Lecture 6-2

Visual exploration with Seaborn

Week 6 Wednesday

Miles Chen, PhD

References:

- https://seaborn.pydata.org/tutorial/function_overview.html
- https://seaborn.pydata.org/generated/seaborn.displot.html
- https://seaborn.pydata.org/api.html

In [1]:
```
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import seaborn as sns
```

Seaborn is for visual exploration

The primary purpose of seaborn is to make plots and visualize data.

You can use seaborn occassionally to fit a model (e.g. linear model or logistic regression model) to your data. But keep in mind that these are simply for visual exploration. You cannot 'extract' the model (e.g. regression coefficients) from Seaborn

In [2]:
```
penguins = sns.load_dataset("penguins")
```

In [3]:
```
penguins.head(40)
```

Out[3]:

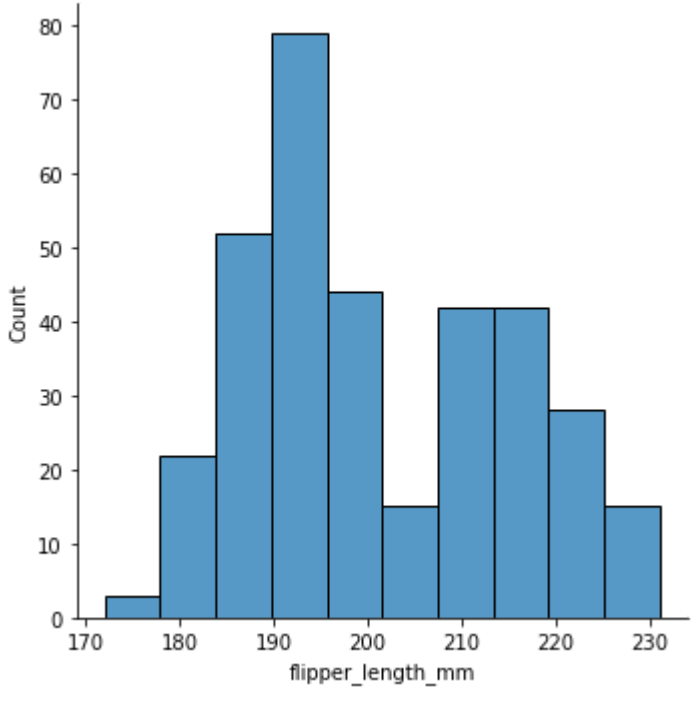
	species	island	bill_length_mm	bill_depth_mm	flipper_length_mm	body_mass_g	sex
0	Adelie	Torgersen	39.1	18.7	181.0	3750.0	Male
1	Adelie	Torgersen	39.5	17.4	186.0	3800.0	Female
2	Adelie	Torgersen	40.3	18.0	195.0	3250.0	Female
3	Adelie	Torgersen	NaN	NaN	NaN	NaN	NaN
4	Adelie	Torgersen	36.7	19.3	193.0	3450.0	Female
5	Adelie	Torgersen	39.3	20.6	190.0	3650.0	Male
6	Adelie	Torgersen	38.9	17.8	181.0	3625.0	Female
7	Adelie	Torgersen	39.2	19.6	195.0	4675.0	Male
8	Adelie	Torgersen	34.1	18.1	193.0	3475.0	NaN
9	Adelie	Torgersen	42.0	20.2	190.0	4250.0	NaN
10	Adelie	Torgersen	37.8	17.1	186.0	3300.0	NaN
11	Adelie	Torgersen	37.8	17.3	180.0	3700.0	NaN
12	Adelie	Torgersen	41.1	17.6	182.0	3200.0	Female
13	Adelie	Torgersen	38.6	21.2	191.0	3800.0	Male
14	Adelie	Torgersen	34.6	21.1	198.0	4400.0	Male
15	Adelie	Torgersen	36.6	17.8	185.0	3700.0	Female
16	Adelie	Torgersen	38.7	19.0	195.0	3450.0	Female
17	Adelie	Torgersen	42.5	20.7	197.0	4500.0	Male
18	Adelie	Torgersen	34.4	18.4	184.0	3325.0	Female
19	Adelie	Torgersen	46.0	21.5	194.0	4200.0	Male
20	Adelie	Biscoe	37.8	18.3	174.0	3400.0	Female
21	Adelie	Biscoe	37.7	18.7	180.0	3600.0	Male
22	Adelie	Biscoe	35.9	19.2	189.0	3800.0	Female
23	Adelie	Biscoe	38.2	18.1	185.0	3950.0	Male
24	Adelie	Biscoe	38.8	17.2	180.0	3800.0	Male
25	Adelie	Biscoe	35.3	18.9	187.0	3800.0	Female
26	Adelie	Biscoe	40.6	18.6	183.0	3550.0	Male

	species	island	bill_length_mm	bill_depth_mm	flipper_length_mm	body_mass_g	sex
27	Adelie	Biscoe	40.5	17.9	187.0	3200.0	Female
28	Adelie	Biscoe	37.9	18.6	172.0	3150.0	Female
29	Adelie	Biscoe	40.5	18.9	180.0	3950.0	Male
30	Adelie	Dream	39.5	16.7	178.0	3250.0	Female
31	Adelie	Dream	37.2	18.1	178.0	3900.0	Male
32	Adelie	Dream	39.5	17.8	188.0	3300.0	Female
33	Adelie	Dream	40.9	18.9	184.0	3900.0	Male
34	Adelie	Dream	36.4	17.0	195.0	3325.0	Female
35	Adelie	Dream	39.2	21.1	196.0	4150.0	Male
36	Adelie	Dream	38.8	20.0	190.0	3950.0	Male
37	Adelie	Dream	42.2	18.5	180.0	3550.0	Female
38	Adelie	Dream	37.6	19.3	181.0	3300.0	Female
39	Adelie	Dream	39.8	19.1	184.0	4650.0	Male

Univariate exploration

In [4]:
```
sns.displot(data = penguins, x = "flipper_length_mm")
# specify the dataframe and which variable to plot
```

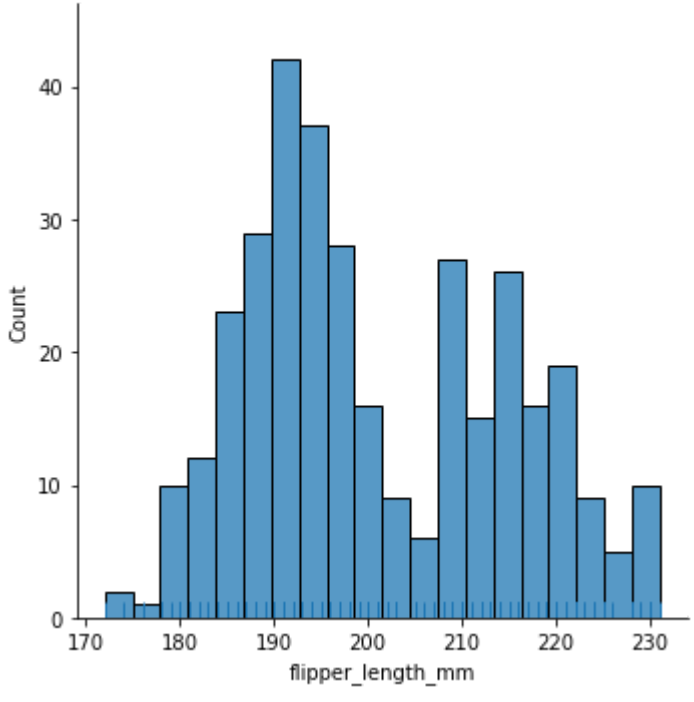
Out[4]:
```
<seaborn.axisgrid.FacetGrid at 0x237f547f2c8>
```



In [5]:

```
sns.displot(data = penguins, x = "flipper_length_mm", bins = 20, rug=True)
# use bins to specify bins
# use rug to add a rug plot
```

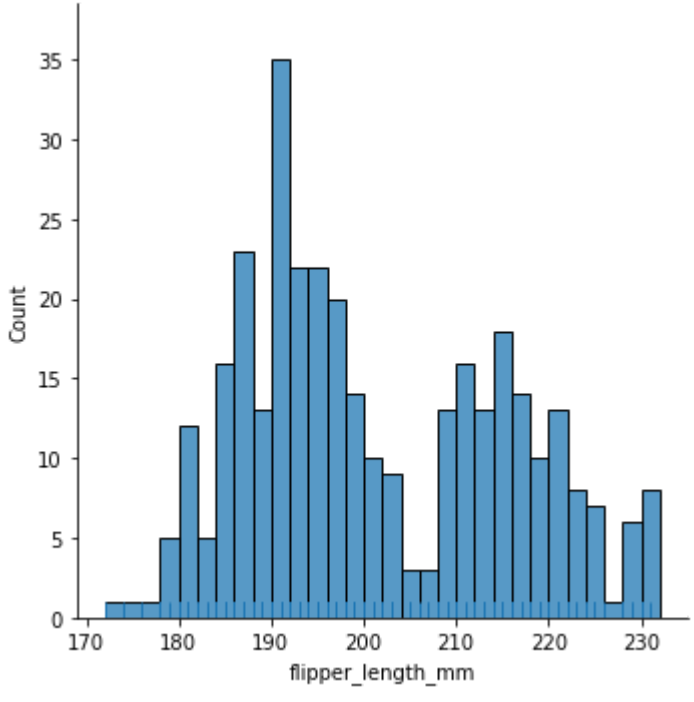
Out[5]: <seaborn.axisgrid.FacetGrid at 0x237f346d488>



In [6]:

```
sns.displot(data = penguins, x = "flipper_length_mm", binwidth = 2, rug=True)
# specify binwidth
```

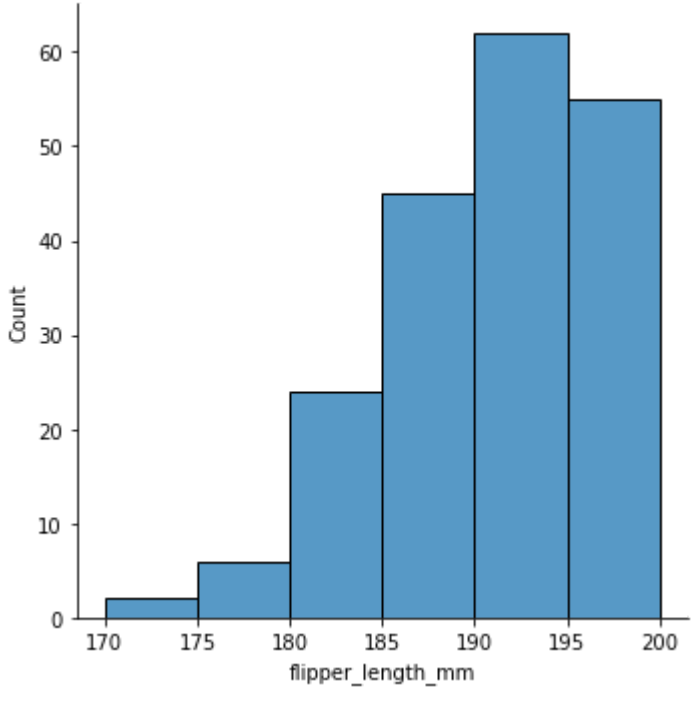
Out[6]: <seaborn.axisgrid.FacetGrid at 0x237f764c648>



