Cheat Sheet: The pandas DataFrame Object

Preliminaries

Start by importing these Python modules

```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
from pandas import DataFrame, Series
```

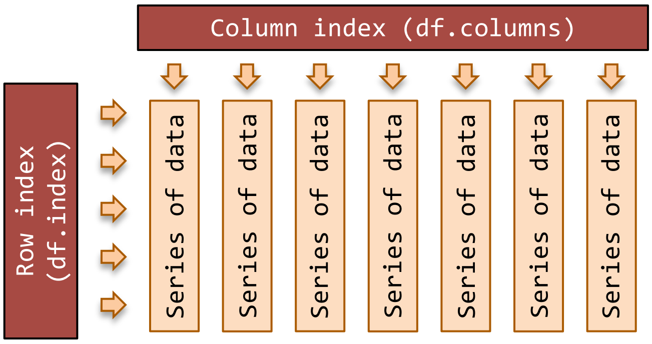
Note: these are the standard import aliases
Note: place this text in the IPython configuration file and at the start of (.py) python files

The conceptual model

Series object: an ordered, one-dimensional array of data with an index. All the data in a Series is of the same data type. Series arithmetic is vectorised after first aligning the Series index for each of the operands.

```
s1 = Series(range(0,4))  # -> 0, 1, 2, 3
s2 = Series(range(1,5))  # -> 1, 2, 3, 4
s3 = s1 + s2             # -> 1, 3, 5, 7
s4 = Series(['a','b'])*3 # -> 'aaa','bbb'
```

DataFrame object: a two-dimensional table of data with column and row indexes. The columns are made up of pandas Series objects.



Get your data into a DataFrame

Load a DataFrame from a CSV file

```
df = pd.read_csv('file.csv')# often works
df = pd.read_csv(‘file.csv’, header=0,
       index_col=0, quotechar=’”’,sep=’:’,
       na_values = [‘na’, ‘-‘, ‘.’, ‘’])
```

Note: refer to pandas docs for all arguments

From inline CSV text to a DataFrame

```
from StringIO import StringIO
data = """, Animal, Cuteness, Desirable
row-1,       dog,     8.7,       True
row-2,       cat,     9.8,       True
row-3,       bat,     2.6,       False"""
df = pd.read_csv(StringIO(data),
       header=0, index_col=0,
       skipinitialspace=True)
```

Note: *skipinitialspace=True* allows a pretty layout

Load DataFrames from a Microsoft Excel file

```
# Each Excel sheet in a Python dictionary
workbook = pd.ExcelFile('file.xlsx')
dictionary = {}
for sheet_name in workbook.sheet_names:
    df = workbook.parse(sheet_name)
    dictionary[sheet_name] = df
```

Note: the parse() method takes many arguments like read_csv() above. Refer to the pandas documentation.

Load a DataFrame from a MySQL database

```
import pymysql
from sqlalchemy import create_engine
engine = create_engine('mysql+pymysql://'
    +'USER:PASSWORD@localhost/DATABASE')
df = pd.read_sql_table('table', engine)
```

Data in Series then combine into a DataFrame

```
# Example 1 ...
s1 = Series(range(6))
s2 = s1 * s1
s2.index = s2.index + 2# misalign indexes
df = pd.concat([s1, s2], axis=1)

# Example 2 ...
s3 = Series({'Tom':1, 'Dick':4, 'Har':9})
s4 = Series({'Tom':3, 'Dick':2, 'Mar':5})
df = pd.concat({'A':s3, 'B':s4 }, axis=1)
```

Note: 1st method has in integer column labels
Note: 2nd method does not guarantee col order
Note: index alignment on DataFrame creation

Get a DataFrame from data in a Python dictionary

```
# default — assume your data in columns
df = DataFrame({
        'col0' : [1.0, 2.0, 3.0, 4.0],
        'col1' : [100, 200, 300, 400]
    })

# use helper method for data in rows
df = DataFrame.from_dict({ # data by row
        'row0' : {'col0':0, 'col1':'A'},
        'row1' : {'col0':1, 'col1':'B'}
    }, orient='index')

df = DataFrame.from_dict({ # data by row
        'row0' : [1, 1+1j, 'A'],
        'row1' : [2, 2+2j, 'B']
    }, orient='index')
```

