Welcome to the CoGrammar Data Cleaning

The session will start shortly...

Questions? Drop them in the chat. We'll have dedicated moderators answering questions.

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Data Science Session Housekeeping

- The use of disrespectful language is prohibited in the questions, this is a supportive, learning environment for all - please engage accordingly. **(Fundamental British Values: Mutual Respect and Tolerance)**
- No question is daft or silly - **ask them!**
- There are **Q&A sessions** midway and at the end of the session, should you wish to ask any follow-up questions. Moderators are going to be answering questions as the session progresses as well.
- If you have any questions outside of this lecture, or that are not answered during this lecture, please do submit these for upcoming Academic Sessions. You can submit these questions here: **Questions**

Data Science Session Housekeeping cont.

- For all **non-academic questions**, please submit a query:
  www.hyperiondev.com/support

- Report a **safeguarding** incident:
  www.hyperiondev.com/safeguardreporting

- We would love your **feedback** on lectures: **Feedback on Lectures**

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Data Cleaning

April 2024

Data Cleaning

- Data cleaning is a crucial step in the data science pipeline
- Ensures **data quality and reliability** for analysis and modeling
- Common data quality issues include **missing data, duplicates, inconsistent formatting, and outliers**

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Learning objectives

- ❖ Describe techniques for **handling missing data** and when each is appropriate to use.
- ❖ Demonstrate how to identify and remove duplicate records in a dataset using Pandas.
- ❖ Explain the importance of **consistent data formatting and apply methods to standardise data.**
- ❖ Define **outliers** and discuss strategies for detecting and handling them appropriately based on the data context.

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Missing Data

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Handling Missing Data

- Missing data refers to the **absence of values in one or more variables in a dataset.**

- Identifying missing values:
  - Look for **null, NaN, or empty cells in the dataset**.
  - Use functions like **isnull()** or **isna()** in Pandas

```
# Identify missing values
df_missing.isnull().sum()
```

✓ 0.0s

```
total_bill    10
tip            0
sex           10
smoker         0
day            0
time           0
size           0
dtype: int64
```

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Understand Missing Data Mechanisms

- These mechanisms are more important if you do research in the field, so we're going to glaze over it
- It helps us understand what techniques to use, but **we could intuit it in most cases**
- Here is the [original paper]

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Understand Missing Data Mechanisms

- **MCAR:** Missing Completely at Random (missingness unrelated to any variables)
  - Smoking status is not recorded in a random sample of patients
- **MAR:** Missing at Random (missingness depends on observed variables)
  - Smoking status is not documented in female patients because the doctor was to shy to ask 🙂
- **MNAR:** Missing Not at Random (missingness depends on missing values themselves)
  - Smoking status is not recorded in patients admitted as an emergency, who are also more likely to have worse outcomes from surgery

Techniques for Handling Missing Data

- **Deletion:** Remove records with missing values (only suitable if missing data is minimal and random).
  - Suitable for random missingness
  - Not the first resort, dropping data means losing some important context or skewing the dataset in some cases

```python
df.shape
```

✓ 0.0s

```
(244, 7)
```

```python
# Deletion: Remove records with missing values
df_deleted = df_missing.dropna()
df_deleted.shape
```

✓ 0.0s

```
(225, 7)
```

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Techniques for Handling Missing Data

❖ **Imputation:** Fill in missing values with estimated or calculated values.

➢ Simple imputation: Mean, median, or mode imputation

```
# Simple Imputation: Fill missing values with mean for numeric columns and mode for categorical
# columns
df_imputed = df_missing.copy()
df_imputed['total_bill'] = df_imputed['total_bill'].fillna(df_imputed['total_bill'].mean())
df_imputed['sex'] = df_imputed['sex'].fillna(df_imputed['sex'].mode()[0])
```

➢ Advanced imputation: K-Nearest Neighbors (KNN), Multiple Imputation by Chained Equations (MICE)

■ We'll get to KNN in another lecture 🤩

Techniques for Handling Missing Data

```python
# Advanced Imputation: KNN Imputation
from sklearn.impute import KNNImputer

# Create a copy of the dataset for KNN imputation
df_imputed_knn = df_missing.copy()

# Initialize and fit the KNN imputer
imputer = KNNImputer(n_neighbors=5)
df_imputed_knn[['total_bill', 'tip', 'size']] = imputer.fit_transform(
    df_imputed_knn[['total_bill', 'tip', 'size']]
)
```

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Which of the following is NOT a common data quality issue?

A. Missing values
B. Duplicates
C. Inconsistent formatting
D. Small sample size

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Which of the following is NOT a common data quality issue?

A. Missing values

B. Duplicates

C. Inconsistent formatting

D. Small sample size

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Which technique is suitable for handling missing data only if the amount is minimal and missing at random?

A. Mean imputation

B. Deletion

C. K-Nearest Neighbours imputation

D. Multiple Imputation by Chained Equations

Which technique is suitable for handling missing data only if the amount is minimal and missing at random?

A. Mean imputation

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C. K-Nearest Neighbours imputation

D. Multiple Imputation by Chained Equations

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Duplicates

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Dealing with Duplicates

- Identify duplicates using functions like duplicated() in Pandas

```python
# Show all duplicated rows
df_duplicates[df_duplicates.duplicated(keep=False)]
```

keep = False just marks all duplicates.

	total_bill	tip	sex	smoker	day	time	size
46	22.23	5.00	Male	No	Sun	Dinner	2
92	5.75	1.00	Female	Yes	Fri	Dinner	2
123	15.95	2.00	Male	No	Thur	Lunch	2
158	13.39	2.61	Female	No	Sun	Dinner	2
198	13.00	2.00	Female	Yes	Thur	Lunch	2
202	13.00	2.00	Female	Yes	Thur	Lunch	2
234	15.53	3.00	Male	Yes	Sat	Dinner	2
244	22.23	5.00	Male	No	Sun	Dinner	2
245	15.53	3.00	Male	Yes	Sat	Dinner	2
246	13.39	2.61	Female	No	Sun	Dinner	2
247	5.75	1.00	Female	Yes	Fri	Dinner	2
248	15.95	2.00	Male	No	Thur	Lunch	2

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Dealing with Duplicates

❖ Dropping duplicates is fine and encouraged, it does not cause the data to lost necessary context

```
# Remove duplicate records
df_deduplicated = df_duplicates.drop_duplicates()
```

In Pandas, which function can be used to identify duplicate records in a dataset?

A. find_duplicates()

B. duplicated()

C. is_duplicate()

D. has_duplicates()

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Formatting and Standardization

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Data Formatting and Standardization

- Consistent data formatting is essential for accurate analysis and compatibility
- Common formatting issues:
  - **Date and time formats:** Ensure consistent representation (e.g., YYYY-MM-DD, HH:MM:SS)
  - **Text case inconsistencies:** Convert text to a consistent case (lowercase or uppercase)
  - **Inconsistent value representations:** Standardize values (e.g., "Yes"/"No" vs. "Y"/"N")

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Data Formatting and Standardization

- Techniques for standardizing data:
  - Convert date/time columns using to_datetime()
  - Convert text case using str.lower() or str.upper()
  - Map inconsistent values to standardized representations

```python
# Standardize text case for 'sex' and 'smoker' columns
df['sex'] = df['sex'].str.upper()
df['smoker'] = df['smoker'].str.title()

df.head()
```

✓ 0.0s

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

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Which of the following is a technique for standardising inconsistent text case?

A. astype()

B. to_datetime()

C. upper() or lower()

D. strip()

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Which of the following is a technique for standardising inconsistent text case?

A. astype()

B. to_datetime()

C. upper() or lower()

D. strip()

Outliers

Outliers

- Outliers are data points that significantly deviate from the rest of the data distribution

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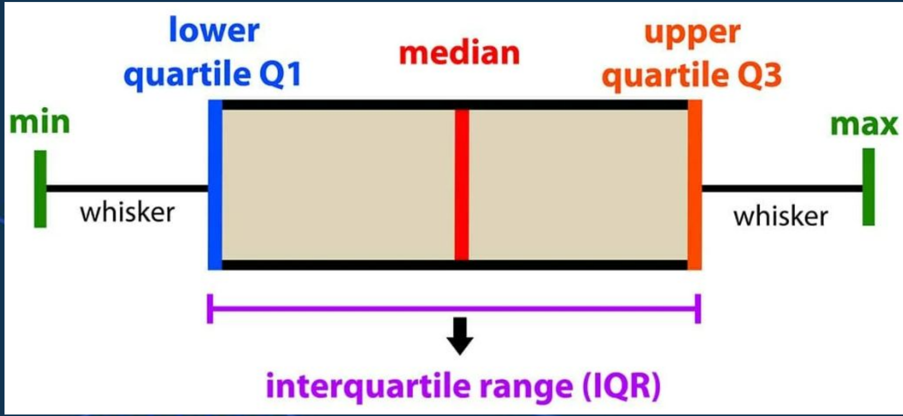
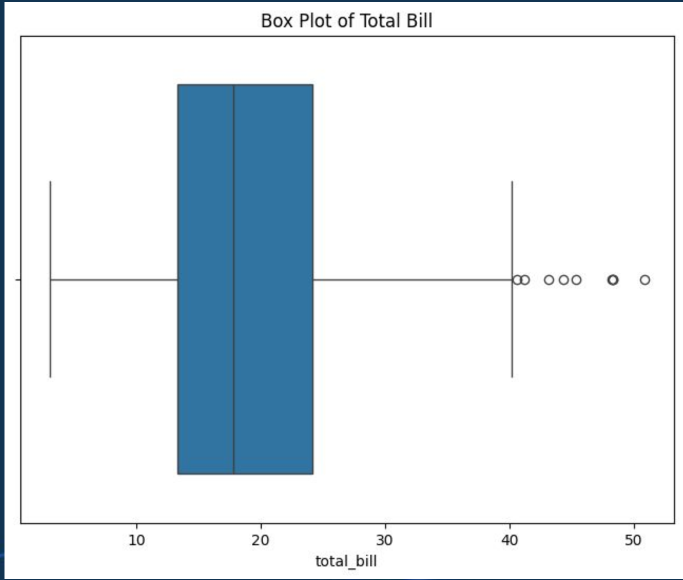
Identifying Outliers

- Visual inspection using plots like box plots, scatter plots, or histograms





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Identifying Outliers

- Statistical methods like z-score or interquartile range (IQR)
  - Much less common given how good box plot already show outliers

```python
# Identify outliers using z-score
from scipy import stats

z_scores = np.abs(stats.zscore(df['total_bill']))
threshold = 2.5
outliers_zscore = np.where(z_scores > threshold)

outliers_zscore
```

✓ 0.0s

```
(array([ 59, 102, 156, 170, 182, 197, 212]),)
```

```python
# Identify outliers using Interquartile Range (IQR)
Q1 = df['total_bill'].quantile(0.25)
Q3 = df['total_bill'].quantile(0.75)
IQR = Q3 - Q1

outliers_iqr = df[(df['total_bill'] < (Q1 - 1.5 * IQR)) | (df['total_bill'] > (Q3 + 1.5 * IQR))]
len(outliers_iqr)
```

✓ 0.0s MagicPython

```
9
```

Handling Outliers

- **Removal:** Remove outliers if they are erroneous or irrelevant to the analysis
  - Use when outliers are clearly erroneous or irrelevant to the analysis
  - Be cautious, as removing outliers may result in loss of information

```
# Removal: Remove outliers
df_removed = df[~((df['total_bill'] < (Q1 - 1.5 * IQR)) | (df['total_bill'] > (Q3 + 1.5 * IQR)))]
df_removed.shape
```

✓ 0.0s MagicPython

```
(235, 9)
```

Handling Outliers

- **Transformation:** Apply mathematical transformations (e.g., logarithmic, square root) to reduce the impact of outliers
  - Use when outliers are valid but have a skewed distribution
  - Helps to reduce the impact of outliers while preserving the data

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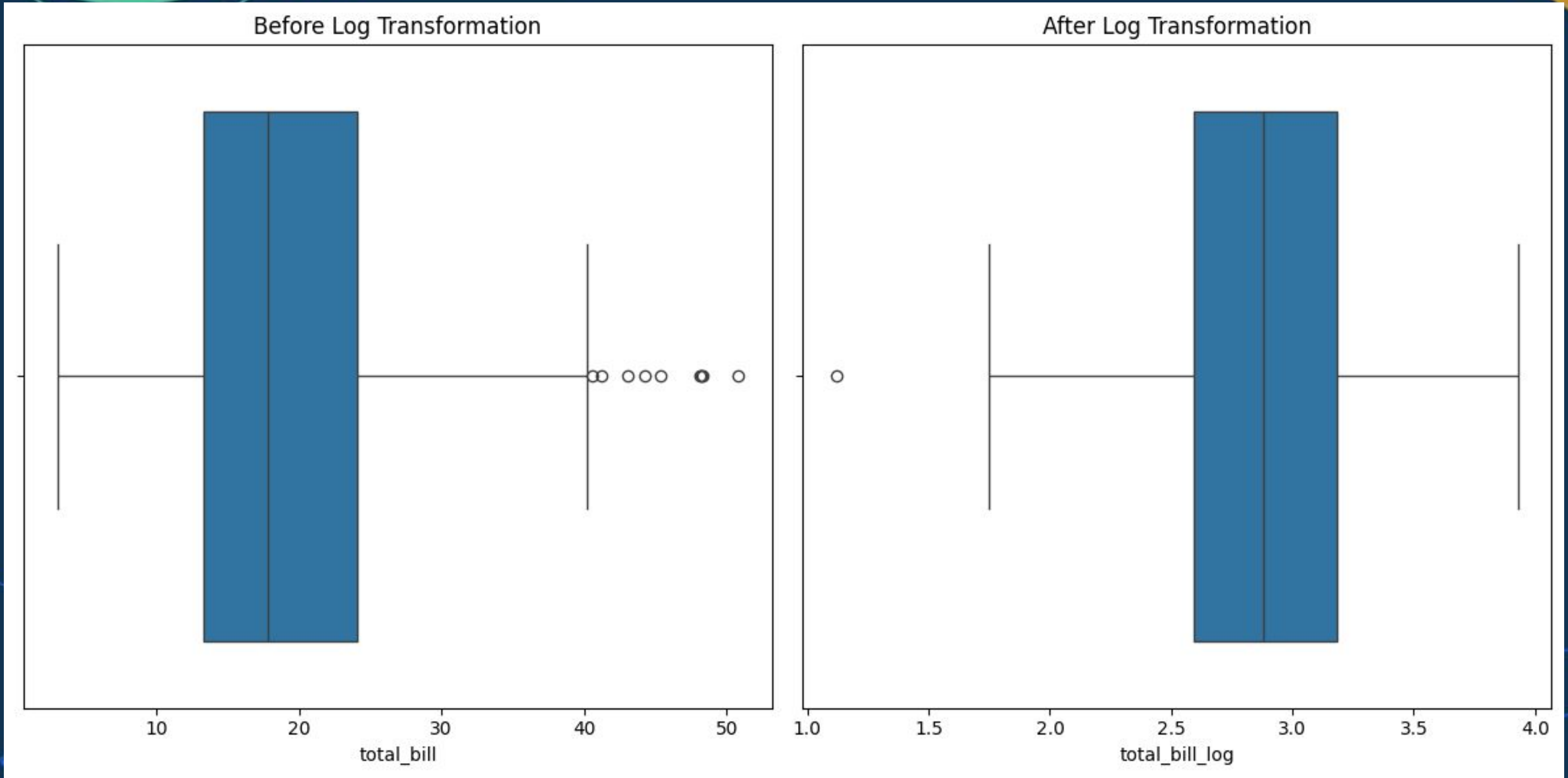
Handling Outliers



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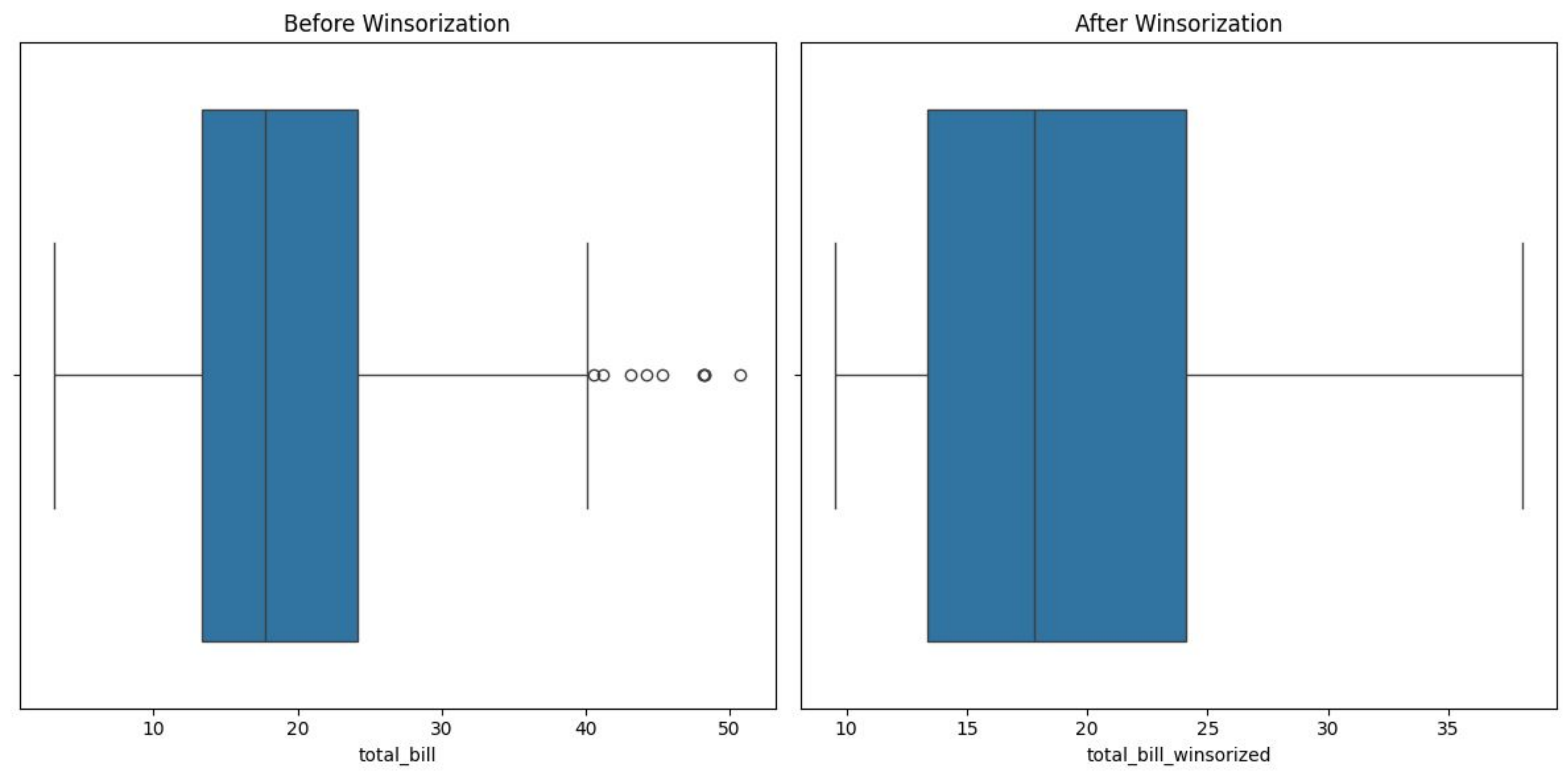
Handling Outliers

- **Winsorization:** Replace extreme values with the nearest non-outlier values
  - Use when outliers are valid but need to be treated to reduce their influence
  - Maintains the overall distribution shape while limiting the extreme values

Handling Outliers



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Which strategy replaces outlier values with the nearest non-outlier values?

A. Removal
B. Transformation
C. Winsorisation
D. Standardisation

Which strategy replaces outlier values with the nearest non-outlier values?

A. Removal

B. Transformation

C. Winsorisation

D. Standardisation

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Iterative Data Cleaning

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Iterating

- Data cleaning is an iterative process that may require multiple rounds
- Continuously assess and refine the cleaned data based on analysis results and feedback
- Integrate data cleaning with data analysis and modeling for optimal results

Libraries

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fuzzywuzzy

- ❖ Provides string matching and similarity scoring functions
- ❖ Key features:
  - ➢ **Ratio:** Calculates the similarity ratio between two strings
  - ➢ **Partial Ratio:** Calculates the similarity ratio considering substrings
  - ➢ **Token Set Ratio:** Calculates the similarity ratio considering common tokens

fuzzywuzzy

```
!pip3 install fuzzywuzzy python-Levenshtein
```

```
from fuzzywuzzy import fuzz
```

```
fuzz.ratio("apple", "appel")
✓ 0.0s
80
```

```
fuzz.partial_ratio("apple", "app")
✓ 0.0s
100
```

```
# Gives a 100 if every token in the first string is in the second string
fuzz.token_set_ratio("apple orange", "orange apple")
✓ 0.0s
100
```

chardet

- Detects the encoding of a given byte string
- Key features:
  - Supports various encodings (e.g., UTF-8, ISO-8859-1, etc.)
  - Provides confidence scores for detected encodings

```
!pip3 install chardet
```

```
import chardet
```

```
byte_string = b"Hello, World!"
encoding = chardet.detect(byte_string)
encoding
```

✓ 0.0s

```
{'encoding': 'ascii', 'confidence': 1.0, 'language': ''}
```

Further Learning

KDNuggets - [Learn Data Cleaning and Preprocessing for Data Science with This Free eBook]

Kaggle - [Short Data Cleaning Course]

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Questions and Answers

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Thank you for attending

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