Air Quality Prediction Project 🧪

This Google Colab notebook demonstrates a complete data science pipeline to predict air quality levels using machine learning.

In [ ]:
```
from google.colab import files
uploaded = files.upload()
```

Choose Files No file chosen Upload widget is only available when the cell has been executed in the current browser session. Please rerun this cell to enable.

```
Saving Air_Quality.csv to Air_Quality.csv
```

In [ ]:
```
import pandas as pd

df = pd.read_csv("Air_Quality.csv")
df.head()
```

Out[ ]:

	Unique ID	Indicator ID	Name	Measure	Measure Info	Geo Type Name	Geo Join ID	Geo Place Name	Time Period	Start_Date	Data Value	Message
0	336867	375	Nitrogen dioxide (NO2)	Mean	ppb	CD	407	Flushing and Whitestone (CD7)	Winter 2014-15	12/01/2014	23.97	NaN
1	336741	375	Nitrogen dioxide (NO2)	Mean	ppb	CD	107	Upper West Side (CD7)	Winter 2014-15	12/01/2014	27.42	NaN
2	550157	375	Nitrogen dioxide (NO2)	Mean	ppb	CD	414	Rockaway and Broad Channel (CD14)	Annual Average 2017	01/01/2017	12.55	NaN
3	412802	375	Nitrogen dioxide (NO2)	Mean	ppb	CD	407	Flushing and Whitestone (CD7)	Winter 2015-16	12/01/2015	22.63	NaN
4	412803	375	Nitrogen dioxide (NO2)	Mean	ppb	CD	407	Flushing and Whitestone (CD7)	Summer 2016	06/01/2016	14.00	NaN

In [ ]:
```
df.info()
df.describe()
df.columns
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 18862 entries, 0 to 18861
Data columns (total 12 columns):
 #   Column          Non-Null Count  Dtype  
---  ------          --------------  -----  
 0   Unique ID       18862 non-null  int64  
 1   Indicator ID    18862 non-null  int64  
 2   Name            18862 non-null  object 
 3   Measure         18862 non-null  object 
 4   Measure Info    18862 non-null  object 
 5   Geo Type Name   18862 non-null  object 
 6   Geo Join ID     18862 non-null  int64  
 7   Geo Place Name  18862 non-null  object 
 8   Time Period     18862 non-null  object 
 9   Start_Date      18862 non-null  object 
 10  Data Value      18862 non-null  float64
 11  Message         0 non-null      float64
dtypes: float64(2), int64(3), object(7)
memory usage: 1.7+ MB
```

