Exploratory_Analysis

July 22, 2025

1 Step 0: Imports and Reading Data

[21]:
```
import pandas as pd
import numpy as np
import matplotlib.pylab as plt
import seaborn as sns
from IPython.display import display

sns.set(style="whitegrid")
plt.rcParams["figure.figsize"] = (14, 6)

path = "../data/"

checkout_1 = pd.read_csv(path + "checkout_1.csv")
checkout_2 = pd.read_csv(path + "checkout_2.csv")
transactions_1 = pd.read_csv(path + "transactions_1.csv")
transactions_2 = pd.read_csv(path + "transactions_2.csv")

pd.set_option('display.max_rows', 30)  # adjust if necessary

print("checkout_1:")
display(checkout_1)

print("checkout_2:")
display(checkout_2)

print("transactions_1:")
display(transactions_1)

print("transactions_2:")
display(transactions_2)
```

checkout_1:

	time	today	yesterday	same_day_last_week	avg_last_week	avg_last_month
0	00h	9	12	11	6.42	4.85
1	01h	3	5	1	1.85	1.92
2	02h	1	0	0	0.28	0.82

3	03h	1	0	0	0.42	0.46
4	04h	0	0	1	0.42	0.21
5	05h	1	1	2	1.28	0.75
6	06h	1	1	5	2.85	2.28
7	07h	2	3	9	5.57	5.21
8	08h	0	1	18	8.71	10.42
9	09h	2	9	30	20.00	19.07
10	10h	55	51	45	29.42	28.35
11	11h	36	44	38	33.71	28.50
12	12h	51	39	39	27.57	25.42
13	13h	36	41	43	25.85	24.21
14	14h	32	35	36	26.14	25.21
15	15h	51	35	49	28.14	27.71
16	16h	41	36	48	27.71	25.64
17	17h	45	30	29	20.42	22.28
18	18h	32	25	25	21.57	18.28
19	19h	33	39	42	22.14	18.67
20	20h	25	24	34	17.42	18.92
21	21h	30	35	34	18.71	17.57
22	22h	28	29	23	15.42	15.64
23	23h	11	28	10	9.57	8.75

checkout_2:

	time	today	yesterday	same_day_last_week	avg_last_week	avg_last_month
0	00h	6	9	5	5.000	4.92
1	01h	3	3	2	2.000	1.92
2	02h	3	1	2	0.420	0.75
3	03h	0	1	1	0.420	0.46
4	04h	0	0	0	0.140	0.21
5	05h	2	1	1	0.710	0.71
6	06h	3	1	2	1.420	2.10
7	07h	10	2	9	3.000	5.03
8	08h	25	0	12	3.710	9.82
9	09h	36	2	27	10.140	17.64
10	10h	43	55	42	26.140	28.57
11	11h	44	36	47	25.000	28.28
12	12h	46	51	46	24.000	25.89
13	13h	45	36	31	20.280	24.17
14	14h	19	32	35	19.570	24.89
15	15h	0	51	42	22.427	27.78
16	16h	0	41	36	21.570	25.53
17	17h	0	45	19	17.710	22.67
18	18h	13	32	29	16.850	18.46
19	19h	32	33	29	18.000	18.21
20	20h	23	25	17	12.140	18.53
21	21h	28	30	23	14.850	17.82
22	22h	29	28	17	12.710	15.50
23	23h	17	11	14	8.280	8.75

transactions_1:

```
        time             status  f0_
0     00h 00           approved    9
1     00h 00             denied    6
2     00h 00           refunded    1
3     00h 01             denied    8
4     00h 01           approved   13
…      …                 …  …
4229  23h 59         processing    4
4230  23h 59             denied    1
4231  23h 59  backend_reversed    5
4232  23h 59           approved   10
4233  23h 59           reversed    6

[4234 rows x 3 columns]
```

transactions_2:

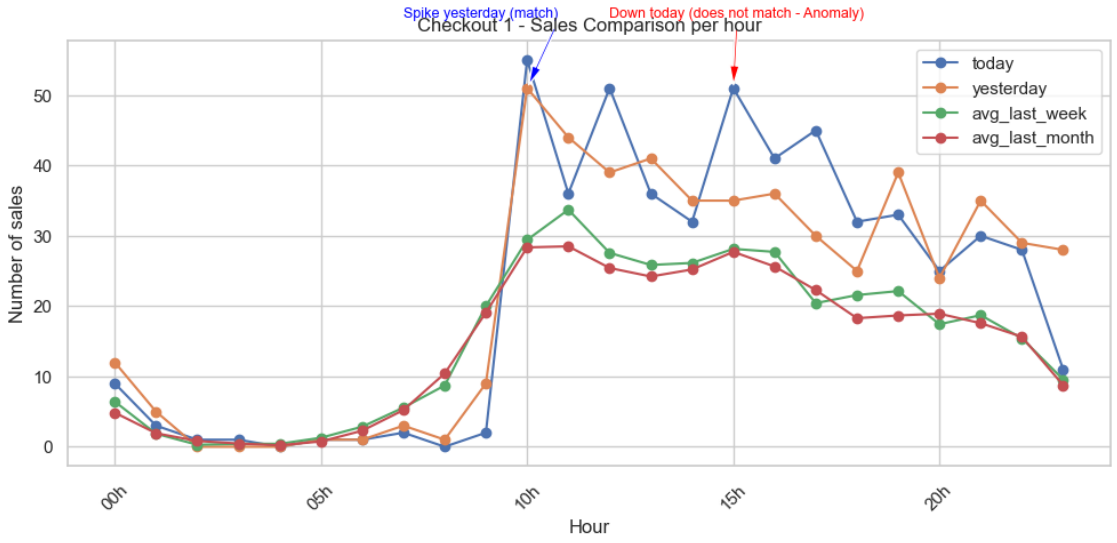
```
        time             status  count
0     00h 00           reversed      7
1     00h 00           approved      9
2     00h 00         processing     12
3     00h 00             denied      3
4     00h 00  backend_reversed      2
…      …                 …    …
3939  23h 57             denied     11
3940  23h 58             denied      4
3941  23h 58           approved     35
3942  23h 59             denied     10
3943  23h 59           approved     38

[3944 rows x 3 columns]
```

