N027074                   2                     1  2014-05-07

          Time  Speed_limit Road_conditions Weather_conditions       Day  \
```

```
751599  19:30         30.0             Dry              Clear  Saturday

                Road_type Light_conditions Gender Severity   Age_Grp
751599  Single carriageway         Daylight   Male  Serious  16 to 20
```

1.0.14 14. Create a separate DataFrame for all serious accidents that happened on a Sunday in wet road conditions. How many were there?

[14]:
```
df2 = df.loc[(
    (df.Severity=='Serious')
    & (df.Day=='Sunday')
    & (df.Road_conditions=='Wet')
)]
df2
```

[14]:
```
        Accident_Index  Number_of_Vehicles  Number_of_Casualties        Date  \
9        197901A7PDD49                   2                     1  1979-07-01
107      197901ALMAE81                   2                     1  1979-01-21
657      197901D8LGF35                   2                     1  1979-08-04
1538     197901FOJEV59                   2                     1  1979-06-24
1542     197901FOPGC24                   2                     1  1979-06-24
…                  …                   …                     …           …
826325   2018521902418                   2                     1  2018-02-12
826477   2018530806661                   2                     1  2018-07-29
827229   201863C114718                   2                     1  2018-09-30
827580   2018961800246                   2                     1  2018-07-15
827618   201897GC01011                   3                     1  2018-11-25

          Time  Speed_limit Road_conditions Weather_conditions     Day  \
9        15:15         30.0             Wet               Rain  Sunday
107      12:00         30.0             Wet                Fog  Sunday
657      11:30         30.0             Wet               Rain  Sunday
1538     09:20         30.0             Wet               Rain  Sunday
1542     15:30         30.0             Wet            Unknown  Sunday
…        …             …                …                 …      …
826325   16:56         20.0             Wet               Rain  Sunday
826477   18:50         30.0             Wet               Rain  Sunday
827229   15:35         30.0             Wet              Clear  Sunday
827580   11:00         60.0             Wet               Rain  Sunday
827618   10:30         60.0             Wet              Clear  Sunday

                 Road_type     Light_conditions  Gender Severity   Age_Grp
9                  Unknown             Daylight    Male  Serious  11 to 15
107     Single carriageway             Daylight    Male  Serious  56 to 65
657     Single carriageway             Daylight    Male  Serious   6 to 10
1538               Unknown             Daylight    Male  Serious  46 to 55
1542               Unknown             Daylight    Male  Serious  16 to 20
```

```
…                    …                      …      …       …        …
826325  Single carriageway  Darkness lights lit    Male  Serious  26 to 35
826477  Single carriageway              Daylight    Male  Serious  46 to 55
827229  Single carriageway              Daylight    Male  Serious  46 to 55
827580  Single carriageway              Daylight  Female  Serious  56 to 65
827618  Single carriageway              Daylight    Male  Serious  56 to 65

[2621 rows x 14 columns]
```

1.0.15 15. Create and assign a new DatetimeIndex for the DataFrame using the Date and Time columns

[15]:
```
df.index = pd.DatetimeIndex(df.Date + ' ' + df.Time)
df
```

[15]:
```
                     Accident_Index  Number_of_Vehicles  Number_of_Casualties  \
1979-01-01 18:20:00  197901A1SEE71                   2                     1
1979-02-01 09:15:00  197901A2JDW40                   1                     1
1979-04-01 08:45:00  197901A4IJV90                   2                     1
1979-04-01 13:40:00  197901A4NIE33                   2                     1
1979-04-01 18:50:00  197901A4SKO47                   2                     1
…                              …                   …                     …
2018-02-07 14:55:00  2018983118818                   2                     1
2018-07-24 07:45:00  2018983119218                   2                     1
2018-10-08 13:25:00  2018983120618                   2                     1
2018-07-18 21:10:00  2018983121918                   2                     1
2018-12-20 15:14:00  2018983133818                   2                     1

