



# The Canadian Cultural Diversity Dashboard: Data Storytelling and Visualization for the Cultural Sector

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**Abstract.** The Canadian Cultural Diversity Dashboard (CCDD) is an interactive online data visualization dashboard designed to elicit insights regarding diversity in the consumption and creation of cultural expressions in Canada. While designed for a particular context it is broadly applicable. Urgency for this type of analytics has amplified given the negative impacts of COVID-19 on the cultural sector and mounting concerns around racial justice and inclusion in society, reflected in considerations regarding cultural funding and creation. The complex, scalable, heterogenous, and multivariate data sets that underlie the CCDD are sourced from demographic data and include factors such as age, geographic location, education level, literacy levels, immigration status, linguistic background and languages spoken, race, Indigenous identity, disability, and gender. Each demographic segment is analyzed according to cultural consumption and creative expression across a breadth of disciplines from literary, visual, to performing arts. We discuss the challenges of collecting, analyzing, and representing diverse demographic data, including biases in data collection. We implemented a dashboard interface to enhance user experience (UX), because similarly to visualizations acting as a repository for data, the dashboard interface is a repository for the visualizations. We considered the level of interaction and user engagement needed to explore this data which led us to the use of an interactive dashboard. A narrative visualization and infographics strategies are combined in order to support editorial layering and interaction design in a co-design project, allowing us to increase research in the application of these two fields.

**Keywords:** Visual analytics · Diversity · Inclusive design · Demographic survey data · Visual metaphors · Data storytelling · Infographics · Narrative visualization · User centered design · Interaction design

## 1 Introduction

The Canadian Cultural Diversity Dashboard (CCDD) is an interactive online data visualization dashboard meant to elicit insights regarding the diversity of publics consuming and creating culture in Canada. CCDD supports policy, planning and decision-making within Canada's Department of Canadian Heritage (DCH) and is equally a communications tool for use with DCH stakeholders. Understanding the needs and interests of

diverse populations is required to design effective services and programs; to address inequity; celebrate and support cultural practices and identities; and understand links between demographic diversity, health, well-being, and culture. Urgency for this type of analytics has amplified given the negative impacts of COVID-19 on the cultural sector and mounting concerns around racial justice and inclusion in cultural funding and creation.

The complex, scalable, heterogenous, and multivariate data sets that underlie the CCDD are sourced from survey and census data available through Statistics Canada [1, 2]. Demographic data includes factors such as age, geographic location, education level, literacy levels, immigration status, linguistic background and languages spoken, race, Indigenous identity, disability, and gender. Each demographic segment is analyzed according to cultural consumption and creative expression across a breadth of disciplines from literary, visual, to performing arts. The advantage of interactive visualization in interpreting such a large multivariate data set is that it helps decision makers focus their full cognitive and perceptual capabilities on the analytical process in managing complex diversity data [3] and supports exploration of context and the discovery of patterns [4]. A requirement of diversity analysis is the inclusion of small data sets, or edge cases, in order to represent marginalized groups who are not always consulted in data collection, or to see emerging trends. Prototype design was informed by prior research in narrative visualization, infographics and multi-variate data visualization and inclusive design. We used a co-design approach with diversity and culture domain experts from the Department of Canadian Heritage. The outcome is the Canadian Cultural Diversity Dashboard (CCDD) which allows two points of entry to the data analysis, from the perspective of creative disciplines or from the perspective of demographic segments.