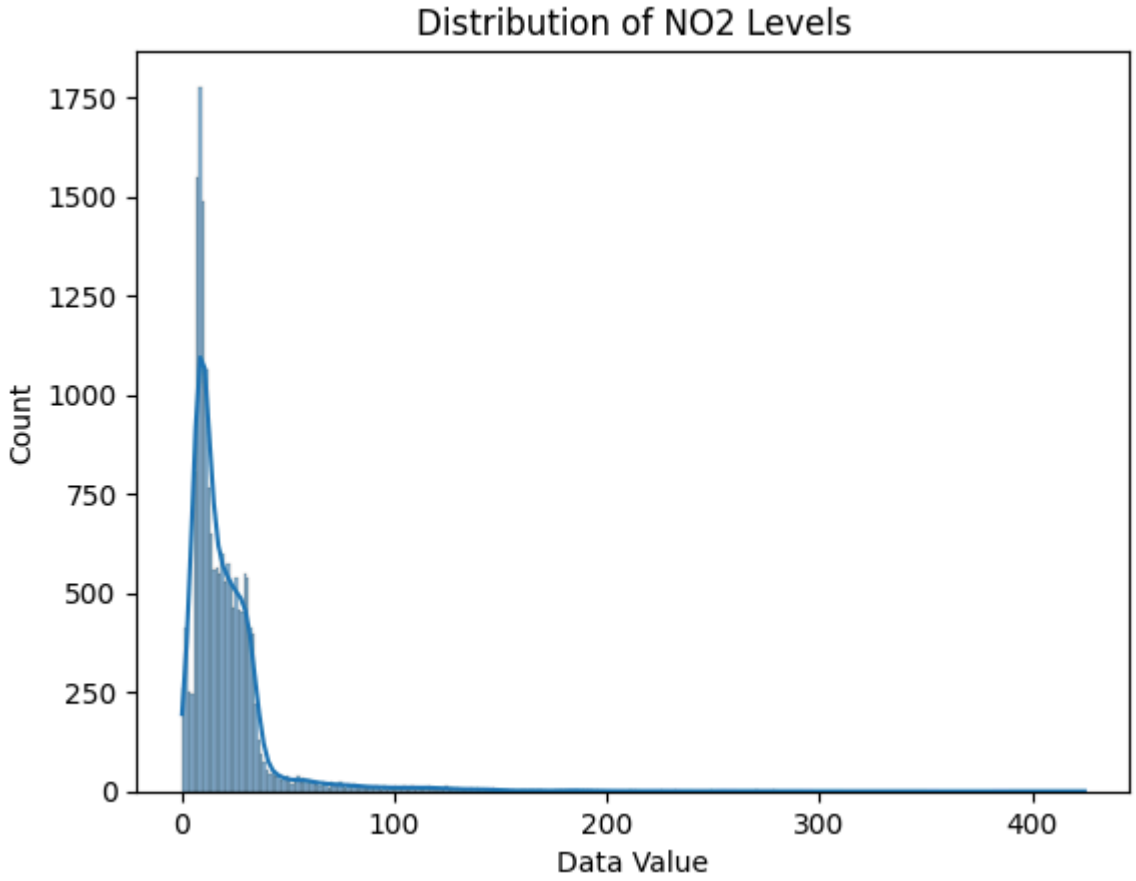
Out[ ]:
```
Index(['Unique ID', 'Indicator ID', 'Name', 'Measure', 'Measure Info',
       'Geo Type Name', 'Geo Join ID', 'Geo Place Name', 'Time Period',
       'Start_Date', 'Data Value', 'Message'],
      dtype='object')
```

In [ ]:
```
print(df.isnull().sum())
print("Duplicates:", df.duplicated().sum())
```

```
Unique ID            0
Indicator ID         0
Name                 0
Measure              0
Measure Info         0
Geo Type Name        0
Geo Join ID          0
Geo Place Name       0
Time Period          0
Start_Date           0
Data Value           0
Message          18862
dtype: int64
Duplicates: 0
```

In [ ]:
```
import seaborn as sns
import matplotlib.pyplot as plt

sns.histplot(df["Data Value"], kde=True)
plt.title("Distribution of NO2 Levels")
plt.show()
```



In [ ]:
```
df["Start_Date"] = pd.to_datetime(df["Start_Date"])
df["Year"] = df["Start_Date"].dt.year
df["Month"] = df["Start_Date"].dt.month
```

In [ ]:
```
df = pd.get_dummies(df, columns=["Geo Type Name", "Geo Place Name"])
```

In [ ]:
```
from sklearn.preprocessing import StandardScaler

features = df.drop(columns=["Data Value", "Message", "Start_Date", "Time Period", "Name", "Measure Info", "Measure"])
target = df["Data Value"]
```

```
scaler = StandardScaler()
X_scaled = scaler.fit_transform(features)
```

In [ ]:
```
from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X_scaled, target, test_size=0.2, random_state=42)
```

In [ ]:
```
from sklearn.ensemble import RandomForestRegressor

model = RandomForestRegressor()
model.fit(X_train, y_train)
```

Out[ ]:
```
▾ RandomForestRegressor
RandomForestRegressor()
```

In [ ]:
```
from sklearn.metrics import mean_absolute_error, r2_score

y_pred = model.predict(X_test)
print("MAE:", mean_absolute_error(y_test, y_pred))
print("R² Score:", r2_score(y_test, y_pred))
```

```
MAE: 1.921785934745134
R² Score: 0.910717600915645
```

In [ ]:
```
sample = X_test[0].reshape(1, -1)
prediction = model.predict(sample)
print("Predicted Value:", prediction)
```

```
Predicted Value: [23.6994]
```

