IOWA

# Data Visualization

WaterSoftHack ‘24

# Objectives

- Understand the process of visualization and its importance in earth sciences
- Understanding visualization principles
- Getting exposed to visualization tools
- Creative interactive and impactful visualizations
- Dive deeper into the projects

# Tools and Libraries

## Web-Based Libraries for Data Analysis

- HydroLang.js, HydroCompute, HydroRTC, D3
- Python for data manipulation and analysis

## Tools for Development

- VSCode
- Online Resource (Stackblitz for JS)
- Google Colab (Python)

# Links for development

Tutorial links (JS):

**HydroLang:** https://hydroinformatics.uiowa.edu/tutorials/hydrolang/

**HydroRTC:** https://hydroinformatics.uiowa.edu/tutorials/hydrortc/

**HydroCompute:** https://hydroinformatics.uiowa.edu/tutorials/hydrocompute/

Other links (JS and Python)

**Google Earth Engine:** https://earthengine.google.com/

**Google Colab (Python) :** https://colab.research.google.com/

**Colab Examples (Python):**
https://drive.google.com/drive/folders/1SKKW1aY2IDF6f779LnuP_6xAgbzJOT2O?usp=sharing

# Part 1 - Introduction

# Introduction

Data visualization is the graphical representation of information and data

Many types, largely dependent on your **audience**

- **Process or Method:** flow chart, diagram, infographic, gantt chart, illustration, timeline
- **Compare, Contrast, or Show Change:** bar, line, box and whiskers, bubble, stacked area, pie
- **Establish a Relationship:** networks, heatmaps, maps, radar, mosaic, venn

# Importance in Hydrology

- **Enhance understanding** by simplifying complex data and identifying trends, patterns, and anomalies
- **Effective communication** by facilitating findings of diverse audiences including scientists, policymakers, and the public
- **Better decision-making,** supporting data-

# Part 2 - Types of Data Visualizations

# Common Types

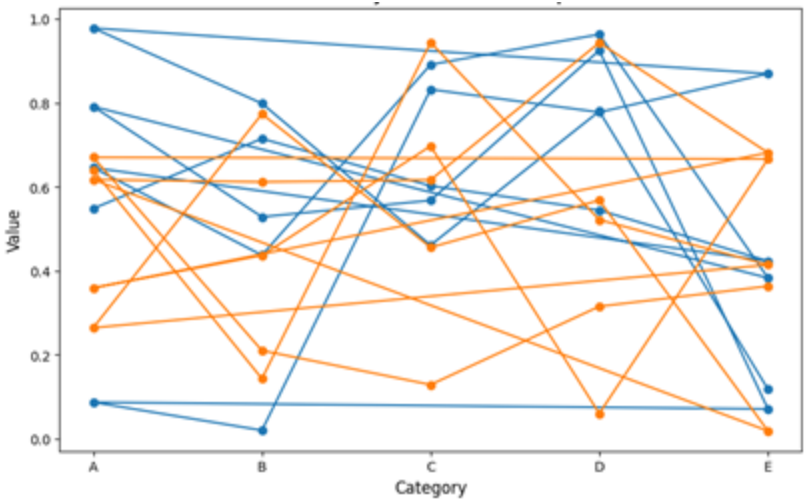
- **Line Charts:** best for showing trends over time (timeseries, relationships between variables)
- **Bar Charts:** great for comparison of quantities across categories (hyetographs)
- **Pie Charts:** Useful for showing proportions
- **Heat Maps:** effective for displaying data density and intensity
- **Scatter Plots:** good for showing relationships between variables
- **Histograms:** used for frequency distributions
- **Maps:** underlying map of a location showing a visualization of interest

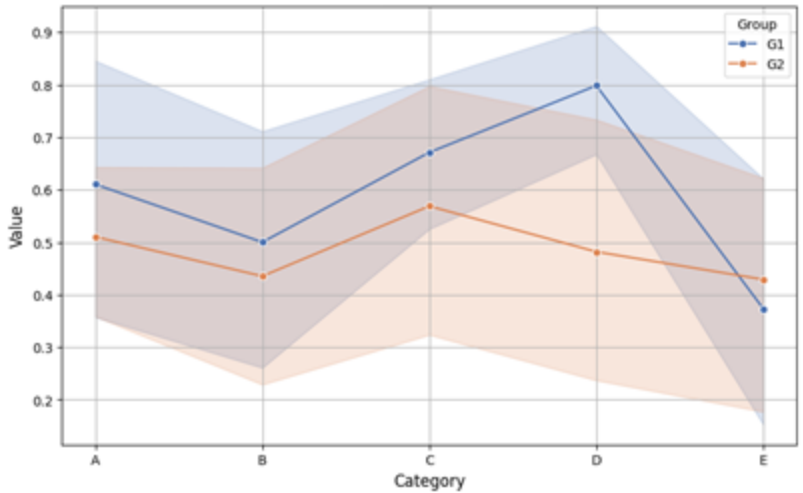
# Part 3 - Principles of Effective Data Visualization

# Best Approaches

**Clarity:** ensuring that visualizations are easy to understand

- Use clear labels, legends, and titles
- Avoid clutter and excessive detail, less is more!

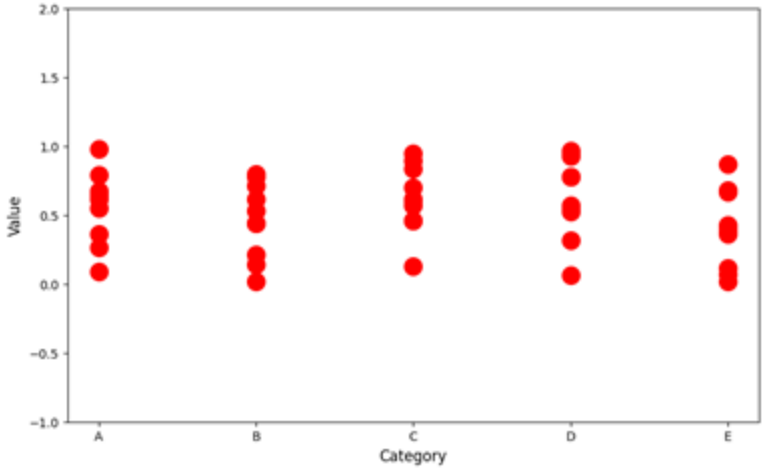


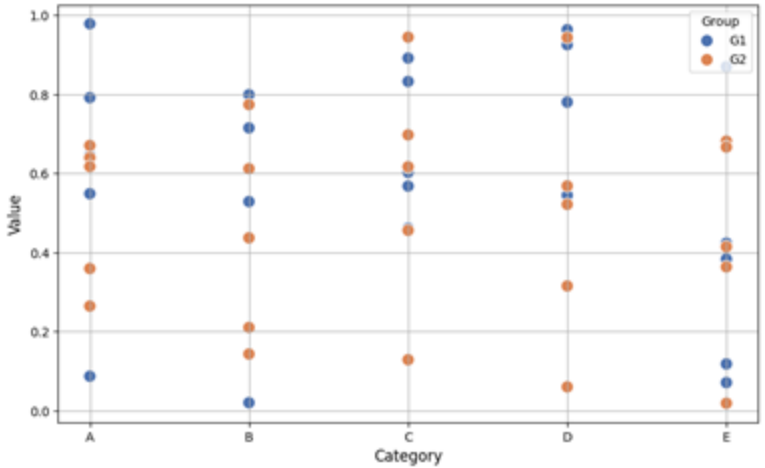



# Best Approaches

**Accuracy:** represent information truthfully and precisely

- Maintain proportional scales
- Avoid misleading representations and distortions

