Usage of Charts and Plots in Data Science

VU Visual Data Science
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Introduction

• Multitude of charts and plots available
• How to select the right chart for a specific task?
• Discussion of suggestions and current research
Usage of Charts
Usage of Charts

• Chart suggestions
• Data Visualization Catalogue
  • [https://datavizcatalogue.com/search.html](https://datavizcatalogue.com/search.html)
Usage of Charts

• Tableau Help
  • https://help.tableau.com/current/pro/desktop/en-us/what_chart_example.htm

• Tableau „Ask Data“ Feature
Usage of Charts

• Chart Chooser
Usage of Charts

• From Data to Viz
  • [https://www.data-to-viz.com/](https://www.data-to-viz.com/)
Usage of Charts

• Starting point is either
  • Data
  • Task
Chart Suggestions—A Thought-Starter

Comparison

Relationship

Distribution

Composition

[Diagram showing various chart types and their uses based on data types and contexts]
Chart Suggestions—A Thought-Starter

Comparison

Relationship

What would you like to show?

Distribution

Composition

Variables

Relationship

Composition

Changin Over Time

Static

Data

Few Periods

Many Periods

Composition

Only Relative Difference Matter

Relative and Absolute Difference Matter

Only Relative Difference Matter

Relative and Absolute Difference Matter

Simple Share of Total

Accumulation or Subtraction to Total

Components of Components

Stacked 100% Column Chart

Stacked Column Chart

Stacked Area Chart

Pie Chart

Waterfall Chart

Stacked 100% Column Chart with Subtotals

[2]
Chart Suggestions—A Thought-Starter

Comparison

Variables:
- Two Variables
- Many Categories
- One Variable per Item
- Among Items
- Few Variables

Relationship

What would you like to show?

Distribution

Composition

Over Time
- Many Periods
- Few Periods

Composition

Static
- Few Variables
- Many Data Points
- Three Variables

Composition

Components of Components

Over Time
- Few Periods
- Many Periods

Composition

Relative and Absolute Differences Matter

Comparison

Single or Few Categories
- Few Periods
- Many Categories

Comparison

Cyclical Data
- Many Periods
- Few Periods

Comparison

Non-Cyclical Data
- Many Periods
- Few Periods

Comparison

Line Chart
- Many Periods
- Few Periods

Comparison

Column Chart
- Many Periods
- Few Periods

Comparison

Bar Chart
- Many Periods
- Few Periods

Comparison

Tableau Table with Embedded Charts
- Many Periods
- Few Periods

Comparison

Variables
- Two Variables
- Many Categories
- One Variable per Item
- Among Items
- Few Variables

Comparison

Bar Chart
- Three Variables

Comparison

Pie Chart
- Single Variable
- Few Data Points

Comparison

Waterfall Chart
- Components of Components
- Simple Share of Total
- Accumulation or Subtraction to Total

Comparison

Stacked Area Chart
- Relative and Absolute Differences Matter

Comparison

Stacked 100% Column Chart
- Only Relative Differences Matter

Comparison

Stacked 100% Area Chart
- Only Relative Differences Matter

Comparison

Stacked Column Chart
- Only Relative Differences Matter
Bar Charts

- Better use **bar charts** for comparison than pie charts
- Hard to read exact **values** in pie charts
Bar Charts

• Better use **bar charts** for comparison than pie charts
• Hard to read exact **values** in pie charts

Bar Charts

• Neighbourhood Effects
Chart Suggestions—A Thought-Starter

Comparison

Relationship

Distribution

Composition

Variable Width Column Chart

Table with Embedded Charts

Bar Chart

Column Chart

Circular Area Chart

Line Chart

Column Chart

Line Chart

Comparison

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Table with Embedded Charts

Bar Chart

Column Chart

Circular Area Chart

Line Chart

Column Chart

Line Chart

Comparison

What would you like to show?
Line Charts

• Time = horizontal
Chart Suggestions—A Thought-Starter

Comparison

What would you like to show?

Relationship

Distribution

Composition

Changing Over Time

Static

Only Relative Difference Matter

Only Relative Difference Matter

Only Relative Difference Matter

Relative and Absolute Difference Matter

Relative and Absolute Difference Matter

Relative and Absolute Difference Matter

Simple Share of Total

Accumulation or Subtraction to Total

Components of Components

Among Items

Few Categories

Many Categories

Many Items

Few Items

One Variable per Item

Two Variables per Item

Three Variables

Single Variable

Two Variables

Three Variables

Many Data Points

Few Data Points

Few Periods

Many Periods

Cyclical Data

Non-Cyclical Data

Single or Few Categories

Many Categories

Over Time

Cumulative Line Chart

Line Chart

Column Chart

Line Chart

Column Histogram

Line Histogram

Scatter Chart

Box and Whisker Chart

Stacked Area Chart

Stacked Column Chart

Stacked 100% Column Chart

Stacked 100% Area Chart

Waterfall Chart
Circular Visualization

- Radial representation to **save screen space**
- Radial = **clock metaphor**
Spatio-Temporal Visualization

• Visualisation of **car stops**
Scatter Plot

- Pattern recognition based on position
- Gestalt Laws: **Law of Proximity**
Gestalt Laws (Lecture 04)

1. **Law of Proximity**
   
   *Spatially close elements appear as grouped and as one.*
Chart Suggestions—A Thought-Starter

- **Comparison**
  - **Relationship**
    - What would you like to show?
  - **Composition**
    - Changing Over Time
    - Static
    - Composition
    - Correlation
    - Association

- **Over Time**
  - Few Data Points
  - Many Data Points

- **Distribution**
  - Single Variable
  - Two Variables
  - Three Variables

- **Bars**
  - Bar Chart
  - Column Chart
  - Line Chart

- **Tables**
  - Table with Embedded Charts

- **Categorical Data**
  - Single or Few Categories
  - Many Categories

- **Time Series Data**
  - Many Periods
  - Few Periods

- **One Variable per Item**
  - Among Items
  - Two Variables
  - Three Variables

- **Two Variables per Item**
  - Many Items
  - Few Items

- **Charts**
  - Stacked Area Chart
  - Stacked 100% Column Chart
  - Waterfall Chart
  - Pie Chart
Chart Suggestions—A Thought-Starter

Comparison

What would you like to show?

Relationship

Composition

Distribution

Changing Over Time

Relationship

Composition

Distribution

Changing Over Time
Parallel Coordinates
Chart Suggestions—A Thought-Starter

Comparison

What would you like to show?

Composition

Changing Over Time

Static

Three Variables

Only Relative Differences Matter

Relative and Absolute Differences Matter

Composition of Components

Accumulation or Subtraction to Total

Components of Components

Three Variables

Two Variables

Relationship

Three Variables

Distribution

Two Variables

Many Variables

Multiple Data Points

Simple Variables

Two Periods

Many Periods

Over Time

Few Periods

Many Categories

Few Categories

Few Items

Many Items

One Variable per Item

Among Items

One Variable per Item

Over Time

Few Periods

Many Categories

Few Categories

Few Items

Many Items

Relationship
Chart Suggestions—A Thought-Starter

- **Comparison**
  - What would you like to show?

- **Relationship**
  - Two Variables
  - Three Variables

- **Composition**
  - Changing Over Time
  - Static

- **Distribution**
  - Single or Few Variables
  - Many Variables

- **Chart Types**
  - Bar Chart
  - Column Chart
  - Scatter Chart
  - Bubble Chart
  - Line Chart
  - Area Chart
  - Pie Chart
  - Waterfall Chart
  - Stacked 100% Column Chart with Subcomponents

- **Guidelines**
  - Two Variables per Item
  - Many Variables per Item
  - Few Variables per Item
  - Many Categories
  - Few Categories
  - One Variable per Item
  - Over Time
  - Among Items
Pie Charts

• Research on **visual interpretation** of pie charts
• Possible **attributes** for judgement
  • Angle
  • Arc length
  • Area
Pie Charts

• Study on interpretation of pie charts
Pie Charts

• More than 90 study participants
• Had to solve several tasks with different pie chart types
Pie Charts

• Results

[Diagram of pie charts showing mean error]
Pie Charts

• Study on **donut charts:**

![Pie charts with different donut charts](image-url)
Pie Charts

• Results:
Pie Charts

• Conclusions
  • Main visual clue: area
  • Donut charts give same results as pie chart
  • Do not use stacked donut charts
  • Icons ok, if more or less round
Pie Charts

• Conclusions
  • Do not use **stacked** donut charts
Chart Suggestions—A Thought-Starter

Comparison

Relationship
What would you like to show?

Distribution

Composition

Treemap
Treemap

Kosten für tägliche Lebensmitteleinkäufe

- Mittagessen
  - Salat
  - Belegtes Br...
  - Suppe
  - Kuchen
  - Eistee
- Frühstück
  - Waffeln
  - Pfannkuchen
  - Tee
  - Kaffee
- Mittagessen
  - Kuchen
  - Eier
Chart Suggestions—A Thought-Starter

Comparison
- What would you like to show?

Composition
- Three Variables
- Changing Over Time
  - Few Periods
  - Many Periods
  - Only Relative Differences Matter
  - Relative and Absolute Differences Matter

Distribution
- Single Variable
- Many Variables
- Two Variables

Relationship
- Two Variables
- Scatter Chart
- Bubble Chart

Among Items
- Two Variables per Item
- Many Categories
- Few Items
- Cyclic Data
- Non-Cyclic Data
- Single or Few Categories
- Many Categories

Over Time
- Few Periods
- Many Periods
Stacked Area Charts
Theme River
Study on Temporal Visualizations

- **Comparison of**
  - Stacked area charts
  - Theme River
  - Streamgraphs
Study on Temporal Visualizations

• 16 participants
• 3 tasks, had to be solved with all chart types
Study on Temporal Visualizations

• **Results**
  • Only **minimal differences** between charts
  • Stacked area charts considered **visually appealing and readable**
  • **Stacked area charts** pose problems
    • **Baseline** might lead to wrong conclusions
    • Theme River better to follow **single categories**
Study on Temporal Visualizations

• **Alternative**: line chart
Map Visualisations

• From Data to Viz
  • https://www.data-to-viz.com/
Geospatial Visualisation

- **Temporal evolution** of values
- **Several maps** next to each other or **glyphs** in map?
Geospatial Visualisation

- Study with **artificially created data**
  - Literacy rate
  - Working hours per week
- **18** participants
- Several **tasks** to solve
Geospatial Visualisation

• Tasks

**One occasion**
- Single Time
  - T1, T2, T3, T4
  - Not relevant

**Locations in a region**
- Time interval
  - T1, T2, T3, T4
  - Ex: correlation for one state in the period [T2-T3] H: Barchart1M
- All times
  - T1, T2, T3, T4
  - Ex: correlation for one state over all time steps H: Barchart1M

**All locations**
- Time interval
  - T1, T2, T3, T4
  - Ex: correlation in the West in T2 H: GlyphSM
  - Ex: correlation in the West in the period [T2-T3] H: GlyphSM
  - Ex: correlation over all states in the period [T2-T3] H: Small Multiples
  - Ex: correlation over all states over all time steps H: Barchart1M
Geospatial Visualisation

• Correlations

Without monotonic evolution

Positive correlation | Negative correlation | No correlation

With monotonic evolution

Literacy rate  
2000  2003

Working hours  
low  high
Geospatial Visualisation

• Results
Application Spotlight: Tableau
Application Spotlight: Tableau

Tableau Desktop: Tableau jetzt 14 Tage kostenlos testen
Application Spotlight: Tableau

• Tableau integrated "Ask Data" feature in 2018
• Provides natural language support
Application Spotlight: Tableau

• Examples
  • „As a histogram“ 

“age as a histogram”
Application Spotlight: Tableau

• **Examples**
  • “How many“

“how many beds for each neighborhood?”
Application Spotlight: Tableau

• Examples
  • „Distribution“

What is the age distribution of those who survived and didn’t survive?
Application Spotlight: Tableau

• Examples
  • „Split this“
Application Spotlight: Tableau

• **Examples**
  • „Trend line“

(c) “scatter plot of survival status by age and fare”

(d) “add a trend line”
Application Spotlight: Tableau

- Allows sequential analysis queries

“show me children aboard who survived”

“break this down by sex and age”

“what’s the correlation between age, fare, and survival”

(a) initial utterance  
(b) implicit intent to retain context  
(c) implicit intent asking for a correlation
Usage of Charts

• Starting point is either
  • Data
  • Task
Usage of Charts

- **Data** = Temporal data
- **Task** defines chart
Usage of Charts

• **Consider suggestions** from serious sources
• Suggestions based on **data** and **task**
• Check **recent studies** on chart usage (visualization & HCI research)
• Consider rules of thumb for **visual mappings** (lecture 04)
References

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References


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[19] https://www.tableau.com