Create play data (useful for testing)

```
# --- with a time-stamp row index:
df1 = DataFrame(np.random.rand(500,10))
df1.index = pd.date_range('1/1/2006',
       periods=len(df1), freq='M')

# --- with alphabetic row and col indexes
import string
df2 = DataFrame(np.random.randn(26,5),
       columns = ['col'+str(i) for i in
                    range(5)],
       index = list(string.uppercase))
df2['cat'] = list('aaaabbbccddef' * 2)
```

Saving a DataFrame

Saving a DataFrame to a CSV file

```
df.to_csv('name.csv', encoding='utf-8')
```

Saving DataFrames to an Excel Workbook

```
from pandas import ExcelWriter
writer = ExcelWriter('filename.xlsx')
df1.to_excel(writer,'Sheet1')
df2.to_excel(writer,'Sheet2')
writer.save()
```

Saving a DataFrame to MySQL

```
import pymysql
from sqlalchemy import create_engine
e = create_engine('mysql+pymysql://' +
    'USER:PASSWORD@localhost/DATABASE')
df.to_sql('TABLE',e, if_exists='replace')
```

Note: if_exists → 'fail', 'replace', 'append'

Saving a DataFrame to a Python dictionary

```
dictionary = df.to_dict()
```

Saving a DataFrame to a Python string

```
dictionary = df.to_string()
```

Note: sometimes may be useful for debugging

Working with the whole DataFrame

Peek at the DataFrame contents

```
df.info()      # info on index and dtypes
summary_df = df.describe()
print (df.head(5))       # first five rows
print (df.tail())        # last few rows
top_left_corner_df = df.iloc[:5, :5]
```

Useful whole-of-DataFrame actions/information

```
df = df.T       # transpose rows and cols
df2 = df.copy()# copy a DataFrame
if df.empty:    # True for empty DataFrame
```

Introduction to row and column indexes

A DataFrame has two Indexes

Typically, the column index (df.columns) is a list of strings (observed variable names) or (less commonly) integers (the default is numbered from 0 to length-1). The row index (df.index) might be:

- Integers - for case or row numbers (default is numbered from 0 to length-1)
- Strings – for case names
- DatetimeIndex or PeriodIndex – for time series data (more on these indexes below)

Get column index and labels

```
idx = df.columns               # get col index
label = df.columns[0]          # 1st col label
lst = df.columns.tolist() # get as a list
```

Change column labels

```
df.rename(columns={'old':'new'},
    inplace=True)
df = df.rename(columns={'a':1,'b':'x'})
```

Get the row index and labels

```
idx = df.index            # get row index
label = df.index[0]       # 1st row label
lst = df.index.tolist()   # get as a list
```

Change the (row) index

```
df.index = idx          # new ad hoc index
df.index = range(len(df)) # set with list
df = df.reset_index() # replace old w new
# note: old index stored as a col in df
df = df.reindex(index=range(len(df)))
df = df.set_index(keys=['r1','r2','etc'])
df.rename(index={'old':'new'},
    inplace=True)
```

Get the integer position of a row or col index label

```
i = df.index.get_loc('row_label')
j = df.columns.get_loc('col0')
```

Trap: returns an integer for a unique match. If not a unique match, may return a slice or mask.

Sort DataFrame by its row or column index

```
df.sort_index(inplace=True) # sort by row
df = df.sort_index(axis=1)  # sort by col
```

Test if the index values are unique/monotonic

```
if df.index.is_unique: pass # ...
if df.columns.is_unique: pass # ...
if df.index.is_monotonic: pass # ...
if df.columns.is_monotonic: pass # ...
```

Note: For a monotonic index, each element is greater than or equal to the previous element

Drop duplicates in the row index

```
df['index'] = df.index # 1 create new col
df = df.drop_duplicates(cols='index',
        take_last=True)# 2 use new col
del df['index']         # 3 del the col
df.sort_index(inplace=True)# 4 tidy up
```

Test if two DataFrames have same row index

```
len(a)==len(b) and all(a.index==b.index)
```

A quick guide to DataFrame indexing

```
s =  df['col_label']      # a selected col
df = df[['L1', 'L2']]     # selected cols
df = df['from':'to']      # selected rows
df = df[i:j] # where i & j are ints: rows
df = df[df['col'] > 0.5] # selected rows
```

Trap: A DataFrame index operation [] will return either selected columns or rows depending on the situation: Indexing a DataFrame on a label or list/array of labels returns selected columns. Indexing a DataFrame with a slice object ":" returns selected rows. Indexing a DataFrame with a Boolean array returns selected rows (see last example above).