                           Date   Time  Speed_limit Road_conditions  \
1979-01-01 18:20:00  1979-01-01  18:20         50.0            Snow
1979-02-01 09:15:00  1979-02-01  09:15         30.0            Snow
1979-04-01 08:45:00  1979-04-01  08:45         30.0            Snow
1979-04-01 13:40:00  1979-04-01  13:40         30.0             Wet
1979-04-01 18:50:00  1979-04-01  18:50         30.0             Wet
…                           …      …            …             …
2018-02-07 14:55:00  2018-02-07  14:55         30.0             Dry
2018-07-24 07:45:00  2018-07-24  07:45         30.0             Dry
2018-10-08 13:25:00  2018-10-08  13:25         20.0             Dry
2018-07-18 21:10:00  2018-07-18  21:10         30.0             Dry
2018-12-20 15:14:00  2018-12-20  15:14         30.0             Wet

                     Weather_conditions        Day           Road_type  \
1979-01-01 18:20:00            Unknown     Monday    Dual carriageway
1979-02-01 09:15:00            Unknown    Tuesday             Unknown
1979-04-01 08:45:00            Unknown   Thursday             Unknown
1979-04-01 13:40:00            Unknown   Thursday             Unknown
1979-04-01 18:50:00            Unknown   Thursday             Unknown
```

```
…                                 …         …                  …
2018-02-07 14:55:00             Clear     Monday  Single carriageway
2018-07-24 07:45:00             Clear    Tuesday  Single carriageway
2018-10-08 13:25:00             Clear     Friday  Single carriageway
2018-07-18 21:10:00             Clear  Wednesday  Single carriageway
2018-12-20 15:14:00              Rain   Thursday  Single carriageway

                        Light_conditions Gender Severity   Age_Grp
1979-01-01 18:20:00  Darkness lights lit   Male  Serious  36 to 45
1979-02-01 09:15:00            Daylight   Male   Slight  46 to 55
1979-04-01 08:45:00            Daylight   Male   Slight  46 to 55
1979-04-01 13:40:00            Daylight   Male   Slight  36 to 45
1979-04-01 18:50:00  Darkness lights lit   Male   Slight  46 to 55
…                                   …    …       …       …
2018-02-07 14:55:00            Daylight   Male   Slight   6 to 10
2018-07-24 07:45:00            Daylight   Male  Serious  56 to 65
2018-10-08 13:25:00            Daylight   Male  Serious  11 to 15
2018-07-18 21:10:00            Daylight   Male  Serious  46 to 55
2018-12-20 15:14:00            Daylight   Male  Serious   6 to 10

[827861 rows x 14 columns]
```

1.0.16 16. Add a new column to the DataFrame called long_date. It should contain the correct dates matching the following format.

- Wednesday 09 February 2012

[23]:
```
df['long_date'] = df.index.strftime('%A %d %B %Y')
df.head()
```

[23]:
```
                     Accident_Index  Number_of_Vehicles  Number_of_Casualties  \
1979-01-01 18:20:00  197901A1SEE71                   2                     1
1979-02-01 09:15:00  197901A2JDW40                   1                     1
1979-04-01 08:45:00  197901A4IJV90                   2                     1
1979-04-01 13:40:00  197901A4NIE33                   2                     1
1979-04-01 18:50:00  197901A4SKO47                   2                     1

                            Date   Time  Speed_limit Road_conditions  \
1979-01-01 18:20:00  1979-01-01  18:20         50.0            Snow
1979-02-01 09:15:00  1979-02-01  09:15         30.0            Snow
1979-04-01 08:45:00  1979-04-01  08:45         30.0            Snow
1979-04-01 13:40:00  1979-04-01  13:40         30.0             Wet
1979-04-01 18:50:00  1979-04-01  18:50         30.0             Wet

