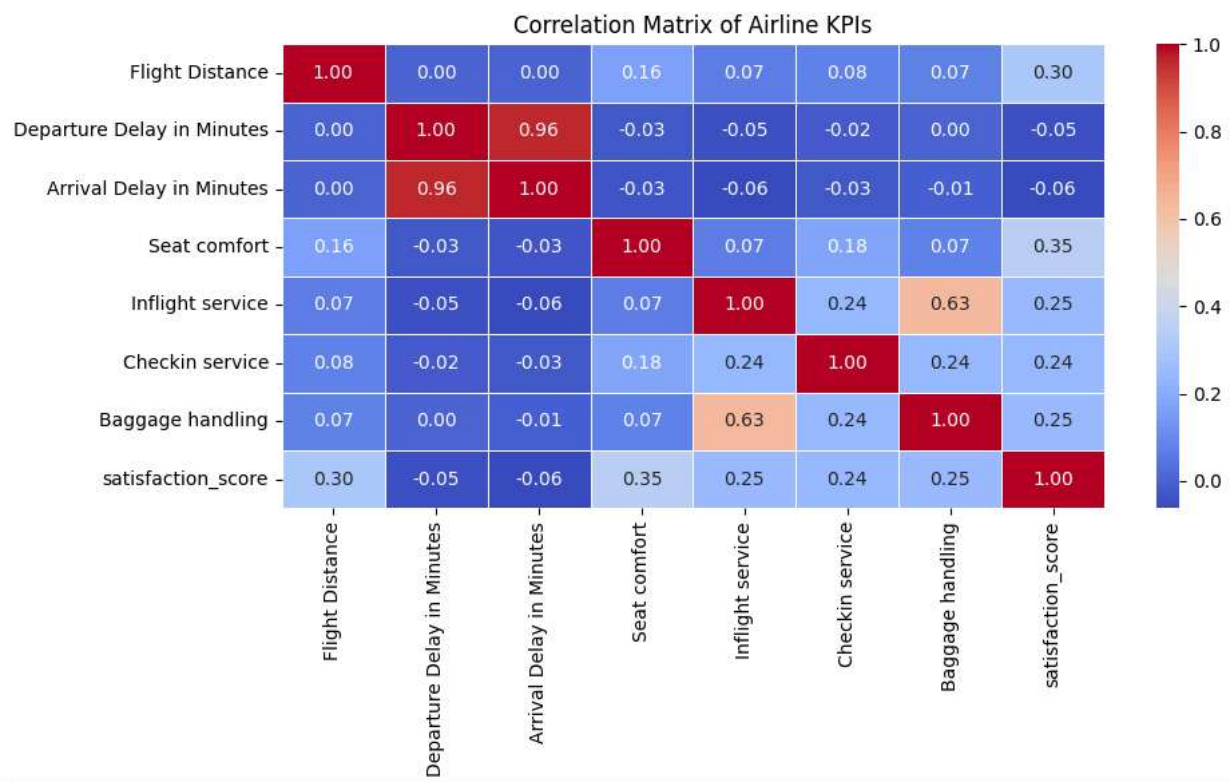
```
from google.colab import files
uploaded = files.upload()
```

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.