## 2 Related Work

### 2.1 Diversity Data

Demographic data at minimum includes the following aspects of human populations: size, distribution, composition, components, determinants, and consequences of population change. Statistics Canada [1, 2] collects “Canadians at Work and Home”, a survey of approximately 20,000 respondents that explores respondents’ views about work, home, leisure and well-being, and the relationships between these. As well as work and family life the survey collects opinion and factual data on culture and leisure, use of communications technology, labour, society and community. These data can allow policy analysts, governments, cultural institutions, the creative sector at large, and diverse and equity seeking groups to better understand the behaviours of cultural consumers and producers. There is a boomerang effect as these behaviours are in part the result of existing policies and practices by governments and the cultural sector. BIPOC (Black, Indigenous, People of Colour) artists have offered concerns that their cultural practices, unless popular culture, are not recognized by funding agencies. Gaps in data between self-reported identities and grants or opportunities provided can indicate unmet need or bias in jury processes. For example, recent studies of public art in Toronto have shown that women, racialized and Indigenous artists are poorly represented in commissions, yet self-report as artists interested in public art [5, 6]. For these reasons ArtWorxTO, a

year of public art in Toronto will favour Indigenous and racialized artists and curators in order to rebalance opportunities and better serve massive populations in the city who fit these categories.

Diversity data requires sensitivity in collection processes, and awareness of the dynamic nature of categories, “In addition to revising typical measures of demography, our developing understanding of multiple and overlapping social identities (e.g., race, ethnicity, gender expression, sexual orientation, etc.) has led to the inclusion of not just more dimensions, but of more refined dimensions” [7, pg. 5]. They underscore the importance of intersectionality, that is the ways that identities are multi-factored, and combinatory approaches to analysis. They recommend constant revisions of definitions such as gender identity or racial identities. Challenges exist when categories in data sources have not yet been updated to contemporary understandings. The government of Canada has changed its gender categories to include non-binary definitions, but after the data we were working with was collected. This was a specific challenge for our team in choosing icons.

Pitoura [8] underscores the importance of “social-minded measures” in gathering, analyzing, and representing data. She states, “In a technical context, diversity ensures that all different kinds of entities are considered and represented in the output of an algorithmic process. It has been extensively studied in information retrieval, search, and recommendations for a variety of reasons. Diversity-enhanced results address ambiguity and cover different information intents, avoid redundancy and enhance information content, and increase user engagement”. Disability studies emphasize the need to be inclusive not only of major trends but groups and practices on the margins [9]. Bias emerges through rounding errors that remove populations that appear small but may simply be underrepresented through data collection methods. As Walny et al. [10] emphasize, visual analytics research continues to seek approaches to represent edge cases. For some data sets we needed to design for extremely small numbers in the diverse and inclusive data that represented sub-populations and their relationship to cultural practices, aiming to make these visible, readable, and comparable to the large numbers. We needed to represent multiple factors from the data to represent intersectional qualities of Canadians’ choices of culture, both for fairness and to engage the intended users of the CCDD. Representing diversity also required consideration of infographic icons that are used for the visualizations, as well as strict adherence to inclusive design standards.

## 2.2 Data Storytelling: Narrative Visualization and Infographics

Narrative visualization structures data in order to tell a story, or multiple stories from its representation. Narrative visualizations can bridge explanatory visualizations and explorative visualizations [11]. Ghidini et al. [12, pg. 2] explain, “Narrative elements in data visualization are able to provide explanation about the subject, and often support a structured interpretation.” Hullman and Diakopoulos [13] argue that narrative strategies provide a means to communicate data, prioritize interpretations directly or indirectly through visual hierarchies, explore multifaceted connotations, and address audience knowledge and socio-cultural differences. They develop a series of rhetorical techniques to structure visualizations based on their observations of visualization practices. Designers direct interpretation by creating visual hierarchies. Hullman and Diakopoulos [13]

define, “four editorial layers that can be used to convey meaning, including the data, visual representation, textual annotations, and interactivity” [13, pg. 2233]. Designers choose the data that they will represent or omit using filtering techniques; their representations then carry these choices into the visual domain using metonymy or metaphor to suggest meanings that are not evident in the data or categorize data in different ways to emphasize values. Annotations direct the viewer’s attention and interaction design leads the viewer to specific subsets of data. Beyond these layers, provenance is a means to identify data sources. Other linguistic tools that build meaning are contrast and classification. “Procedural rhetoric” are editorial choices such as spatial ordering, partial animations, menus, or search bars that drive the viewer’s experience. Their framework serves as a constructive feedback mechanism for the designer in understanding how different individuals interpret designs and visuals.

Segal and Heer [14] differentiate interaction strategies for narrative visualizations according to the degree to which users are directed through the visualization or supported to explore freely. These are a “Martini Glass”, Interactive Slideshow” or “Drill-Down Story”. Our approach was closest to the latter, “the user can interact with particular points of the visualization to reveal additional details and background information relevant to the main theme” [11, pg. 9] Our research challenges arguments that explicit metaphors are no more effective in engaging visualization viewers than simple graphs [15]. Diamond [16] demonstrates that graphs are culturally bound as are all representations. Bateman et al. [17] suggest that it is not the use of metaphors in visualization that is the problem but the appropriate choice of metaphor.

Smiciklas [18] contradicts Boy’s findings that narrativity has no impact on visualization legibility or interpretation, by illustrating the ways that infographics which are narrative by definition, have impacted significant societal decisions. Infographics can mobilize cognitively entrenched spatial patterns known as image schemas which are a recurring structure within our cognitive processes to establish patterns of understanding and reasoning [19]. Harrison et al. [20] studied image schemas and determined that engagement occurred rapidly, within 500 ms of seeing a graphic. They catalogue users’ aesthetic preferences by demographics, specifically age, education level and gender and propose, “When optimizing the design of an infographic to make a good first impression, therefore, designers should aim for a low to medium complexity (e.g., by choosing a limited number of image and text areas), and a medium to high colorfulness” [20, pg. 1190] if they wish to reach their largest audience. As an alternative, designers can design for specific sub-groups, knowing their preferences and build a dashboard that allows personalization. Storytelling strategies combined with succinct graphics appear to enhance data analysis.

### 3 Methodology

Our co-design approach drew from Sedlmair et al. [21] who propose four steps for visualization design: analyze a specific real-world problem faced by domain experts; design many possibilities to address the problem; validate the proposed design with the domain experts (users); reflect the lessons learned during the design development. We gained an understanding of the communications strategies and internal culture of our

Heritage Canada partners. They were new to visual analytics but had a strong background in data analytics, infographics, and text-based narrative. We held workshops to share visualization techniques and approaches to infographics, joined by iterative sketching, prototyping and critiques. Other stakeholders, including cultural communities celebrate effective storytelling and powerful visual imagery. For all of these reasons we decided on a data storytelling approach that combined narrative visualization and infographics.

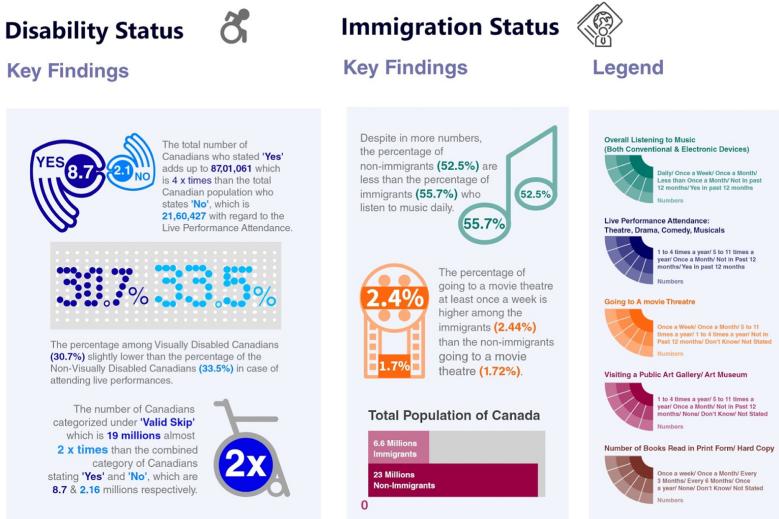
## 4 Visualization Approach

We chose a mix of narrative visualization and infographics techniques, responding to the needs of our collaborators and the larger cultural community in order, “to provide models of actual and theoretical worlds and provide manipulation of data” [4, pg. 3]. To apply narrative techniques, we needed to identify suitable visualization typologies to summarize the multidimensional data and present it in context using infographics techniques without influencing or biasing analysis. We researched The Data Visualization Catalogue, a library of different information visualization types [22] matching data visualization typologies, their functions, and their applications to the data narratives they intend to reflect. The Data Viz Project [23], includes interactive data models [D3.js [24] as does Bostock et al.’s D3 data-driven documents [25]. As does Bostock et al.’s D<sup>3</sup> data-driven documents [25]. The diversity demographic data was structured in spreadsheets; we translated it using *Flourish Studio* [26] *Tableau* [27], a charting tool, *Datawrapper* [28, 29] and *D3.js* [25] into visualizations.

We chose a series of visualization typologies for this project. An Alluvial diagram reviews distribution, elicits comparisons, indicates correlations, and displays trends over time. A Sunburst Diagram serves to visualize hierarchical data, with parts to a whole, depicted by concentric circles with sliced outer rings. Best practices in visualization offer different ways of analyzing the same data in order to encourage users’ critical engagement with the data [4]. Both the Alluvial Diagram and Sunburst Diagram provide comparisons and distributions, which means, there could be a few choices of visualization types for the same data set. A Chord Diagram visualizes the interrelationships between entities. A Violin Plot visualizes the distribution of data and its probability density. A Pictorial Chart uses relative sizes or repetitions of the same icon, picture, or symbol to show comparison between volumes. A Radial Column Chart uses a grid of concentric circles where bar charts are plotted. A Choropleth Map displays divided geographical areas or regions that are in relation to a data variable. A Donut Chart functions identically to a pie chart, except for the blank space inside that we use to display information. A Treemap displays hierarchical data as a set of nested rectangles with subcategory rectangles inside. At times we combined two different visualization types such as a Choropleth map of Canada for overview and pie charts for detail. We tried various approaches to edge case analytics (including semantic zooms) to represent small data, making these visible, readable, and comparable to the large numbers.

Pictograms, symbols, and icons can be more easily read and understood by individuals without demanding a particular language. Drawing from infographics principles, of blending data with design to support the rapid understanding of data, we implemented graphical cues and pictographs in our data visualization and in explanatory sections. For example, to represent disability status, we illustrated the ‘Key Findings’ section

of the dashboard with icons of Braille, the writing system for visually impaired; sign language communication tool for deaf individuals; and we included an icon of the active wheelchair. Disability status and cultural consumption is presented in Fig. 1. These strategies were carried into prototype design.



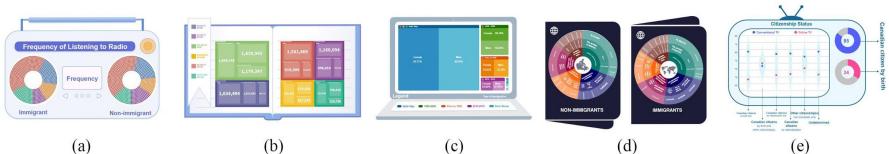
**Fig. 1.** Example of the implementation of Pictograms, Semiotics, and Iconography

## 5 Prototype

### 5.1 Design Strategy

The chosen visualization typologies act as infrastructures where we embedded the metaphors which function as the bridge to interpret the data or data context. Metaphors are a catalyst to propel audiences' insights into the data story. At times we used infographics to frame visualizations, situating these within a creative medium (Music for example). In other instances, we used pictograms or symbols within graphs in order to correlate numbers with their context. In Fig. 2 (a and e) the radio image frames analytics regarding radio listening in Canada. A Donut Chart not only functions for comparisons, proportions, parts-to-a-whole, but also fits in the "radio", giving interactors a quick idea of proportional distribution of the data. When hovering on different colors which represent different frequencies, the users can see the corresponding numbers and legends in the graph. We used text annotations with highlighted keywords in order to focus the viewer's attention and provide interpretation of the data. These processes speak to the editorial layer of choosing data and expressing the data through appropriate representations that suggest meanings not immediately imminent within the data [13].

In Fig. 3 the data indicates the proportion of the population going to movie theatres, hence we used the metaphor of "cinema seat" as an icon to represent numerical data. The



**Fig. 2.** These show several implementations of visual metaphors that use visualization typologies to analyze creative medium

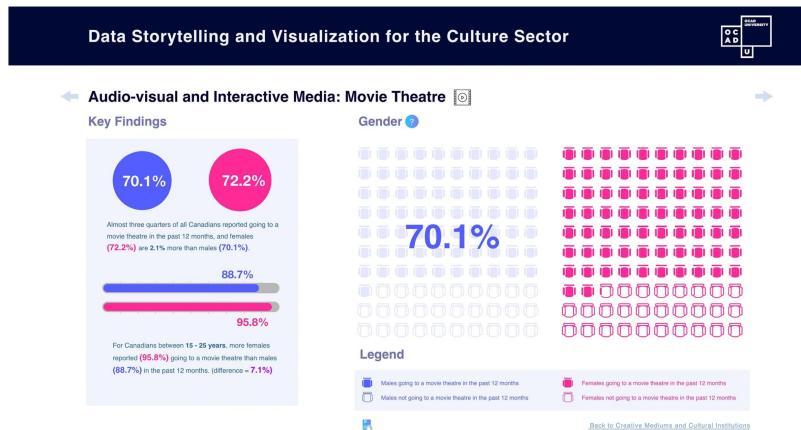
icon is used to allow the user to read and interpret the data more easily, while colours add a level of gender differentiation between attendees; blue representing self-identified males and red self-identified females.

Similar to visualizations acting as a repository for data, the dashboard interface is a repository for the visualizations. We implemented a dashboard interface [17] to enhance User Experience. We considered the level of interaction and user engagement needed to explore this data which led us to the use of an interactive dashboard which nestles between Segal and Heer's concept of slide show or drill down story in its openness. From our analysis of the data, we gained the insight that two points of entry were needed. Users could explore a creative medium to understand a population segment's engagement with it, or users could choose a demographic segment and discover their cultural interests. To make a clear and consistent structure, we divided the dashboard space vertically into three sections (columns): Visualization, Legends, and Key Findings, referenced in Fig. 3. These constructs can be understood as "procedural rhetoric" as discussed by Hullman, and Diakopoulos [13]. We divided the dashboard space into three columns. Navigation buttons such as backward, forward, back to the homepage, are represented by an icon button next to the title "gender" which shows the infographic when hovering on it, as well as the "source" button at the bottom which shows our data source. We aimed to keep the dashboard functions concise with sufficient information and context for the visual analytics.

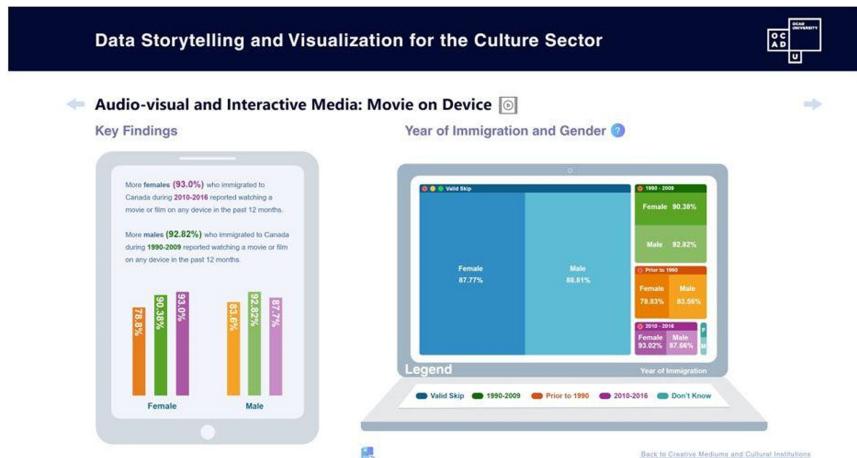
We considered the user navigation while designing the interface prototype. For example, in Fig. 3 there is an icon button next to the title "gender" which shows the infographic when hovering on it, as well as the "source" button in the bottom which shows our data source, ensuring that we provide the user with provenance. By applying these interactive buttons, along with the hovering effect on the graph which presents the percentage above the pictorial chart, we aim to keep the dashboard concise while containing sufficient information and context for the visual analytics. The interaction creates an enhanced user experience to allow users to immerse in the visualization that tells the data story. This strategy adopts Segal and Heer's "transition guidance" approach [14, pg. 7].

In Fig. 4 visualizations present two demographic factors, gender, and year of immigration in relation to movie watching practices on digital devices. A Treemap Visualization provides a hierarchical representation of proportional data in the form of nested rectangles, visualizing the proportion of individuals who reported watching a movie or film on any device in the past 12 months by year of immigration and gender. The data is framed by a laptop metaphor.

The colour scheme plays a significant role in branding the research, corresponding with the Heritage Canada's use of colours to depict specific artistic disciplines. We



**Fig. 3.** These visualizations provide an analysis of attendance at movie theatres organized by gender.



**Fig. 4.** Gender and immigration status in relation to digital media consumption on a device. Data labels are used as a semiotic tool to provide interpretation for users.

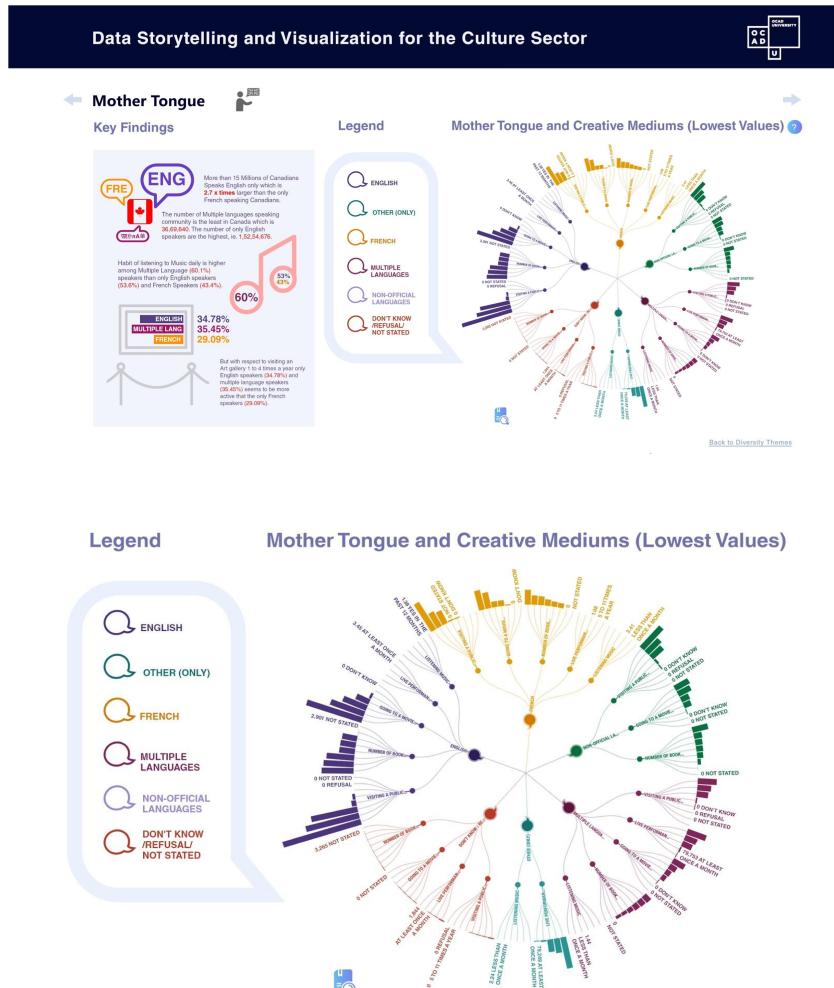
intentionally kept the format minimal to avoid stealing the attraction of the data visualizations which represented the subject matter. We applied a similar colour scheme to all the visualization and kept the contrast of color design for accessibility strictly complied with the WCAG principle which stands for Web Content Accessibility Guideline, with regard to the wide diversity of our audiences.

## 5.2 Data Storytelling - Two Examples from the Dashboard

We now provide two detailed examples of dashboard construction, the choice of visualizations, use of metaphors and interaction design and analysis indicated through the strategy.

### Mother Tongue and Creative Mediums

**Description:** Figure 5 depicts the distribution of the number of people engaged in various Creative Mediums segregated as per their mother tongue in Canada. The data labels on bars display only the lowest values of the set from the six main linguistic categories. The creative mediums are presented by further subdivisions/linked nodes which include listening/making to music (digital or conventional radio), attending live



**Fig. 5.** Mother Tongue and Creative Mediums along with the DataViz Close-up

performances (dance, theatre, etc.), written works (frequency of reading habit), Cultural institutions (art galleries, libraries, museums, nature parks, historical sites) are included in addition to audio-visual and interactive media (TV, Online, movie theatre etc.).

**Color Coding:** Six vibrant colours are used to represent the official, non-official and other multiple languages spoken by the Canadian population. Speech bubbles, musical notes, national symbols, and gallery icons are used for accurate, and more rapid readability.

– *Key Findings:*

- More than 15 Million of Canadians Speak English only which is 2.7 times larger than the only French-speaking Canadians.
- The number of multiple language speaking communities is the least in Canada which is 36,69,640. The number of only English speakers is the highest, 1,52,54,676.
- The habit of listening to Music daily is higher among Multiple Language (60.1%) speakers than only English speakers (53.6%) and French Speakers (43.4%).
- With respect to visiting an Art gallery 1 to 4 times a year, English speakers (34.78%) and multiple language speakers (35.45%) seem to be more active than the only French speakers (29.09%).

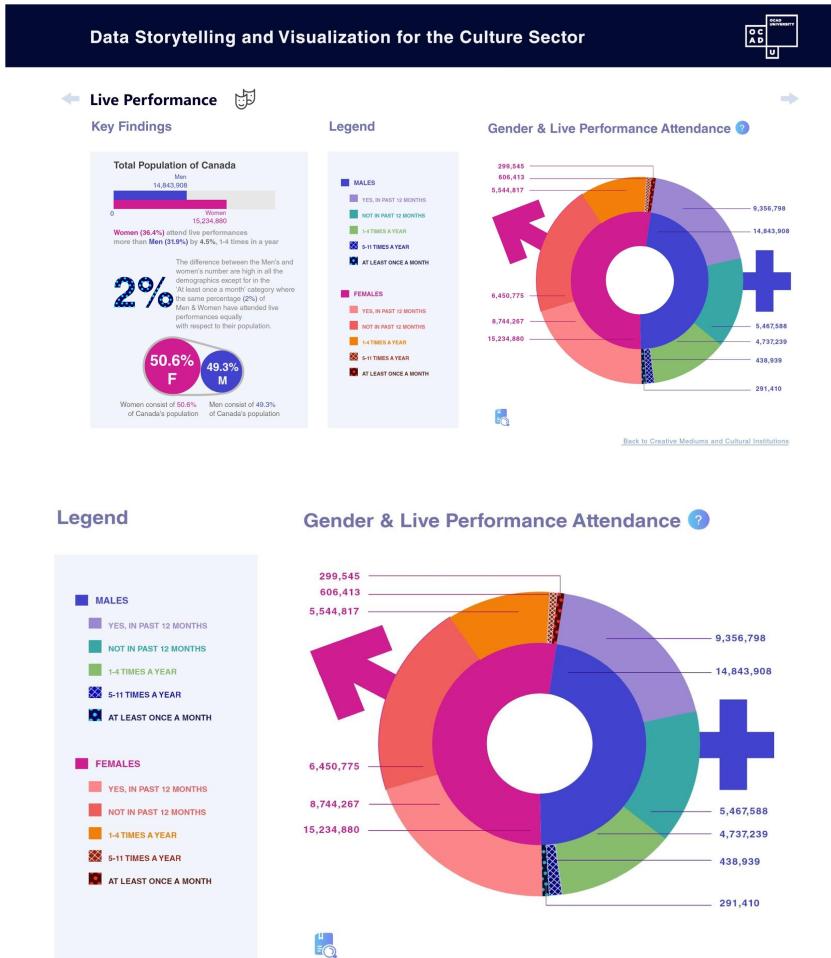
## Live Performance Attendance

**Description:** Figure 6 represents the Sunburst data visualization made up of concentric circles, visualizing the hierarchical distribution of Canadian population by their gender (self-identified males and females) and their live performance attendance (including Theatre, Drama, Comedy and Musicals). The further subdivisions or leaf nodes represent the number of times (frequency) of the visits by the audience separately over a period of a year.

**Color Coding:** The warmer colours like red, orange, and pink hues represent the female ratio while the cooler colours such as green, blue, and purple depict the male ratio. The gender icon has been constructed within the layout of the Sunburst diagram. Visual textures/patterns are used for making minimal values legible.

– *Key Findings:*

- Women (36.4%) attend live performances more than men (31.9%) by 4.5%, 1–4 times in a year.
- Women consist of 50.6% of Canada's population, 15.23 million.
- Men consist of 49.3% of Canada's population, 14.84 million.
- The difference between the Men's and women's numbers are high in all the demographics except for in the 'At least once a month' category where the same percentage (2%) of Men & Women have attended live performances equally with respect to their population.



**Fig. 6.** This set of visualization analyzes attendance at live performances on the basis of gender.

## 6 Conclusion and Future Work

### 6.1 Conclusions

The application of narrative devices and rhetorical strategies [13] allowed effective use of layers of meaning and interpretation of this complex multidimensional data set and the design of improved user interaction. The concept of Provenance Rhetoric [13, 2011, pg. 4] was of value to the analysis of our inclusive data set, where it was important to cite data sources, designated by a source button. It allows stakeholders to understand the qualities and limits of the data used for analysis and visualization. We also revealed methodological choices, through a question mark “how to read” button, providing a level of transparency which Fernandez et al. [7] emphasize when dealing with diversity data. We were rigorous in matching metaphor to subject. The concept of Mapping Rhetoric [13],

pg. 4–5] inspired our application of visual metaphors and metonymy, including colour mappings, in which different colors represent different groups. We used typographic emphases, an element of Linguistic-based Rhetoric [13, pg. 5–6] such as sizing and bolding texts to direct users.

Our prototype bridges infographics and narrative visualization. Design choices considered the users’ familiarity of data visualizations. The pictograms and infographics provided clear data information by using an unintrusive and objective visual style. These extracted key insights which helped the users, included those without visualization knowledge, to capture and understand the data.

By developing an interactive visualization strategy, we discovered correlations in the data and allowed discovery over well sequenced navigation which would not have been possible through static infographics and lengthy text descriptions [20]. Our research methods and argue that designers must effectively represent diversity and inclusion data analysis in ways that can address diverse stakeholders, from equity seeking groups, to policy analysts, to agencies and companies implementing diversity strategies.

## 6.2 Future Work

Interest in representing demographic data in relation to cultural creation and consumption continues to grow in Canada and elsewhere, allowing for the ongoing development of our prototypes. The representation of diversity data requires constant review and revision. Having worked with existing data sets we will explore expanded methods of accessing diversity data and structuring this data (including survey data from Statistics Canada, Heritage Canada, and cultural funding agencies), we will experiment with narrative strategies that frame data without directing users’ conclusions [30]. We will consistently update our design of demographic icons for a range of gender identities, Indigenous and racialized identities, and vetting these with our partners and their stakeholders.

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