In [7]:

```
sns.displot(data = penguins, x = "flipper_length_mm", bins = [170, 175, 180, 185, 190, 195, 200])
# custom breakpoints
```

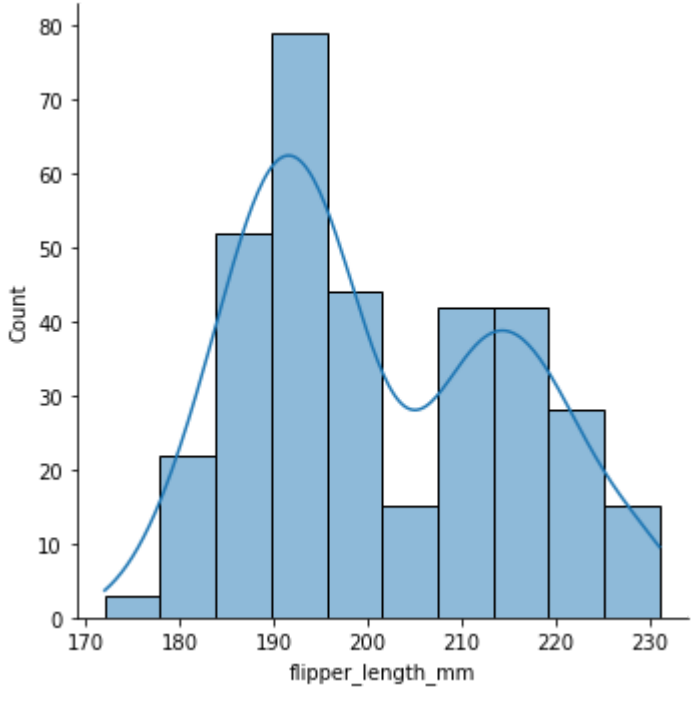
Out[7]: <seaborn.axisgrid.FacetGrid at 0x237f768d3c8>



In [8]:

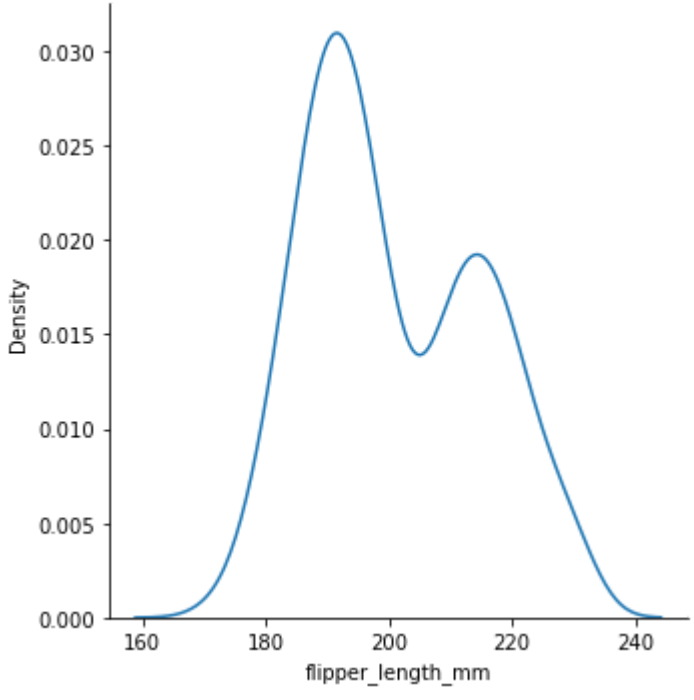
```
sns.displot(data = penguins, x = "flipper_length_mm", kde = True)
# you can add a kernel density estimate curve
```

Out[8]: <seaborn.axisgrid.FacetGrid at 0x237f894b248>



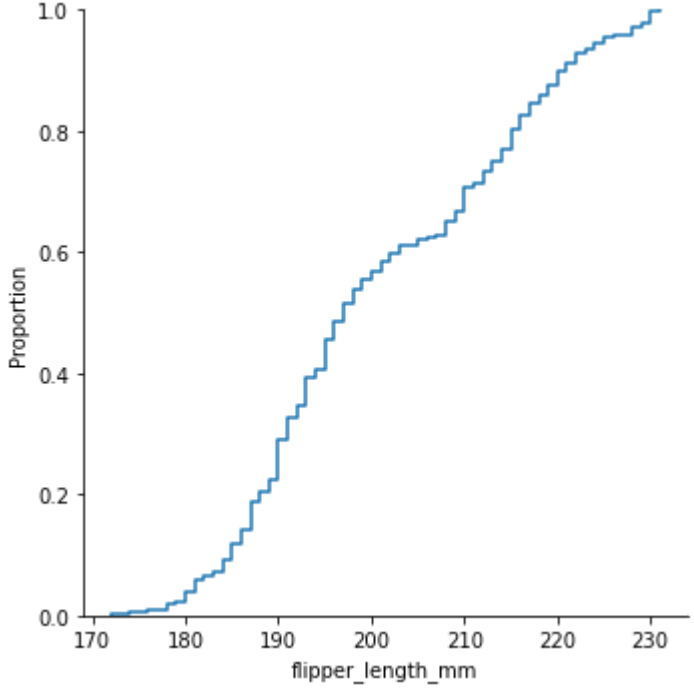
In [9]:
```
sns.displot(data = penguins, x = "flipper_length_mm", kind = "kde")
```

Out[9]:
```
<seaborn.axisgrid.FacetGrid at 0x237f894b288>
```



In [10]:
```
sns.displot(data = penguins, x = "flipper_length_mm", kind = "ecdf")
```

Out[10]:
```
<seaborn.axisgrid.FacetGrid at 0x237f8a45fc8>
```



bivariate and multivariate plots

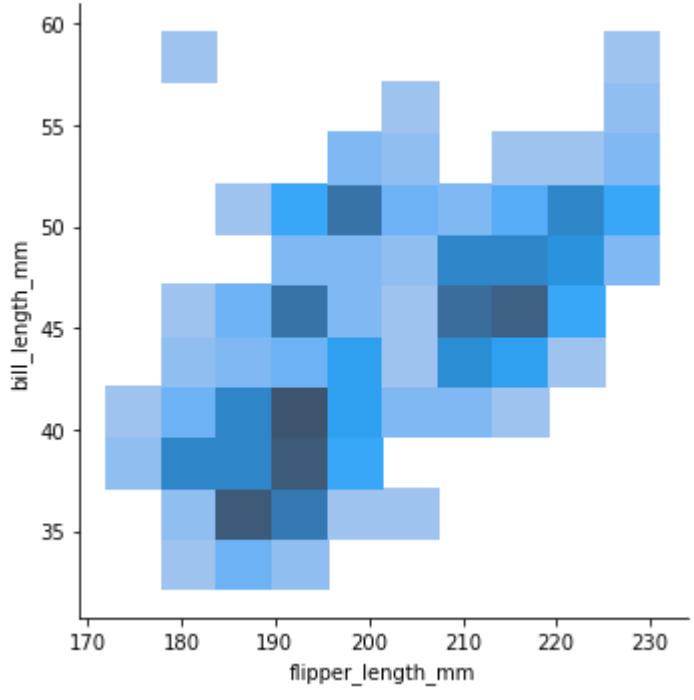
In [11]:
```
penguins.head(20)
```

Out[11]:

	species	island	bill_length_mm	bill_depth_mm	flipper_length_mm	body_mass_g	sex
0	Adelie	Torgersen	39.1	18.7	181.0	3750.0	Male
1	Adelie	Torgersen	39.5	17.4	186.0	3800.0	Female
2	Adelie	Torgersen	40.3	18.0	195.0	3250.0	Female
3	Adelie	Torgersen	NaN	NaN	NaN	NaN	NaN
4	Adelie	Torgersen	36.7	19.3	193.0	3450.0	Female
5	Adelie	Torgersen	39.3	20.6	190.0	3650.0	Male
6	Adelie	Torgersen	38.9	17.8	181.0	3625.0	Female
7	Adelie	Torgersen	39.2	19.6	195.0	4675.0	Male
8	Adelie	Torgersen	34.1	18.1	193.0	3475.0	NaN
9	Adelie	Torgersen	42.0	20.2	190.0	4250.0	NaN
10	Adelie	Torgersen	37.8	17.1	186.0	3300.0	NaN
11	Adelie	Torgersen	37.8	17.3	180.0	3700.0	NaN
12	Adelie	Torgersen	41.1	17.6	182.0	3200.0	Female
13	Adelie	Torgersen	38.6	21.2	191.0	3800.0	Male
14	Adelie	Torgersen	34.6	21.1	198.0	4400.0	Male
15	Adelie	Torgersen	36.6	17.8	185.0	3700.0	Female
16	Adelie	Torgersen	38.7	19.0	195.0	3450.0	Female
17	Adelie	Torgersen	42.5	20.7	197.0	4500.0	Male
18	Adelie	Torgersen	34.4	18.4	184.0	3325.0	Female
19	Adelie	Torgersen	46.0	21.5	194.0	4200.0	Male

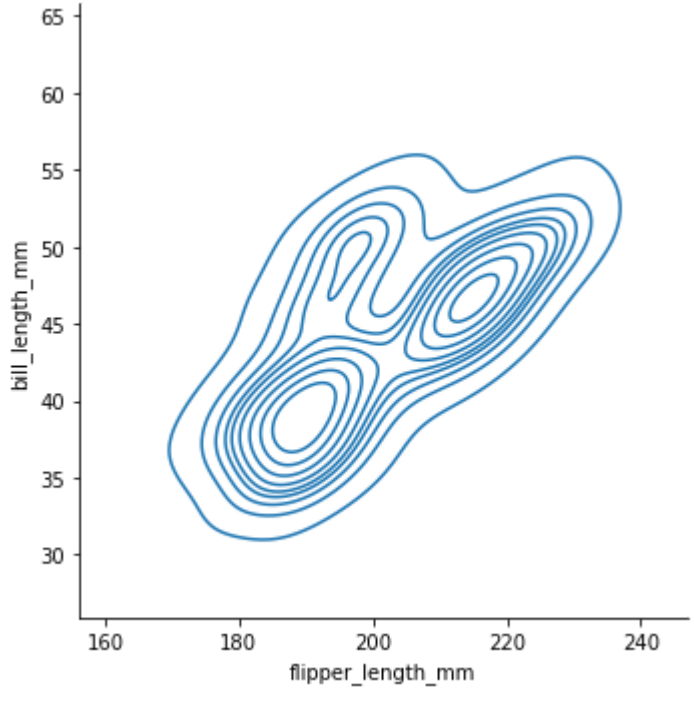
In [12]:
```
sns.displot(data=penguins, x="flipper_length_mm", y="bill_length_mm")
```

