In [228…
```
%%html

<h1>List of chapters in this book:<h1>
<h2>Chapter 9 - Plotting & Visualization</h2>
<h2>Chapter 10 - Data Aggregation and Group Operations</h2>
```

List of chapters in this book:

Chapter 9 - Plotting & Visualization

Chapter 10 - Data Aggregation and Group Operations

In [1]:
```
%%html
<h2>Chapter 9 - Plotting & Visualization</h2>
Code examples are taken from <a href="https://github.com/wesm/pydata-book/blob/3rd-edition/ch09.ipynb">https://gith
```

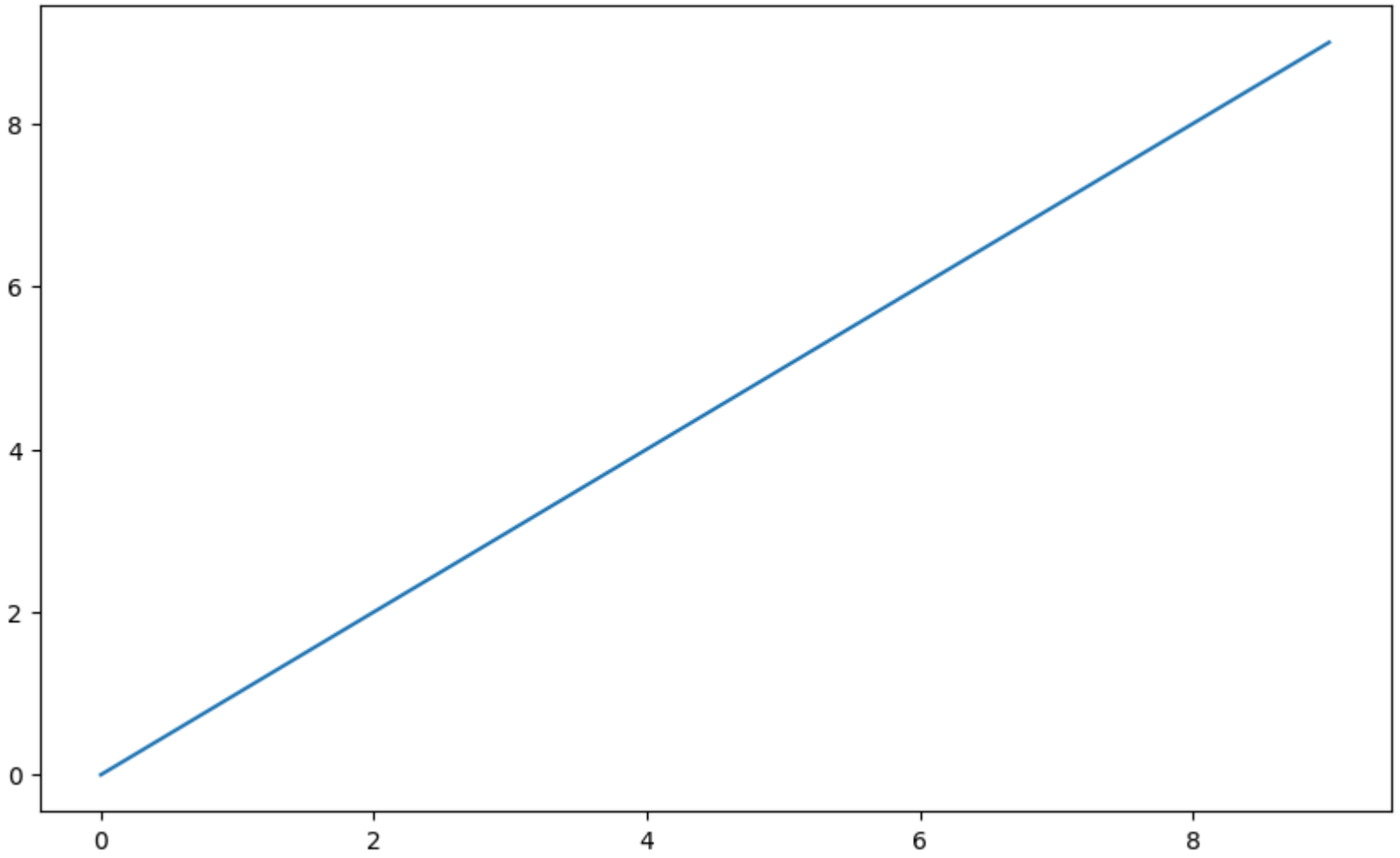
Chapter 9 - Plotting & Visualization

Code examples are taken from https://github.com/wesm/pydata-book/blob/3rd-edition/ch09.ipynb

In [17]:
```
import numpy as np
import pandas as pd
PREVIOUS_MAX_ROWS = pd.options.display.max_rows
pd.options.display.max_rows = 20
pd.options.display.max_colwidth = 80
pd.options.display.max_columns = 20
np.random.seed(12345)
import matplotlib.pyplot as plt
import matplotlib
plt.rc("figure", figsize=(10, 6))
np.set_printoptions(precision=4, suppress=True)
```

In [18]:
```
data = np.arange(10)
data
plt.plot(data)
```

Out[18]:
```
[<matplotlib.lines.Line2D at 0x7f15ecaac090>]
```

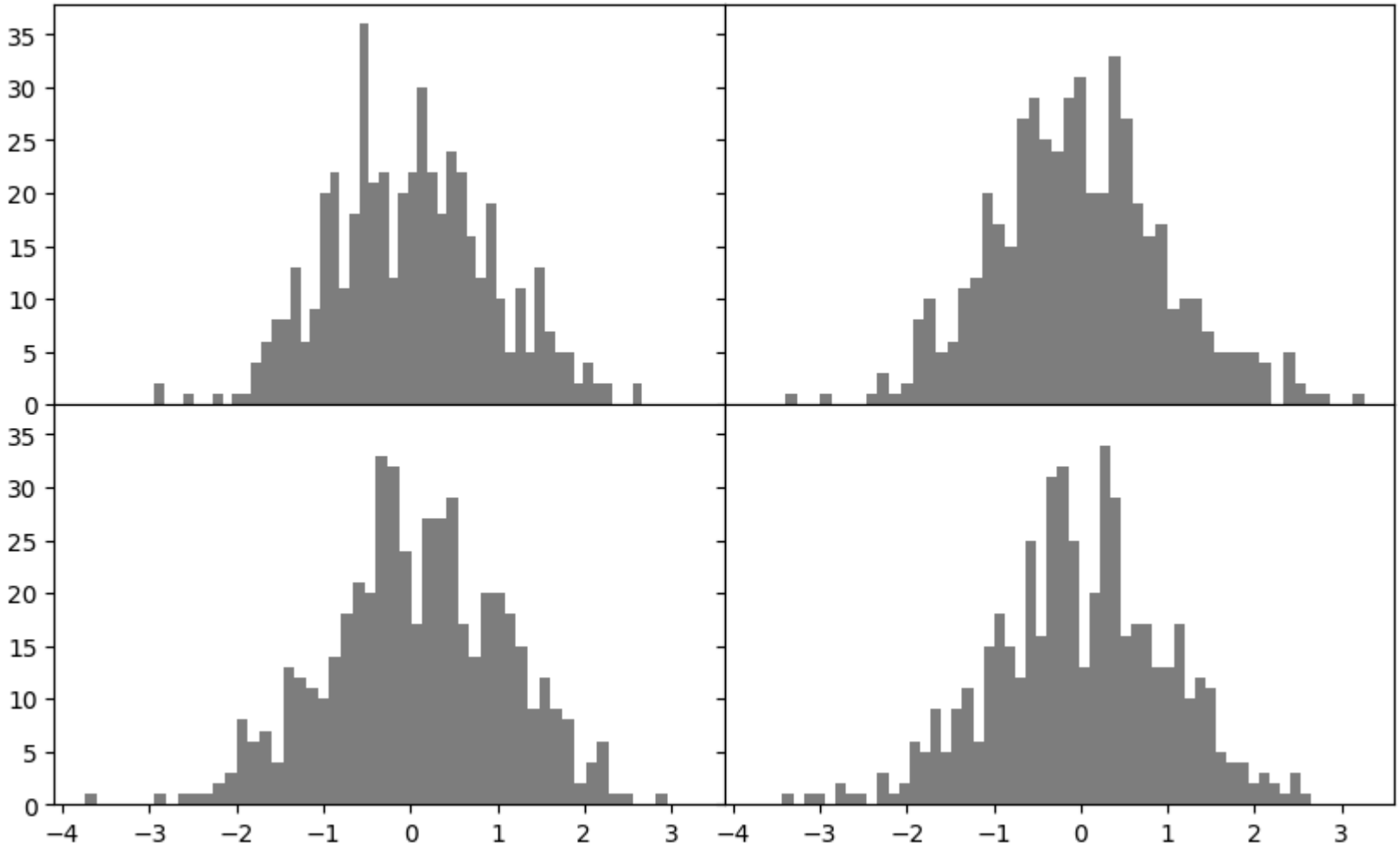


In [32]:
```
# Plot resides Figure object. Plot figure has a number of options, but notably figzie
```

In [20]:
```
# We can't make a plot with a blank figure. You have tot create one or more subplots
```

In [21]:
```
fig, axes = plt.subplots(2, 3)
axes
```

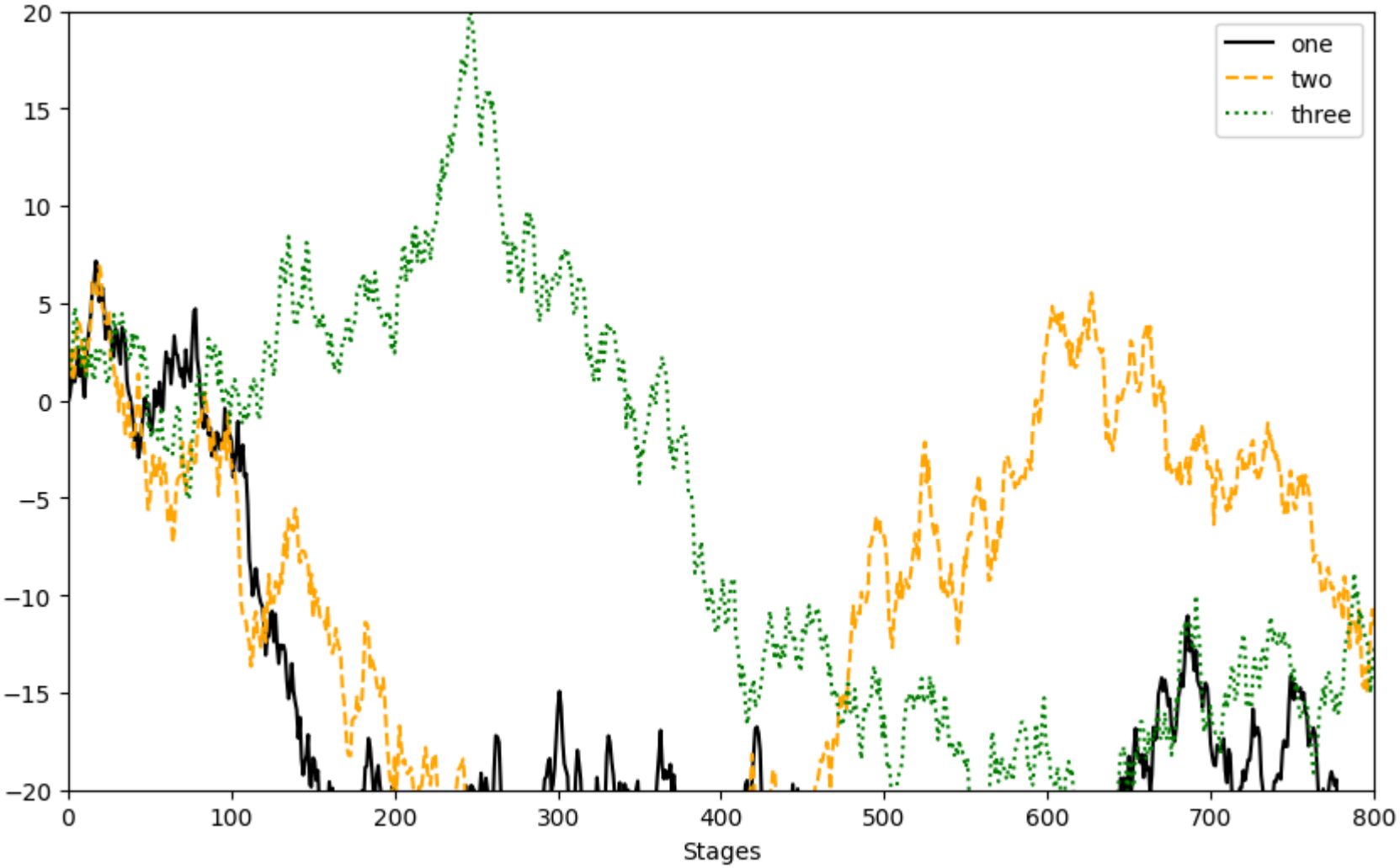
In [33]:
```
fig, axes = plt.subplots(2, 2, sharex=True, sharey=True)
for i in range(2):
    for j in range(2):
        axes[i, j].hist(np.random.standard_normal(500), bins=50,
                        color="black", alpha=0.5)
fig.subplots_adjust(wspace=0, hspace=0)
```



