



CLEANING DATA IN PYTHON

Data types



Prepare and clean data

	name	sex	treatment a	treatment b
0	Daniel	male	-	42
1	John	male	12	31
2	Jane	female	24	27



Data types

```
In [1]: print(df.dtypes)
name      object
sex        object
treatment a  object
treatment b  int64
dtype: object
```

- There may be times we want to convert from one type to another
 - Numeric columns can be strings, or vice versa



Converting data types

```
In [2]: df['treatment b'] = df['treatment b'].astype(str)
```

```
In [3]: df['sex'] = df['sex'].astype('category')
```

```
In [4]: df.dtypes
```

```
Out[4]:
```

name	object
sex	category
treatment a	object
treatment b	object
dtype:	object



Categorical data

- Converting categorical data to 'category' dtype:
 - Can make the DataFrame smaller in memory
 - Can make them be utilized by other Python libraries for analysis



Cleaning data

- Numeric data loaded as a string

	name	sex	treatment a	treatment b
0	Daniel	male	-	42
1	John	male	12	31
2	Jane	female	24	27



Cleaning bad data

```
In [5]: df['treatment a'] = pd.to_numeric(df['treatment a'],  
....:                                     errors='coerce')
```

```
In [6]: df.dtypes
```

```
Out[6]:
```

name	object
sex	category
treatment a	float64
treatment b	object
dtype:	object



CLEANING DATA IN PYTHON

Let's practice!



CLEANING DATA IN PYTHON

Using regular expressions to clean strings



String manipulation

- Much of data cleaning involves string manipulation
 - Most of the world's data is unstructured text
- Also have to do string manipulation to make datasets consistent with one another



Validate values

- 17
- \$17
- \$17.89
- \$17.895



String manipulation

- Many built-in and external libraries
- 're' library for regular expressions
 - A formal way of specifying a pattern
 - Sequence of characters
- Pattern matching
 - Similar to globbing



Example match

- 17 12345678901 `\d*`
- \$17 \$12345678901 `\$\d*`
- \$17.00 \$12345678901.42 `\$\d* \.\d*`
- \$17.89 \$12345678901.24 `\$\d* \.\d{2}`
- ~~\$17.895 \$12345678901.999~~ `^\$\d* \.\d{2}$`

“I have 17.89 USD”



Using regular expressions

- Compile the pattern
- Use the compiled pattern to match values
- This lets us use the pattern over and over again
- Useful since we want to match values down a column of values



Using regular expressions

```
In [1]: import re
```

```
In [2]: pattern = re.compile('\$\d*\.\d{2}')
```

```
In [3]: result = pattern.match('$17.89')
```

```
In [4]: bool(result)  
True
```



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Using functions to clean data



Complex cleaning

- Cleaning step requires multiple steps
 - Extract number from string
 - Perform transformation on extracted number
- Python function



Apply

```
In [1]: print(df)
```

	treatment a	treatment b
Daniel	18	42
John	12	31
Jane	24	27

```
In [2]: df.apply(np.mean, axis=0)
```

```
Out[2]:
```

treatment a	18.000000
treatment b	33.333333

```
dtype: float64
```



Apply

```
In [3]: print(df)
```

	treatment a	treatment b
Daniel	18	42
John	12	31
Jane	24	27

```
In [4]: df.apply(np.mean, axis=1)
```

```
Out[4]:
```

Daniel	30.0
John	21.5
Jane	25.5

```
dtype: float64
```



Applying functions

	Job #	Doc #	Borough	Initial Cost	Total Est. Fee
0	121577873	2	MANHATTAN	\$75000.00	\$986.00
1	520129502	1	STATEN ISLAND	\$0.00	\$1144.00
2	121601560	1	MANHATTAN	\$30000.00	\$522.50
3	121601203	1	MANHATTAN	\$1500.00	\$225.00
4	121601338	1	MANHATTAN	\$19500.00	\$389.50



Write the regular expression

```
In [5]: import re
```

```
In [6]: from numpy import NaN
```

```
In [7]: pattern = re.compile('^$\d*\.\d{2}$')
```



Writing a function

 example.py

```
def my_function(input1, input2):  
    # Function Body  
    return value
```



Write the function

diff_money.py

```
def diff_money(row, pattern):  
  
    icost = row['Initial Cost']  
    tef = row['Total Est. Fee']  
  
    if bool(pattern.match(icost)) and bool(pattern.match(tef)):  
  
        icost = icost.replace("$", "")  
        tef = tef.replace("$", "")  
  
        icost = float(icost)  
        tef = float(tef)  
  
        return icost - tef  
    else:  
  
        return(NaN)
```




Write the function

```
In [8]: df_subset['diff'] = df_subset.apply(diff_money,  
...:                                     axis=1,  
...:                                     pattern=pattern)
```

```
In [9]: print(df_subset.head())
```

	Job #	Doc #	Borough	Initial Cost	Total Est. Fee	diff
0	121577873	2	MANHATTAN	\$75000.00	\$986.00	74014.0
1	520129502	1	STATEN ISLAND	\$0.00	\$1144.00	-1144.0
2	121601560	1	MANHATTAN	\$30000.00	\$522.50	29477.5
3	121601203	1	MANHATTAN	\$1500.00	\$225.00	1275.0
4	121601338	1	MANHATTAN	\$19500.00	\$389.50	19110.5