Trap: with slice operations: slicing by row labels (3rd example above) uses a non-pythonic inclusive-to; whereas integer position slicing on the row-index (4th example above) uses a pythonic exclusive-to.

Working with columns of data (axis=1)

A DataFrame column is a pandas Series object

Selecting columns

```
s = df['colName'] # select column by name
df = df[['a','b']]    # select 2 or more
df = df[['c','a','b']]# change order
s = df[df.columns[0]] # select by number
```

Selecting columns with Python attributes

```
s = df.a            # same as s = df['a']
# cannot create new columns by attribute
df.existing_col = df.a / df.b
df['new_col'] = df.a / df.b
```

Trap: column names must be valid identifiers.

Adding new columns to a DataFrame

```
df['new_col'] = range(len(df))
df['new_col'] = np.repeat(np.nan,len(df))
df['random'] = np.random.rand(len(df))
df['index_as_col'] = df.index
df1[['b','c']] = df2[['e','f']]
df3 = df1.append(other=df2)
```

Trap: When adding an indexed pandas object as a new column, only items from the new series that have a corresponding index in the DataFrame will be added. The receiving DataFrame is not extended to accommodate the new series. If you want to merge, see the notes below on merging/joining DataFrames.
Trap: when adding a python list or numpy array, the column will be added by integer position.

Swap column contents

```
df[['B', 'A']] = df[['A', 'B']]
```

Dropping columns (mostly by label)

```
df = df.drop('col1', axis=1)
df.drop('col1', axis=1, inplace=True)
df = df.drop(['col1','col2'], axis=1)
s = df.pop('col') # drops from frame
del df['col'] # even classic python works
df.drop(df.columns[0], inplace=True)
```

Vectorised arithmetic on columns

```
df['proportion']=df['count']/df['total']
df['percent'] = df['proportion'] * 100.0
```

Apply numpy mathematical functions to columns

```
df['log_data'] = np.log(df['col1'])
df['rounded'] = np.round(df['col2'], 2)
```

Note: Many more mathematical functions

Columns value set based on criteria

```
df['b']=df['a'].where(df['a']>0,other=0)
df['d']=df['a'].where(df.b!=0,other=df.c)
```

Note: where other can be a Series or a scalar

Data type conversions

```
s =  df['col'].astype(str)  # Series dtype
na = df['col'].values       # numpy array
pl = df['col'].tolist()     # python list
```

Note: useful dtypes for Series conversion: int, float, str
Trap: index lost in conversion from Series to array or list

Iterating over the Dataframe cols

```
for (col_label,series) in df.iteritems():
    pass # do something ...
```

Common column-wide methods/attributes

```
value = df['col'].dtype  # type of data
value = df['col'].size   # col dimensions
value = df['col'].count()# non-NA count
value = df['col'].sum()
value = df['col'].prod()
value = df['col'].min()
value = df['col'].max()
value = df['col'].mean()
value = df['col'].median()
value = df['col'].cov(df['col2'])
s =     df['col'].describe()
s =     df['col'].value_counts()
```

Find index label for min/max values in column

```
label =  df['col1'].idxmin()
label =  df['col1'].idxmax()
```

Common column element-wise methods

```
s = df['col'].isnull()
s = df['col'].notnull() # not isnull()
s = df['col'].astype(float)
s = df['col'].round(decimals=0)
s = df['col'].diff(periods=1)
s = df['col'].shift(periods=1)
s = df['col'].to_datetime()
s = df['col'].fillna(0) # replace NaN w 0
s = df['col'].cumsum()
s = df['col'].cumprod()
s = df['col'].pct_change(periods=4)
s = df['col'].rolling_sum(periods=4,
                          window=4)
```

Note: also rolling_min(), rolling_max(), and many more.

Append a column of row sums to a DataFrame

```
df['Total'] = df.sum(axis=1)
```

Note: also means, mins, maxs, etc.

Multiply every column in DataFrame by Series

```
df = df.mul(s, axis=0) # on matched rows
```

Note: also add, sub, div, etc.