                     Weather_conditions       Day         Road_type  \
1979-01-01 18:20:00            Unknown    Monday  Dual carriageway
1979-02-01 09:15:00            Unknown   Tuesday           Unknown
```

```
1979-04-01 08:45:00            Unknown  Thursday           Unknown
1979-04-01 13:40:00            Unknown  Thursday           Unknown
1979-04-01 18:50:00            Unknown  Thursday           Unknown

                       Light_conditions Gender Severity   Age_Grp  \
1979-01-01 18:20:00  Darkness lights lit   Male  Serious  36 to 45
1979-02-01 09:15:00            Daylight   Male   Slight  46 to 55
1979-04-01 08:45:00            Daylight   Male   Slight  46 to 55
1979-04-01 13:40:00            Daylight   Male   Slight  36 to 45
1979-04-01 18:50:00  Darkness lights lit   Male   Slight  46 to 55

                                    long_date
1979-01-01 18:20:00     Monday 01 January 1979
1979-02-01 09:15:00  Thursday 01 February 1979
1979-04-01 08:45:00       Sunday 01 April 1979
1979-04-01 13:40:00       Sunday 01 April 1979
1979-04-01 18:50:00       Sunday 01 April 1979
```

1.0.17 17. What is the worst day on record in terms of the number of accidents that were reported?

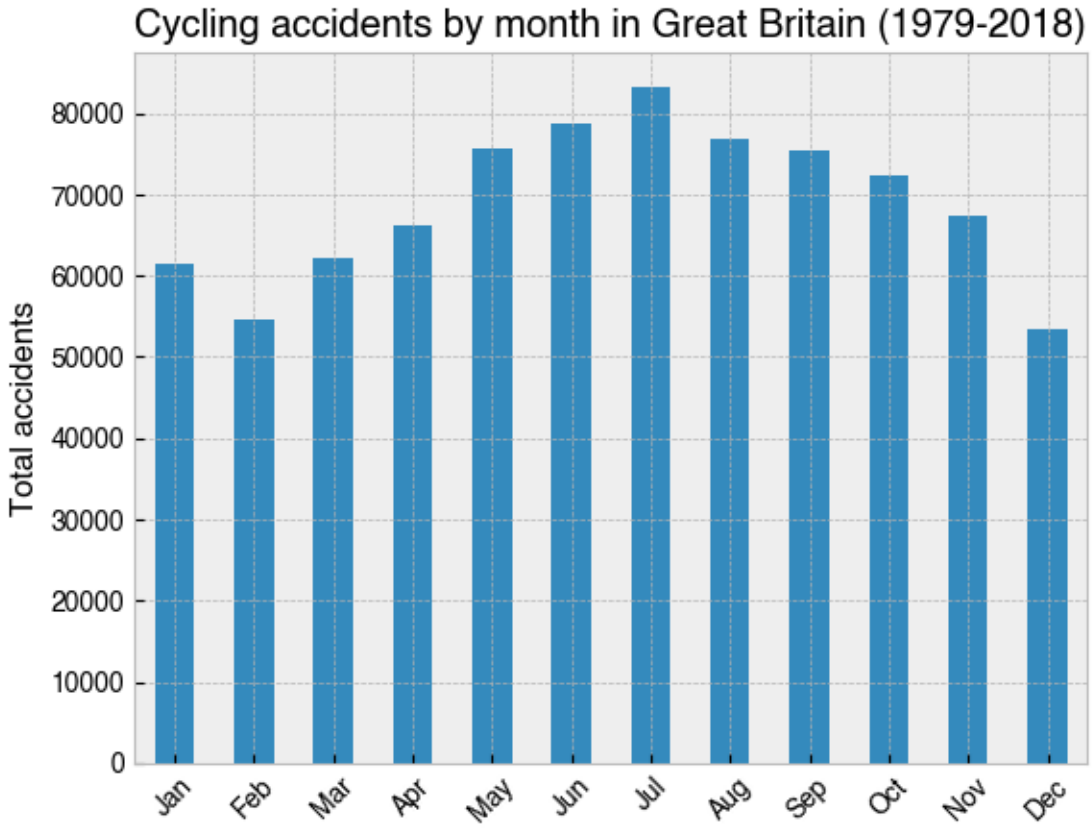
[16]:
```
df.groupby(df.index.date)['Accident_Index'].count().sort_values()
```

[16]:
```
2010-12-25      2
2009-01-01      2
2017-10-12      3
2003-01-01      3
2007-12-25      3
               …
1984-07-23    152
1983-07-21    154
1983-07-25    154
1989-07-26    161
1983-11-25    166
Name: Accident_Index, Length: 14609, dtype: int64
```

1.0.18 18. Make a bar chart showing total accidents by month of the year

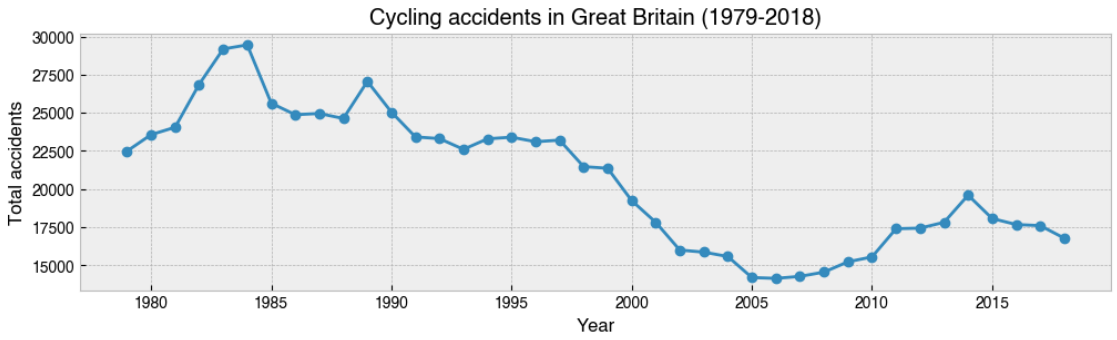
[17]:
```
months = ['Jan', 'Feb', 'Mar', 'Apr', 'May', 'Jun', 'Jul', 'Aug', 'Sep', 'Oct',␣
 ↪'Nov', 'Dec']
ax = (
    df.groupby(df.index.month)['Accident_Index']
    .count()
    .plot(kind='bar')
)
ax.set_xticklabels(months, rotation=45)
```

