

Notebook 3.2 - Pandas for CEO Data Management

Management Science - Mastering Business Data

Introduction

Welcome back to the CEO suite at Bean Counter!

Your Data Challenge as CEO

Now that you've mastered NumPy for numerical analysis, you face a new challenge: Bean Counter's data comes in spreadsheets, CSVs, and databases. You have:

- Sales reports from 50+ locations
- Product catalogs with thousands of items
- Customer data with demographics and preferences
- Supplier information across multiple regions

The Problem: This data has labels, categories, dates, and mixed types. NumPy arrays aren't enough, you need something more powerful!

Your Tool: Pandas - Think of it as Excel but better, capable of handling millions of rows.

In this tutorial, you'll learn to wrangle business data, turning spreadsheets into actionable insights.

💡 Tip

Excel cannot have more than 1 million rows!

ℹ️ How to Use This Tutorial

First import pandas and numpy. Work through exercises marked "YOUR CODE BELOW".

Section 1 - DataFrames: Your CEO's Digital Spreadsheet

A DataFrame is like a better Excel spreadsheet in Python. Let's create one for Bean Counter's store performance.

```
import pandas as pd
import numpy as np

# Create a DataFrame from a dictionary
store_data = {
```

```

'store_id': [101, 102, 103, 104, 105],
'location': ['Downtown', 'Airport', 'University', 'Beach', 'Mall'],
'monthly_sales': [450000, 620000, 380000, 290000, 510000],
'staff_count': [45, 62, 38, 28, 52],
'customer_rating': [4.8, 4.5, 4.9, 4.7, 4.6]
}

df = pd.DataFrame(store_data)
print("Bean Counter Store Performance:")
print(df)
print(f"\nDataFrame shape: {df.shape} (rows, columns)")

```

```

Bean Counter Store Performance:
   store_id  location  monthly_sales  staff_count  customer_rating
0      101  Downtown        450000          45           4.8
1      102    Airport        620000          62           4.5
2      103  University       380000          38           4.9
3      104     Beach        290000          28           4.7
4      105      Mall        510000          52           4.6

```

DataFrame shape: (5, 5) (rows, columns)

DataFrames vs NumPy Arrays

- NumPy arrays: Great for numerical calculations
- Pandas DataFrames: Perfect for labeled, mixed-type data
- Think of DataFrames as spreadsheets!

Exercise 1.1 - Create Product Catalog DataFrame

Build a DataFrame for Bean Counter's top products.

```

import pandas as pd

# Create a dictionary with product data
product_data = {
    'product_name': ['Espresso', 'Latte', 'Cappuccino', 'Americano',
'Mocha'],
    'price': [2.50, 4.50, 4.00, 3.00, 5.00],
    'cost': [0.75, 1.50, 1.25, 0.90, 1.80],
    'units_sold_daily': [450, 320, 280, 210, 190]
}

# YOUR CODE BELOW

# Create DataFrame
products_df =

```

```

# Test your DataFrame
assert products_df.shape == (5, 4), "Should have 5 products and 4 columns"
assert list(products_df.columns) == ['product_name', 'price', 'cost',
'units_sold_daily']
assert products_df['price'].sum() == 19.00, "Total price should be 19.00"
print("Bean Counter Product Catalog:")
print(products_df)
print("Perfect! Your product catalog is ready for analysis!")

```

Section 2 - Exploring Your Business Data

As CEO, you need to quickly understand your data. Pandas provides powerful exploration tools.

```

import pandas as pd
import numpy as np

# Create sample sales data
np.random.seed(42)
sales_data = pd.DataFrame({
    'date': pd.date_range('2024-01-01', periods=100),
    'store_id': np.random.choice([101, 102, 103, 104, 105], 100),
    'daily_revenue': np.random.uniform(8000, 15000, 100),
    'customers': np.random.randint(200, 500, 100),
    'avg_ticket': np.random.uniform(15, 35, 100)
})

# Key exploration methods
print("First 5 rows:")
print(sales_data.head())

print("\n\nData Info:")
print(sales_data.info())

print("\n\nStatistical Summary:")
print(sales_data.describe().round(2))

```

```

First 5 rows:
      date  store_id  daily_revenue  customers  avg_ticket
0 2024-01-01        104     14404.717729       466    29.178220
1 2024-01-02        105     13950.270045       350    26.056400
2 2024-01-03        103     11146.154719       497    20.930203
3 2024-01-04        105     8667.870815       298    23.395617
4 2024-01-05        105     10595.727765       462    20.124139