```
# STEP 2: Load the dataset
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

# Load CSV
df = pd.read_csv("test.csv")

# STEP 3: Convert satisfaction to numerical score
df['satisfaction_score'] = df['satisfaction'].map({
    'satisfied': 1,
    'neutral or dissatisfied': 0
})

# STEP 4: Select KPI columns for correlation
kpi_columns = [
    'Flight Distance',
    'Departure Delay in Minutes',
    'Arrival Delay in Minutes',
    'Seat comfort',
    'Inflight service',
    'Checkin service',
    'Baggage handling',
    'satisfaction_score'
]

# Drop rows with missing values
kpi_data = df[kpi_columns].dropna()

# STEP 5: Compute correlation matrix
corr_matrix = kpi_data.corr()

# STEP 6: Plot the heatmap
plt.figure(figsize=(10, 6))
sns.heatmap(corr_matrix, annot=True, cmap='coolwarm', fmt=".2f", linewidths=0.5)
plt.title("Correlation Matrix of Airline KPIs")
plt.tight_layout()
plt.show()
```



```
!pip install dowhy
!apt-get install graphviz libgraphviz-dev pkg-config
!pip install pygraphviz
```

```
Requirement already satisfied: dowhy in /usr/local/lib/python3.11/dist-packages (0.12)
Requirement already satisfied: causal-learn>=0.1.3.0 in /usr/local/lib/python3.11/dist-packages (from dowhy) (0.1.4.1)
Requirement already satisfied: cvxpy>=1.2.2 in /usr/local/lib/python3.11/dist-packages (from dowhy) (1.6.4)
Requirement already satisfied: cython<3.0 in /usr/local/lib/python3.11/dist-packages (from dowhy) (0.29.37)
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Requirement already satisfied: scikit-learn>1.0 in /usr/local/lib/python3.11/dist-packages (from dowhy) (1.6.1)
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Requirement already satisfied: graphviz in /usr/local/lib/python3.11/dist-packages (from causal-learn>=0.1.3.0->dowhy) (0.20.3)
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Requirement already satisfied: python-dateutil>=2.8.2 in /usr/local/lib/python3.11/dist-packages (from pandas>1.0->dowhy) (2.8.2)
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Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.11/dist-packages (from matplotlib->causal-learn>=0.1.3
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Requirement already satisfied: pillow>=8 in /usr/local/lib/python3.11/dist-packages (from matplotlib->causal-learn>=0.1.3.0->dowh
Requirement already satisfied: pyparsing>=2.3.1 in /usr/local/lib/python3.11/dist-packages (from matplotlib->causal-learn>=0.1.3.
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
graphviz is already the newest version (2.42.2-6ubuntu0.1).
The following packages were automatically installed and are no longer required:
  libbz2-dev libpkgconf3 libreadline-dev
Use 'apt autoremove' to remove them.
The following additional packages will be installed:
  libgail-common libgail18 libgtk2.0-0 libgtk2.0-bin libgtk2.0-common libgvc6-plugins-gtk
  librsvg2-common libxdot4
Suggested packages:
  gvfs
The following packages will be REMOVED:
  pkgconf r-base-dev
The following NEW packages will be installed:
  libgail-common libgail18 libgraphviz-dev libgtk2.0-0 libgtk2.0-bin libgtk2.0-common
  libgvc6-plugins-gtk librsvg2-common libxdot4 pkg-config
0 upgraded, 10 newly installed, 2 to remove and 29 not upgraded.
Need to get 2,482 kB of archives.
After this operation, 7,671 kB of additional disk space will be used.
```
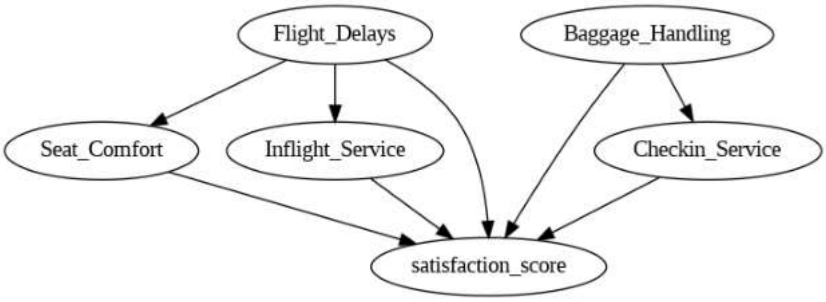

```
# STEP 2: Import
import pandas as pd
from dowhy import CausalModel
from IPython.display import Image, display
import matplotlib.pyplot as plt
import seaborn as sns

# STEP 3: Load your dataset
df = pd.read_csv("test.csv")

# STEP 4: Create numeric satisfaction score
df['satisfaction_score'] = df['satisfaction'].map({
    'satisfied': 1,