In [54]:
```
fig, ax = plt.subplots()
#ax.set_xticks([0, 250, 500, 750, 1000])
#ax.set_xticklabels(["one", "two", "three", "four", "five"], rotation=30, fontsize=8)
ax.plot(np.random.randn(1000).cumsum(), color="black", label="one");
ax.plot(np.random.randn(1000).cumsum(), color="orange", linestyle="dashed",
        label="two");
ax.plot(np.random.randn(1000).cumsum(), color="green", linestyle="dotted",
        label="three");
ax.set_xlabel("Stages")

#Legend
ax.legend()
ax.set_xlim(0, 800)
ax.set_ylim(-20, 20)
```

Out[54]:
```
(-20.0, 20.0)
```



In [55]:
```
# Saving plots to file
fig.savefig("figpath.svg")
```

In [56]:
```
%%html
<h3>matplotlib Configuration</h3>
```

matplotlib Configuration

In [58]:
```
plt.rc("figure", figsize=(10,10))
plt.rc("font", family="monospace", weight="bold", size=8)
```

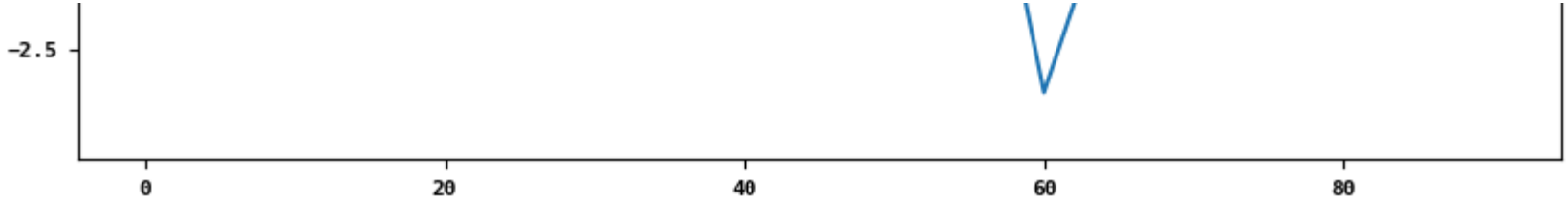
In [59]:
```
%%html
<h3>Plotting with pandas & seaborn</h3>
```

Plotting with pandas & seaborn

In [60]:
```
s = pd.Series(np.random.standard_normal(10).cumsum(), index=np.arange(0, 100, 10))
s.plot()
```

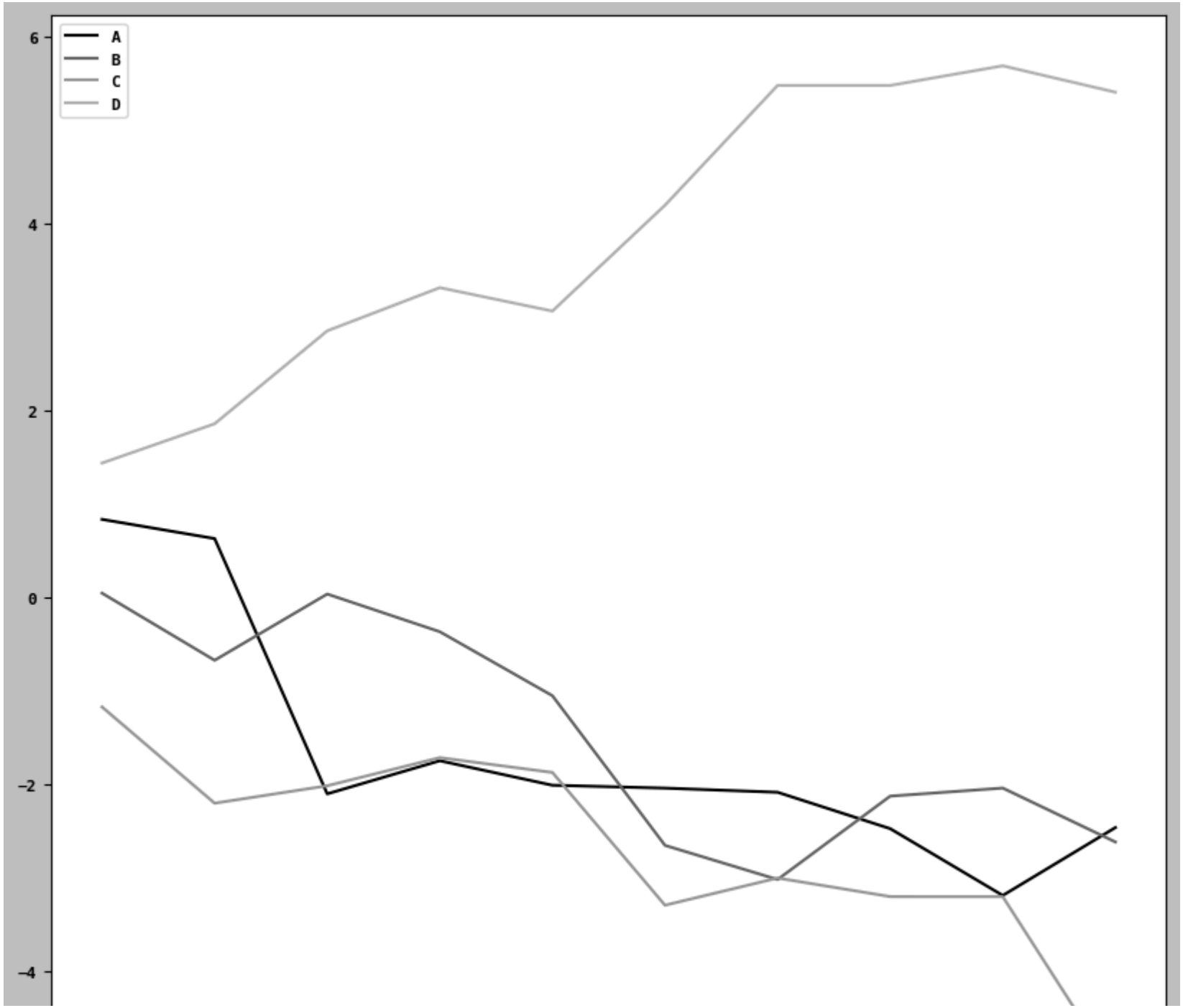
Out[60]:
```
<Axes: >
```

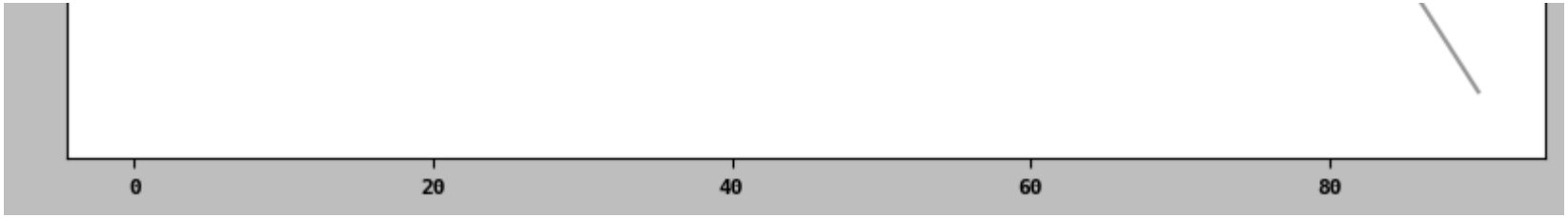

1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0



In [61]:
```
df = pd.DataFrame(np.random.standard_normal((10, 4)).cumsum(0),
                  columns=["A", "B", "C", "D"],
                  index=np.arange(0, 100, 10))
plt.style.use('grayscale')
df.plot()
```

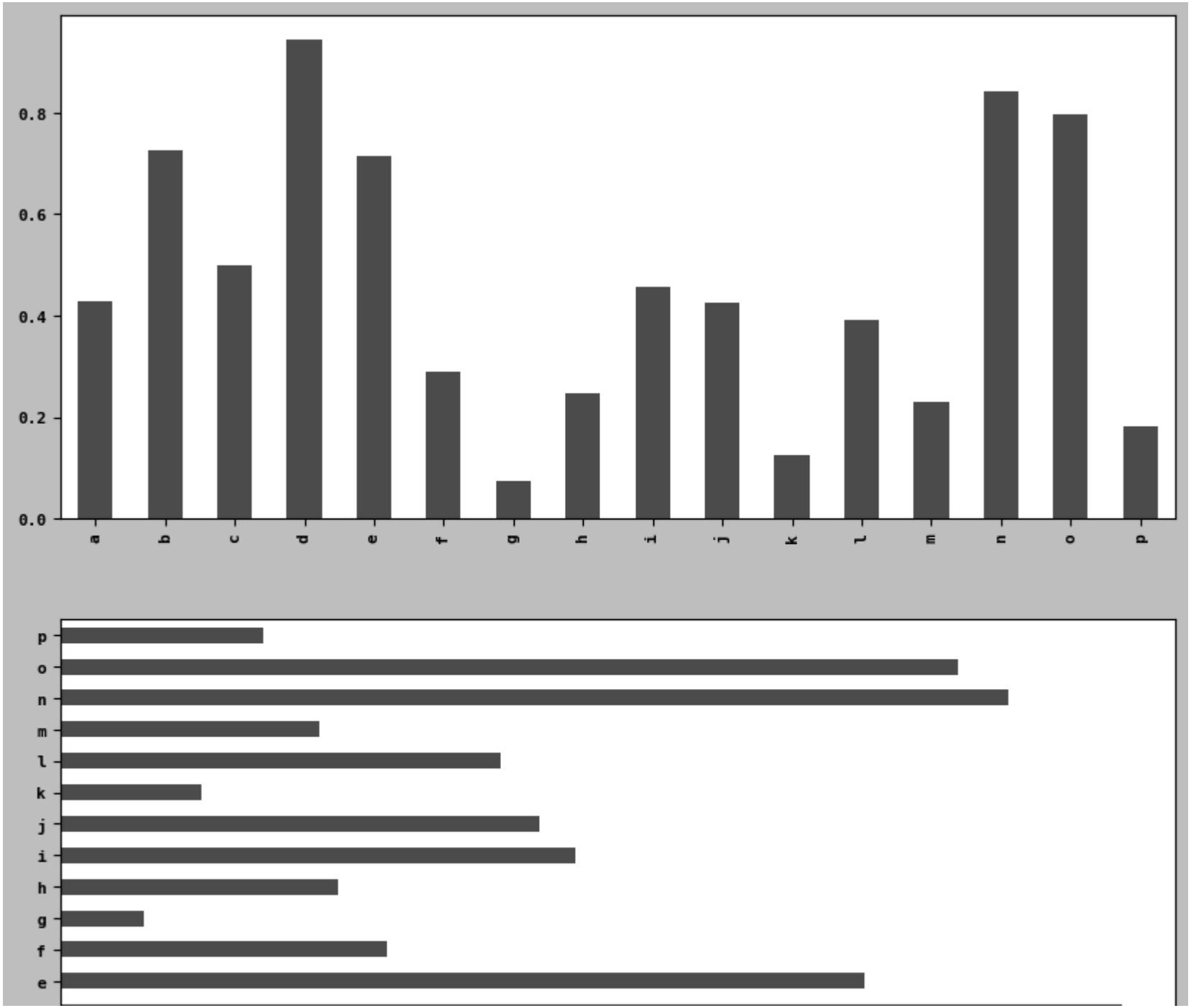
Out[61]: <Axes: >


A
B
C
D
6
4
2
0
−2
−4



In [63]:
```
fig, axes = plt.subplots(2, 1)
data = pd.Series(np.random.uniform(size=16), index=list("abcdefghijklmnop"))
data.plot.bar(ax=axes[0], color="black", alpha=0.7)
data.plot.barh(ax=axes[1], color="black", alpha=0.7)
```