```
ax.set_ylabel('Total accidents')
ax.set_title('Cycling accidents by month in Great Britain (1979-2018)');
```



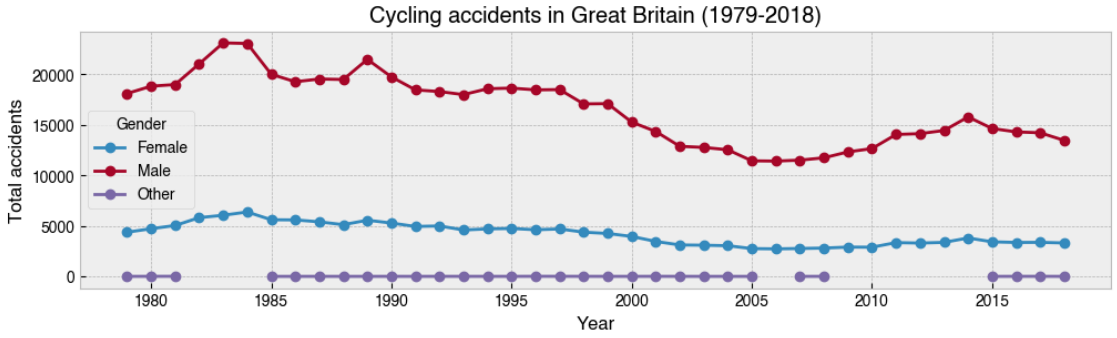
1.0.19 19. Make a line graph showing the total number of accidents that occurred each year from 1979-2018. Have accidents declined overall? In which years did the most and least cycling accidents occur?

[18]:
```
ax = (
    df.groupby(df.index.year)['Accident_Index']
    .count()
    .plot(kind='line', figsize=(12, 3), marker='o')
)
ax.set_ylabel('Total accidents')
ax.set_xlabel('Year')
ax.set_title('Cycling accidents in Great Britain (1979-2018)');
```



1.0.20 20. Repeat the above, but this time with separate lines for `Gender`

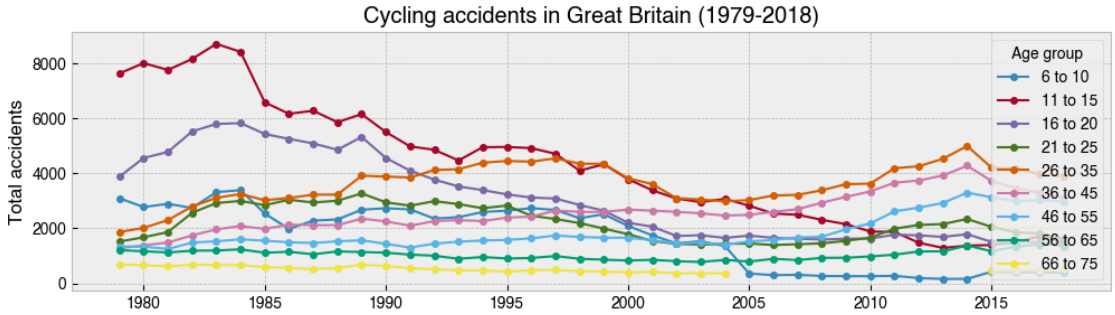
[19]:
```
ax = (
    df.groupby([df.index.year, 'Gender'])['Accident_Index']
    .count()
    .unstack()
    .plot(kind='line', figsize=(12, 3), marker='o')
)
ax.set_ylabel('Total accidents')
ax.set_xlabel('Year')
ax.set_title('Cycling accidents in Great Britain (1979-2018)');
```



1.0.21 21. Repeat the above, but this time with separate lines for `Age_Grp`

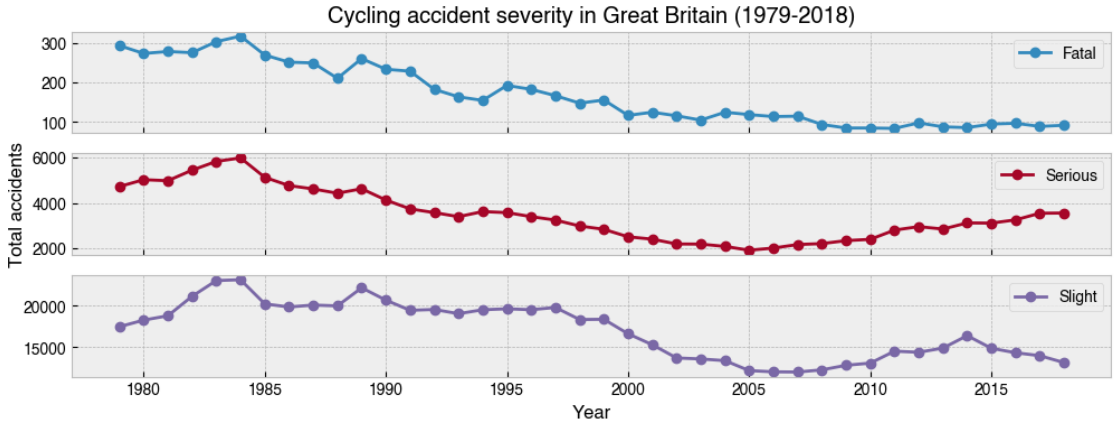
[20]:
```
group_order = [
    '6 to 10',
    '11 to 15',
    '16 to 20',
    '21 to 25',
    '26 to 35',
    '36 to 45',
```

