Module 04: Lab 01

Visual Reporting and Storytelling

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November 21, 2024

# 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 = "notebook"  
from pyspark.sql import SparkSession  
from pyspark.sql.functions import col  
  
  
# 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)

Setting default log level to "WARN".  
To adjust logging level use sc.setLogLevel(newLevel). For SparkR, use setLogLevel(newLevel).  
25/03/24 09:17:58 WARN NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable  
 25/03/24 09:18:06 WARN SparkStringUtils: Truncated the string representation of a plan since it was too large. This behavior can be adjusted by setting 'spark.sql.debug.maxToStringFields'.

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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\_FROM")\  
 .filter((df.SALARY\_FROM.isNotNull()) & (df.SALARY\_FROM != 0))\  
 .toPandas()  
fig = px.box(pdf, x="EMPLOYMENT\_TYPE\_NAME", y="SALARY\_FROM",  
 title="Salary Distribution by Employment Type",  
 color="EMPLOYMENT\_TYPE\_NAME",  
 notched=True,  
 color\_discrete\_sequence=px.colors.qualitative.Prism,  
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 "SALARY\_FROM": "salary",  
 })  
fig.update\_layout(font\_family="Times New Roman",  
 title\_font\_size=20,  
 width=1000,  
 height=600)  
fig.write\_image("\_output/figure-q1.svg")

Salary Distribution

Insights from this visualization:

1. full-time jobs are paid with the highest salary on average
2. the highest salary is only available to full-time workers

# 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:** Write two sentences about what the graph reveals.

# Your code for 2nd question here  
pdf = df.select("NAICS2\_NAME", "SALARY\_FROM")\  
 .filter(df.SALARY\_FROM > 0)\  
 .toPandas()  
fig = px.box(pdf, x="NAICS2\_NAME", y="SALARY\_FROM",  
 title="Salary Distribution by Industry",  
 color="NAICS2\_NAME",  
 color\_discrete\_sequence=px.colors.qualitative.Prism,  
 labels={  
 "NAICS2\_NAME": "industry",  
 "SALARY\_FROM": "salary",  
 })  
fig.update\_layout(font\_family="Times New Roman",  
 title\_font\_size=20,  
 width=1000,  
 height=1200)  
fig.write\_image("\_output/figure-q2.svg")

Salary Distribution

Insights from this visualization

1. Public Administration and Educational Services are the industries with lowest average paying level
2. Information sector offers the highest average salary

# 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:** Write two sentences about what the graph reveals.

# Your code for 3rd question here  
pdf = df.select("POSTED")\  
 .filter(df.POSTED.isNotNull())\  
 .groupBy("POSTED")\  
 .count()\  
 .orderBy("POSTED")\  
 .toPandas()  
fig = px.line(pdf, x="POSTED", y="count",  
 title="Job Posting Trends Over Time",  
 color\_discrete\_sequence=px.colors.qualitative.Prism,  
 labels={  
 "POSTED": "Posted Time",  
 "count": "Number of Job Postings",  
 })  
fig.update\_layout(font\_family="Times New Roman",  
 title\_font\_size=20,  
 width=1200,  
 height=600)  
fig.write\_image("\_output/figure-q3.svg")

Job Posting Trends Over Time

Insights from the data:

1. the fluctuation of job posting numbers has a weekly periodic pattern
2. most of the jobs are posted on friday

# 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:** Write two sentences about what the graph reveals.

# Your code for 4th question here  
pdf = df.select("TITLE\_NAME")\  
 .filter(df.TITLE\_NAME.isNotNull())\  
 .groupBy("TITLE\_NAME")\  
 .count()\  
 .orderBy("count", ascending=False)\  
 .limit(10)\  
 .toPandas()  
fig = px.bar(pdf, x="TITLE\_NAME", y="count",  
 title="Top 10 Job Titles",  
 color\_discrete\_sequence=px.colors.qualitative.Prism,  
 labels={  
 "TITLE\_NAME": "Job Title",  
 "count": "Job Count",  
 })  
fig.update\_layout(font\_family="Times New Roman",  
 title\_font\_size=20,  
 width=1000,  
 height=600)  
fig.write\_image("\_output/figure-q4.svg")

Top 10 Job Titles by Count

Insights from the data:

1. Data Analyst is the most popular job
2. Most of the popular jobs have something to do with data science

# 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:** Write two sentences about what the graph reveals.

# Your code for 5th question here  
pdf = df.select("REMOTE\_TYPE\_NAME")\  
 .filter(df.REMOTE\_TYPE\_NAME.isNotNull())\  
 .groupBy("REMOTE\_TYPE\_NAME")\  
 .count()\  
 .toPandas()  
fig = px.pie(pdf, names="REMOTE\_TYPE\_NAME", values="count",  
 title="Remote v.s. On-Site Jobs",  
 color\_discrete\_sequence=px.colors.qualitative.Prism,  
 labels={  
 "REMOTE\_TYPE\_NAME": "Remote/On-Site Type",  
 "count": "Job Count",  
 })  
fig.update\_layout(font\_family="Times New Roman",  
 title\_font\_size=20,  
 width=800,  
 height=600)  
fig.write\_image("\_output/figure-q5.svg")

Remote vs On-Site Jobs

Insights from the data:

1. most of the job postings do not specify remote/on-site type, which may indicate on-site working
2. very little job postings explictly rule out remote working