Out[63]: <Axes: >


0.0
0.2
0.4
0.6
0.8
a
b
c
d
e
f
g
h
i
j
k
l
m
n
o
p
p
o
n
m
l
k
j
i
h
g
f
e

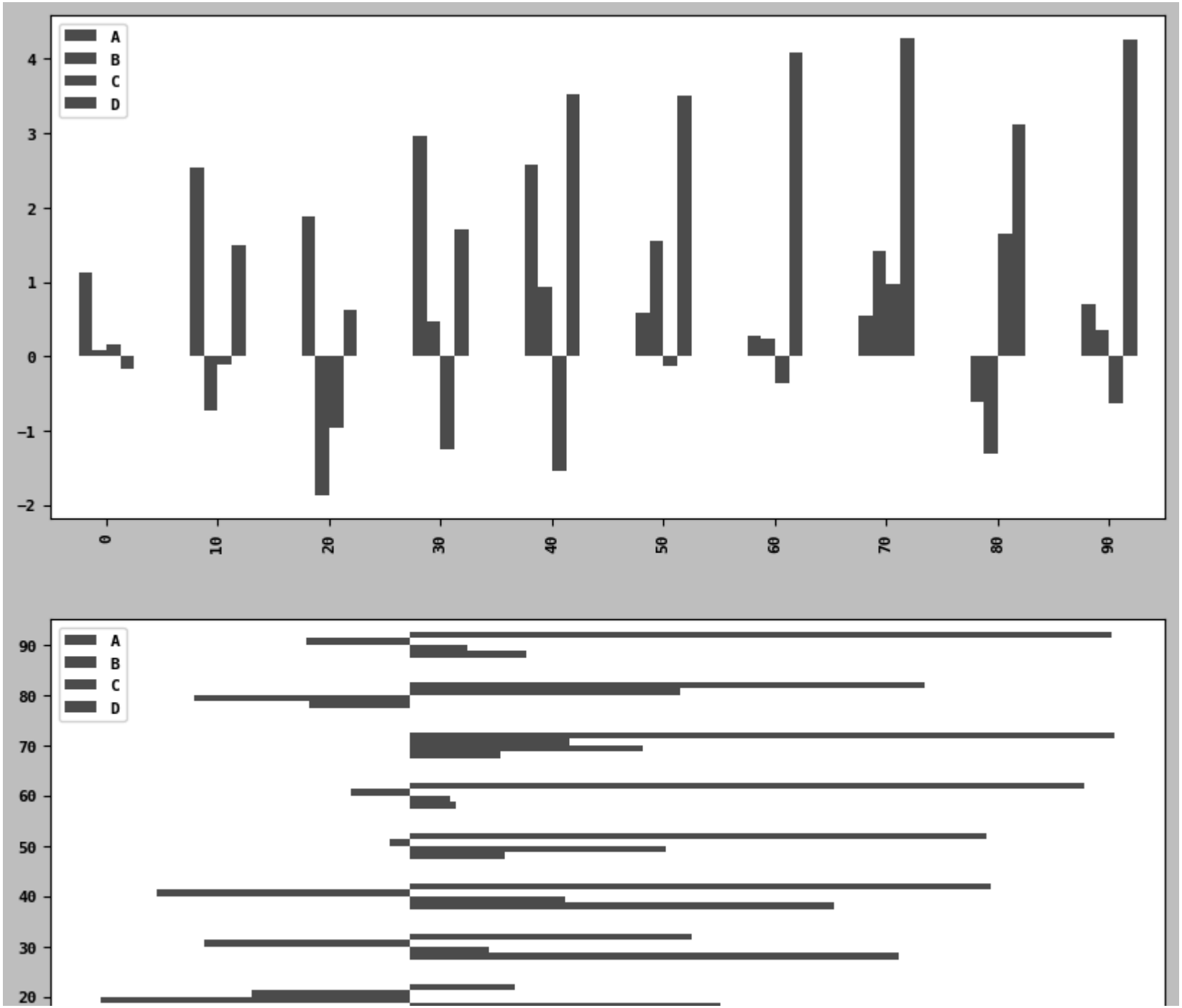
In [67]:
```
%%HTML
series.plot method arguments which can be applicable to df as well
<img src="images/series_plot.png" width= 400>
```

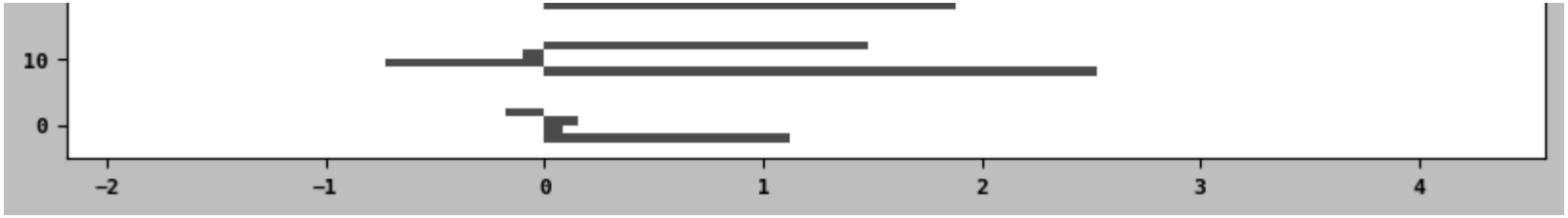
series.plot method arguments which can be applicable to df as well

No description has been provided for this image

In [66]:
```
fig, axes = plt.subplots(2, 1)
df = pd.DataFrame(np.random.standard_normal((10, 4)).cumsum(0),
                  columns=["A", "B", "C", "D"],
                  index=np.arange(0, 100, 10))
plt.style.use('grayscale')
df.plot.bar(ax=axes[0], color="black", alpha=0.7)
df.plot.barh(ax=axes[1], color="black", alpha=0.7)
```

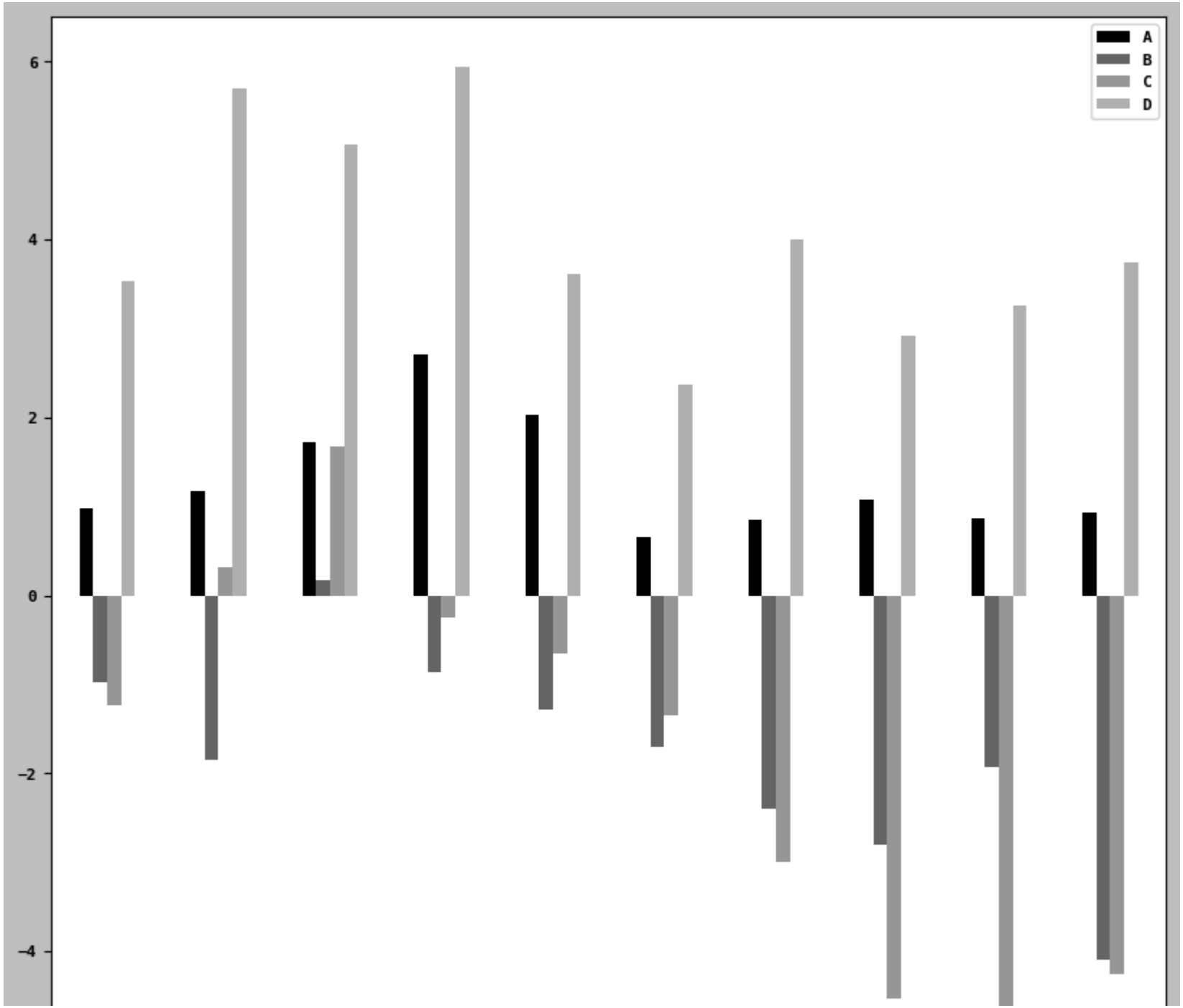
Out[66]: <Axes: >


A
B
C
D
4
3
2
1
0
−1
−2
0
10
20
30
40
50
60
70
80
90
A
B
C
D
90
80
70
60
50
40
30
20



In [68]:
```
df = pd.DataFrame(np.random.standard_normal((10, 4)).cumsum(0),
                  columns=["A", "B", "C", "D"],
                  index=np.arange(0, 100, 10))
plt.style.use('grayscale')
df.plot.bar()
```

