# PedaViz: Visualising Hour-Level Pedestrian Activity

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## ABSTRACT

Effective visualisation plays a vital role in generating insights from data. The selection of graph types however, is highly dependent on the analysis tasks and data types at hand. For example, spatio-temporal visualisations encode changes in data over time and space. Although they have the potential of revealing overall tendencies and movement patterns, building effective spatio-temporal visualisations is challenging because it requires encoding all three attributes of spatio-temporal data i.e. thematic (values of attributes), temporal and spatial in a single visualisation. In this application design study, we present PedaViz for representing hour-level spatio-temporal attributes within a single visualisation; a 24-hour radial visual metaphor that encodes hour-level temporal and daily temperature attributes while utilising a thematic map display to present spatial attributes. The design was applied on city planning domain using Melbourne's pedestrian count and temperature data. Results of our preliminary user evaluation suggest that our visualisation is easily understandable by users; and supports users in carrying out selected analysis tasks.

## CCS CONCEPTS

• **Human-centered computing → Visualization application domains**; **Information visualization**;

## KEYWORDS

Spatiotemporal data, urban data, visual design, application study

## 1 INTRODUCTION

It is easier to comprehend large amounts of information presented in concise graphical formats than in tabular spreadsheets and databases [1]. By visualising data in charts, people are able to draw conclusions from the presented information. Users can more easily spot trends and relationships between data attributes that would otherwise have been difficult to see in raw datasets [15]. Hence effective visualisation plays a vital role in the process of generating insights from data [25]. The selection of chart types is highly dependent on the analysis tasks and data types at hand [7, 22]. For instance, line graph related visual displays present observations as connected points on a grid and have been shown to be very effective in representing data with temporal attributes and viewing trends [23, 26]. As another example, cartographic maps are effective tools for representing geo-spatial attributes [3]. Spatio-temporal visualisation encodes changes in data over time and space. Although it has the potential of revealing overall tendencies and movement patterns [27], building effective spatio-temporal visualisations is challenging because it requires encoding all three attributes of spatio-temporal data i.e. thematic (values of attributes), temporal and spatial [3] in a single visualisation in a comprehensible manner. Hence, we lend our effort to tackle this difficult problem in city planning domain.

In this paper, we discuss our approach for encoding hour-level spatio-temporal attributes within a single visualisation in city planning domain: a 24-hour radial visual metaphor for representing both hour-level temporal and temperature data attributes while utilising a thematic map to present geo-spatial attributes. Moreover, we implemented a prototype application called PedaViz for the city planning domain using Melbourne pedestrian count containing spatio-temporal attributes, and daily temperature data. PedaViz has been applied to large pedestrian datasets and in this domain it has the capability to enable city planners to better understand how the city is utilised by pedestrians, understand the effect of factors such as daily temperature and key city events on pedestrian activity, and to better inform them of how to plan for the future needs of the city economically, and socially.

Results of user study with PedaViz were promising and suggest that it is easily understood by users; aids users in carrying out analysis tasks; and supports decision making especially where the context provided by the geo-spatial attributes of the data needs to be retained. Additionally, an evaluation of the syntactic properties of PedaViz using the principles of the Physics of Notations (PoN) [14] is also discussed.

## 2 MOTIVATING SCENARIO

### 2.1 City of Melbourne

Approximately 800,000 people visit the Central Business District (CBD) of the City of Melbourne every day and constitute its pedestrian population [18]. The City of Melbourne local government has set up sensors throughout the city to provide pedestrian counts for every hour at a given location. These are targetted to provide a means to understanding the usage of different areas of the city,


*VINCI '18, August 13–15, 2018, Växjö, Sweden*

ACM ISBN 978-1-4503-6501-7/18/08…$15.00
https://doi.org/10.1145/3231622.3231626

**Table 1: The data attributes**

| Attribute | Description | Characteristics |
|---|---|---|
| Sensor ID | Unique identifier assigned to sensor | Numeric |
| Latitude | Geographical coordinate of sensor location | Spatial |
| Longitude | Geographical coordinate of sensor location | Spatial |
| Hourly Counts | Total hourly pedestrian counts | Numeric |
| Date | Date count was recorded | Temporal |
| Time of day | Hour of day count was recorded | Temporal |
| Temperature | Hourly temperature | Numeric |
| Location Type | Sensor location category | Textual |

and also multiple factors of societal influence, such as commercial activities and social norms, amongst others. Pedestrian activity and city planning have been considered areas of important research in both academia and industry. Before the advent of smart cities and sensors streaming data, Gehl and his team, carried out a manual survey of the City of Melbourne and captured the characteristics of its civic life by having staff standing at various parts of the city and counting passing pedestrians for a 10 minute window [9]. They then generalised the data for up to an hour and analysed how public infrastructures affect the way people spent their time. The results of these analyses were used by the city planners to make incremental changes to the public spaces, resulting in an increased numbers of people engaged in civic life [9].

