BDA_Ch3

2019 年 11 月 13 日

In [ ]:
```
# 首先需要引入 pandas 及相关的包
from pandas import Series

arr = [1,2,3,4,5]# 创建列表
series1 = Series(arr)# 通过列表创建 Series
# 遍历 Series
for index, val in series1.items():
    print(index, val)
series1[1] = 'two'# 根据位置下标修改值
series1.index = ['a','b','c','d','e']# 修改索引标签
series1['d'] = 'four'# 根据标签下表修改值
series1.name = 'column_name'
# 与字典不同，这里的索引标签可以重复
series1.index = ['a','b','c','d','c']
# 使用 rename 方法进行重命名，inplace = True：不创建新的对象，直接对原始对象进行修改
series1.rename('new_name',inplace = True)
print(series1['c'])# 列出所有索引标签为'c' 的元素
print(series1[['a','d']])# 可以列多个标签，但是要用列表形式
print(series1[[1,2,4]])# 通过位置来进行检索
print(series1[1:4])
# 通过 append() 添加 Series，注意一定要有赋值操作
series1 = series1.append(Series([6],index=['f']))
series1.rename(index={'f':'e'},inplace = True)# 更改行标签
#drop() 删除索引标签为'a' 的元素并创建一个新的对象，所以需要使用 inplace = True
series1.drop('a', inplace = True)
del series1['b']#del 命令直接修改原对象
print(Series({'aa':1,'bb':2}))# 也可以通过字典来创建 Series
```

In [ ]:
```
from pandas import DataFrame
import pandas as pd
import numpy as np

#np.nan 表示缺失值
df1 = DataFrame({'From_To': [' LoNDon_paris ', ' MAdrid_miLAN ', ' londON_StockhOlm '
                             ,'Budapest_PaRis', 'Brussels_londOn'],
                 'FlightNumber': [10045, np.nan, 10065, np.nan, 10085],
                 'RecentDelays': [[23, 47], [], [24, 43, 87], [13], [67, 32]],
                 'Airline': ['KLM(!)', '<Air France> (12)', '(British Airways. )'
                             ,'12. Air France', '"Swiss Air"']})
# 按行遍历 DataFrame，按列遍历则为 iteritems()
for index, row in df1.iterrows():
    print(row['From_To'])
#loc 进行数据查询，其中的参数均为索引
df1.loc[0,'Airline']
```

```
# 与 loc 不同，iloc 中的参数均为数字，表示二维表中的位置，-1 表示最后一位
df1.iloc[0,0]
# 切片略有不同
#iloc 中 1:3 不包括 3，loc 中的 1:3 包括 3
df1.iloc[1:3,0]
df1.loc[1:3,'Airline']
# 使用 loc 来进行切片选择一部分数据
#1:3 表示从行索引为 1 开始到行索引为 3，('From_To','Airline') 表示选择 From_To 和 Airline 这两列
df1.loc[1:3,('From_To','Airline')]
# 使用 iloc 的话
df1.iloc[1:3,[0,3]]
# 使用 loc 来切片选择 From_To 这一列，这里 () 可以省略
#df1.From_To 表示 df1 的 From_To 这一列，str.upper() 为所有的字母变为大写
df1.loc[:,'From_To'] = df1.From_To.str.upper()
df1.loc[:,'From_To'] = df1.From_To.str.lower()# 改为小写
# 剔除出 Airline 中的噪音数据
df1['Airline'] = df1.Airline.str.extract('([a-zA-Z\s]+)')
# 将出发点和目的地分开成两列
# 注意这里的 expand 参数，如果为 True 则分割后成为多列
# 如果为 False 则分割后仍然为一列，用一组列表来表示多个地点
df1.From_To.str.split('_', expand=True)
# 上述语句仅仅是生成一个新的 DataFrame 对象，并不修改 df1 本身
# 需要通过 join 来拼接两个 DataFrame，并将拼接后新生成的 DataFrame 赋值给 df1
df1 = df1.join(df1.From_To.str.split('_', expand=True))
# 对列进行重命名
# 如果没有标注 columns，默认为对行索引进行重命名
df1.rename(columns={0:'From',1:'To'},inplace=True)
# 删除 From_To 这一列，同样的，如果没有标注 columns，默认为删除'From_To' 这一行
# 当然，因为没有这样一行，所以会报错
df1.drop(columns=['From_To'],inplace=True)
# 添加行
# 如果不指定行索引的话，必须使用 ignore_index=True
df1 = df1.append({'FlightNumber':'MF8169','RecentDelays':[],'Airline':'Xiamen Airline'
                  ,'From':'Xiamen','To':'Beijing'},ignore_index=True)
# 或者用如下方式指定行索引
# 此处需要先通过 DataFrame() 创建一个 DataFrame，然后再使用 append
df1 = df1.append(DataFrame([{'FlightNumber':'MF8159','RecentDelays':[],
                             'Airline':'Xiamen Airline','From':'Xiamen'
                             ,'To':'Beijing'}],index=[8]))
```

In [ ]:
```
import pandas as pd

#header 表示列名所在的行，如果没有列名则为 None
#sheet_name 表示要读取的 Sheet，可以是具体名字，也可以是第几张 Sheet
data = pd.read_excel('test.xlsx', sheet_name = 0, header = 0)
print(data)
# 查看前 5 行数据
print(data.head(5))
# 查看最后 5 行数据
print(data.tail(5))
# 查看简单统计数据
data.describe()
# 数据的筛选
```

```
data[data.日开盘价>10]
data[data.公司简称.str.startswith('万')]
data[data.公司简称.str.contains('A')]
# 列级别的操作
data['new_col1'] = data['日最高价'] - data['日最低价']
data['new_col2'] = data['日最高价'] * data['日最低价']

data.rename(columns={0:'stock_id',1:'company'}, inplace=True)
writer = pd.ExcelWriter('out.xlsx')
data.to_excel(writer, 'sheet1', header = True, index = False)
writer.save()
```

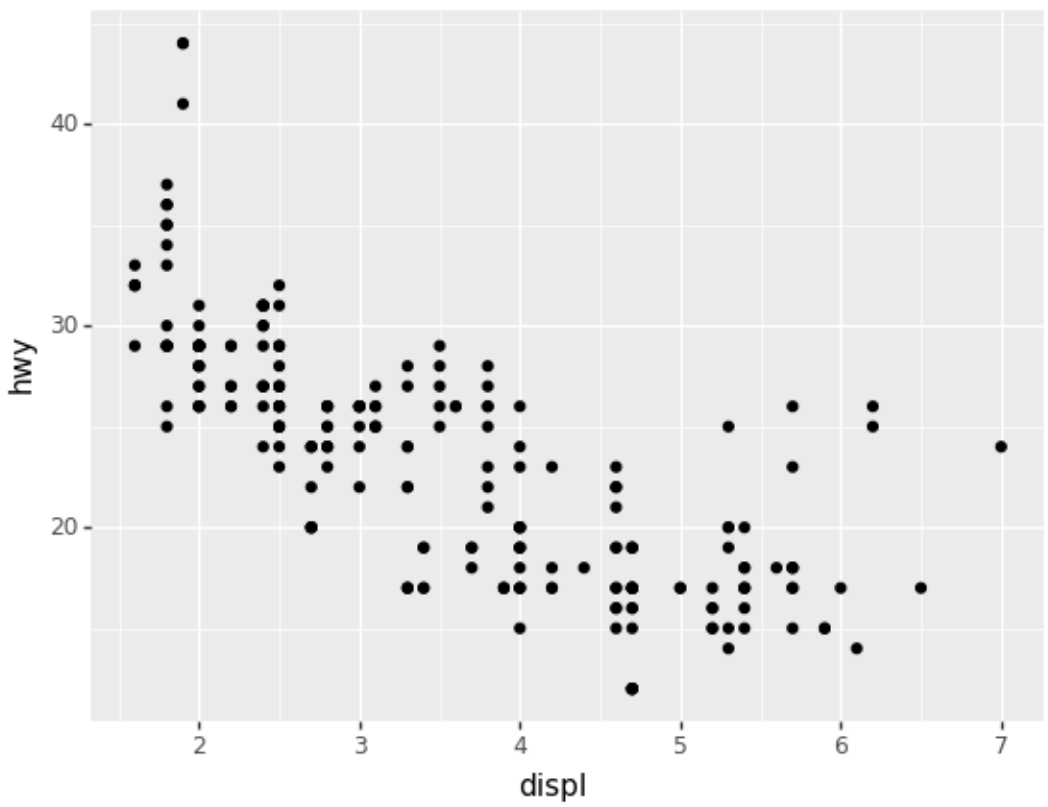
In [5]:
```
# 引入 json 文件解析包
import json

# 正常打开文件
f = open('json_test.json')
# 使用 json 包加载文件内容，加载后就会变成嵌套的字典形式
json_data = json.load(f)
# 在这个文件中，第一层是字典，字典里面嵌套了一个列表（第二层）
sites = json_data['sites']
print(sites)
print('-----------------')
# 第三层是字典
# 使用 for 循环来进行遍历
for s in sites:
    #s 就是其中一个字典
    # 具体的数据提取方式和字典完全一样
    print('{0}:\t{1}'.format(s['name'],s['url']))
# 关闭文件
f.close()
```

```
[{'name': ' 菜鸟教程', 'url': 'www.runoob.com'},
{'name': 'google', 'url': 'www.google.com'},
{'name': ' 微博', 'url': 'www.weibo.com'}]
-----------------
菜鸟教程:       www.runoob.com
google:         www.google.com
微博:       www.weibo.com
```

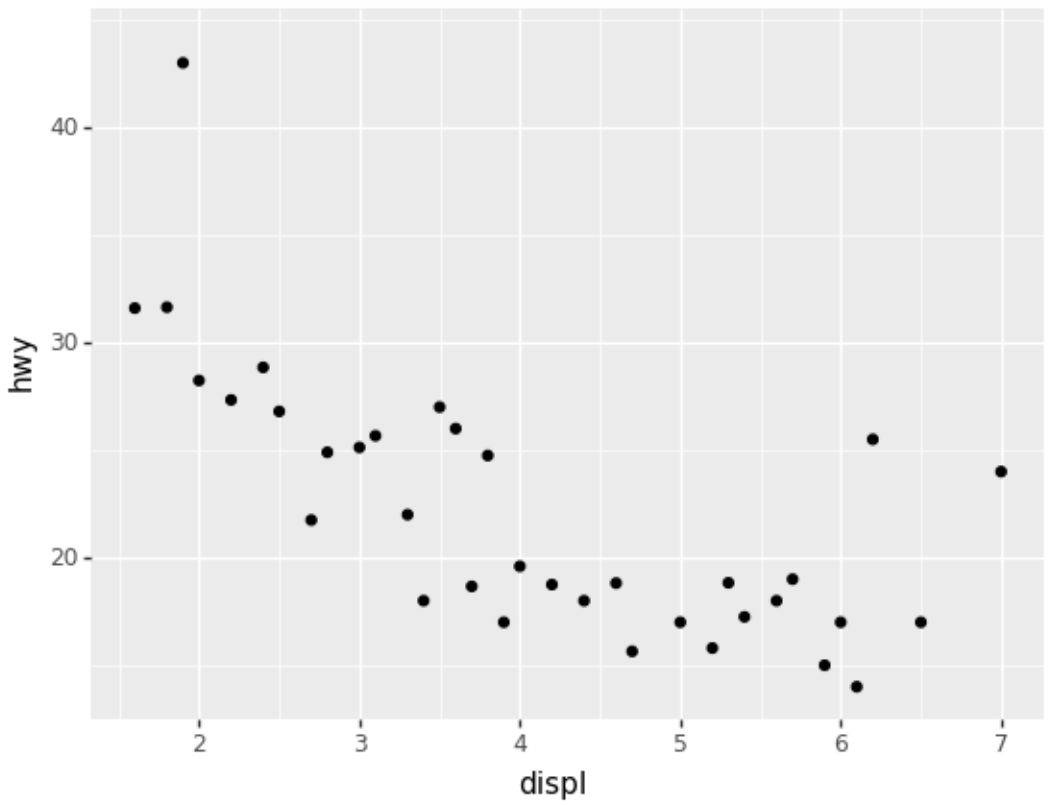
In [2]:
```
from plotnine import * # 导入 plotnine 包的所有绘图函数
from plotnine.data import * # 导入 plotnine 包中的所有数据

#plotnine 自带的关于汽车油耗数据集 mpg
ggplot(mpg,aes(x='displ',y='hwy'))+geom_point()
```