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Duplicate and missing data



Duplicate data

- Can skew results
- `‘.drop_duplicates()’` method

	name	sex	treatment a	treatment b
0	Daniel	male	-	42
1	John	male	12	31
2	Jane	female	24	27
3	Daniel	male	-	42



Drop duplicates

```
In [1]: df = df.drop_duplicates()
```

```
In [2]: print(df)
```

	name	sex	treatment a	treatment b
0	Daniel	male	-	42
1	John	male	12	31
2	Jane	female	24	27



Missing data

	total_bill	tip	sex	smoker	day	time	size
0	16.99	1.01	Female	No	Sun	Dinner	2.0
1	NaN	1.66	Male	No	Sun	Dinner	3.0
2	21.01	3.50	Male	No	Sun	Dinner	3.0
3	23.68	NaN	Male	No	Sun	Dinner	2.0
4	24.59	3.61	NaN	NaN	Sun	NaN	4.0

- Leave as-is
- Drop them
- Fill missing value



Count missing values

```
In [3]: tips_nan.info()
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 244 entries, 0 to 243
Data columns (total 7 columns):
total_bill    202 non-null float64
tip           220 non-null float64
sex           234 non-null object
smoker        229 non-null object
day           243 non-null object
time          227 non-null object
size          231 non-null float64
dtypes: float64(3), object(4)
memory usage: 13.4+ KB
None
```



Drop missing values

```
In [4]: tips_dropped = tips_nan.dropna()
```

```
In [5]: tips_dropped.info()
<class 'pandas.core.frame.DataFrame'>
Int64Index: 147 entries, 0 to 243
Data columns (total 7 columns):
total_bill    147 non-null float64
tip           147 non-null float64
sex           147 non-null object
smoker        147 non-null object
day           147 non-null object
time          147 non-null object
size          147 non-null float64
dtypes: float64(3), object(4)
memory usage: 9.2+ KB
```


Fill missing values with `.fillna()`

- Fill with provided value
- Use a summary statistic



Fill missing values

```
In [6]: tips_nan['sex'] = tips_nan['sex'].fillna('missing')
```

```
In [7]: tips_nan[['total_bill', 'size']] = tips_nan[['total_bill',  
....:                                                'size']].fillna(0)
```

```
In [8]: tips_nan.info()  
<class 'pandas.core.frame.DataFrame'>  
RangeIndex: 244 entries, 0 to 243  
Data columns (total 7 columns):  
total_bill    244 non-null float64  
tip           220 non-null float64  
sex           244 non-null object  
smoker        229 non-null object  
day           243 non-null object  
time          227 non-null object  
size          244 non-null float64  
dtypes: float64(3), object(4)  
memory usage: 13.4+ KB
```



Fill missing values with a test statistic

- Careful when using test statistics to fill
- Have to make sure the value you are filling in makes sense
- Median is a better statistic in the presence of outliers



Fill missing values with a test statistic

```
In [9]: mean_value = tips_nan['tip'].mean()
```

```
In [10]: print(mean_value)
2.964681818181819
```

```
In [11]: tips_nan['tip'] = tips_nan['tip'].fillna(mean_value)
```

```
In [12]: tips_nan.info()
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 244 entries, 0 to 243
Data columns (total 7 columns):
total_bill    244 non-null float64
tip           244 non-null float64
sex           244 non-null object
smoker        229 non-null object
day           243 non-null object
time          227 non-null object
size          244 non-null float64
dtypes: float64(3), object(4)
memory usage: 13.4+ KB
```



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Testing with asserts



Assert statements

- Programmatically vs visually checking
- If we drop or fill NaNs, we expect 0 missing values
- We can write an assert statement to verify this
- We can detect early warnings and errors
- This gives us confidence that our code is running correctly



Asserts

```
In [1]: assert 1 == 1
```

```
In [2]: assert 1 == 2
```

```
-----  
AssertionError                                Traceback (most recent call last)  
<ipython-input-65-a810b3a4aded> in <module>()  
----> 1 assert 1 == 2
```

```
AssertionError:
```




Google stock data

	Date	Open	High	Low	Close	Volume	Adj Close
0	2017-02-09	831.729980	NaN	826.500000	830.059998	1192000.0	NaN
1	2017-02-08	830.530029	834.250000	825.109985	829.880005	1300600.0	829.880005
2	2017-02-07	NaN	NaN	823.289978	NaN	1664800.0	NaN
3	2017-02-06	820.919983	822.390015	NaN	821.619995	NaN	821.619995
4	2017-02-03	NaN	826.130005	819.349976	820.130005	1524400.0	820.130005



Test column

```
In [1]: assert google.Close.notnull().all()
```

```
-----  
AssertionError                                Traceback (most recent call last)  
<ipython-input-49-eec77130a77f> in <module>()  
----> 1 assert google.Close.notnull().all()
```

```
AssertionError:
```



Test column

```
In [1]: google_0 = google.fillna(value=0)
```

```
In [2]: assert google_0.Close.notnull().all()
```



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