Out[68]: <Axes: >


A
B
C
D
6
4
2
0
−2
−4

In [69]:
```
tips = pd.read_csv("examples/tips.csv")
tips.head()
```

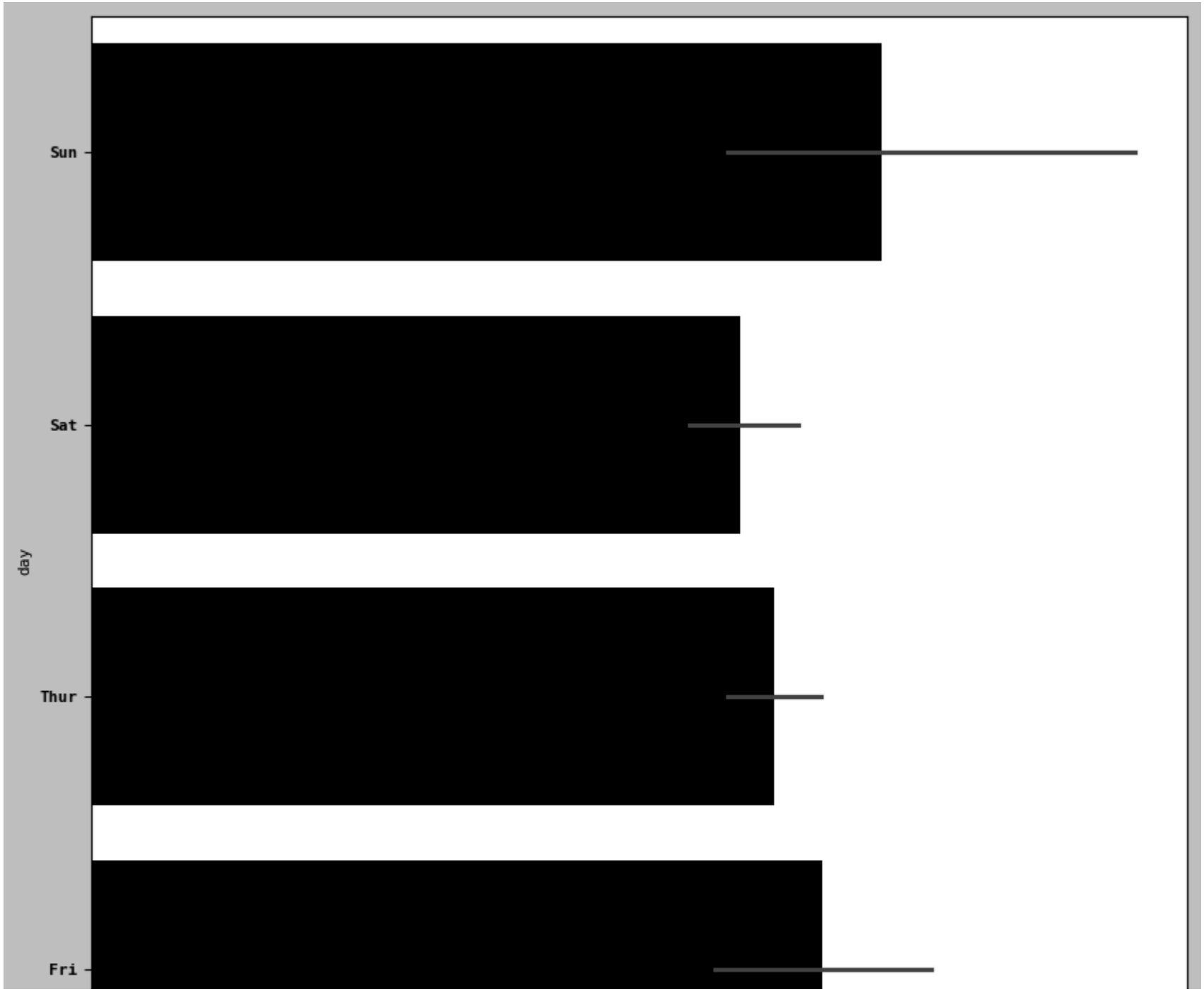
Out[69]:

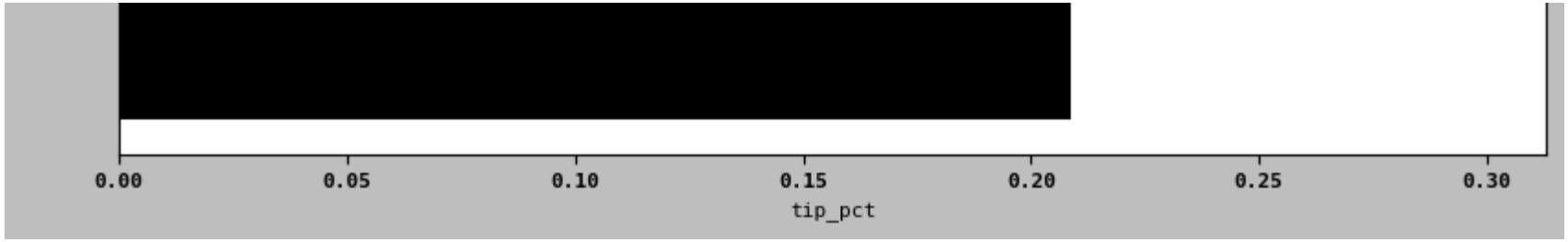
	total_bill	tip	smoker	day	time	size
0	16.99	1.01	No	Sun	Dinner	2
1	10.34	1.66	No	Sun	Dinner	3
2	21.01	3.50	No	Sun	Dinner	3
3	23.68	3.31	No	Sun	Dinner	2
4	24.59	3.61	No	Sun	Dinner	4

In [72]:
```
import seaborn as sns

tips["tip_pct"] = tips["tip"] / (tips["total_bill"] - tips["tip"])
tips.head()
sns.barplot(x="tip_pct", y="day", data=tips, orient="h")
```

