

Toward Design Justice in Data Visualization: An Ojibwe Language and Medicine Wheel Approach for Designing Data Visualizations

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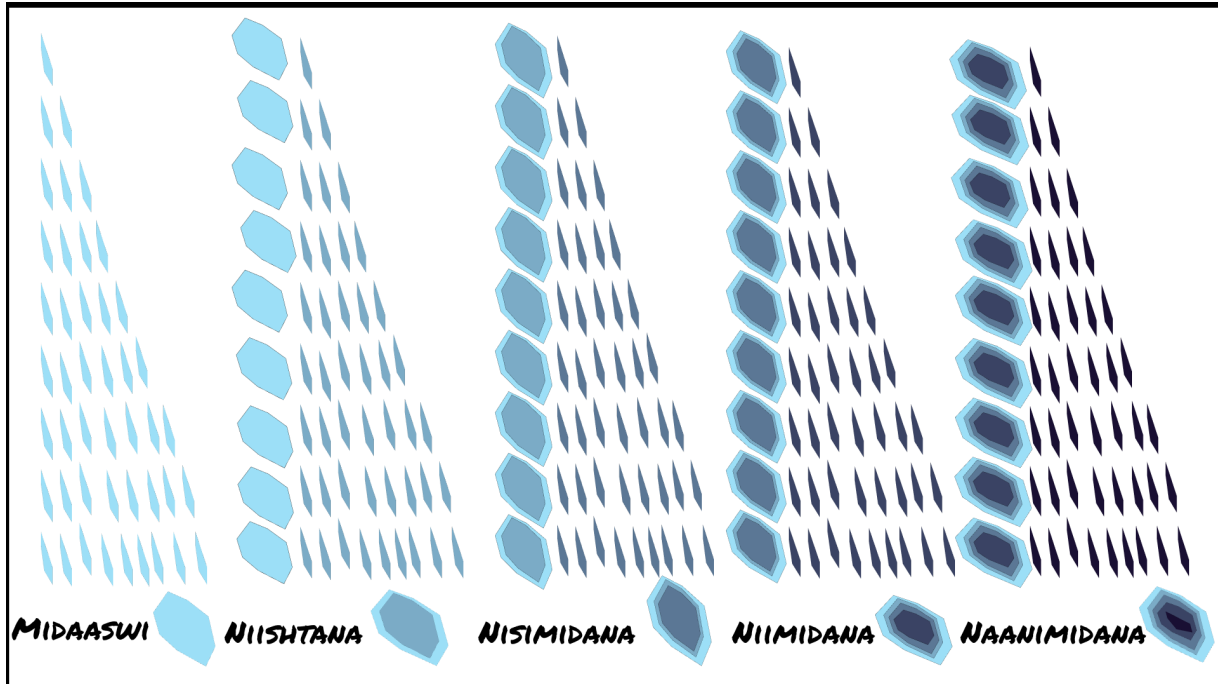


Figure 1: We present a fully sketched out visual language that is based on our understanding of the Ojibwemowin counting system. This is the basis for communicating quantitative information about independent variables in our dataset. Here, we are counting from 1-50 using our Ojibwemowin-based visual language.

ABSTRACT

We explore the role the Design Justice framework and movement might play in data visualization by demonstrating an Ojibwe language and Medicine Wheel approach to designing ecological data visualizations. The long-term goals are to reduce the barriers for Indigenous communities to participate in data-driven conversations and create a design space for tribal and non-tribal communities to converge for co-design activities. The design provocation described in this paper draws upon gradient design and the Ojibwe language to create culturally relevant visual encodings for analyzing wild rice data. We believe that ecological data visualizations designed in this way, grounded in design justice principles, can transform data analysis and discourse across ecological data stakeholder communities. Early feedback from Ojibwe community demonstrations suggests that orienting the data to concepts familiar to Ojibwe culture and traditions helps ground the data in context and provides opportunities for envisioning new ways to encode and interact with data.

Index Terms: Design justice, data visualization, Indigenous com-

puting.

1 INTRODUCTION

Moving the field of data visualization beyond interdisciplinary collaborative spaces and into community environments requires ethical care that goes beyond traditional interdisciplinary arrangements. In particular, when working with communities who have a history of being excluded and mistreated by dominant cultures, including academic researchers and technologists [1, 2, 3, 4]. Participatory action research (PAR) and community-based participatory research (CBPR) take approaches that center community voices to re-center who design and research serves [1, 5]. The design justice framework goes further by analyzing “how design distributes benefits and burdens between various groups of people. Design justice focuses explicitly on the ways that design reproduces and/or challenges the matrix of domination (white supremacy, heteropatriarchy, capitalism, ableism, settler colonialism, and other forms of structural inequality)” [1]. Design justice is both a framework and a movement, with an active community of practice working towards “re-distributing design’s benefits and burdens; meaningful participation in design decisions; and recognition of community-based, Indigenous, and diasporic design traditions, knowledge, and practices” [1]. Given this attention and commitment to doing non-extractive and generative research, we see the design justice framework as the best strategy for doing community-engaged data visualization

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research.

Design Justice Principles	
Principle 1:	We use design to sustain, heal, and empower our communities, as well as to seek liberation from exploitative and oppressive systems.
Principle 2:	We center the voices of those who are directly impacted by the outcomes of the design process.
Principle 3:	We prioritize design's impact on the community over the intentions of the designer.
Principle 4:	We view change as emergent from an accountable, accessible, and collaborative process, rather than as a point at the end of a process.
Principle 5:	We see the role of the designer as a facilitator rather than an expert.
Principle 6:	We believe that everyone is an expert based on their own lived experience, and that we all have unique and brilliant contributions to bring to a design process.
Principle 7:	We share design knowledge and tools with our communities.
Principle 8:	We work towards sustainable, community-led and -controlled outcomes.
Principle 9:	We work towards non-exploitative solutions that reconnect us to the earth and to each other.
Principle 10:	Before seeking new design solutions, we look for what is already working at the community level. We honor and uplift traditional, indigenous, and local knowledge and practices.

Quoted from the Design Justice Network

Figure 2: The design justice principles as articulated by the Design Justice Network [6]

To activate design justice in practice, the framework is founded upon 10 principles to help align and guide newcomers to implementing a design justice practice. These principles are listed in Figure 2. Looking across ACM and IEEE Xplorer, there are some early examples of applying design justice in computing, most of which utilize the design justice framework as a means of interpreting data [7, 8, 9] or as inspiration for using methodologies in a more ethical manner [10, 11, 12, 13, 14]. While our work certainly aligns with this commitment to advancing design justice by bringing it into new contexts, work by Ostrowski and colleagues is more aligned with our objectives of applying, expanding, and modifying core tenets of the design justice framework. Ostrowski et al.[15], expand on the design questions posed by Costanza-Chock in their book *Design Justice: Community-led Practices to Build the Worlds we Need* [1], and also apply the design justice framework to policy design for robot-human interaction [16]. Across this body of literature, only Hedditch and Vyas [3] explicitly use the 10 design justice principles to discuss and analyze their work. While all of these examples suggest good potential alignment for computing, the literature does not yet include an example of design justice principles being applied directly to a design challenge, nor any from the field of data visualization.

From an Ojibwe positionality (first author), we expand this set of examples by addressing **design justice principle 10 (DJP 10)**: *Before seeking new design solutions, we look for what is already working at the community level. We honor and uplift traditional, indigenous, and local knowledge and practices.* What follows is an early example of creating an Ojibwe-centered visual language for designing culturally responsive data visualizations. Our contributions are: 1) an example of design justice principle 10 being applied in data visualization, 2) a design process that enables both Indigenous and data visualization communities to converge, and 3) a list of future directions for design justice-based data visualization and Indigenous data visualization.

2 MAKING OJIBWE DATA VISUALIZATIONS

We present the process we took for sketching an Ojibwemowin (the term used to refer to the Ojibwe language in Ojibwe) data visualization. We first begin by stating our positionalities and then walk readers through the process, ending each subsection with a subjective reflection on how design justice principle 10 was applied.

2.1 Author positionalities

The first author, Sean J. Dorr, is an enrolled member of the Mille Lacs Band of Ojibwe (a federally recognized Native American tribe located in east central Minnesota) and is from the Marten Clan. He

has spent a lifetime connecting and reconnecting with the Ojibwe language and Ojibwe traditional practices.