    'neutral or dissatisfied': 0
})

# STEP 5: Rename columns for modeling
df_clean = df.rename(columns={
    'Departure Delay in Minutes': 'Flight_Delays',
    'Arrival Delay in Minutes': 'Arrival_Delay',
    'Seat comfort': 'Seat_Comfort',
```

```
    'Inflight service': 'Inflight_Service',
    'Checkin service': 'Checkin_Service',
    'Baggage handling': 'Baggage_Handling'
})

# STEP 6: Filter for relevant columns
df_model = df_clean[[
    'Flight_Delays', 'Seat_Comfort', 'Inflight_Service',
    'Checkin_Service', 'Baggage_Handling', 'satisfaction_score'
]].dropna()

# STEP 7: Define updated causal graph (with intermediates)
causal_graph = """
digraph {
    Flight_Delays -> Seat_Comfort;
    Flight_Delays -> Inflight_Service;
    Flight_Delays -> satisfaction_score;
    Inflight_Service -> satisfaction_score;
    Seat_Comfort -> satisfaction_score;
    Checkin_Service -> satisfaction_score;
    Baggage_Handling -> Checkin_Service;
    Baggage_Handling -> satisfaction_score;
}
"""



# STEP 8: Create causal model
model = CausalModel(
    data=df_model,
    treatment="Flight_Delays",
    outcome="satisfaction_score",
    graph=causal_graph
)

# STEP 9: View graph (optional)
model.view_model()


# STEP 10: Identify and estimate effect
identified_estimand = model.identify_effect()
causal_estimate = model.estimate_effect(
    identified_estimand,
    method_name="backdoor.linear_regression"
)

# STEP 11: Print result
print("Estimated Causal Effect of Flight Delays on Satisfaction (via mediators):")
print(causal_estimate)
```




```
Estimated Causal Effect of Flight Delays on Satisfaction (via mediators):
*** Causal Estimate ***

## Identified estimand
Estimand type: EstimandType.NONPARAMETRIC_ATE

### Estimand : 1
Estimand name: backdoor
Estimand expression:
       d
────────────────(E[satisfaction_score])
d[Flight_Delays]
Estimand assumption 1, Unconfoundedness: If U→{Flight_Delays} and U→satisfaction_score then P(satisfaction_score|Flight_Delays,,U) =

## Realized estimand
b: satisfaction_score~Flight_Delays+Flight_Delays*Checkin_Service+Flight_Delays*Baggage_Handling
Target units:

## Estimate
Mean value: -0.0006752057421900992
### Conditional Estimates
__categorical__Checkin_Service  __categorical__Baggage_Handling
(0.999, 2.0]                    (0.999, 3.0]                    -0.003203
                                (3.0, 4.0]                      -0.001754
                                (4.0, 5.0]                      -0.000869
(2.0, 3.0]                      (0.999, 3.0]                    -0.002062
                                (3.0, 4.0]                      -0.000591
                                (4.0, 5.0]                       0.000300
(3.0, 4.0]                      (0.999, 3.0]                    -0.001275
                                                                -0.000589
                                                                 0.000950
                                                                 0.001841
dtype: float64
/usr/local/lib/python3.11/dist-packages/dowhy/causal_estimator.py:266: FutureWarning: The default of observed=False is deprecated ar
  by_effect_mods = data.groupby(effect_modifier_names)
/usr/local/lib/python3.11/dist-packages/dowhy/causal_estimators/regression_estimator.py:131: FutureWarning: Series.__getitem__ trea
  intercept_parameter = self.model.params[0]
/usr/local/lib/python3.11/dist-packages/dowhy/causal_estimators/regression_estimator.py:131: FutureWarning: Series.__getitem__ trea
  intercept_parameter = self.model.params[0]
/usr/local/lib/python3.11/dist-packages/dowhy/causal_estimators/regression_estimator.py:131: FutureWarning: Series.__getitem__ trea
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```