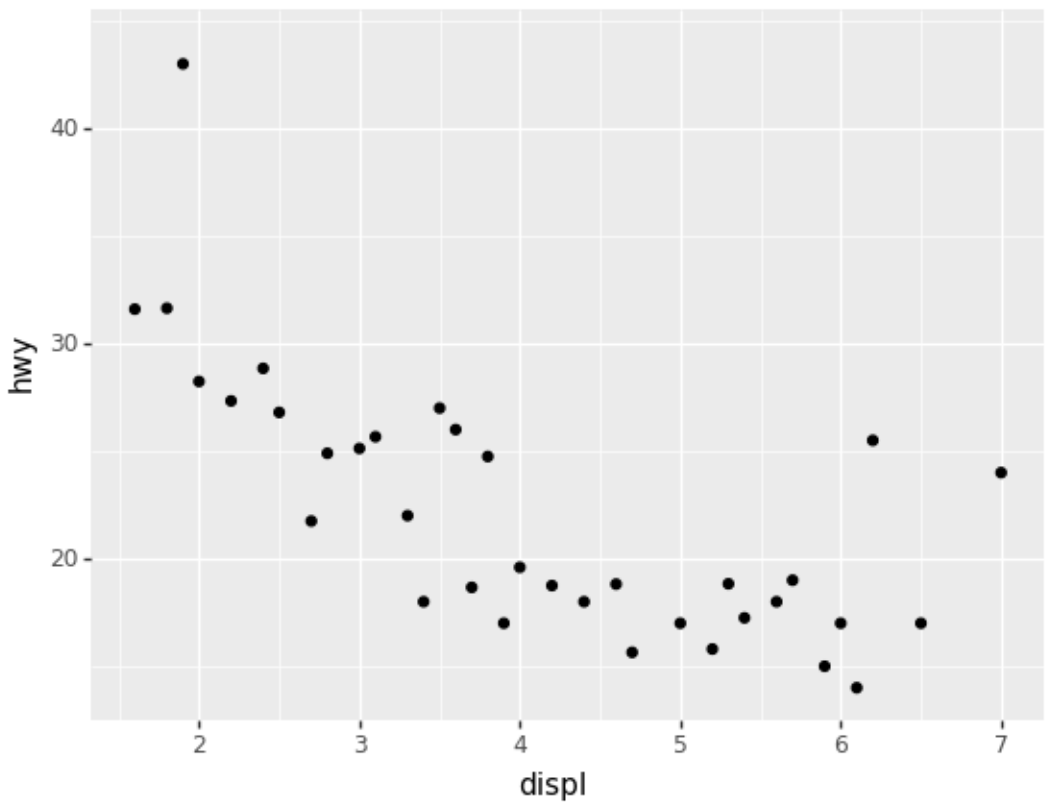
Out[2]: <ggplot: (-9223371842269796513)>

In [3]:
```
#summary 默认返回条件均值, E(y|x)
# 即每一个 x 值对应的 y 的均值
ggplot(mpg,aes(x='displ',y='hwy'))+geom_point(stat='summary')
```



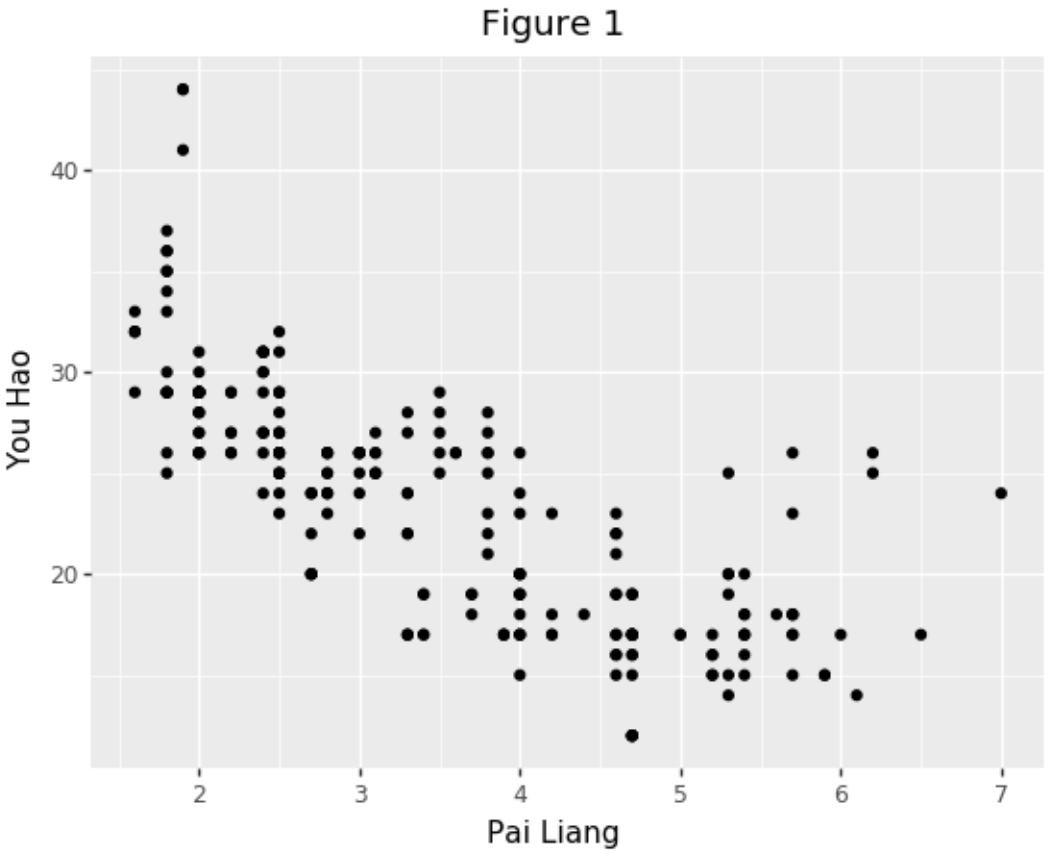
Out[3]: <ggplot: (-9223371842269816362)>

In [4]:
```
# 对应的 stat 函数
ggplot(mpg,aes(x='displ',y='hwy'))+stat_summary(geom='point')
```



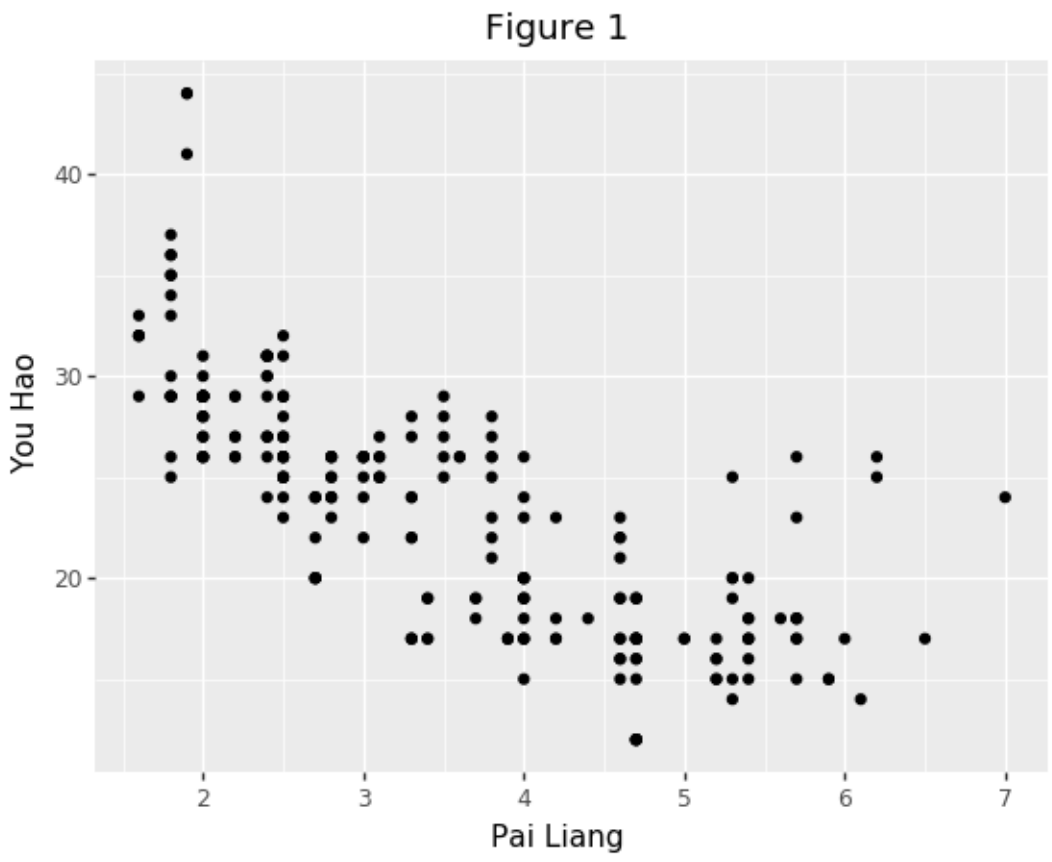
Out[4]: <ggplot: (194585068008)>

In [8]:
```
# 修改轴坐标，添加图标题
# 注意整个语句用一对圆括号括了起来，所以可以换行
(ggplot(mpg,aes(x='displ',y='hwy'))+geom_point()+ggtitle('Figure 1')
 +xlab('Pai Liang')+ylab('You Hao'))
```



Out[8]: <ggplot: (89413311152)>

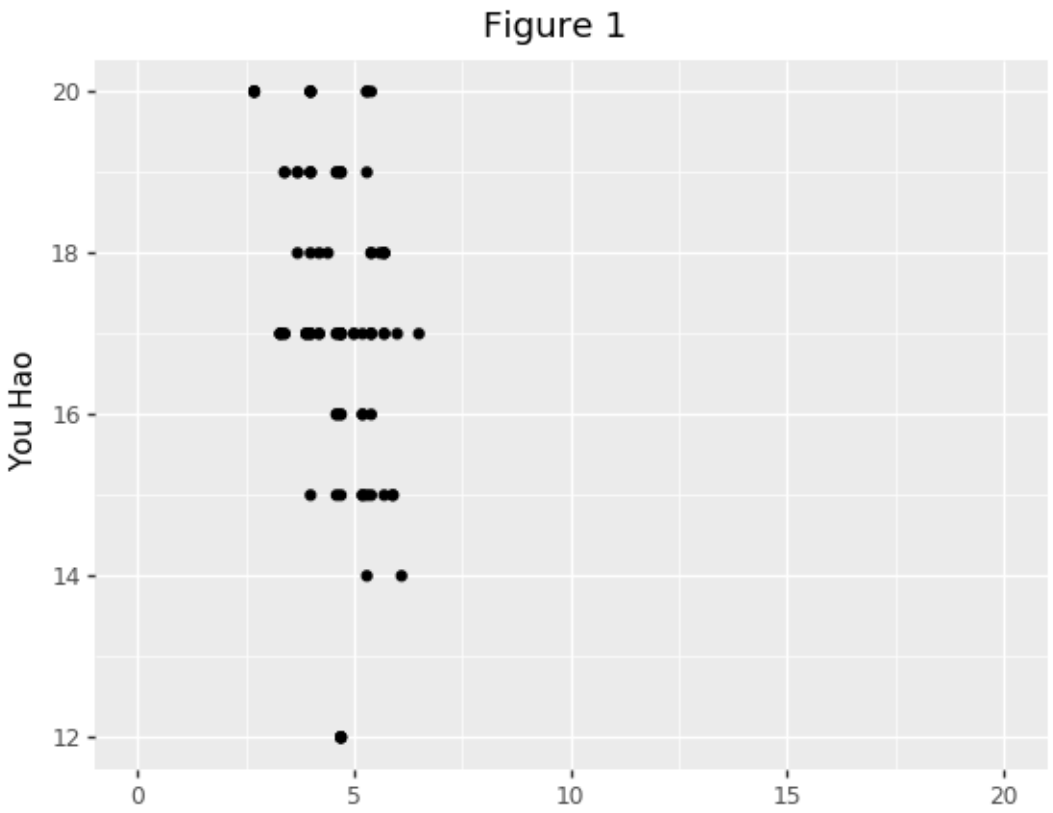
In [9]:
```
# 另外一种更改标题的方式
(ggplot(mpg,aes(x='displ',y='hwy'))+geom_point()
 +labs(title='Figure 1',x='Pai Liang',y='You Hao'))
```



Out[9]: <ggplot: (89400756281)>

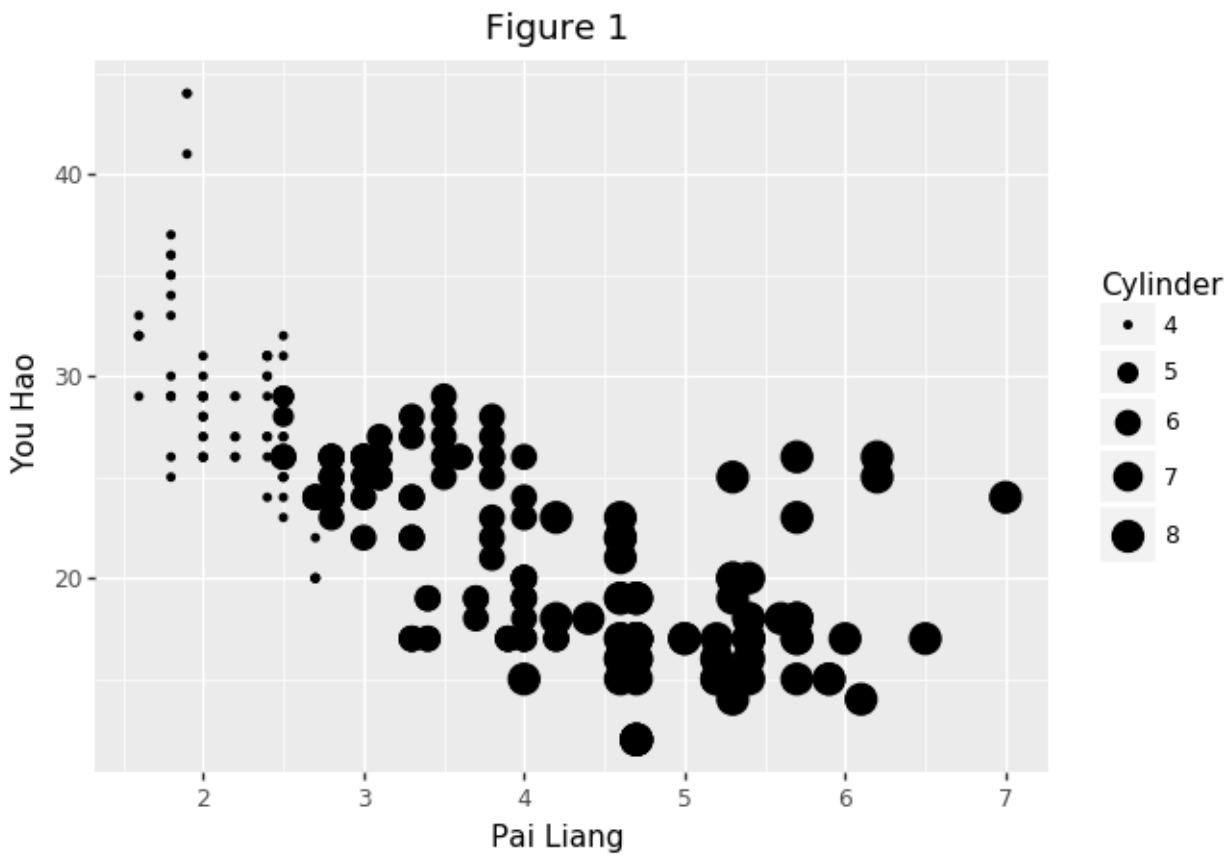
In [16]:
```
# 更改坐标轴显示范围 xlim, ylim
# 对于连续型变量可以使用 None 来设定单侧界限
# 比如 ylim(None,20) 表示最大值为 20, 下限系统自动设置
# 如果 x 轴是离散型变量, 则可以使用 xlim(值 1,..., 值 n) 来进行筛选
# 省略 x 轴标签
(ggplot(mpg,aes(x='displ',y='hwy'))+geom_point()
 +labs(title='Figure 1',x='',y='You Hao')
 +xlim(0,20)+ylim(20,30))
```

```
c:\users\binfang\appdata\local\programs\python\python37\lib\site-packages\plotnine\layer.py:452: PlotnineWarning: ge
  self.data = self.geom.handle_na(self.data)
```



