TOWARDS AN UNDERSTANDING OF COMFORT AND WELLBEING OF OLDER PEOPLE USING OCCUPANT CENTRIC MODELS

THE UNIVERSITY of ADELAIDE

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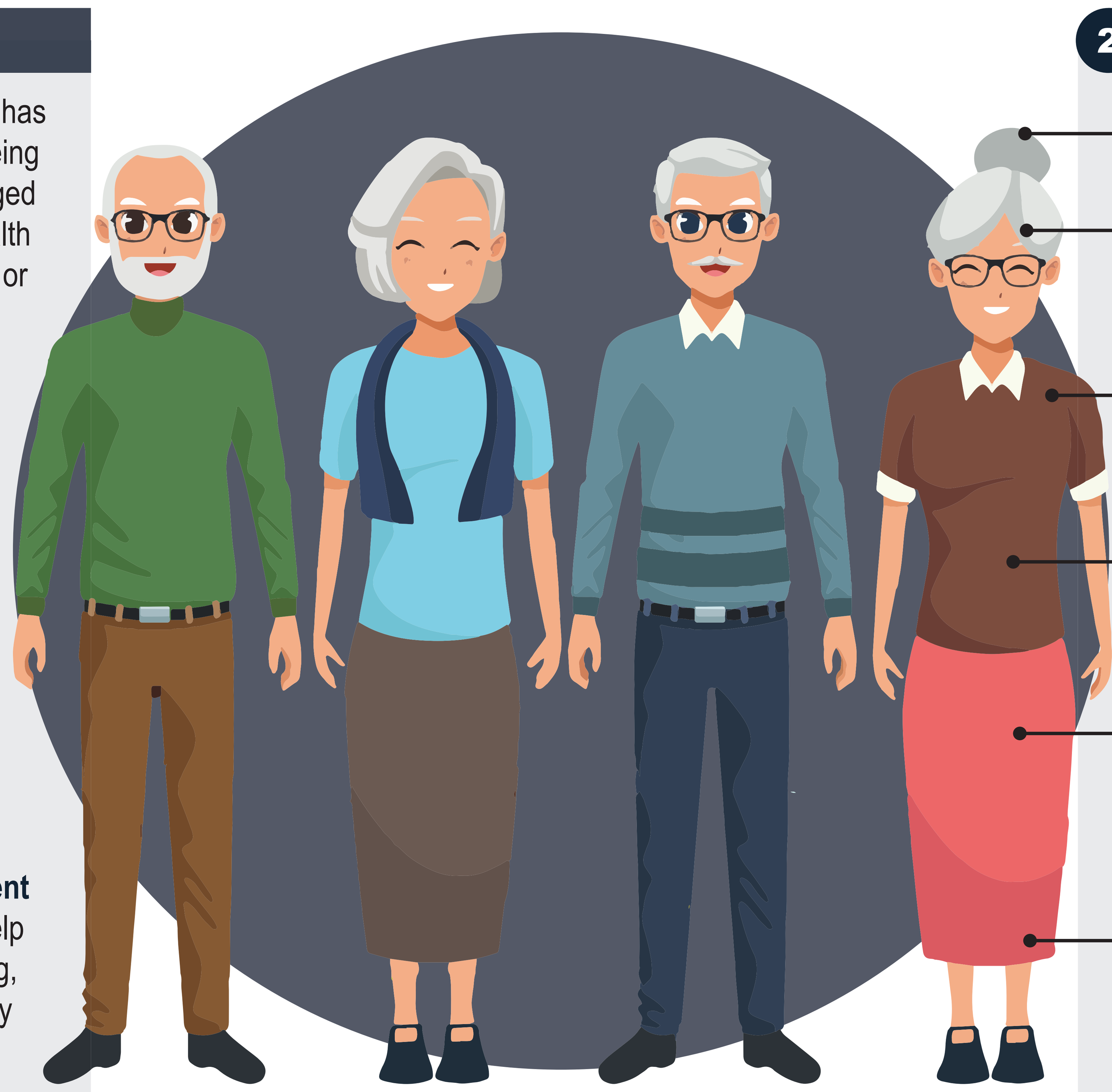
1 SUMMARY

The worldwide demographic trend of an ageing society has important implications in the built environment. As the ageing population increases, designers are increasingly challenged to manage the diverse needs of older citizens so that health and quality of life are improved and independent living – or “ageing in place” - can be guaranteed.

In this context, since older people’s individual differences are excessively wide, considering them as a single and uniform population can lead to misleading conclusions. Consequently, this study aims to investigate **relationships between thermal comfort and wellbeing of older people on an individualized level, by developing occupant centric and data driven comfort models using machine learning algorithms**, as opposed to the generalized static models traditionally used today.

This approach seeks to **enable more adequate design guidelines and thermal conditioning management for older people’s built environment**, which could help decrease health-related vulnerability, enhance wellbeing, minimize reliance on heating and cooling, reduce energy use and ultimately diminish fuel poverty.



2 CONTEXT

World’s population is ageing at a fast rate (UN, 2017).

HETEROGENEITY

Older people have great diversity when it comes to health, quality of life, needs and preferences (WHO, 2015).

AGE IN PLACE

The majority of older people want to remain in their own homes for as long as possible (Judd et al., 2010).

STANDARDS USE AGGREGATE MODELS

Current practice for thermal comfort management is focused on the population level (PMV and adaptive models).

THERMAL DISCOMFORT

Considering older people as a single population in terms of thermal perception could result in leaving a significant number of them in discomfort (Schweiker et al., 2018).