Out[12]:
```
<seaborn.axisgrid.FacetGrid at 0x237f87c0cc8>
```



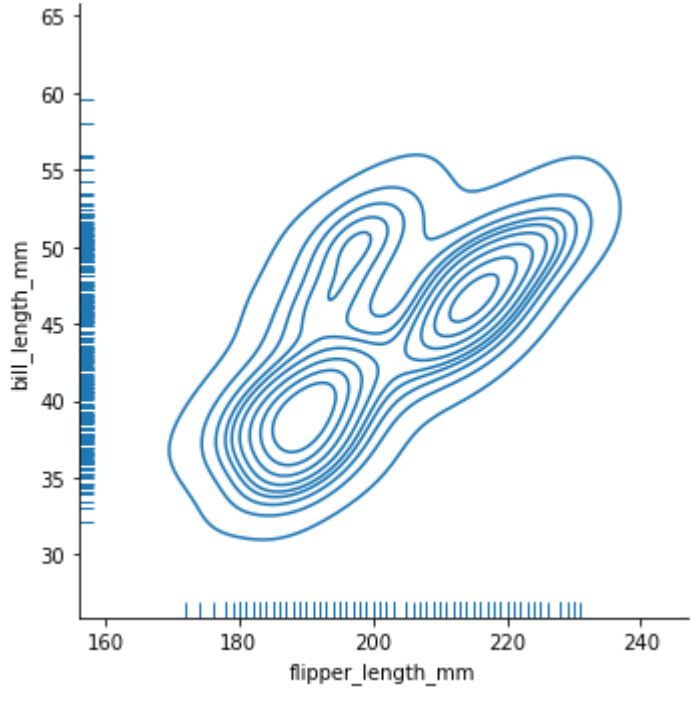
In [13]:
```
sns.displot(data=penguins, x="flipper_length_mm", y="bill_length_mm", kind="kde")
```

Out[13]:
```
<seaborn.axisgrid.FacetGrid at 0x237f8ab3248>
```



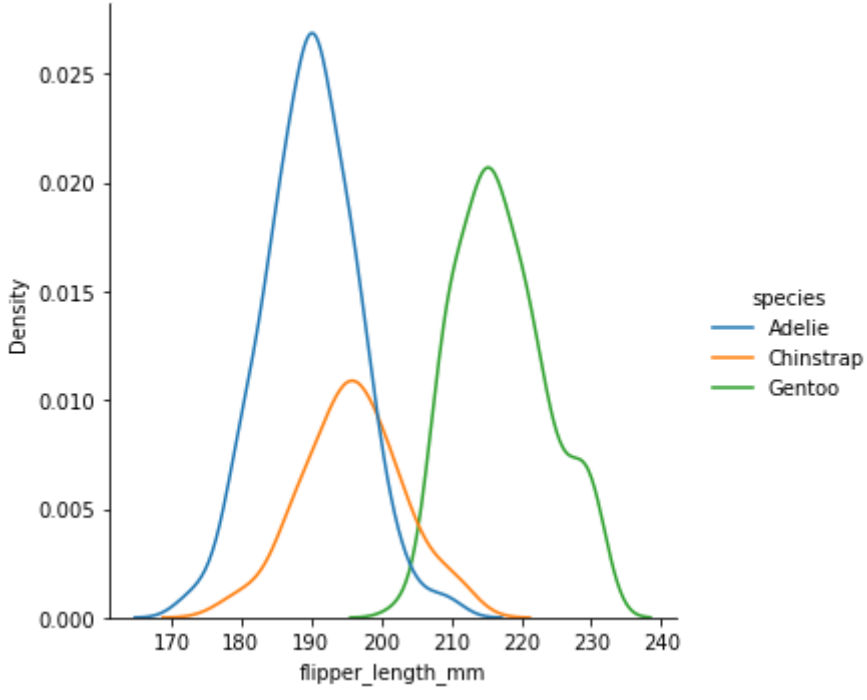
In [14]:
```
sns.displot(data=penguins, x="flipper_length_mm", y="bill_length_mm", kind="kde", rug=True)
```

Out[14]:
```
<seaborn.axisgrid.FacetGrid at 0x237f924e6c8>
```



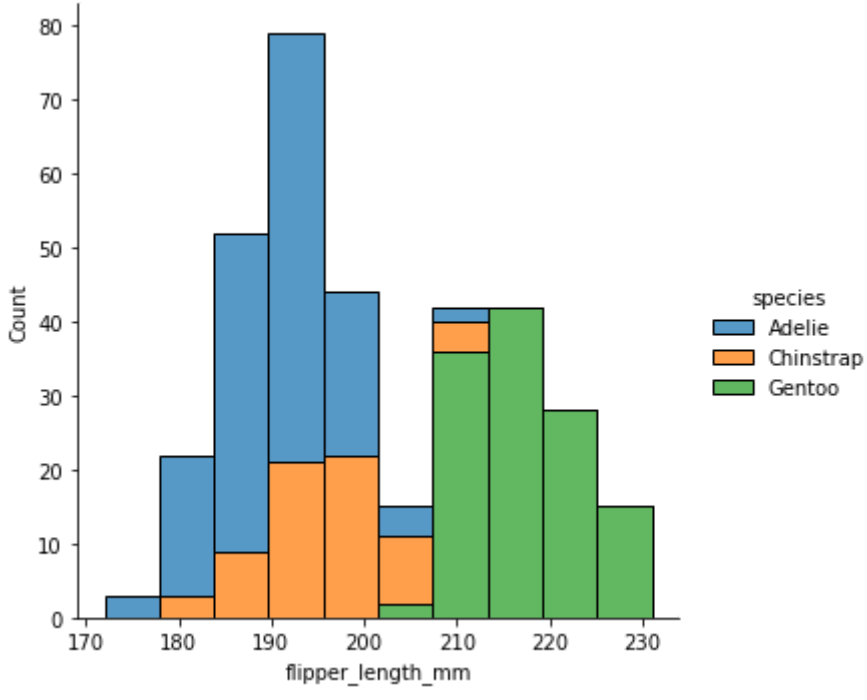
In [15]:
```
sns.displot(data=penguins, x="flipper_length_mm", hue="species", kind="kde")
```

Out[15]:
```
<seaborn.axisgrid.FacetGrid at 0x237f8b7e048>
```



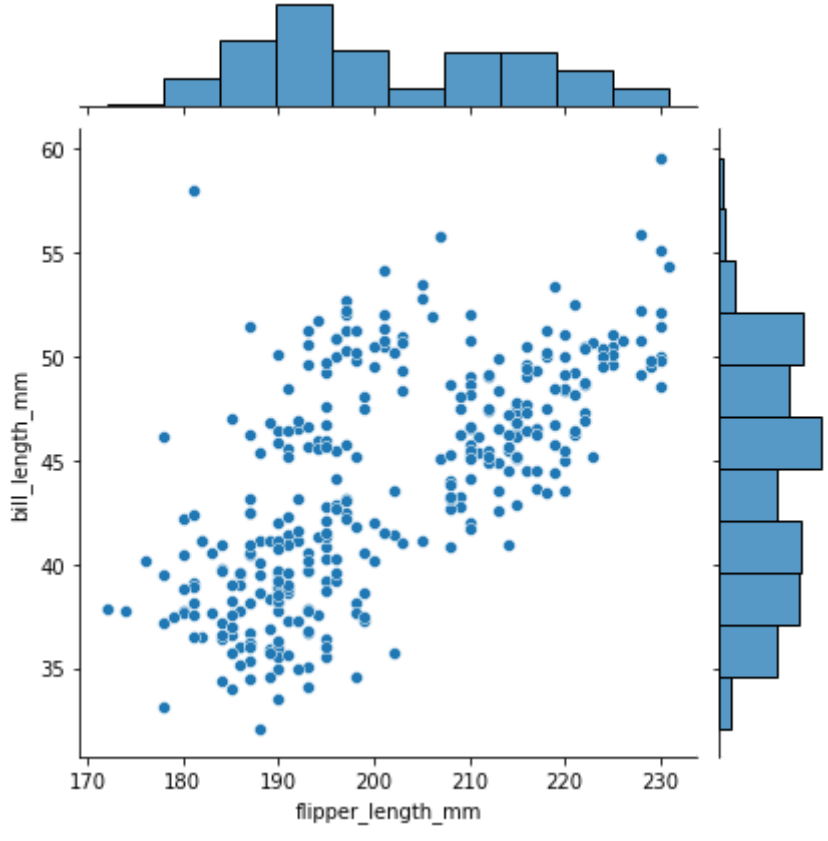
In [16]:
```
sns.displot(data=penguins, x="flipper_length_mm", hue="species", multiple="stack")
```

Out[16]:
```
<seaborn.axisgrid.FacetGrid at 0x237f93cb388>
```



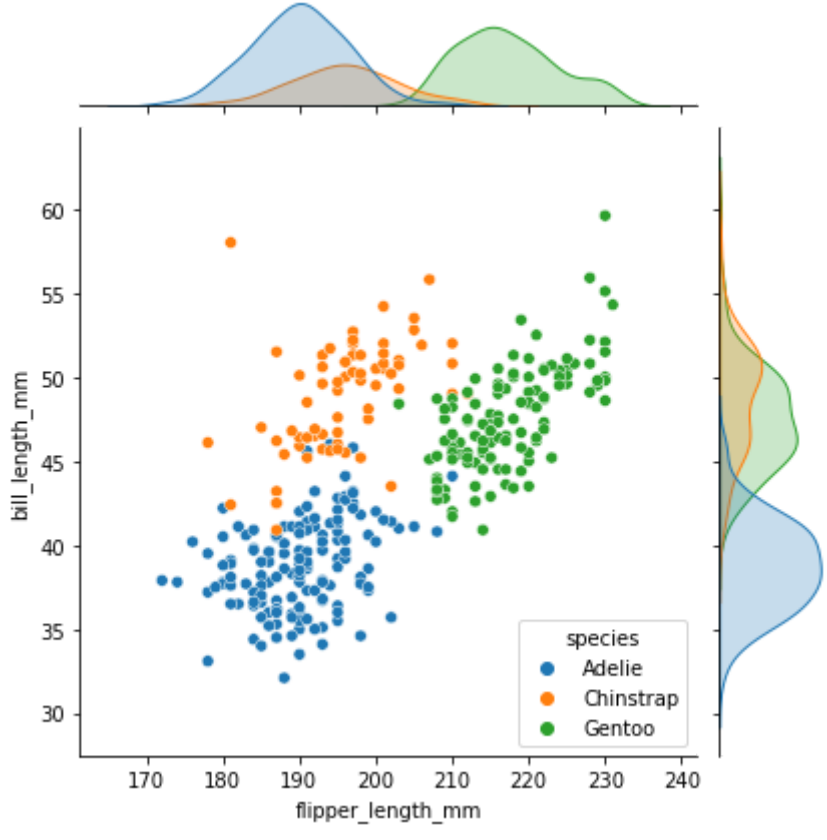
In [17]:
```
sns.jointplot(data=penguins, x="flipper_length_mm", y="bill_length_mm")
```