```

```

Data Info:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 100 entries, 0 to 99
Data columns (total 5 columns):
 #   Column          Non-Null Count  Dtype  

```

```

--- ----- -----
0 date 100 non-null datetime64[ns]
1 store_id 100 non-null int64
2 daily_revenue 100 non-null float64
3 customers 100 non-null int64
4 avg_ticket 100 non-null float64
dtypes: datetime64[ns](1), float64(2), int64(2)
memory usage: 4.0 KB
None

```

Statistical Summary:

| | date | store_id | daily_revenue | customers | avg_ticket |
|-------|---------------------|----------|---------------|-----------|------------|
| count | 100 | 100.00 | 100.00 | 100.00 | 100.00 |
| mean | 2024-02-19 12:00:00 | 103.07 | 11401.73 | 353.45 | 24.58 |
| min | 2024-01-01 00:00:00 | 101.00 | 8003.64 | 201.00 | 15.10 |
| 25% | 2024-01-25 18:00:00 | 102.00 | 9788.71 | 298.00 | 18.84 |
| 50% | 2024-02-19 12:00:00 | 103.00 | 11243.92 | 351.50 | 24.22 |
| 75% | 2024-03-15 06:00:00 | 104.00 | 12869.13 | 426.75 | 29.37 |
| max | 2024-04-09 00:00:00 | 105.00 | 14984.18 | 498.00 | 34.64 |
| std | | Nan | 1.40 | 1899.23 | 85.48 |

Exercise 2.1 - Explore Store Performance

Use pandas exploration methods to understand store performance data.

```

import pandas as pd
import numpy as np

# Store performance data
performance_df = pd.DataFrame({
    'store': ['Plaza', 'Station', 'Park', 'Beach', 'Airport', 'Mall',
'Downtown', 'University'],
    'quarterly_revenue': [1250000, 980000, 870000, 650000, 1450000,
1100000, 1350000, 920000],
    'profit_margin': [32.5, 28.7, 30.1, 25.4, 35.2, 31.8, 33.9, 29.5],
    'customer_count': [45000, 38000, 34000, 28000, 52000, 41000, 48000,
36000],
    'satisfaction': [4.7, 4.5, 4.6, 4.8, 4.4, 4.6, 4.8, 4.9]
})

# YOUR CODE BELOW
# 1. Display the first 3 rows and store in a variable
first_rows =

# 2. Get the shape (rows, columns) and save it
data_shape =

# 3. Get summary statistics for numerical columns and store them
summary_stats =

```

```

# Test your exploration
assert data_shape == (8, 5), "Should have 8 stores and 5 columns"
assert len(first_rows) == 3, "first_rows should have 3 stores"
assert isinstance(summary_stats, pd.DataFrame), "summary_stats should be a DataFrame"
print("First 3 stores:")
print(first_rows)
print(f"\nDataFrame shape: {data_shape}")
print("Great exploration! You understand your data structure!")

```

Section 3 - Selecting and Filtering CEO Reports

As CEO, you need to slice and dice data to answer specific questions.

```

import pandas as pd

# Sample store data
df = pd.DataFrame({
    'store': ['Downtown', 'Airport', 'Beach', 'Mall', 'University'],
    'revenue': [450000, 620000, 290000, 510000, 380000],
    'profit': [135000, 155000, 65000, 140000, 95000],
    'rating': [4.8, 4.5, 4.7, 4.6, 4.9]
})

# Selecting columns
print("Revenue column:")
print(df['revenue'])

print("\n\nMultiple columns:")
print(df[['store', 'profit']])

# Filtering with conditions
print("\n\nHigh performers (revenue > 400k):")
high_performers = df[df['revenue'] > 400000]
print(high_performers)

```

```

Revenue column:
0    450000
1    620000
2    290000
3    510000
4    380000
Name: revenue, dtype: int64

```

```

Multiple columns:
      store  profit
0   Downtown  135000
1     Airport  155000
2      Beach   65000
3       Mall  140000

```

```
4 University 95000
```

```
High performers (revenue > 400k):
   store  revenue  profit  rating
0  Downtown    450000  135000     4.8
1    Airport    620000  155000     4.5
3      Mall    510000  140000     4.6
```

⚠ Single vs Double Brackets

- `df['column']` returns a Series (single column)
- `df[['column']]` returns a DataFrame (even with one column)
- `df[['col1', 'col2']]` selects multiple columns

Exercise 3.1 - Filter Strategic Locations

Identify stores meeting specific CEO criteria.

```
import pandas as pd

stores_df = pd.DataFrame({
    'location': ['Plaza', 'Station', 'Park', 'Beach', 'Airport', 'Mall',
'Downtown', 'University'],
    'monthly_revenue': [125000, 98000, 87000, 65000, 145000, 110000,
135000, 92000],
    'growth_rate': [5.2, -2.1, 3.8, -0.5, 8.7, 4.1, 6.3, 2.9],
    'staff': [25, 20, 18, 15, 32, 23, 28, 19]
})
```

```
# YOUR CODE BELOW
# 1. Select only location and monthly_revenue columns
revenue_report =

# 2. Filter stores with revenue > 100000
high_revenue_stores =

# 3. Filter stores with positive growth
growing_stores =
```

```
# Test your filtering
assert len(high_revenue_stores) == 4, "Should find 4 high revenue stores"
assert all(high_revenue_stores['monthly_revenue'] > 100000), "All selected
stores should have revenue > 100000"
assert len(growing_stores) == 6, "Should find 6 stores with positive
growth"
assert all(growing_stores['growth_rate'] > 0), "All selected stores should
have positive growth"
print(f"High revenue stores: {list(high_revenue_stores['location'])}")
```

```
print(f"Growing stores: {list(growing_stores['location'])}")
print("Excellent! You've identified your star performers!")
```

Section 4 - Creating Strategic Insights

As CEO, you need to create new metrics and sort data for decision-making.

```
import pandas as pd

# Product performance data
products = pd.DataFrame({
    'product': ['Espresso', 'Latte', 'Cappuccino', 'Americano', 'Mocha'],
    'revenue': [11250, 14400, 11200, 6300, 9500],
    'cost': [3375, 4800, 3500, 1890, 3420],
    'units_sold': [4500, 3200, 2800, 2100, 1900]
})

# Create new calculated columns
products['profit'] = products['revenue'] - products['cost']
products['margin_percent'] = (products['profit'] / products['revenue'] * 100).round(1)
products['price_per_unit'] = (products['revenue'] / products['units_sold']).round(2)

# Sort by profit (descending)
products_sorted = products.sort_values('profit', ascending=False)

print("Product Profitability Analysis:")
print(products_sorted[['product', 'profit', 'margin_percent']])
```

```
Product Profitability Analysis:
      product  profit  margin_percent
1       Latte    9600        66.7
0   Espresso    7875        70.0
2  Cappuccino    7700        68.8
4      Mocha    6080        64.0
3  Americano    4410        70.0
```

Exercise 4.1 - CEO Performance Dashboard

Create a comprehensive performance analysis with calculated metrics.

```
import pandas as pd

# Store operational data
operations_df = pd.DataFrame({
    'store': ['Plaza', 'Airport', 'Beach', 'Mall', 'Downtown'],
    'revenue': [125000, 145000, 65000, 110000, 135000],
    'costs': [87500, 94250, 48750, 77000, 87750],
    'customers': [4500, 5200, 2800, 4100, 4800],
```

```

'staff': [25, 32, 15, 23, 28]
})

# YOUR CODE BELOW
# 1. Calculate profit for each store
operations_df['profit'] =

# 2. Calculate profit margin percentage
operations_df['profit_margin'] =

# 3. Calculate revenue per customer
operations_df['revenue_per_customer'] =

# 4. Calculate customers per staff (efficiency)
operations_df['efficiency'] =

# 5. Sort by profit (highest to lowest)
top_performers =

```

```

# Test your dashboard
assert operations_df['profit'].sum() == 184750, "Total profit should be 184,750"
assert operations_df['profit_margin'].max() == 35.0, "Highest margin should be 35%"
assert top_performers.iloc[0]['store'] == 'Airport', "Airport should be most profitable"
print("CEO Dashboard - Top Performers by Profit:")
print(top_performers[['store', 'profit', 'profit_margin', 'efficiency']])
print("Great CEO dashboard! You have visibility of performance!")

```

Section 5 - Reading Real Business Data

As CEO, you'll work with data from various sources. Let's load real files!

```

import pandas as pd
import io

# Simulate reading a CSV file (in practice, you'd use pd.read_csv('filename.csv'))
csv_data = """store_id,location,jan_sales,feb_sales,mar_sales
101,Downtown,125000,132000,118000
102,Airport,145000,152000,148000
103,Beach,82000,79000,85000
104,Mall,98000,102000,105000
105,University,76000,81000,79000"""

df = pd.read_csv(io.StringIO(csv_data))
print("Quarterly Sales Report (loaded from CSV):")
print(df)

# Calculate Q1 totals

```

```

df['q1_total'] = df['jan_sales'] + df['feb_sales'] + df['mar_sales']
print("\nWith Q1 Totals:")
print(df[['location', 'q1_total']])

```

Quarterly Sales Report (loaded from CSV):

| | store_id | location | jan_sales | feb_sales | mar_sales |
|---|----------|------------|-----------|-----------|-----------|
| 0 | 101 | Downtown | 125000 | 132000 | 118000 |
| 1 | 102 | Airport | 145000 | 152000 | 148000 |
| 2 | 103 | Beach | 82000 | 79000 | 85000 |
| 3 | 104 | Mall | 98000 | 102000 | 105000 |
| 4 | 105 | University | 76000 | 81000 | 79000 |

With Q1 Totals:

| | location | q1_total |
|---|------------|----------|
| 0 | Downtown | 375000 |
| 1 | Airport | 445000 |
| 2 | Beach | 246000 |
| 3 | Mall | 305000 |
| 4 | University | 236000 |

💡 Reading Different File Types

```

# CSV files
df = pd.read_csv('sales_data.csv')

# Excel files
df = pd.read_excel('report.xlsx', sheet_name='Sales')

# Specify columns to read
df = pd.read_csv('data.csv', usecols=['date', 'revenue'])

```

Exercise 5.1 - Load and Analyze Sales Data

Process a CSV file containing Bean Counter's sales data.

```

import pandas as pd
import io

# Simulated CSV data (in practice, you'd read from a file)
csv_content = """product,category,price,units_sold,customer_rating
Espresso,Coffee,2.50,4500,4.7
Latte,Coffee,4.50,3200,4.8
Cappuccino,Coffee,4.00,2800,4.6
Croissant,Food,3.50,1200,4.5
Muffin,Food,2.75,1800,4.4
Sandwich,Food,6.50,900,4.7
Mocha,Coffee,5.00,1900,4.5
Americano,Coffee,3.00,2100,4.6"""

```

```

# YOUR CODE BELOW
# 1. Read the CSV data
sales_df = pd.read_csv(io.StringIO(csv_content))

# 2. Calculate revenue for each product
sales_df['revenue'] =

# 3. Filter for only Coffee products
coffee_df =

# 4. Sort coffee products by units_sold (highest first)
coffee_sorted =

# 5. Calculate total coffee revenue
total_coffee_revenue =


# Test your data loading and analysis
assert len(coffee_df) == 5, "Should have 5 coffee products"
assert coffee_sorted.iloc[0]['product'] == 'Espresso', "Espresso should be top seller"
assert total_coffee_revenue == 52650.0, f"Coffee revenue should be 52,650"
print("Top Coffee Products by Volume:")
print(coffee_sorted[['product', 'units_sold', 'revenue']])
print(f"\nTotal Coffee Revenue: ${total_coffee_revenue:,.2f}")
print("Perfect! You can now load and analyze real business data!")

```

Conclusion

Congratulations! You've learned the first steps in Pandas for management!

You've learned:

- DataFrames - Creating and working with structured business data
- Exploration - Using head(), info(), describe() for quick insights
- Selection - Accessing specific columns and rows of data
- Filtering - Finding data that meets business criteria
- Calculated Columns - Creating new metrics from existing data
- Sorting - Ranking data by any metric
- File I/O - Loading data from CSV and Excel files

Your Bean Counter CEO data toolkit now includes:

- Ability to work with spreadsheet-like data in Python
- Tools to explore and understand large datasets quickly
- Skills to filter and find exactly the data you need
- Power to create custom metrics and KPIs
- Capability to process data from multiple file formats

Remember:

- DataFrames are like Excel spreadsheets, but better

- Use `df['column']` for single columns, `df[['col1', 'col2']]` for multiple
- Filter with boolean conditions: `df[df['revenue'] > 100000]`
- Create new columns with calculations: `df['profit'] = df['revenue'] - df['cost']`
- Sort with `sort_values()` to rank your data
- Load real data with `pd.read_csv()` and `pd.read_excel()`

What's Next: In the final session of the Python introduction, you'll combine NumPy and Pandas with visualization to create compelling charts and graphs that will wow the board of directors and drive strategic decisions!

Solutions

You will likely find solutions to most exercises online. However, I strongly encourage you to work on these exercises independently without searching explicitly for the exact answers to the exercises. Understanding someone else's solution is very different from developing your own. Use the lecture notes and try to solve the exercises on your own. This approach will significantly enhance your learning and problem-solving skills.

Remember, the goal is not just to complete the exercises, but to understand the concepts and improve your programming abilities. If you encounter difficulties, review the lecture materials, experiment with different approaches, and don't hesitate to ask for clarification during class discussions.

Bibliography