Out[72]:
```
<Axes: xlabel='tip_pct', ylabel='day'>
```

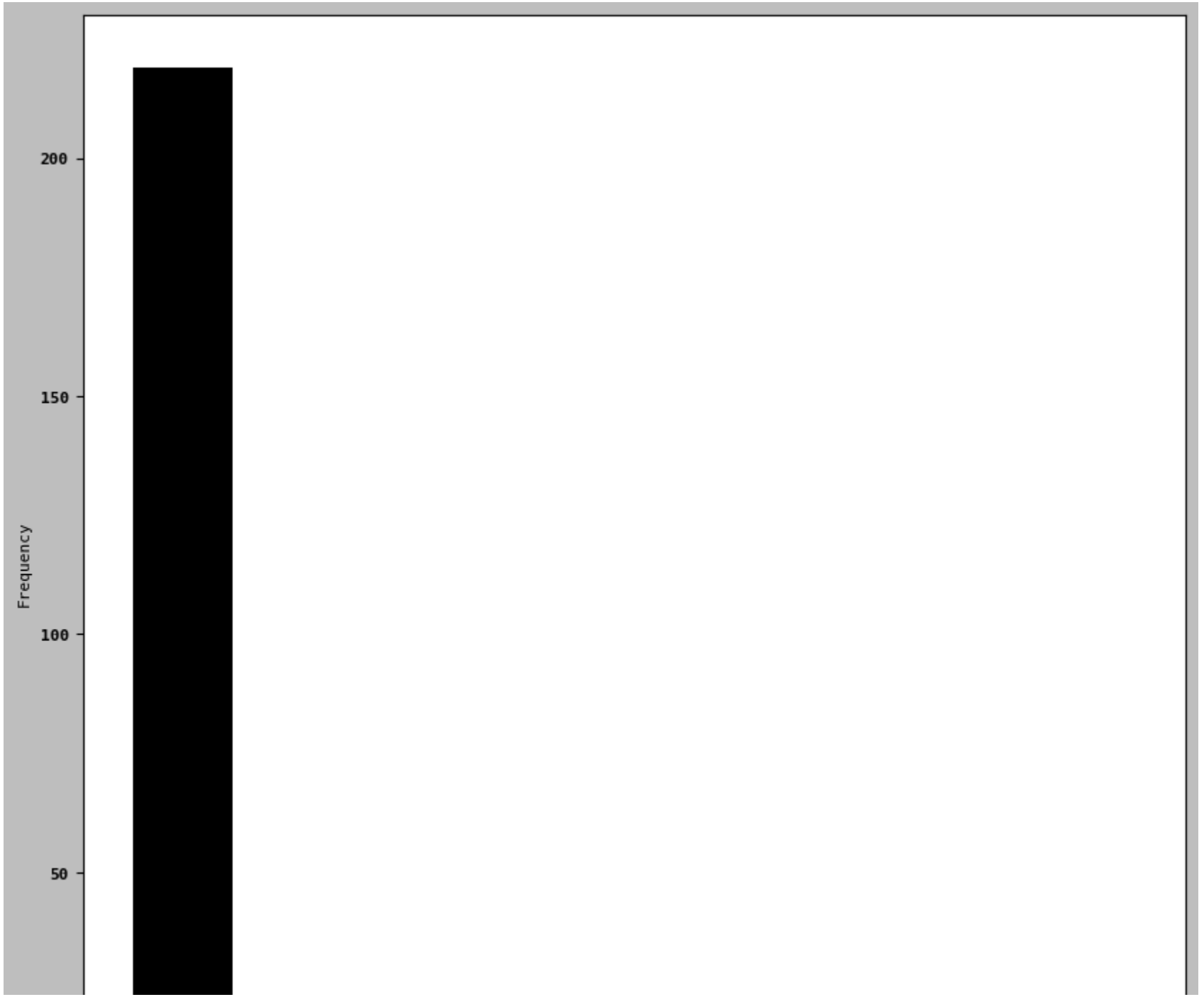

Sun
Sat
Thur
Fri
day

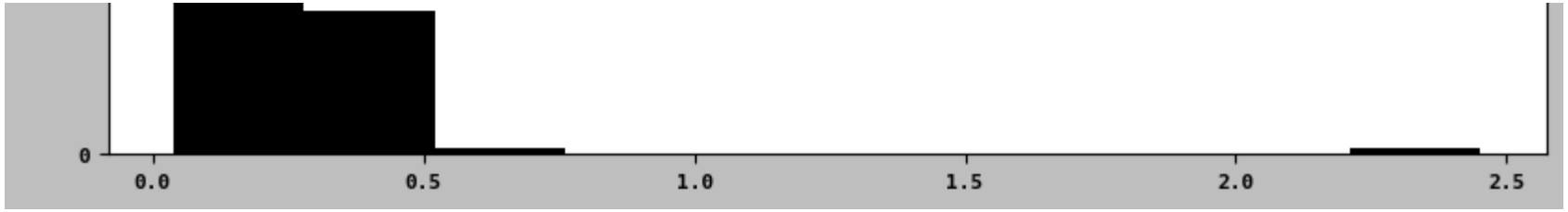


In [73]:
```
plt.close("all")
```

In [74]:
```
tips["tip_pct"].plot.hist()
```

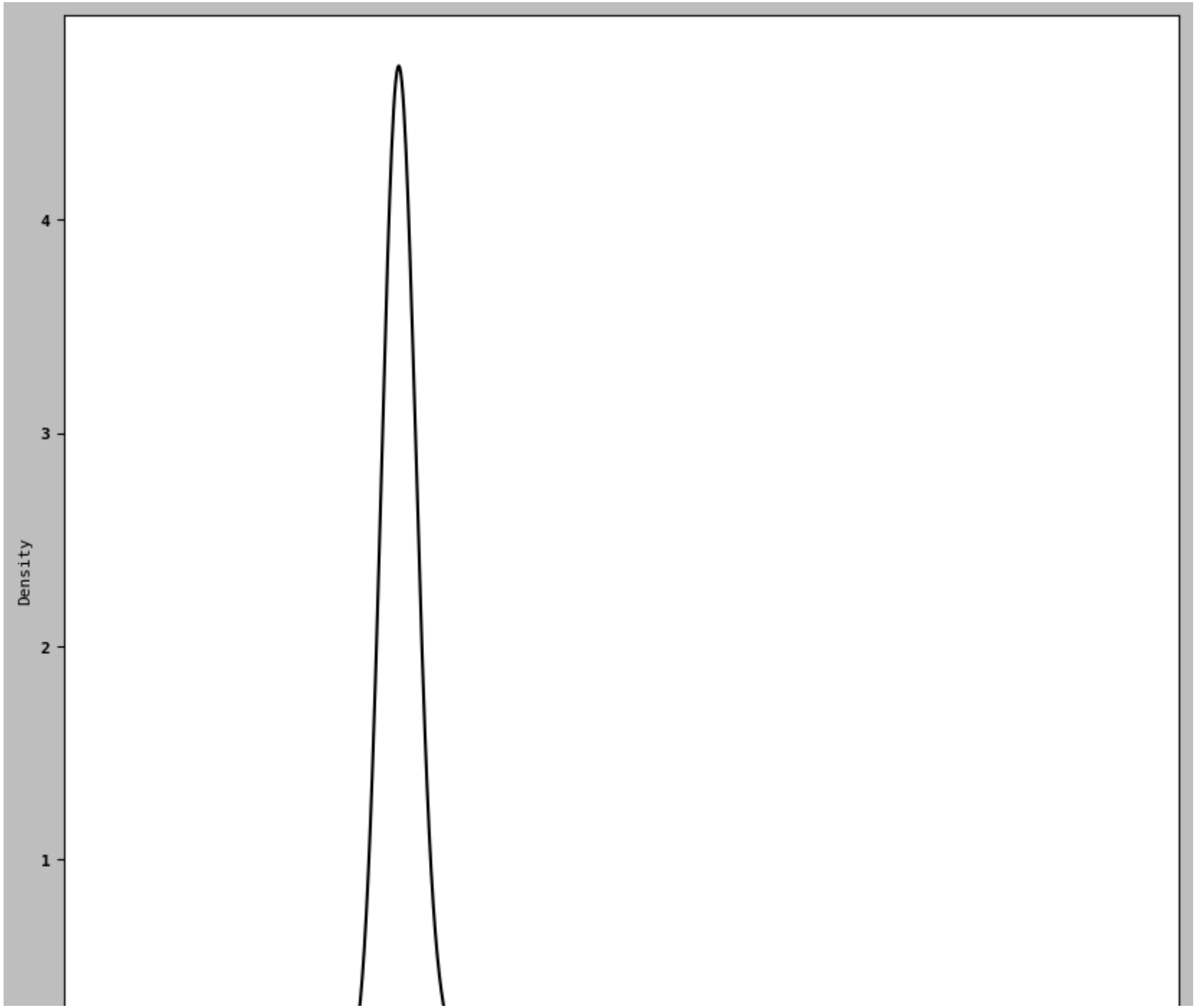
Out[74]:
```
<Axes: ylabel='Frequency'>
```

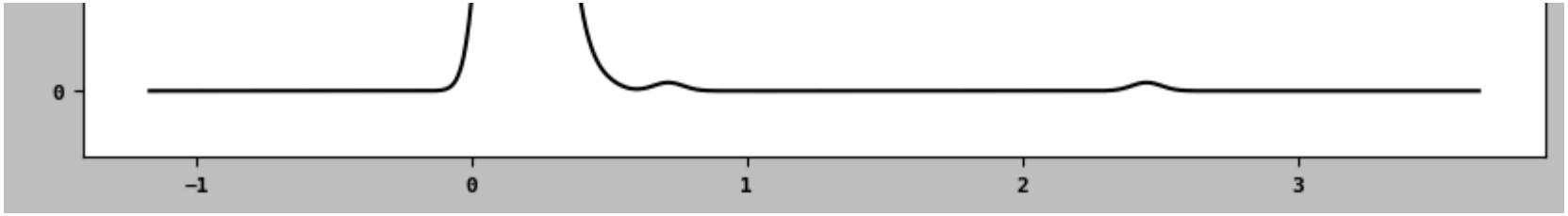

200
150
Frequency
100
50



In [76]:
```
# Kernal density estimate (KDE) plot
tips["tip_pct"].plot.density()
```

Out[76]: <Axes: ylabel='Density'>


Density
4
3
2
1

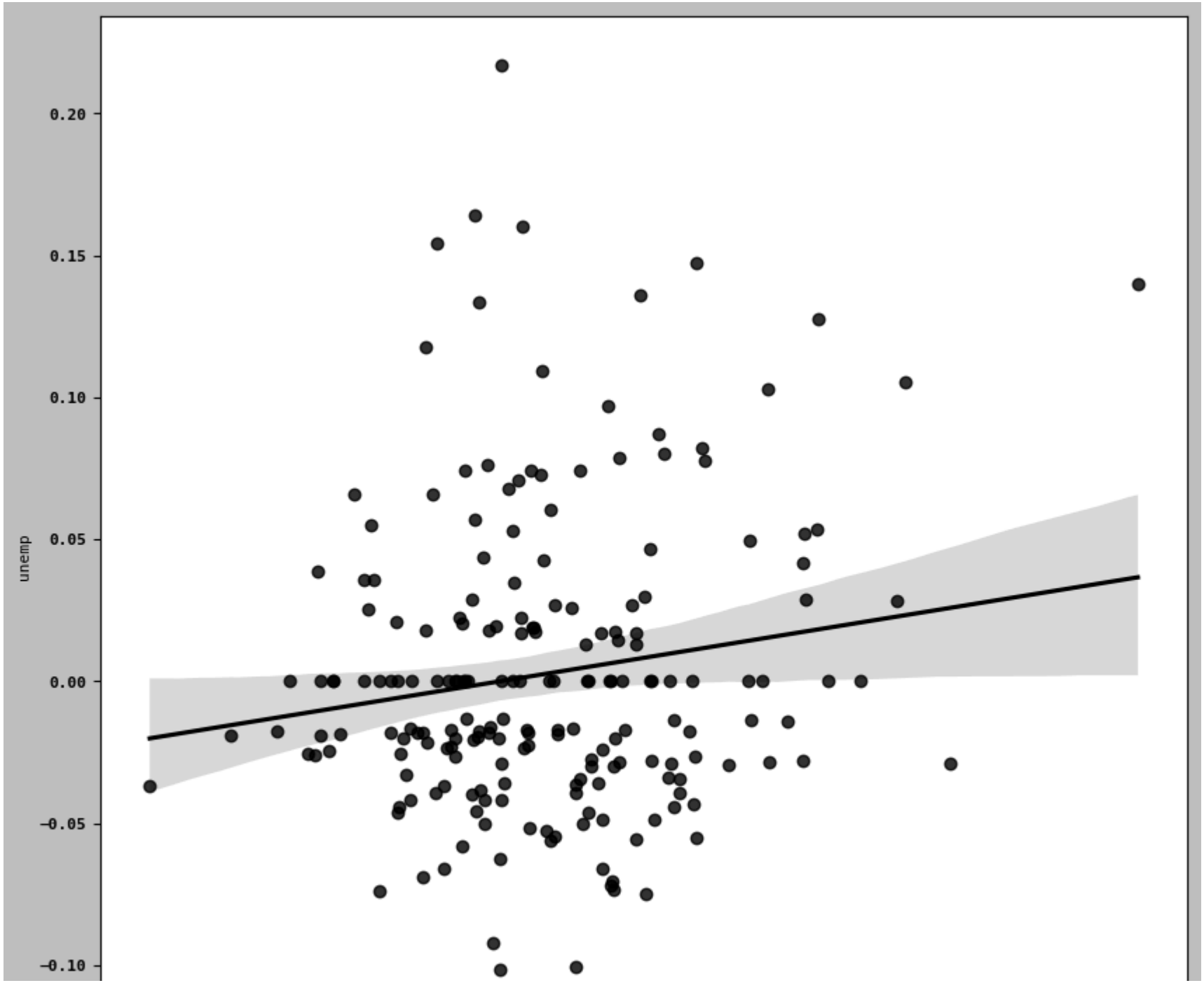


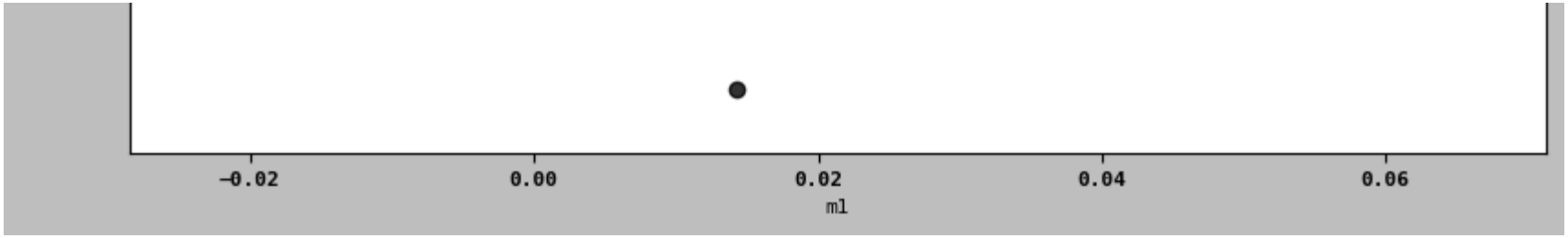
In [77]:
```
macro = pd.read_csv("examples/macrodata.csv")
data = macro[["cpi", "m1", "tbilrate", "unemp"]]
trans_data = np.log(data).diff().dropna()
trans_data.tail()
```

Out[77]:

	cpi	m1	tbilrate	unemp
198	-0.007904	0.045361	-0.396881	0.105361
199	-0.021979	0.066753	-2.277267	0.139762
200	0.002340	0.010286	0.606136	0.160343
201	0.008419	0.037461	-0.200671	0.127339
202	0.008894	0.012202	-0.405465	0.042560

In [80]:
```
# scatter plot with linear regression line
ax = sns.regplot(x="m1", y="unemp", data=trans_data)
```