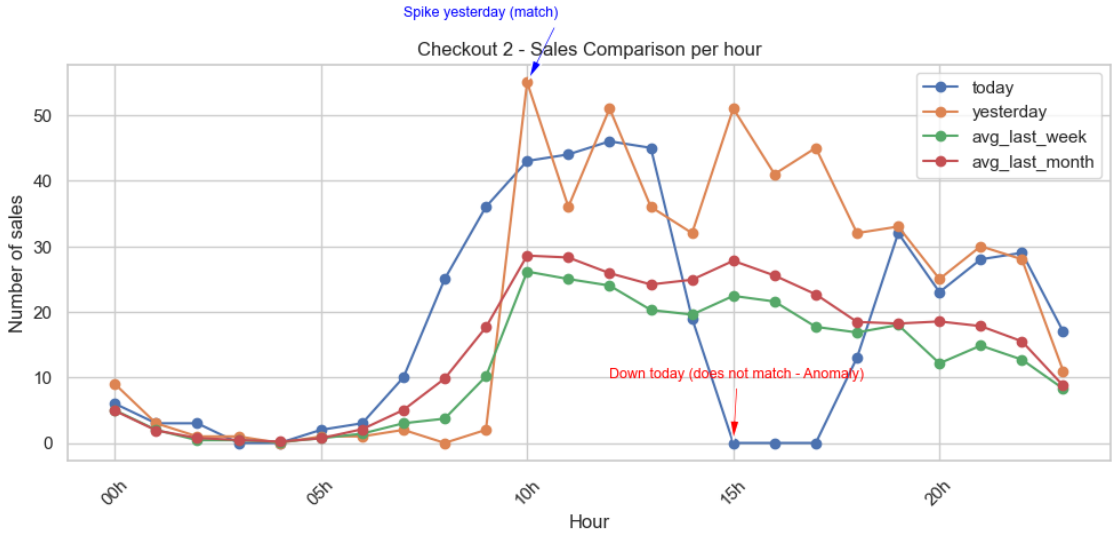
2 Step 1 : Data understanding

2.1 Graphical visualisation and SQL query

[23]:
```
checkout_1 = pd.read_csv("../data/checkout_1.csv")
checkout_2 = pd.read_csv("../data/checkout_2.csv")

def plot_checkout(df, title):
    fig, ax = plt.subplots(figsize=(10, 5))

    # Desenha as linhas
    df.plot(
        x='time',
        y=['today', 'yesterday', 'avg_last_week', 'avg_last_month'],
        kind='line',
```

```
        marker='o',
        ax=ax,
        title=title
    )

    ax.set_xlabel("Hour")
    ax.set_ylabel("Number of sales")
    ax.grid(True)
    ax.tick_params(axis='x', rotation=45)

    # Anotação para queda abrupta às 15h (today == 0)
    if '15h' in df['time'].values:
        idx_15 = df[df['time'] == '15h'].index[0]
        y15 = df.loc[idx_15, 'today']
        ax.annotate(
            'Down today (does not match - Anomaly)',
            xy=(idx_15, y15),
            xytext=(idx_15 - 3, y15 + 10),
            textcoords='data',
            fontsize=9,
            color='red',
            arrowprops=dict(facecolor='red', shrink=0.05, width=1.5,␣
↪headwidth=6)
        )

    # Anotação para spike às 10h (yesterday)
    if '10h' in df['time'].values:
        idx_10 = df[df['time'] == '10h'].index[0]
        y10 = df.loc[idx_10, 'yesterday']
        ax.annotate(
            'Spike yesterday (match)',
            xy=(idx_10, y10),
            xytext=(idx_10 - 3, y10 + 10),
            textcoords='data',
            fontsize=9,
            color='blue',
            arrowprops=dict(facecolor='blue', shrink=0.05, width=1.5,␣
↪headwidth=6)
        )

    plt.tight_layout()
    plt.show()

# Exemplo de uso para checkout_1 e checkout_2
plot_checkout(checkout_1, "Checkout 1 - Sales Comparison per hour")
plot_checkout(checkout_2, "Checkout 2 - Sales Comparison per hour")
```





[26]:
```
from pandasql import sqldf

pysqldf = lambda q: sqldf(q, globals())

# Join
checkout_1['checkout_id'] = 1
checkout_2['checkout_id'] = 2

checkout_data = pd.concat([checkout_1, checkout_2], ignore_index=True)
```

```
query = """
SELECT
    time,
    MAX(CASE WHEN checkout_id = 1 THEN today ELSE NULL END) AS checkout_1_today,
    MAX(CASE WHEN checkout_id = 2 THEN today ELSE NULL END) AS checkout_2_today
FROM checkout_data
WHERE time IN ('10h', '15h')
GROUP BY time
ORDER BY CASE
    WHEN time = '10h' THEN 1
    WHEN time = '15h' THEN 2
    ELSE 3
END;
"""

anomaly = pysqldf(query)
display(anomaly)
```

	time	checkout_1_today	checkout_2_today
0	10h	55	43
1	15h	51	0

2.2 Step 2 : Identification of Anomalous Behaviors

Based on the visual analysis and the SQL query performed, two relevant anomalies were detected in the hourly sales data:

2.2.1 Anomaly 1: Sales Drop at Checkout 2 from 3 PM Onwards

Observation:
For `checkout_2`, there is a significant drop in **"today"** sales starting from **3 PM**. The sales volume at `checkout_2` at 3 PM is **0**, which represents a sharp decline compared to:

- 51 sales **yesterday**
- 42 sales **same day last week**
- **Last week's average**: 22.43
- **Last month's average**: 27.78

This drop to nearly zero persists in the following hours, indicating a possible **operational failure** or **interruption** in the `checkout_2` system during this period.

Comparison:
At the same time, `checkout_1` registered **51 sales**, also surpassing its historical values:

- 35 sales **yesterday**
- **Last week's average**: 28.14
- **Last month's average**: 27.71

This reinforces that the drop was **specific to checkout_2**, ruling out external causes or general low demand.

2.2.2 Anomaly 2: Sales Spike at 10 AM Across Both Checkouts

Observation:
Both checkout systems showed a **significant spike in sales at 10 AM**, exceeding historical references:

Checkout 1:

- **Today:** 55 sales
- **Yesterday:** 51 sales
- **Same day last week:** 45 sales
- **Last week's average:** 29.42
- **Last month's average:** 28.35

Checkout 2:

- **Today:** 43 sales
- **Yesterday:** 55 sales
- **Same day last week:** 42 sales
- **Last week's average:** 26.14
- **Last month's average:** 28.57

Although slightly below yesterday's figure for `checkout_2`, the current volume still represents a **significant increase compared to the averages**, suggesting a possible **promotional event** or **change in consumer behavior** at this time.

2.2.3 Conclusion

These anomalies were detected based on visual analysis (graphs) and validated via SQL, allowing for a clear explanation of out-of-pattern behaviors in the context of hourly sales.