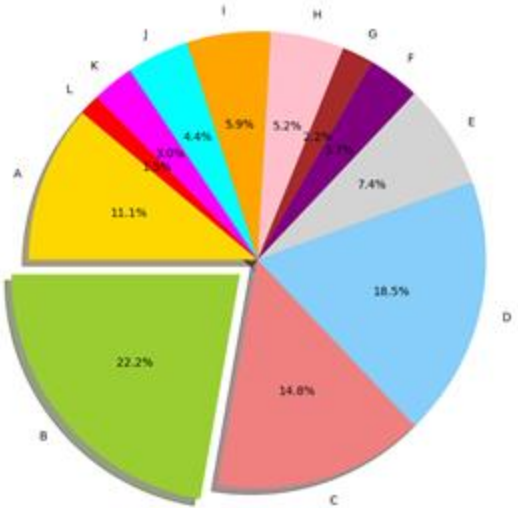


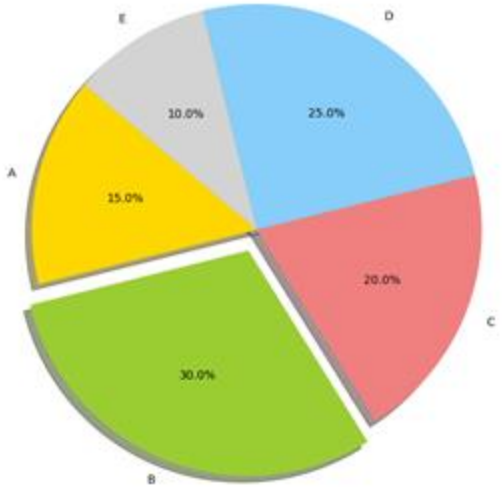



# Best Approaches

**Simplicity:** keep designs straightforward and focused

- Use minimalistic design elements
- Highlight the most important information

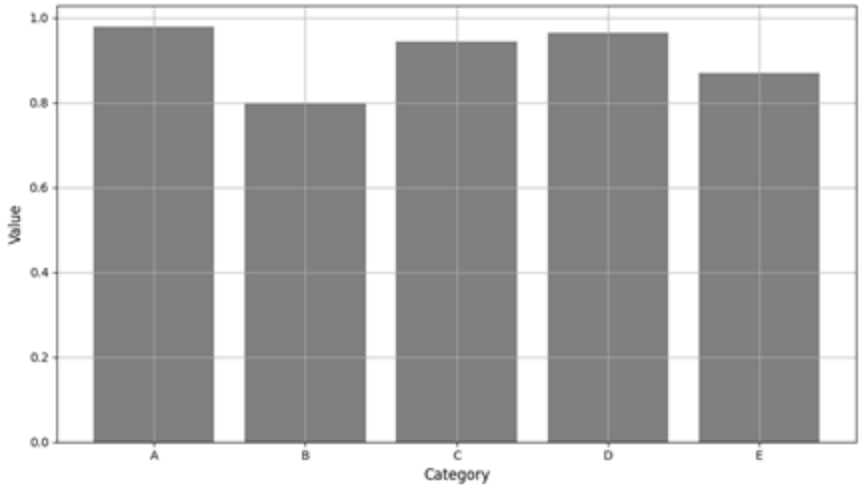


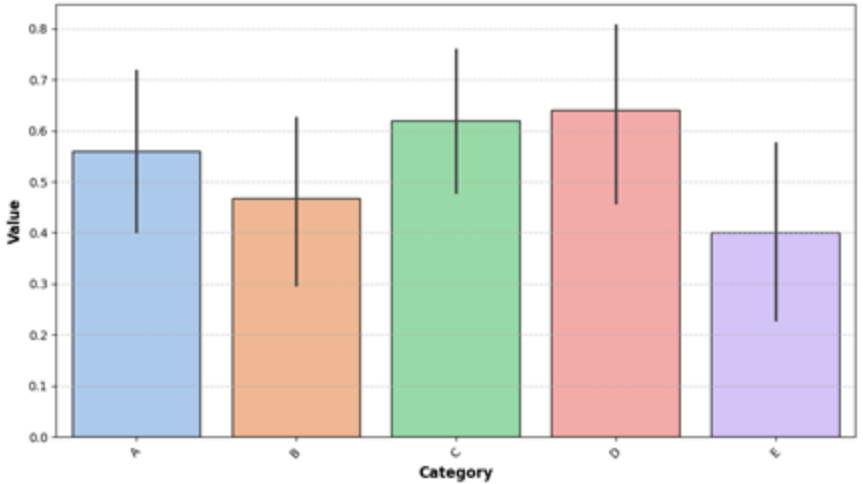



# Best Approaches

**Aesthetics:** make visualizations appealing

- Choosing an appropriate color scheme
- Balance visual elements to enhance readability

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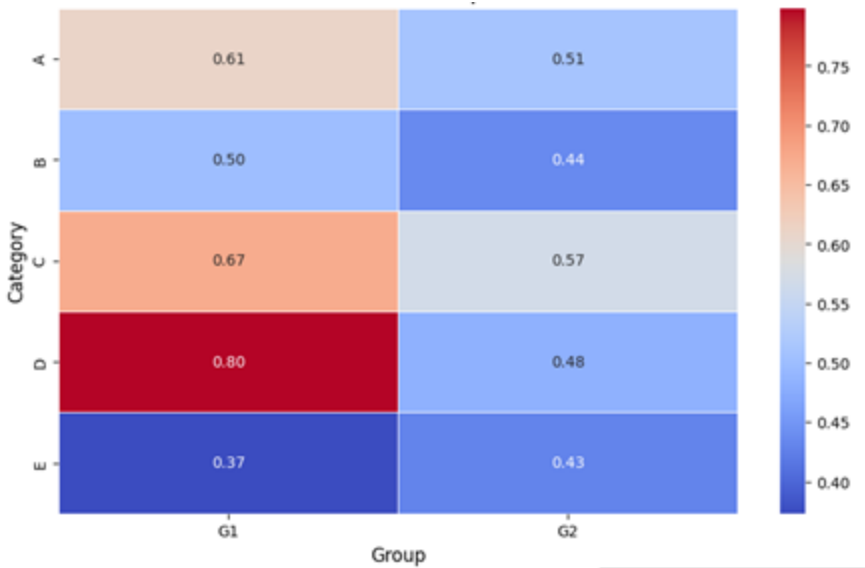
A
B
C
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Category
0.61
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0.50
0.44
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0.57
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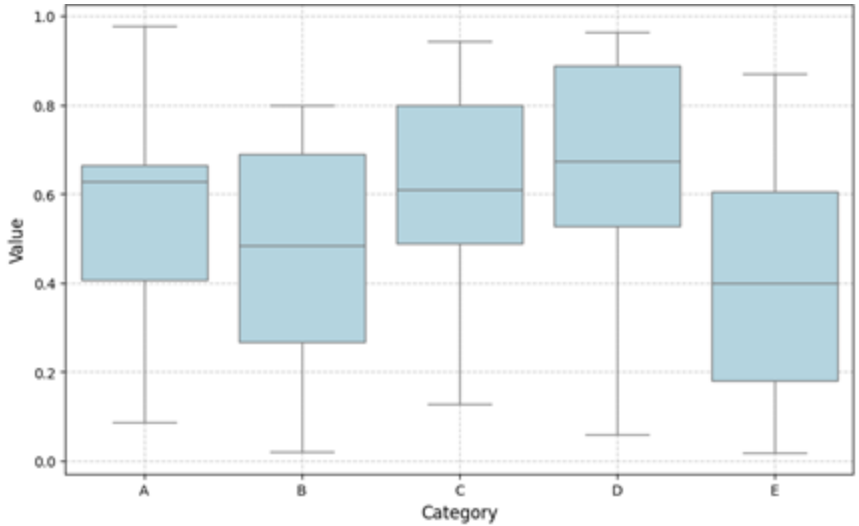
1.0
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Value
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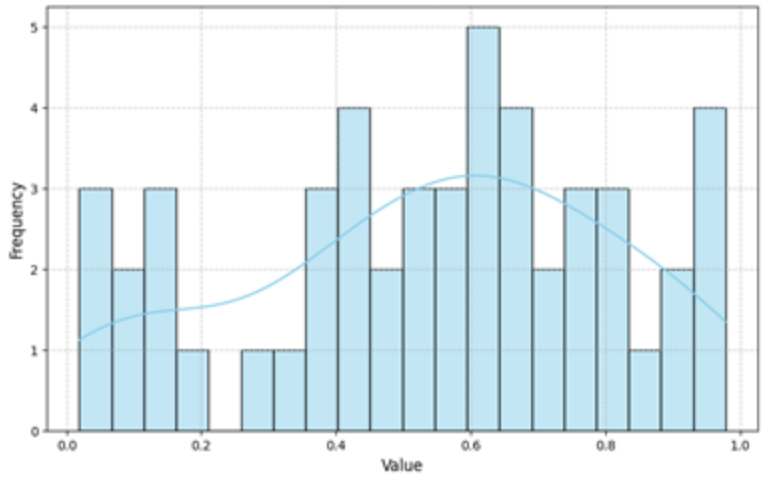

5
4
3
2
1
0
Frequency
0.0
0.2
0.4
0.6
0.8
1.0
Value

# Maps and Layers

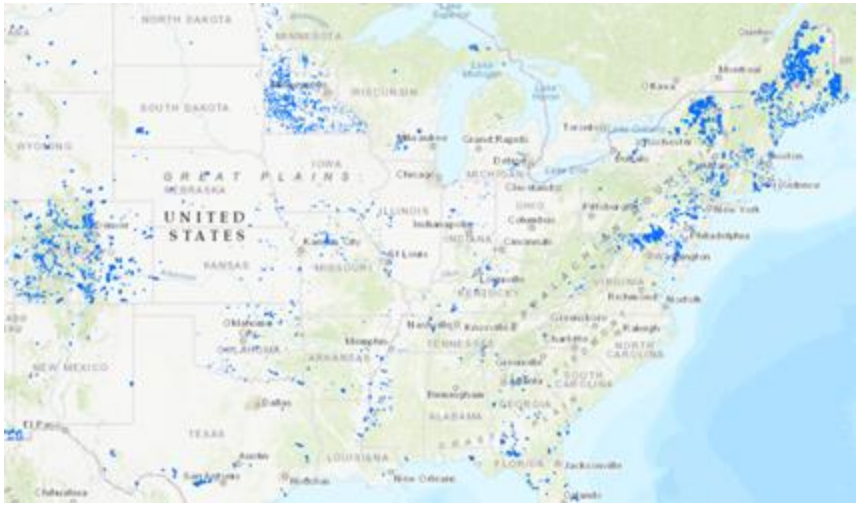
## Good Practices

- Easy to read with clear labels and minimal clutter
- Truthful representation with correct scales and proportions
- Focus on the essential information
- Readable text and symbols with good contrast

## Bad Practices

- Cluttered with excessive data
- Misleading
- Missing legends or explanations
- Varying styles throughout

*The above map depicts conservation easements in the United States as of 2018*




Source: https://urbanpatternsblog.wordpress.com/2019/03/05/bad-maps-and-good-maps/

# Choosing the Right Visualization Type

**Always** try to match the data you have with the message you want to convey

**Examples**

- Line charts for trends
- Bar charts for comparisons
- Heat maps for spatial data/correlations
- Clearly state labels and layers in your maps, make the best out of the clutter!

# Part 4 - Tools for Data Visualization

# Overview of Available Tools and Libraries

**JavaScript**

- **HydroLang:** create maps and charts through the API, powered by google charts, google maps, leaflet
- **D3:** flexible and powerful library for interactive and dynamic data visualizations
- **Plotly:** Easy-to-Use for interactive charts and dashboards

**Python**

- **Matplotlib:** standard library used for chart generation
- **Seaborn:** great for creating heatmaps and relational visuals
- **Bokeh:** for creating interactive visualizations

# Overview of Available Tools and Libraries

## GIS Tools

- **ArcGIS:** need license
- **QGIS:** free and open source
- **Python** using GDAL/OGR

## Online Resources

- **Google Earth Engine:** javascript-based containing multiple options for data visualization and manipulation
- **OpenLayers:** high performance engine for the rendering GIS on the web

# Part 6 - Advanced Visualization Techniques

# Importance

We can now have interactivity through web applications to get better and faster insights on our visualizations

**Examples**

- **Interactive Charts** enhancing user engagement and data exploration
- **Maps** to visually explore spatial data
- **Dashboards** the combination of multiple comprehensive data analysis

# Examples

Data visualization dashboard for streamflow forecasting
https://hydroinformatics.uiowa.edu/lab/hydrosuite/hydrocompute/cs2/

Weather Dashboards
https://www.arcgis.com/apps/dashboards/737e5317ef7343feb3b859f7757682e0

IFIS
https://ifis.iowafloodcenter.org/ifis/app/

USGS National Weather Dashboard
https://dashboard.waterdata.usgs.gov/app/nwd/en/

# Best Practices for User Dashboards

**To Consider**

- Always have a **User-Centered** design
- **Simplicity and Clarity** wins the race
- **Consistency** is key for wide adoption
- Utilize the best tools for **Performance**
- Enable **Interactivity** across your tool

**Try to get feedback in your design!**

# Part 6 - Example Case Studies

# Visualizing a shapefile on the web

**Steps**

- Convert the shapefile to geoJSON object
- Load it into a map engine (Leaflet, Google Maps, D3)
- Attach the layer into a visualization object

https://stackblitz.com/edit/vitejs-vite-njnuhu?file=index.html

# Additional Resources

Best practices for visualizations:

https://guides.library.duke.edu/datavis/topten

Best practices for mapping:

https://www.esri.com/about/newsroom/arcuser/visualization-best-practices/

# Q/A Discussions

# Next Hour - Training