Monitoring at-home care patients through a scalar polar plot visualization of motion sensor data

Michael A. McGavin and Michael Bauer, PhD

Department of Computer Science, The University of Western Ontario, London, ON, CANADA

BACKGROUND

- Approx. 18% of the Canadian population is 65 or older (6.6 million seniors). A 2010 survey by the American Association of Retired Persons determined that 88 percent of people over age 65 want to stay in their residence for as long as possible
- As such, research has been devoted to develop ways to ensure seniors are able to maintain a high quality of life without having to relocate to assisted living communities and long-term care facilities. This has led to using sensors in individual residences to capture daily activity data
- Visualizing data is a powerful method of data analysis that can help humans easily gain insight about a dataset. Data visualization allows users to transition from just looking at data, to see patterns arising from the data. The sensor data collected is time-based, can be large and difficult to explore

OBJECTIVE

The purpose of this research is to visualize motion sensor data to enable users to detect patterns in behavior, both regular and irregular

MATERIALS & METHODS

- Motion sensor data was collected from patients' homes. These involved motion, pressure, and contact data. Sensors were placed in common areas such as kitchens, living rooms, bedrooms and bathrooms. Pressure sensors are limited to client's beds and sofa chairs and contact sensors monitor exterior doors
- A polar plot was chosen as visualization due to its radial nature being analogous to a clock and the hours of the day (Fig 1).
- Weighted random sampling was performed on the cleaned data to display multiple months' worth of data, allowing the viewer to determine patterns without an overly-crowded plot (Fig 2).
- A modified version of *Algorithm L* [1] was used to implement the weighted random sampling (reservoir sampling).
- Python 3 was used as the coding language to create the visualization due to its user-defined libraries
- Libraries used were Pandas for its dataframe structure, PlotlyExpress to create the polar plot, and Dash to host a testing server and view output

Figure 1: Polar plot displaying 6 months of motion sensor data without any statistical sampling applied:

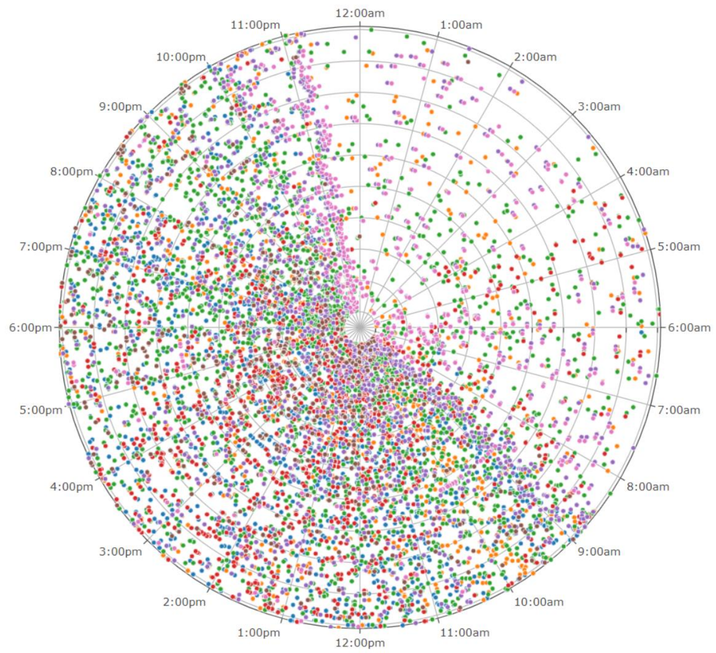
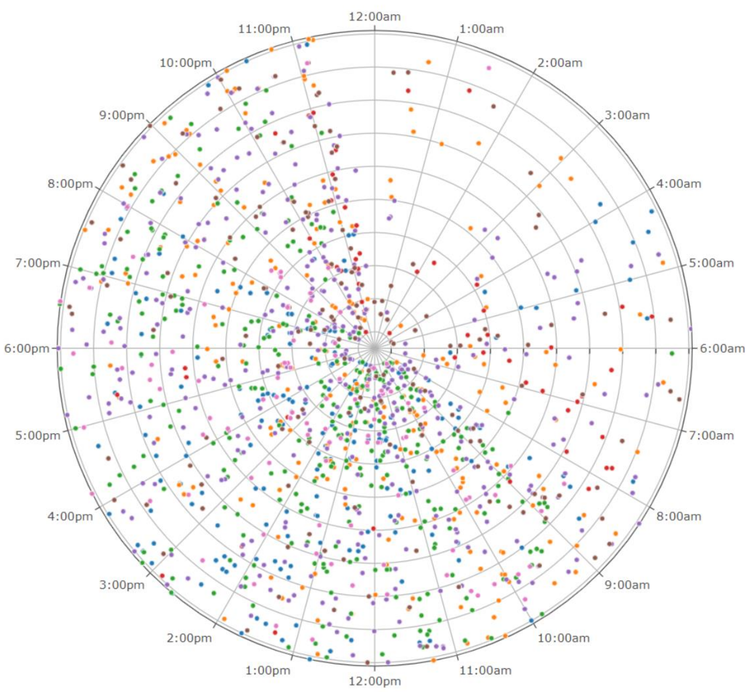


Figure 2: Polar plot displaying 6 months of motion sensor data with weighted random sampling applied:



RESULTS

- Before sampling was applied, the plot was far too crowded to determine any behavior
- After weighted random sampling was applied, the plot was readable, and behavior could be discerned
- Overall, this method was successful in achieving the goal of scaling a polar plot visualization of sensor data
- Developed algorithms to display multiple sensor data in a polar plot

DISCUSSION & CONCLUSION

- Weighted random sampling allowed the visualization to retain a true representation of the original data set. It ensured there was no such sensor that was overrepresented thus giving an inaccurate overlook of the patient's behavior
- Due to the random nature of the sampling, every sample taken from the same dataset will be entirely unique which can lead to variance in determining behavior
- Future steps would be to pair this visualization with another such as a stream graph to display the entire timeframe, and then using a polar plot to display a single day within that timeframe

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REFERENCES

[1] Kim-Hung Li. 1994. Reservoir-sampling algorithms of time complexity O(n(1 + log(N/n))). ACM Trans. Math. Softw. 20, 4 (Dec. 1994), 481–493. DOI:https://doi.org/10.1145/198429.198435