Out[16]: <ggplot: (-9223371908191863457)>

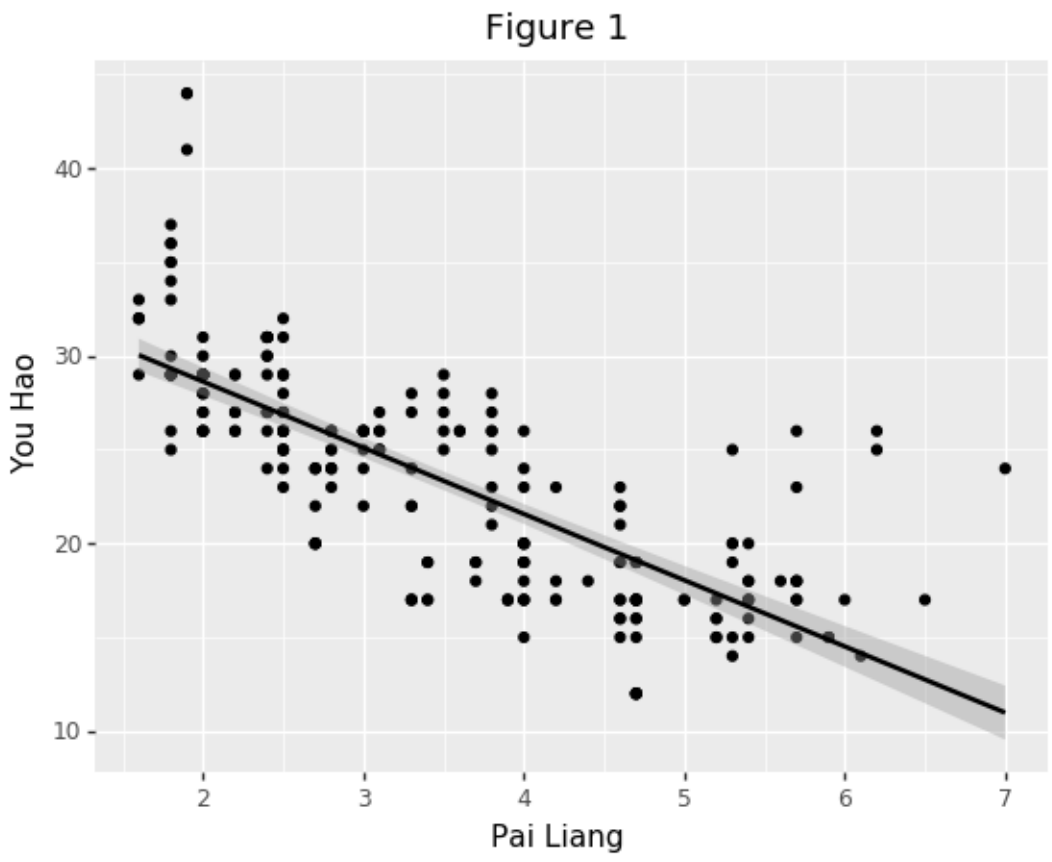
In [10]:
```
# 改变点的大小，变成气泡图
# 气泡面积大小就是变量值的大小（相对）
# 用 size 参数指定
# 在 geom_point() 中可以用 color 参数指定颜色
# 比如 geom_point(color='blue')
(ggplot(mpg,aes(x='displ',y='hwy', size='cyl'))+geom_point()
 +labs(title='Figure 1',x='Pai Liang',y='You Hao',size='Cylinder'))
```



Out[10]: <ggplot: (-9223371911203886108)>

In [10]:
```
# 添加一条趋势线
#method = 'lm' 表示使用线性拟合的方式
# 默认会给出置信区间，用阴影表示
(ggplot(mpg,aes(x='displ',y='hwy'))+geom_point()
 +labs(title='Figure 1',x='Pai Liang',y='You Hao')+geom_smooth(method='lm'))
```

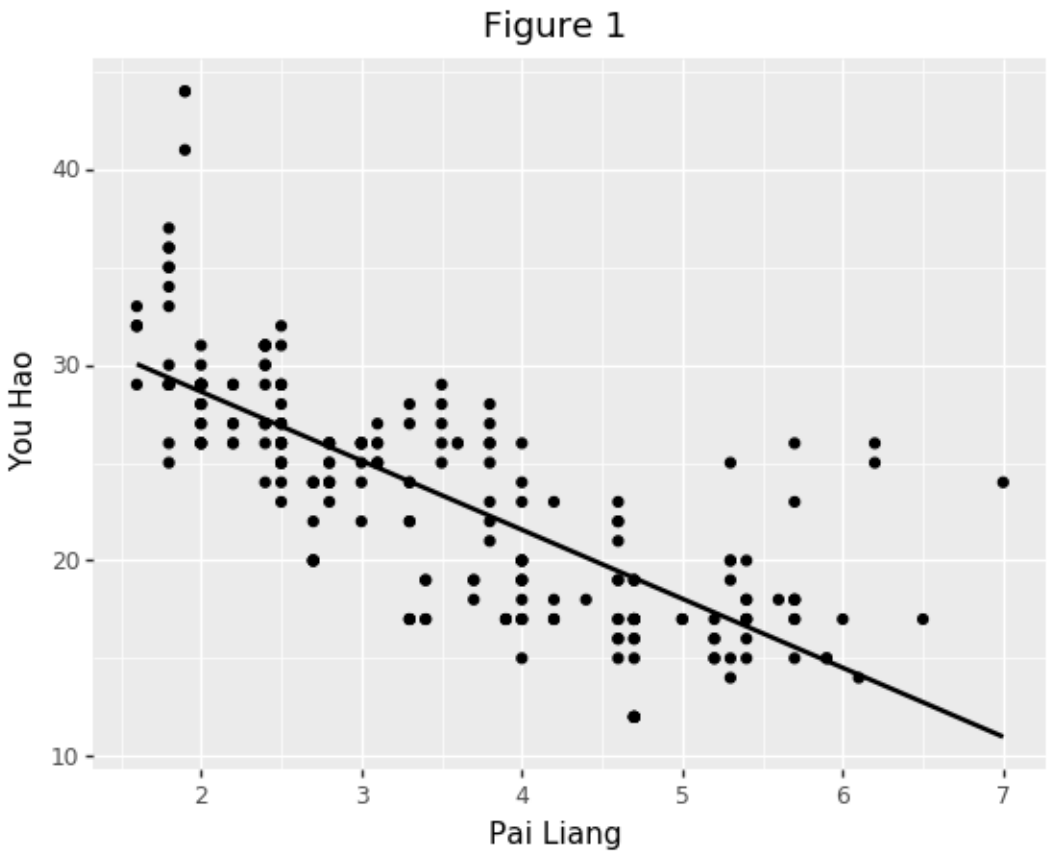
```
c:\users\binfang\appdata\local\programs\python\python37\lib\site-packages\numpy\core\fromnumeric.py:2495: FutureWarn
  return ptp(axis=axis, out=out, **kwargs)
```



Out[10]: <ggplot: (89413449736)>

In [11]:
```
# 使用 se=False 选项去掉置信区间
(ggplot(mpg,aes(x='displ',y='hwy'))+geom_point()
 +labs(title='Figure 1',x='Pai Liang',y='You Hao')+geom_smooth(method='lm',se=False))
```

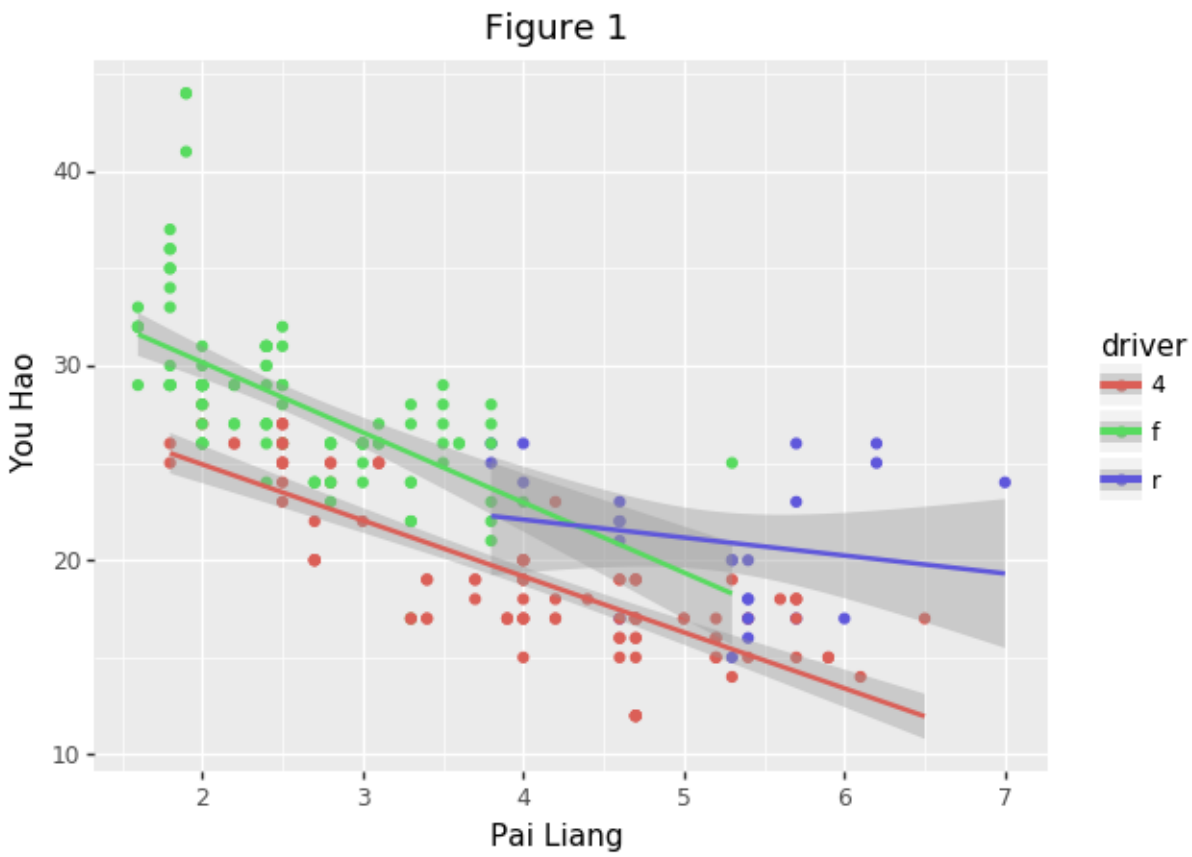
```
c:\users\binfang\appdata\local\programs\python\python37\lib\site-packages\numpy\core\fromnumeric.py:2495: FutureWarn
  return ptp(axis=axis, out=out, **kwargs)
```



Out[11]: <ggplot: (89413408618)>

In [7]:
```
# 分组展示
# 以 drv 变量（汽车的驱动方式）为分组变量
# 这里使用的是对不同的组别上不同的颜色的方式，所以用了 color 参数
# 颜色系统自动会进行设置，当然也可以自行设置
# 由于是在 ggplot 里面进行的分组设置，因此所有的图层都会分组
(ggplot(mpg,aes(x='displ',y='hwy', color='factor(drv)'))+geom_point()
 +labs(title='Figure 1',x='Pai Liang',y='You Hao',color='driver')
 +geom_smooth(method='lm'))
```

```
c:\users\binfang\appdata\local\programs\python\python37\lib\site-packages\numpy\core\fromnumeric.py:2495: FutureWarn
  return ptp(axis=axis, out=out, **kwargs)
```