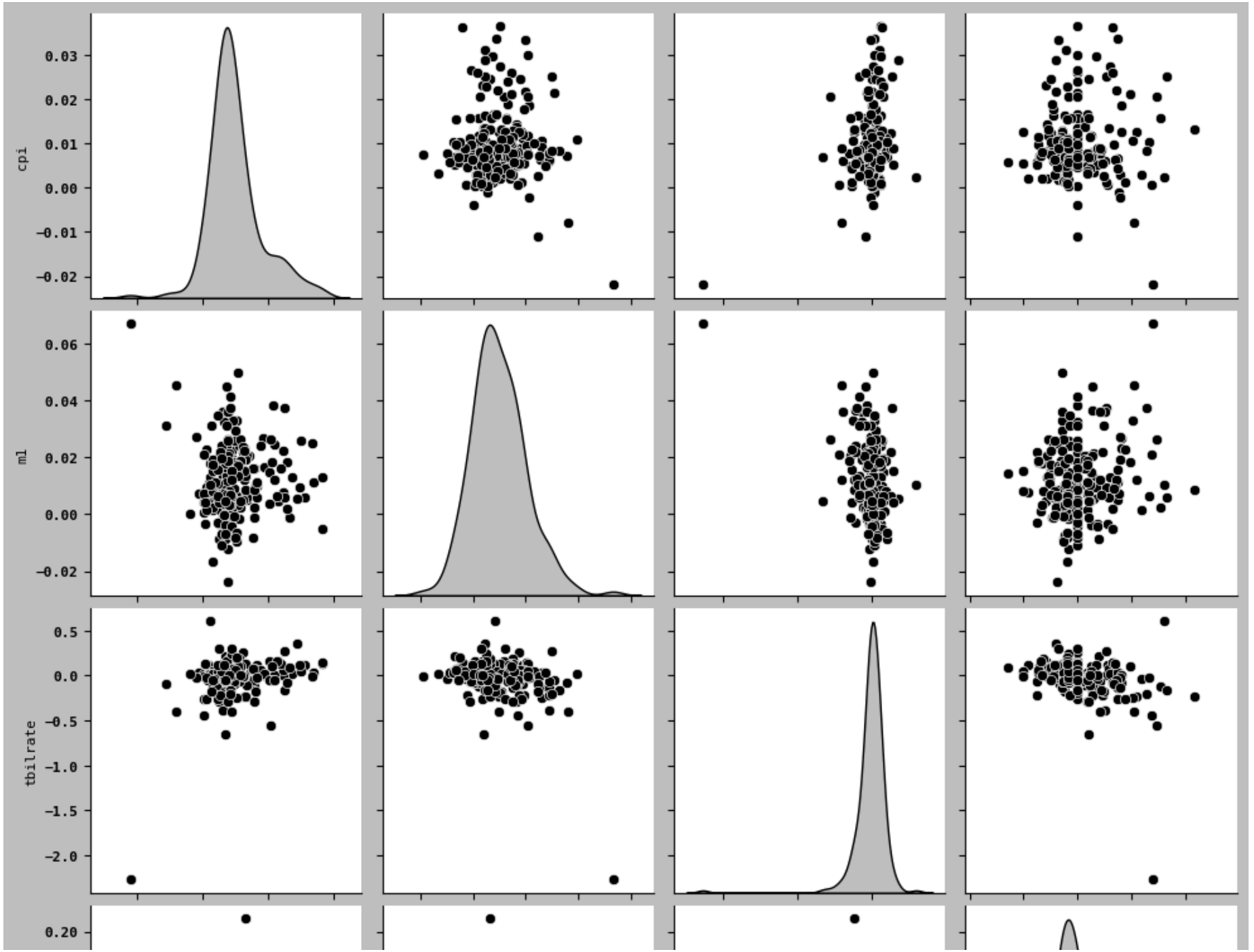

0.20
0.15
0.10
0.05
0.00
−0.05
−0.10
unemp

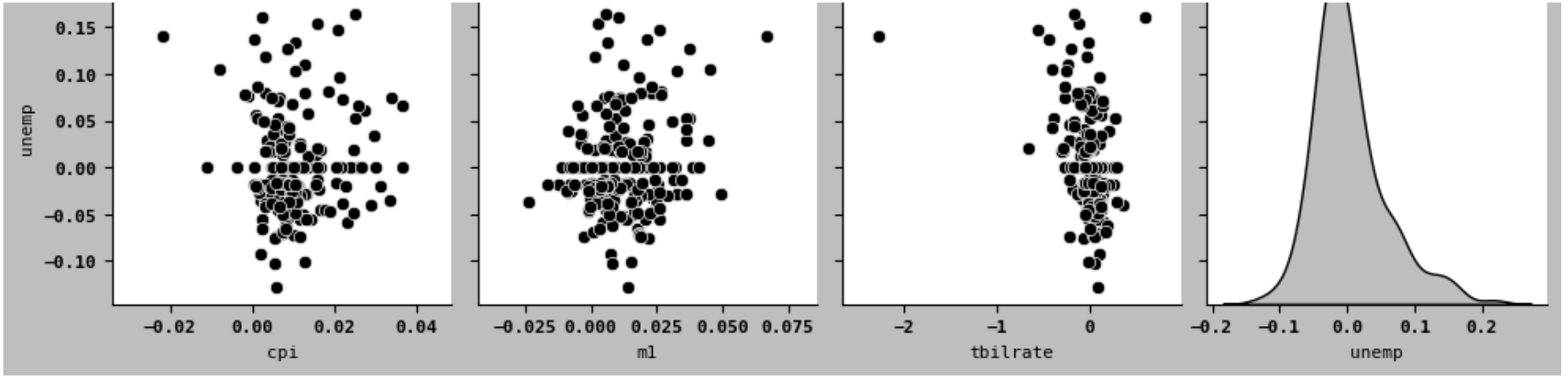


In [81]:
```
# scatter plot matrxix

sns.pairplot(trans_data, diag_kind="kde")
```

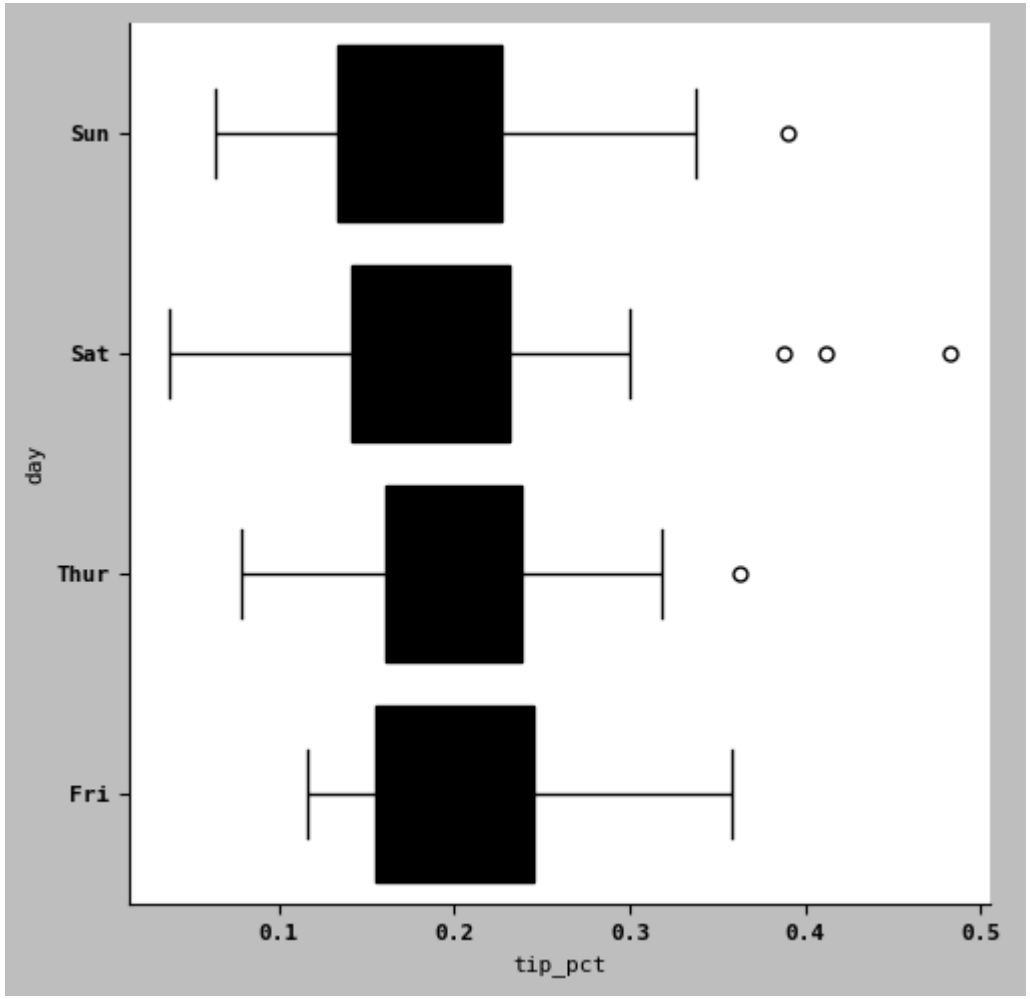
Out[81]: <seaborn.axisgrid.PairGrid at 0x7f15b78bc790>


cpi
m1
tbilrate
0.03
0.02
0.01
0.00
−0.01
−0.02
0.06
0.04
0.02
0.00
−0.02
0.5
0.0
−0.5
−1.0
−1.5
−2.0
0.20



In [82]:
```
sns.catplot(x="tip_pct", y="day", kind="box",
            data=tips[tips.tip_pct < 0.5])
```

Out[82]:
```
<seaborn.axisgrid.FacetGrid at 0x7f15b7e79050>
```



In [87]:
```
%%html
<h2>Chapter 10 - Data Aggregation and Group Operations</h2>
Code examples are taken from <a href="https://github.com/wesm/pydata-book/blob/3rd-edition/ch10.ipynb">https://gith
<br/>
<br/>
Illustration of group aggregation
<img src="images/group_agg.png" width=400/>
```

Chapter 10 - Data Aggregation and Group Operations

Code examples are taken from https://github.com/wesm/pydata-book/blob/3rd-edition/ch10.ipynb

Illustration of group aggregation

 No description has been provided for this image

In [88]:
```
# The group operation can be considered as split-apply-combine = > a series or df split into groups based on one mo
# The splitting is performed on a particular axis of the object.
# Once it's done, a function is applied to each group, producing a new value.
# Finally all the results are combined into a result object.
```

In [106…
```
import numpy as np
import pandas as pd
PREVIOUS_MAX_ROWS = pd.options.display.max_rows
pd.options.display.max_columns = 20
pd.options.display.max_rows = 20
pd.options.display.max_colwidth = 80
np.random.seed(12345)
import matplotlib.pyplot as plt
plt.rc("figure", figsize=(10, 6))
np.set_printoptions(precision=4, suppress=True)
```

In [107…
```
df = pd.DataFrame({"key1" : ["a", "a", None, "b", "b", "a", None],
                   "key2" : pd.Series([1, 2, 1, 2, 1, None, 1],
                                      dtype="Int64"),
                   "data1" : np.random.standard_normal(7),
                   "data2" : np.random.standard_normal(7)})
df
```

Out[107…

	key1	key2	data1	data2
0	a	1	-0.204708	0.281746
1	a	2	0.478943	0.769023
2	None	1	-0.519439	1.246435
3	b	2	-0.555730	1.007189
4	b	1	1.965781	-1.296221
5	a	<NA>	1.393406	0.274992
6	None	1	0.092908	0.228913

In [108…
```
mean = df.groupby("key1").mean()
```

In [109…
```
mean
```

Out[109…

key1	key2	data1	data2
a	1.5	0.555881	0.441920
b	1.5	0.705025	-0.144516

In [111…
```
df['data1'].groupby(df["key1"]).mean()
```

Out[111…
```
key1
a    0.555881
b    0.705025
Name: data1, dtype: float64
```

In [112…
```
# We can pass multiple keys
df.groupby(["key1","key2"]).mean()
```

Out[112…

key1	key2	data1	data2
a	1	-0.204708	0.281746
	2	0.478943	0.769023
b	1	1.965781	-1.296221
	2	-0.555730	1.007189

In [113…
```
df.groupby(["key1","key2"]).size() # similar to count(*) in SQL
```

Out[113…
```
key1  key2
a     1       1
      2       1
b     1       1
      2       1
dtype: int64
```

In [114…
```
df.groupby(["key1","key2"], dropna=False).size()
```

Out[114…
```
key1  key2
a     1       1
      2       1
      <NA>    1
b     1       1
      2       1
NaN   1       2
dtype: int64
```

In [119…
```
df.groupby(["key1","key2"]).count() # similar to aize in pandas & count(*) in SQL, but it only takes the nonnull va
```