Selecting columns with .loc, .iloc and .ix

```
df = df.loc[:, 'col1':'col2'] # inclusive
df = df.iloc[:, 0:2]          # exclusive
```

A slice of columns can be selected by label (using df.loc[rows, cols]); by integer position (using df.iloc[rows, cols]); or a hybrid of the two (using df.ix[rows, cols])
Note: the row slice object : copies all rows
Note: For .loc, the indexes can be:

- A single label (eg. 'A')
- A list/array of labels (eg. ['A', 'B'])
- A slice object of labels (eg. 'A':'C')
- A Boolean array

Note: For .iloc, the indexes can be

- A single integer (eg. 27)
- A list/array of integers (eg. [1, 2, 6])
- A slice object with integers (eg. 1:9)

Note: For .ix the indexes can be mixed – primarily label based but falls back to integer position (for non integer indexes only)

Working with rows (axis=0)

Adding rows

```
df = original_df.append(more_rows_in_df)
```

Hint: convert to a DataFrame and then append. Both DataFrames should have same column labels.

Dropping rows (by name)

```
df = df.drop('row_label')
df = df.drop(['row1','row2']) # multi-row
```

Boolean row selection by values in a column

```
df = df[df['col2'] >= 0.0]
df = df[(df['col3']>=1.0) |
                       (df['col1']<0.0)]
df = df[df['col'].isin([1,2,5,7,11])]
df = df[~df['col'].isin([1,2,5,7,11])]
df = df[df['col'].str.contains('hello')]
```

Trap: bitwise "or", "and" “not” co-opted to be Boolean operators on a Series of Boolean (ie. & | ~)
Trap: need parentheses around comparisons.

Select a slice of rows by integer position

[inclusive-from : exclusive-to [: step]]
default start is 0; default end is len(df)

```
df = df[:]       # copy DataFrame
df = df[0:2]     # rows 0 and 1
df = df[-1:]     # the last row
df = df[2:3]     # row 2 (the third row)
df = df[:-1]     # all but the last row
df = df[::2]     # every 2nd row (0 2 ..)
```

Trap: a single integer without a colon is a column label for integer numbered columns.

Select a slice of rows by label/index

[inclusive-from : inclusive–to [: step]]

```
df = df['a':'c'] # rows 'a' through 'c'
```

Trap: doesn't work on integer labelled rows

Append a row of column totals to a DataFrame

```
# Option 1: use dictionary comprehension
sums = {col: df[col].sum() for col in df}
sums_df = DataFrame(sums,index=['Total'])
df = df.append(sums_df)

# Option 2: All done with pandas
df = df.append(DataFrame(df.sum(),
                   columns=['Total']).T)
```

Iterating over DataFrame rows

```
for (index, row) in df.iterrows(): # pass
```

Trap: row data type may be coerced.

Sorting DataFrame rows by column values

```
df = df.sort(df.columns[0],
                         ascending=False)
df.sort(['col1', 'col2'], inplace=True)
```

Random selection of rows

```
import random as r
k = 20 # pick a number
selection = r.sample(range(len(df)), k)
df_sample = df.iloc[selection, :]
```

Note: this sample is not sorted

Working with cells

Selecting a cell by row and column labels

```
value = df.at['row', 'col']
value = df.loc['row', 'col']
value = df['col']['row']         # tricky
```

Note: .at[] fastest label based scalar lookup

Setting a cell by row and column labels

```
df.at['row, 'col'] = value
df.loc['row, 'col'] = value
df['col']['row'] = value         # tricky
```

Selecting and slicing on labels

```
df = df.loc['row1':'row3', 'col1':'col3']
```

Note: the "to" on this slice is inclusive.

Setting a cross-section by labels

```
df.loc['A':'C', 'col1':'col3'] = np.nan
df.loc[1:2,'col1':'col2']=np.zeros((2,2))
df.loc[1:2,'A':'C']=othr.loc[1:2,'A':'C']
```

Remember: inclusive "to" in the slice

Selecting a cell by integer position

```
value = df.iat[9, 3]         # [row, col]
value = df.iloc[0, 0]        # [row, col]
value = df.iloc[len(df)-1,
                       len(df.columns)-1]
```

Selecting a range of cells by int position

```
df = df.iloc[2:4, 2:4] # subset of the df
df = df.iloc[:5, :5]   # top left corner
s = df.iloc[5, :] # returns row as Series
df = df.iloc[5:6, :] # returns row as row
```

Note: exclusive "to" – same as python list slicing.