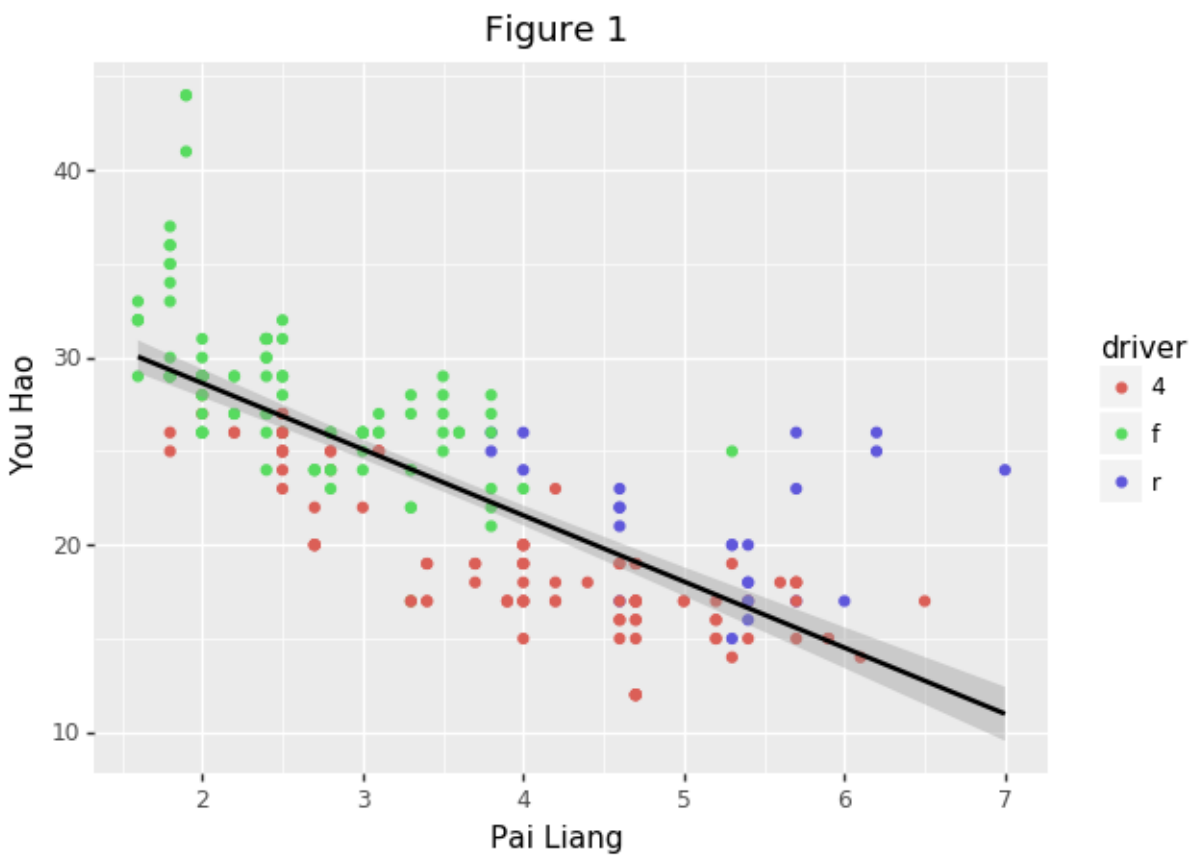


Out[7]: <ggplot: (125647019966)>

In [33]: # 这里仅在散点图图层进行了分组，因此拟合曲线部分不受影响

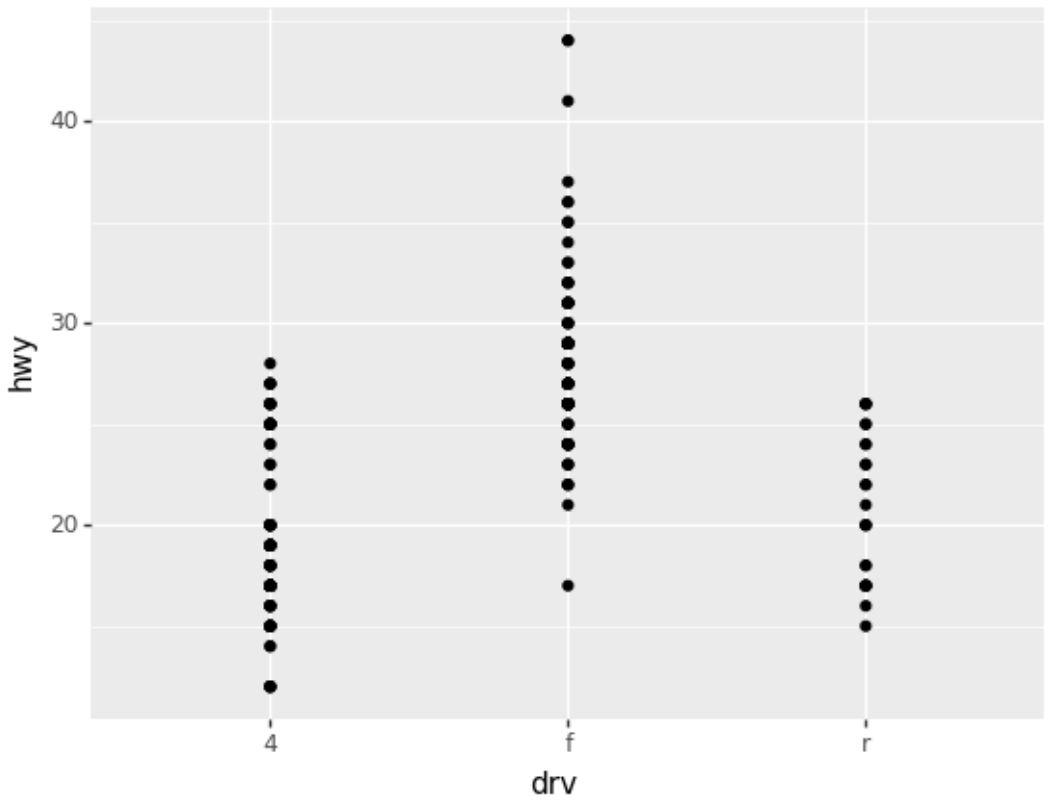
```
(ggplot(mpg,aes(x='displ',y='hwy'))+geom_point(aes(color='factor(drv)'))
 +labs(title='Figure 1',x='Pai Liang',y='You Hao',color='driver')
 +geom_smooth(method='lm'))
```

```
c:\users\binfang\appdata\local\programs\python\python37\lib\site-packages\numpy\core\fromnumeric.py:2495: FutureWarn
  return ptp(axis=axis, out=out, **kwargs)
```



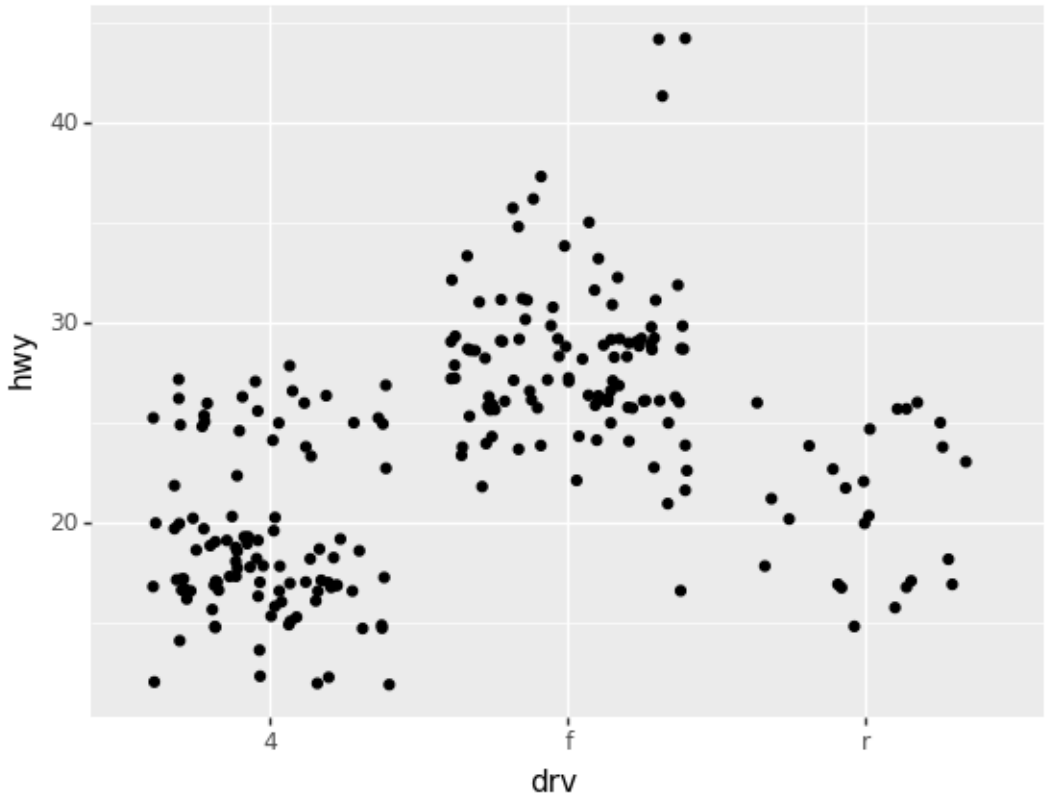
Out[33]: <ggplot: (89413356310)>

In [13]:
```
ggplot(mpg,aes('drv','hwy'))+geom_point()
```



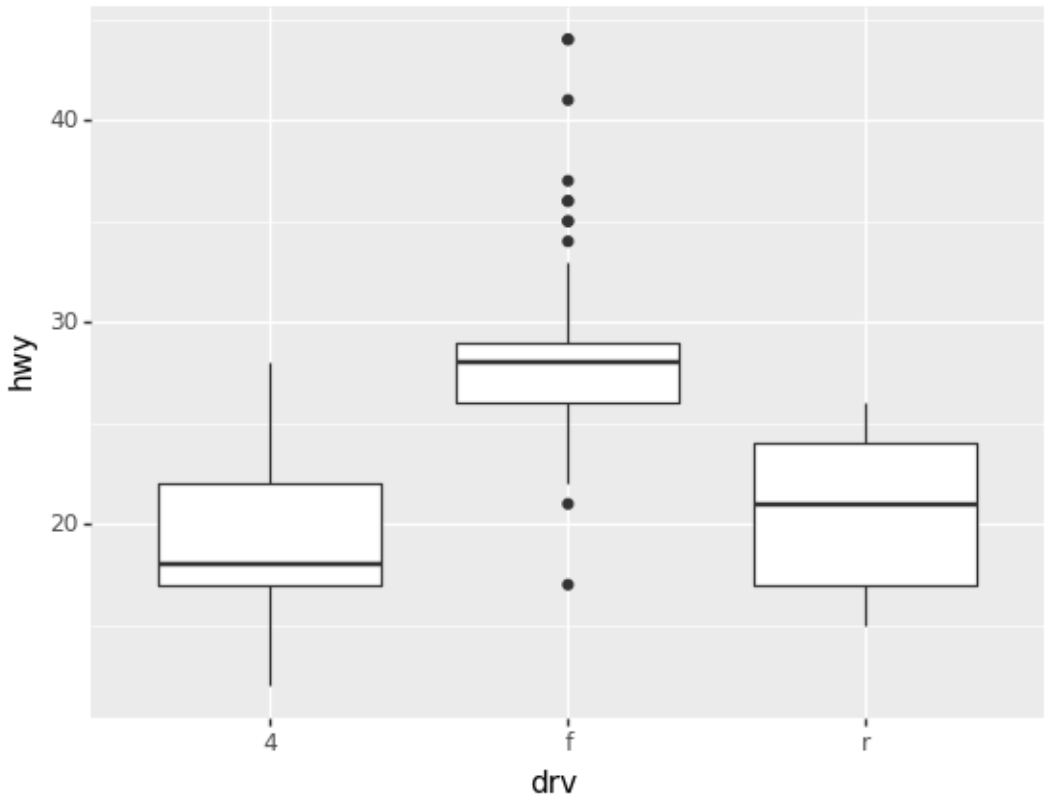
Out[13]: <ggplot: (-9223371947454019503)>

In [14]:
```
# 扰动点图，在数据中加入一些随机噪声
ggplot(mpg,aes('drv','hwy'))+geom_jitter()
```



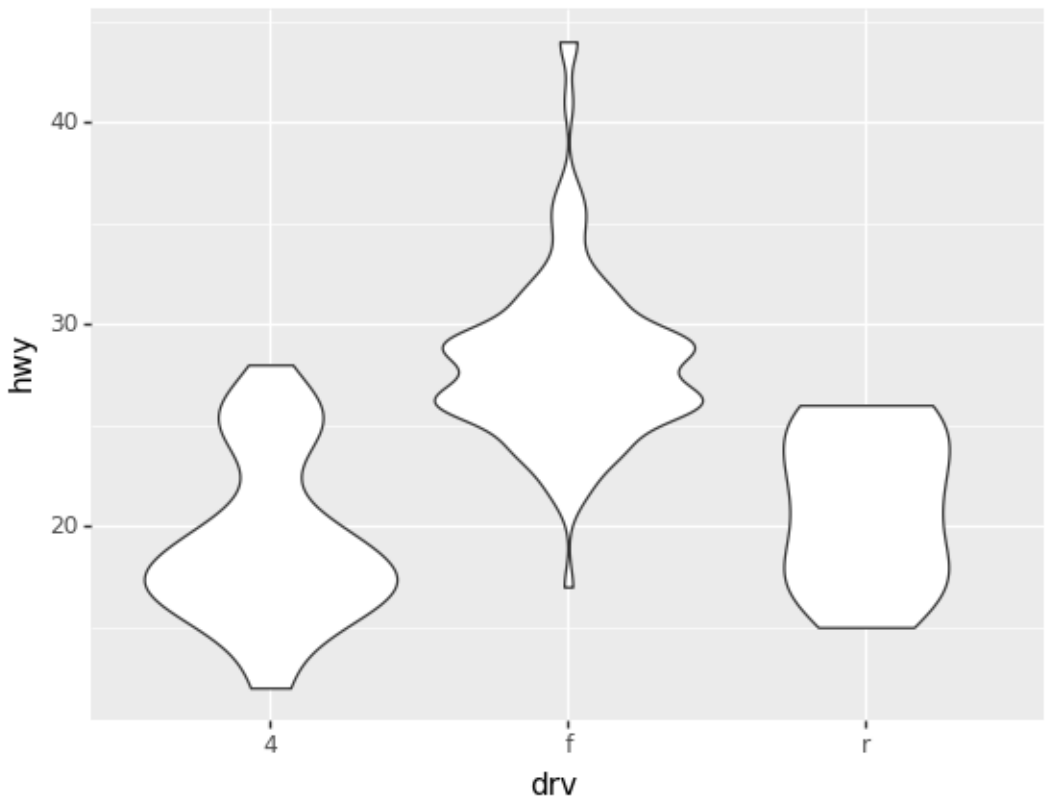
Out[14]: <ggplot: (-9223371947437948363)>