## 2.2 City Planning Analysis Exercises

The responsibility of planning the best utilisation of land and infrastructural resources of a city is usually undertaken by city planners [20]. They are tasked with the analysis of urban data from a wide variety of sources, ranging from population characteristics to map land areas and economic activities. The results of these analyses provide insights to how the city is being used and are the basis for urban planning. However, many analytical exercises associated with the investigation of urban data usage require the consideration of spatio-temporal attributes. We have identified some of these exercises that are useful to city planners and utilised them as guidelines for designing and assessing our PedaViz tool [16, 20]. These exercises include:

(**Exercise 1**) Visualise the count of people passing a sensor location at certain hours of the day while preserving the geo-spatial context of the data domain;

(**Exercise 2**) Check patterns of pedestrian build up at key city locations;

(**Exercise 3**) Compare two or more sensor locations to see the *relative* difference in traffic at different time of the day, given daily temperature;

(**Exercise 4**) Analyse the effect of key city events, such as public holidays or sporting events, on pedestrian activity while also preserving the geo-spatial context of the data domain;

Furthermore, the above analysis exercises can be carried out given certain climatic conditions, such as hourly temperature (used in this case study) or rainfall at the locations, to see how these influence pedestrian activity in the city.

## 2.3 Data Collection and Description

PedaViz prototype visualisation approach has been applied to the City of Melbourne pedestrian count data.

The sensors are installed on street poles and under overhangs at different location within the city. There are three main criteria for determining these sensor locations - main pedestrian thoroughfares, retail and event activity, and egress and entry flow to these areas [18]. Every location with a sensor constitute a counting zone and records all pedestrian traffic within that zone. The data is logged onto a data recorder and then stored every 10 to 15 minutes. The data is further made available to the public through the city council's website to allow users to download raw data in different formats.

In this work, we have used the data collected from 2013 to 2016 [17]. A preview of the attributes of the data is shown in Table 1. We categorise the data attributes based on their characteristics as follows:

- **Spatial attributes**, such as the latitude and longitude geographic information;
- **Temporal attributes**, such hour and date;
- **Numeric attributes**, such as sensor ID, hourly pedestrian counts and temperature;
- **Textual attributes**, such as location type.

# 3 RELATED WORK

## 3.1 Visual Analysis of Spatio-Temporal Data

Studies have been carried out in the field of spatio-temporal data visualisation including the development of geo-spatial applications and the categorisation of visualisation techniques and algorithms. Andrienko et al. [3] reviewed the techniques of spatio-temporal visualisations from existing literature. They categorised the different methods into two broad categories - those that depend on the type of spatio-temporal data being analysed and those that are driven by the specific exploratory tasks. Across both categories, the spatial (where), temporal (when), and object components (what) of spatio-temporal data form the basis of spatio-temporal visualisations. Diehl et al. [5] presented an interactive platform for analysing spatio-temporal data in short term weather forecast. The system combines geo-referenced maps, timeline, and spatial filtering to help users discover trends and errors in weather forecast models.

In other example studies, Ferreira et al. [6] proposed a tool for visualising taxi trips using the city of New York as a case study. Their tool offers users a means of expressing a wide range of spatio-temporal queries while investigating mobility patterns across the city, and is suitable for exploring and comparing visualisations. Another example is the work of Reda et al. [19] who proposed a tool for the analysis of spatio-temporal changes in social networks. The tool uses timeline displays for depicting the organisation of the community and its changes over time and spatial cubes for representing movements within the community.

Although, the aforementioned studies are focused on the visual analysis of spatio-temporal data in certain other domains, they do not tackle the challenge of visualising hour-level spatio-temporal

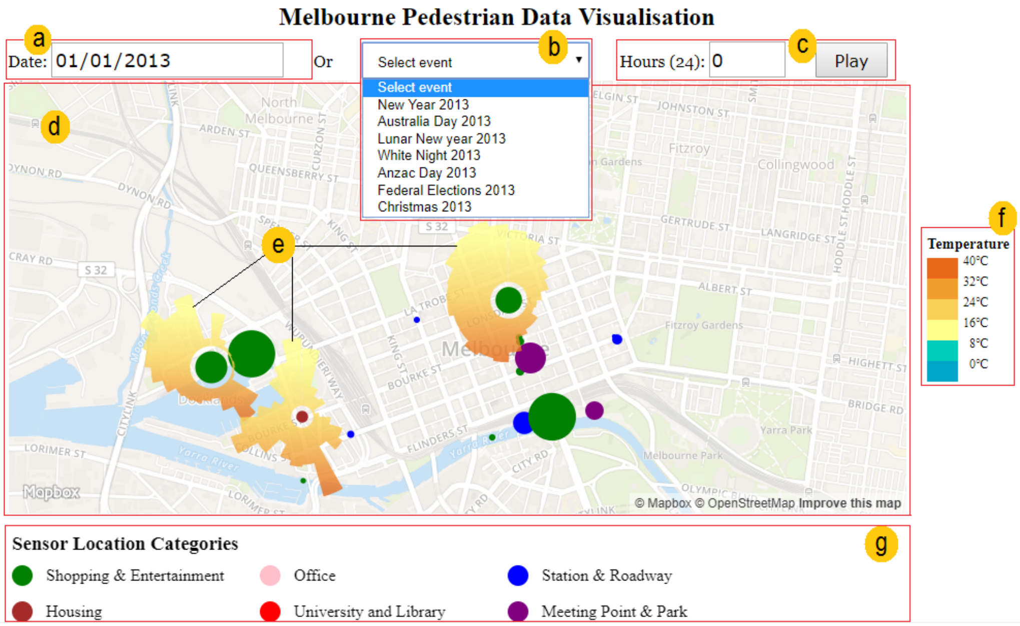



**Figure 1: The user interface with controls and legends. (a) Date selection control, (b) Event control, (c) Hour selection control and animation button, (d) Thematic map, (e) 24-hour radial visual metaphor encoding pedestrian count per hour and daily temperature, (f) Temperature legend and (g) Sensor location categories legend.**

data in urban planning domain. Our work addresses this challenge using the city of Melbourne as a case study.

## 3.2 Radial Visual Metaphors in Applications

One of the earliest depiction of radial visual metaphors in encoding data dates back to the 1858, when Florence Nightingale [2] visualised the monthly number of deaths that occurred from preventable diseases, wounds, and those due to other causes during the Crimean war. Since then, radial-like visual metaphors have been shown to be well suited for depicting cyclic phenomena [2].

Recently, researchers have adapted the radial visual metaphor to visualise data in various domains. ClockMap [8] combines a circular nested treemap layout with a circular glyph representation for displaying hierarchical time series data. Kintzel et al. [11] introduced ClockView to display activity over time of thousands of hosts in computer networks. Another work with a similar approach is that of Seebacher et al. [21] They overlaid a radial glyph on a map to visualise spatio-temporal event prediction. Their visualisation allows researchers in the field of viticulture and biology to investigate the spread dynamics of invasive species. However, our work differs from these others because it is a application study applied to spatio-temporal visualisation challenges in urban planning domain and the radial visual metaphor encodes two different cyclic quantities i.e. hour-level temporal attributes and daily temperature.

# 4 VISUALISATION DESIGN

PedaViz's adopted visual components are discussed below. An example screenshot of the prototype in use for visualising City of Melbourne pedestrian count data is shown in Figure 1.

**Visual Component 1: Thematic Map.**
(**Exercise 1**), each sensor is depicted by a circle coloured based on the location's category. These categories and colours are listed in Figure 1(g). Each circle is positioned on the map using the geographic coordinates attributes (longitude and latitude of the sensor). Area of the circles is proportional to the overall hourly count of people recorded by the sensors in each location of the city. Locations with similar activities have been grouped together as shown in Figure 1(d & g).

Thematic maps are useful for analysing proportions over geographic areas [3]. Although analysis involving statistical proportions can be explored with diverse non-cartographic visualisations such as line graphs, other tasks involving investigation of changing spatio-temporal attributes are better shown with maps [3]. The thematic map provides a useful context to the user in determining the actual locations of the sensors in the city.

**Visual Component 2: 24-Hour Radial Visual Metaphor.**
(**Exercise 2 & 3**), When a circle is hovered over or selected, it expands into a 24-sided radial polygon where each side of the polygon represents an hour. The length of each side corresponds to the hourly counts *relative* to each location as shown in Figure 1(e). In order to reduce occlusion, the opacity of the polygons was reduced. This makes it visible and yet transparent enough to see underlying location points. The colour of the 24-sided radial polygon Figure 1(f) corresponds to the hourly daily temperature and aligns with the colour gradient standard generally depicted in various weather visualisations - red for warmer temperature and blue for cooler temperature.

We adopted the radial layout because it is well suited to encoding cyclic phenomena such as hour-level temporal attribute [2].

In addition, as visual metaphors have been shown to shape how information is interpreted and influences how visualisations are understood [28], we also adopted this radial visual metaphor to represent the temporal attribute of hour, informed by the intuition of an object with which users already measure time [16] - a principle known as *Semantic Transparency* that encourages the use of mnemonics. Moreover, the polygon extends seamlessly from the circumference of the circle without extra perceptual effort or shift in focus (the principle of *Complexity Management*), and at the same time offers a visual summary of the underlying data without leaving the context provided by the map (geo-spatial attributes) - principle of *Cognitive Integration*.

**Time Selection Control:** lets the user select temporal condition in the visualisation. As shown in Figure 1(a & c), the two controls, Date and Hour pickers allow users to select date and hour, updating the visualisation accordingly.

**Event Control:** allows the user to select temporal conditions - users can select any event to visualise how pedestrian counts increase and decrease at certain times without having to remember the date of the event, shown as Figure 1(b) (**Exercise 4**).

**Animation Control:** The Play button in Figure 1(c) allows the user to animate the visualisation for a certain period and see how the counts change using hourly updates as frames in a day. This provides a means for visualisation storytelling and investigation of pedestrians traffic build up pattern (**Exercise 2**).

*Tool Implementation.* We implemented PedaViz as a cross - platform tool in HTML and JavaScript, with D3.js library and Mapbox JavaScript API. PedaViz uses Mapbox to render the map, and D3 to render interactive SVG elements (circles, and 24-sided polygons) on the map. It is a lightweight client-side tool that requires no server installation or maintenance.

## 5 EXAMPLE SCENARIO

Consider Mindy, a newly engaged urban planner, who is tasked with the analysis of Melbourne Central Business District (CBD) urban data, in order to plan for the use of the city; tasks include identifying the busy (and less busy) locations, peak times (and down times) and understanding how traffic builds up over time at the various locations. She is also to help determine how much human resources such as security officials are allocated to the various locations as required.

Her first task is to visualise the count of people at various location at different time of the day (**Exercise 1**). Also, because she recently just moved from Adelaide to Melbourne, she is not familiar with Melbourne CBD geographical landscape and so she wishes to retain the geospatial location of the data and observe how pedestrian counts vary geographically. She begins by selecting a date (Figure 1a) and a time (Figure 1c) using the time selection controls. This lets her see the pedestrian counts at different time, as the visualisation updates with the changing hour.

Her second task is to observe pedestrian traffic build up pattern (**Exercise 2**) and so she selects the animation control play button (Figure 1c). She observes the animation and notes the traffic build up pattern (Figure 3a, 3b, 3c and 3d) e.g. the population was relatively small at 10 AM and then increased at midday, with further increase around 2PM before thinning out in the evening at 6 PM.

Moreover, she decides to compare two locations to see the overall *relative* difference in traffic and the effect of daily temperature (**Exercise 3**). She selects each location (circles) on the thematic map to reveal the 24-sided radial polygons ( as in Figure 2) with the length of each side denoting the count at each hour of the day (a visual summary of hourly count) and the colour representing temperature value.

Furthermore, she decides to carry out similar exercises as recorded above for a public holiday or event such as the Lunar New Year (**Exercise 4**). Instead of referring to a calendar for date, she simply selects the relevant event from the event control (Figure 1b) and proceeds to carry out her analysis.

Mindy's story represents the kind of exercises useful to urban planners as summarised in subsection 2.2.

PedaViz can support planning for the future needs of the city economically, socially and otherwise e.g. determining opportunities to enhance pedestrian walkways and transportation system. The visualisation can also find application in informing how security officers are deployed to certain locations based on human traffic. Additionally, it can also be extended to help everyday users plan their commute better, and even inform business decisions as to where to locate ideal sites for setting up their businesses. It has the potential to assist businesses in optimising their marketing and advertisement strategies based on pedestrian activity.

## 6 SYNTACTIC AND SEMANTIC EVALUATION OF PEDAVIZ

### 6.1 Evaluation Using the Physics of Notations Principles

To evaluate the syntactic properties of our PedaViz approach, we utilise the principles of the Physics of Notations (PoN) [14]. We examine important issues identified from this evaluation below.

**Semiotic Clarity:** Semiotic clarity demands that there be a 1:1 correspondence between semantic concepts and graphical symbols. PedaViz defines symbols for spatial, pedestrian count and temperature data, capturing all their attributes with their corresponding visual variables.

**Perceptual Discriminability:** This refers to the ease and accuracy with which graphical symbols can be differentiated from each other. PedaViz defines unique variables for all its semantic constructs except for the colour variable. In order to capture types of location categories and daily temperature simultaneously, PedaViz uses colour for location type categories and colour+brightness for daily temperature. However, it uses different colour legends to facilitate comprehension.

**Semantic Transparency:** Mapping the two geospatial domain attributes to positional and orientation visual variables preserves the spatial layout, hence it is semantically transparent. Moreover, depicting a cyclic phenomenon such as hour attribute with a 24 sided radial metaphor increases PedaViz's semantic immediacy.

**Complexity Management:** This requires that graphical symbols do not overload user's mind. A potential source of increased cognitive load in PedaViz is overlapping radials. However, in order to minimize occlusion, the opacity of the radials were reduced, making it visible and yet transparent enough to see underlying location points.

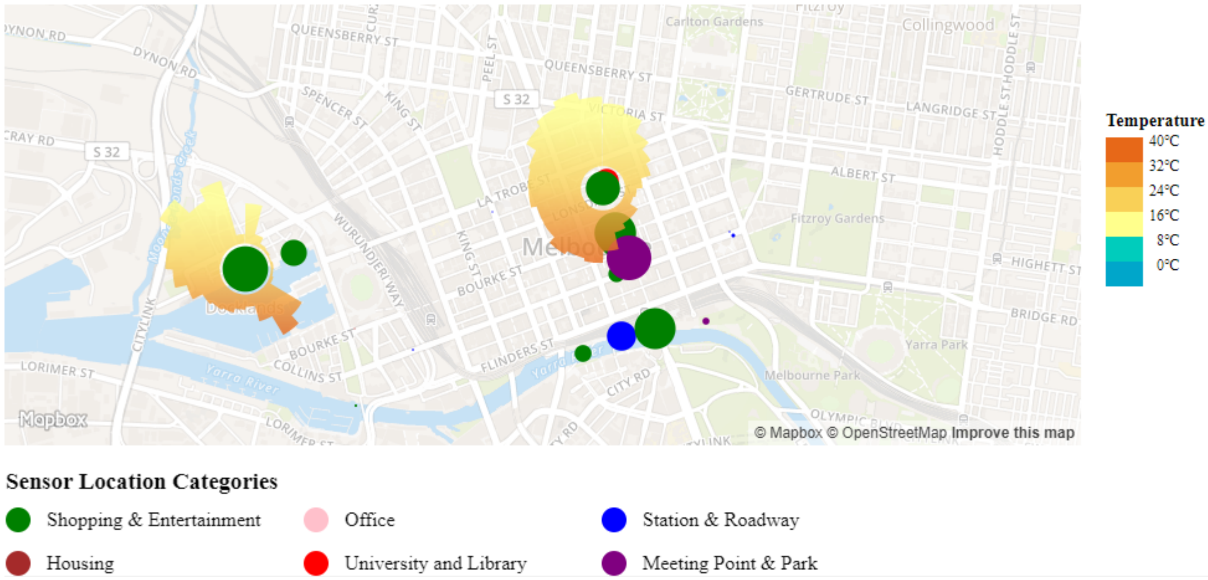
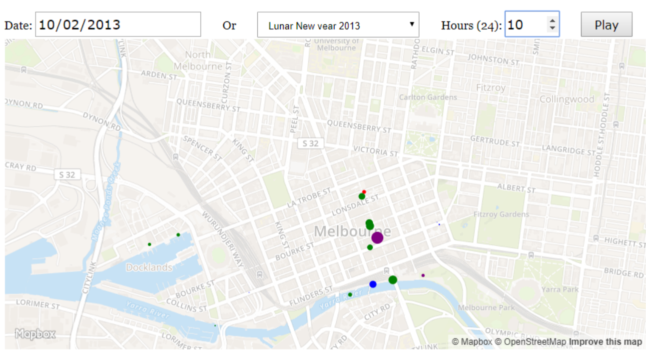
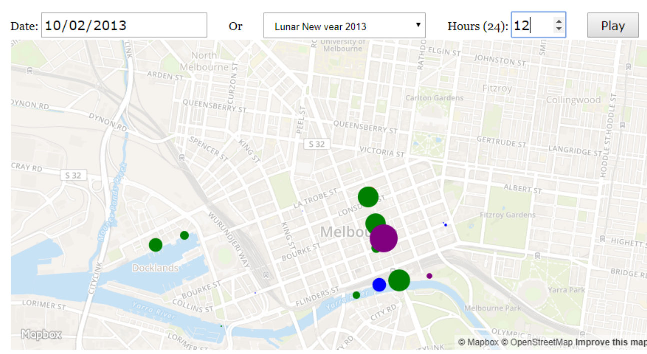


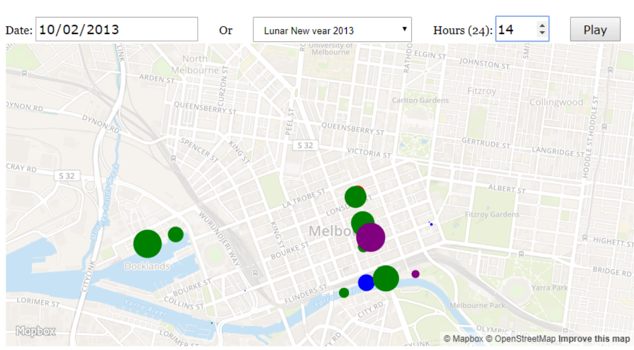

**Figure 2: Relative hour-level traffic comparison between two locations using 24-sided radial polygons.**



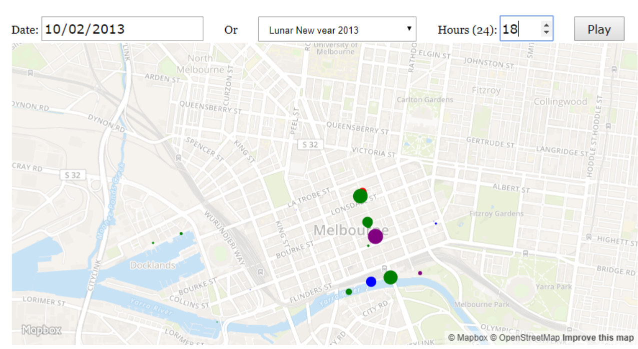

**(a) Pedestrian count at *10 AM* (10th February 2013).**




**(b) Pedestrian count at *12 PM* (10th February 2013).**




**(c) Pedestrian count at *2 PM* (10th February 2013).**




**(d) Pedestrian count at *6 PM* (10th February 2013).**

**Figure 3: Example *hourly* snapshots of pedestrian count visualisation on 10th February 2013.**

**Cognitive Integration:** This refers to the ability to navigate cognitive maps [24]. In the context of thematic maps, it implies allowing the user to traverse the map without extra cognitive load and support operations such as pan and zoom. PedaViz supports pan and zoom as is characteristic of most GIS visualisations.

**Visual Expressiveness:** This refers to the number of visual variables used in a system. There are 8 visual variables defined in PoN and PedaViz utilises 7 of the 8 variables (vertical position, horizontal position, orientation, shape, size, colour and brightness). PedaViz does not use texture, which is already used by the thematic map.

**Dual Coding:** PedaViz already uses most of the available visual variables, hence it does not employ dual coding.

**Graphic Economy:** A consideration of graphic economy which refers to the number of graphical symbols used in a system is important since there is a limit to the human ability to discriminate between distinct alternatives; around 7 categories according to [13] or 4 as recommended by [4]. Having a low graphic economy and a design devoid of unnecessary layers of complexities is useful in helping users quickly learn a visualisation system. PedaViz has a low graphic economy of 4 and its design is simple and straightforward.

**Cognitive Fit:** Cognitive fit theory states that different representations of information are suitable for different audiences and tasks. The design of PedaViz is influenced by the tasks of urban planners and is meant to be comprehensible to both expert and novice users alike.

## 6.2 User Evaluation

Beyond the PoN evaluation of the syntactic properties of PedaViz, we have carried out user experiments in order to gain some early feedback on the semantic effectiveness of the visualisation approach and further iteration.

*6.2.1 Participants.* We recruited a total of 25 participants (21 male and 4 female) to participate in this study. In order to increase the diversity in demographics of participants, we contacted them through flyers on notice boards across campus, mailing list and a Facebook group announcement (15 participants were postgraduate students, 8 were undergraduate students and 2 were industry professionals). Participants' background covered the fields of Computer Science, Engineering, Design and Business Management.

Participants were between 18 and 40 years old. Participants self-reported data analysis skills ranged from *somewhat familiar (3)* to *very familiar (4)* on a 4-point Likert scale.

Furthermore, participants were provided with a desktop computer running Microsoft Windows 7, a 19-inch LCD monitor, and standard peripheral devices - keyboard and mouse.

*6.2.2 Procedure.* Each participant had a separate evaluation session that lasted for about 30 minutes. Participants were informed of the purpose, benefits and voluntary nature of the evaluation study and were requested to sign a consent form before the session began. An investigator then proceeded to give a 5 minutes explanation of the phases in the study and how participants are expected to carry them out. Participants were introduced to PedaViz, filled a demographic pre-survey and reported on their background with data analysis. In the next phase, participants were asked to complete a set of analysis tasks; participants were shown a series of seven screenshots of PedaViz visualisation from which they were expected to answer seven questions.

After completing the tasks, participants completed a survey about the comprehension of PedaViz and the perceptual difficulties encountered. They completed the survey using a 5-point Likert scale (1: Strongly disagree, 2: Disagree, 3: Neutral, 4: Agree, and 5: Strongly agree). In addition, there were comment boxes provided in the survey questionnaire to accommodate feedback from participants.

*6.2.3 Experiment Tasks.* Participants were provided with screenshots of PedaViz to answer the task questions.

The task questions measured the accuracy of participants in making judgement on pedestrian activity in the city of Melbourne, using the pedestrian count data visualised with PedaViz. Moreover, accuracy was chosen as the primary measure and participants were encouraged to answer the task questions as accurately as possible.

Furthermore, upon completion of the analysis tasks, participants were asked to complete a post-experiment comprehension survey. The survey evaluates the capacity of PedaViz to provide a context for understanding the data domain, and the confidence of participants in making decisions based on the insights gained from the visualisation.

*6.2.4 Results.* The analysis tasks were designed to measure the accuracy of participants performing tasks using PedaViz in a typical analysis scenario. The task result shows that overall participants performed very well on the tasks. We observed a mean test score of 79% (SD = 1). This shows that participants were able to carry out similar analysis exercises as those listed in section subsection 2.2 using PedaViz. Although participant task completion time was not our performance metric, we found out that participants on average spent approximately 14 minutes on the task.

The results collected from the visualisation comprehension survey are shown in Figure 4. In general, participants found the analysis tasks easy to complete (Q1: 72% agree and 12% strongly agree). The results show that participants found it easy to understand the 24-hour radial visual metaphor (Q3: 56% agree and 20% strongly agree). Also, participants agree that our visualisation aided them in answering the task questions (Q2: 40% agree and 48% strongly agree, Q5: 24% agree and 32% strongly agree).

Participants reported to better understand the context of the data domain using PedaViz. Specifically, participants' response shows that both the underlying thematic map and 24-hour radial visual metaphor aided their understanding of the pedestrian count data (Q4: 45.8% agree and 37.5% strongly agree, Q6: 48% agree and 44% strongly agree).

Furthermore, a crucial, if not perhaps the most important, task in information visualisation is decision making based on the results of analyses and visualisations. The objective of information visualisation is not realised until it can support users in making accurate and timely decisions. Participants responded that PedaViz supports decision making and that they are able to make decisions based on the insight gleaned from the visualisation (Q7: 48% agree and 44% strongly agree, Q8: 52% agree and 44% strongly agree).

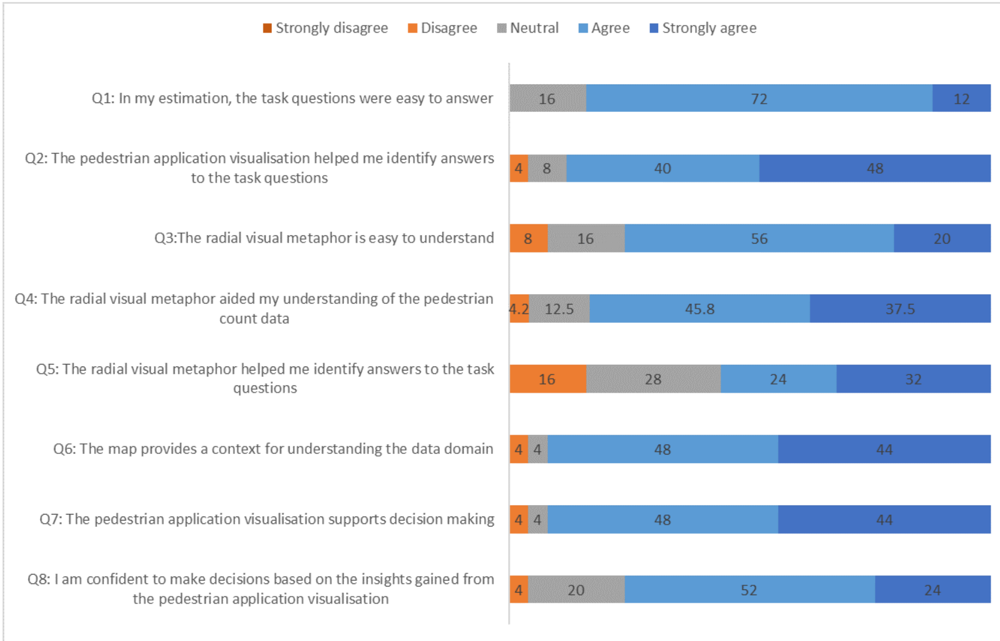



**Figure 4: Results based on visualisation comprehension survey.**

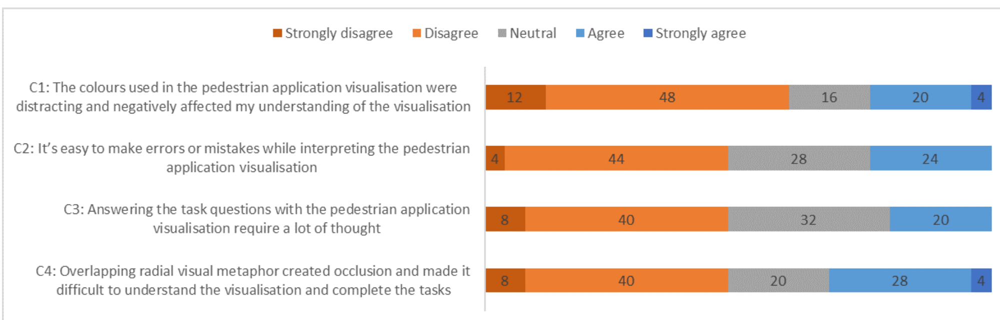



**Figure 5: Results based on perceptual difficulties survey.**

Although the response from participants was mostly positive, participants also experienced some perceptual difficulties while completing the analysis tasks using PedaViz (Q5: 16% disagree). For instance, P1 notes that it is *difficult to identify hour in the custom visualisation.* This may be due to the fact that participants are not accustomed to the 24-hour radial visual metaphor. Moreover, users' comprehension of graphs is highly affected by prior knowledge about graphs [10, 12]. The results of perceptual difficulties survey is summarised in Figure 5 (The higher the percentage of strongly disagree/disagree, the lesser the effect of perceptual difficulties).

*6.2.5 Threats to Validity.* We have taken precautions to minimise threats to validity and their effects in this study. Nonetheless, some threats may have affected our results and conclusions.

**Survey** Although the surveys were simplified and participants were encouraged to ask questions during the experiment session, some participants may have been hesitant to ask questions and therefore responded based on their understanding of the questions. This may have affected perceptual difficulties experienced by some participants.

## 7 DISCUSSION AND FUTURE WORK

Although PedaViz closely aligns with the design guidelines proposed by the PoN, the evaluation using PoN only describes the syntactic effectiveness of its visual metaphors. The semantic usefulness can only be demonstrated with a user study.

The results of our study are promising and shows that PedaViz is a relevant approach in combining spatial and temporal data attributes in a single visualisation in urban planning domain. However, we noticed that users do not want to be limited to the use of single visualisations in carrying out their analysis tasks but rather take advantage of the unique features that several visualisations offer. Some users suggested to have multiple visualisations for performing a single visualisation task. For instance, using PedaViz visualisation to understand the spatial context of the data and an overview of pedestrian activity and switching to a line graph visualisation to uncover finer details.

This is an important area for subsequent work - extending PedaViz to include linking and brushing with other visualisations specifically line graph, so that a highlight or change in one visualisation is reflected in others. This will provide more insight than can be obtained from a single visualisation type.

One limitation of this work is its focus on day-by-day comparison. A primary reason we chose a day-by-day visualisation within the city planning domain is to show, in one glance, the overview of daily/hourly pedestrian counts and the effect of city events and daily temperature on pedestrian activity to the user while preserving the context that the map (geo-spatial attributes) provide. We believe that since the visualisation is effective in day-by-day comparison, it might be usefully generalised to other temporal attributes such as month and year comparison, using segments to represent different aggregations of time. An area for future work is thus to extend the prototype application to include year-by-year and month-by-month aggregates comparison.

Furthermore, we plan to formally evaluate the effectiveness of PedaViz with expert users such as city planners, so as to be able to judge how the tool helps them carry out their everyday analysis tasks, and seek places for further improvement in its design.

## 8 CONCLUSION

In this paper, we highlighted the capacity of spatio-temporal visualisations in revealing movement patterns, and the inherent challenges in effectively encoding all three aspects of spatio-temporal data in a visualisation. We discussed a motivating scenario in city planning domain and then presented our approach for adapting the radial visual metaphor over a thematic map to encode daily temperature, hour-level and geo-spatial data attributes.

We implemented a prototype tool, PedaViz, within the context of city planning using Melbourne pedestrian count and temperature data, and evaluated the visual metaphors using the principles of PoN. Moreover, results of early studies indicate the usefulness of the tool in helping users carry out spatio-temporal analysis tasks. Furthermore, we provided directions for subsequent work with the goal of supporting users on their journey of insight discovery and decision making.

## ACKNOWLEDGMENTS

Humphrey O. Obie is supported by a Data61 International Postgraduate Award. Part of this work is also supported by the ARC Discovery Project scheme DP140102185.

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