The second author, Daniel F. Keefe, is a white man of European descent. He is a father, husband, artist, technologist, and advocate.

2.2 Connecting with Data and Making Gradients

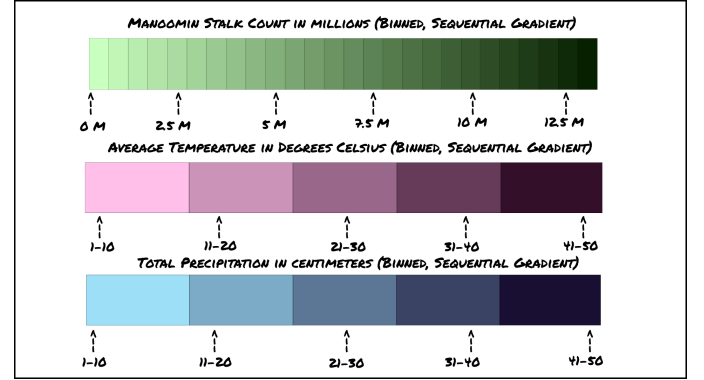


Figure 3: The three binned, sequential gradients that are applied throughout the dataset in our example.

The data used in our example is from an active CBPR collaboration at the University of Minnesota - Twin Cities called Kawe Gidaa-naanaagadawendaamin Manoomin, which translates to “First we must consider Manoomin/Psin (wild rice)” [17]. Wild rice, herein referred to in Ojibwemowin as Manoomin, is commonly found in lakes, streams, and marshes, and thrives in calm waters that are clean with mucky stream or lake bottom [18]. Due to environmental stressors, Manoomin in the Great Lakes region of the United States has been declining [17]. Culturally, Manoomin is an important plant for Native Americans throughout the Great Lakes region, including Ojibwe, as a food source and medicine [17]. The Kawe Gidaa-naanaagadawendaamin Manoomin project team brings together tribal community members and tribal natural resource managers with non-tribal researchers and natural resource managers to address improving the health of Manoomin for the region [17]. While we find this project to be inspiring and an exceptional example of how to work with Indigenous communities from a strong ethical center, all research projects that interface with Indigenous communities will run into the challenges of one partner having to bend to the other’s preferences for communicating information. Typically, Indigenous communities are the ones bending to try to understand the statistical vocabulary and visual renderings of quantitative data. Our example offers an entry point for Indigenous communities to leverage their culture and language to (re)claim and give voice to the data in such settings.

In our example, the number of Manoomin stalks for Lake Alice in Wisconsin, USA, is the primary focus, with average temperature and precipitation for a given Manoomin lifstage serving as independent variables. The time period reported on for this example is 2015, 2017, and 2019. Neither author of this manuscript plays a role in the data analysis with this data set for research purposes. As a result, these variables were selected given their potential to support the development of a visual language. The first step in sketching an Ojibwemowin visual language involves creating gradients that fit the data set for exploratory data analysis. As seen in Figure 3, we created three binned, sequential gradients using a split-complementary approach for color selection. Color selection for the split-complementary palette started with the pink to purple gradient, as this gradient resembles the color of the tops of Manoomin when the plant reaches maturity. From there, green and blue gradients establish an intuitive association with the data they encode,

Manoomin and precipitation, respectively.

Reflection on DJP 10: Before seeking new design solutions, we look for what is already working at the community level. We honor and uplift traditional, indigenous, and local knowledge and practices.

- Applying natural color mapping attempts to address both parts of this principle. Our intention is to spark dialogue about how to create a gradient based on the natural setting of Manoomin in an attempt to develop a common data language. We hypothesize that discussions of this nature will lead to more artists and other community makers participating in the creation of visual and interactive languages that are legible to their communities.
- Although neither author is explicitly part of the Gidaanaagadawendaamin Manoomin project team, we both collaborate with project members in other settings. The Gidaanaagadawendaamin Manoomin project team’s approach to CBPR is exceptional and embodies DJP 10.

2.3 Sketching a Data Visual Language with Ojibwemowin Counting

1: BEZHIG	11: ASHI-BEZHIG	21: ASHI-BEZHIG
2: NIIZH	12: ASHI-NIIZH	22: ASHI-NIIZH
3: NISWI	13: ASHI-NISWI	23: ASHI-NISWI
4: NIUWIN	14: ASHI-NIUWIN	24: ASHI-NIUWIN
5: NAANAN	15: ASHI-NAANAN	25: ASHI-NAANAN
6: INGODWAASWI	16: ASHI-INGODWAASWI	26: ASHI-INGODWAASWI
7: NIIZHWAASWI	17: ASHI-NIIZHWAASWI	27: ASHI-NIIZHWAASWI
8: ISHWAASWI	18: ASHI-ISHWAASWI	28: ASHI-ISHWAASWI
9: ZHAANGASWI	19: ASHI-ZHAANGASWI	29: ASHI-ZHAANGASWI
10: MIDAASWI	20: NIISHTANA	30: NISIMIDANA

Figure 4: A visual example of using markers to distinguish which set of ten is being communicated in Ojibwemowin. Markers precede the value that is being communicated (e.g., 21 is niishtana ashi-bezhig). This pattern repeats as values increase.

Next, we incorporate the binned sequential nature of our gradient designs to match the Ojibwemowin counting system. As seen in Figure 4, Ojibwemowin counts 1-9, then marks 10. This mark is used in front of stating the individual values after 10, e.g., midaaswi ashi-bezhig for 11. This pattern continues as values increase, with the marker of each set of 10 being the important aspect of communicating which value is being referenced. In Figure 5, we use our gradient for total precipitation to demonstrate how one could construct a visual language that expresses this critical aspect of markers in Ojibwemowin counting. Finally, as seen in Figure 1, we present a visual representation of values 1-50 using our gradient for total precipitation to demonstrate how one could approach making a visual language that is based on Ojibwemowin counting. With our approach for communicating information fully sketched out, we next turn our attention to mapping the data to the Ojibwe Medicine Wheel conceptual model.

Reflection on DJP 10: Before seeking new design solutions, we look for what is already working at the community level. We honor and uplift traditional, indigenous, and local knowledge and practices.

- Aligning with counting as the starting point for creating an Ojibwemowin-based visual language creates opportunities for

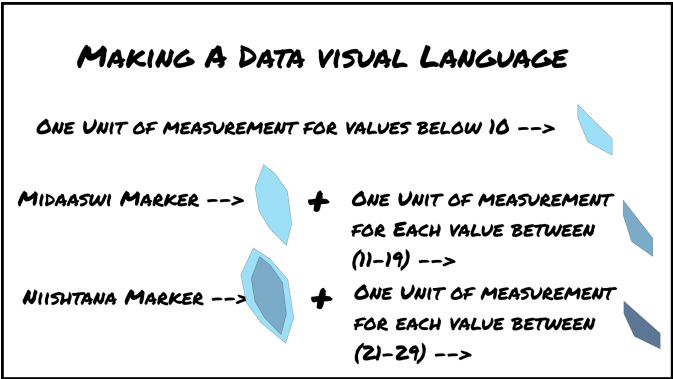


Figure 5: The process of building our Ojibwemowin-based visual language system. Starting with 1-10 in our gradient, our system for communicating markers applies the exact steps of increasing values as our gradients.

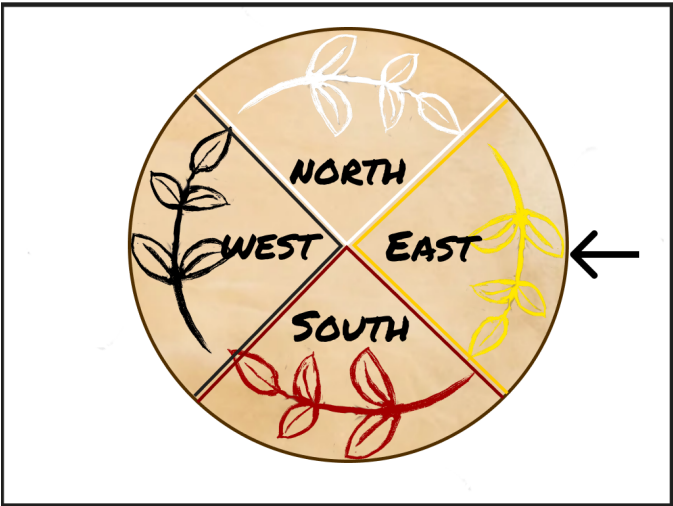


Figure 6: For an Ojibwe Medicine Wheel, one begins in the East and then moves sequentially in clockwise fashion around the circle.

teaching data visualization concepts early in life. This aligns exceptionally well with Ojibwe language medium schools looking to incorporate science, technology, art, and math (STEAM) approaches in their curriculum. Furthermore, for Ojibwe language learners, connecting Ojibwemowin lessons with seasonal activities, such as Manoomin harvesting, is considered a best practice [19]. We hypothesize that incorporating data visualization design activities with lessons that are based on seasonal Ojibwe happenings will increase data fluency at scale over time. The path to achieving this vision is prioritizing DJP 10.

2.4 Applying an Ojibwe Medicine Wheel Conceptual Model to the Data

With our visual system in place for rendering quantitative data, next we move to mapping the data to an Ojibwe interpretation of the Medicine Wheel. The Medicine Wheel is referred to as a conceptual model as it provides a structure for making sense of the world around us. As seen in Figure 6, there is an order in which one moves around the Medicine Wheel, starting in the east where the sun rises, progressing clockwise to the south, then west, and finally north, which is the ending point for one cycle. Each direction is associ-

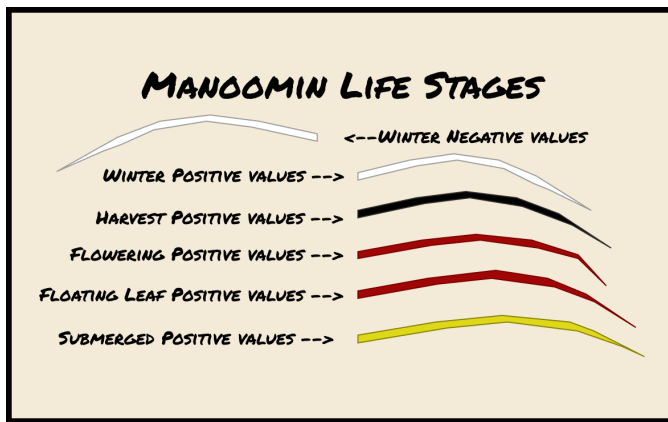


Figure 7: Medicine Wheel and Manoomin Lifestages are mapped onto each other as a way to structure the underlying data corresponding to each Manoomin lifestage.

ated with a specific season and life stage: east is linked to spring and new life (babies and children), south to summer and adolescence, west to fall and adulthood, and north to winter and elderhood [20]. While many subcategories could be mapped to the Medicine Wheel, these are the categories that we have chosen to focus on in our example, as they lend themselves nicely to the ecological nature of our dataset. In our dataset, Manoomin stalk counts are analyzed in relation to several variables, of which we focus on average temperature and total precipitation of each life stage of Manoomin. As seen in Figure 7, Medicine Wheel seasons are applied to the approximate corresponding Manoomin lifestage. Winter is the time when the seeds that have reached the bed of the water body are settling in to begin germination in the spring. Most of the spring Manoomin is submerged, making its way to the floating leaf and flowering stages next, before reaching full maturity in the early fall.

Reflection on DJP 10: Before seeking new design solutions, we look for what is already working at the community level. We honor and uplift traditional, indigenous, and local knowledge and practices.

- Much like using Ojibwemowin counting as a basis for our visual language, applying an Ojibwe understanding of the Medicine Wheel aligns with existing community knowledge and provides a structure for incorporating seasonal ecological data. If a community member is unfamiliar with their community's approach to Medicine Wheel concepts, designing in this way offers an opportunity for cultural sharing internally. We hypothesize that aligning data visualization design with existing conceptual models used by a community will lead to more opportunities for cultural knowledge transfer.

2.5 Applying our Ojibwemowin Visual Data Language to the Dataset

Last in our process is applying our sketch of an Ojibwemowin visual data language to the dataset. Our sketch blends elements from traditional data visualization with our Ojibwemowin visual data language to facilitate comparison and identify differences, aiming to spark questions about the data. As seen in Figure 8, Manoomin stalk counts are mapped by length (bar height), color (gradient for the bin of data), and are positioned on a common scale. According to Munzner, the position on a common scale is the most effective channel for mapping magnitude data in a way that gets the data noticed, with length being third and color luminance being seventh most effective [21]. We applied these mappings to first draw attention to the number of Manoomin stalks measured for a year, and

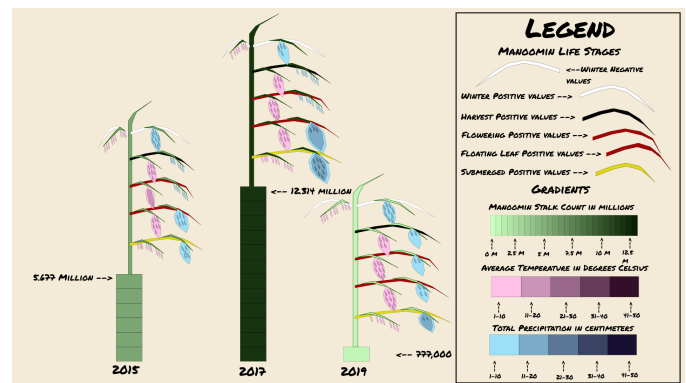


Figure 8: Manoomin stalk numbers by year are represented along a common axis with an Ojibwemowin-based visual language.

then move our readers' eyes to the data that may offer an explanation, or spark a question, resting on top of the bars.

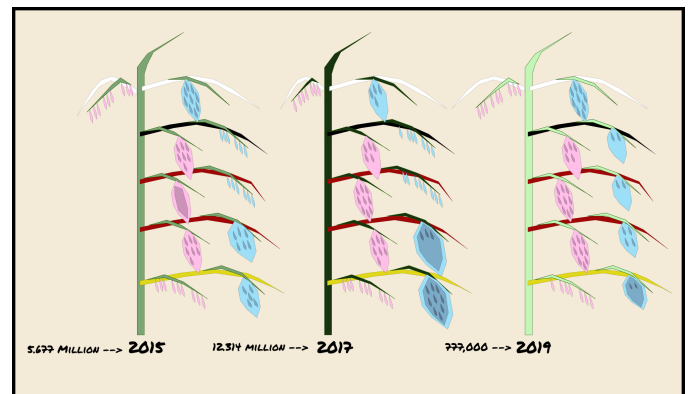


Figure 9: A zoomed-in view of the data. Notice Ojibwemowin visual approach for communicating total precipitation values in the twenties.

Zooming in on the independent variables of the data set, as seen in Figure 9 we are greeted with the application of our Ojibwemowin visual data language, as the data for average temperature and total precipitation of a given Manoomin lifestage hang from a Medicine Wheel color-coded leaf. Notice the absence of a double-digit marker for total precipitation in 2015 and 2017 during the flowering and harvesting Manoomin life stages, compared to 2019. Following this line of inquiry, in an interactive environment, users could filter the data to examine total precipitation across all years to further analyze the data and develop research questions for investigation.

Reflection on DJP 10: Before seeking new design solutions, we look for what is already working at the community level. We honor and uplift traditional, indigenous, and local knowledge and practices.

- The successes of connecting with DJP 10 stem from earlier stages in this design process. The culmination of ideas requires working directly with and in the community to determine whether or not this approach aligns with what is already working at the community level. The design goal in our case is always to honor and uplift traditional, Indigenous, and local knowledge and practices. This is especially important when working with data that directly impacts the community. In the Indigenous context, this is all ecological climate data. Developing a design justice practice will help data visualization

practitioners interface with Indigenous communities more effectively and ethically. As a result, we develop better relationships with each other and our planet.

3 DISCUSSION, IMPLICATIONS, AND FUTURE DIRECTIONS

In our sketch of creating an Ojibwemowin data visual language, we were able to make inroads to realizing DJP 10 in just two moves (using Ojibwemowin counting and Ojibwe notions of a Medicine Wheel). The ability to do so in a relatively lightweight manner is mainly dependent on the first author's positionality as an Ojibwe who is actively involved in learning the language and (re)connecting with his cultural traditions. Having this insider positionality and knowledge allows DJP 10 to transition from an aspirational and guiding role to one that is actionable and applied. While the lack of inclusion in computing is well documented [22], implementing a design justice practice can help overcome these barriers by working directly with community partners to develop technical skills and receive design training. To initiate this movement, we identify how our project intersects with other design justice principles and lay out future opportunities for the field of data visualization to implement design justice principles.

3.1 Indigenous Intersections with Other Design Justice Principles

For the future field of Indigenous Data Visualization, Indigenous colleagues will find themselves naturally drawn to DJP 10 given its scope and mission. However, there are several design justice principles that Indigenous communities, who are grounded in their language and traditions, are uniquely qualified to address in ways that will be equally, if not more, lightweight in execution as our example. For instance, **DJP 9:** *We work towards non-exploitative solutions that reconnect us to the earth and to each other*, aligns well with notions of being a 'good relative', which means to be in good ethical standing among a kinship network of relationships that include other-than-human relationships [23]. Good relative-based design from an Indigenous community's ethical center can lead the field in how to execute DJP 9 properly. Furthermore, when embodying 'good relative' ethics, **DJP 4:** *We view change as emergent from an accountable, accessible, and collaborative process, rather than as a point at the end of a process*, almost seems redundant, as this is how one lives. This points to the need for Indigenous communities to connect with their assets by centering their ways of knowing and being to design the tools and technologies that embody their values and ethics; not to be of service to computing, but to their expansive kinship networks.

Overlapping the 'good relative' approach with design justice principles creates opportunities for Indigenous and non-Indigenous communities to converge. In doing so, we will make progress on the grand challenge of realizing **DJP 1:** *We use design to sustain, heal, and empower our communities, as well as to seek liberation from exploitative and oppressive systems*. Healing and liberation from exploitative and oppressive systems benefit us all and are what's at stake when working at the intersection of Indigenous communities, data, and computing technologies.

3.2 Future Opportunities for Data Visualization

While this paper has predominantly focused on how to apply design justice principles from an Indigenous perspective, there are several entry points to implementing design justice principles in a data visualization practice. Two promising directions in our line of inquiry are workshop design and authoring tools.

Although the design workshop has its known challenges of power dynamics [2], taking a design justice approach can help reduce opportunities for causing harm [1]. Specifically, if researchers orient themselves to **DJP 7:** *We share design knowledge and tools with our communities*, **DJP 8:** *We work towards sustainable,*

community-led and -controlled outcomes, and **DJP 3:** *We prioritize design's impact on the community over the intentions of the designer*. Centering all three or any one of these principles readjusts the focus and intent of the design workshop, thus making progress toward realizing DJP 1.

In the direction of authoring tools, we suggest aligning with **DJP 2:** *We center the voices of those who are directly impacted by the outcomes of the design process*, **DJP 5:** *We see the role of the designer as a facilitator rather than an expert*, and **DJP 6:** *We believe that everyone is an expert based on their own lived experience, and that we all have unique and brilliant contributions to bring to a design process*. Each of these design justice principles aligns well with empowering users to create data visualizations that are meaningful and expressive on their terms. Reorienting to a position that embraces all three or one of these principles has the potential to enhance current imaginings of data visualization authoring tool design. For example, if we, as a data visualization community, were to embrace DJP 6 in co-creating authoring tools with Indigenous communities, we might find ourselves navigating new directions in the realms of data physicalizations, sonics, and haptics to meet the needs of a wide set of community expert data authors, thereby expanding the set of examples used to inspire next generation computing technologies.

4 CONCLUSION

From an Ojibwe positionality, we presented an early example of how to create an Ojibwemowin-based data visualization for analyzing ecological data (Manoomin) and apply design justice principle 10 in the process. Throughout our example, we reflected on the extent to which DJP 10 is being centered in the design process, as well as future considerations for implementation. Our reflections aim to help our colleagues understand how we apply design justice principles in creating data visualizations. Future directions for implementing design justice principles in both the current field of Data Visualization and the emerging field of Indigenous Data Visualization were covered to help usher in the era of design justice-based data visualization.

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