In [ ]:
```
!pip install gradio
```

```
Collecting gradio
  Downloading gradio-5.29.0-py3-none-any.whl.metadata (16 kB)
Collecting aiofiles<25.0,>=22.0 (from gradio)
  Downloading aiofiles-24.1.0-py3-none-any.whl.metadata (10 kB)
Requirement already satisfied: anyio<5.0,>=3.0 in /usr/local/lib/python3.11/dist-packages (from gradio) (4.9.0)
Collecting fastapi<1.0,>=0.115.2 (from gradio)
  Downloading fastapi-0.115.12-py3-none-any.whl.metadata (27 kB)
Collecting ffmpy (from gradio)
  Downloading ffmpy-0.5.0-py3-none-any.whl.metadata (3.0 kB)
Collecting gradio-client==1.10.0 (from gradio)
  Downloading gradio_client-1.10.0-py3-none-any.whl.metadata (7.1 kB)
Collecting groovy~=0.1 (from gradio)
  Downloading groovy-0.1.2-py3-none-any.whl.metadata (6.1 kB)
Requirement already satisfied: httpx>=0.24.1 in /usr/local/lib/python3.11/dist-packages (from gradio) (0.28.1)
Requirement already satisfied: huggingface-hub>=0.28.1 in /usr/local/lib/python3.11/dist-packages (from gradio) (0.30.2)
Requirement already satisfied: jinja2<4.0 in /usr/local/lib/python3.11/dist-packages (from gradio) (3.1.6)
Requirement already satisfied: markupsafe<4.0,>=2.0 in /usr/local/lib/python3.11/dist-packages (from gradio) (3.0.2)
Requirement already satisfied: numpy<3.0,>=1.0 in /usr/local/lib/python3.11/dist-packages (from gradio) (2.0.2)
Requirement already satisfied: orjson~=3.0 in /usr/local/lib/python3.11/dist-packages (from gradio) (3.10.18)
Requirement already satisfied: packaging in /usr/local/lib/python3.11/dist-packages (from gradio) (24.2)
Requirement already satisfied: pandas<3.0,>=1.0 in /usr/local/lib/python3.11/dist-packages (from gradio) (2.2.2)
Requirement already satisfied: pillow<12.0,>=8.0 in /usr/local/lib/python3.11/dist-packages (from gradio) (11.2.1)
Requirement already satisfied: pydantic<2.12,>=2.0 in /usr/local/lib/python3.11/dist-packages (from gradio) (2.11.4)
Collecting pydub (from gradio)
  Downloading pydub-0.25.1-py2.py3-none-any.whl.metadata (1.4 kB)
Collecting python-multipart>=0.0.18 (from gradio)
  Downloading python_multipart-0.0.20-py3-none-any.whl.metadata (1.8 kB)
Requirement already satisfied: pyyaml<7.0,>=5.0 in /usr/local/lib/python3.11/dist-packages (from gradio) (6.0.2)
Collecting ruff>=0.9.3 (from gradio)
  Downloading ruff-0.11.9-py3-none-manylinux_2_17_x86_64.manylinux2014_x86_64.whl.metadata (25 kB)
Collecting safehttpx<0.2.0,>=0.1.6 (from gradio)
  Downloading safehttpx-0.1.6-py3-none-any.whl.metadata (4.2 kB)
Collecting semantic-version~=2.0 (from gradio)
  Downloading semantic_version-2.10.0-py2.py3-none-any.whl.metadata (9.7 kB)
Collecting starlette<1.0,>=0.40.0 (from gradio)
  Downloading starlette-0.46.2-py3-none-any.whl.metadata (6.2 kB)
Collecting tomlkit<0.14.0,>=0.12.0 (from gradio)
  Downloading tomlkit-0.13.2-py3-none-any.whl.metadata (2.7 kB)
Requirement already satisfied: typer<1.0,>=0.12 in /usr/local/lib/python3.11/dist-packages (from gradio) (0.15.3)
Requirement already satisfied: typing-extensions~=4.0 in /usr/local/lib/python3.11/dist-packages (from gradio) (4.13.2)
Collecting uvicorn>=0.14.0 (from gradio)
```

```
  Downloading uvicorn-0.34.2-py3-none-any.whl.metadata (6.5 kB)
Requirement already satisfied: fsspec in /usr/local/lib/python3.11/dist-packages (from gradio-client==1.10.0->gradio) (2025.3.
2)
Requirement already satisfied: websockets<16.0,>=10.0 in /usr/local/lib/python3.11/dist-packages (from gradio-client==1.10.0->g
radio) (15.0.1)
Requirement already satisfied: idna>=2.8 in /usr/local/lib/python3.11/dist-packages (from anyio<5.0,>=3.0->gradio) (3.10)
Requirement already satisfied: sniffio>=1.1 in /usr/local/lib/python3.11/dist-packages (from anyio<5.0,>=3.0->gradio) (1.3.1)
Requirement already satisfied: certifi in /usr/local/lib/python3.11/dist-packages (from httpx>=0.24.1->gradio) (2025.4.26)
Requirement already satisfied: httpcore==1.* in /usr/local/lib/python3.11/dist-packages (from httpx>=0.24.1->gradio) (1.0.9)
Requirement already satisfied: h11>=0.16 in /usr/local/lib/python3.11/dist-packages (from httpcore==1.*->httpx>=0.24.1->gradio)
(0.16.0)
Requirement already satisfied: filelock in /usr/local/lib/python3.11/dist-packages (from huggingface-hub>=0.28.1->gradio) (3.1