Setting cell by integer position

```
df.iloc[0, 0] = value        # [row, col]
df.iat[7, 8] = value
```

Setting cell range by integer position

```
df.iloc[0:3, 0:5] = value
df.iloc[1:3, 1:4] = np.ones((2, 3))
df.iloc[1:3, 1:4] = np.zeros((2, 3))
df.iloc[1:3, 1:4] = np.array([[1, 1, 1],
                              [2, 2, 2]])
```

Remember: exclusive-to in the slice

.ix for mixed label and integer position indexing

```
value = df.ix[5, 'col1']
df = df.ix[1:5, 'col1':'col3']
```

Operate on the whole DataFrame

```
df.fillna(0, inplace=True) # np.nan → 0
df = df.replace(r'\s+', np.nan,
      regex=True) # white space → np.nan
```

Views and copies

From the manual: The rules about when a view on the data is returned are dependent on NumPy. Whenever an array of labels or a boolean vector are involved in the indexing operation, the result will be a copy.

Joining/Combining DataFrames

Three ways to join two DataFrames:

- merge (a database/SQL-like join operation)
- concat (stack side by side or one on top of the other)
- combine_first (splice the two together, choosing values from one over the other)

Merge on indexes

```
df_new = pd.merge(left=df1, right=df2,
          how='outer', left_index=True,
          right_index=True)
```

How: 'left', 'right', 'outer', 'inner'
How: outer=union/all; inner=intersection

Merge on columns

```
df_new = pd.merge(left=df1, right=df2,
          how='left', left_on='col1',
          right_on='col2')
```

Trap: When joining on columns, the indexes on the passed DataFrames are ignored.
Trap: many-to-many merges on a column can result in an explosion of associated data.

Join on indexes (another way of merging)

```
df_new = df1.join(other=df2, on='col1',
                how='outer')
df_new = df1.join(other=df2,on=['a','b'],
                how='outer')
```

Note: DataFrame.join() joins on indexes by default. DataFrame.merge() joins on common columns by default.

Simple concatenation is often the best

```
df=pd.concat([df1,df2],axis=0)#top/bottom
df = df1.append([df2, df3])   #top/bottom
df=pd.concat([df1,df2],axis=1)#left/right
```

Trap: can end up with duplicate rows or cols
Note: concat has an ignore_index parameter

Combine_first

```
df = df1.combine_first(other=df2)

# multi-combine with python reduce()
df = reduce(lambda x, y:
        x.combine_first(y),
            [df1, df2, df3, df4, df5])
```

Uses the non-null values from df1. The index of the combined DataFrame will be the union of the indexes from df1 and df2.

Group By: Split-Apply-Combine

The pandas "group by" mechanism allows us to split the data into groups, apply a function to each group independently and then combine the results.

Grouping

```
grouped = df.groupby('cat') # by one col
grouped2 = df.groupby(['c1','c2']) # by 2
print (grouped.groups)
```

Note: groupby() returns a pandas groupby object
Note: the groupby object attribute .groups contains a dictionary mapping of the groups.

Iterating groups

```
for name, group in grouped:
    print (name)
    print (group)
```

Selecting a group

```
dfa = df.groupby('cat').get_group('a')
dfb = df.groupby('cat').get_group('b')
```

Applying an aggregating function

```
s = df.groupby('cat')['col1'].sum()
s = df.groupby('cat')['col1'].agg(np.sum)
df_summary = df.groupby('cat').describe()
df_row_1s = df.groupby('cat').head(1)
```

Note: aggregating functions reduce the dimension by one – they include: mean, sum, size, count, std, var, sem, describe, first, last, min, max

Applying multiple functions

```
g = df.groupby('cat')
dfx = g['col2'].agg([np.sum, np.mean])
```

Note: g['col2'] above is shorthand for df.groupby('cat')['col2'], without the need for regrouping.

Group by a row index (non-hierarchical index)

```
df = df.set_index(keys='cat')
s = df.groupby(level=0)['col1'].sum()
dfg = df.groupby(level=0).sum()
```

Working with dates, times and their indexes

Dates and time – points and spans

With its focus on time-series data, pandas has a suite of tools for managing dates and time: either as a point in time (a Timestamp) or as a span of time (a Period).

```
t = pd.Timestamp('2013-01-01')
p = pd.Period('2013-01-01', freq='M')
```

Dates and time – stamps and spans as indexes

An index of Timestamps is a DatetimeIndex.
An index of Periods is a PeriodIndex.

```
date_strs = ['2014-01-01', '2014-04-01',
             '2014-07-01', '2014-10-01']

dti = pd.DatetimeIndex(date_strs)

pid = pd.PeriodIndex(date_strs, freq='D')
pim = pd.PeriodIndex(date_strs, freq='M')
piq = pd.PeriodIndex(date_strs, freq='Q')

print (pid[1] - pid[0])  # 90 days
print (pim[1] - pim[0])  #  3 months
print (piq[1] - piq[0])  #  1 quarter

time_strs = ['2015-01-01 02:10:40.12345',
             '2015-01-01 02:10:50.67890']
pis = pd.PeriodIndex(time_strs, freq='U')

df.index = pd.period_range('2015-01',
        periods=len(df), freq='M')

dti = pd.to_datetime(['04-01-2012'],
  dayfirst=True) # Australian date format
pi = pd.period_range('1960-01-01',
  '2015-12-31', freq='M')
```

Hint: unless you are working in less than seconds, prefer PeriodIndex over DateTimeImdex.

Frequency constants (not a complete list)

Name	Description
U	Microsecond
L	Millisecond
S	Second
T	Minute
H	Hour
D	Calendar day
B	Business day
W-{MON, TUE, …}	Week ending on …
MS	Calendar start of month
M	Calendar end of month
QS-{JAN, FEB, …}	Quarter start with year starting (QS – December)
Q-{JAN, FEB, …}	Quarter end with year ending (Q – December)
AS-{JAN, FEB, …}	Year start (AS - December)
A-{JAN, FEB, …}	Year end (A - December)

From DatetimeIndex to Python datetime objects

```
dti = pd.DatetimeIndex(pd.date_range(
  start='1/1/2011', periods=4, freq='M'))
s = Series([1,2,3,4], index=dti)
na = dti.to_pydatetime()      #numpy array
na = s.index.to_pydatetime() #numpy array
```

From DatetimeIndex to PeriodIndex and back

```
df = DataFrame(np.random.randn(20,3))
df.index = pd.date_range('2015-01-01',
       periods=len(df), freq='M')

dfp = df.to_period(freq='M')
dft = dfp.to_timestamp()
```

Note: from period to timestamp defaults to the point in time at the start of the period.

Working with a PeriodIndex

```
pi = pd.period_range('1960-01','2015-12',
                        freq='M')
na = pi.values  # numpy array of integers
lp = pi.tolist() # python list of Periods
sp = Series(pi)# pandas Series of Periods
ss = Series(pi).astype(str) # S of strs
ls = Series(pi).astype(str).tolist()
```

Error handling with dates

```
# 1st example returns string not Timestamp
t = pd.to_datetime('2014-02-30')
# 2nd example returns NaT (not a time)
t = pd.to_datetime('2014-02-30',
      coerce=True)
# NaT like NaN tests True for isnull()
b = pd.isnull(t) # --> True
```

Upsampling and downsampling

```
# upsample from quarterly to monthly
pi = pd.period_range('1960Q1',
       periods=220, freq='Q')
df = DataFrame(np.random.rand(len(pi),5),
       index=pi)
dfm = df.resample('M', convention='end')
# use ffill or bfill to fill with values

# downsample from monthly to quarterly
dfq = dfm.resample('Q', how='sum')
```

Row selection with a time-series index

```
# start with the play data above
idx = pd.period_range('2015-01',
       periods=len(df), freq='M')
df.index = idx

february_selector = (df.index.month == 2)
february_data = df[february_selector]

q1_data = df[(df.index.month >= 1) &
   (df.index.month <= 3)]

mayornov_data = df[(df.index.month == 5)
   | (df.index.month == 11)]

totals = df.groupby(df.index.year).sum()
```

Also: year, month, day [of month], hour, minute, second, dayofweek [Mon=0 .. Sun=6], weekofmonth, weekofyear [numbered from 1], week starts on Monday], dayofyear [from 1], …

The tail of a time-series DataFrame

```
df = df.last("5M") # the last five months
```

Working with missing and non-finite data

Working with missing data

Pandas uses the not-a-number construct (np.nan and float('nan')) to indicate missing data. The Python None can arise in data as well. It is also treated as missing data; as is the pandas not-a-time (pd.NaT) construct.

Missing data in a Series

```
s = Series( [8,None,float('nan'),np.nan])
           #[8,      NaN,   NaN,    NaN]
s.isnull() #[False, True, True,  True]
s.notnull()#[True, False, False, False]
```

Missing data in a DataFrame

```
df = df.dropna() # drop all rows with NaN
df = df.dropna(axis=1) # same for cols
df=df.dropna(how='all') #drop all NaN row
df=df.dropna(thresh=2) # drop 2+ NaN in r
# only drop row if NaN in a specified col
df = df.dropna(df['col'].notnull())
```

Non-finite numbers

With floating point numbers, pandas provides for positive and negative infinity.

```
s = Series([float('inf'), float('-inf'),
     np.inf, -np.inf])
```

Pandas treats integer comparisons with plus or minus infinity as expected.

Testing for finite numbers

(using the data from the previous example)

```
b = np.isfinite(s)
```

Working with Categorical Data

Categorical data

The pandas Series has an R factors-like data type for encoding categorical data.

```
s = Series(['a','b','a','c','b','d','a'],
                       dtype='category')
df['B'] = df['A'].astype('category')
```

Note: the key here is to specify the "category" data type.
Note: categories will be ordered on creation if they are sortable. This can be turned off. See ordering below.

Convert back to the original data type

```
s = Series(['a','b','a','c','b','d','a'],
                       dtype='category')
s = s.astype('string')
```

Ordering, reordering and sorting

```
s = Series(list('abc'), dtype='category')
print (s.cat.ordered)
s=s.cat.reorder_categories(['b','c','a'])
s = s.sort()
s.cat.ordered = False
```

Trap: category must be ordered for it to be sorted

Renaming categories

```
s = Series(list('abc'), dtype='category')
s.cat.categories = [1, 2, 3] # in place
s = s.cat.rename_categories([4,5,6])
# using a comprehension ...
s.cat.categories = ['Group ' + str(i)
    for i in s.cat.categories]
```

Trap: categories must be uniquely named

Adding new categories

```
s = s.cat.add_categories([4])
```

Removing categories

```
s = s.cat.remove_categories([4])
s.cat.remove_unused_categories() #inplace
```

Working with strings

Working with strings

```
# assume that df['col'] is series of
strings
s = df['col'].str.lower()
s = df['col'].str.upper()
s = df['col'].str.len()

# the next set work like Python
df['col'] += 'suffix'        # append
df['col'] *= 2               # duplicate
s = df['col1'] + df['col2'] # concatenate
```

Most python string functions are replicated in the pandas DataFrame and Series objects.

Regular expressions

```
s = df['col'].str.contains('regex')
s = df['col'].str.startswith('regex')
s = df['col'].str.endswith('regex')
s = df['col'].str.replace('old', 'new')
```

Note: pandas has many more regex methods.

Basic Statistics

Summary statistics

```
s = df['col1'].describe()
df1 = df.describe()
```

Value counts

```
s = df['col1'].value_counts()
```

Cross-tabulation (frequency count)

```
ct = pd.crosstab(index=df['a'],
        cols=df['b'])
```

Quantiles and ranking

```
quants = [0.05, 0.25, 0.5, 0.75, 0.95]
q = df.quantile(quants)
r = df.rank()
```

Histogram binning

```
count, bins = np.histogram(df['col1'])
count, bins = np.histogram(df['col'],
               bins=5)
count, bins = np.histogram(df['col1'],
               bins=[-3,-2,-1,0,1,2,3,4])
```

Correlation and covariance

```
df_cm = df.corr()
df_cv = df.cov()
```

Regression

```
import statsmodels.formula.api as sm
result = sm.ols(formula="col1 ~ col2 +
          col3", data=df).fit()
print (result.params)
print (result.summary())
```

Smoothing example using rolling_apply

```
k3x5 = np.array([1,2,3,3,3,2,1]) / 15.0
s = pd.rolling_apply(df['col1'],
       window=7,
         func=lambda x: (x * k3x5).sum(),
          min_periods=7, center=True)
```

Cautionary note

This cheat sheet was cobbled together by bots roaming the dark recesses of the Internet seeking ursine and pythonic myths. There is no guarantee the narratives were captured and transcribed accurately. You use these notes at your own risk. You have been warned.