In [15]:
```
# 箱体图
# 最大值、75%、中位数、25%、最小值，散点表示异常值
ggplot(mpg,aes('drv','hwy'))+geom_boxplot()
```



Out[15]: <ggplot: (-9223371947437883932)>

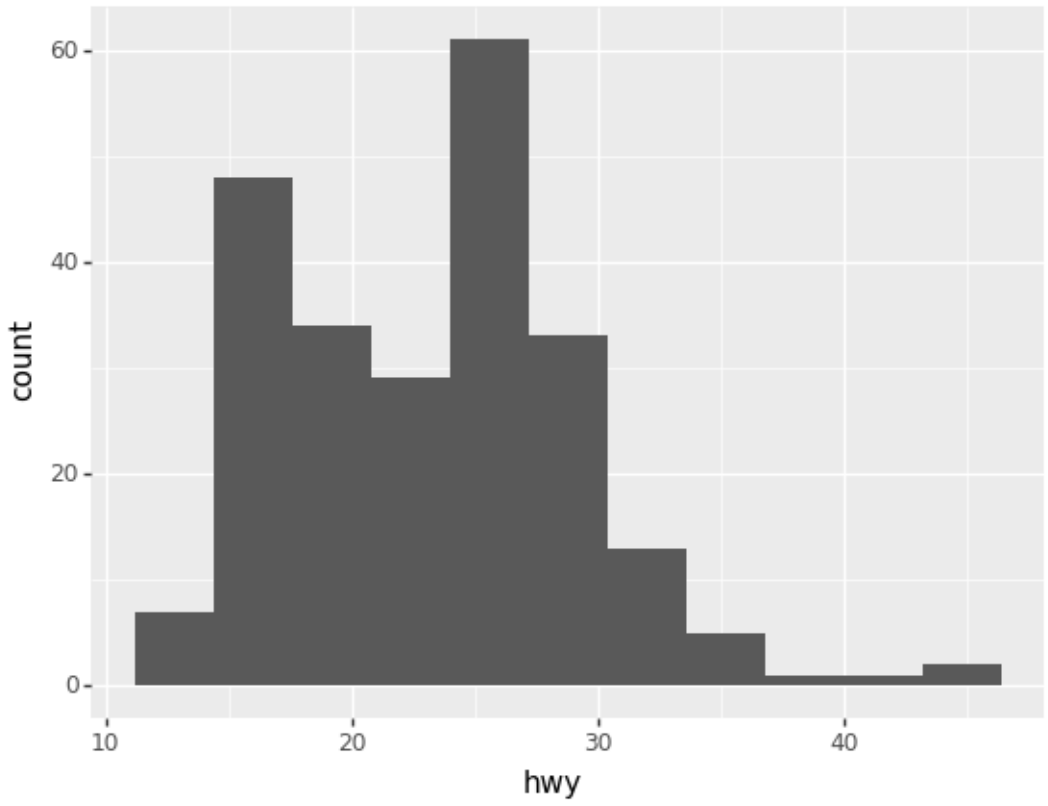
In [16]:
```
# 小提琴图
# 曲线表示数据的分布
ggplot(mpg,aes('drv','hwy'))+geom_violin()
```



Out[16]: <ggplot: (89416828252)>

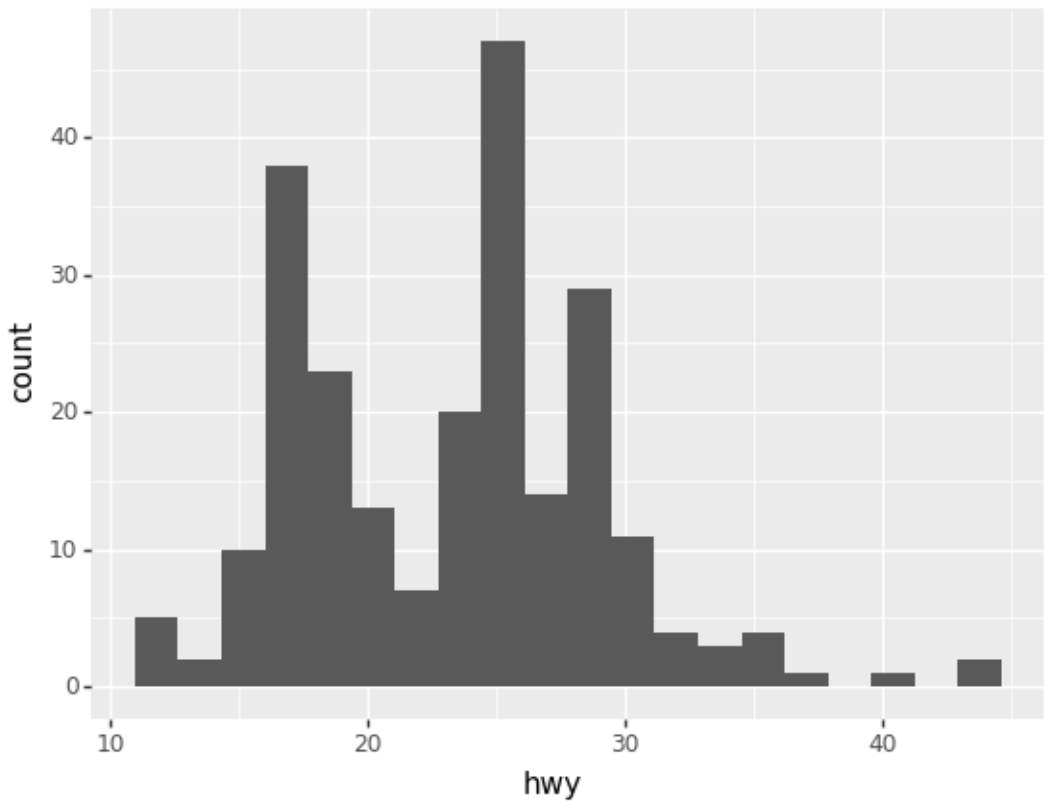
In [17]:
```
# 直方图
ggplot(mpg,aes('hwy'))+geom_histogram()
```

```
c:\users\binfang\appdata\local\programs\python\python37\lib\site-packages\plotnine\stats\stat_bin.py:93: PlotnineWar
  warn(msg.format(params['bins']), PlotnineWarning)
```



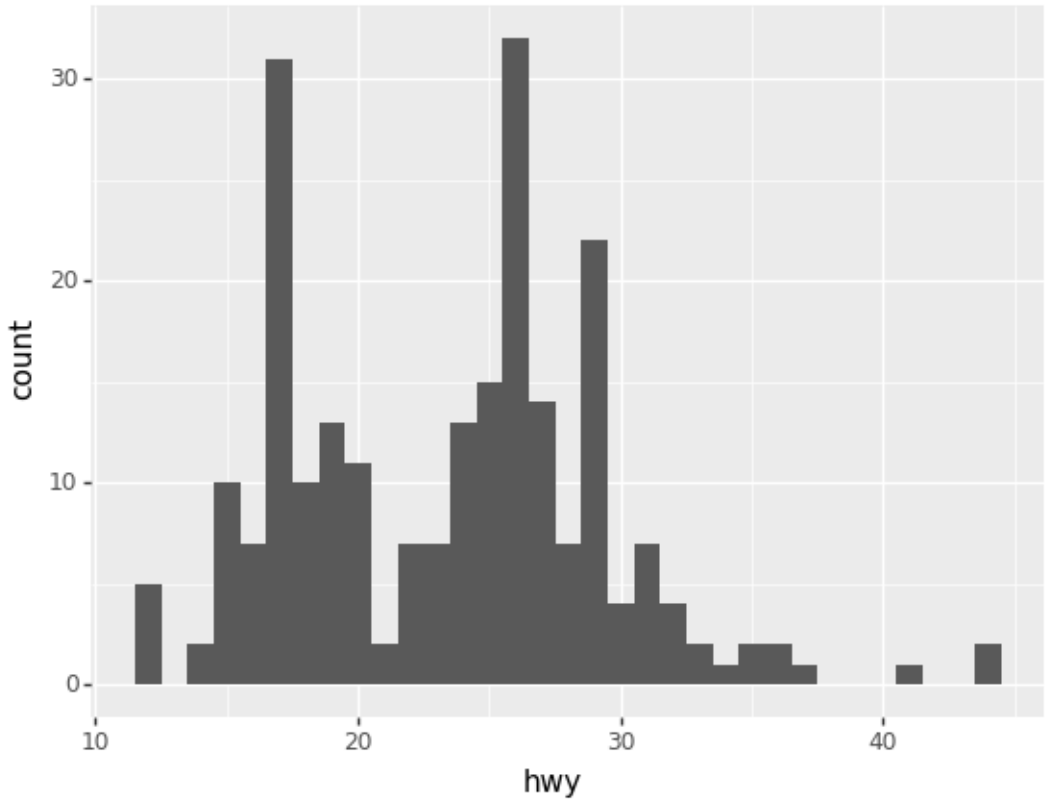
Out[17]: <ggplot: (-9223371947437831010)>

In [18]:
```
# 将直方图的组数设置为 20
ggplot(mpg,aes('hwy'))+geom_histogram(bins=20)
```



Out[18]: <ggplot: (-9223371947437725829)>

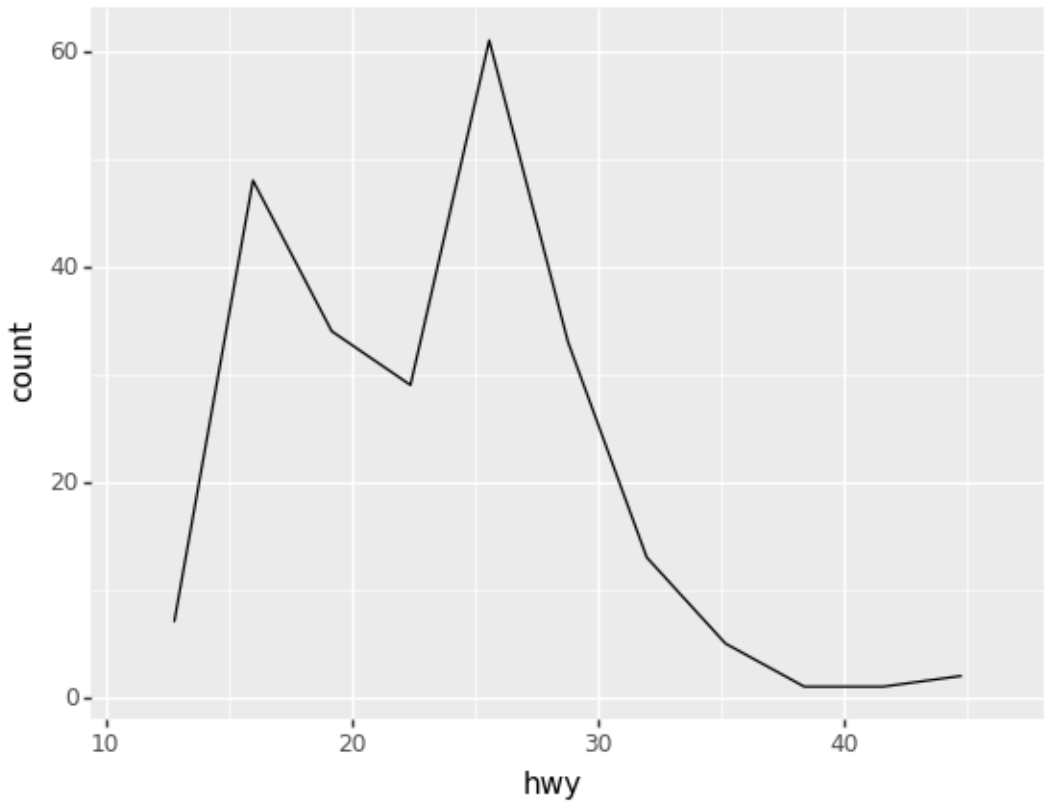
In [20]:
```
# 或者将每组的宽度设置为 1
ggplot(mpg,aes('hwy'))+geom_histogram(binwidth=1)
```



