In [1]:

```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib as plt
%matplotlib inline
```

1.数据概览

In [2]:

```
df=pd.read_csv("./mobike.csv")
```

In [3]:

```
df.head()
```

Out[3]:

	Unnamed: 0	user_id	start_time	end_time	timeduration	bikeid	tripduration	from_station_id
0	439283	21499218	11/14/2018 7:37	11/14/2018 7:44	7	2631	436	319
1	603317	21694389	12/18/2018 19:02	12/18/2018 19:10	7	1565	445	164
2	109957	21110722	10/9/2018 12:37	10/9/2018 12:55	18	2231	1090	163
3	428082	21485409	11/12/2018 12:30	11/12/2018 12:40	9	4226	581	226
4	395437	21445994	11/7/2018 7:29	11/7/2018 7:35	6	3475	390	77

有unnamed的列，实际意义为索引

In [4]:

```
#指定索引列
df=pd.read_csv("./mobike.csv",index_col=0)
```

In [5]:

```
df.head()
```

Out[5]:

	user_id	start_time	end_time	timeduration	bikeid	tripduration	from_station_id	from
439283	21499218	11/14/2018 7:37	11/14/2018 7:44	7	2631	436	319	G
603317	21694389	12/18/2018 19:02	12/18/2018 19:10	7	1565	445	164	Fr
109957	21110722	10/9/2018 12:37	10/9/2018 12:55	18	2231	1090	163	
428082	21485409	11/12/2018 12:30	11/12/2018 12:40	9	4226	581	226	
395437	21445994	11/7/2018 7:29	11/7/2018 7:35	6	3475	390	77	

In [6]:

```
df.shape
```

Out[6]:

```
(6427, 14)
```

In [7]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 6427 entries, 439283 to 278179
Data columns (total 14 columns):
 #   Column             Non-Null Count  Dtype  
---  ------             --------------  -----  
 0   user_id            6427 non-null   int64  
 1   start_time         6427 non-null   object 
 2   end_time           6427 non-null   object 
 3   timeduration       6427 non-null   int64  
 4   bikeid             6427 non-null   int64  
 5   tripduration       6427 non-null   int64  
 6   from_station_id    6427 non-null   int64  
 7   from_station_name  6427 non-null   object 
 8   to_station_id      6427 non-null   int64  
 9   to_station_name    6427 non-null   object 
 10  usertype           6427 non-null   object 
 11  gender             5938 non-null   object 
 12  birthyear          5956 non-null   float64
 13  age                6427 non-null   object 
dtypes: float64(1), int64(6), object(7)
memory usage: 753.2+ KB
```

jupyter

- start_time和end_time是object，需要转换为日期时间格式
- usertype和gender需要转换为dummy型
- age需要转化为数值型

- gender和birthyear有缺失值，但是birthyear与age意义相同，不对birthyear做处理

In [8]:

```
df.describe()
```

Out[8]:

	user_id	timeduration	bikeid	tripduration	from_station_id	to_station_id	bir
count	6.427000e+03	6427.000000	6427.000000	6.427000e+03	6427.000000	6427.000000	5956.
mean	2.135519e+07	11.778902	3491.637934	1.060471e+03	195.038432	198.502567	1982.4
std	2.181294e+05	9.692236	1912.171846	1.456811e+04	148.170025	148.939873	11.1
min	2.098358e+07	0.000000	2.000000	6.100000e+01	2.000000	2.000000	1906.
25%	2.116805e+07	5.000000	1852.000000	3.490000e+02	77.000000	80.000000	1977.
50%	2.135114e+07	9.000000	3618.000000	5.590000e+02	168.000000	172.000000	1986.
75%	2.154376e+07	15.000000	5179.500000	9.320000e+02	287.000000	287.000000	1991.
max	2.174223e+07	59.000000	6470.000000	1.139070e+06	662.000000	661.000000	2002.

- birthyear有异常值，用age验证

- timeduration最小值为0，需要关注

In [9]:

```
#检查是否有重复数据
sum(df.duplicated())
```

Out[9]:

```
0
```

2.数据处理

2.1检查use_id有无重复值

In [10]:

```
df.user_id.nunique()
```

Out[10]:

```
6427
```

- 无重复值

2.2数据类型转换以及提取新数据

2.2.1 starttime

In [11]:

```
#因为有timeduration，所以只用关注start_time
df["start_time"]=pd.to_datetime(df["start_time"])
```

In [12]:

```
df["start_time"].dt.year.unique()
```

Out[12]:

```
array([2018], dtype=int64)
```

- 表明全部是2018年的数据

In [13]:

```
df["start_time"].dt.month.unique()
```

Out[13]:

```
array([11, 12, 10], dtype=int64)
```

- 表明只有第四季度的数据
- 故选择提取星期和小时作为新数据

In [14]:

```
df["dayofweek"]=df["start_time"].dt.dayofweek
df["hour"]=df["start_time"].dt.hour
```

2.2.2 timeduration

In [15]:

```
df["timeduration"].describe()
```

Out[15]:

```
count    6427.000000
mean       11.778902
std         9.692236
min         0.000000
```

```
25%           5.000000
50%           9.000000
75%          15.000000
max          59.000000
Name: timeduration, dtype: float64
```

In [16]:

```
#查看异常数据
df[df["timeduration"]<1]
```

Out[16]:

	user_id	start_time	end_time	timeduration	bikeid	tripduration	from_station_id	from_
109113	21109759	2018-10-09 11:29:00	10/9/2018 12:29	0	4875	3616	225	
72232	21067313	2018-10-06 10:15:00	10/6/2018 11:15	0	4733	3606	419	L
69595	21064115	2018-10-05 18:27:00	10/5/2018 19:28	0	2064	3650	50	Clark
302629	21336986	2018-10-27 15:33:00	10/27/2018 16:34	0	5051	3634	3	Sh
592619	21681993	2018-12-17 09:17:00	12/17/2018 10:18	0	4316	3652	99	La

- 0实际上表明骑行了1小时

In [17]:

```
df["timeduration"]=df["timeduration"].replace(0,60).astype(int)
```

In [18]:

```
df["timeduration"].describe()
```

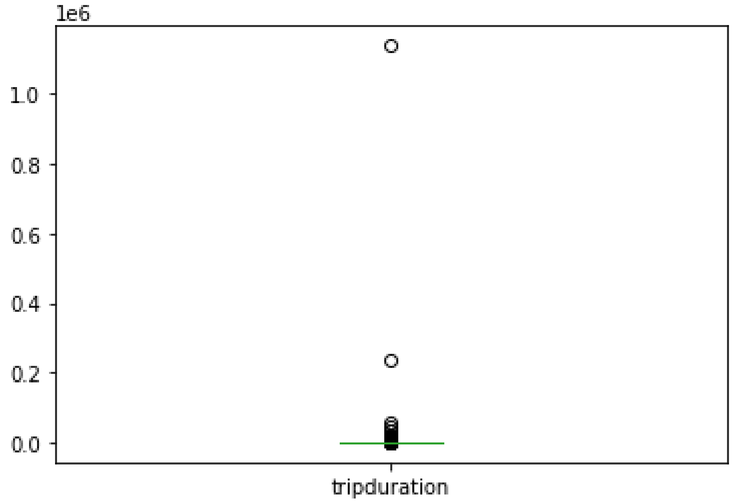
Out[18]:

```
count     6427.000000
mean        11.825580
std          9.779498
min          1.000000
25%          5.000000
50%          9.000000
75%         15.000000
max         60.000000
Name: timeduration, dtype: float64
```

2.2.3 tripduration

In [19]:

```
df["tripduration"].plot(kind="box");
```



·存在异常值，需要处理

In [20]:
```
df["tripduration"].describe()
```

Out[20]:
```
count    6.427000e+03
mean     1.060471e+03
std      1.456811e+04
min      6.100000e+01
25%      3.490000e+02
50%      5.590000e+02
75%      9.320000e+02
max      1.139070e+06
Name: tripduration, dtype: float64
```

In [21]:
```
df["tripduration"].quantile(0.25)
```

Out[21]:
```
349.0
```

In [22]:
```
IQR=df["tripduration"].quantile(0.75)-df["tripduration"].quantile(0.25)
Max=df["tripduration"].quantile(0.75)+1.5*IQR
Max
```

Out[22]:
```
1806.5
```

In [23]:
```
df=df[df["tripduration"]<=Max]
```

2.2.4 station相关

In [24]:
```
#将id从int更改为字符型
df["from_station_id"]=df["from_station_id"].astype(str)
df["to_station_id"]=df["to_station_id"].astype(str)
```

2.2.5 usertype

In [25]:
```
df.usertype.unique()
```

Out[25]:
```
array(['Subscriber', 'Customer'], dtype=object)
```

2.2.6 age

In [26]:

```
df.age.unique()
```

Out[26]:

```
array(['37', '31', '30', '40', '25', '48', ' ', '28', '27', '34', '33',
       '26', '20', '23', '22', '54', '52', '57', '29', '39', '51', '55',
       '32', '49', '58', '42', '61', '35', '41', '63', '50', '38', '36',
       '43', '44', '19', '59', '45', '46', '56', '21', '24', '47', '66',
       '64', '62', '77', '69', '60', '68', '70', '53', '113', '73', '18',
       '67', '65', '71', '79', '17', '74', '72', '101'], dtype=object)
```

In [27]:

```
df[df["age"]==" "]
```

Out[27]:

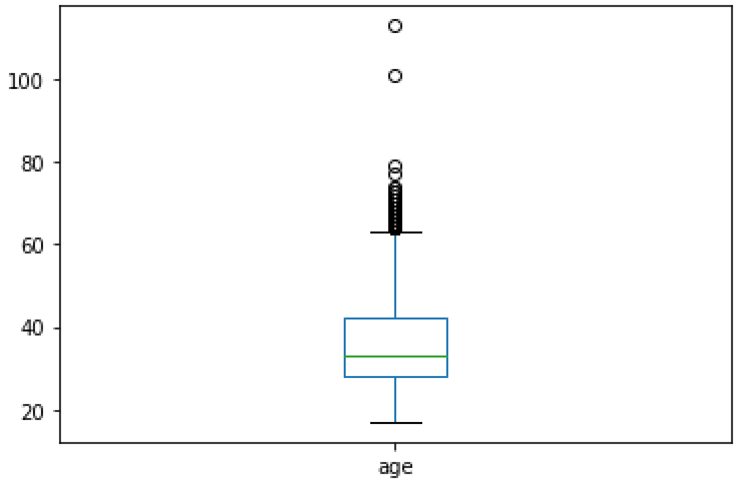
	user_id	start_time	end_time	timeduration	bikeid	tripduration	from_station_id	from_
371796	21417733	2018-11-03 16:32:00	11/3/2018 16:54	22	983	1347	31	
92242	21090205	2018-10-08 12:10:00	10/8/2018 12:18	7	1582	453	341	Ad
331956	21371191	2018-10-30 18:42:00	10/30/2018 18:59	17	6267	1056	128	
208326	21225619	2018-10-18 10:52:00	10/18/2018 11:17	24	4129	1465	97	
46950	21037586	2018-10-04 00:41:00	10/4/2018 0:57	15	5393	956	31	
...	...	...	...	...	...	...	...	
205299	21221955	2018-10-18 07:14:00	10/18/2018 7:31	17	6188	1063	176	Cl
6782	20991669	2018-10-01 14:59:00	10/1/2018 15:17	18	2566	1093	3	Sh
306859	21341969	2018-10-28 12:24:00	10/28/2018 12:45	20	718	1255	284	N
484317	21553590	2018-11-22 15:38:00	11/22/2018 15:59	20	762	1246	76	La
244515	21268874	2018-10-22 14:16:00	10/22/2018 14:40	24	2591	1458	90	N

292 rows × 16 columns

- age为空值是birthyear也是空值
- 无法用birthyear补充age的空值

In [28]:

```
#观察age的异常值，为后续处理作准备
df[df["age"]!=" "]["age"].astype(int).plot(kind="box");
```



- 有大量不合常理的异常值

In [29]:

```
#填充缺失值
age_median=int(df[df["age"]!=" "]["age"].astype(int).median())
age_median
```

Out[29]:

```
33
```

In [30]:

```
df["age"]=df.age.str.replace(" ",str(age_median)).astype(int)
```

In [31]:

```
df["age"].describe()
```

Out[31]:

```
count    5968.000000
mean       36.303619
std        10.851063
min        17.000000
25%        28.000000
50%        33.000000
75%        42.000000
max       113.000000
Name: age, dtype: float64
```

In [32]:

```
df["age"].quantile(0.25)
```

Out[32]:

```
28.0
```

In [33]:

```
IQR_age=df["age"].quantile(0.75)-df["age"].quantile(0.25)
Max_age=df["age"].quantile(0.75)+1.5*IQR_age
Max_age
```

Out[33]:

```
63.0
```

In [34]:

```
df=df[df["age"]<=63]
```

2.2.7 删除无关变量

In [35]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 5853 entries, 439283 to 278179
Data columns (total 16 columns):
 #   Column             Non-Null Count  Dtype
---  ------             --------------  -----
 0   user_id            5853 non-null   int64
 1   start_time         5853 non-null   datetime64[ns]
 2   end_time           5853 non-null   object
 3   timeduration       5853 non-null   int32
 4   bikeid             5853 non-null   int64
 5   tripduration       5853 non-null   int64
 6   from_station_id    5853 non-null   object
 7   from_station_name  5853 non-null   object
 8   to_station_id      5853 non-null   object
 9   to_station_name    5853 non-null   object
 10  usertype           5853 non-null   object
 11  gender             5548 non-null   object
 12  birthyear          5561 non-null   float64
 13  age                5853 non-null   int32
 14  dayofweek          5853 non-null   int64
 15  hour               5853 non-null   int64
dtypes: datetime64[ns](1), float64(1), int32(2), int64(5), object(7)
memory usage: 731.6+ KB
```

In [36]:

```
useless=["user_id","start_time","end_time","bikeid","from_station_name","to_station_name","b
df=df.drop(useless,axis=1)
```

2.3 处理后数据查看

In [37]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 5853 entries, 439283 to 278179
Data columns (total 9 columns):
 #   Column            Non-Null Count  Dtype
---  ------            --------------  -----
 0   timeduration      5853 non-null   int32
 1   tripduration      5853 non-null   int64
 2   from_station_id   5853 non-null   object
 3   to_station_id     5853 non-null   object
 4   usertype          5853 non-null   object
 5   gender            5548 non-null   object
 6   age               5853 non-null   int32
 7   dayofweek         5853 non-null   int64
 8   hour              5853 non-null   int64
dtypes: int32(2), int64(3), object(4)
memory usage: 411.5+ KB
```

In [38]:

```
df.describe()
```

Out[38]:

	timeduration	tripduration	age	dayofweek	hour
count	5853.000000	5853.000000	5853.000000	5853.000000	5853.000000
mean	9.934393	625.527593	35.683752	2.513070	13.261746
std	6.339840	380.226556	9.970922	1.832262	4.749735
min	1.000000	61.000000	17.000000	0.000000	0.000000
25%	5.000000	336.000000	28.000000	1.000000	9.000000

	timeduration	tripduration	age	dayofweek	hour
50%	8.000000	521.000000	33.000000	2.000000	14.000000
75%	13.000000	828.000000	41.000000	4.000000	17.000000
max	30.000000	1805.000000	63.000000	6.000000	23.000000

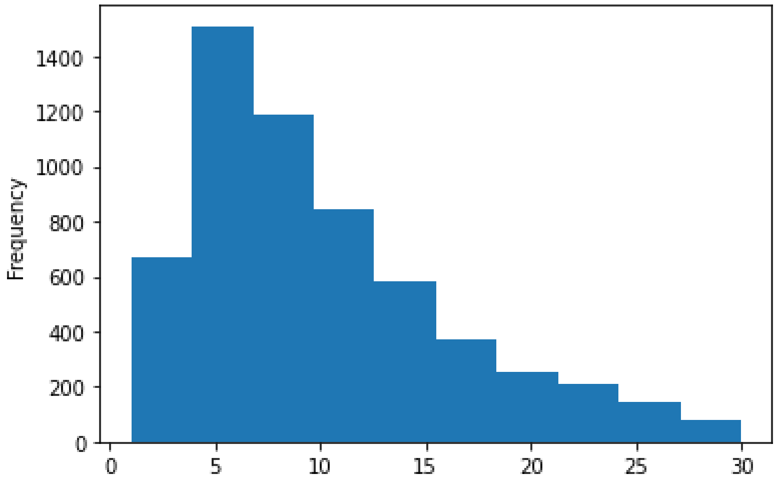
3.单变量分析

3.1 数值变量

3.1.1 timeduration

In [39]:

```
df["timeduration"].plot(kind="hist");
```

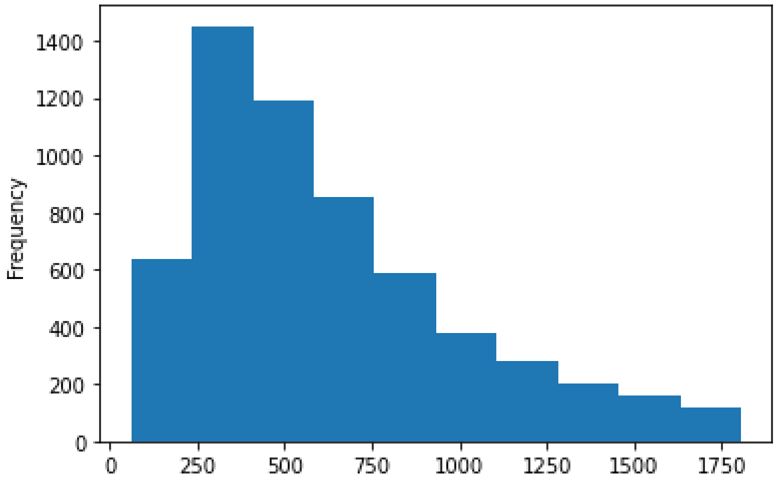


- 数据主要集中分布在0~15分钟

3.1.2 tripduration

In [40]:

```
df["tripduration"].plot(kind="hist");
```

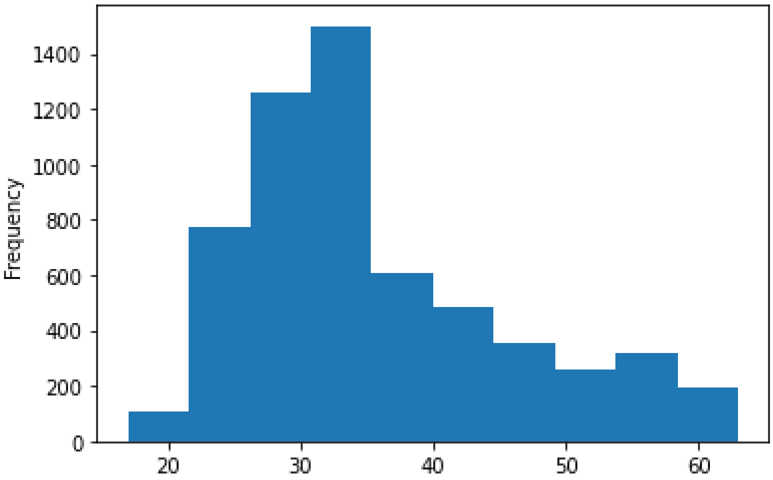


- 数据集中分布在1000以内，符合“最后一公里”的目标

3.1.3 age

In [41]:

```
df["age"].plot(kind="hist");
```



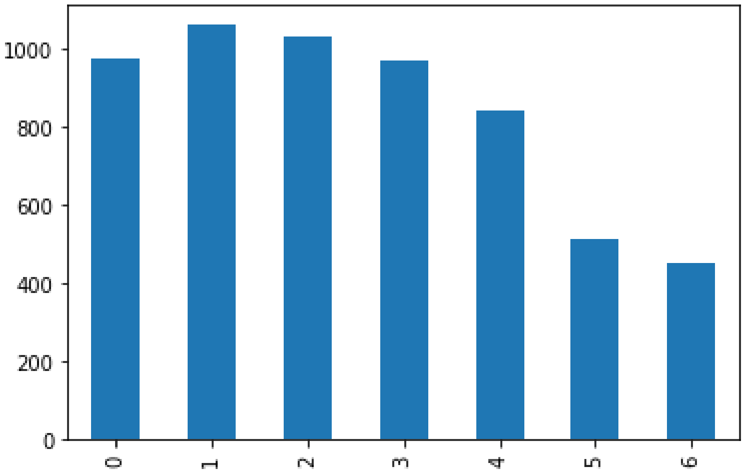
- 主要为25~40岁的人

3.2 分类变量

3.2.1 dayofweek

In [42]:

```
df["dayofweek"].value_counts().sort_index().plot(kind="bar");
```

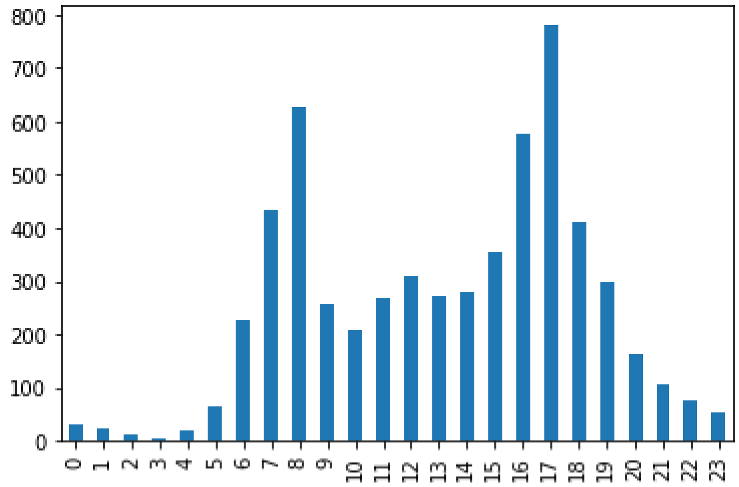


- 主要在工作日骑行

3.2.2 hour

In [43]:

```
df["hour"].value_counts().sort_index().plot(kind="bar");
```

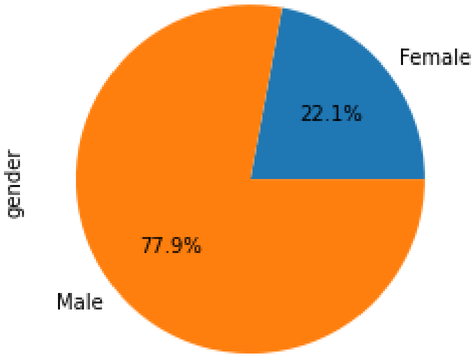


- 骑行时间主要在上班和下班时间达到高峰

3.2.3 gender

In [44]:

```
df["gender"].value_counts().sort_index().plot(kind="pie",autopct="%1.1f%%");
```

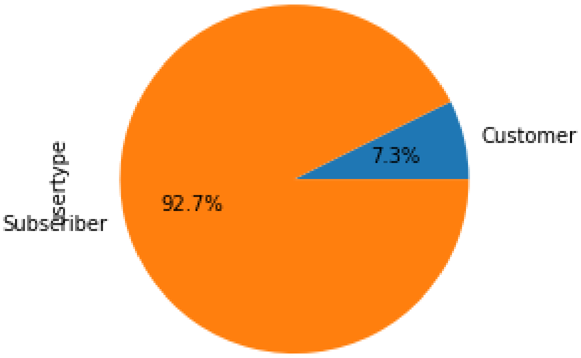


- 男性客户占超过4/3

3.2.4 usertype

In [45]:

```
df["usertype"].value_counts().sort_index().plot(kind="pie",autopct="%1.1f%%");
```



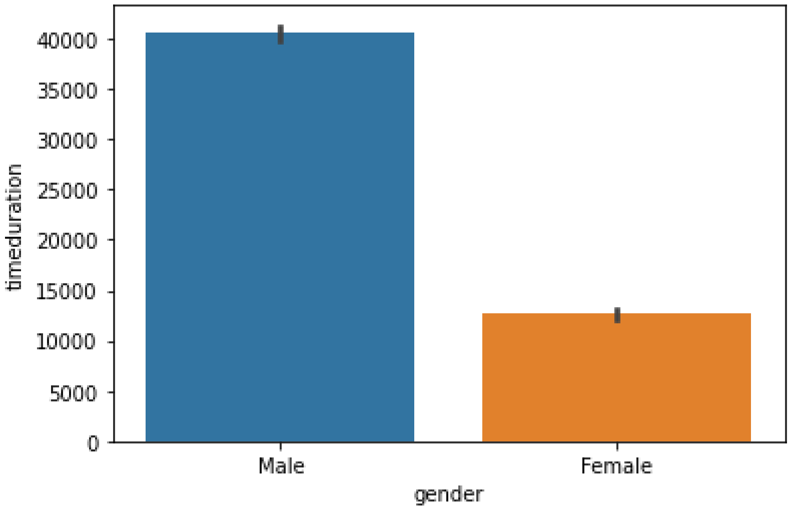
- 办理单车卡的用户占绝大多数

4. 多变量

4.1 将数值变量分类

In [46]:

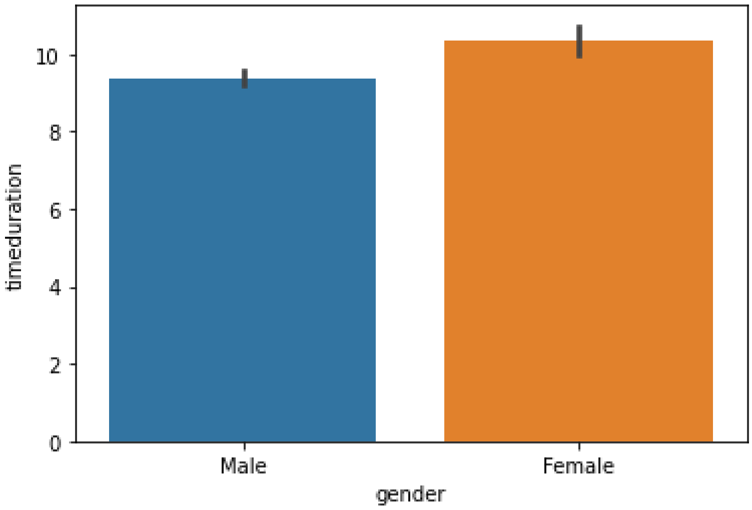
```
sns.barplot(x="gender",y="timeduration",data=df,estimator=sum);
```



- 男性总骑行时长高于女性

In [47]:

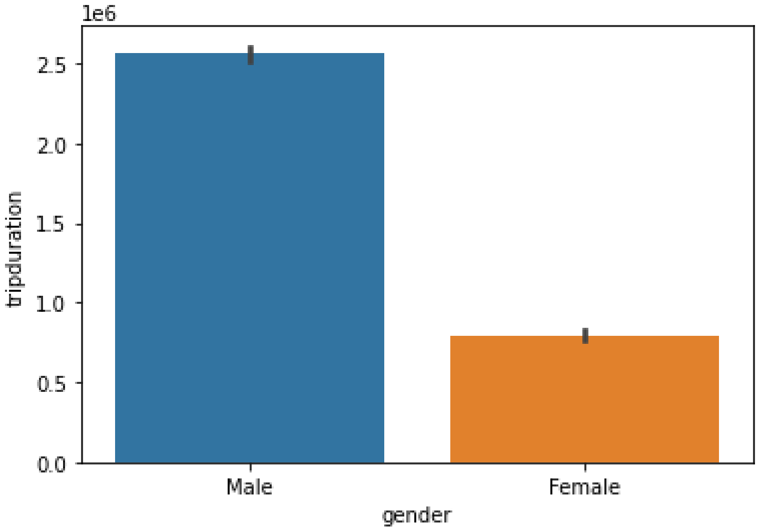
```
sns.barplot(x="gender",y="timeduration",data=df);
```



- 但女性平均骑行时长高于男性

In [48]:

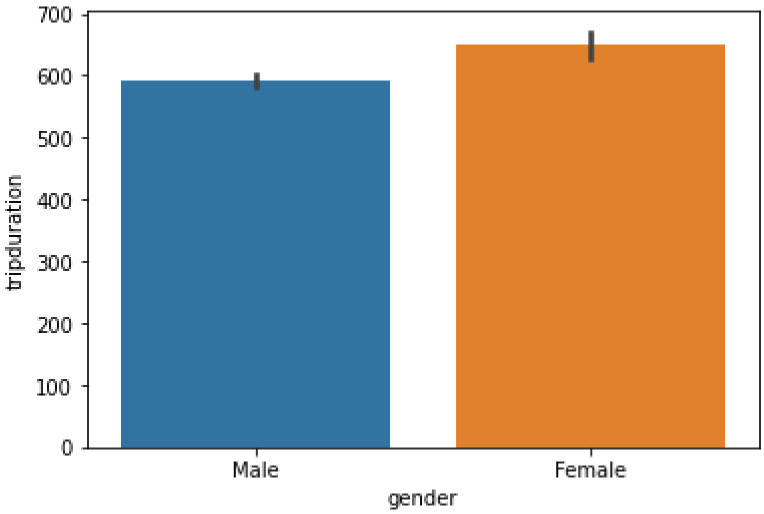
```
sns.barplot(x="gender",y="tripduration",data=df,estimator=sum);
```



- 男性的总骑行里程高于女性

In [49]:

```
sns.barplot(x="gender",y="tripduration",data=df);
```



- 但女性的平均骑行里程也高于男性

4.2 将分类变量分类

In [50]:

```
tmp=pd.DataFrame(df.groupby(["dayofweek","gender"])["hour"].count()).reset_index()
tmp
```

Out[50]:

	dayofweek	gender	hour
0	0	Female	206
1	0	Male	720
2	1	Female	245
3	1	Male	786
4	2	Female	201
5	2	Male	799
6	3	Female	191

	dayofweek	gender	hour
7	3	Male	738
8	4	Female	150
9	4	Male	665
10	5	Female	129
11	5	Male	330
12	6	Female	102
13	6	Male	286

In [51]:

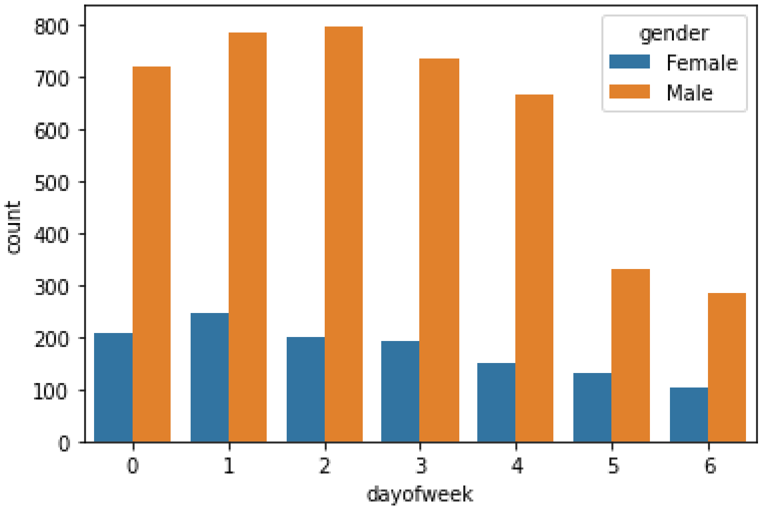
```
tmp=tmp.rename(columns={'hour':'count'})
tmp
```

Out[51]:

	dayofweek	gender	count
0	0	Female	206
1	0	Male	720
2	1	Female	245
3	1	Male	786
4	2	Female	201
5	2	Male	799
6	3	Female	191
7	3	Male	738
8	4	Female	150
9	4	Male	665
10	5	Female	129
11	5	Male	330
12	6	Female	102
13	6	Male	286

In [52]:

```
sns.barplot(x="dayofweek",y="count",hue="gender",data=tmp);
```



- 男女在一周内骑行的趋势是统一的，工作日多而周末少

In [53]:

```
tmp=pd.DataFrame(df.groupby(["dayofweek","usertype"])["hour"].count()).reset_index()
tmp
```

Out[53]:

	dayofweek	usertype	hour
0	0	Customer	69
1	0	Subscriber	906
2	1	Customer	46
3	1	Subscriber	1016
4	2	Customer	47
5	2	Subscriber	986
6	3	Customer	56
7	3	Subscriber	916
8	4	Customer	49
9	4	Subscriber	793
10	5	Customer	78
11	5	Subscriber	439
12	6	Customer	85
13	6	Subscriber	367

In [54]:

```
tmp=tmp.rename(columns={'hour':'count'})
tmp
```

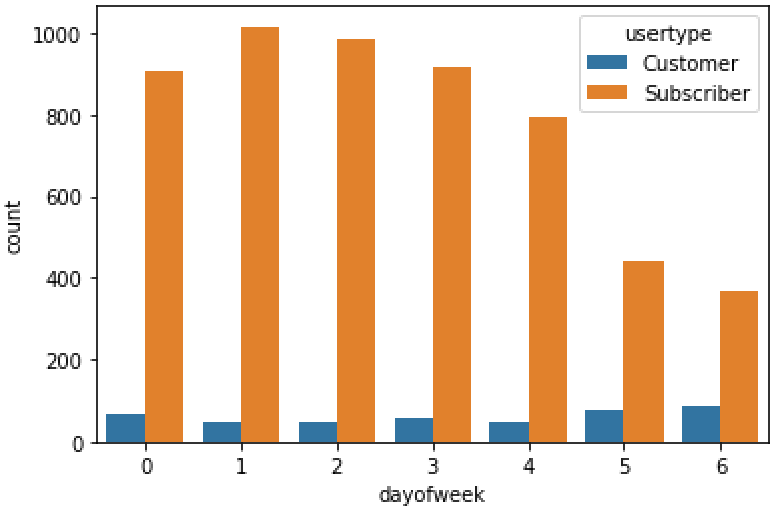
Out[54]:

	dayofweek	usertype	count
0	0	Customer	69
1	0	Subscriber	906
2	1	Customer	46
3	1	Subscriber	1016

	dayofweek	usertype	count
4	2	Customer	47
5	2	Subscriber	986
6	3	Customer	56
7	3	Subscriber	916
8	4	Customer	49
9	4	Subscriber	793
10	5	Customer	78
11	5	Subscriber	439
12	6	Customer	85
13	6	Subscriber	367

In [55]:

```
sns.barplot(x="dayofweek",y="count",hue="usertype",data=tmp);
```



- 购买单车卡的用户在在工作日骑行多而周末少
- 没有购买单车卡的用户在一周七天内骑行时间没有明显区别

5.建模

5.1 gender和usertype数据处理

In [56]:

```
df1=df.drop(["from_station_id","to_station_id"],axis=1)
df1.head()
```

Out[56]:

	timeduration	tripduration	usertype	gender	age	dayofweek	hour
439283	7	436	Subscriber	Male	37	2	7
603317	7	445	Subscriber	Male	31	1	19
109957	18	1090	Customer	Male	30	1	12
428082	9	581	Subscriber	Female	30	0	12

	timeduration	tripduration	usertype	gender	age	dayofweek	hour
395437	6	390	Subscriber	Male	40	2	7

In [57]:

```
df1=pd.get_dummies(df1,drop_first=True)
df1.head()
```

Out[57]:

	timeduration	tripduration	age	dayofweek	hour	usertype_Subscriber	gender_Male
439283	7	436	37	2	7	1	1
603317	7	445	31	1	19	1	1
109957	18	1090	30	1	12	0	1
428082	9	581	30	0	12	1	0
395437	6	390	40	2	7	1	1

5.2 聚类分析

5.2.1 建立模型

In [58]:

```
from sklearn.preprocessing import scale
from sklearn.cluster import KMeans as kms
from sklearn.metrics import silhouette_score
```

In [59]:

```
x=df1[["timeduration","tripduration","age","dayofweek","hour","usertype_Subscriber","gender_
kms_3=kms(n_clusters=3,random_state=10)
model_3=kms_3.fit(x)
```

In [60]:

```
df1["cluster"]=model_3.labels_
df1.head()
```

Out[60]:

	timeduration	tripduration	age	dayofweek	hour	usertype_Subscriber	gender_Male	clust
439283	7	436	37	2	7	1	1	
603317	7	445	31	1	19	1	1	
109957	18	1090	30	1	12	0	1	
428082	9	581	30	0	12	1	0	
395437	6	390	40	2	7	1	1	

5.2.2 用轮廓系数评估

In [61]:

```
pre_3=model_3.predict(x)
score_3=silhouette_score(x,pre_3)
print(score_3)
```

```
0.5927291085417886
```

5.2.3 优化

In [62]:

```
kms_4=kms(n_clusters=4,random_state=10)
model_4=kms_4.fit(x)
```

In [63]:

```
pre_4=model_4.predict(x)
score_4=silhouette_score(x,pre_4)
print(score_4)
```

```
0.5544459748009721
```

In [64]:

```
kms_5=kms(n_clusters=5,random_state=10)
model_5=kms_5.fit(x)
```

In [65]:

```
pre_5=model_5.predict(x)
score_5=silhouette_score(x,pre_5)
print(score_5)
```

```
0.5338770991550901
```

- 分成3组是得分最高的

5.2.4 查看分群效果

In [66]:

```
df1.groupby(['cluster'])['age'].describe()
```

Out[66]:

	count	mean	std	min	25%	50%	75%	max
cluster								
0	831.0	35.854392	9.359705	18.0	30.0	33.0	40.0	63.0
1	3145.0	35.409857	10.052038	17.0	28.0	33.0	41.0	63.0
2	1877.0	36.067128	10.086871	17.0	29.0	33.0	41.0	63.0

- 对年龄没有很好的分群效果

In [67]:

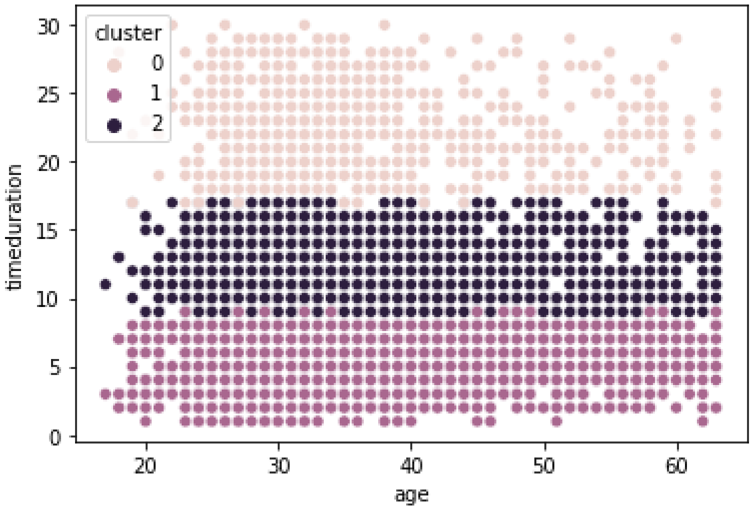
```
df1.groupby(['cluster'])['timeduration'].describe()
```

Out[67]:

	count	mean	std	min	25%	50%	75%	max
cluster								
0	831.0	22.216606	3.403579	17.0	19.0	22.0	25.0	30.0
1	3145.0	5.296979	1.963456	1.0	4.0	5.0	7.0	9.0
2	1877.0	12.266915	2.339892	9.0	10.0	12.0	14.0	17.0

In [68]:

```
sns.scatterplot(x="age",y="timeduration",hue="cluster",data=df1);
```



- 对timeduration分群效果不错

In [69]:

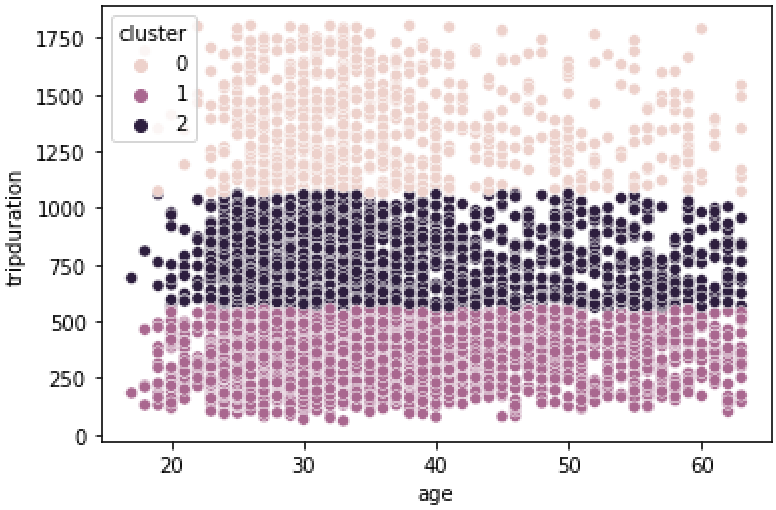
```
df1.groupby(['cluster'])['tripduration'].describe()
```

Out[69]:

cluster	count	mean	std	min	25%	50%	75%	max
0	831.0	1362.537906	203.515491	1064.0	1190.0	1328.0	1517.0	1805.0
1	3145.0	346.956439	116.665077	61.0	252.0	348.0	442.0	556.0
2	1877.0	765.991476	139.274957	557.0	644.0	748.0	877.0	1063.0

In [70]:

```
sns.scatterplot(x="age",y="tripduration",hue="cluster",data=df1);
```



- 对tripduration分群效果不错

In [71]:

```
df1.groupby(['cluster'])['dayofweek'].describe()
```

Out[71]:

cluster	count	mean	std	min	25%	50%	75%	max
0	831.0	2.651023	1.984517	0.0	1.0	2.0	4.0	6.0

	count	mean	std	min	25%	50%	75%	max
cluster								
1	3145.0	2.478537	1.786007	0.0	1.0	2.0	4.0	6.0
2	1877.0	2.509856	1.836764	0.0	1.0	2.0	4.0	6.0

- 对dayofweek分群效果不佳

In [72]:

```
df1.groupby(['cluster'])['hour'].describe()
```

Out[72]:

	count	mean	std	min	25%	50%	75%	max
cluster								
0	831.0	13.771360	4.514042	0.0	11.0	15.0	17.0	23.0
1	3145.0	13.120191	4.837452	0.0	8.0	14.0	17.0	23.0
2	1877.0	13.273308	4.689552	0.0	8.0	14.0	17.0	23.0

- 对hour分群效果不佳

6.业务解读

- 超过95%的用户办理了单车卡
- 用户的主要使用时间在工作日，但没有购买单车卡的用户在周末与工作日的骑行时间没有明显差别
- 男性用户多于女性用户，超过4/3 的男性用户
- 男性总骑行时间和里程高于女性，但平均值小于女性

- 分为3组时效果最佳
- 仅对timeduration和tripduration两个连续型变量有较好的分群效果
- 对其余变量分群效果均不佳
- timeduration被分为1~9,9~17,17~30三组
- tripduration被分为61~556,557~1063,1064~1805