```
    '46 to 55',
    '56 to 65',
    '66 to 75'
]
ax = (
    df.groupby([df.index.year, 'Age_Grp'])['Accident_Index']
    .count()
    .unstack()[group_order]
    .plot(kind='line', figsize=(12, 3), marker='o', lw=1.5, ms=4)
)
ax.set_ylabel('Total accidents')
ax.set_title('Cycling accidents in Great Britain (1979-2018)')
ax.legend(title='Age group');
```



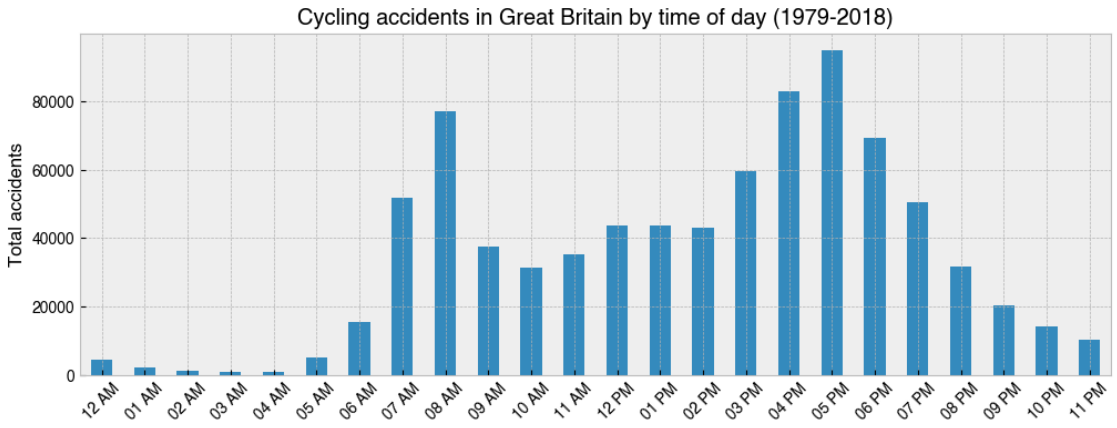
1.0.22 22. Repeat the above, but this time with separate subplots for `Severity`

[21]:
```
ax = (
    df.groupby([df.index.year, 'Severity'])['Accident_Index']
    .count()
    .unstack()
    .plot(kind='line', figsize=(12, 4), marker='o', subplots=True)
)
ax[1].set_ylabel('Total accidents')
ax[2].set_xlabel('Year')
ax[0].set_title('Cycling accident severity in Great Britain (1979-2018)');
```



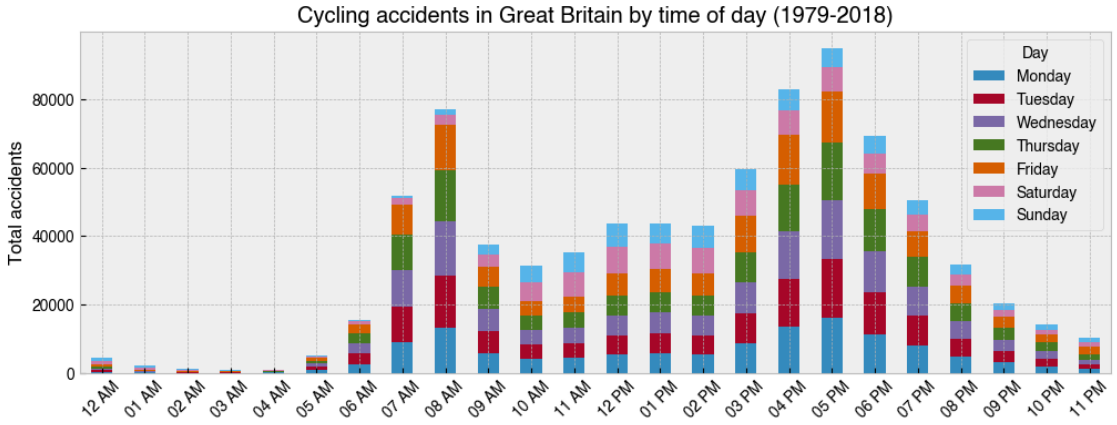
1.0.23 23. Make a bar chart showing the total number of accidents for each hour in the day from 1979-2018

[22]:
```
import datetime