Out[20]: <ggplot: (89417049962)>

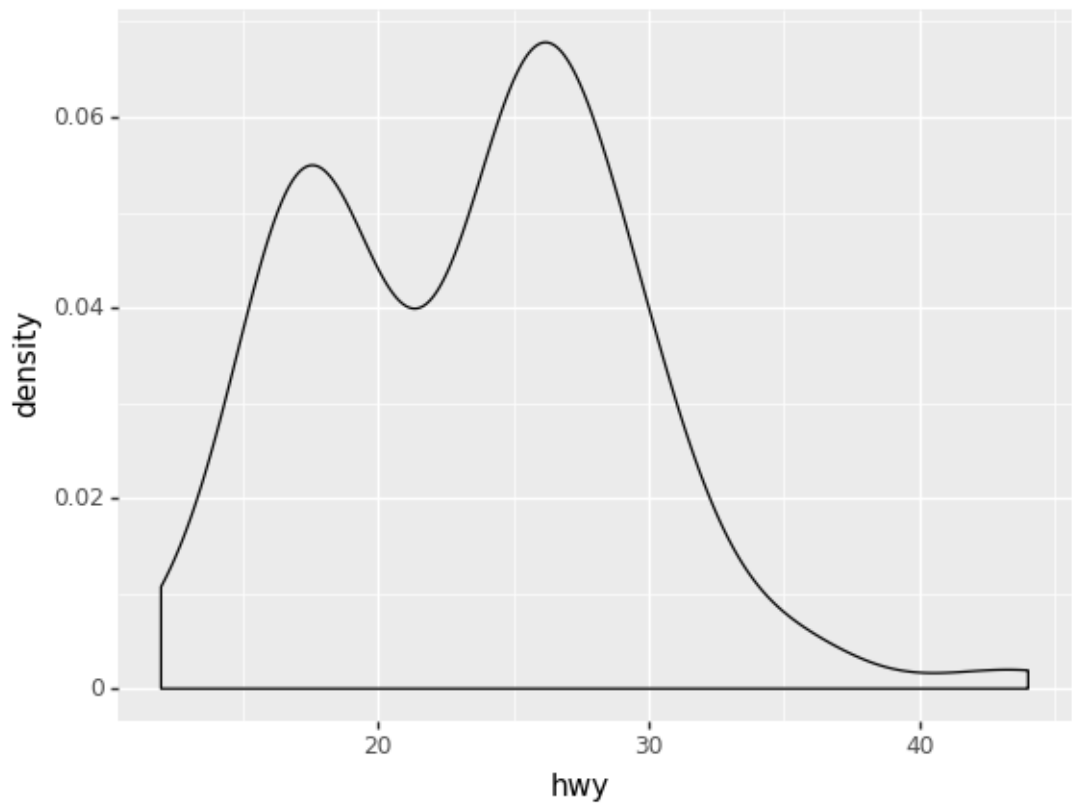
In [3]:
```
# 频数多边图
ggplot(mpg,aes('hwy'))+geom_freqpoly()
```

```
c:\users\binfang\appdata\local\programs\python\python37\lib\site-packages\plotnine\stats\stat_bin.py:93: PlotnineWar
  warn(msg.format(params['bins']), PlotnineWarning)
```



Out[3]: <ggplot: (128659241792)>

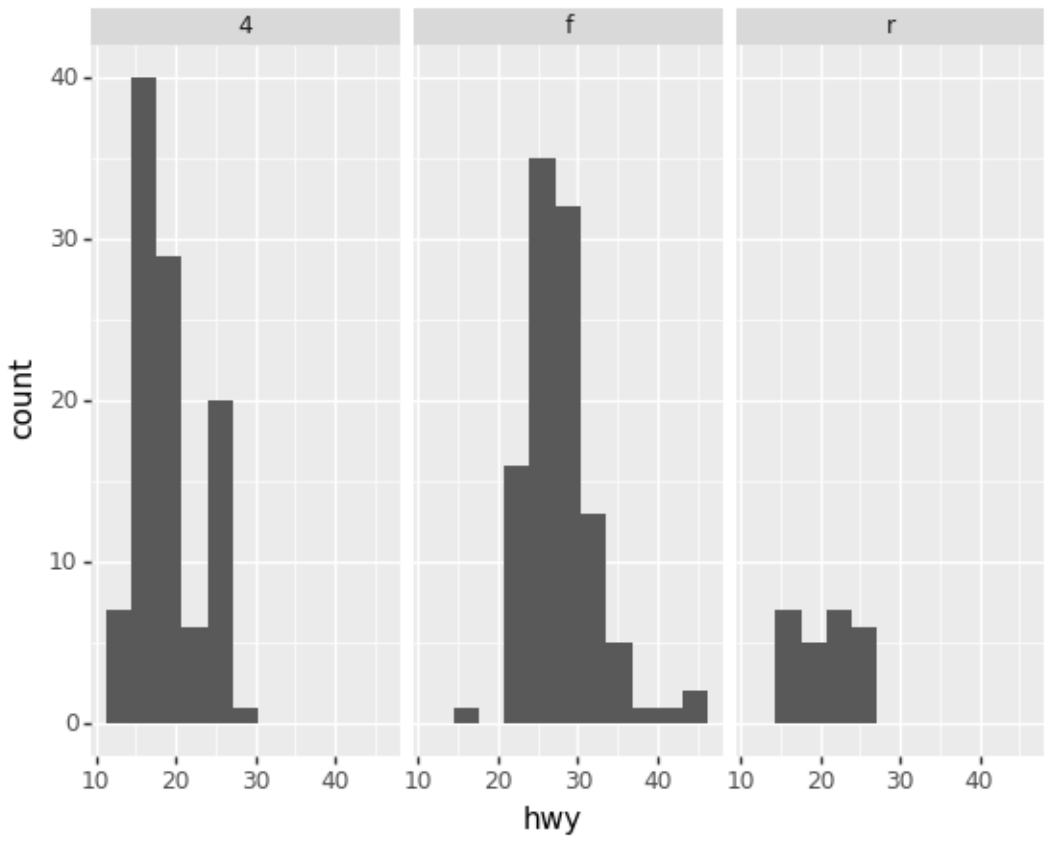
In [21]:
```
# 密度图
ggplot(mpg,aes('hwy'))+geom_density()
```



Out[21]: <ggplot: (-9223371947441402827)>

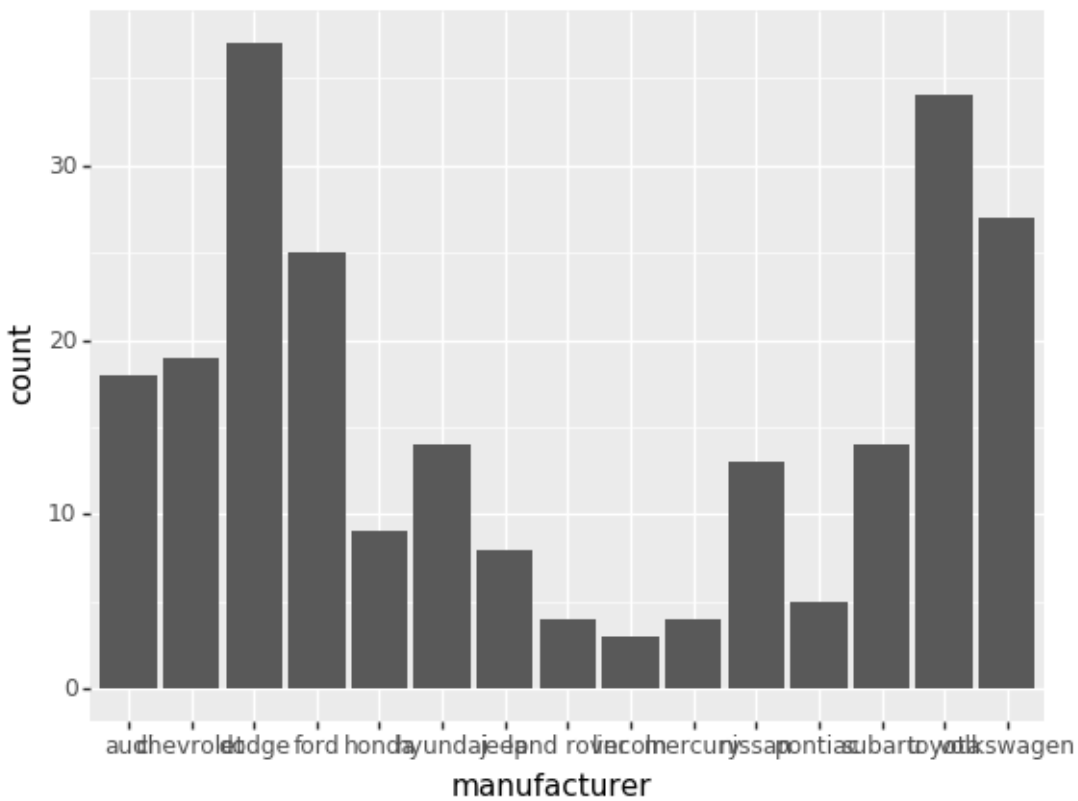
In [22]:
```
# 根据变量 drv 分面展示
#facet_wrap 为分面函数
# 注意，和分组不同，分面是绘制了三个不同的图，而不是在一个图上绘制三组数
ggplot(mpg,aes('hwy'))+geom_histogram()+facet_wrap('drv')
```

```
c:\users\binfang\appdata\local\programs\python\python37\lib\site-packages\plotnine\stats\stat_bin.py:93: PlotnineWar
  warn(msg.format(params['bins']), PlotnineWarning)
```



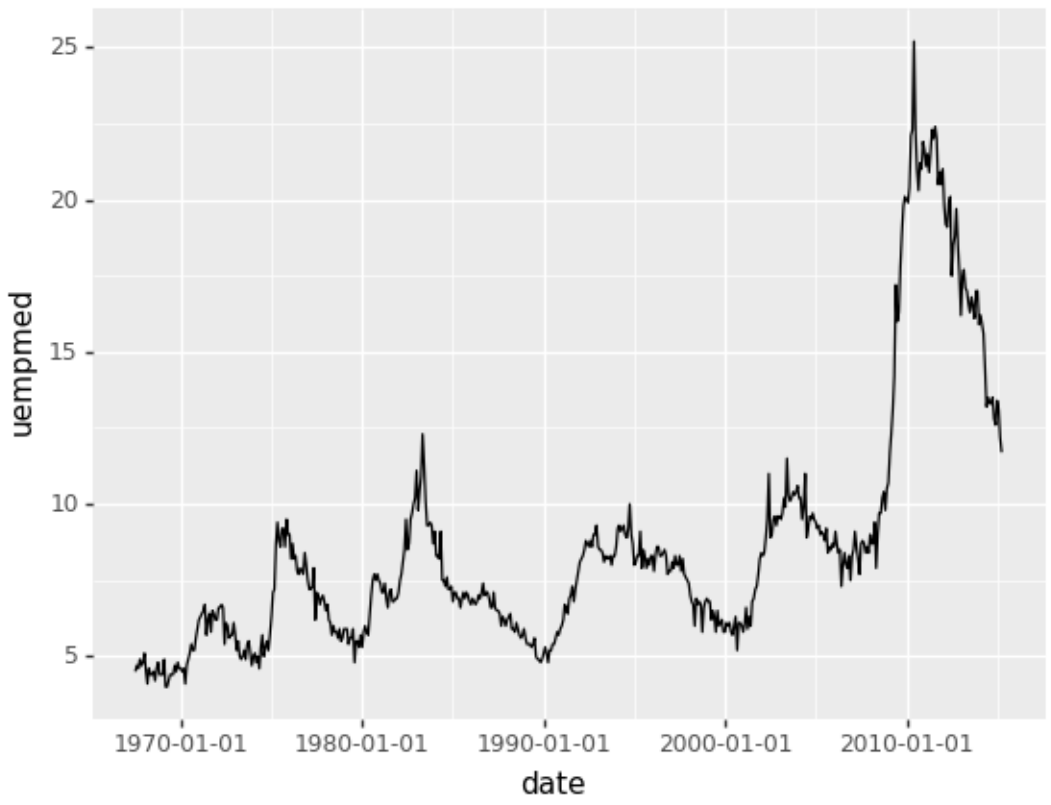
Out[22]:
```
<ggplot: (89413322374)>
```

In [23]:
```
# 条形图
ggplot(mpg,aes('manufacturer'))+geom_bar()
```



Out[23]: <ggplot: (-9223371947441378188)>

In [24]:
```
# 折线图
# 年份与失业持续时长的关系图
ggplot(economics, aes('date', 'uempmed')) + geom_line()
```