Out[119…

		data1	data2
key1	key2		
a	1	1	1
	2	1	1
b	1	1	1
	2	1	1

In [120…
```
%%html
<h2>Iterating over groups</h2>
```

Iterating over groups

In [123…
```
for name, group in df.groupby("key1"):
    print(group)
    print("hello")
```

```
  key1  key2     data1     data2
0    a     1 -0.204708  0.281746
1    a     2  0.478943  0.769023
5    a  <NA>  1.393406  0.274992
hello
  key1  key2     data1     data2
3    b     2 -0.555730  1.007189
4    b     1  1.965781 -1.296221
hello
```

In [130…
```
%%html
<h3>Selecting a column or subset of columns</h3>
```

Selecting a column or subset of columns

In [136…
```
grouped = df.groupby(["key1","key2"])['data1'].mean()
grouped
```

Out[136…
```
key1  key2
a     1      -0.204708
      2       0.478943
b     1       1.965781
      2      -0.555730
Name: data1, dtype: float64
```

In [137…
```
%%html
<h3>Grouping with Dictionaries & Series</h3>
```

Grouping with Dictionaries & Series

In [138…
```
people = pd.DataFrame(np.random.standard_normal((5, 5)),
                      columns=["a", "b", "c", "d", "e"],
                      index=["Joe", "Steve", "Wanda", "Jill", "Trey"])
people.iloc[2:3, [1, 2]] = np.nan # Add a few NA values
people
```

Out[138…

	a	b	c	d	e
Joe	1.352917	0.886429	-2.001637	-0.371843	1.669025
Steve	-0.438570	-0.539741	0.476985	3.248944	-1.021228
Wanda	-0.577087	NaN	NaN	0.523772	0.000940
Jill	1.343810	-0.713544	-0.831154	-2.370232	-1.860761
Trey	-0.860757	0.560145	-1.265934	0.119827	-1.063512

In [139…
```
mapping = {"a": "red", "b": "red", "c": "blue",
           "d": "blue", "e": "red", "f" : "orange"}
```

In [143…
```
by_column = people.groupby(mapping, axis="columns")
by_column.sum()
```

```
/tmp/ipykernel_45502/2628240624.py:1: FutureWarning: DataFrame.groupby with axis=1 is deprecated. Do `frame.T.groupb
y(...)` without axis instead.
  by_column = people.groupby(mapping, axis="columns")
```

Out[143…

	blue	red
Joe	-2.373480	3.908371
Steve	3.725929	-1.999539
Wanda	0.523772	-0.576147
Jill	-3.201385	-1.230495
Trey	-1.146107	-1.364125

In [144…
```
by_column.sum()
```

Out[144…

	blue	red
Joe	-2.373480	3.908371
Steve	3.725929	-1.999539
Wanda	0.523772	-0.576147
Jill	-3.201385	-1.230495
Trey	-1.146107	-1.364125

In [146…
```
%%html
<h3>Grouping by index levels</h3>
```

Grouping by index levels

In [147…
```
columns = pd.MultiIndex.from_arrays([["US", "US", "US", "JP", "JP"],
                                     [1, 3, 5, 1, 3]],
                                     names=["cty", "tenor"])
hier_df = pd.DataFrame(np.random.standard_normal((4, 5)), columns=columns)
hier_df
```

Out[147…

cty			US		JP
tenor	1	3	5	1	3
0	0.332883	-2.359419	-0.199543	-1.541996	-0.970736
1	-1.307030	0.286350	0.377984	-0.753887	0.331286
2	1.349742	0.069877	0.246674	-0.011862	1.004812
3	1.327195	-0.919262	-1.549106	0.022185	0.758363

In [149…

```
hier_df.groupby(level="cty", axis=1).count()
```

```
/tmp/ipykernel_45502/84208998.py:1: FutureWarning: DataFrame.groupby with axis=1 is deprecated. Do `frame.T.groupby(...)` without axis instead.
  hier_df.groupby(level="cty", axis=1).count()
```

Out[149…

cty	JP	US
0	2	3
1	2	3
2	2	3
3	2	3

In [150…

```
%%html
<h3>Data aggregation</h3>
```

Data aggregation

In [158…

```
df
```

Out[158…

	key1	key2	data1	data2
0	a	1	-0.204708	0.281746
1	a	2	0.478943	0.769023
2	None	1	-0.519439	1.246435
3	b	2	-0.555730	1.007189
4	b	1	1.965781	-1.296221
5	a	<NA>	1.393406	0.274992
6	None	1	0.092908	0.228913

In [162…

```
grouped = df.groupby("key1")
grouped.sum()
```

Out[162…

	key2	data1	data2
key1			
a	3	1.667642	1.325760
b	3	1.410050	-0.289032

In [157…

```
# We can use our own aggregation function
def peak_to_peak(arr):
    return arr.max() - arr.min()
grouped.agg(peak_to_peak)
```

Out[157…

	key2	data1	data2
key1			
a	1	1.598113	0.494031
b	1	2.521511	2.303410

In [163…

```
grouped.describe()
```

Out[163…

	key2								data1							
	count	mean	std	min	25%	50%	75%	max	count	mean	…	75%	max	count	mean	std	r
key1																	
a	2.0	1.5	0.707107	1.0	1.25	1.5	1.75	2.0	3.0	0.555881	…	0.936175	1.393406	3.0	0.441920	0.283299	0.2749
b	2.0	1.5	0.707107	1.0	1.25	1.5	1.75	2.0	2.0	0.705025	…	1.335403	1.965781	2.0	-0.144516	1.628757	-1.2962

2 rows × 24 columns

In [224…

```
%%html
<h3>Column-wise and multiple function application</h3>
groupby methods
<img src="images/groupby_methods1.png" width=400>
<img src="images/groupby_methods2.png" width=400>
```

Column-wise and multiple function application

groupby methods

No description has been provided for this image

No description has been provided for this image

In [165…

```
tips = pd.read_csv("examples/tips.csv")
tips.head()
```

Out[165…

	total_bill	tip	smoker	day	time	size
0	16.99	1.01	No	Sun	Dinner	2
1	10.34	1.66	No	Sun	Dinner	3
2	21.01	3.50	No	Sun	Dinner	3
3	23.68	3.31	No	Sun	Dinner	2
4	24.59	3.61	No	Sun	Dinner	4

In [166…
```
tips["tip_pct"] = tips["tip"] / tips["total_bill"]
tips.head()
```

Out[166…

	total_bill	tip	smoker	day	time	size	tip_pct
0	16.99	1.01	No	Sun	Dinner	2	0.059447
1	10.34	1.66	No	Sun	Dinner	3	0.160542
2	21.01	3.50	No	Sun	Dinner	3	0.166587
3	23.68	3.31	No	Sun	Dinner	2	0.139780
4	24.59	3.61	No	Sun	Dinner	4	0.146808

In [174…
```
grouped = tips.groupby(["day", "smoker"])
grouped_pct = grouped["tip_pct"]
grouped_pct.agg("mean")
```

Out[174…
```
day   smoker
Fri   No        0.151650
      Yes       0.174783
Sat   No        0.158048
      Yes       0.147906
Sun   No        0.160113
      Yes       0.187250
Thur  No        0.160298
      Yes       0.163863
Name: tip_pct, dtype: float64
```

In [176…
```
# We can pass list of functions
grouped_pct.agg(["mean","count",peak_to_peak])
```

Out[176…

		mean	count	peak_to_peak
day	smoker			
Fri	No	0.151650	4	0.067349
	Yes	0.174783	15	0.159925
Sat	No	0.158048	45	0.235193
	Yes	0.147906	42	0.290095
Sun	No	0.160113	57	0.193226
	Yes	0.187250	19	0.644685
Thur	No	0.160298	45	0.193350
	Yes	0.163863	17	0.151240

In [177…

```
# We can name them as well

grouped_pct.agg([("Average","mean"),("Size","count"),("Peak to Peak",peak_to_peak)])
```

Out[177…

		Average	Size	Peak to Peak
day	smoker			
Fri	No	0.151650	4	0.067349
	Yes	0.174783	15	0.159925
Sat	No	0.158048	45	0.235193
	Yes	0.147906	42	0.290095
Sun	No	0.160113	57	0.193226
	Yes	0.187250	19	0.644685
Thur	No	0.160298	45	0.193350
	Yes	0.163863	17	0.151240

In [179…

```
grouped[["tip_pct","total_bill"].agg([("Average","mean"),("Size","count"),("Peak to Peak",peak_to_peak)])
```

Out[179…

		tip_pct			total_bill		
		Average	Size	Peak to Peak	Average	Size	Peak to Peak
day	smoker						
Fri	No	0.151650	4	0.067349	18.420000	4	10.29
	Yes	0.174783	15	0.159925	16.813333	15	34.42
Sat	No	0.158048	45	0.235193	19.661778	45	41.08
	Yes	0.147906	42	0.290095	21.276667	42	47.74
Sun	No	0.160113	57	0.193226	20.506667	57	39.40
	Yes	0.187250	19	0.644685	24.120000	19	38.10
Thur	No	0.160298	45	0.193350	17.113111	45	33.68
	Yes	0.163863	17	0.151240	19.190588	17	32.77

In [183…

```
# We can also pass a dictionary to agg
grouped.agg({"tip" : np.max, "size" : "sum"})
```

```
/tmp/ipykernel_45502/1179710144.py:2: FutureWarning: The provided callable <function max at 0x7f163c0fb060> is curre
ntly using SeriesGroupBy.max. In a future version of pandas, the provided callable will be used directly. To keep cu
rrent behavior pass the string "max" instead.
  grouped.agg({"tip" : np.max, "size" : "sum"})
```

Out[183…

day	smoker	tip	size
Fri	No	3.50	9
	Yes	4.73	31
Sat	No	9.00	115
	Yes	10.00	104
Sun	No	6.00	167
	Yes	6.50	49
Thur	No	6.70	112
	Yes	5.00	40

In [191…

```
%%html
<h3>Apply: General split-apply-combine</h3>
```

Apply: General split-apply-combine

In [188…

```
grouped = tips.groupby(["day", "smoker"])
grouped.mean(numeric_only=True)
```

Out[188…

day	smoker	total_bill	tip	size	tip_pct
Fri	No	18.420000	2.812500	2.250000	0.151650
	Yes	16.813333	2.714000	2.066667	0.174783
Sat	No	19.661778	3.102889	2.555556	0.158048
	Yes	21.276667	2.875476	2.476190	0.147906
Sun	No	20.506667	3.167895	2.929825	0.160113
	Yes	24.120000	3.516842	2.578947	0.187250
Thur	No	17.113111	2.673778	2.488889	0.160298
	Yes	19.190588	3.030000	2.352941	0.163863

In [189…

```
def top(df, n=5, column="tip_pct"):
    return df.sort_values(column, ascending=False)[:n]
top(tips, n=6)
```

Out[189…

	total_bill	tip	smoker	day	time	size	tip_pct
172	7.25	5.15	Yes	Sun	Dinner	2	0.710345
178	9.60	4.00	Yes	Sun	Dinner	2	0.416667
67	3.07	1.00	Yes	Sat	Dinner	1	0.325733
232	11.61	3.39	No	Sat	Dinner	2	0.291990
183	23.17	6.50	Yes	Sun	Dinner	4	0.280535
109	14.31	4.00	Yes	Sat	Dinner	2	0.279525

In [190…

```
tips.groupby("smoker").apply(top)
```

```
/tmp/ipykernel_45502/2530541573.py:1: DeprecationWarning: DataFrameGroupBy.apply operated on the grouping columns. T
his behavior is deprecated, and in a future version of pandas the grouping columns will be excluded from the operati
on. Either pass `include_groups=False` to exclude the groupings or explicitly select the grouping columns after grou
pby to silence this warning.
  tips.groupby("smoker").apply(top)
```