8.0)
Requirement already satisfied: requests in /usr/local/lib/python3.11/dist-packages (from huggingface-hub>=0.28.1->gradio) (2.3
2.3)
Requirement already satisfied: tqdm>=4.42.1 in /usr/local/lib/python3.11/dist-packages (from huggingface-hub>=0.28.1->gradio)
(4.67.1)
Requirement already satisfied: python-dateutil>=2.8.2 in /usr/local/lib/python3.11/dist-packages (from pandas<3.0,>=1.0->gradi
o) (2.9.0.post0)
Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.11/dist-packages (from pandas<3.0,>=1.0->gradio) (2025.2)
Requirement already satisfied: tzdata>=2022.7 in /usr/local/lib/python3.11/dist-packages (from pandas<3.0,>=1.0->gradio) (2025.
2)
Requirement already satisfied: annotated-types>=0.6.0 in /usr/local/lib/python3.11/dist-packages (from pydantic<2.12,>=2.0->gra
dio) (0.7.0)
Requirement already satisfied: pydantic-core==2.33.2 in /usr/local/lib/python3.11/dist-packages (from pydantic<2.12,>=2.0->grad
io) (2.33.2)
Requirement already satisfied: typing-inspection>=0.4.0 in /usr/local/lib/python3.11/dist-packages (from pydantic<2.12,>=2.0->g
radio) (0.4.0)
Requirement already satisfied: click>=8.0.0 in /usr/local/lib/python3.11/dist-packages (from typer<1.0,>=0.12->gradio) (8.1.8)
Requirement already satisfied: shellingham>=1.3.0 in /usr/local/lib/python3.11/dist-packages (from typer<1.0,>=0.12->gradio)
(1.5.4)
Requirement already satisfied: rich>=10.11.0 in /usr/local/lib/python3.11/dist-packages (from typer<1.0,>=0.12->gradio) (13.9.
4)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.11/dist-packages (from python-dateutil>=2.8.2->pandas<3.0,>=
1.0->gradio) (1.17.0)
Requirement already satisfied: markdown-it-py>=2.2.0 in /usr/local/lib/python3.11/dist-packages (from rich>=10.11.0->typer<1.0,
>=0.12->gradio) (3.0.0)
Requirement already satisfied: pygments<3.0.0,>=2.13.0 in /usr/local/lib/python3.11/dist-packages (from rich>=10.11.0->typer<1.
0,>=0.12->gradio) (2.19.1)
Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/python3.11/dist-packages (from requests->huggingface-
hub>=0.28.1->gradio) (3.4.1)
```

```
Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.11/dist-packages (from requests->huggingface-hub>=
0.28.1->gradio) (2.4.0)
Requirement already satisfied: mdurl~=0.1 in /usr/local/lib/python3.11/dist-packages (from markdown-it-py>=2.2.0->rich>=10.11.0
->typer<1.0,>=0.12->gradio) (0.1.2)
Downloading gradio-5.29.0-py3-none-any.whl (54.1 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 54.1/54.1 MB 20.0 MB/s eta 0:00:00
Downloading gradio_client-1.10.0-py3-none-any.whl (322 kB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 322.9/322.9 kB 24.0 MB/s eta 0:00:00
Downloading aiofiles-24.1.0-py3-none-any.whl (15 kB)
Downloading fastapi-0.115.12-py3-none-any.whl (95 kB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 95.2/95.2 kB 7.0 MB/s eta 0:00:00
Downloading groovy-0.1.2-py3-none-any.whl (14 kB)
Downloading python_multipart-0.0.20-py3-none-any.whl (24 kB)
Downloading ruff-0.11.9-py3-none-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (11.5 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 11.5/11.5 MB 129.8 MB/s eta 0:00:00
Downloading safehttpx-0.1.6-py3-none-any.whl (8.7 kB)
Downloading semantic_version-2.10.0-py2.py3-none-any.whl (15 kB)
Downloading starlette-0.46.2-py3-none-any.whl (72 kB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 72.0/72.0 kB 6.1 MB/s eta 0:00:00
Downloading tomlkit-0.13.2-py3-none-any.whl (37 kB)
Downloading uvicorn-0.34.2-py3-none-any.whl (62 kB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 62.5/62.5 kB 4.7 MB/s eta 0:00:00
Downloading ffmpy-0.5.0-py3-none-any.whl (6.0 kB)
Downloading pydub-0.25.1-py2.py3-none-any.whl (32 kB)
Installing collected packages: pydub, uvicorn, tomlkit, semantic-version, ruff, python-multipart, groovy, ffmpy, aiofiles, star
lette, safehttpx, gradio-client, fastapi, gradio
Successfully installed aiofiles-24.1.0 fastapi-0.115.12 ffmpy-0.5.0 gradio-5.29.0 gradio-client-1.10.0 groovy-0.1.2 pydub-0.25.
1 python-multipart-0.0.20 ruff-0.11.9 safehttpx-0.1.6 semantic-version-2.10.0 starlette-0.46.2 tomlkit-0.13.2 uvicorn-0.34.2
```