ax = (
    df.groupby(df.index.hour)['Accident_Index']
    .count()
    .plot(kind='bar', figsize=(12, 4))
)
ax.set_ylabel('Total accidents')
ax.set_title('Cycling accidents in Great Britain by time of day (1979-2018)')
hours = [datetime.time(i).strftime('%I %p') for i in range(24)]
ax.set_xticklabels(hours, rotation=45);
```



1.0.24 24. As above, but with stacked bars using different colours for each day of the week

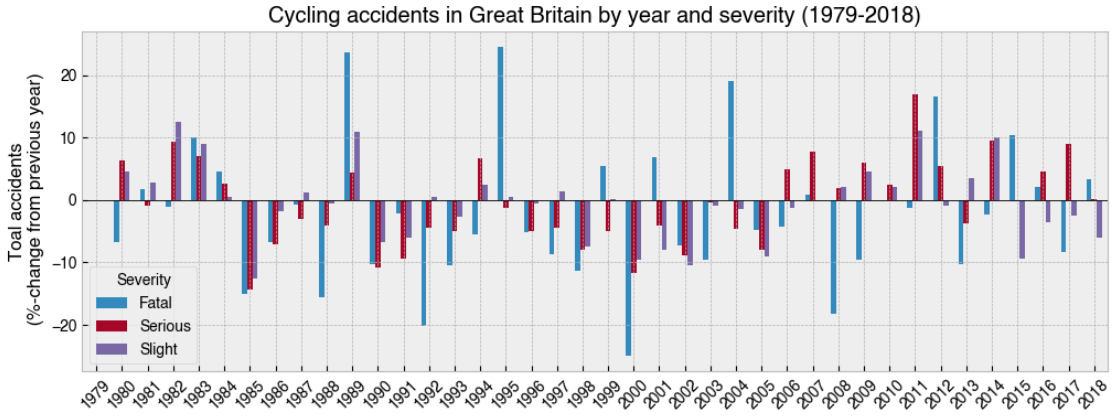
[23]:
```
import datetime

group_order = ['Monday', 'Tuesday', 'Wednesday', 'Thursday', 'Friday',␣
 ↪'Saturday', 'Sunday']

ax = (
    df.groupby([df.index.hour, 'Day'])['Accident_Index']
    .count()
    .unstack()[group_order]
    .plot(kind='bar', figsize=(12, 4), stacked=True)
)
ax.set_ylabel('Total accidents')
ax.set_title('Cycling accidents in Great Britain by time of day (1979-2018)')
hours = [datetime.time(i).strftime('%I %p') for i in range(24)]
ax.set_xticklabels(hours, rotation=45);
```



1.0.25 25. Make a bar chart showing the year-on-year percentage change for accidents with different coloured bars for each `Severity`

[24]:
```
ax = (
    df.groupby([df.index.year, 'Severity'])['Accident_Index']
    .count()
    .unstack()
    .pct_change()
    .mul(100)
    .plot
    .bar(figsize=(12, 4), rot=45, width=.6)
)
ax.axhline(0, 0, 1, lw=.6, c='k')
```

```
ax.set_ylabel('Toal accidents\n (%-change from previous year)')
ax.set_title('Cycling accidents in Great Britain by year and severity␣
 ↪(1979-2018)');
```



[ ]: