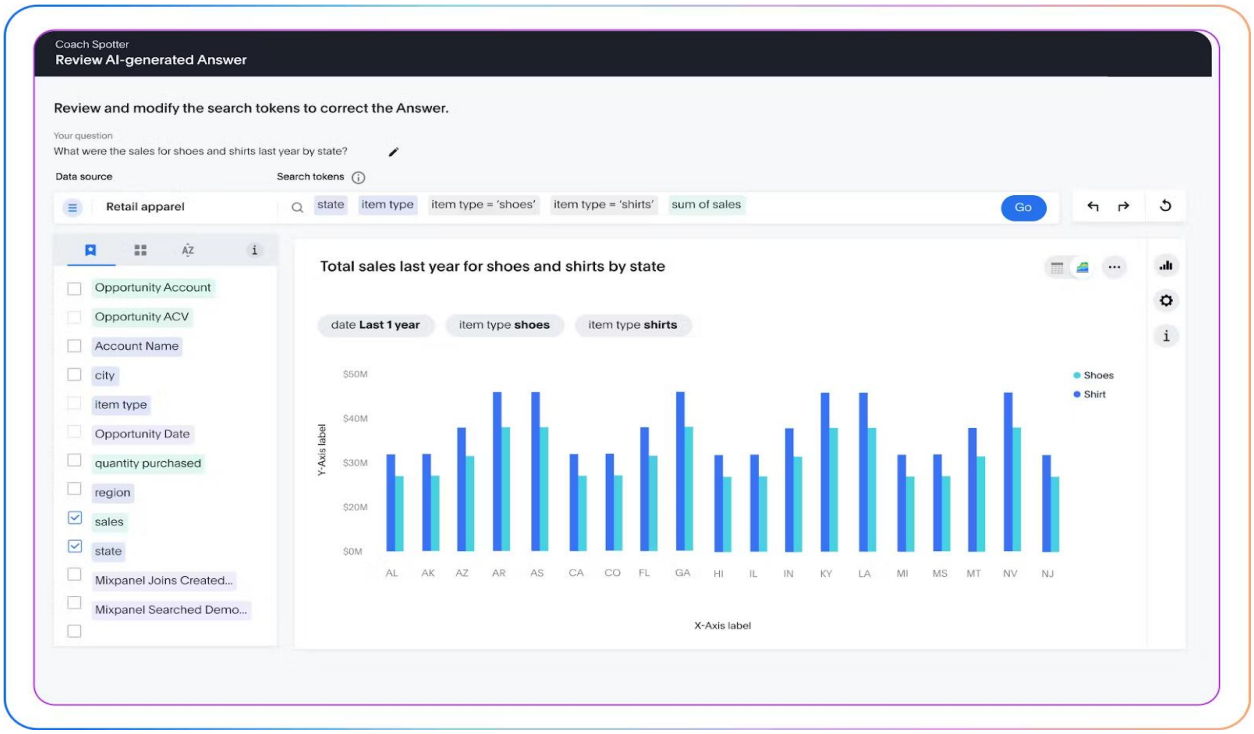
UNIT IV

STREAMING VISUALIZATION, AI DASHBOARDS AND OBSERVABILITY

Real-Time Dashboards – Streaming Data Visualization – Business Intelligence for Streaming Data – Grafana – Kibana – Apache Superset – Real-Time Mobile Applications – Video Streaming Analytics – Stream Monitoring – OpenTelemetry – Prometheus – Distributed Tracing – AI-powered Observability – Alerting Systems – Cloud Monitoring – Digital Twin Dashboards – Generative AI for Data Insights.

Real-Time Dashboard



- **Real-time dashboards** are a form of visualization that automatically updates the user's screen with relevant information based on the latest available data.
- In other words, a real-time dashboard is a **graphical user interface** with a simple display that visualizes performance indicators and essential metrics crucial to specific business processes, functions, and objectives.
- Real-time dashboards differ from traditional business intelligence tools by processing and displaying data with **minimal latency**.

- They combine stream processing capabilities with interactive visualizations to present live updates of metrics, events, and system states.
- These onscreen visualizations combine the latest real-time information with historical data that outlines trends over time to create **functional, data-based predictions and suggestions**.

