Study Guide: Data Manipulation with Python

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Main concepts

❏ **File management** – The table below summarizes the useful commands to make sure the working directory is correctly set:

Category	Action	Command
Paths	Change directory to another path	os.chdir(path)
	Get current working directory	os.getcwd()
	Join paths	os.path.join(path_1, ..., path_n)
Files	List files and folders in a directory	os.listdir(path)
	Check if path is a file / folder	os.path.isfile(path) os.path.isdir(path)
	Read / write csv file	pd.read_csv(path_to_csv_file) df.to_csv(path_to_csv_file)

❏ **Chaining** – It is common to have successive methods applied to a data frame to improve readability and make the processing steps more concise. The method chaining is done as follows:

```Python
# df gets some_operation_1, then some_operation_2, ..., then some_operation_n
(df
.some_operation_1(params_1)
.some_operation_2(params_2)
.     ...
.some_operation_n(params_n))
```

❏ **Exploring the data** – The table below summarizes the main functions used to get a complete overview of the data:

Category	Action	Command
Look at data	Select columns of interest	df[col_list]
	Remove unwanted columns	df.drop(col_list, axis=1)
	Look at n first rows / last rows	df.head(n) / df.tail(n)
	Summary statistics of columns	df.describe()
Paths	Data types of columns	df.dtypes / df.info()
	Number of (rows, columns)	df.shape

❏ **Data types** – The table below sums up the main data types that can be contained in columns:

Data type	Description	Example
object	String-related data	'teddy bear'
float64	Numerical data	24.0
int64	Numeric data that are integer	24
datetime64	Timestamps	'2020-01-01 00:01:00'

Data preprocessing

❏ **Filtering** – We can filter rows according to some conditions as follows:

```Python
df[df['some_col'] some_operation some_value_or_list_or_col]
```

where some_operation is one of the following:

Category	Operation	Command
Basic	Equality / non-equality	== / !=
	Inequalities	<, <=, >=, >
	And / or	& /	
Advanced	Check for missing value	pd.isnull()
	Belonging	.isin([val_1, ..., val_n])
	Pattern matching	.str.contains('val')

❏ **Changing columns** – The table below summarizes the main column operations:

Operation	Command
Add new columns on top of old ones	df.assign(new_col=lambda x: some_operation(x))
Rename columns	df.rename(columns={ 'current_col': 'new_col_name'}) })
Unite columns	df['new_merged_col'] = (df[old_cols_list].agg('-'.join, axis=1))

❏ **Conditional column** – A column can take different values with respect to a particular set of conditions with the np.select() command as follows:

Python

```python
np.select(
    [condition_1, ..., condition_n],   # If condition_1, ..., condition_n
    [value_1, ..., value_n],           # Then value_1, ..., value_n respectively
    default=default_value              # Otherwise, default_value
)
```

Remark: the np.where(condition_if_true, value_true, value_other) *command can be used and is easier to manipulate if there is only one condition.*

❏ **Mathematical operations** – The table below sums up the main mathematical operations that can be performed on columns:

Operation	Command
$\sqrt{x}$	np.sqrt(x)
$\lfloor x \rfloor$	np.floor(x)
$\lceil x \rceil$	np.ceil(x)

❏ **Datetime conversion** – Fields containing datetime values are converted from string to datetime as follows:

Python

```python
pd.to_datetime(col, format)
```

where format is a string describing the structure of the field and using the commands summarized in the table below:

Category	Command	Description	Example
Year	'%Y' / '%y'	With / without century	2020 / 20
Month	'%B' / '%b' / '%m'	Full / abbreviated / numerical	August / Aug / 8
Weekday	'%A' / '%a'	Full / abbreviated	Sunday / Sun
	'%u' / '%w'	Number (1-7) / Number (0-6)	7 / 0
Day	'%d' / '%j'	Of the month / of the year	09 / 222
Time	'%H' / '%M'	Hour / minute	09 / 40
Timezone	'%Z' / '%z'	String / Number of hours from UTC	EST / -0400

❏ **Date properties** – In order to extract a date-related property from a datetime object, the following command is used:

Python

```python
datetime_object.strftime(format)
```

where format follows the same convention as in the table above.

Data frame transformation

❏ **Merging data frames** – We can merge two data frames by a given field as follows:

Python

```python
df1.merge(df2, join_field, join_type)
```

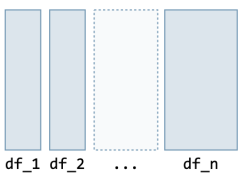where join_field indicates fields where the join needs to happen:

Case	Fields are equal	Fields are different
Command	on='field'	left_on='field_1', right_on='field_2'

and where join_type indicates the join type, and is one of the following:

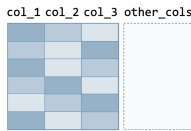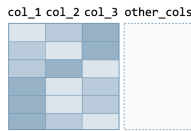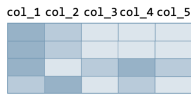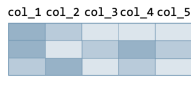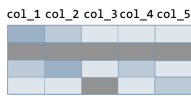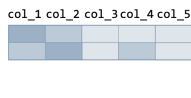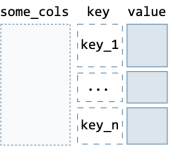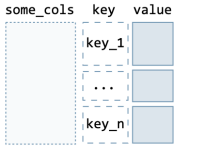| Join type	Option	Illustration
Inner join	how='inner'	
Left join	how='left'	
Right join	how='right'	
Full join	how='outer'	

Remark: a cross join can be done by joining on an undifferentiated column, typically done by creating a temporary column equal to 1.

