Module 04: Lab 01

Visual Reporting and Storytelling

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# Objectives

By the end of this lab, you will: 1. Load and analyze the **Lightcast dataset** in **Spark DataFrame**. 2. Create **five easy and three medium-complexity visualizations** using **Plotly**. 3. Explore **salary distributions, employment trends, and job postings**. 4. Analyze **skills in relation to NAICS/SOC/ONET codes and salaries**. 5. Customize **colors, fonts, and styles** in all visualizations (**default themes result in a 2.5-point deduction**). 6. Follow **best practices for reporting on data communication**.

# Step 1: Load the Dataset

import pandas as pd  
import plotly.express as px  
import plotly.io as pio  
pio.renderers.default = "vscode"  
from pyspark.sql import SparkSession  
from pyspark.sql.functions import col  
import plotly.graph\_objects as go  
  
  
# Initialize Spark Session  
spark = SparkSession.builder.appName("LightcastData").getOrCreate()  
  
# Load Data  
df = spark.read.option("header", "true").option("inferSchema", "true").option("multiLine","true").option("escape", "\"").csv("./data/lightcast\_job\_postings.csv")  
  
# Show Schema and Sample Data  
df.printSchema()  
df.show(5)

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|1b5c3941e54a1889e...| 9/6/2024| 2024-09-06 20:32:...| 1|6/2/2024|7/20/2024| 48| [\n "Job Board"\n]|[\n "disabledper...|[\n "https://www...| []| NULL|Sr. Lead Data Mgm...|About this role:\...| 6/12/2024| 10|37615159| Wells Fargo|Wells Fargo| false| [\n 99\n]| [\n "No Educatio...| 99|No Education Listed| NULL| NULL| 1|Full-time (> 32 h...| 3| NULL| false| NULL| 0| [None]| NULL| NULL| NULL|{\n "lat": 33.44...| UGhvZW5peCwgQVo=| Phoenix, AZ| 4013| Maricopa, AZ|38060|Phoenix-Mesa-Chan...| 4| Arizona| 4013| Maricopa, AZ| 4013| Maricopa, AZ| 38060|Phoenix-Mesa-Chan...| 38060|Phoenix-Mesa-Chan...| 52|Finance and Insur...| 522|Credit Intermedia...| 5221|Depository Credit...| 52211| Commercial Banking|522110| Commercial Banking|ET2114E0404BA30075|Management Analysts|sr lead data mgmt...|[\n "KS123QX62QY...|[\n "Exit Strate...|[\n "KS123QX62QY...| [\n "Exit Strate...| []| []|[\n "KS7G6NP6R6L...|[\n "Reliability...|[\n "KS4409D76NW...|[\n "SAS (Softwa...|15-2051.01|Business Intellig...|15-2051.01|Business Intellig...| []| []| []| []| []| []| 15-0000|Computer and Math...| 15-2000|Mathematical Scie...| 15-2050|Data Scientists| 15-2051|Data Scientists| 23|Information Techn...| 231113|Data / Data Minin...| 23111310| Data Analyst| 2311| Data Analysis and...| 23111310| Data Analyst| 231113| Data / Data Minin...| 2311| Data Analysis and...| 23| Information Techn...|15-0000|Computer and Math...|15-2000|Mathematical Scie...|15-2050|Data Scientists|15-2051|Data Scientists| [\n 6\n]| [\n "Data Privac...| 52|Finance and Insur...| 522|Credit Intermedia...| 5221|Depository Credit...| 52211| Commercial Banking| 522110| Commercial Banking|  
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+--------------------+-----------------+----------------------+----------+--------+---------+--------+--------------------+--------------------+--------------------+-----------+-------------------+--------------------+--------------------+---------------+----------------+--------+--------------------+-----------+-------------------+----------------+---------------------+-------------+-------------------+-------------+------------------+---------------+--------------------+--------------------+--------------------+-------------+------+-----------+----------------+-------------------+---------+-----------+--------------------+--------------------+-------------+------+--------------+-----+--------------------+-----+----------+---------------+--------------------+---------------+--------------------+------------+--------------------+------------+--------------------+------+--------------------+------+--------------------+------+--------------------+------+--------------------+------+--------------------+------------------+-------------------+--------------------+--------------------+--------------------+--------------------+-----------------------+--------------------+--------------------+--------------------+--------------------+--------------------+--------------------+----------+--------------------+----------+--------------------+--------------------+--------------------+--------------------+--------------------+--------------------+--------------------+----------+--------------------+----------+--------------------+----------+---------------+----------+---------------+---------------+--------------------+--------------+--------------------+--------------------------+-------------------------------+--------------------+-------------------------+-----------------------------+----------------------------------+-----------------+----------------------+-----------------------+----------------------------+------------------+-----------------------+-------+--------------------+-------+--------------------+-------+---------------+-------+---------------+-----------------+----------------------+------------+--------------------+------------+--------------------+------------+--------------------+------------+--------------------+------------+--------------------+  
only showing top 5 rows

# 1. Salary Distribution by Employment Type

* Identify salary trends across different employment types.
* **Filter the dataset**
  + Remove records where **salary is missing or zero**.
* **Aggregate Data**
  + Group by **employment type** and compute salary distribution.
* **Visualize results**
  + Create a **box plot** where:
    - **X-axis** = EMPLOYMENT\_TYPE\_NAME
    - **Y-axis** = SALARY\_FROM
  + Customize **colors, fonts, and styles** to avoid a **2.5-point deduction**.
* **Explanation:** Write two sentences about what the graph reveals.

# Your Code for 1st question here  
pdf = df.select("EMPLOYMENT\_TYPE\_NAME", "SALARY").toPandas()  
fig = px.box(pdf,   
 x="EMPLOYMENT\_TYPE\_NAME",   
 y="SALARY",   
 title="Salary Distribution by Employment Type",   
 color\_discrete\_sequence=["#2E8B57"])  
fig.update\_layout(font\_family="Arial", title\_font\_size=16)  
fig.show()  
fig.write\_image("output/figure1.svg")

Unable to display output for mime type(s): application/vnd.plotly.v1+json

[Salary Distribution](output/figure1.svg)

# 2. Salary Distribution by Industry

* Compare salary variations across industries.
* **Filter the dataset**
  + Keep records where **salary is greater than zero**.
* **Aggregate Data**
  + Group by **NAICS industry codes**.
* **Visualize results**
  + Create a **box plot** where:
    - **X-axis** = NAICS2\_NAME
    - **Y-axis** = SALARY\_FROM
  + Customize colors, fonts, and styles.
* **Explanation:** The graph reveals that salary distribution varies significantly across industries, with certain sectors like “Manufacturing” and “Finance and Insurance” exhibiting higher median salaries and more outliers at the upper end. Additionally, industries such as “Retail Trade” and “Accommodation and Food Services” tend to have lower salary distributions with less variability, indicating more standardized pay scales in those sectors.

# Your code for 2nd question here  
import plotly.express as px  
  
df\_filtered = df.filter(df["SALARY\_FROM"] > 0)  
  
pdf = df\_filtered.select("NAICS2\_NAME", "SALARY\_FROM").toPandas()  
  
fig = px.box(pdf,   
 x="NAICS2\_NAME",   
 y="SALARY\_FROM",   
 title="Salary Distribution by Industry",  
 color\_discrete\_sequence=["#2E8B57"])  
  
fig.update\_layout(font\_family="Arial", title\_font\_size=16)  
  
fig.show()  
  
fig.write\_image("output/figure2.svg")

[Stage 57:> (0 + 1) / 1]

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[Salary Distribution](output/figure2.svg)

# 3. Job Posting Trends Over Time

* Analyze how job postings fluctuate over time.
* **Aggregate Data**
  + Count job postings per **posted date (POSTED)**.
* **Visualize results**
  + Create a **line chart** where:
    - **X-axis** = POSTED
    - **Y-axis** = Number of Job Postings
  + Apply custom colors and font styles.
* **Explanation:** The line chart shows significant fluctuations in the number of job postings over time, with several noticeable peaks and troughs. There are periodic spikes in postings, indicating potential hiring cycles or seasonal trends affecting job availability.

# Your code for 3rd question   
pdf = df.select("POSTED").groupBy("POSTED").count().toPandas()  
  
pdf.columns = ["POSTED", "Number of Job Postings"]  
  
fig = px.line(pdf, x="POSTED", y="Number of Job Postings",   
 title="Job Posting Trends Over Time",   
 markers=True,   
 line\_shape="linear",  
 color\_discrete\_sequence=["#E74C3C"])  
  
fig.update\_layout(font\_family="Arial", title\_font\_size=16)  
  
fig.show()  
fig.write\_image("output/figure3.svg")

[Stage 58:> (0 + 1) / 1]

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[Salary Distribution](output/figure3.svg)

# 4. Top 10 Job Titles by Count

* Identify the most frequently posted job titles.
* **Aggregate Data**
  + Count the occurrences of each **job title (TITLE\_NAME)**.
  + Select the **top 10 most frequent titles**.
* **Visualize results**
  + Create a **bar chart** where:
    - **X-axis** = TITLE\_NAME
    - **Y-axis** = Job Count
  + Apply custom colors and font styles.
* **Explanation:** The graph reveals that “Data Analysts” is the most frequently posted job title, significantly surpassing other roles in demand. Other job titles such as “Business Intelligence Analysts,” “Enterprise Architects,” and “Data Modelers” also have notable postings, but their counts are much lower compared to Data Analysts.

# Your code for 4th question here  
job\_title\_counts = df.groupBy("TITLE\_NAME").count().orderBy("count", ascending=False).limit(10)  
  
pdf = job\_title\_counts.toPandas()  
  
fig = px.bar(pdf, x="TITLE\_NAME", y="count",   
 title="Top 10 Job Titles by Count",  
 color\_discrete\_sequence=["#FF5733"])  
  
fig.update\_layout(font\_family="Arial", title\_font\_size=16)  
  
fig.show()  
  
fig.write\_image("output/figure4.svg")

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[Salary Distribution](output/figure4.svg)

# 5. Remote vs On-Site Job Postings

* Compare the proportion of remote and on-site job postings.
* **Aggregate Data**
  + Count job postings by **remote type (REMOTE\_TYPE\_NAME)**.
* **Visualize results**
  + Create a **pie chart** where:
    - **Labels** = REMOTE\_TYPE\_NAME
    - **Values** = Job Count
  + Apply custom colors and font styles.
* **Explanation:** The pie chart shows that a significant portion (78%) of job postings do not specify a remote type, while only 17.2% are explicitly marked as remote positions. Hybrid remote and non-remote job postings make up a very small fraction of the total, indicating that most job postings either do not classify remote status or are primarily on-site.

# Your code for 5th question here  
remote\_counts = df.groupBy("REMOTE\_TYPE\_NAME").count().toPandas()  
  
custom\_colors = ["#FF6F61", "#6B5B95", "#88B04B", "#D65076", "#45B8AC"] # Custom color set  
  
fig = px.pie(remote\_counts,   
 names="REMOTE\_TYPE\_NAME",   
 values="count",   
 title="Remote vs On-Site Job Postings",  
 color\_discrete\_sequence=custom\_colors)  
  
fig.update\_layout(  
 font\_family="Arial",  
 title\_font\_size=18,  
 legend\_title\_font\_size=14,  
 paper\_bgcolor="#f8f8f8",   
 plot\_bgcolor="#ffffff"   
)  
  
fig.show()  
  
fig.write\_image("output/figure5.svg")

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[Salary Distribution](output/figure5.svg)

# 6. Skill Demand Analysis by Industry (Stacked Bar Chart)

* Identify which skills are most in demand in various industries.
* **Aggregate Data**
  + Extract **skills** from job postings.
  + Count occurrences of skills grouped by **NAICS industry codes**.
* **Visualize results**
  + Create a **stacked bar chart** where:
    - **X-axis** = Industry
    - **Y-axis** = Skill Count
    - **Color** = Skill
  + Apply custom colors and font styles.
* **Explanation:** Write two sentences about what the graph reveals.

# Your code for 6th question here  
from pyspark.sql.functions import split, explode, col, regexp\_replace  
  
df\_split = df.withColumn("SKILLS\_NAME", split(col("SKILLS\_NAME"), ",\n "))   
df\_split = df\_split.withColumn("SKILLS\_NAME", explode(col("SKILLS\_NAME")))   
df\_split = df\_split.withColumn("Skill", regexp\_replace(col("SKILLS\_NAME"), r'\n', ''))   
  
df\_aggregated = df\_split.groupBy("NAICS2\_NAME", "Skill").count()  
pdf = df\_aggregated.toPandas()  
  
top\_skills = pdf.groupby('Skill')['count'].sum().nlargest(10).index  
pdf\_filtered = pdf[pdf['Skill'].isin(top\_skills)].dropna(subset=['Skill'])  
pdf\_filtered['Skill'] = pdf\_filtered['Skill'].astype(str) # 确保数据类型正确  
  
fig = px.bar(  
 pdf\_filtered,  
 x='NAICS2\_NAME',  
 y='count',  
 color='Skill',  
 title='Skill Demand by Industry',  
 labels={'NAICS2\_NAME': 'Industry', 'count': 'Skill Count', 'Skill': 'Skill'},  
 barmode='stack',  
 color\_discrete\_sequence=px.colors.sequential.Sunsetdark   
)  
  
fig.update\_layout(  
 font\_family="Arial",  
 title\_font\_size=22,  
 xaxis\_title="Industry",  
 yaxis\_title="Skill Count",  
 xaxis\_tickangle=45,  
 plot\_bgcolor="#f4f4f4",   
 paper\_bgcolor="#ffffff"  
)  
  
fig.show()  
fig.write\_image("output/figure6.svg")

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[Salary Distribution](output/figure6.svg)

# 7. Salary Analysis by ONET Occupation Type (Bubble Chart)

* Analyze how salaries differ across ONET occupation types.
* **Aggregate Data**
  + Compute **median salary** for each occupation in the **ONET taxonomy**.
* **Visualize results**
  + Create a **bubble chart** where:
    - **X-axis** = ONET\_NAME
    - **Y-axis** = Median Salary
    - **Size** = Number of job postings
  + Apply custom colors and font styles.
* **Explanation:** The graph shows that the median salary for the “Business Intelligence Analysts” occupation is approximately $88k. Additionally, the large bubble size indicates a high number of job postings for this occupation, suggesting strong demand in the job market.

# Your code for 7th question here  
from pyspark.sql.functions import col, count, percentile\_approx  
  
filtered\_df = df.filter(  
 (col("SALARY\_FROM").isNotNull()) & (col("SALARY\_FROM") > 0) &  
 (col("ONET\_NAME").isNotNull()) & (col("ONET\_NAME") != "")  
)  
  
summary\_df = filtered\_df.groupBy("ONET\_NAME").agg(  
 percentile\_approx("SALARY\_FROM", 0.5).alias("MEDIAN\_SALARY"),  
 count("\*").alias("JOB\_COUNT")  
).toPandas()  
  
fig = px.scatter(  
 summary\_df,  
 x="ONET\_NAME",  
 y="MEDIAN\_SALARY",  
 size="JOB\_COUNT",  
 title="Salary Analysis by ONET Occupation Type",  
 size\_max=50,   
 color\_discrete\_sequence=px.colors.sequential.Plasma\_r   
)  
  
fig.update\_layout(  
 font\_family="Arial",  
 title\_font\_size=22,  
 xaxis\_title="ONET Occupation",  
 yaxis\_title="Median Salary",  
 xaxis\_tickangle=45,  
 plot\_bgcolor="#f4f4f4",   
 paper\_bgcolor="#ffffff",  
 font=dict(size=12),  
 margin=dict(l=50, r=50, t=50, b=120)   
)  
fig.show()  
fig.write\_image("output/figure7.svg")

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[Salary Distribution](output/figure7.svg)

# 8. Career Pathway Trends (Sankey Diagram)

* Visualize job transitions between different occupation levels.
* **Aggregate Data**
  + Identify career transitions between **SOC job classifications**.
* **Visualize results**
  + Create a **Sankey diagram** where:
    - **Source** = SOC\_2021\_2\_NAME
    - **Target** = SOC\_2021\_3\_NAME
    - **Value** = Number of transitions
  + Apply custom colors and font styles.
* **Explanation:** The Sankey diagram illustrates the career transitions between Computer and Mathematical Occupations and Mathematical Science Occupations. The wide gray flow between the two categories suggests a significant number of job transitions, indicating a strong relationship between these fields in career movement.

# Your code for 8th question here  
  
transition\_counts = df.groupBy("SOC\_2021\_2\_NAME", "SOC\_2021\_3\_NAME").count().toPandas()  
  
all\_labels = list(set(transition\_counts["SOC\_2021\_2\_NAME"]).union(set(transition\_counts["SOC\_2021\_3\_NAME"])))  
label\_map = {name: i for i, name in enumerate(all\_labels)}  
  
source\_indices = transition\_counts["SOC\_2021\_2\_NAME"].map(label\_map)  
target\_indices = transition\_counts["SOC\_2021\_3\_NAME"].map(label\_map)  
values = transition\_counts["count"]  
  
node\_colors = ["#FF6F61", "#6B5B95", "#88B04B", "#D65076", "#45B8AC"] \* (len(all\_labels) // 5 + 1)  
link\_colors = ["rgba(67, 162, 202, 0.5)" for \_ in range(len(values))] # Light blue transparent links  
  
fig = go.Figure(go.Sankey(  
 node=dict(  
 pad=15,  
 thickness=20,  
 line=dict(color="black", width=0.5),  
 label=all\_labels,  
 color=node\_colors[:len(all\_labels)]   
 ),  
 link=dict(  
 source=source\_indices,  
 target=target\_indices,  
 value=values,  
 color=link\_colors   
 )  
))  
  
fig.update\_layout(  
 title\_text="Career Pathway Trends (Sankey Diagram)",  
 font=dict(size=12, family="Arial"),  
 paper\_bgcolor="#f5f5f5",   
 plot\_bgcolor="#ffffff"  
)  
  
fig.show()  
  
fig.write\_image("output/figure8.svg")

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[Salary Distribution](output/figure8.svg)