Key features of real-time dashboards

- **Live data updates:** Automatically refreshes as new data comes in—no waiting on batch processing or manual refreshes. You're always working with the most current view.
- **Customizable layouts:** Focus on what matters most. Drag and drop KPIs, charts, tables, and maps to build a dashboard tailored to your goals and workflows.
- **Data filters**: Quickly zoom in on what you need. Filter data by time period, region, user segment, or product type to get to the right insights fast.
- **Intelligent alters:** Know the moment something changes.. Smart alerts use logic, trends, and AI to notify you when KPIs spike or drop unexpectedly, empowering you to act before the issue snowballs.
- **AI features:** Discover hidden patterns with AI-powered tools. Platforms like ThoughtSpot offer built-in AI Analyst like Spotter that deliver real, contextual answers in minutes.
- **Sharing and exporting:** Easily share live dashboards, export visuals, or send reports to keep stakeholders informed, wherever they are.

Core components and functionality

- **Data ingestion and processing**
- Real-time dashboards require efficient real-time data ingestion systems to handle continuous data streams.
- This typically involves:
  - High-throughput data pipelines
  - Windowed aggregation for metric calculation
  - Anomaly detection for automated alerting

- **Visualization techniques**
- Modern dashboards employ various visualization methods to represent live data effectively:
    - Time-series charts with live updates
    - Heat maps for density visualization
    - Gauge charts for current state indicators
    - Status indicators for binary conditions

Seven Real-Time Dashboards

- **Operational Dashboard**
- The best example of a dashboard that businesses use is the operational dashboard. These dashboards display important employee data related to performance, especially crucial performance indicators. Different companies have different KPIs, and therefore the metrics displayed on these dashboards will differ depending on the organization.
- Businesses customarily use these dashboards since they demonstrate whether the employees are achieving their targets and gauge whether the organization's collective performance is on track.

- **Analytic Dashboards**
- These dashboards can help determine whether businesses meet their objectives by **combining current data with historical data** to create valuable insights. Most analytic dashboards are complex, featuring a combination of what-if statements and highly complex models. Business experts and corporate analysts generally use analytical dashboards.

- **Financial Performance Dashboard**
- These dashboards are mainly used to assess capital utilization within a company. The dashboard typically gives real-time data on the different assets and liabilities of the company. Assets on display can include long-term investments, inventory, accounts receivables, cash in hand, cash in the bank, and current assets.
- Correspondingly, some of the liabilities on display on the dashboard include accounts payable and current liabilities. Other aspects of the balance sheet that can be displayed on the dashboard consist

of current earnings, common stock, and shareholder equity. The information is essential to the staff responsible for monitoring the company's fiscal position.

- **Procurement Cost Dashboard**

- This dashboard highlights a **company's financial position**, focusing on economic data relating to procurement. These dashboards often link agencies, freelancers, contractors, and suppliers involved in procurement. Additionally, these dashboards can also display a variety of metrics relevant to cost reduction in the procurement process, such as procurement ROI, cost avoidance, cost savings, cost reduction, and cost of the purchase order.

- **Healthcare Analytics Dashboard**

- This type of dashboard is generally used within the **healthcare sector** to monitor vital patient data about the relationship between the quality of services at the hospital and overall patient satisfaction. The information displayed on these dashboards includes safety information, waiting times, treatments being undertaken, staffing levels, and patient satisfaction rates.

- **Analytical Retail KPI Dashboard**

- These dashboards are crucial for keeping a close eye on operations in a **retail business**. In particular, this dashboard is about maintaining customer happiness by ensuring the supply chain is efficient. Some of the real-time data displayed on the interface include average backorder rate, total sales volume, customer retention rate, new and returning customers, and average rate of return.

- **KPI Analytical Dashboard (for Fast Moving Consumer Goods)**

- This dashboard was explicitly created to assess **supply chain management** of fast-moving consumer goods, allowing companies to synchronize several processes for optimal performance. A general overview shows current information about all critical departments. Then, the dashboard allows drill down into data, including on-time/ late deliveries, inventory turnover (in hours and days), number of products sold before expiry, out of stock rate, and average selling time.

Pillars of Real-Time Dashboard

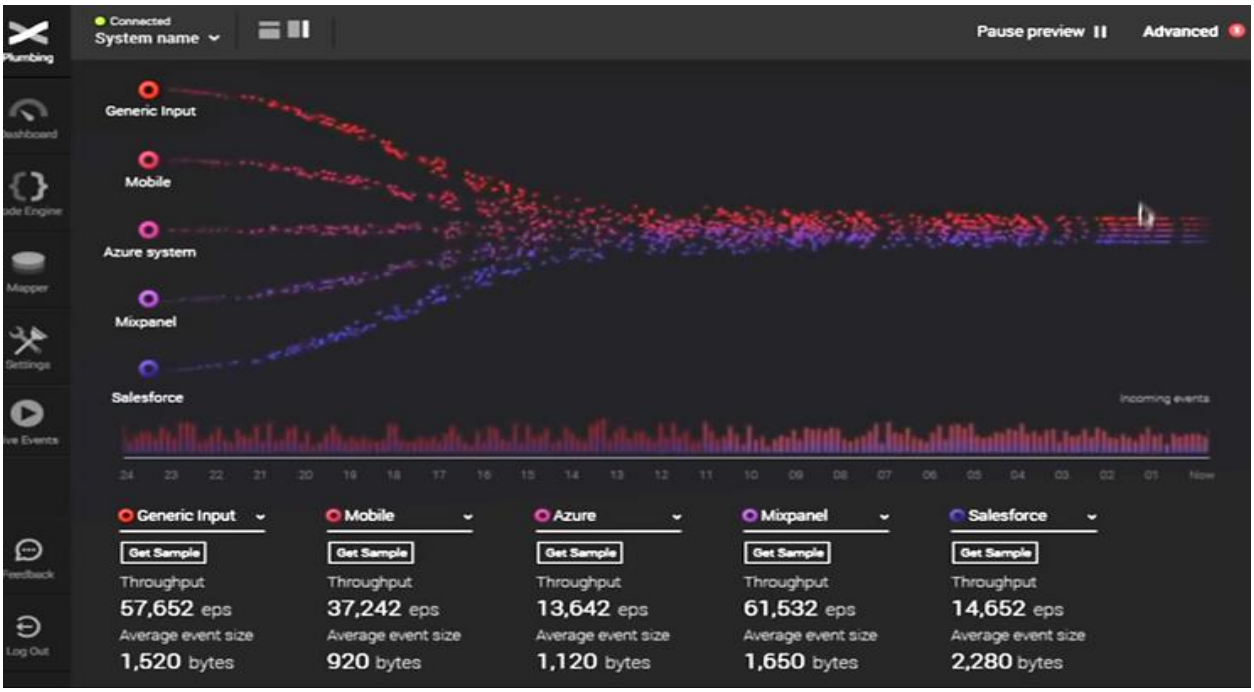
- **Management Strategic Dashboard**
- **CMO Strategic Dashboard**
- **SaaS Management Dashboard**

- **CFO Dashboard**
- **Sales KPI Dashboard**

Benefits of Using a Real-Time Dashboard

- Save time by making data-driven decisions on what to focus on
- Enhance IT efficiency by enabling IT DevSecOps teams to access the most current operational and security data
- Connect to and combine a variety of data sources into a single visualization
- Share live dashboards within an organization or between organizations to convey information
- Decrease costs by optimizing resource allocation

STREAMING DATA VISUALIZATION



Streaming Data Visualization?

- Streaming data visualization refers to the **representation of live data as it is generated – a clear**

example of event stream processing in action.

- It dynamically depicts live data feeds through interactive charts, graphs, and animations that update themselves as new data arrives, allowing for effective streaming analytics.

- Streaming data visualization helps in **real-time monitoring and analysis of data streams** for quick recognition of trends, patterns, and anomalies.

Key aspects of streaming data visualization are:

- **Dynamic insights:** Ability to gain insights and make decisions based on present data.
- **Real-time analysis:** Rapid recognition of trends, outliers, and patterns in live data feeds.
- **Multiple data streams:** Ability to visualize data concurrently and compare multiple continuous data streams.
- **Interactivity:** Users can interact with the visuals by zooming, filtering, highlighting, etc. to focus on relevant information.
- **Continuous visual rendering**: Charts and graphs update automatically with new data from ongoing streams without having to regenerate them.

The Importance Of Real-Time Visualization

- Real-time visualization is a critical tool for various industries since it enables immediate understanding and action based on stream data.
- This transforms ***how businesses operate and make decisions***.
- Let's discuss the major benefits of real-time visualization and see how it impacts trend identification, data management, decision-making, and more.

I. Immediate Trend Identification In Data Streaming

- To handle streaming data, you should **spot trends and anomalies right as they happen.**
- For example, in sectors like financial trading or network security management, every moment is critical when you need to **quickly identify emerging patterns**.

- This immediate insight through data visualization allows you and your team to **make timely decisions** which is vital in situations where even a small delay could be detrimental.

II. Handling High Data Volumes

- In environments where large amounts of data are continuously received, real-time visualization becomes a crucial tool.
- With it, you can view the data and **understand the complex interactions within individual records** as they happen.
- This function helps maintain an overview of constantly evolving situations and **guarantees that no critical information is missed.**

III. Quick Data Comprehension

- Real-time visualization gives you the power to quickly make sense of incoming data.
- With **high-frame-rate charts and dashboards that refresh on their own**, you can tap into various data streams.
- This speeds up your understanding of the data and also makes it easier to share insights with your team.

- **IV. Impact On Business Strategies**
- The insights from real-time visualization **shape your business strategies and operations.** As a business owner, this gives you the edge in making quick and well-informed decisions. With good data visualizations, you are always a step ahead in the dynamic world of business.

- **V. Engaging Visuals For Wider Understanding**
- Data visualization **makes complex data clear and accessible to everyone in your team.** It turns complex numbers into understandable visuals and ensures that everyone, regardless of their technical background, can grasp the information. This strengthens teamwork, as it allows every member to contribute towards shared goals.

Data Format & Its Significance In Streaming Data Visualization

- Selecting the right data format is highly important for efficiently visualizing data and understanding

it.

- Each format, be it human-readable like JSON and CSV, or non-human-readable like binary, has its strengths

A. Human-Readable Formats

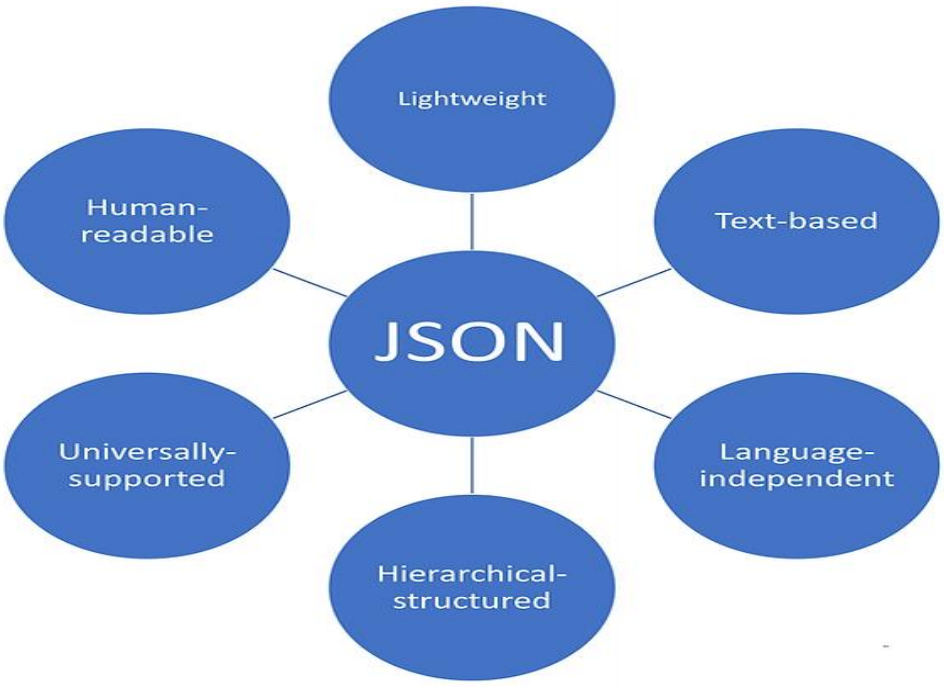
- **Plain Text:** This includes various text encodings like UTF-8, UTF-16, etc. It provides unstructured but readable text, making it versatile for numerous data scenarios.

- **CSV (Comma-Separated Values):** CSV files have a simple structure that makes them ideal for storing tabular data. The first line contains field names and each subsequent line lists the values for those fields, with commas or other characters separating the values.

- **XML (eXtensible Markup Language):** It is a text-based format that uses tags to define elements within a document. Known for its verbosity and flexibility, XML provides a standardized, flexible way to represent complex, hierarchical data.

- **JSON (JavaScript Object Notation):** JSON is a text-based format that uses a simple syntax to represent data objects consisting of key-value pairs. It is more concise than XML while retaining its advantages over simpler formats like CSV.

- **Key/Value Pairs:** In this format, data is organized into pairs of keys and corresponding values. Each key serves as a unique identifier for its associated value. It is widely used because of its adaptability and flexibility in representing fields and data across various contexts.



B. Non-Human-Readable Formats

- **Binary:** This is the fundamental representation of data in computing, using 0s and 1s. Though not directly used in visualization, it is essential for data storage and processing.
- **Hex (Hexadecimal):** Utilizing characters 0–9 and a–f, this base-16 format is used in computing, particularly for data encoding.
- **Base64:** Expanding to 64 characters, Base64 is used for transmitting and encoding more complex types of data compared to hexadecimal.

C. Importance Of Data Formats In Streaming Data Visualization

- **Data Processing and Interpretation:** The data format you choose will impact how the data is ingested and processed for visualization. You may need extra steps for more complex or non-standard formats to visualize them effectively.
- **Visualization Clarity and Efficiency:** The chosen format can affect the clarity and performance of visual representations. Formats that are compatible with the visualization tool's structure improve readability and speed.
- **User Experience:** Choosing the right data format enhances the user experience by providing clear, understandable visualizations of streaming data. This is critical for real-time decision-making based on visualized data.

8 Steps In Streaming Data Visualization For Data Analysis

- Streaming data visualization involves several steps that provide a structured approach to guarantee that the visualization is accurate, engaging, and insightful. Let's explore each of these steps in detail.

Step 1. Data Collection & Data Ingestion

- The first step starts with **collecting data from various sources in real-time, including sensors, log files, and online transaction systems**. Once this data is gathered, it is then ingested into the system. This ingestion prepares the raw data for the next steps which involve detailed processing and analysis.

Step 2. Data Processing & Transformation

- In this step, the **imported raw data is cleaned, organized, and converted into a format that is more suitable for visualization**. This step is key to preparing the data for detailed analysis and effective visualization.

Step 3. Choosing The Right Visualization Type

Step 4. Designing The Visualization

- Now the focus shifts to **designing the visual representation of the data.**
- This involves determining the aesthetics, user experience, and clarity of the visualization.
- The goal is to make the data visually compelling and easy to comprehend.
- **Choose appropriate visual encodings** like shapes, colors, positions, sizes, and motion to represent different attributes

Step 5. Implementing Interactivity & Real-Time Updates

- Now you have to **build interactive features and update data in real-time.**
- The aim is to create a dynamic visualization that accurately reflects the continuous data flow and enhances its engagement and usefulness for immediate decision-making.
- This transforms the visualization from a static display into a lively and practical tool.

Step 6. Testing & Optimization

- In this stage, the visualization undergoes **iterative testing and refinement to improve performance, accuracy, and usability**.
- This optimizes quality and effectiveness through ongoing enhancements aligned with required standards.
- Each round of testing reveals improvement opportunities to enhance the quality and effectiveness.

Step 7. Deployment & Integration

- Now the finalized visualization is **integrated into business environments and workflows,** with a focus on accessibility, seamless functionality, and compatibility with required systems.
- This integration allows you to effectively utilize visualization in daily operations, making it an integral part of decision-making processes and maximizing its utility for the organization.

Step 8. Monitoring & Maintenance

- Once deployed, you have to **continuously monitor and maintain the visualization system**.
- This keeps the system up-to-date and functional and lets you make timely improvements or updates as needed.

- Regular monitoring **keeps the visualization responsive, reliable, and in sync** with changing business needs and ensures it remains useful and effective in the long run.

Complexities In Real-Time Streaming Visualization

- i. Inconsistent Data & Error Handling
- ii. Scalability & High Volume Data Processing
- iii. Data Security & Access Control
- iv. Managing Unbounded & Late-Arriving Data
- v. Balancing Detail & Overview In Visualizations
- vi. Concept Evolution & Cluster Specification