❏ **Concatenation** – The table below summarizes the different ways data frames can be concatenated:

Type	Command	Illustration
Rows	`pd.concat([df_1, ..., df_n], axis=0)`	df_1 df_2 ⋮ df_n
Columns	`pd.concat([df_1, ..., df_n], axis=1)`	df_1 df_2 ... df_n

❒ **Common transformations** – The common data frame transformations are summarized in the table below:

Type	Command	Illustration Before	Illustration After

Long to wide	`pd.pivot_table(`
	    `df, values='value',`
	    `index=some_cols,`
	    `columns='key',`
	    `aggfunc=np.sum`
	`)`
		some_cols key value
		key_1
		...
		key_n
			some_cols key_1 ... key_n

Wide to long	`pd.melt(`
	    `df, var_name='key',`
	    `value_name='value',`
	    `value_vars=[`
	        `'key_1', ..., 'key_n'`
	    `], id_vars=some_cols`
	`)`
		some_cols key_1 ... key_n	some_cols key value
			key_1
			...
			key_n

❒ **Row operations** – The following actions are used to make operations on rows of the data frame:

Action	Command	Illustration Before	Illustration After

Sort with respect to columns	`df.sort_values(`
	    `by=['col_1', ..., 'col_n'],`
	    `ascending=True`
	`)`
		col_1 col_2 col_3 other_cols	col_1 col_2 col_3 other_cols

Dropping duplicates	`df.drop_duplicates()`	col_1 col_2 col_3 col_4 col_5	col_1 col_2 col_3 col_4 col_5
Drop rows with at least a null value	`df.dropna()`	col_1 col_2 col_3 col_4 col_5	col_1 col_2 col_3 col_4 col_5

Aggregations

❒ **Grouping data** – A data frame can be aggregated with respect to given columns as follows:

col_1 ... col_n some_cols   col_1 ... col_n agg_metric
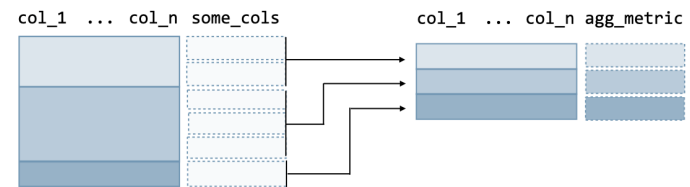
The Python command is as follows:

```Python
(df
.groupby(['col_1', ..., 'col_n'])
.agg({'col': builtin_agg})
```

where `builtin_agg` is among the following:

| Category	Action	Command
Properties	Count of observations	`'count'`
Values	Sum of values of observations	`'sum'`
	Max / min of values of observations	`'max' / 'min'`
	Mean / median of values of observations	`'mean' / 'median'`
	Standard deviation / variance across observations	`'std' / 'var'`

❏ **Custom aggregations** – It is possible to perform customized aggregations by using lambda functions as follows:

```python
df_agg = (
    df
    .groupby(['col_1', ..., 'col_n'])
    .apply(lambda x: pd.Series({
        'agg_metric': some_aggregation(x)
    }))
)
```

Window functions

❏ **Definition** – A window function computes a metric over groups and has the following structure:
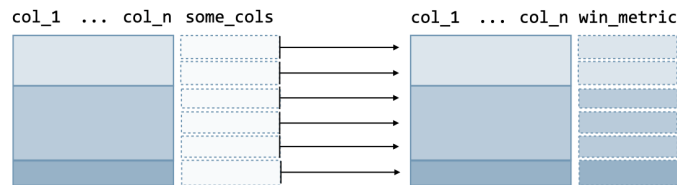
The Python command is as follows:

```python
(df
.assign(win_metric = lambda x:
        x.groupby(['col_1', ..., 'col_n'])['col'].window_function(params))
```

Remark: applying a window function will not change the initial number of rows of the data frame.

❏ **Row numbering** – The table below summarizes the main commands that rank each row across specified groups, ordered by a specific field:

Join type	Command	Example
`x.rank(method='first')`	Ties are given different ranks	1, 2, 3, 4
`x.rank(method='min')`	Ties are given same rank and skip numbers	1, 2.5, 2.5, 4
`x.rank(method='dense')`	Ties are given same rank and do not skip numbers	1, 2, 2, 3

❏ **Values** – The following window functions allow to keep track of specific types of values with respect to the group:

Command	Description
`x.shift(n)`	Takes the nth previous value of the column
`x.shift(-n)`	Takes the nth following value of the column