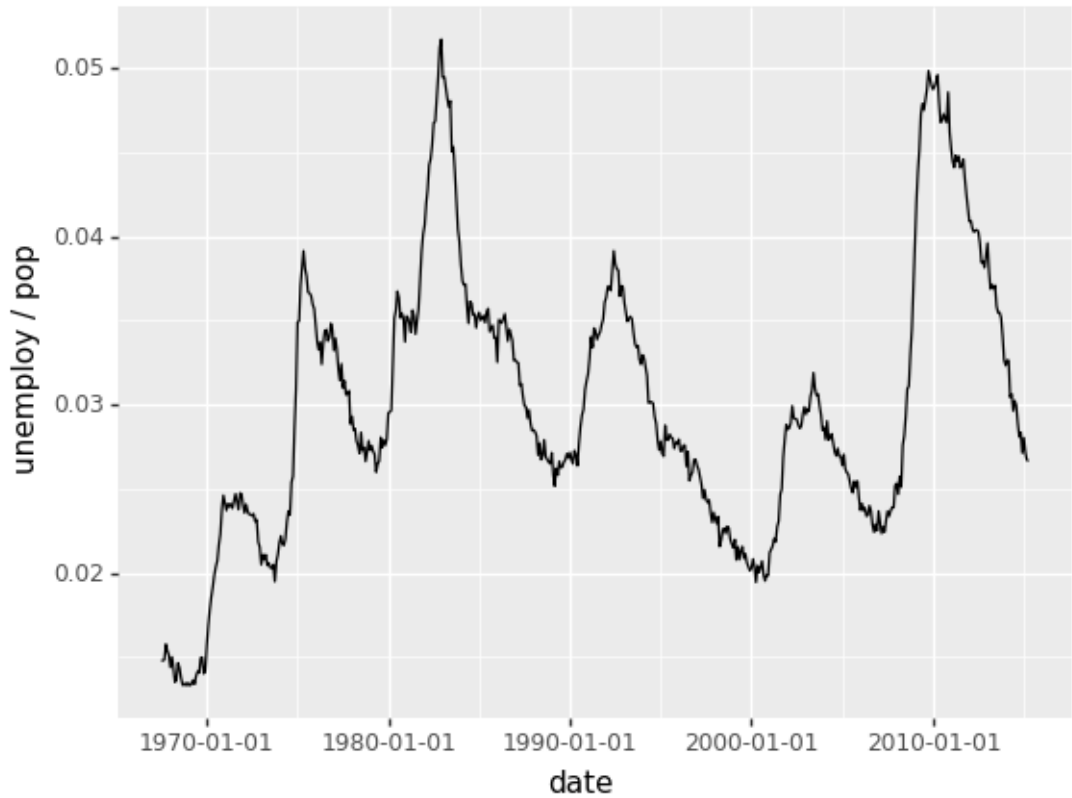


Out[24]: <ggplot: (89413486519)>

In [25]:
```
# 查看 economics 这个数据集的信息
economics.info()
```

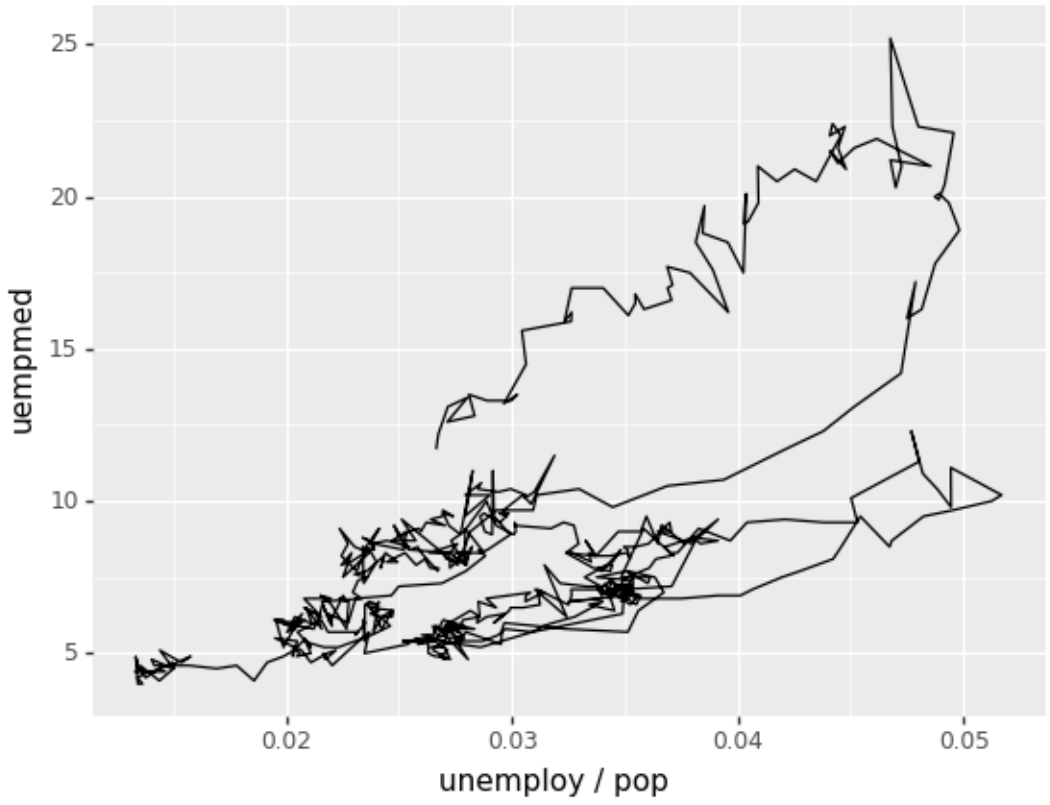
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 574 entries, 0 to 573
Data columns (total 6 columns):
date        574 non-null datetime64[ns]
pce         574 non-null float64
pop         574 non-null int64
psavert     574 non-null float64
uempmed     574 non-null float64
unemploy    574 non-null int64
dtypes: datetime64[ns](1), float64(3), int64(2)
memory usage: 27.0 KB
```

In [26]:
```
# 时间与失业率的关系
# 失业率是通过失业人数除以总人口计算出来的
ggplot(economics, aes('date', 'unemploy / pop')) + geom_line()
```



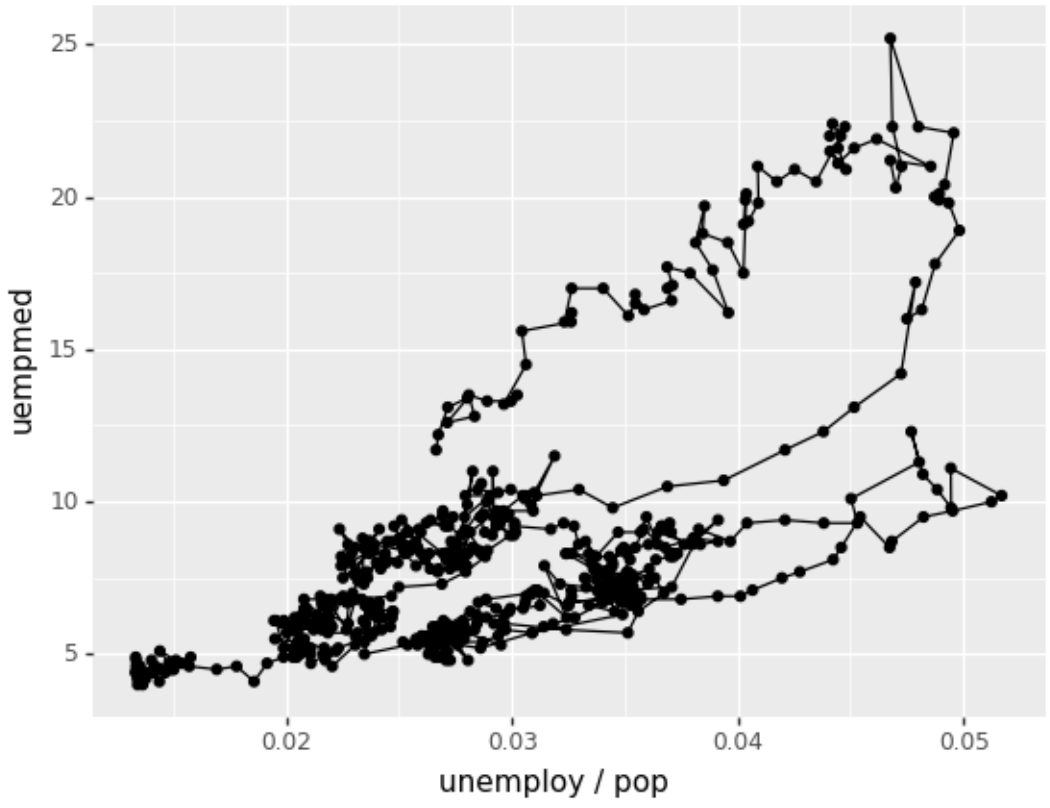
Out[26]: <ggplot: (89413392739)>

In [27]:
```
# 失业率与失业时长的关系
ggplot(economics, aes('unemploy / pop','uempmed')) + geom_path()
```



Out[27]: <ggplot: (89416901373)>

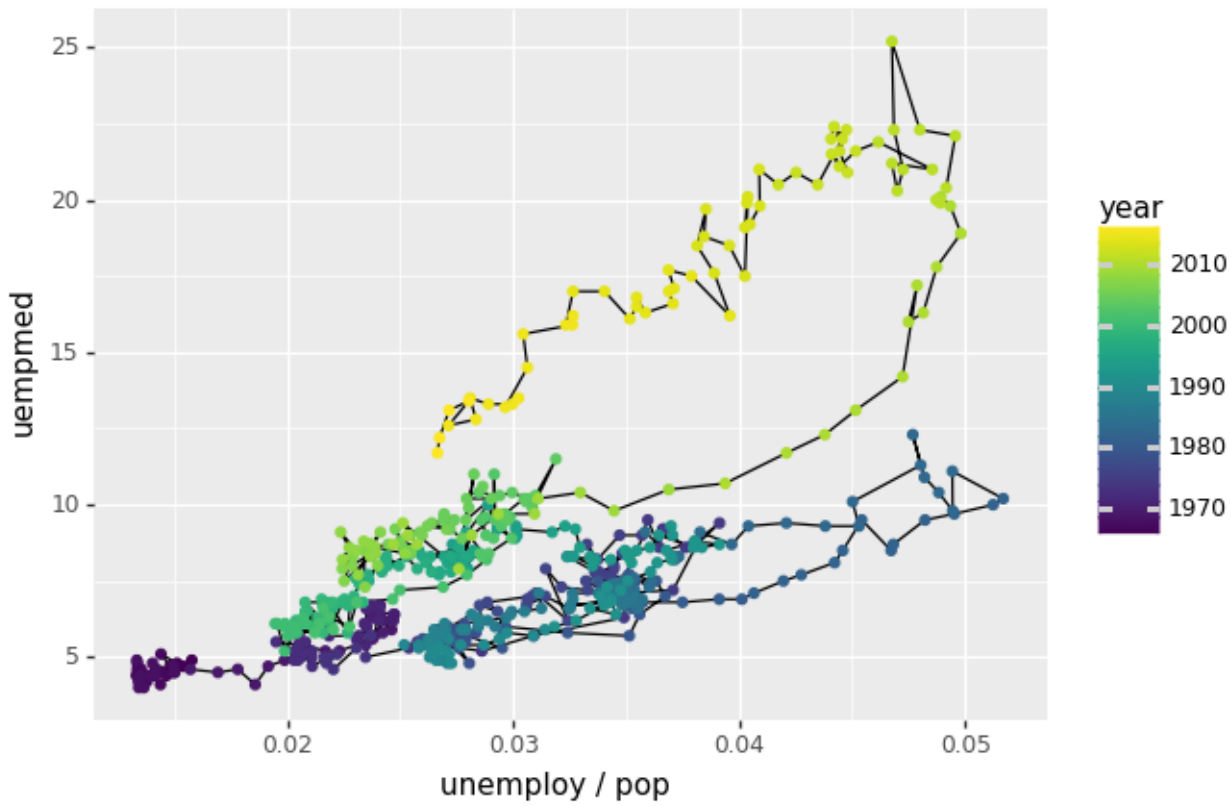
In [28]:
```
# 添加点
ggplot(economics, aes('unemploy / pop','uempmed')) + geom_path()+geom_point()
```



Out[28]: <ggplot: (-9223371947437936331)>

In [29]:
```
# 为不同年份着不同颜色
# 因为年份是一个连续的变量，所以颜色会有一个渐变的过程，这样更加容易理解图
```

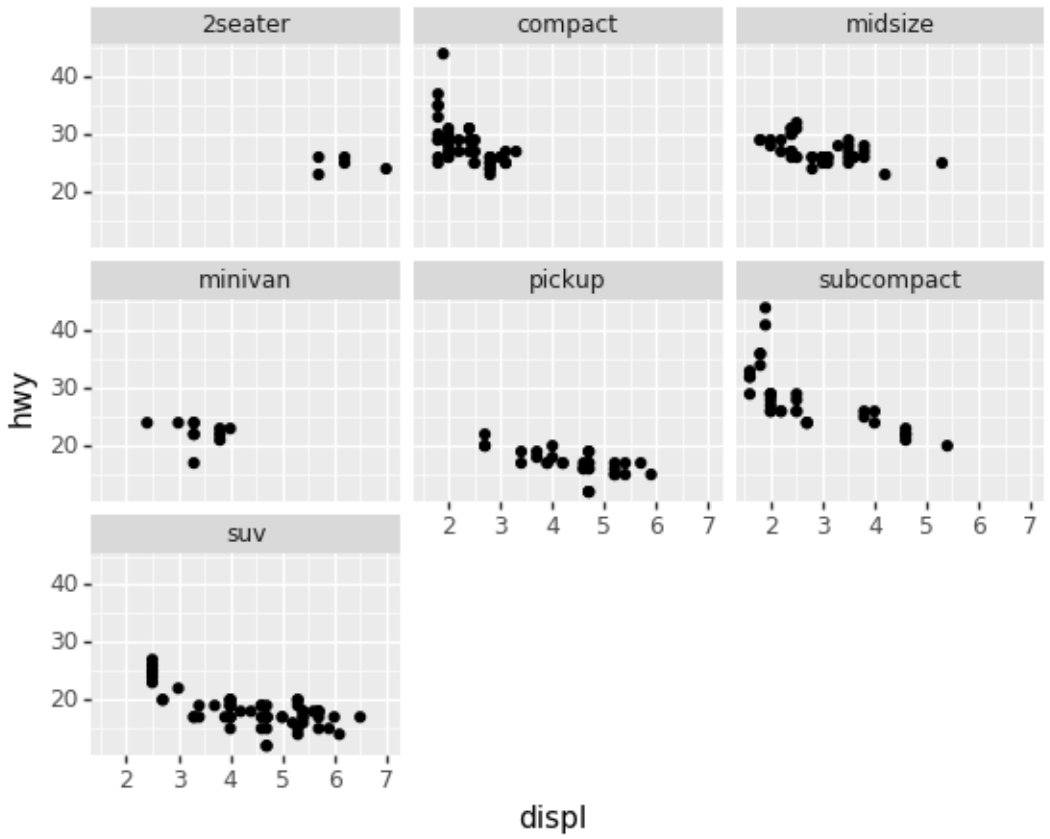
```
econ2 = economics.join(economics['date'].dt.year.rename('year',inplace = True))
ggplot(econ2, aes('unemploy / pop','uempmed')) + geom_path()+geom_point(aes(color='year'))
```



Out[29]: <ggplot: (89413503054)>

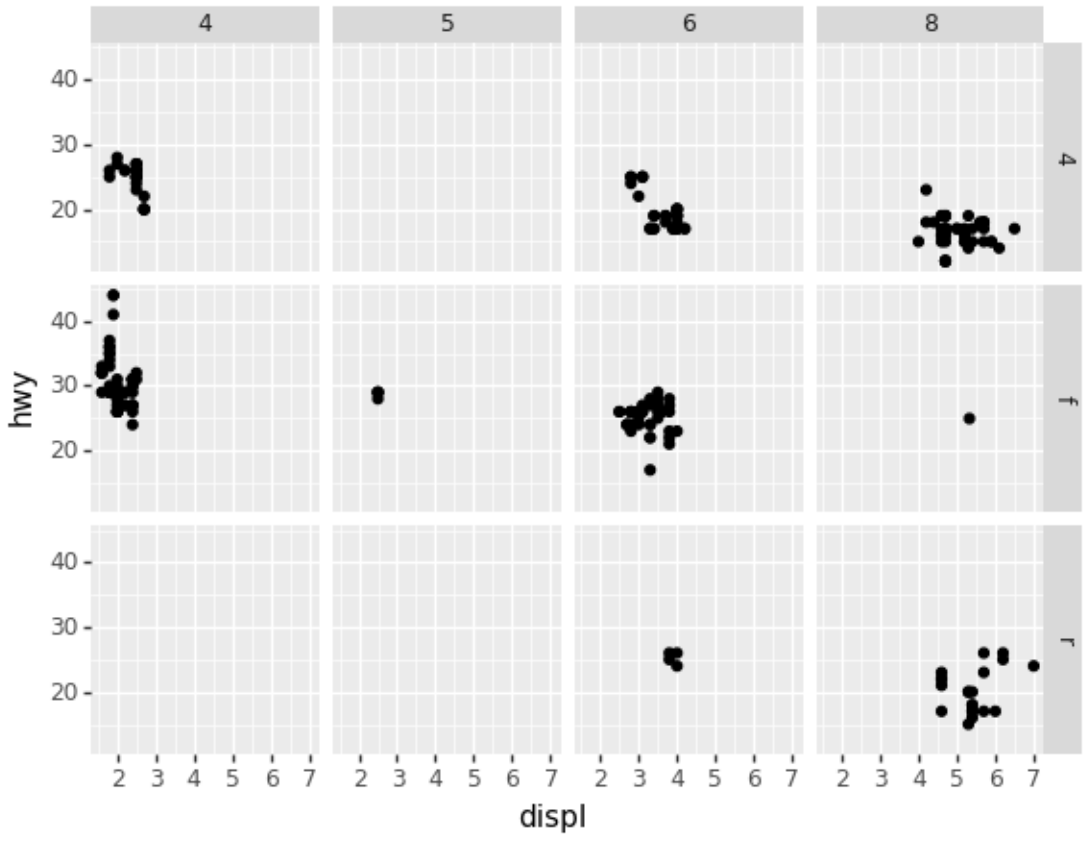
```
In [8]: # 网格分面函数 facet_grid
        # 封装分面函数 facet_wrap
        from plotnine import * # 导入 plotnine 包的所有绘图函数
        from plotnine.data import * # 导入 plotnine 包中的所有数据

