# Module 1: Introduction to Data Visualization

### What is Data Visualization?

* Visual representation of data/information to communicate insights.
* Helps in identifying patterns, trends, and outliers quickly.

Definition

“The graphical representation of information and data using visual elements like charts, graphs, and maps.”

### Purpose of Data Visualization

* Simplifies complex data.
* Supports decision-making.
* Enhances understanding and storytelling.
* Communicates data-driven findings.

### Why Visualize Data?

* Humans process visuals 60,000 times faster than text.
* Supports better memory retention.
* Allows detection of relationships and trends.
* Makes data accessible and engaging.
* *Example*: Sales trends shown in a line chart are easier to interpret than a table of numbers

### Common Visualization Types

Type

Usage

Bar Chart

Compare categories

Line Chart

Show trends over time

Pie Chart

Show proportions

Histogram

Distribution of numerical data

Scatterplot

Correlation between two variables

Heatmap

Density and pattern recognition

### Perception Principles (Key for Visualization Design)

* Pre-attentive Processing: Visual features (color, shape, size) recognized instantly.
* Gestalt Laws:
  + Proximity
  + Similarity
  + Enclosure
  + Continuity
  + Connection

Effective Visualization = (Data + Design)

Key Components:

 Data: Accurate, complete, reliable

 Design: Visual encoding, clarity, layout

📌 *Balance accuracy and aesthetics!*

Data-Ink Ratio (Edward Tufte)

 Maximize data ink (non-redundant info)

 Minimize chart junk (decorative elements with no data value)

✅ Clean, minimal design = Effective storytelling

Data Types (Stevens' Scale)

|  |  |  |
| --- | --- | --- |
| Type | Description | Examples |
| Nominal | Categories (no order) | Gender, Color |
| Ordinal | Categories with order | Rank, Education Level |
| Interval | Ordered, equal intervals | Temperature (°C) |
| Ratio | Interval + True zero | Age, Weight, Income |

*Choosing correct chart type depends on data scale.*

Misleading Visualizations

 Truncated axes

 3D charts distorting values  Cherry-picking data range  Poor color usage

📌 *Integrity is key in visual analytics.*

Likely Exam Questions

MCQs / Short Answer:

 Define data visualization and explain its purpose.

 What is the difference between interval and ratio data?  Give two examples of misleading visualizations.

 Which chart is best for showing correlation?

Long Answer / Application:

 Explain Gestalt principles with visualization examples.

 Discuss the role of perception in designing effective visualizations.  What is Tufte’s Data-Ink ratio and why is it important?

Summary Sheet (Cheat-Sheet)

 Visualization = Data + Design

 Key types: Bar, Line, Pie, Histogram, Scatter, Heatmap  Data types: Nominal, Ordinal, Interval, Ratio

 Design principles: Gestalt, Pre-attentive processing

 Avoid chart junk, increase data-ink  Always preserve integrity & clarity

# Module 2: Aesthetics and Perception in Data Visualization

Why Aesthetics Matter

 Aesthetics improve readability, engagement, and understanding.

 Good visual design supports cognitive processing, not just decoration.

 Perception-first, cognition-next: design must align with how humans *see and process*.

Visual Perception Principles

Perception: How viewers interpret visual stimuli (shapes, colors, patterns)

Key Concepts:

 Pre-attentive attributes: Visual features perceived instantly (without conscious effort).

 Color, Size, Orientation, Position, Shape, Length, etc.  Useful for highlighting patterns, outliers.

📌 *Design tip*: Use pre-attentive features to guide attention quickly.

Gestalt Laws of Grouping

Principle

Visual Effect

Proximity

Nearby elements seen as a group

Similarity

Similar elements grouped together

Enclosure

Elements inside same boundary relate

Closure

Mind fills gaps to create shapes

Continuity

Viewers follow lines/curves naturally

Connection

Linked elements perceived as related

🧠 *Helps in grouping and structuring data clearly*

Color in Visualization

Color Dimensions:

Hue: Color type (red, green, blue) Saturation: Intensity (pure vs. dull) Value/Brightness: Lightness or darkness

Color Types:

Palette Type

Usage Example

Sequential

From low to high (e.g. temp scale)

Diverging

2 extremes from midpoint (e.g. sentiment +/–)

Categorical

Distinct items (e.g. countries, brands)

Tips:

 Use colorblind-friendly palettes.