In [16]:

```python
import gradio as gr
import numpy as np
import pandas as pd

# Save column names used during training
feature_columns = features.columns

def predict_air_quality(geo_id, year, month):
    # Reconstruct an input row with all columns set to 0
    input_data = pd.DataFrame(np.zeros((1, len(feature_columns))), columns=feature_columns)

    # Insert the actual inputs into the correct columns
```

```
    if 'Geo Join ID' in input_data.columns:
        input_data.at[0, 'Geo Join ID'] = geo_id
    if 'Year' in input_data.columns:
        input_data.at[0, 'Year'] = year
    if 'Month' in input_data.columns:
        input_data.at[0, 'Month'] = month

    # Predict
    input_scaled = scaler.transform(input_data)
    prediction = model.predict(input_scaled)

    return f"Predicted NO₂ Level: {prediction[0]:.2f} ppb"

# Launch Gradio
interface = gr.Interface(
    fn=predict_air_quality,
    inputs=[
        gr.Number(label="Geo ID"),
        gr.Number(label="Year"),
        gr.Number(label="Month")
    ],
    outputs=gr.Text(label="Predicted NO₂ Level"),
    title="Air Quality Predictor"
)

interface.launch(share=True)
```

```
Colab notebook detected. To show errors in colab notebook, set debug=True in launch()
* Running on public URL: https://461b6d8411ba1f6e51.gradio.live

This share link expires in 1 week. For free permanent hosting and GPU upgrades, run `gradio deploy` from the terminal in the wo
rking directory to deploy to Hugging Face Spaces (https://huggingface.co/spaces)
```

Air Quality Predictor

Geo ID

0

Year

0

Month

0

Predicted NO_2 Level

Flag

Clear Submit

Use via API · Built with Gradio · Settings

Out[16]:

🎓 Air Quality Predictor Complete!

You've built a full machine learning pipeline and deployed a simple interactive app.