        #facet_wrap 是按照某个变量 (这里是 class) 进行分组, ncol 指定总共有几列, 然后依次排列
        # 也可以用 nrow 指定总共有几行
        ggplot(mpg, aes('displ','hwy'))+geom_point()+facet_wrap('~class',ncol=3)
```



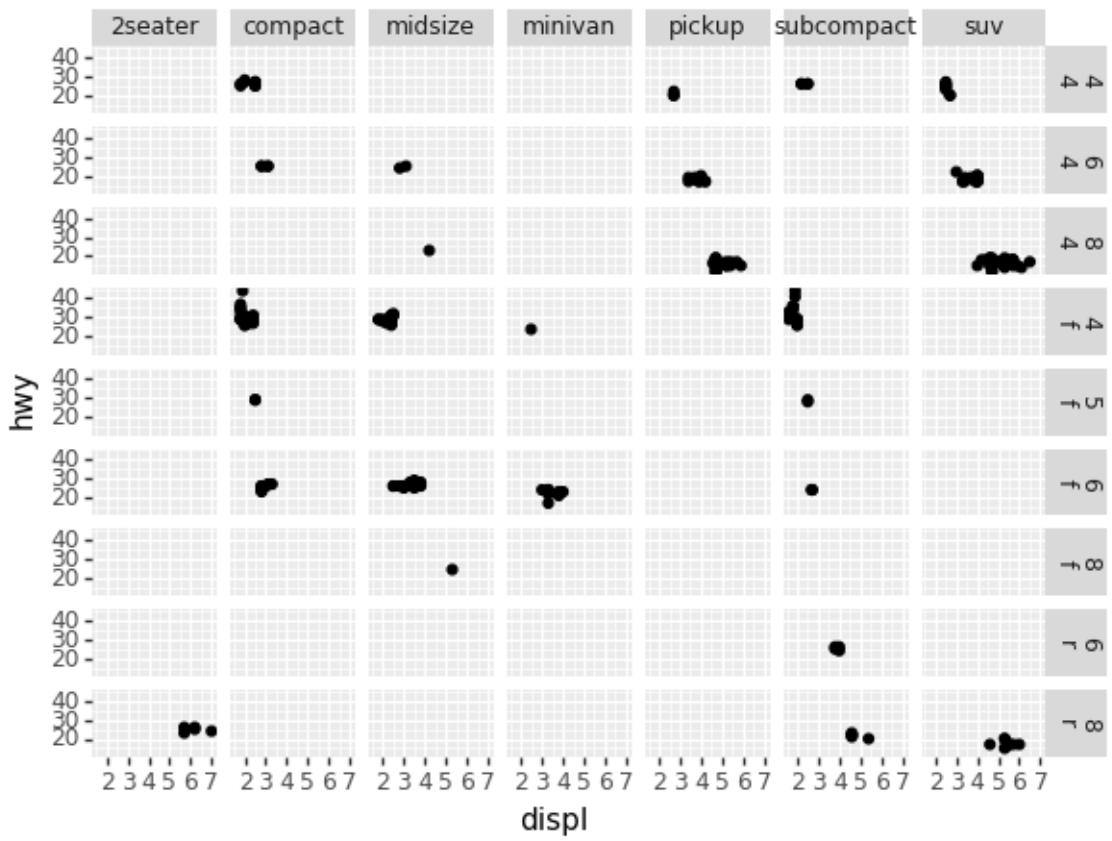
Out[8]: <ggplot: (-9223371867810572186)>

In [12]: *#facet_wrap 是按照某两个变量 (这里是 drv~cyl) 进行分组*
#drv 按列展开, cyl 按行展开
ggplot(mpg, aes('displ','hwy'))+geom_point()+facet_grid('drv~cyl')



Out[12]: <ggplot: (169044409520)>

In [11]:
```
# 也可以几个变量相加，图像就会展示存在的变量组合
ggplot(mpg, aes('displ','hwy'))+geom_point()+facet_grid('drv+cyl~class')
```



Out[11]: <ggplot: (-9223371867812106201)>

In [37]:
```
# 地图
from pyecharts.charts import Map
from pyecharts import options as opts

# 基本语法：map.add(标题，数据，地图)
# 后面还可以添加选项，比如 set_global_opts 进行全局设定
#max_=70, min_=40 表示最小值 40、最大值 70
#title=" 福建省 AQI 空气指数 " 表示图的标题
map = Map().add('AQI',[["福州市",48],["厦门市",51],["泉州市",68],
                       ["莆田市",61],["南平市",47],["三明市",50],
                       ["漳州市",49],["龙岩市",41],["宁德市",51]],"福建").set_global_opts(
    title_opts=opts.TitleOpts(title="福建省 AQI 空气指数"),
    visualmap_opts=opts.VisualMapOpts(max_=70, min_=40),)
#render 表示将图输出到某个 HTML 文件中
map.render('BDA_ch3_map1.html')
```

Out[37]: 'C:\\Users\\binfang\\Documents\\teaching\\Code\\jupyter\\BDA_ch3_map1.html'

In [55]:
```
# 南丁格尔玫瑰图
from pyecharts.charts import Polar

# 本质上是一个极坐标画图
#add_schema() 函数中设定角度坐标轴（相当于 x 轴）
#add() 函数中添加数据
#stack 参数表示进行堆积展示，值相同的堆在一起
# 如果不添加 stack 参数则默认分组展示
```

```
polar = Polar().add_schema(
    angleaxis_opts=opts.AngleAxisOpts(data=['甲','乙','丙','丁','戊'])).add(
    '英语成绩',[10,15,12,17,30],type_ = 'bar', stack ='1').add(
    '数学成绩',[22,11,19,15,28],type_ = 'bar', stack ='2').add(
    '语文成绩',[11,14,10,19,31],type_ = 'bar', stack ='1').add(
    '物理成绩',[24,10,18,20,25],type_ = 'bar', stack ='2')
polar.render('BDA_ch3_polar.html')
```

```
Out[55]: 'C:\\Users\\binfang\\Documents\\teaching\\Code\\jupyter\\BDA_ch3_polar.html'
```

```
In [75]: # 关系图
from pyecharts.charts import Graph

# 结点属性
#name 节点名字，symbolSize 节点大小，value 节点标签，category 节点所属的类
# 除了 name，其它属性都可以省略
# 注意不同属性的数据类型
nodes = [{'name':'A','symbolSize':10,'value':3,'category':0},
         {'name':'B','symbolSize':12,'value':3,'category':1},
         {'name':'C','symbolSize':14,'value':3,'category':1},
         {'name':'D','symbolSize':20,'value':1,'category':0},
         {'name':'E','symbolSize':25,'value':2,'category':1}]
# 节点之间的连线
links = [{'source':'A','target':'B'},
         {'source':'A','target':'C'},
         {'source':'A','target':'D'},
         {'source':'B','target':'C'},
         {'source':'C','target':'E'},
         {'source':'B','target':'E'},]
# 类的名称
# 注意：这里的字典的顺序和之前节点中定义的相对应
#0 表示第一个字典，1 表示第二个字典……
categories=[{'name':'cluster1'},{'name':'cluster2'}]
#repulsion 表示点和点之间的距离，可以省略
graph = Graph().add('', nodes, links, categories, repulsion=5000).set_global_opts(
    title_opts=opts.TitleOpts(title="关系网络"))
graph.render('BDA_ch3_graph.html')
```

```
Out[75]: 'C:\\Users\\binfang\\Documents\\teaching\\Code\\jupyter\\BDA_ch3_graph.html'
```

```
In [79]: # 使用 pyecharts 绘制词云图
from pyecharts.charts import WordCloud

# 词库以及词频
words = [['Xuesen Qian',4],
         ['Yonghuai Guo',6],
         ['Jiaxian Deng',1],
         ['Ole Gunnar Solskjaer',2],
         ['Massimiliano Allegri',4],
         ['Emre Can',1],
         ['Mario Mandzukic',1],
         ['Andrew Carnegie',1],
         ['John D. Rockefeller',1],
         ['Bill Gates',1],
```

```
            ['Jeff Bezos',3],
            ['Bob Iger',1],]
        #word_size_range 表示词所展示尺寸大小的范围
        #shape 表示词云的形状
        #'circle', 'cardioid', 'diamond', 'triangle-forward', 'triangle', 'pentagon', 'star'
        #pyecharts 无法自定义形状
        wc = WordCloud().add('', words, word_size_range=[20,100],
                             shape='diamond').set_global_opts(
            title_opts=opts.TitleOpts(title='WordCloud'))
        wc.render('BDA_ch3_wordcloud.html')
```

Out[79]: 'C:\\Users\\binfang\\Documents\\teaching\\Code\\jupyter\\BDA_ch3_wordcloud.html'

In [86]:
```
# 使用 WordCloud 绘制词云图
# 这个库就可以使用自定义的图片，让词云填充图片
from matplotlib import pyplot as plt
from wordcloud import WordCloud
from PIL import Image
import numpy as np

#WordCloud 库能够自动根据空格等进行分词，因此直接输入文字即可
# 中文的话需要预先进行分词工作
words = '''
At the exhibition booth dedicated to Shanghai's craftsmanship and heritage,
fashion crossovers and creative collaborations are the main themes.
Rural art, mainly colorful paintings depicting the idyllic lifestyle
and landscape of the suburban area of Shanghai, has been adopted by Phoenix bicycles,
a local time-honored brand, and silk scarves from Shang Xia,
a luxury brand in which Hermes has invested.
Xi stressed on Sunday during an inspection tour of Shanghai that
the science and technology innovation board and the pilot registration system of new share
sales experimented on the board must remain committed to their roles,
and the quality of listed firms should be improved.
"The STAR Market should stay committed to its role of supporting real high-tech enterprises,
by sticking with IPO standards and review procedures
that are inclusive to them and characteristics of the registration-based system," he said.
The recent retreat of STAR-listed stocks is within expectations
and can be interpreted as a return to rational valuation levels,
Dong added, citing that investor enthusiasm and the scarcity of available investment targets
when the new board debuted has led to over-valuation.
'''
# 读入图片
# 由于使用的是 PIL 库中的 Image 包，所以需要 numpy 包进行转换
img = np.array(Image.open('doraemon.jpg'))
# mask 参数指定要填充的图片
#background_color 指定背景色，默认为黑色
#generate() 函数对文本进行分词和统计
wc = WordCloud(mask = img, background_color = 'white').generate(words)
# 不指定 mask 则最后形成的词云为矩形
#wc = WordCloud(background_color = 'white').generate(words)
# 展示图片
plt.imshow(wc)
# 取消坐标轴
plt.axis('off')
```

```
plt.show()
# 将图片另存为文件
wc.to_file('BDA_ch3_wordcloud.png')
```

Out[86]: <wordcloud.wordcloud.WordCloud at 0x1d414badeb8>