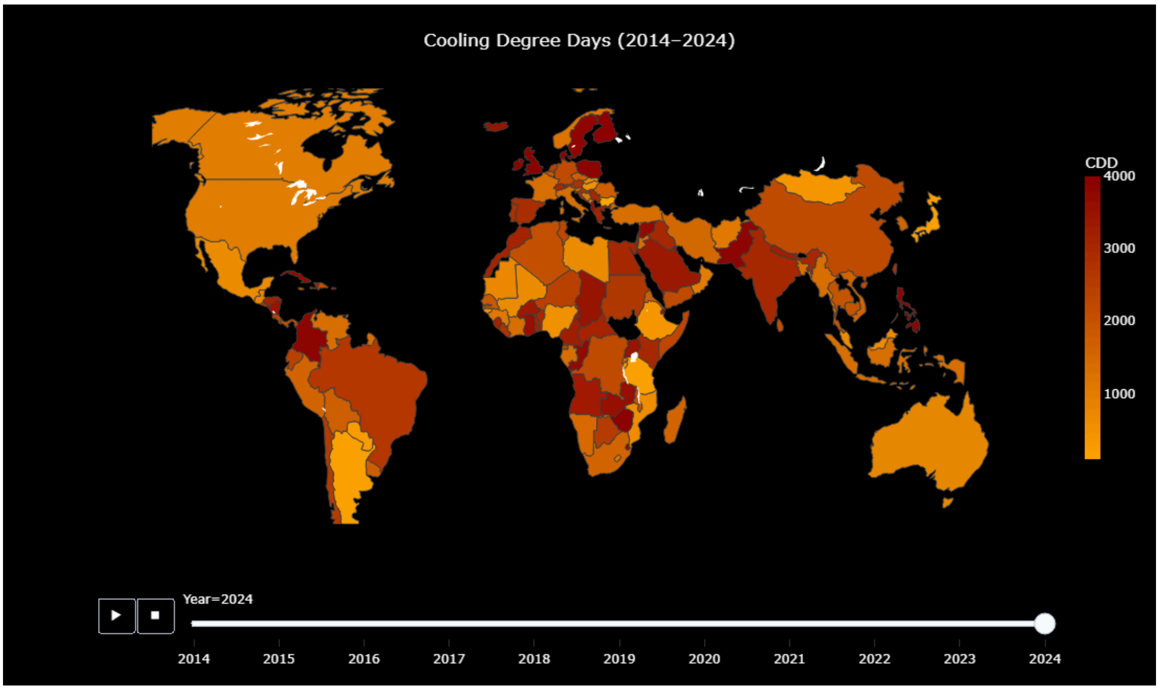
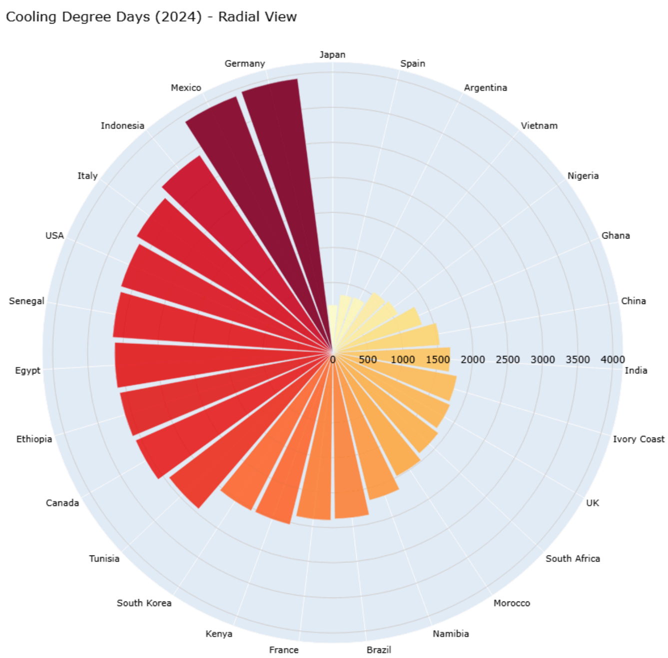
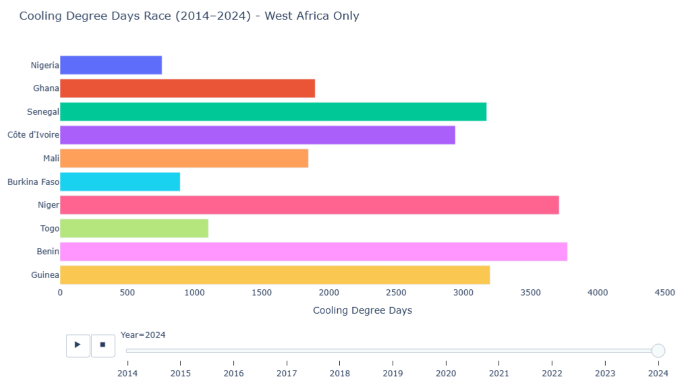
InfoVis Redesign







By: Gbemisayo Adelaja

Date: 06/04/2025

INFOSCI 301

Prof. Luyao Zhang

Theory

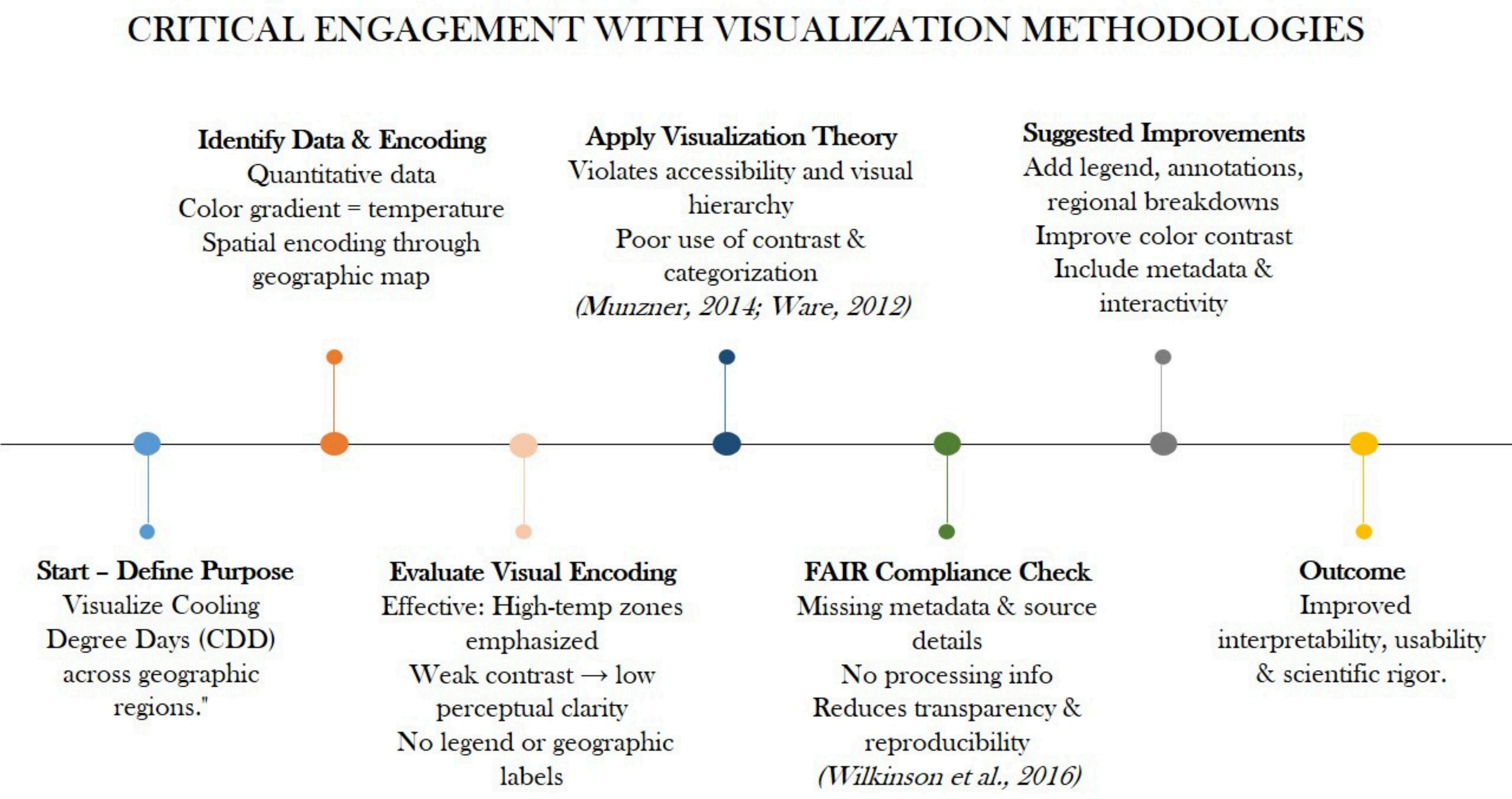


Fig 1. Flowchart of critique process (created using powerpoint)

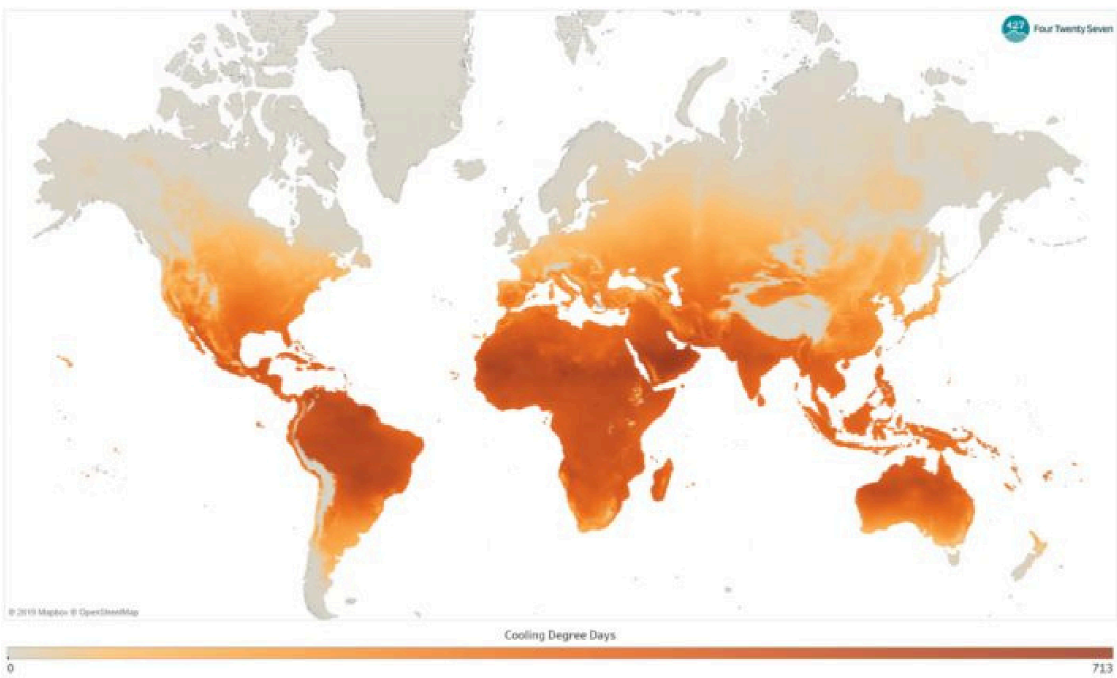


Fig 2. Heatmap of cooling degree days.
Source: https://aws.amazon.com/blogs/publicsector/leveraging-the-cloud-for-rapid-climate-risk-assessments/

The heatmap in the AWS article serves as a tool for visualizing temperature variations, and its use is appropriate given its ability to encode dense spatial data through color (Munzner, 2014, Ch. 7). According to visualization design principles, heatmaps are effective for representing quantitative variables distributed over a geographic surface, such as Cooling Degree Days (CDD), as they offer immediate visual cues for pattern recognition (Munzner, 2014). The dataset appears quantitative, with spatial geometry mapped to color gradients, successfully highlighting high-temperature zones through intensity.

However, its effectiveness is limited by the lack of a clear legend, geographic markers, and metadata on data sources and processing, which hinders reproducibility and accessibility (Wilkinson et al., 2016). The gradient lacks perceptual contrast, reducing differentiation across values (Ware, 2012), and the absence of contextual annotations diminishes communicative value. Well-structured visual hierarchies and categorical contrasts—critical for interpretability—are underutilized (Munzner, 2014; Ware, 2012). Adding interactivity, such as regional breakdowns or labels, would improve user engagement.

The FAIR principles—Findable, Accessible, Interoperable, and Reusable—promote better data sharing by ensuring transparency, standardization, and long-term usability. To comply, the dataset should include standardized formats, clear metadata, and open access (Wilkinson et al., 2016).

References:

Munzner, T. (2014). Visualization Analysis and Design. CRC Press.

Ware, C. (2012). Information Visualization: Perception for Design. Elsevier.

Wilkinson, M. D., et al. (2016). The FAIR Guiding Principles. Scientific Data, 3, 160018.

Research

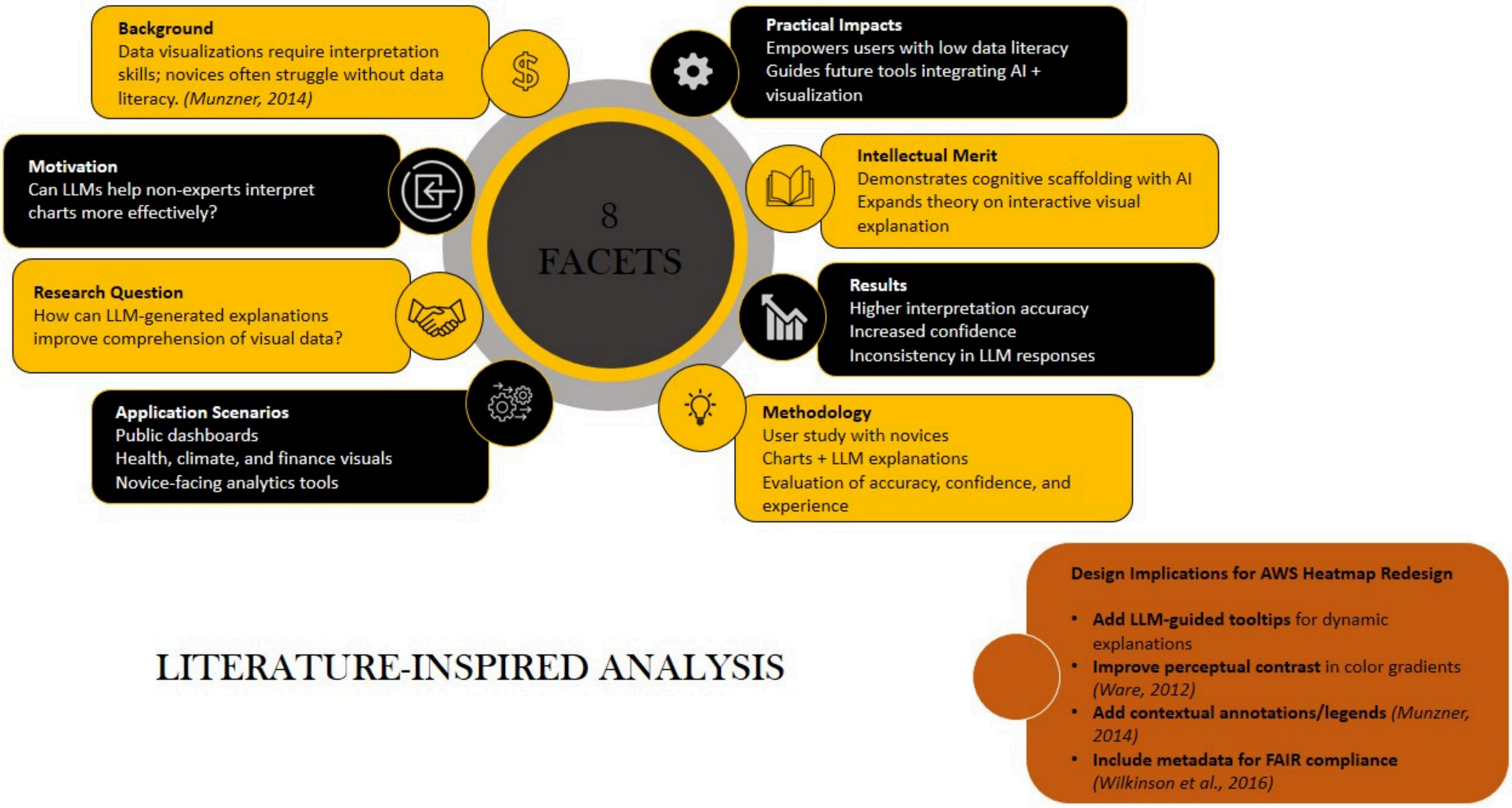


Fig 3. Flowchart of research (created using powerpoint)

The study by Choe et al. (2024) explores how large language models (LLMs) can assist novices in interpreting data visualizations, improving accessibility and comprehension. Traditional chart interpretation requires prior data literacy, often creating barriers for non-experts (Munzner, 2014).

By integrating LLM-guided explanations, the study demonstrates how users can dynamically engage with visual data, reducing cognitive overload and enhancing understanding (Ware, 2012). Findings suggest that interactive elements significantly improve interpretation accuracy and user confidence, though challenges remain in response consistency (Choe et al., 2024).

These insights directly inform the redesign of the AWS heatmap. The current visualization lacks sufficient contrast and contextual annotations, limiting perceptual clarity (Ware, 2012). Implementing interactive elements, such as LLM-guided explanations or tooltips, would enhance comprehension and align with FAIR data principles by improving accessibility and metadata transparency (Wilkinson et al., 2016).

Additionally, refining the color gradient and integrating categorical distinctions would optimize data encoding for better readability (Munzner, 2014). By incorporating these strategies, the heatmap can evolve into a more effective tool for climate risk assessment, bridging the gap between data presentation and user comprehension.

References

Choe, K., Lee, C., Lee, S., Song, J., Cho, A., Kim, N. W., & Seo, J. (2024). Enhancing Data Literacy On-demand: LLMs as Guides for Novices in Chart Interpretation.
Munzner, T. (2014). Visualization Analysis and Design. CRC Press.
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Practice

Amazon QuickSight, a scalable BI tool, enables interactive visualization through an intuitive interface and rapid processing via its SPICE engine (AWS, 2024). While it supports accessible data exploration with features like dynamic filters and AI-generated insights, it offers limited customization and a relatively narrow range of visualization types (Gartner, 2024; Yurbi, 2023). These constraints make it less ideal for tailored, research-focused redesigns requiring perceptual precision.

In contrast, using Python with libraries such as pandas, numpy, and plotly provides greater flexibility, reproducibility, and control over visual encoding. Python enables fine-tuned adjustments in color contrast, layout, and interactivity—key factors for optimizing perceptual clarity and adhering to visualization best practices (Ware, 2012). Moreover, Python's open-source nature supports FAIR principles by promoting transparency, reusability, and standardization (Wilkinson et al., 2016). Plotly, in particular, allows for interactive and high-resolution visualizations suitable for both exploration and presentation.

Given these strengths, Python was chosen over QuickSight for the heatmap redesign to allow deeper customization, better FAIR compliance, and a more rigorous visualization process.

References

AWS. (2024). *Amazon QuickSight Documentation*.
Gartner. (2024). *Magic Quadrant for Analytics and BI Platforms*.
Ware, C. (2012). *Information Visualization: Perception for Design*. Morgan Kaufmann.
Wilkinson, M. D., et al. (2016). The FAIR guiding principles for scientific data management and stewardship. *Scientific Data, 3*, 160018.
Yurbi. (2023). *Amazon QuickSight Review: Pros & Cons*.
Transcenda. (2022). *Enhancing Data Exploration with AI-driven BI Tools*.

Innovation

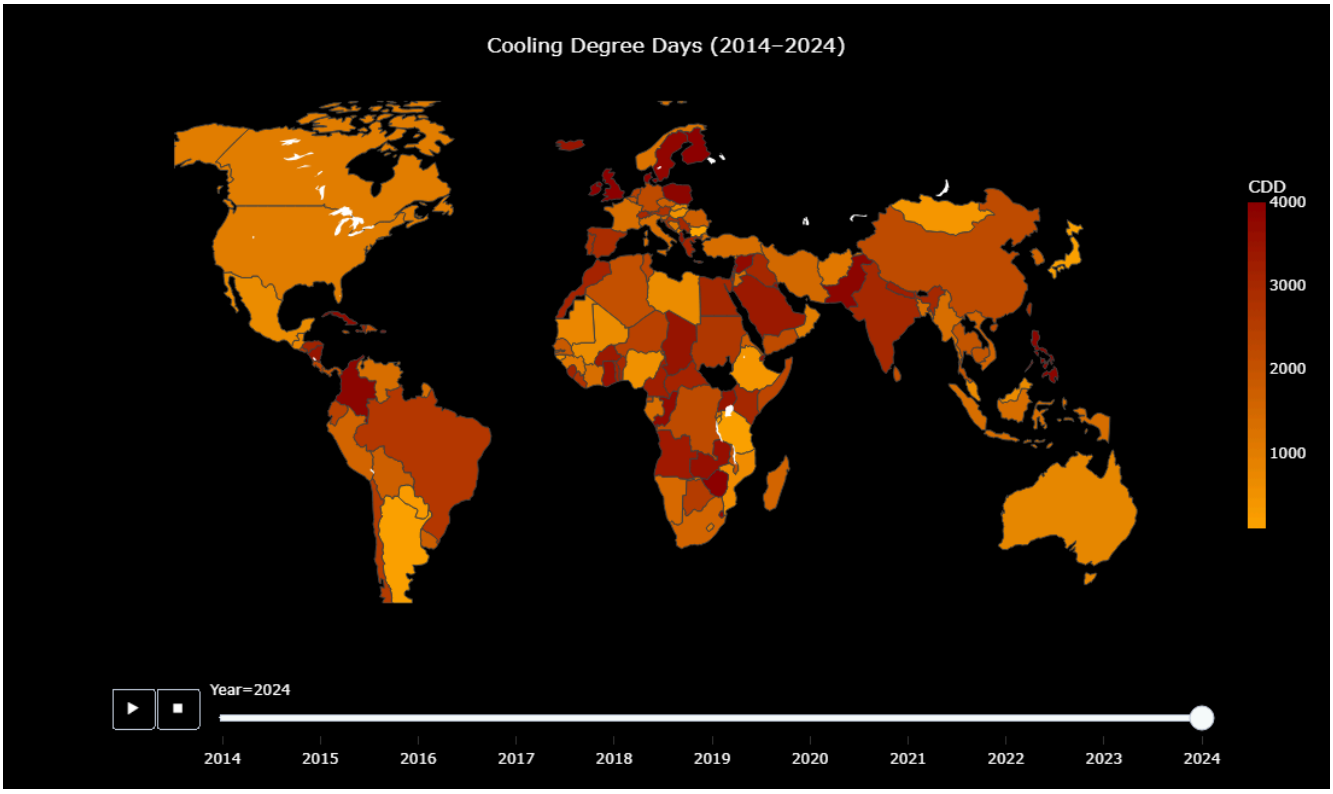

Fig 4. Heatmap redesigned (created using python code)

Innovation

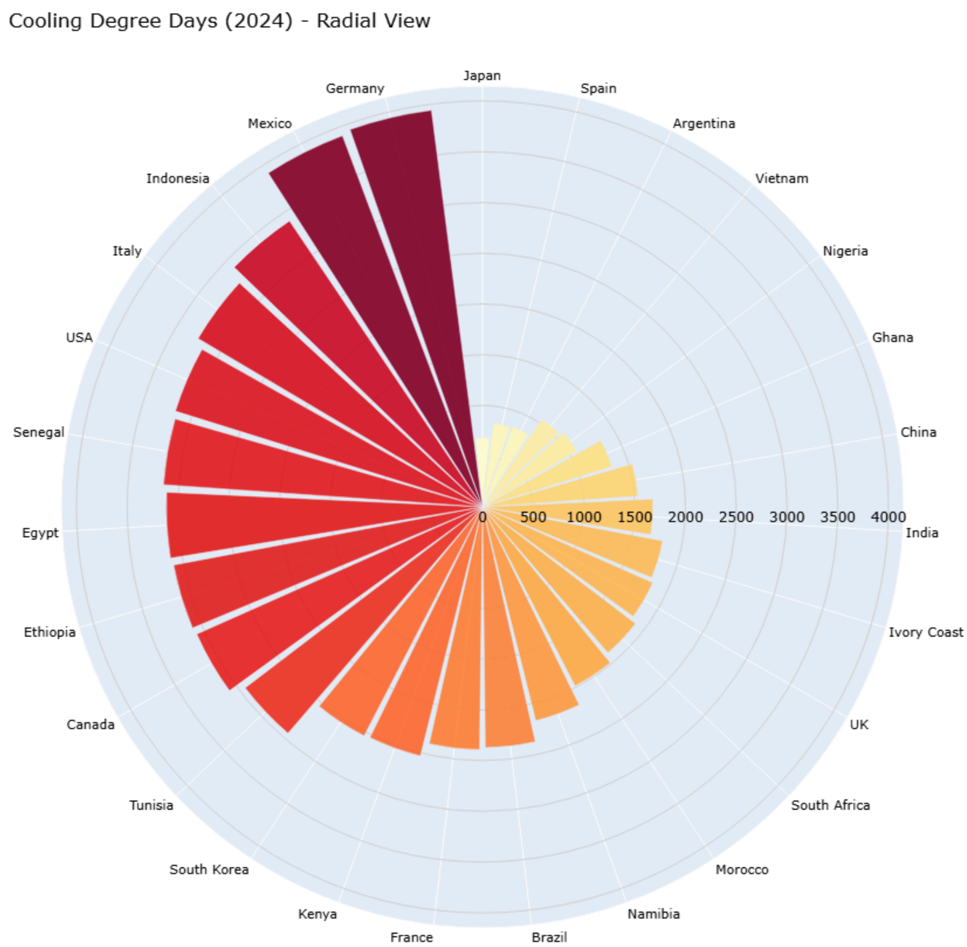

Fig 5. Radial chart as alternative visualization (created using python code)

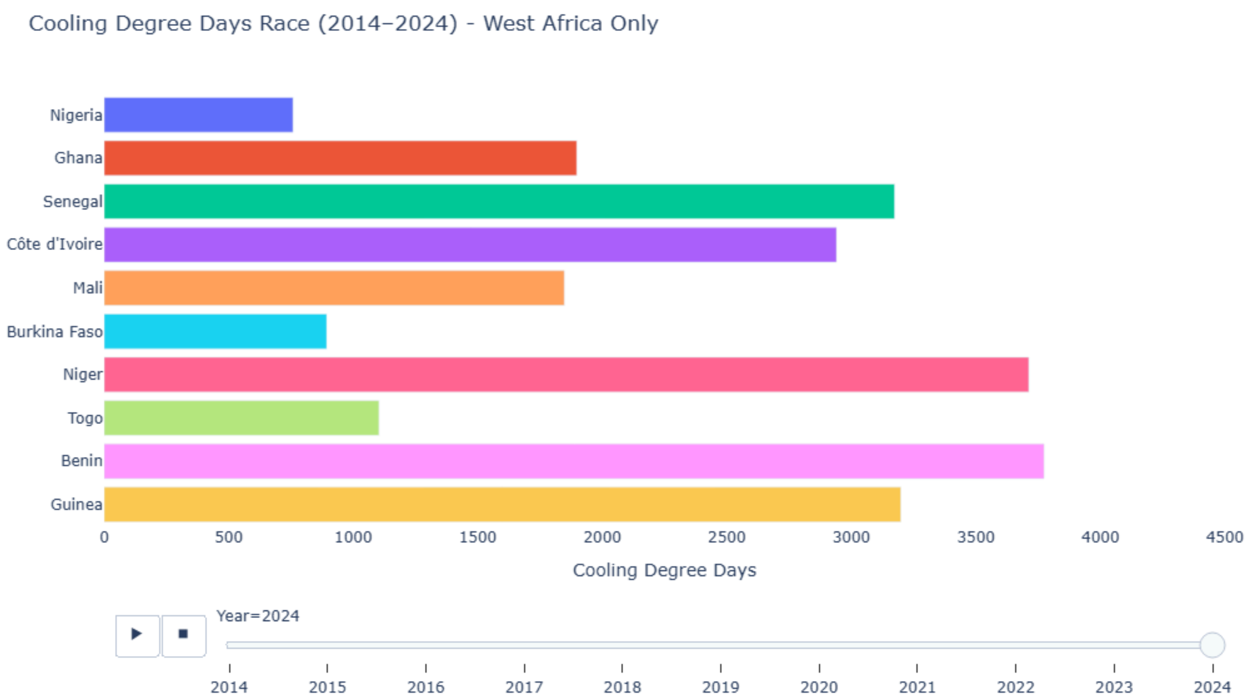

Fig 6. Snake race bar chart as alternative visualization (created using python code)

The redesigned AWS visualization uses Python libraries—pandas, plotly, and numpy—to address the original heatmap's limitations while offering a richer, more accessible user experience. Due to the unavailability of the original dataset, simulated data was generated using Python to support the redesign. Python was chosen over Amazon QuickSight for its flexibility, reproducibility, and ability to fine-tune visual elements such as color contrast and interactivity (Ware, 2012).

Three distinct visualization types were employed, each serving a unique analytical goal. The heatmap provides a broad overview of spatial and temporal Cooling Degree Days (CDD) patterns using intuitive color encoding (Munzner, 2014, p. 145). The snake race bar chart tracks yearly trends and rankings through animation, engaging users and highlighting change over time (p. 125). The radial bar chart captures cyclical and seasonal patterns, which are central to understanding climate-related data (p. 130). Both the heatmap and snake race bar chart are interactive—users can hover over each datapoint to reveal specific values and press play to view data transitions across years. These interactions enhance comprehension and engagement, especially for non-expert users. Additionally, LLM-guided tooltips provide real-time contextual explanations, aligning with principles of exploratory visualization (Choe et al., 2024).

The redesign also adheres to FAIR principles by including standardized formats, clear metadata, and accessible outputs, supporting findability, accessibility, interoperability, and reusability (Wilkinson et al., 2016). Overall, the Python-powered redesign improves usability, interpretability, and scientific value for climate risk assessments.

References

Choe, E. K., et al. (2024). Interactive Data Explanation with LLMs.
Munzner, T. (2014). Visualization Analysis and Design. CRC Press.
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Wilkinson, M. D., et al. (2016). Scientific Data, 3, 160018.

Sustainable development goal contribution

This project supports Sustainable Development Goal (SDG) **13: Climate Action** by enhancing the communication of climate-related data through effective visualization redesign. By improving how Cooling Degree Days (CDD) data is presented, the project enables clearer understanding of climate trends, helping policymakers, researchers, and the public make informed decisions about mitigation and adaptation strategies (United Nations, 2015). Interactive and accessible visualizations lower barriers for non-experts, democratizing climate data interpretation and fostering broader participation in climate initiatives (Choe et al., 2024).

The integration of FAIR principles ensures that data remains Findable, Accessible, Interoperable, and Reusable, further amplifying its impact (Wilkinson et al., 2016). Clear, inclusive visualizations are crucial for translating complex environmental data into actionable knowledge, ultimately contributing to global efforts to combat climate change and build resilience against its effects (Munzner, 2014).

Fig 7. Sustainable development goal logo (gotten from their website)

References

Choe, E., Kim, S., & Lee, B. (2024). Empowering Novices in Visualization Interpretation with LLMs.

Munzner, T. (2014). *Visualization Analysis and Design*. CRC Press.

United Nations. (2015). *Transforming our world: the 2030 Agenda for Sustainable Development*.

Wilkinson, M. D., et al. (2016). The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data*, 3, 160018.

Feedback

At the Digital Technology for Sustainability Symposium, I had a meaningful conversation with a professor that deeply influenced my Information Visualization (InfoVis) Redesign project. He praised the interactivity of my visualizations but suggested using question-based titles to prompt deeper user engagement. This aligns with research showing that question-driven titles act as cognitive hooks, increasing curiosity and interpretation (Liu, Stasko, & Dwyer, 2020; Hullman & Diakopoulos, 2011). He also encouraged exploring immersive visualization through Augmented Reality (AR), envisioning a globe interface where users could zoom into countries for localized data.

Though advanced AR is beyond my current skills, it reminded me of Reality Composer, an accessible AR tool I explored earlier in the semester (Álvarez-Marín, Rodríguez-Fórtiz, & Martínez-Nieto, 2023). Immersive tools can enable “embodied interaction,” helping users better understand complex, multidimensional systems (Dey et al., 2018). While full AR implementation is a future goal, I’m now redesigning graph titles as thought-provoking questions and beginning to storyboard 3D visualization concepts. This professor’s feedback expanded my perspective on public engagement, narrative framing, and immersive design.

References
Álvarez-Marín, A., Rodríguez-Fórtiz, M. J., & Martínez-Nieto, A. (2023). Designing AR for beginners: A usability analysis of Reality Composer. Journal of Interactive Media, 19(2), 45–60.

Dey, A., Billinghurst, M., Lindeman, R. W., & Swan, J. E. (2018). A systematic review of 10 years of augmented reality usability studies: 2005 to 2014. Frontiers in Robotics and AI, 5, 37. https://doi.org/10.3389/frobt.2018.00037

Hullman, J., & Diakopoulos, N. (2011). Visualization rhetoric: Framing effects in narrative visualization. IEEE Transactions on Visualization and Computer Graphics, 17(12), 2231–2240. https://doi.org/10.1109/TVCG.2011.255

Liu, S., Stasko, J. T., & Dwyer, T. (2020). Thought-provoking questions in visualization titles: A study on viewer engagement. Information Visualization, 19(3), 165–181.

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Loe Bi who peer review the draft and gave insightful feedback

Prof. Ming-Chun Huang who gave me feedback during the Digital Technology for Sustainability Symposium at Duke Kunshan University.

INFOSCI 301 classmate who gave feedback during classes

Future Research

Fig 8. image taken at the Zhouzhang Mystery of Life Museum

The visit to the Zhouzhuang Mystery of Life Museum inspired new possibilities for connecting digital humanities, biodiversity education, and community-based learning. While the museum's physical exhibits of human and animal anatomy were striking, they also highlighted barriers for non-experts and sensitive audiences. A future research direction would explore redesigning such experiences into an Augmented Reality (AR) environment. Using tools like the Apple Vision Pro, visitors could virtually interact with anatomical structures, zoom in for detail, and learn at their own pace, improving accessibility and emotional comfort (Billinghurst et al., 2015).

Incorporating multilingual options would further enhance inclusivity for international audiences. This approach aligns with ethical scientific storytelling, aesthetic sensitivity, and user-centered design principles, extending digital humanities into biological education while respecting diverse community needs (Svensson, 2016). Future visualization projects can build on this immersive, ethical model to foster deeper engagement across disciplines.

References

Billinghurst, M., Clark, A., & Lee, G. (2015). A Survey of Augmented Reality. *Foundations and Trends in Human–Computer Interaction,* 8(2–3), 73–272.

Svensson, P. (2016). The Humanistic Turn in Digital Humanities. *Journal of Digital Humanities,* 2(3).

Additional flowcharts

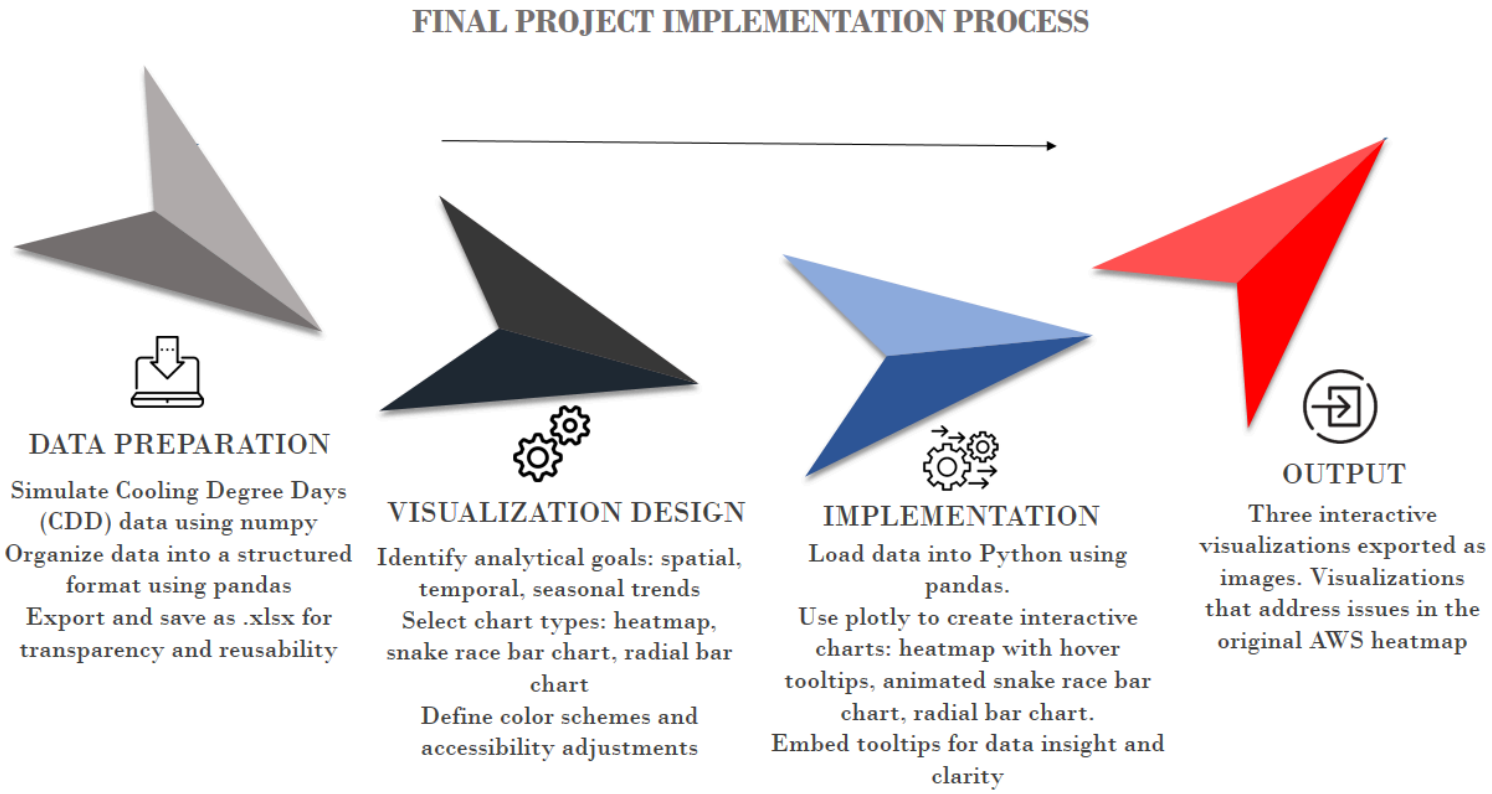

Fig 9. Flowchart of final project implementation process (created using powerpoint)

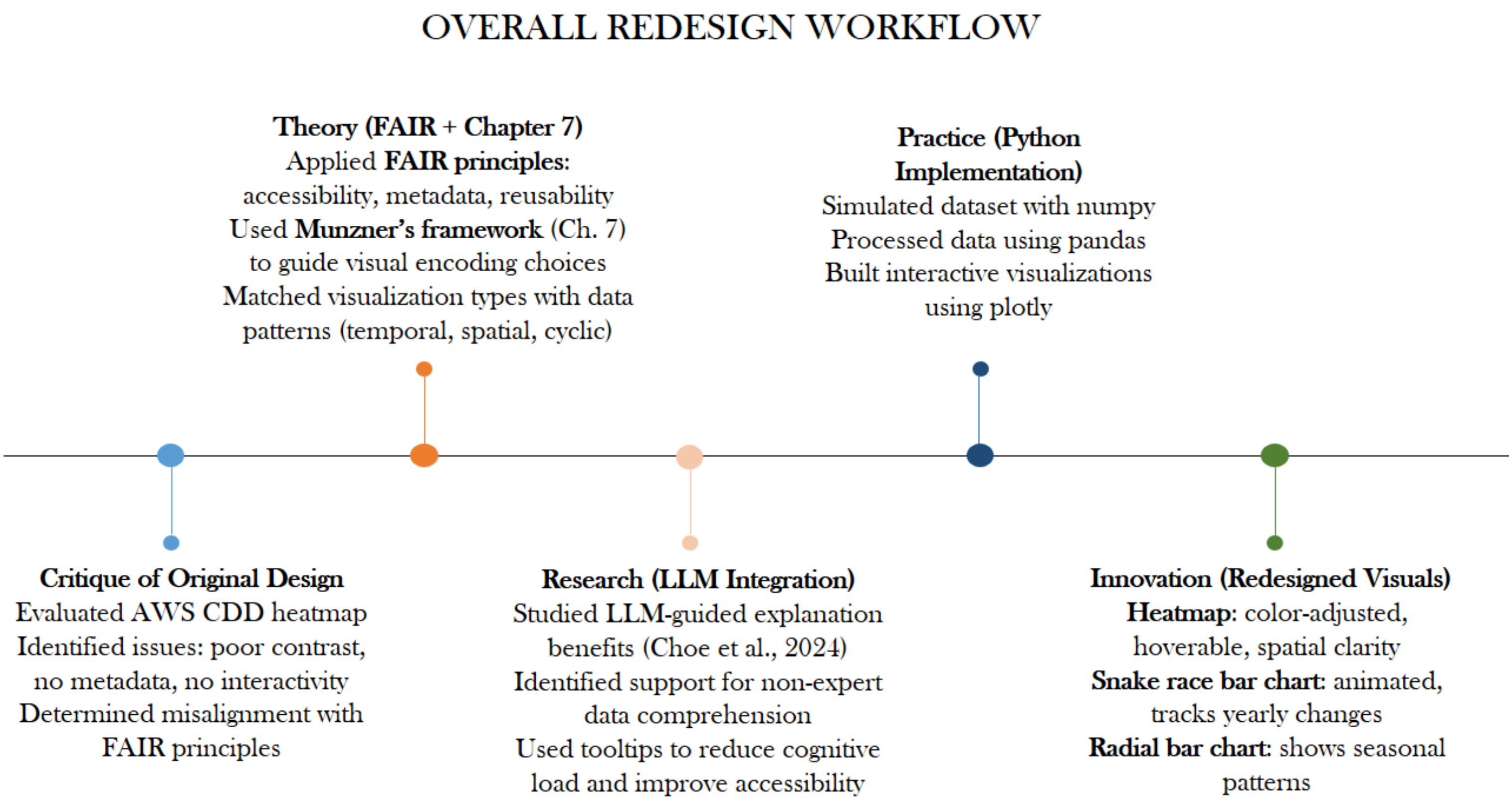

Fig 10. Flowchart of overall redesign (created using powerpoint)

GitHub link: https://github.com/Gbemisayo1/Re-design