Out[17]:
```
<seaborn.axisgrid.JointGrid at 0x237fa494088>
```



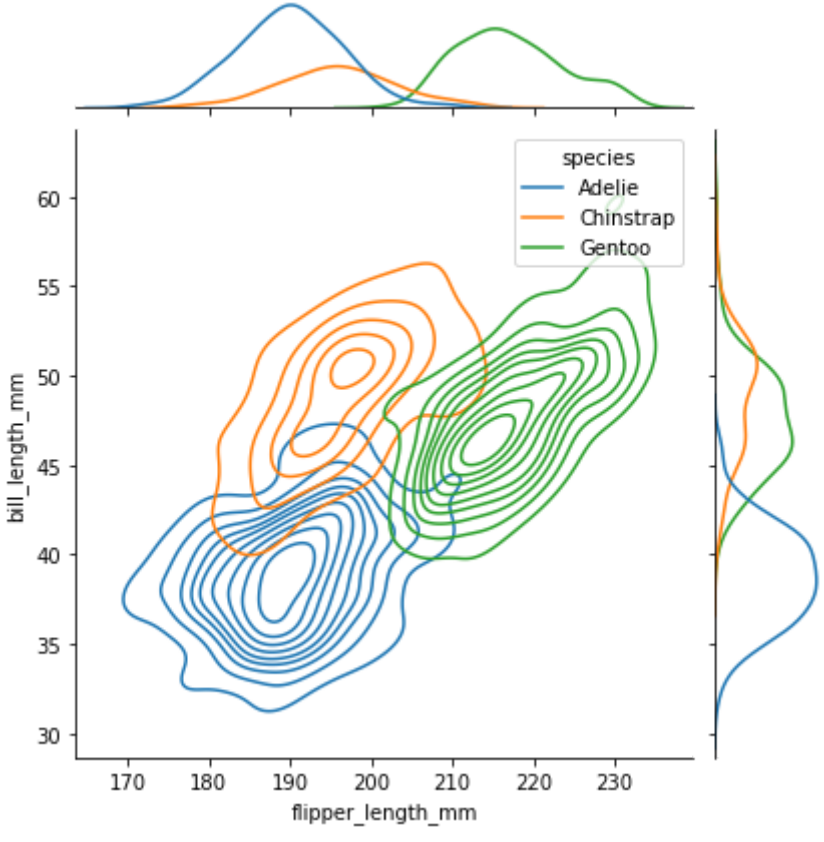
In [18]:
```
sns.jointplot(data=penguins, x="flipper_length_mm", y="bill_length_mm", hue = "species")
```

Out[18]:
```
<seaborn.axisgrid.JointGrid at 0x237fa600508>
```



In [19]:
```
sns.jointplot(data=penguins, x="flipper_length_mm", y="bill_length_mm", hue = "species", kind = "kde
```

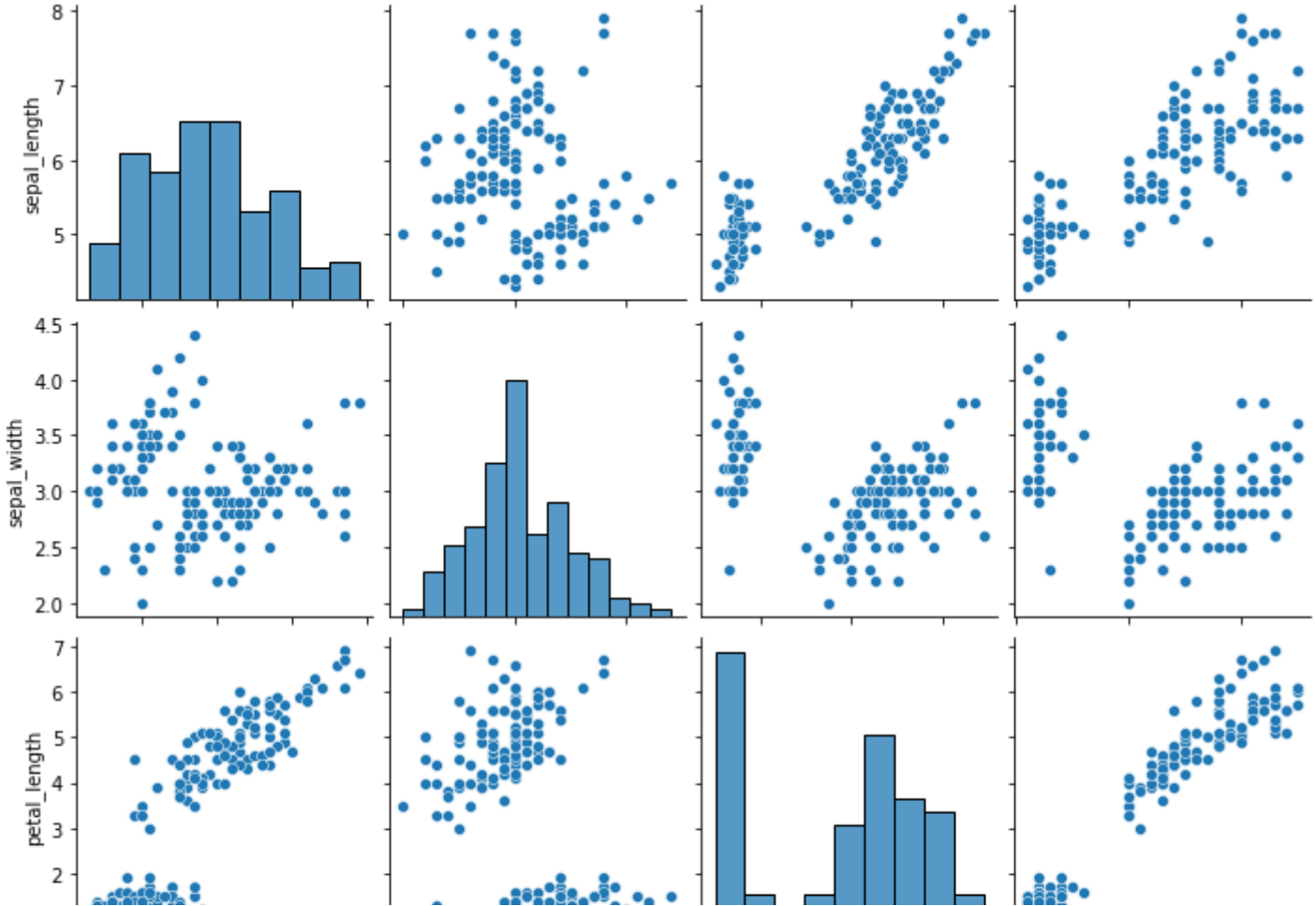
Out[19]:
```
<seaborn.axisgrid.JointGrid at 0x237fa727d08>
```

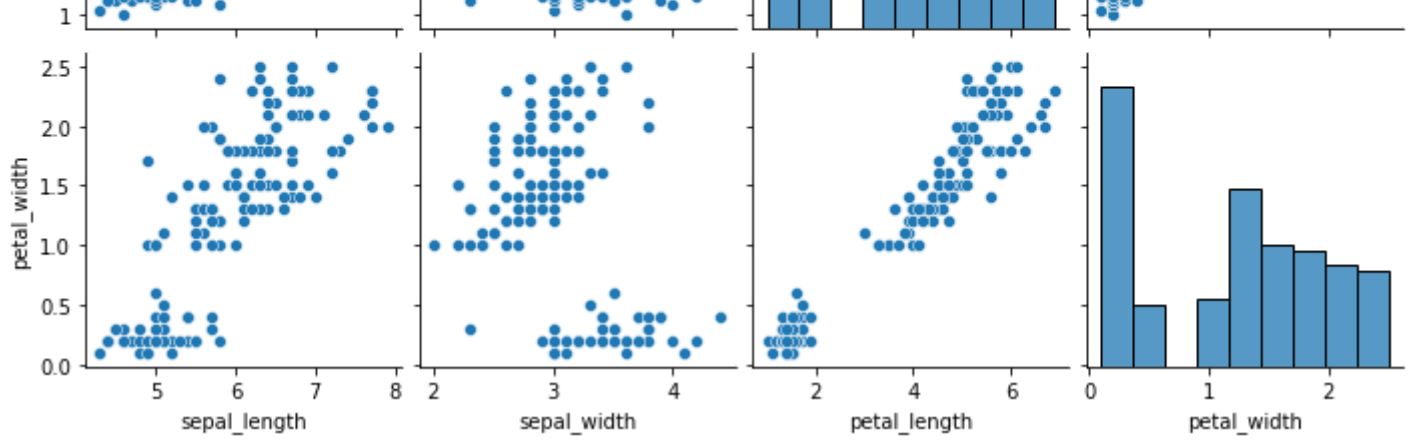


Pair-wise plots for multiple numeric data variables

In [20]:
```
# good ol' iris data
iris = sns.load_dataset("iris")
sns.pairplot(iris)
```

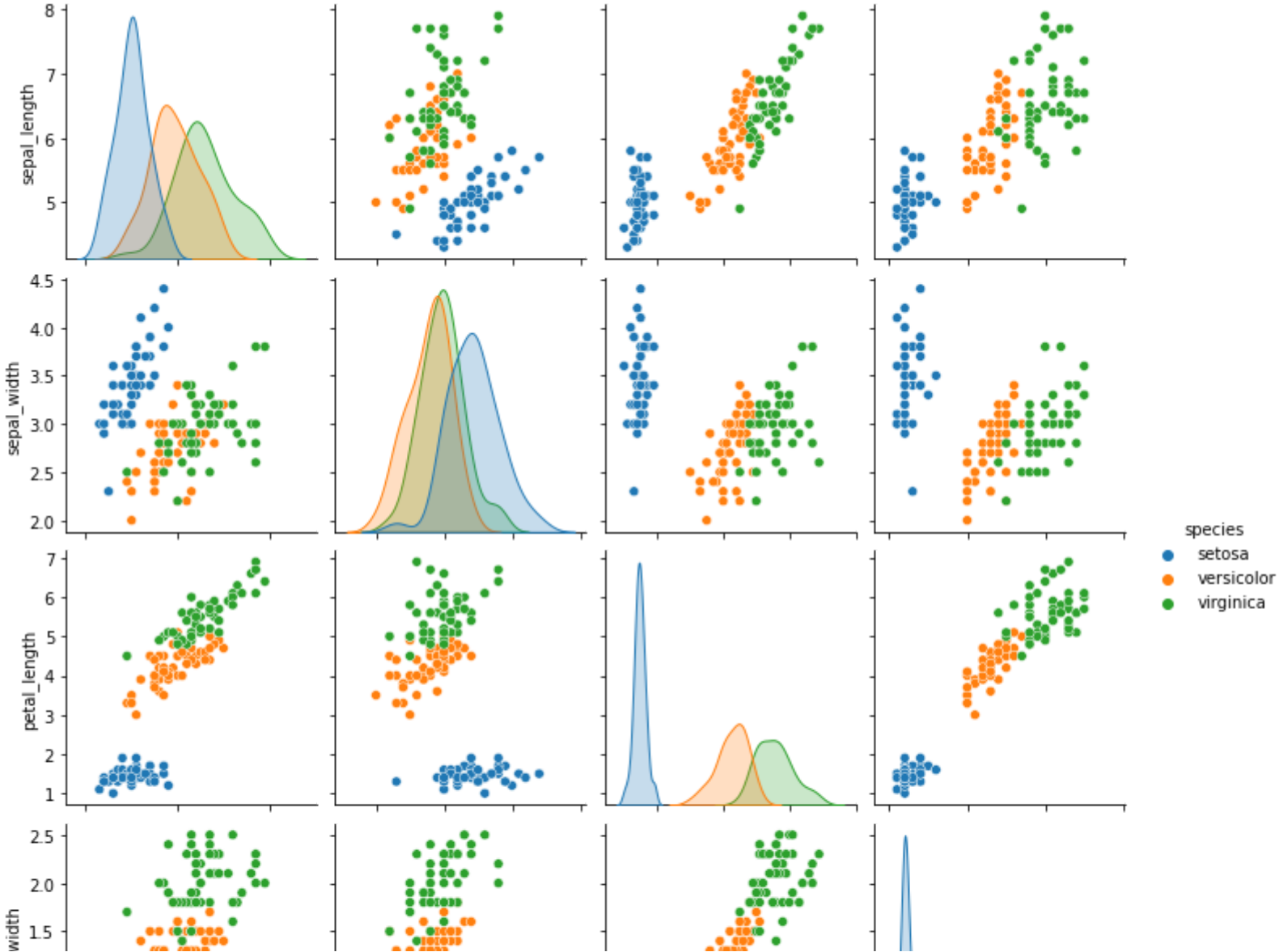
Out[20]:
```
<seaborn.axisgrid.PairGrid at 0x237f927cec8>
```

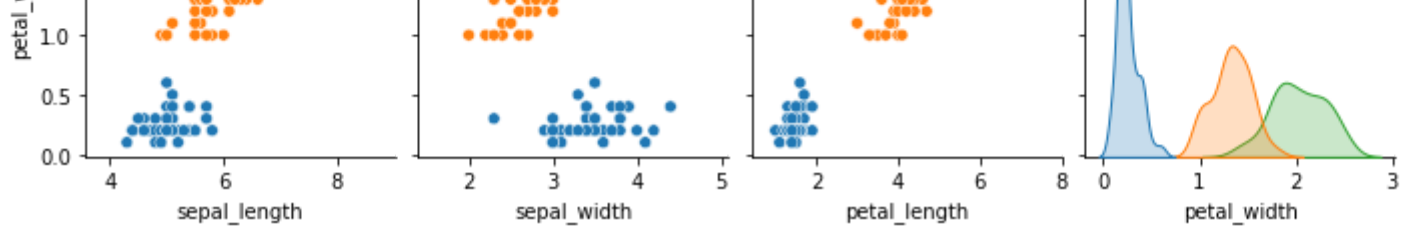



petal_width
sepal_length
sepal_width
petal_length
petal_width

In [21]:
```
sns.pairplot(iris, hue="species")
```

Out[21]:
```
<seaborn.axisgrid.PairGrid at 0x237fb15e648>
```




petal_width
1.0
0.5
0.0
4
6
8
sepal_length
2
3
4
5
sepal_width
2
4
6
8
petal_length
0
1
2
3
petal_width

Univariate plots separated by category

In [22]:
```
tips = sns.load_dataset("tips")
tips.head(10)
# tips data, contains numeric vars: total_bill, tip, size
# categorical vars: sex, smoker, day, time
```

Out[22]:

	total_bill	tip	sex	smoker	day	time	size
0	16.99	1.01	Female	No	Sun	Dinner	2
1	10.34	1.66	Male	No	Sun	Dinner	3
2	21.01	3.50	Male	No	Sun	Dinner	3
3	23.68	3.31	Male	No	Sun	Dinner	2
4	24.59	3.61	Female	No	Sun	Dinner	4
5	25.29	4.71	Male	No	Sun	Dinner	4
6	8.77	2.00	Male	No	Sun	Dinner	2
7	26.88	3.12	Male	No	Sun	Dinner	4
8	15.04	1.96	Male	No	Sun	Dinner	2
9	14.78	3.23	Male	No	Sun	Dinner	2

In [23]:
```
tips.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 244 entries, 0 to 243
Data columns (total 7 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   total_bill  244 non-null    float64
 1   tip         244 non-null    float64
 2   sex         244 non-null    category
 3   smoker      244 non-null    category
 4   day         244 non-null    category
```

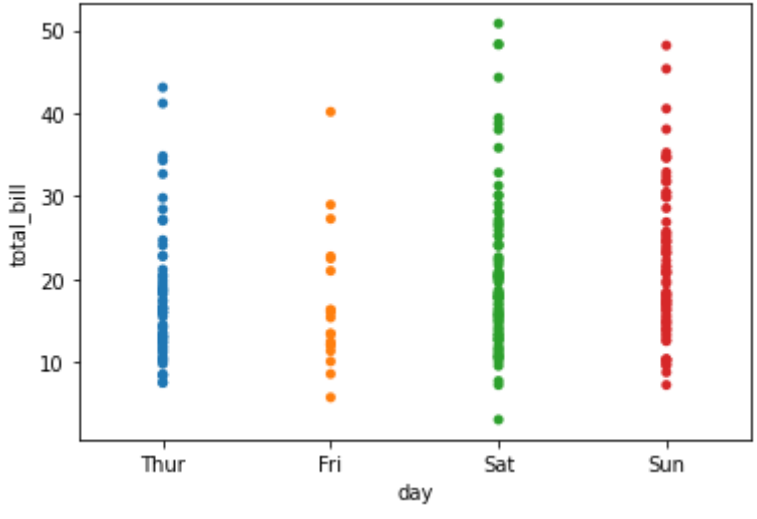
```
 5   time        244 non-null    category
 6   size        244 non-null    int64
dtypes: category(4), float64(2), int64(1)
memory usage: 7.4 KB
```

In [24]:

```
sns.stripplot(x="day", y="total_bill", data=tips, jitter = False)
# like a dotplot, but the dots are plotted on top of each other
```

Out[24]:

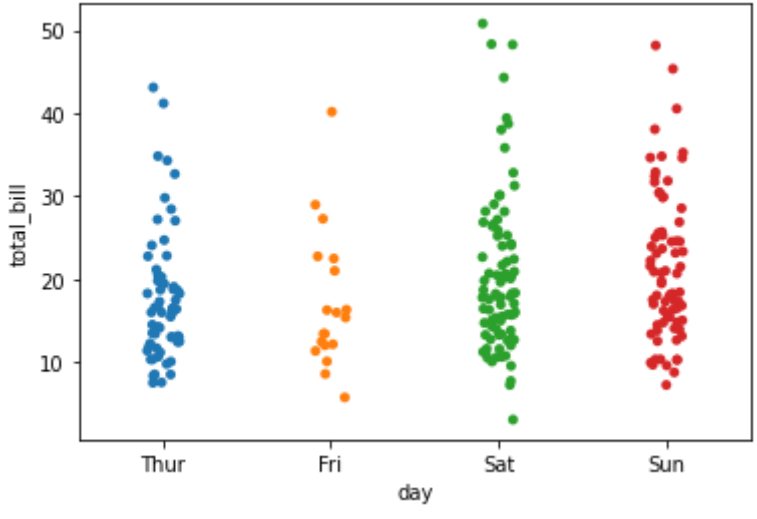
```
<AxesSubplot:xlabel='day', ylabel='total_bill'>
```



In [25]:

```
sns.stripplot(x="day", y="total_bill", data=tips, jitter=True)
# adding jitter allows us to see where points were overlapping
```

Out[25]: <AxesSubplot:xlabel='day', ylabel='total_bill'>

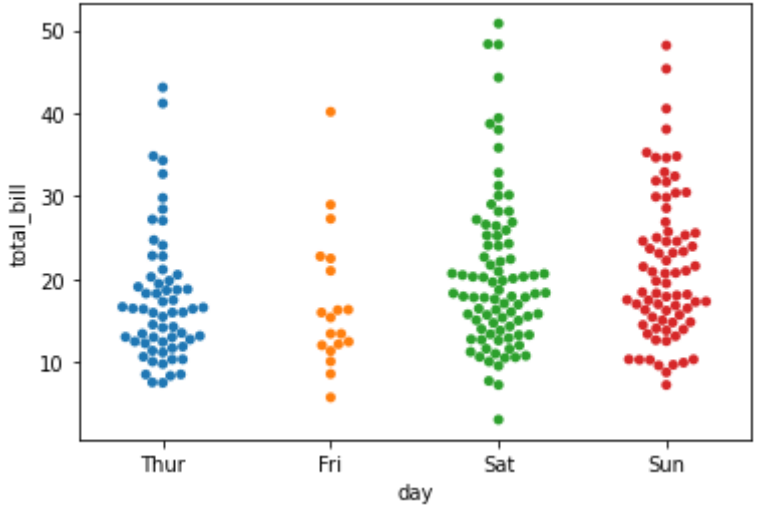


In [26]:

```
sns.swarmplot(x="day", y="total_bill", data=tips)
# swarmplots are like symmetric dotplots
```

Out[26]:

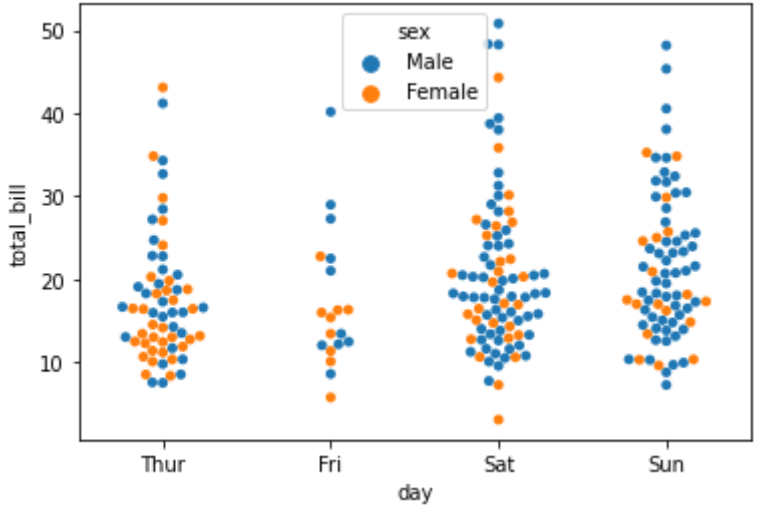
```
<AxesSubplot:xlabel='day', ylabel='total_bill'>
```



In [27]:

```
sns.swarmplot(x="day", y="total_bill", hue="sex", data=tips)
# you can change the color of the point based on another categorical variable
# seaborn automatically adds a legend
```

Out[27]: <AxesSubplot:xlabel='day', ylabel='total_bill'>

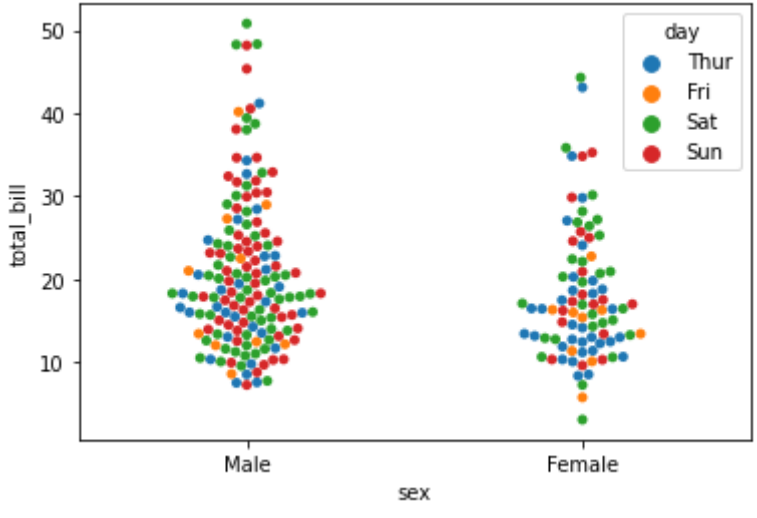


In [28]:

```
sns.swarmplot(x="sex", y="total_bill", hue="day", data=tips)
# this plot is harder on the eyes, but contains the same info as above
# the data is separated based on sex and colored based on the day
# but the colors aren't helping me
```

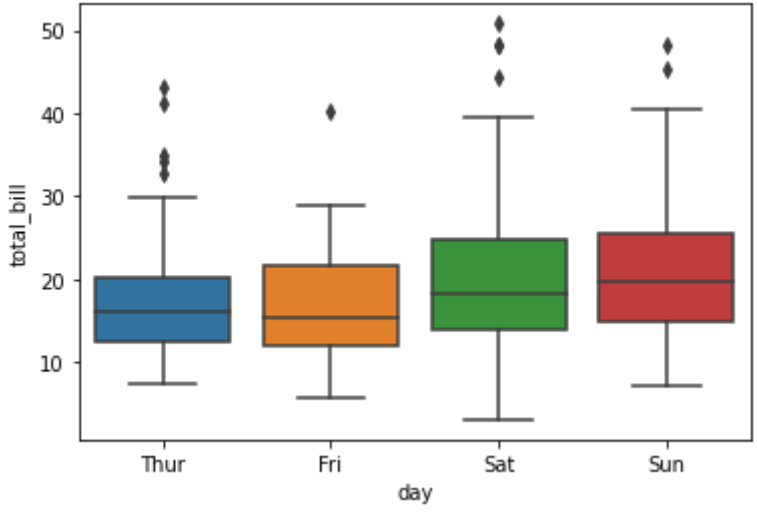
Out[28]:

```
<AxesSubplot:xlabel='sex', ylabel='total_bill'>
```



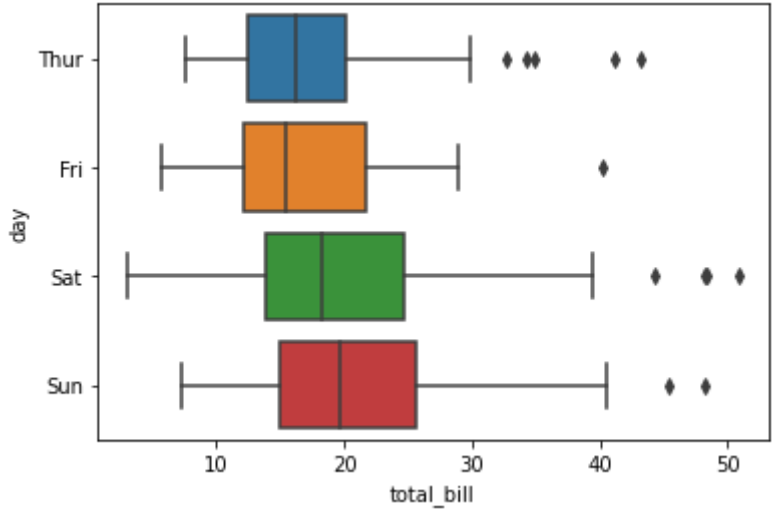
In [29]:
```
sns.boxplot(x="day", y="total_bill", data=tips) # boxplots
```

Out[29]:
```
<AxesSubplot:xlabel='day', ylabel='total_bill'>
```



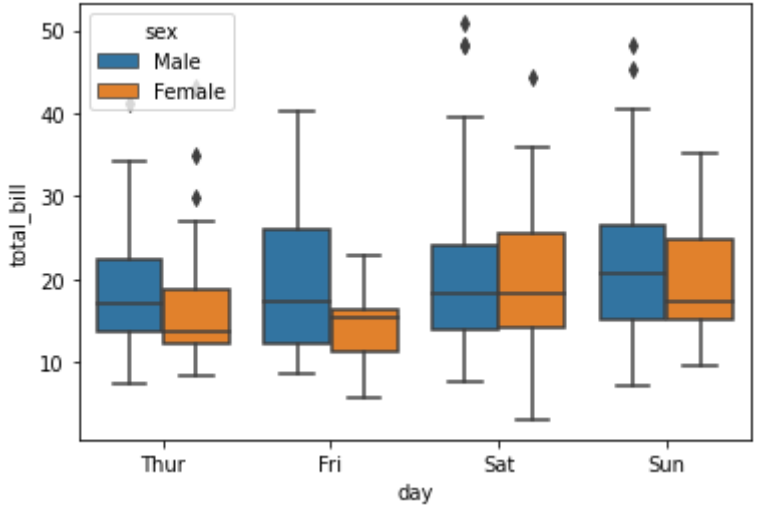
In [30]:
```
sns.boxplot(y="day", x="total_bill", data=tips) # boxplots
```

Out[30]:
```
<AxesSubplot:xlabel='total_bill', ylabel='day'>
```



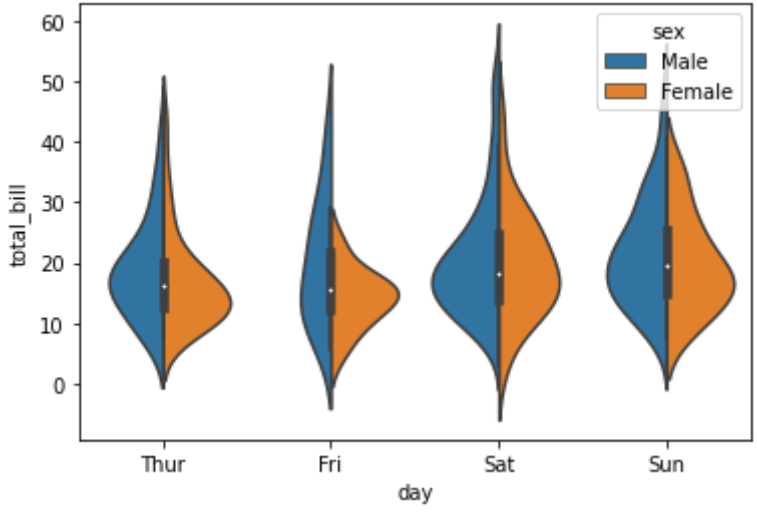
In [31]:
```
sns.boxplot(x="day", y="total_bill", hue="sex", data=tips) # boxplots
```

Out[31]:
```
<AxesSubplot:xlabel='day', ylabel='total_bill'>
```



In [32]:
```
sns.violinplot(x="day", y="total_bill", hue="sex", data=tips, split=True)
# i'm not a huge fan of these plots
```

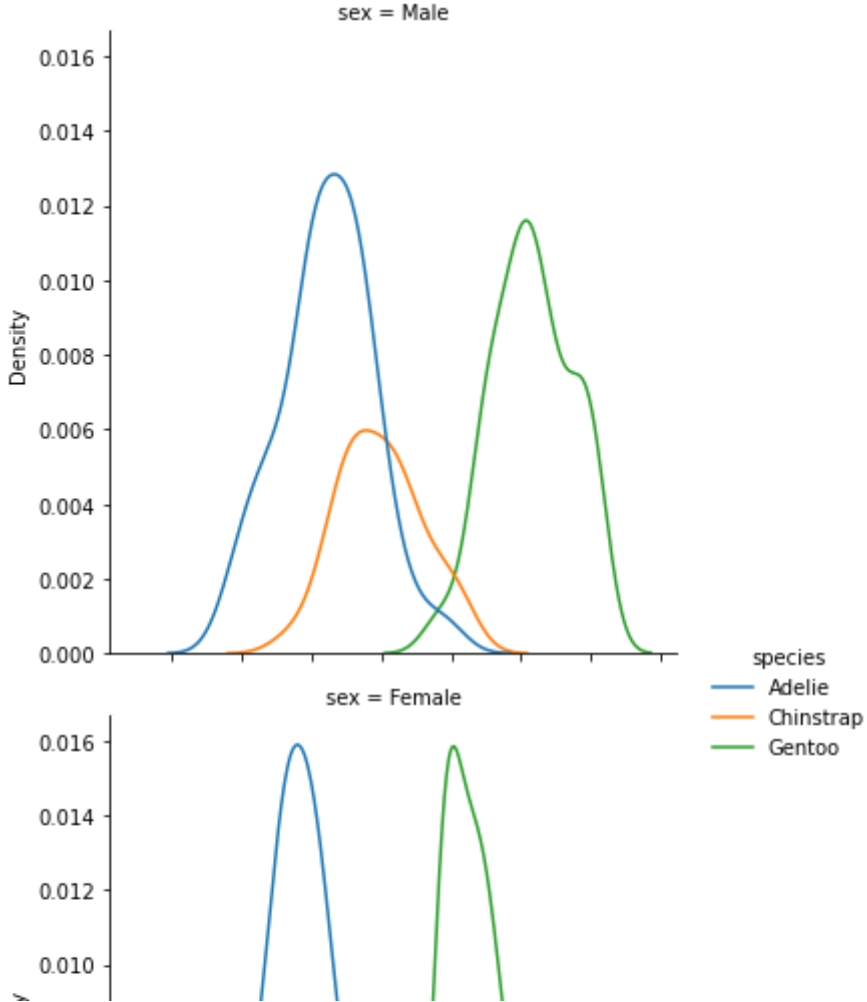
Out[32]:
```
<AxesSubplot:xlabel='day', ylabel='total_bill'>
```

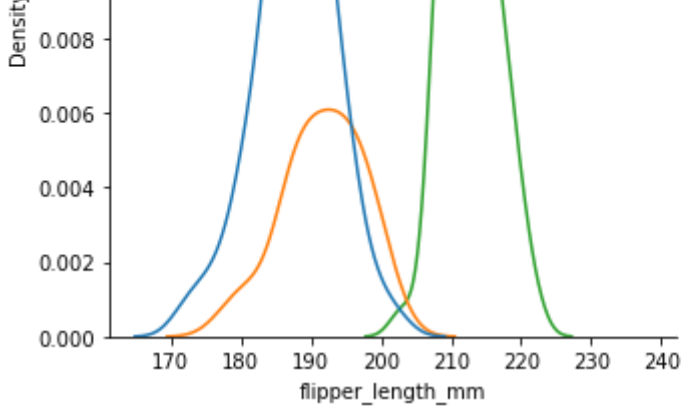


facet grids to make several plots

In [33]:
```
# specify the column or row to create a grid based on that variable
sns.displot(data=penguins, x="flipper_length_mm", hue="species", row="sex", kind="kde")
```

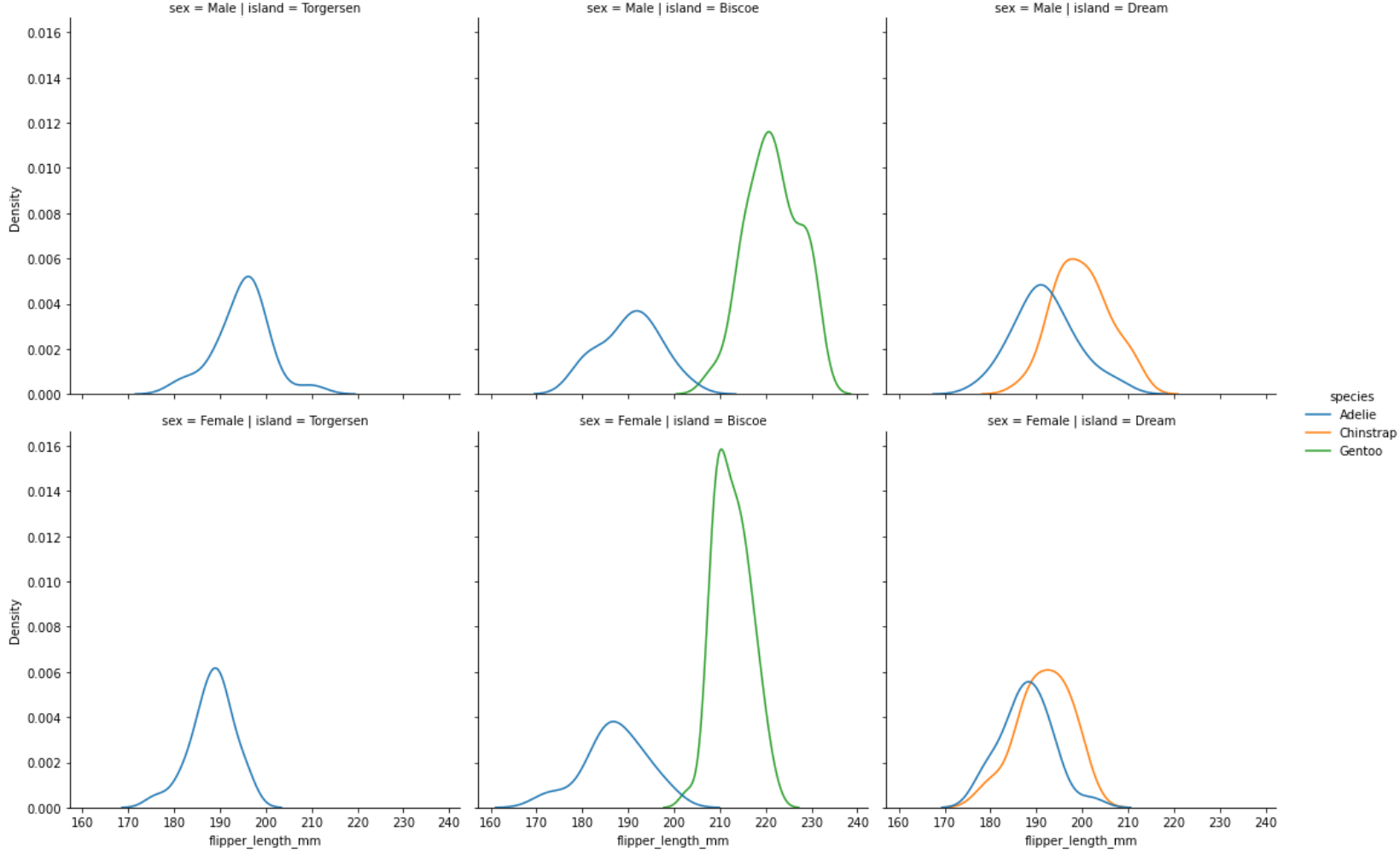
Out[33]: <seaborn.axisgrid.FacetGrid at 0x237fbfa5dc8>




Density
0.008
0.006
0.004
0.002
0.000
170
180
190
200
210
220
230
240
flipper_length_mm

In [34]:
```
sns.displot(data=penguins, x="flipper_length_mm", hue="species", row="sex", col = "island", kind="kd
```

Out[34]:
```
<seaborn.axisgrid.FacetGrid at 0x237fbbf8248>
```

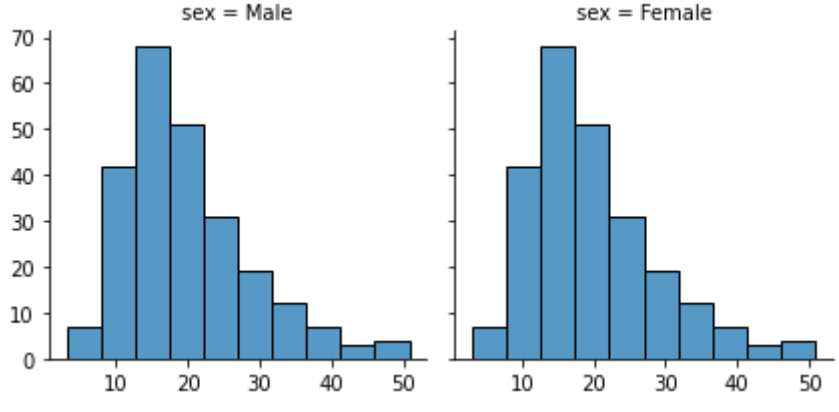


In [35]:

```
g = sns.FacetGrid(tips, col="sex", margin_titles=True)  # define the facet grid
# the facet grid will subset the data based on the categorical variable you provide it
g.map(sns.histplot, data = tips, x = "total_bill", bins=10)
# you then 'map' a plot command (e.g. sns.distplot, or plt.hist) to the facet grid
# be sure to pass the appropriate arguments
```

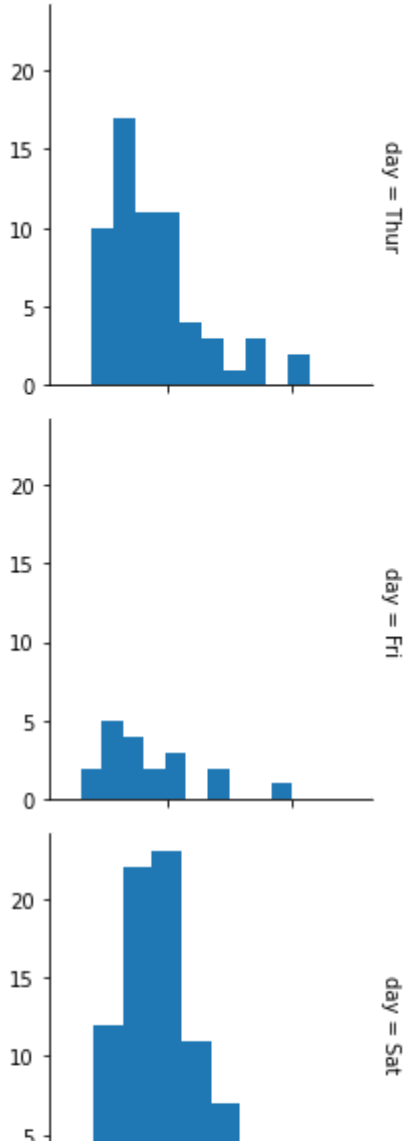
Out[35]:

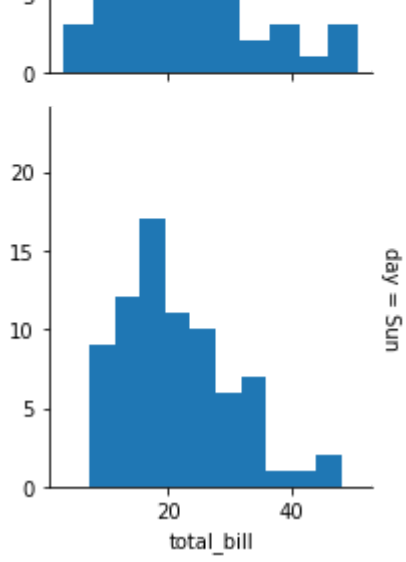
```
<seaborn.axisgrid.FacetGrid at 0x237fdca5408>
```



In [36]:
```
g = sns.FacetGrid(tips, row = 'day', margin_titles=True)
g.map(plt.hist, "total_bill")
```

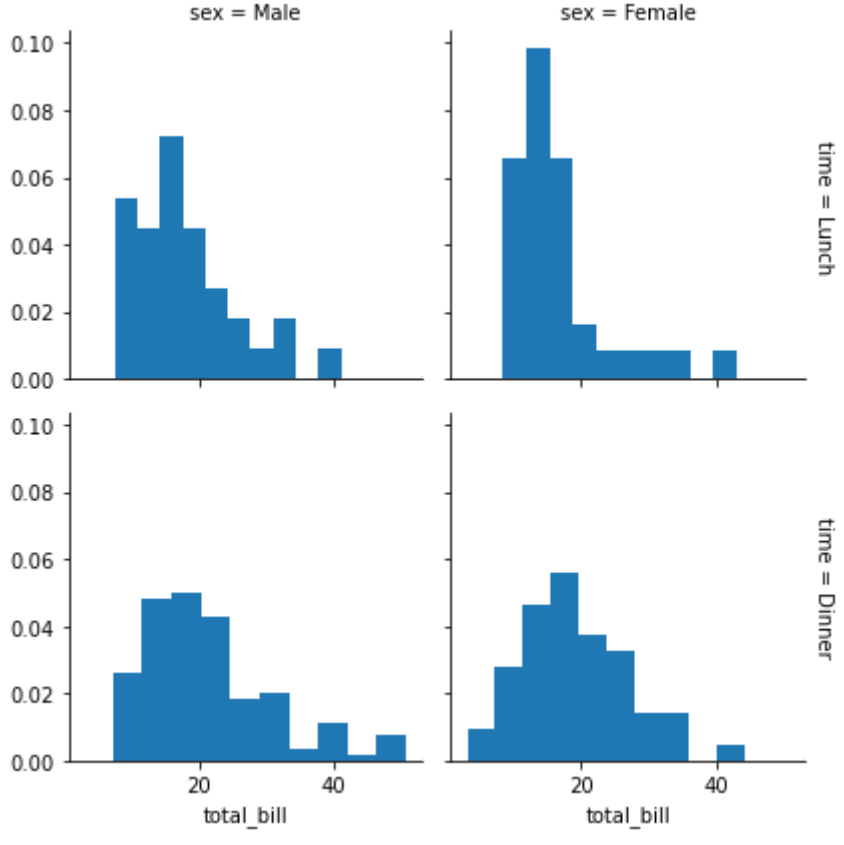
Out[36]: <seaborn.axisgrid.FacetGrid at 0x237fdd45748>




0
20
15
10
5
0
20
40
total_bill
day = Sun

In [37]:
```
g = sns.FacetGrid(tips, row = 'time', col='sex', margin_titles=True) # you can even have a 2D facet
g.map(plt.hist, "total_bill", density = True, bins=10)
```

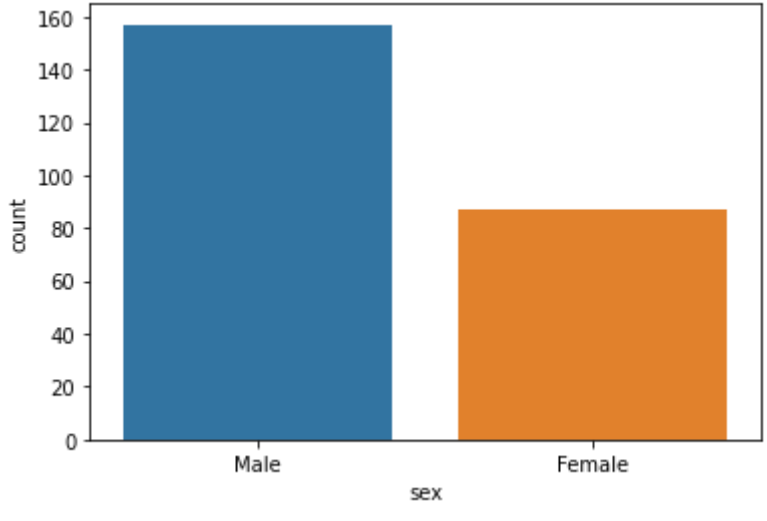
Out[37]: <seaborn.axisgrid.FacetGrid at 0x237fdf73d48>



bar charts (count plots) for data that is only categorical

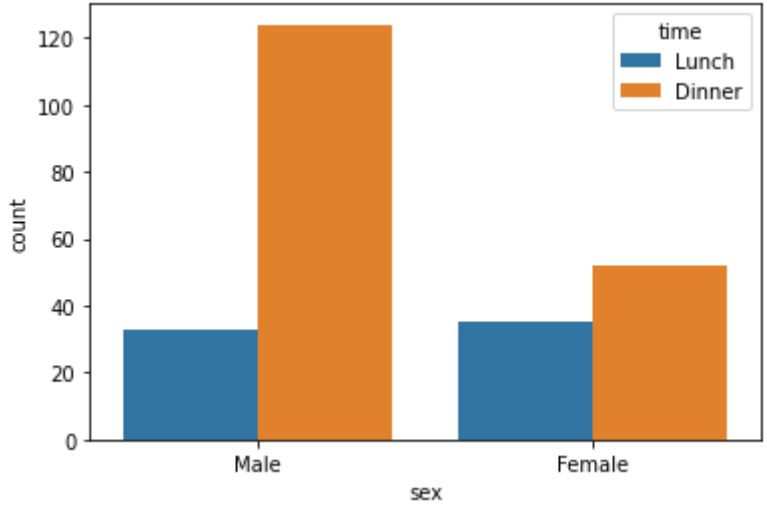
In [38]:
```
sns.countplot(x="sex",data=tips)
```

Out[38]:
```
<AxesSubplot:xlabel='sex', ylabel='count'>
```



In [39]:
```
sns.countplot(x="sex",hue = 'time', data=tips)
```

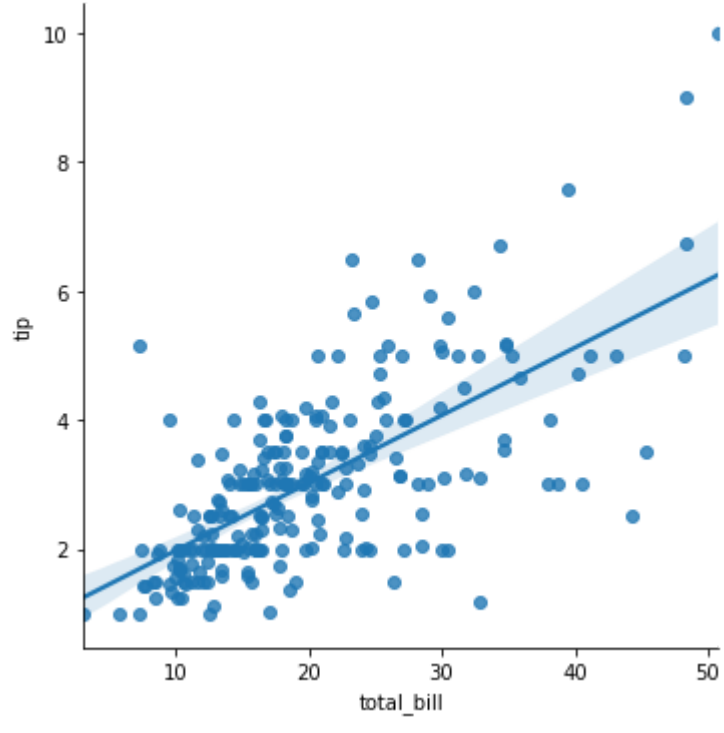
Out[39]:
```
<AxesSubplot:xlabel='sex', ylabel='count'>
```



fitting basic statistical models

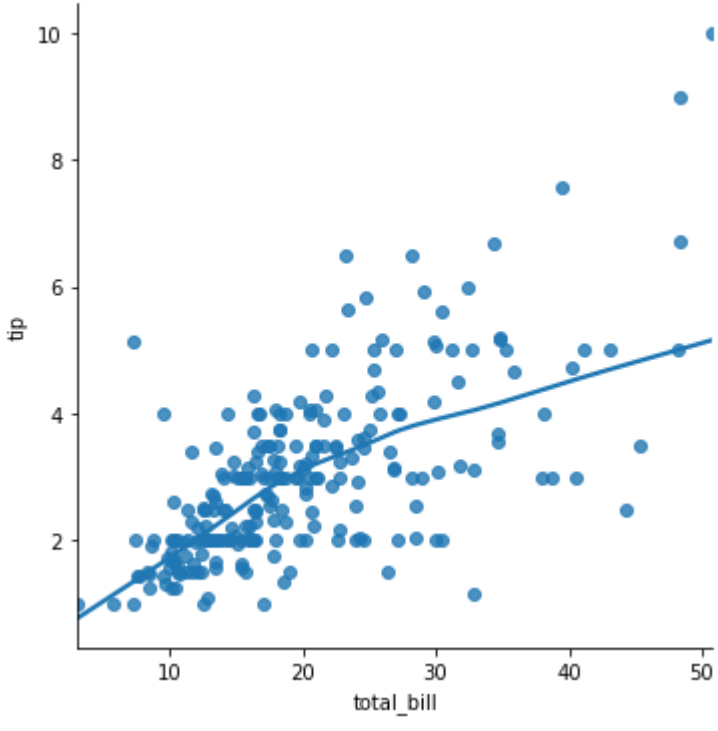
In [40]:
```
sns.lmplot(x="total_bill", y="tip", data=tips)
```

Out[40]:
```
<seaborn.axisgrid.FacetGrid at 0x237ff51d548>
```



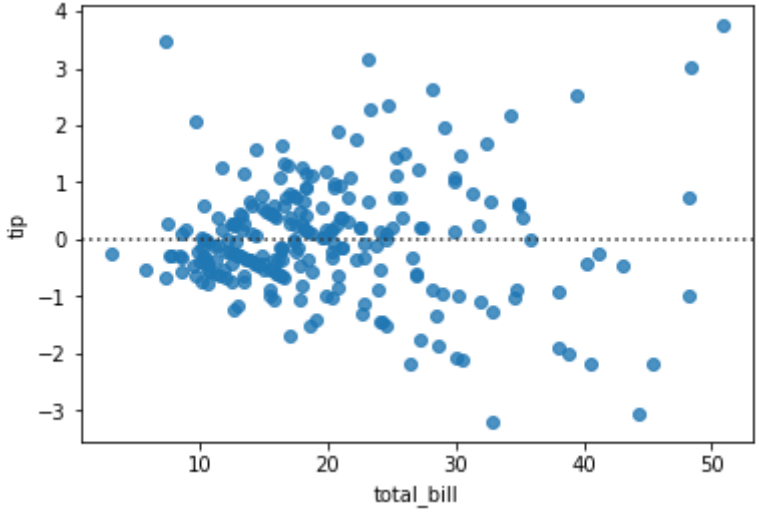
In [41]:
```
sns.lmplot(x="total_bill", y="tip", data=tips, lowess=True)
```

Out[41]:
```
<seaborn.axisgrid.FacetGrid at 0x237ff5a0348>
```



In [42]:
```
sns.residplot(x="total_bill", y="tip", data=tips)
```

Out[42]:
```
<AxesSubplot:xlabel='total_bill', ylabel='tip'>
```



In [43]:
```
sns.lmplot(x = "total_bill", y = "tip", hue = "smoker", data=tips)
```

Out[43]: <seaborn.axisgrid.FacetGrid at 0x237ff666188>