Out[190…

		total_bill	tip	smoker	day	time	size	tip_pct
smoker								
No	**232**	11.61	3.39	No	Sat	Dinner	2	0.291990
	149	7.51	2.00	No	Thur	Lunch	2	0.266312
	51	10.29	2.60	No	Sun	Dinner	2	0.252672
	185	20.69	5.00	No	Sun	Dinner	5	0.241663
	88	24.71	5.85	No	Thur	Lunch	2	0.236746
Yes	**172**	7.25	5.15	Yes	Sun	Dinner	2	0.710345
	178	9.60	4.00	Yes	Sun	Dinner	2	0.416667
	67	3.07	1.00	Yes	Sat	Dinner	1	0.325733
	183	23.17	6.50	Yes	Sun	Dinner	4	0.280535
	109	14.31	4.00	Yes	Sat	Dinner	2	0.279525

In [192…

```
%%html
<h3>Qunatile and Bucket Analysis</h3>
```

Qunatile and Bucket Analysis

In [193…

```
frame = pd.DataFrame({"data1": np.random.standard_normal(1000),
                      "data2": np.random.standard_normal(1000)})
frame.head()
quartiles = pd.cut(frame["data1"], 4)
quartiles.head(10)
```

Out[193…
```
0     (-1.23, 0.489]
1     (0.489, 2.208]
2     (-1.23, 0.489]
3     (-1.23, 0.489]
4     (0.489, 2.208]
5     (0.489, 2.208]
6     (-1.23, 0.489]
7     (-1.23, 0.489]
8    (-2.956, -1.23]
9     (-1.23, 0.489]
Name: data1, dtype: category
Categories (4, interval[float64, right]): [(-2.956, -1.23] < (-1.23, 0.489] < (0.489, 2.208] < (2.208, 3.928]]
```

In [194…
```
def get_stats(group):
    return pd.DataFrame(
        {"min": group.min(), "max": group.max(),
        "count": group.count(), "mean": group.mean()}
    )

grouped = frame.groupby(quartiles)
grouped.apply(get_stats)
```

```
/tmp/ipykernel_45502/2015905501.py:7: FutureWarning: The default of observed=False is deprecated and will be changed
to True in a future version of pandas. Pass observed=False to retain current behavior or observed=True to adopt the
future default and silence this warning.
  grouped = frame.groupby(quartiles)
```

Out[194…

		min	max	count	mean
data1					
(-2.956, -1.23]	**data1**	-2.949343	-1.230179	94	-1.658818
	data2	-3.399312	1.670835	94	-0.033333
(-1.23, 0.489]	**data1**	-1.228918	0.488675	598	-0.329524
	data2	-2.989741	3.260383	598	-0.002622
(0.489, 2.208]	**data1**	0.489965	2.200997	298	1.065727
	data2	-3.745356	2.954439	298	0.078249
(2.208, 3.928]	**data1**	2.212303	3.927528	10	2.644253
	data2	-1.929776	1.765640	10	0.024750

In [197…

```
# Filling the null values
states = ["Ohio", "New York", "Vermont", "Florida",
          "Oregon", "Nevada", "California", "Idaho"]
group_key = ["East", "East", "East", "East",
             "West", "West", "West", "West"]
data = pd.Series(np.random.standard_normal(8), index=states)
data[["Vermont", "Nevada", "Idaho"]] = np.nan
data
```

Out[197…

```
Ohio          1.105913
New York     -1.613716
Vermont            NaN
Florida       0.406510
Oregon        0.359244
Nevada             NaN
California   -1.691656
Idaho              NaN
dtype: float64
```

In [198…

```
data.groupby(group_key).count()
```

Out[198…
```
East    3
West    2
dtype: int64
```

In [199…
```
def fill_mean(group):
    return group.fillna(group.mean())

data.groupby(group_key).apply(fill_mean)
```

Out[199…
```
East  Ohio          1.105913
      New York     -1.613716
      Vermont      -0.033764
      Florida       0.406510
West  Oregon        0.359244
      Nevada       -0.666206
      California   -1.691656
      Idaho        -0.666206
dtype: float64
```

In [200…
```
%%html
<h3>Group wise linear regression</h3>
```

Group wise linear regression

In [203…
```
close_px = pd.read_csv("examples/stock_px.csv", parse_dates=True,
                       index_col=0)
close_px.info()
close_px.tail(4)
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 2214 entries, 2003-01-02 to 2011-10-14
Data columns (total 4 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   AAPL    2214 non-null   float64
 1   MSFT    2214 non-null   float64
 2   XOM     2214 non-null   float64
 3   SPX     2214 non-null   float64
dtypes: float64(4)
memory usage: 86.5 KB
```

Out[203…

	AAPL	MSFT	XOM	SPX
2011-10-11	400.29	27.00	76.27	1195.54
2011-10-12	402.19	26.96	77.16	1207.25
2011-10-13	408.43	27.18	76.37	1203.66
2011-10-14	422.00	27.27	78.11	1224.58

In [201…

```
import statsmodels.api as sm
def regress(data, yvar=None, xvars=None):
    Y = data[yvar]
    X = data[xvars]
    X["intercept"] = 1.
    result = sm.OLS(Y, X).fit()
    return result.params
```

In [205…

```
def spx_corr(group):
    return group.corrwith(group["SPX"])
rets = close_px.pct_change().dropna()
```

In [207…

```
def get_year(x):
    return x.year

by_year = rets.groupby(get_year)
by_year.apply(spx_corr)
```

Out[207…

	AAPL	MSFT	XOM	SPX
2003	0.541124	0.745174	0.661265	1.0
2004	0.374283	0.588531	0.557742	1.0
2005	0.467540	0.562374	0.631010	1.0
2006	0.428267	0.406126	0.518514	1.0
2007	0.508118	0.658770	0.786264	1.0
2008	0.681434	0.804626	0.828303	1.0
2009	0.707103	0.654902	0.797921	1.0
2010	0.710105	0.730118	0.839057	1.0
2011	0.691931	0.800996	0.859975	1.0

In [208…

```
def corr_aapl_msft(group):
    return group["AAPL"].corr(group["MSFT"])
by_year.apply(corr_aapl_msft)
```

Out[208…

```
2003    0.480868
2004    0.259024
2005    0.300093
2006    0.161735
2007    0.417738
2008    0.611901
2009    0.432738
2010    0.571946
2011    0.581987
dtype: float64
```

In [209…

```
by_year.apply(regress, yvar="AAPL", xvars=["SPX"])
```

Out[209…

	SPX	intercept
2003	1.195406	0.000710
2004	1.363463	0.004201
2005	1.766415	0.003246
2006	1.645496	0.000080
2007	1.198761	0.003438
2008	0.968016	-0.001110
2009	0.879103	0.002954
2010	1.052608	0.001261
2011	0.806605	0.001514

In [227…

```
%%html
Pivot table options
<img src="images/pivot_table_options.png" width=400>
```

Pivot table options

 No description has been provided for this image

In [210…

```
# Pivot table
tips.head()
tips.pivot_table(index=["day", "smoker"],
                 values=["size", "tip", "tip_pct", "total_bill"])
```

Out[210…

		size	tip	tip_pct	total_bill
day	**smoker**				
Fri	**No**	2.250000	2.812500	0.151650	18.420000
	Yes	2.066667	2.714000	0.174783	16.813333
Sat	**No**	2.555556	3.102889	0.158048	19.661778
	Yes	2.476190	2.875476	0.147906	21.276667
Sun	**No**	2.929825	3.167895	0.160113	20.506667
	Yes	2.578947	3.516842	0.187250	24.120000
Thur	**No**	2.488889	2.673778	0.160298	17.113111
	Yes	2.352941	3.030000	0.163863	19.190588

In [211…

```
tips.pivot_table(index=["time", "day"], columns="smoker",
                 values=["tip_pct", "size"])
```

Out[211…

		size		tip_pct	
	smoker	**No**	**Yes**	**No**	**Yes**
time	**day**				
Dinner	**Fri**	2.000000	2.222222	0.139622	0.165347
	Sat	2.555556	2.476190	0.158048	0.147906
	Sun	2.929825	2.578947	0.160113	0.187250
	Thur	2.000000	NaN	0.159744	NaN
Lunch	**Fri**	3.000000	1.833333	0.187735	0.188937
	Thur	2.500000	2.352941	0.160311	0.163863

In [212…

```
tips.pivot_table(index=["time", "day"], columns="smoker",
                 values=["tip_pct", "size"], margins=True)
```

Out[212…

		size			tip_pct		
	smoker	No	Yes	All	No	Yes	All
time	day						
Dinner	Fri	2.000000	2.222222	2.166667	0.139622	0.165347	0.158916
	Sat	2.555556	2.476190	2.517241	0.158048	0.147906	0.153152
	Sun	2.929825	2.578947	2.842105	0.160113	0.187250	0.166897
	Thur	2.000000	NaN	2.000000	0.159744	NaN	0.159744
Lunch	Fri	3.000000	1.833333	2.000000	0.187735	0.188937	0.188765
	Thur	2.500000	2.352941	2.459016	0.160311	0.163863	0.161301
All		2.668874	2.408602	2.569672	0.159328	0.163196	0.160803

In [213…

```
tips.pivot_table(index=["time", "smoker"], columns="day",
                 values="tip_pct", aggfunc=len, margins=True)
```

Out[213…

	day	Fri	Sat	Sun	Thur	All
time	smoker					
Dinner	No	3.0	45.0	57.0	1.0	106
	Yes	9.0	42.0	19.0	NaN	70
Lunch	No	1.0	NaN	NaN	44.0	45
	Yes	6.0	NaN	NaN	17.0	23
All		19.0	87.0	76.0	62.0	244

In [214…

```
tips.pivot_table(index=["time", "size", "smoker"], columns="day",
                 values="tip_pct", fill_value=0)
```

Out[214…

		day	Fri	Sat	Sun	Thur
time	size	smoker				
Dinner	1	No	0.000000	0.137931	0.000000	0.000000
		Yes	0.000000	0.325733	0.000000	0.000000
	2	No	0.139622	0.162705	0.168859	0.159744
		Yes	0.171297	0.148668	0.207893	0.000000
	3	No	0.000000	0.154661	0.152663	0.000000
…	…	…	…	…	…	…
Lunch	3	Yes	0.000000	0.000000	0.000000	0.204952
	4	No	0.000000	0.000000	0.000000	0.138919
		Yes	0.000000	0.000000	0.000000	0.155410
	5	No	0.000000	0.000000	0.000000	0.121389
	6	No	0.000000	0.000000	0.000000	0.173706

21 rows × 4 columns

In [216…

```
from io import StringIO
data = """Sample  Nationality  Handedness
1   USA  Right-handed
2   Japan    Left-handed
3   USA  Right-handed
4   Japan    Right-handed
5   Japan    Left-handed
6   Japan    Right-handed
7   USA  Right-handed
8   USA  Left-handed
9   Japan    Right-handed
10  USA  Right-handed"""
data = pd.read_table(StringIO(data), sep="\s+")
data
```

Out[216…

	Sample	Nationality	Handedness
0	1	USA	Right-handed
1	2	Japan	Left-handed
2	3	USA	Right-handed
3	4	Japan	Right-handed
4	5	Japan	Left-handed
5	6	Japan	Right-handed
6	7	USA	Right-handed
7	8	USA	Left-handed
8	9	Japan	Right-handed
9	10	USA	Right-handed

In [220…

```
data.pivot_table(index="Nationality",columns="Handedness", aggfunc="count", margins=True)
```

Out[220…

	Sample		
Handedness	**Left-handed**	**Right-handed**	**All**
Nationality			
Japan	2	3	5
USA	1	4	5
All	3	7	10

In [221…

```
# We can do above using crosstab
pd.crosstab(data["Nationality"], data["Handedness"], margins=True)
```

Out[221…

Handedness Nationality	Left-handed	Right-handed	All
Japan	2	3	5
USA	1	4	5
All	3	7	10

In [ ]: