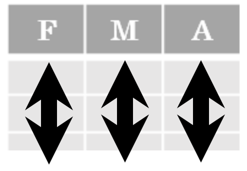
Data Wrangling

with pandas Cheat Sheet
http://pandas.pydata.org

Pandas API Reference   Pandas User Guide

Tidy Data – A foundation for wrangling in pandas

In a tidy data set:



Each **variable** is saved in its own **column**

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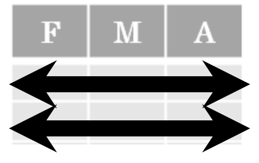
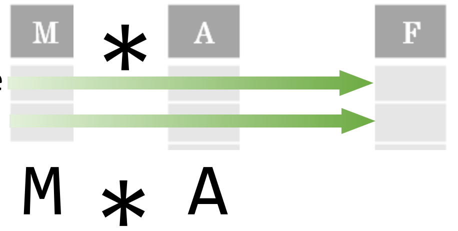


Each **observation** is saved in its own **row**

Tidy data complements pandas's **vectorized operations**. pandas will automatically preserve observations as you manipulate variables. No other format works as intuitively with pandas.



Creating DataFrames

	a	b	c
1	4	7	10
2	5	8	11
3	6	9	12

```
df = pd.DataFrame(
         {"a" : [4, 5, 6],
          "b" : [7, 8, 9],
          "c" : [10, 11, 12]},
        index = [1, 2, 3])
```
Specify values for each column.

```
df = pd.DataFrame(
     [[4, 7, 10],
      [5, 8, 11],
      [6, 9, 12]],
     index=[1, 2, 3],
     columns=['a', 'b', 'c'])
```
Specify values for each row.

		a	b	c
N	v			
D	1	4	7	10
	2	5	8	11
e	2	6	9	12

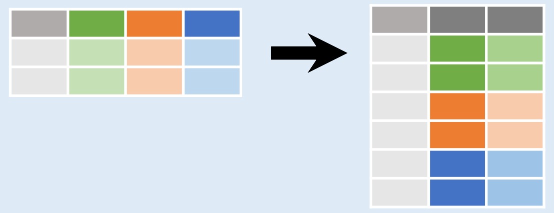
```
df = pd.DataFrame(
         {"a" : [4 ,5, 6],
          "b" : [7, 8, 9],
          "c" : [10, 11, 12]},
index = pd.MultiIndex.from_tuples(
        [('d', 1), ('d', 2),
         ('e', 2)], names=['n', 'v']))
```
Create DataFrame with a MultiIndex

Method Chaining

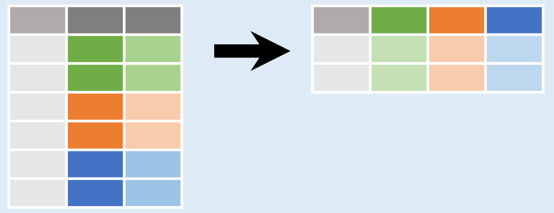
Most pandas methods return a DataFrame so that another pandas method can be applied to the result. This improves readability of code.

```
df = (pd.melt(df)
        .rename(columns={
                'variable':'var',
                'value':'val'})
        .query('val >= 200')
     )
```

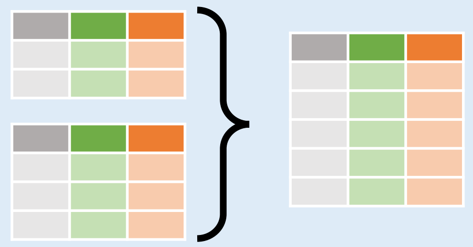
Reshaping Data – Change layout, sorting, reindexing, renaming



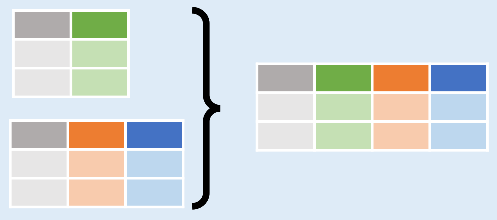
`pd.melt(df)`
Gather columns into rows.



`df.pivot(columns='var', values='val')`
Spread rows into columns.



`pd.concat([df1,df2])`
Append rows of DataFrames



`pd.concat([df1,df2], axis=1)`
Append columns of DataFrames

`df.sort_values('mpg')`
Order rows by values of a column (low to high).

`df.sort_values('mpg', ascending=False)`
Order rows by values of a column (high to low).

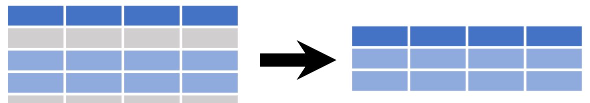
`df.rename(columns = {'y':'year'})`
Rename the columns of a DataFrame

`df.sort_index()`
Sort the index of a DataFrame

`df.reset_index()`
Reset index of DataFrame to row numbers, moving index to columns.

`df.drop(columns=['Length', 'Height'])`
Drop columns from DataFrame

Subset Observations - rows



`df[df.Length > 7]`
Extract rows that meet logical criteria.

`df.drop_duplicates()`
Remove duplicate rows (only considers columns).

`df.sample(frac=0.5)`
Randomly select fraction of rows.

`df.sample(n=10)` Randomly select n rows.

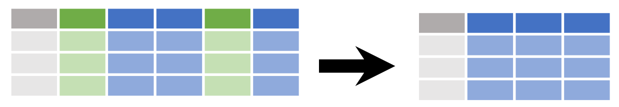
`df.nlargest(n, 'value')`
Select and order top n entries.

`df.nsmallest(n, 'value')`
Select and order bottom n entries.

`df.head(n)`
Select first n rows.

`df.tail(n)`
Select last n rows.

Subset Variables - columns



`df[['width', 'length', 'species']]`
Select multiple columns with specific names.

`df['width']` *or* `df.width`
Select single column with specific name.

`df.filter(regex='regex')`
Select columns whose name matches regular expression *regex*.

Using query

query() allows Boolean expressions for filtering rows.

```
df.query('Length > 7')
df.query('Length > 7 and Width < 8')
df.query('Name.str.startswith("abc")',
             engine="python")
```

Subsets - rows and columns

Use **`df.loc[]`** and **`df.iloc[]`** to select only rows, only columns or both.
Use **`df.at[]`** and **`df.iat[]`** to access a single value by row and column.
First index selects rows, second index columns.

`df.iloc[10:20]`
Select rows 10-20.

`df.iloc[:, [1, 2, 5]]`
Select columns in positions 1, 2 and 5 (first column is 0).

`df.loc[:, 'x2':'x4']`
Select all columns between x2 and x4 (inclusive).

`df.loc[df['a'] > 10, ['a', 'c']]`
Select rows meeting logical condition, and only the specific columns .

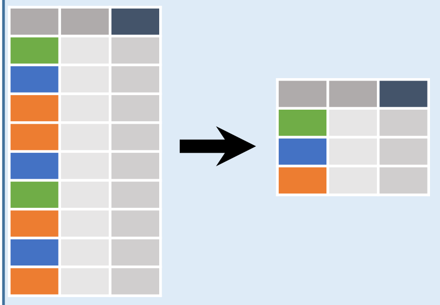
`df.iat[1, 2]` Access single value by index

`df.at[4, 'A']` Access single value by label

Logic in Python (and pandas)			
<	Less than	!=	Not equal to
>	Greater than	`df.column.isin(values)`	Group membership
==	Equals	`pd.isnull(obj)`	Is NaN
<=	Less than or equals	`pd.notnull(obj)`	Is not NaN
>=	Greater than or equals	`&,|,~,^,df.any(),df.all()`	Logical and, or, not, xor, any, all

regex (Regular Expressions) Examples	
`'\.'`	Matches strings containing a period '.'
`'Length$'`	Matches strings ending with word 'Length'
`'^Sepal'`	Matches strings beginning with the word 'Sepal'
`'^x[1-5]$'`	Matches strings beginning with 'x' and ending with 1,2,3,4,5
`'^(?!Species$).*'`	Matches strings except the string 'Species'

Group Data



`df.groupby(by="col")`
Return a GroupBy object, grouped by values in column named "col".

`df.groupby(level="ind")`
Return a GroupBy object, grouped by values in index level named "ind".

All of the summary functions listed above can be applied to a group.
Additional GroupBy functions:

`size()`
Size of each group.

`agg(function)`
Aggregate group using function.

The examples below can also be applied to groups. In this case, the function is applied on a per-group basis, and the returned vectors are of the length of the original DataFrame.

`shift(1)`
Copy with values shifted by 1.

`rank(method='dense')`
Ranks with no gaps.

`rank(method='min')`
Ranks. Ties get min rank.

`rank(pct=True)`
Ranks rescaled to interval [0, 1].

`rank(method='first')`
Ranks. Ties go to first value.

`shift(-1)`
Copy with values lagged by 1.

`cumsum()`
Cumulative sum.

`cummax()`
Cumulative max.

`cummin()`
Cumulative min.

`cumprod()`
Cumulative product.

Summarize Data

`df['w'].value_counts()`
Count number of rows with each unique value of variable

`len(df)`
# of rows in DataFrame.

`df.shape`
Tuple of # of rows, # of columns in DataFrame.

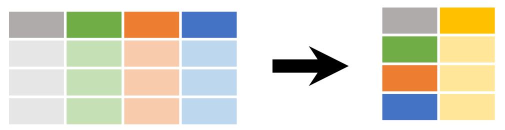
`df['w'].nunique()`
# of distinct values in a column.

`df.describe()`
Basic descriptive and statistics for each column (or GroupBy).

`df.info()`
Prints a concise summary of the DataFrame.

`df.memory_usage()`
Prints the memory usage of each column in the DataFrame.

`df.dtypes`
Prints a Series with the dtype of each column in the DataFrame.



pandas provides a large set of **summary functions** that operate on different kinds of pandas objects (DataFrame columns, Series, GroupBy, Expanding and Rolling (see below)) and produce single values for each of the groups. When applied to a DataFrame, the result is returned as a pandas Series for each column. Examples:

`sum()`
Sum values of each object.

`count()`
Count non-NA/null values of each object.

`median()`
Median value of each object.

`quantile([0.25,0.75])`
Quantiles of each object.

`apply(function)`
Apply function to each object.

`min()`
Minimum value in each object.

`max()`
Maximum value in each object.

`mean()`
Mean value of each object.

`var()`
Variance of each object.

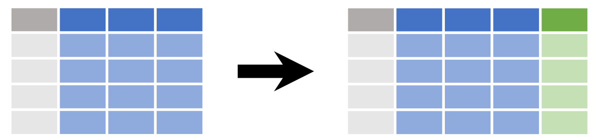
`std()`
Standard deviation of each object.

Handling Missing Data

`df.dropna()`
Drop rows with any column having NA/null data.

`df.fillna(value)`
Replace all NA/null data with value.

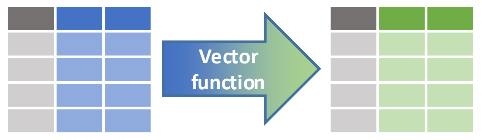
Make New Columns

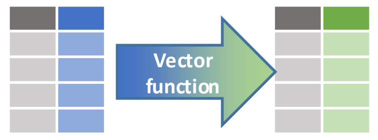


`df.assign(Area=lambda df: df.Length*df.Height)`
Compute and append one or more new columns.

`df['Volume'] = df.Length*df.Height*df.Depth`
Add single column.

`pd.qcut(df.col, n, labels=False)`
Bin column into n buckets.





pandas provides a large set of **vector functions** that operate on all columns of a DataFrame or a single selected column (a pandas Series). These functions produce vectors of values for each of the columns, or a single Series for the individual Series. Examples:

`max(axis=1)`
Element-wise max.

`clip(lower=-10,upper=10)`
Trim values at input thresholds

`min(axis=1)`
Element-wise min.

`abs()`
Absolute value.

Windows

`df.expanding()`
Return an Expanding object allowing summary functions to be applied cumulatively.

`df.rolling(n)`
Return a Rolling object allowing summary functions to be applied to windows of length n.

Combine Data Sets

adf

x1	x2
A	1
B	2
C	3

+

bdf

x1	x3
A	T
B	F
D	T

=

Standard Joins

x1	x2	x3
A	1	T
B	2	F
C	3	NaN

`pd.merge(adf, bdf,`
`         how='left', on='x1')`
Join matching rows from bdf to adf.

x1	x2	x3
A	1.0	T
B	2.0	F
D	NaN	T

`pd.merge(adf, bdf,`
`         how='right', on='x1')`
Join matching rows from adf to bdf.

x1	x2	x3
A	1	T
B	2	F

`pd.merge(adf, bdf,`
`         how='inner', on='x1')`
Join data. Retain only rows in both sets.

x1	x2	x3
A	1	T
B	2	F
C	3	NaN
D	NaN	T

`pd.merge(adf, bdf,`
`         how='outer', on='x1')`
Join data. Retain all values, all rows.

Filtering Joins

x1	x2
A	1
B	2

`adf[adf.x1.isin(bdf.x1)]`
All rows in adf that have a match in bdf.

x1	x2
C	3

`adf[~adf.x1.isin(bdf.x1)]`
All rows in adf that do not have a match in bdf.

ydf

x1	x2
A	1
B	2
C	3

+

zdf

x1	x2
B	2
C	3
D	4

=

Set-like Operations

x1	x2
B	2
C	3

`pd.merge(ydf, zdf)`
Rows that appear in both ydf and zdf (Intersection).

x1	x2
A	1
B	2
C	3
D	4

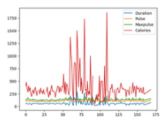
`pd.merge(ydf, zdf, how='outer')`
Rows that appear in either or both ydf and zdf (Union).

x1	x2
A	1

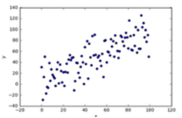
```
pd.merge(ydf, zdf, how='outer',
         indicator=True)
.query('_merge == "left_only"')
.drop(columns=['_merge'])
```
Rows that appear in ydf but not zdf (Setdiff).

Plotting

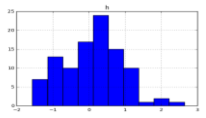
df.plot()
Plot a line graph for the DataFrame.



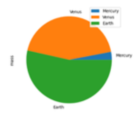
df.plot.scatter(x='w', y='h')
Plot a scatter graph of the DataFrame.



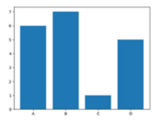
df.plot.hist()
Plot a histogram of the DataFrame.



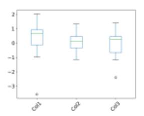
df.plot.pie()
Plot a pie chart of the DataFrame.



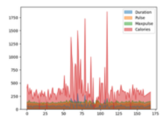
df.plot.bar()
Plot a line graph for the DataFrame.



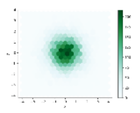
df.plot.boxplot()
Plot a scatter graph of the DataFrame.



df.plot.area()
Plot an area graph of the DataFrame.



df.plot.hexbin()
Plot a hexbin graph of the DataFrame.



df.plot(subplots=True)
Separate into different graphs for each column in the DataFrame.

df.plot(title="Graph of A against B")
Sets the title of the graph.

df.plot(cumulative=True)
Creates a cumulative plot

df.plot(bins=30)
Set the number of bins into which data is grouped (histograms)

df.plot(stacked=True)
Stacks the data for the columns on top of each other. (bar, barh and area only)

df.plot(alpha=0.5)
Sets the transparency of the plot to 50%.

df.plot(subplots=True, title=['col1', 'col2', 'col3'])
Arguments can be combined for more flexibility when graphing, this would plot a separate line graph for of column of a 3-columned DataFrame. The first string in the list of titles applies to the graph of the left-most column.

Changing Type

pd.to_numeric(data)
Convert non-numeric types to numeric.

pd.to_datetime(data)
Convert non-datetime types to datetime type

pd.to_timedelta(data)
Convert non- timedelta types to timedelta

df.astype(type)
Convert data to (almost) any given type including categorical

df.infer_objects()
Attempts to infer a better type for object type data.

df.convert_dtypes()
Convert columns to best possible dtypes

Datetime

With a Series containing data of type datetime, the dt accessor is used to get various components of the datetime values:

s.dt.year
Extract the year

s.dt.month
Extract the month as an integer.

s.dt.day
Extract the day (int) from the date.

s.dt.quarter
Find which quarter the date lies in.

s.dt.hour
Extract the hour.

s.dt.minute
Extract the minute.

s.dt.second
Extract the second.

Mapping

Apply a mapping to every element in a DataFrame or Series, useful for recategorizing or transforming data.

s.map(lambda x: 2*x)
Returns a copy of the series where every entry is doubled

df.apply(lambda s: s.max() - s.min(), axis=1)
Returns a Series with the difference of the maximum and minimum values of each row of the DataFrame

Series String Operations

Similar to python string operations, except these are vectorized to apply to the entire Series efficiently.

s.str.count(pattern)
Returns a series with the integer counts in each element.

s.str.get(index)
Returns a series with the data at the given index for each element.

s.str.join(sep)
Returns a series where each element has been concatenated.

s.str.title()
Converts the first character of each word to be a capital.

s.str.len()
Returns a series with the lengths of each element.

s.str.cat()
Concatenate elements into a single string

s.str.partition(sep)
Splits the string on the first instance of the separator

s.str.slice(start, stop, step)
Slices each string

s.str.replace(pat, rep)
Use regex to replace patterns in each string.

s.str.isalnum()
Checks whether each element is alpha-numeric

Input/Output

Common file types for data input include CSV, JSON, HTML which are human-readable, while the common output types are usually more optimized for performance and scalability such as feather, parquet and HDF.

df = pd.read_csv(filepath)
Read data from csv file

df = pd.read_html(filepath)
Read data from html file

df = pd.read_excel(filepath)
Read data from xls (and related) files

df = pd.read_sql(filepath)
Read data from sql file

pd.read_clipboard()
Read text from clipboard

df.to_parquet(filepath)
Write data to parquet file

df.to_feather(filepath)
Write data to feather file

df.to_hdf(filepath)
Write data to HDF file

df.to_clipboard()
Copy object to the system clipboard

Frequently Used Options

Pandas offers some 'options' to globally control how Pandas behaves, display etc. Options can be queried and set via: **pd.options.*option_name*** (where *option_name* is the name of an option). For example:

pd.options.display.max_rows = 20
Set the **display.max_rows** option to 20.

Functions

get_option(option)
Fetch the value of the given option.

set_option(option)
Set the value of the given option.

reset_option(options)
Reset the values of all given options to default settings.

describe_option(options)
Print descriptions of given options.

option_context(options)
Execute code with temporary option settings that revert to prior settings after execution.

Display options

display.max_rows
The maximum number of rows displayed in pretty-print.

display.max_columns
The maximum number of columns displayed in pretty-print.

display.expand_frame_repr
Controls whether the DataFrame representation stretches across pages.

display.large_repr
Controls whether a DataFrame that exceeds maximum rows/columns is truncated or summarized

display.precision
The output display precision in decimal places.

display.max_colwidth
The maximum width of columns, longer cells will be truncated.

display.max_info_columns
The maximum number of columns displayed after calling **info()**.

display.chop_threshold
Sets the rounding threshold to zero when displaying a Series/DataFrame.

display.colheader_justify
Controls how column headers are justified.