# 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.

import ast  
  
pdf = df.select("SKILLS\_NAME", "NAICS\_2022\_2")\  
 .filter(df.SKILLS.isNotNull())\  
 .toPandas()  
  
pdf["SKILLS\_NAME"] = pdf["SKILLS\_NAME"].apply(ast.literal\_eval)  
pdf = pdf.explode("SKILLS\_NAME").reset\_index(drop=True)  
  
skill\_industry\_count = pdf.groupby(["NAICS\_2022\_2", "SKILLS\_NAME"]).size().reset\_index(name='count')  
skill\_industry\_count = skill\_industry\_count\  
 .sort\_values(['NAICS\_2022\_2', 'count'], ascending=[True, False])\  
 .groupby('NAICS\_2022\_2')\  
 .head(3)\  
 .reset\_index(drop=True)

# Your code for 6th question here  
fig = px.bar(skill\_industry\_count, x="NAICS\_2022\_2", y="count",  
 title="Skill Demand Analysis by Industry",  
 color="SKILLS\_NAME",  
 color\_discrete\_sequence=px.colors.qualitative.Prism,  
 text="SKILLS\_NAME",  
 labels={  
 "NAICS\_2022\_2": "Industry",  
 "count": "Job Count",  
 })  
fig.update\_layout(font\_family="Times New Roman",  
 title\_font\_size=20,  
 width=1200,  
 height=1000)  
fig.write\_image("\_output/figure-q6.svg")

Skill Demand By Industry

Insights from the data:

1. Communications is almost always the most needed skill in every industry, showing the importance of soft-skills
2. Data Analysis is highly favorable across many industries

# 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:** Write two sentences about what the graph reveals.

# Your code for 7th question here  
from pyspark.sql.functions import median, max, count  
pdf = df.select("ONET\_NAME", "SALARY")\  
 .groupBy("ONET\_NAME")\  
 .agg(median("SALARY").alias("MEDIAN\_SALARY"), count("\*").alias("JOB\_COUNT"))\  
 .toPandas()  
  
  
'''  
this data is problematic,  
we only have data for one ONET\_NAME (Business Intelligence Analysts)  
'''  
pdf.head(10)

|  | ONET\_NAME | MEDIAN\_SALARY | JOB\_COUNT |
| --- | --- | --- | --- |
| 0 | Business Intelligence Analysts | 116300.0 | 72454 |
| 1 | None | NaN | 44 |

fig = px.scatter(pdf, x="ONET\_NAME", y="MEDIAN\_SALARY",  
 size="JOB\_COUNT",  
 color="MEDIAN\_SALARY",  
 title="Median Salary by ONET Occupation Type",  
 labels={  
 "ONET\_NAME": "ONET Occupation Type",  
 "MEDIAN\_SALARY": "median salary",  
 "JOB\_COUNT": "number of jobs",  
 })  
  
fig.update\_layout(font\_family="Times New Roman",  
 title\_font\_size=20,  
 width=1200,  
 height=1000)  
fig.write\_image("\_output/figure-q7.svg")

Median Salary by ONET Occupation Type

Insights from the data:

1. the dataset contains only one ONET Occupation Type, that is Business Intelligence Analysts
2. the median salary of Business Intelligence Analysts is about 116k

# 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:** Write two sentences about what the graph reveals.

# Your code for 8th question here  
pdf = df.groupBy("SOC\_2021\_2\_NAME", "SOC\_2021\_3\_NAME")\  
 .count()\  
 .toPandas()  
  
'''  
this data is problematic,  
we only have data for one SOC\_2021\_2\_NAME and one SOC\_2021\_3\_NAME  
'''  
pdf.head(10)

|  | SOC\_2021\_2\_NAME | SOC\_2021\_3\_NAME | count |
| --- | --- | --- | --- |
| 0 | None | None | 44 |
| 1 | Computer and Mathematical Occupations | Mathematical Science Occupations | 72454 |

# reference: https://plotly.com/python/sankey-diagram/  
import plotly.graph\_objects as go  
  
labels = pdf['SOC\_2021\_2\_NAME'].unique().tolist() + pdf['SOC\_2021\_3\_NAME'].unique().tolist()  
label\_to\_index = {label: index for index, label in enumerate(labels)}  
  
source = pdf['SOC\_2021\_2\_NAME'].map(label\_to\_index)  
target = pdf['SOC\_2021\_3\_NAME'].map(label\_to\_index)  
value = pdf['count']  
  
  
fig = go.Figure(data=[go.Sankey(  
 node=dict(  
 pad=15,  
 thickness=20,  
 line=dict(color="black", width=0.5),  
 label=list(pdf['SOC\_2021\_2\_NAME'].unique()) + list(pdf['SOC\_2021\_3\_NAME'].unique()),  
 color="blue"  
 ),  
 link=dict(  
 source=source,  
 target=target,  
 value=value,  
 )  
)])  
  
fig.update\_layout(title\_text="Career Pathway Trends Between SOC Occupation Levels",  
 font\_size=20,  
 font\_family="Times New Roman",  
 width=1200,  
 height=900)  
  
fig.write\_image("\_output/figure-q8.svg")

Career Pathway Trends Between SOC Occupation Levels

Insights from the data:

1. The data contains only one SOC\_2021\_2\_NAME
2. The data contains only one SOC\_2021\_2\_NAME
3. All Computer and Mathematical Occupations become Mathematical Science Occupations