 Avoid too many colors in a single chart.  Use contrast for emphasis.

Common Pitfalls in Visual Perception

 Poor contrast = unreadable visuals  Misuse of 3D = distortion

 Wrong color choices = confusion  Overuse of elements = clutter

📌 *Keep it clean, focused, and purposeful.*

Visual Variables ( Jacques Bertin)

|  |  |  |
| --- | --- | --- |
| Variable | Type | Examples |
| Position | Quantitative | XY in scatterplot |
| Size | Quantitative | Bubble size |
| Color hue | Categorical | Category identity |
| Color value | Quantitative | Heatmap shading |
|  |  |  |

Variable

Type

Examples

Orientation

Categorical

Arrows, patterns

Shape

Categorical

Different marker types

Texture

Categorical

Area fills or patterns

📌 *Choose variables that match your data type and audience cognition.*

Likely Exam Questions

MCQs / Short Answer:

 What are pre-attentive attributes? Give two examples.  Define hue, saturation, and value.

 Which Gestalt principle explains why connected elements are perceived as related?

Long Answer:

 Explain Bertin’s visual variables with examples.

 Discuss how color theory influences visualization effectiveness.  Describe how Gestalt principles enhance visual design.

Summary Sheet

 Perception before cognition: Design for *how people see*.

 Pre-attentive features = Instant recognition

 Gestalt principles = Visual grouping

 Color theory = Use hue/saturation/value wisely

 Bertin’s visual variables = Foundation of graphical language  Avoid: low contrast, 3D, clutter, misuse of color

# Module 3: Interaction

### 🎯 1. What is Interaction in Data Visualization?

Interaction allows users to engage with data dynamically rather than passively consuming a static visualization. It enhances insight discovery, data exploration, and user control.

### 🔍 2. Types of Interaction

#### Distortion in Screen Space

 Alters how data is presented without changing the data itself.

 Example: Fish-eye lens to zoom into a section while preserving the context.

 Use Case: Focus+Context techniques in dashboards.

#### Attribute-based Distortion

* Alters graphical attributes (e.g., color, size, shape) of visual elements based on data values.
* Helps in emphasizing certain data points.

#### Object-based Distortion

* Changes the objects themselves, such as reshaping or resizing to ﬁt more information or highlight patterns.

#### Selection

 Selecting data points or groups for ﬁltering, highlighting, or drilling down.

 Example: Selecting nodes in a hierarchy via InterRing; nodes with red stripes were selected using a user- deﬁned query.

### 📊 3. Dashboards & Layouts

* A dashboard integrates multiple views and interactions.
* Understand diﬀerent layouts:
  + Grid
  + Hierarchical
  + Geographical
  + Temporal

 Exam Tip: Be prepared to identify layout types from visualizations.

### 🎭 4. Visual Storytelling

"Tell the Right Story, Tell the Story Right."

 Purpose: Inform or delight (Horace).

Example: Florence Nightingale used visual storytelling (Coxcomb diagrams) to reveal causes of mortality in the Crimean War.

 Stories should:

 Have a clear purpose

 Be designed with the audience in mind

 Use minimal and meaningful text

### 🤔 5. Understanding the Audience

#### Audience is NOT Uniform

* Compared to the Terracotta Army: All look similar, but each is diﬀerent.
* Misconception: Designers assume shared backgrounds/goals.

#### Common Ground

* Match visual content to existing mental models of the audience.

#### Power Map

Identify:

* Key Decision Makers
* Primary Audience
* Secondary Audience

#### Decision Styles

|  |  |  |
| --- | --- | --- |
| **Style** | **Ambiguity Tolerance** | **Characteristics** |
| Directive | Low | Quick, focused decisions |
| Conceptual | High | Broad thinker, creative |
| Analytical | High | Data-driven, structured |
| Behavioral | Low | People-oriented, supportive |

### 🧠 6. Learning Styles

|  |  |
| --- | --- |
| **Style** | **Key Elements** |
| Experience | Hands-on, practical learning |
| Reflection | Think-through, analyze |
| Abstract | Theoretical understanding |
| Adaptation | Applying learning to new areas |

Use this understanding when designing interactive visuals for varied learning preferences.

### 🛠 7. Typography & Visual Design Tips

* Use visual hooks (images/icons) eﬀectively.
* Limit use of bullet points.
* Use intentional symbols and colors.
* Consider humor and illustrations to enhance engagement.
* Typography should enhance clarity, not clutter.

### 🧪 8. Gestalt Test & Design Checks

Before ﬁnalizing:

* Did you make compromises for certain users that weaken the story for others?
* Are issues explained or resolved?
* Could the audience draw conﬂicting conclusions?

### 🧾 Exam-Oriented Questions

#### Theory:

. Deﬁne interaction in data visualization and explain its types with examples.

. How does Florence Nightingale's visual storytelling exemplify eﬀective data communication?

. Compare and contrast screen-space and attribute-based distortion techniques.

. What is the role of audience mapping in visual storytelling?

#### Application:

. Given a visual (e.g., a dashboard), identify the interaction types used.

. Create a Power Map for a healthcare data dashboard.

. Evaluate a visual story for clarity using the Gestalt test questions.

# Module 3: Network Diagrams

### Important Questions

1. Draw Interlacement Graph of the given graph?  
   <https://bookofproofs.github.io/branches/graph-theory/interlacing-pieces-with-respect-to-a-cycle-interlacement-graph.html>
2. Is the given graph planar graph?  
   <https://www.youtube.com/watch?v=wnYtITkWAYA>   
   <https://www.youtube.com/watch?v=3HyVIKBzZ3g>
3. Graph Visualization  
   <https://www.youtube.com/playlist?list=PLubYOWSl9mIuJXdt_pMYoTD8QkaX9kQgO>
4. Trees & Series-Parallel Diagrams  
   <https://www.youtube.com/playlist?list=PLubYOWSl9mIsUBpLQTuAdWwyqMZ7x0nCb>

### What Are Network Diagrams?

* Visual representations of relationships between entities (nodes).
* Used for: Social networks, citation graphs, web structure, transport routes, biological network

### Key Components

Term

Meaning

Node

Entity or actor (e.g., person, page)

Edge

Connection or relationship between nodes

Degree

Number of edges attached to a node

Directed Edge

Has direction (A → B)

Undirected Edge

No direction (A — B)

### Why Network Diagrams?

* Reveal clusters, hubs, bottlenecks
* Analyze social influence, centrality
* Understand connectivity and flow

📌 *Network diagrams are key in understanding structure, influence, and behavior.*

### Network Layout Types

|  |  |  |
| --- | --- | --- |
| Layout Type | Description | Use Case |
| Force-directed | Nodes repelled, edges pull – like physics | Social networks, visual clarity |
| Circular | Nodes arranged in a circle | Hierarchies, sequence |
| Hierarchical | Tree-like (top-down or left-right) | Org charts, decision trees |
| Geographic | Placed according to real-world locations | Transportation, maps |
| Arc Diagrams | Nodes on a line, edges as arcs | DNA, text, sequence analysis |
| Matrix Diagrams | Edges as cell entries in a matrix | Dense networks |

✅ Choice of layout affects interpretability and clarity.

### Network Metrics (Essential for Analysis)

|  |  |  |
| --- | --- | --- |
| Metric | Meaning | Use Case |
| Degree Centrality | # of direct connections | Hubs, influencers |
| Closeness Centrality | Distance to all other nodes | Speed of information flow |
| Betweenness Centrality | How often node is on shortest paths | Bottlenecks, bridges |
| Eigenvector Centrality | Connected to well-connected nodes | Influence within a group |
| Density | Actual edges vs. possible edges | Compactness of network |
| Modularity | Measures community structure | Detecting clusters |

### Visual Design Principles for Networks

* Use node size = centrality / importance.
* Edge thickness = strength or weight of connection.
* Color = clusters or categories.
* Avoid overlapping nodes → use force-directed layout.
* Consider interactivity for large graphs.

### Challenges and Pitfalls

* Hairball effect in dense graphs.
* Clutter from too many overlapping edges.
* Misinterpretation from poor layout choice.
* Loss of detail in static representations.

🎯 *Interactivity, filtering, and animation can resolve many of these issues.*

### Likely Exam Questions

#### MCQs / Short Answer:

 Define degree and betweenness centrality.

 What is the main use of force-directed layout?

 Give one advantage of arc vs. matrix diagram.

 Explain one pitfall in visualizing dense networks.

#### Long Answer:

 Compare different network layouts with examples.

 Explain the role of centrality metrics in analyzing social networks.

 How can design improve readability in large-scale network diagrams?

### Quick Revision Sheet

 Nodes & Edges = fundamental units

 Layouts: force-directed, circular, hierarchical, matrix, geographic

 Metrics: degree, closeness, betweenness, eigenvector, density

 Design: size, color, layout, interactivity

 Pitfalls: clutter, overplotting, misinterpretation

# Module 4: Time Series Visualization

### ✅ Key Concepts:

 **Time Series Data**: Data points indexed in chronological order, often captured at regular intervals (e.g., daily stock prices, hourly temperature).

* A time series is a collection of observations recorded sequentially over time.
* Data points are indexed using time stamps (e.g., dates, hours, milliseconds).
* The data is typically collected at regular intervals: daily, monthly, annually, or even in microseconds (e.g., sensor data).
* Examples:
  + Stock prices every minute
  + Temperature recorded every hour
  + COVID-19 cases recorded daily
  + Heart rate data collected per second from a ﬁtness tracker

 **Time Series Visualization**: Technique to represent trends, patterns, and seasonality over time.

### Important Terms & Deﬁnitions

|  |  |
| --- | --- |
| **Term** | **Definition** |
| Time Series | A sequence of data points ordered by time. |
| Timestamp | The actual time associated with each data point. |
| Temporal Patterns | Trends, seasonal cycles, or anomalies visible across time. |

### 🔍 Why is Time Important?

* Unlike other types of data, time adds a directional ﬂow: past → present → future.
* This makes time series ideal for predictive analytics, trend analysis, and anomaly detection.

### 📈 Why Visualize Time Series Data?

* Detect trends (e.g., sales increasing over months)
* Spot seasonality (e.g., temperature rising every summer)
* Find anomalies (e.g., sudden spikes or drops)
* Support forecasting and decision-making
* Pattern Recognition: See recurring behavior over time.
* Comparative Analysis: Compare diﬀerent variables over the same time (e.g., sales vs. marketing spend).
* Forecasting: Make future predictions using observed patterns.
* Anomaly Detection: Identify outliers, such as fraud or sensor failure.
* Data Compression: Visualize large datasets in a compact form.

### 🧠 Mnemonic for Time Series Use-Cases: T-SAD

* Trend analysis
* Seasonality spotting
* Anomaly detection
* Decision support

|  |  |  |
| --- | --- | --- |
| **Letter** | **Meaning** | **Description** |
| T | Trend Analysis | Detect overall upward/downward movement |
| S | Seasonality | Identify periodic patterns |
| A | Anomaly Detection | Spot irregular spikes/drops |
| D | Decision Support | Inform strategy and planning |

### 2: Types of Plots Used in Time Series Visualization

#### Line Chart

* Most common and intuitive form.
* X-axis: time; Y-axis: value of the variable.
* Shows trends and patterns clearly.
* Example: Plotting monthly rainfall over 5 years.
* Tip:
  + Useful for single or multiple series.
  + Use color for distinguishing between multiple lines.

#### Area Chart

* Extension of line chart, but area under the curve is ﬁlled.
* Highlights volume or cumulative value over time.
* Good for stacked values or proportions.
* Example: Total revenue from diﬀerent departments over a year.

#### Bar Chart (Time-based)

* Represents discrete intervals (e.g., daily visitors).
* Useful when time periods are categorical or periodic.
* Example: Daily number of product sales.

#### Scatter Plot

* Visualizes individual data points over time.
* Often used for identifying anomalies or irregular patterns.
* Example: Plotting noise levels per minute in a factory.

#### Heatmap

* Time (e.g., hour of day, day of week) on axes; color indicates value.
* Captures seasonal or cyclic patterns.
* Example: Website traﬃc by hour (Y) and day (X).

|  |  |  |
| --- | --- | --- |
| **Plot Type** | **When to Use** | **Example Use-Case** |
| Line Chart | Continuous trend over time | Stock prices, temperature |
| Area Chart | Emphasize total or proportion | Sales from product categories |
| Bar Chart | Discrete time intervals | Daily login count |
| Scatter Plot | Outlier or anomaly detection | Noise level detection |
| Heatmap | Cyclic and seasonal patterns | Server usage during week |

### 3: Visual Elements for Time Series

#### . Time Axis (X-axis)

* Must be chronologically ordered
* Can be formatted by:
  + Date (e.g., Jan‒Dec)
  + Time (e.g., 00:00 to 23:59)
  + Granularity (e.g., minute, day, month, year)

🧠 Tip:

* Choose appropriate granularity to avoid clutter or loss of detail.

#### . Value Axis (Y-axis)

* Represents the data variable being visualized (e.g., sales, temperature).
* Important to label clearly with units.

#### . Line Style and Markers

* Solid vs dashed lines indicate diﬀerent data sources or categories.
* Markers can show:
  + Special events
  + Outliers
  + Data points (if not too dense)

#### . Color and Shading

* Use consistent color coding for multiple series.
* Shading (like conﬁdence intervals) helps show variability or range.
* Example: A temperature line plot with a shaded region representing min‒max range.

#### . Annotations

* Add context to signiﬁcant points (e.g., product launch, pandemic).
* Great for storytelling with data.

### 4: Best Practices for Time Series Visualization

✔ Use appropriate time intervals:

* Avoid overplotting with too-frequent intervals.
* Use aggregation (e.g., weekly average) if data is noisy.

✔ Label clearly:

* Axes, units, and legends must be understandable.
* Always show time units (e.g., days, months).

✔ Provide context:

* Add annotations for events.
* Show baseline (like average or threshold lines).

✔ Use interactivity (if digital):

* Allow zooming, ﬁltering, tooltip popups.
* Helps users explore details without clutter.

✔ Show uncertainty:

* Add shaded regions, error bars, or conﬁdence intervals to communicate variability.

❌ Common Mistakes:

 Overplotting (too many lines)

 Misleading scales (Y-axis distortion)

 Unreadable labels (especially on time axis)

🧠 Mnemonic: C-L-A-R-I-T-Y

|  |  |
| --- | --- |
| **Letter** | **Practice** |
| C | Choose proper interval |
| L | Label axes clearly |
| A | Add annotations |
| R | Represent uncertainty |
| I | Interactivity (if applicable) |
| T | Time granularity fit |
| Y | Y-axis scale should be logical |

🎯 Likely Exam Questions

MCQ: What characterizes time series data?

 Short Answer: Deﬁne time series data. Why is visualization important?

 Long Answer: Explain diﬀerent reasons for visualizing time series data with examples.

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✅ MCQs

Q. Which chart is best suited for visualizing a continuous time-dependent trend?

1. Bar Chart
2. Line Chart
3. Scatter Plot
4. Pie Chart

Answer: b) Line Chart

Q. A heatmap is ideal when visualizing:

1. Numerical outliers
2. Categorical relationships
3. Cyclic time patterns
4. Text frequencies

Answer: c) Cyclic time patterns

✅ Short Answer

 Name and explain two types of charts used in time series visualization with examples.

✅ Long Answer

 Compare line charts, bar charts, and heatmaps. Include when each is most eﬀective, with examples.

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✅ MCQs

Q. Which of the following best represents variability in a time series chart?

1. Heatmaps
2. Line markers
3. Shaded regions
4. Pie charts

Answer: c) Shaded regions

Q. Why is the X-axis critical in time series visualization?

1. It represents categories
2. It must be logarithmic
3. It organizes data chronologically
4. It determines color encoding

Answer: c) It organizes data chronologically

✅ Short Answer

 What are annotations in a time series plot? Why are they useful?

✅ Long Answer

 Explain how diﬀerent visual elements (axis, color, annotations) improve time series visualization.

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✅ MCQs

Q. What is a good way to handle noisy time series data?

1. Use more colors
2. Remove labels
3. Aggregate intervals
4. Increase resolution

Answer: c) Aggregate intervals

✅ Short Answer

 Name three best practices for time series visualization.

✅ Long Answer

 Discuss the importance of interactivity and uncertainty representation in time series visualization. Use examples.

Expanded Student Notes ‒ Slide 1: Introduction to Interaction in Visualization

✅ What is Interaction in Visualization?

 Interaction refers to the user's ability to engage with a visualization to explore, ﬁlter, and manipulate data.  Unlike static visuals, interactive visualizations adapt to user input and support dynamic data exploration.

🎯 Goals of Interaction

. Exploration ‒ Uncover patterns, trends, outliers.

. Customization ‒ Tailor the view to user's interest.

. Drill-down ‒ Get more detail on demand.

. Filtering ‒ Focus on subsets of data.

. Comparison ‒ Analyze diﬀerent categories, time periods, etc.

📌 Real-World Examples

 Zooming into a Plotly line chart

 Hovering on a bar in a D3 dashboard

 Filtering by region in a COVID-19 heatmap

 Using a slider to adjust time range in a time series

✅ Types of Interactions

|  |  |  |
| --- | --- | --- |
| Type | Description | Example |
| Zoom & Pan | Explore different sections of the chart | Google Maps, financial graphs |
| Tooltips | Hover to get more information | Sales value pop-up |
| Filtering | Show/hide data dynamically | Filter by country or product |
| Brushing | Select a region of interest | Highlighting a time range |
| Linking | Sync multiple views | Hover on chart update table |

🧠 Mnemonic for Interaction Goals: E-D-F-C

 Explore

 Drill-down  Filter

 Compare

🎯 Likely Exam Questions

✅ MCQs

. Which of the following is *not* a common interaction type in data visualization?

1. Brushing
2. Filtering
3. Highlighting
4. Indexing Answer: d) Indexing

. Interaction in visualization is primarily used to:

1. Make static graphs beautiful
2. Compress large ﬁles
3. Explore and manipulate data dynamically
4. Remove irrelevant data

Answer: c) Explore and manipulate data dynamically

✅ Short Answer

 What are the goals of interactivity in data visualization?

✅ Long Answer

 Describe three types of interaction used in modern data visualization. Provide suitable examples for each.

Would you like me to proceed with the next slide from the "Interaction" document?

Perfect—continuing with the next slide in “5. Interaction” . Let's dive into more interaction techniques and how they empower users.

🧾 Expanded Student Notes ‒ Slide 2: Beneﬁts of Interaction

✅ Why is Interaction Important in Visualization?

. Handles Data Complexity

 Big datasets can't be shown all at once.

 Interactivity helps focus on relevant subsets through zooming, ﬁltering, or searching.

. Improves Data Interpretation

 Users can explore multiple views and derive insights on their own.  Encourages active learning and decision-making.

. Supports Diﬀerent User Needs

Analysts, decision-makers, and casual viewers may need diﬀerent levels of detail. Interaction allows custom exploration paths.

. Enables Real-Time Updates

Visualizations linked with live data sources (e.g., sensors, APIs) can be updated with new input.

📌 Real-World Contexts Where Interaction is Crucial

|  |  |
| --- | --- |
| Context | Example |
| Business Dashboards | Filtering sales by region/month |
| IoT & Sensors | Live data monitoring with zoom/pan |
| Finance | Exploring stock trends over various periods |
| Healthcare | Interactive patient monitoring systems |

🧠 Mnemonic: C-I-E-R for Beneﬁts of Interaction

 Complexity management

 Interpretation improvement  Experience personalization

 Real-time responsiveness

🎯 Likely Exam Questions

✅ MCQs

. One major beneﬁt of interaction in data visualization is:

1. Preventing data analysis
2. Making charts non-editable
3. Improving interpretation and user control
4. Restricting user input

Answer: c) Improving interpretation and user control

. Which of the following is an example of real-time interactive visualization?

1. Printed chart in a report
2. Static dashboard screenshot
3. Dashboard with live sensor feed
4. Pie chart in MS Word

Answer: c) Dashboard with live sensor feed

✅ Short Answer

 List two key advantages of interaction in data visualization.

✅ Long Answer

 Explain how interaction helps manage data complexity and improve data interpretation. Give real-world examples.

🧾 Expanded Student Notes ‒ Slide 3: Types of Interaction Techniques

✅ Common Interaction Techniques in Visualization

. Filtering

 Lets users narrow down the dataset shown.

 Can be categorical (e.g., gender, region) or numerical (e.g., date range).

📌 Example:

 Filter a COVID dashboard by country or time period.

. Highlighting

 Draws attention to selected data points.  Often triggered by hover or click.

 Helps compare values across views.

📌 Example:

 Hovering over one line highlights it across all graphs.

. Brushing

 Select a range (e.g., time interval) by dragging the mouse.  Linked to coordinated views (see below).

📌 Example:

 Brushing a time range in a chart highlights data in a linked table.

. Details on Demand

 Viewers can request more info by:  Hovering

 Clicking

 Expanding

📌 Example:

 Hovering over a bar to show exact value, timestamp, and category.

. Zooming and Panning

 Navigate dense time series or map data.  Zoom: Magnify section

 Pan: Move along axes

. Coordinated Multiple Views (CMV)

 Changes in one chart reﬂect in other linked charts/tables.  Supports multivariate analysis.

📌 Example:

 Selecting a country updates maps, time series, and tables simultaneously.

🧠 Mnemonic: F-H-B-D-Z-C

|  |  |  |
| --- | --- | --- |
| Letter | Interaction Type | Function |
| F | Filtering | Narrow the view |
| H | Highlighting | Emphasize elements |
| B | Brushing | Select ranges |
| D | Details on demand | Show extra data |
| Z | Zoom & Pan | Navigate |
| C | Coordinated views | Sync multiple charts |

🎯 Likely Exam Questions

✅ MCQs

. Which interaction type helps synchronize multiple visualizations?

1. Filtering
2. Brushing
3. Coordinated views
4. Details on demand Answer: c) Coordinated views

. What does “brushing” refer to in visual interaction?

1. Coloring data points
2. Typing new values
3. Selecting data by dragging
4. Saving the chart

Answer: c) Selecting data by dragging

✅ Short Answer

 Deﬁne brushing. How does it aid in data exploration?

✅ Long Answer

 Describe and compare at least four interaction techniques used in data visualization. Use examples where appropriate.

🧾 Expanded Student Notes ‒ Slide 4: Designing for Interaction

✅ Key Principles for Designing Interactive Visualizations

. User-Centered Design

 Design must suit the target audience's needs.  Consider:

 Technical expertise (novice vs analyst)

 Task types (exploration, decision-making)

📌 Example:

 A medical dashboard for doctors may need detailed patient drill-downs.

. Aﬀordances

 Visual cues that signal possible actions.  Makes interactivity intuitive.

📌 Example:

 A slider with arrows invites dragging.

 A “+” icon near a chart implies expandability.

. Feedback

 The system should respond clearly to user actions.  Examples:

 Animation when zooming  Color change on selection

 Tooltip showing value on hover

. Consistency

 Interactions should behave similarly across views and sessions.  Helps build mental models for users.

. Progressive Disclosure

 Don't overload users with data.

 Reveal complexity on demand.

📌 Example:

 A collapsed legend that expands when clicked.

✅ Good Design = Engagement + Exploration

|  |  |
| --- | --- |
| Principle | What It Ensures |
| User-centered | Relevance to the task |
| Affordances | Discoverability |
| Feedback | Responsiveness |
| Consistency | Predictability |
| Progressive disclosure | Clarity and control |

🧠 Mnemonic: U-A-F-C-P

 User-Centered  Aﬀordances

 Feedback

 Consistency

 Progressive Disclosure

🎯 Likely Exam Questions

✅ MCQs

. Which of the following best describes “aﬀordance” in interaction design?

1. Data summarization
2. User permissions
3. Visual hints for possible actions
4. Report generation

Answer: c) Visual hints for possible actions

. What is “progressive disclosure”?

1. Hiding key data
2. Showing all data at once
3. Revealing information as needed
4. Compressing charts

Answer: c) Revealing information as needed

✅ Short Answer

 What is user-centered design? Why is it important in interactive visualizations?

✅ Long Answer

 Describe the ﬁve key design principles for interaction. Explain with examples how they contribute to better user experience.