PERSONAL COMFORT MODELS

Instead of an average response from a large population, personalized models predict individuals’ thermal comfort responses (Kim et al., 2018).

3 OBJECTIVES

Support adequate residential design for older people to live independently and age in place, by:

INVESTIGATING

the thermal environment of a sample of houses occupied by older people;

COLLECTING DATA

on the occupants’ preferences and sensations during various seasons and weather conditions;

DEVELOPING

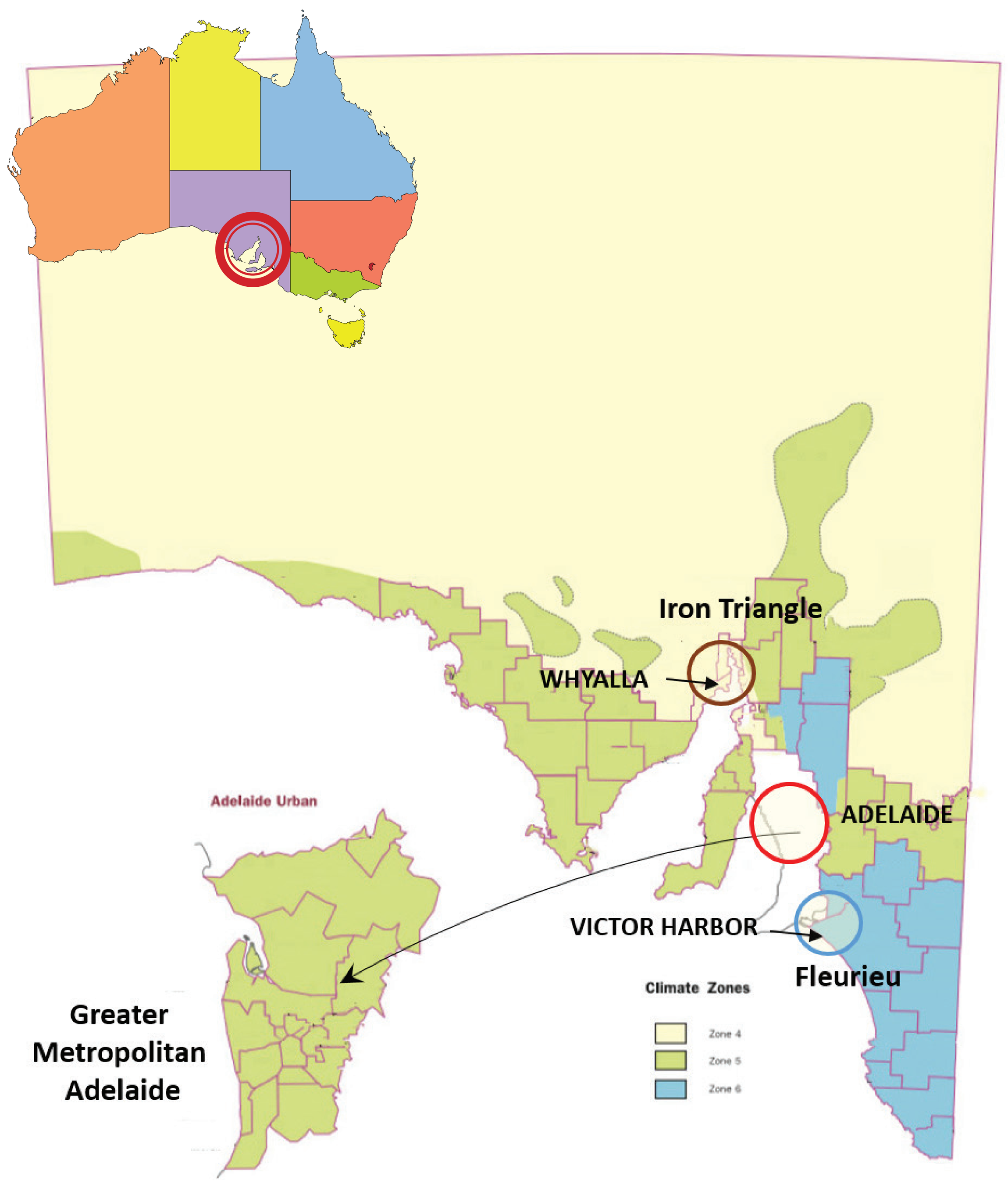
occupant centric models for older people, considering their personal characteristics and the conditions of their thermal environments;

TESTING AND VALIDATING

the performance of the models in predicting thermal comfort and wellbeing;

DEMONSTRATING

how design guidelines can be developed by the application of occupant centric models for older people’s houses.



4 STUDY DESIGN

9 MONTHS from January to October 2019, covering summer and winter.

57 HOUSEHOLDS, in South Australia, in 3 different climate zones.

71 PARTICIPANTS, aged 65 or over, living independently.

+5000 SURVEY ANSWERS in total, so far.

Questionnaires and check-lists

Thermal comfort survey tablet

Indoor environment data loggers

5 MODELLING PROCESS

The conceptual framework that guides this project is based on the work of Kim et al. (2018).

ENVIRONMENTAL/ BEHAVIOURAL CONDITIONS
THERMAL SENSATION VOTE

Temperature, radiant temperature, relative humidity, air speed, activity level, clothing insulation level, thermal sensation on a 7-point-scale

MACHINE LEARNING MODEL

Feedforward Neural Networks or Multilayer Perceptrons (MLPs) (Goodfellow et al., 2016)

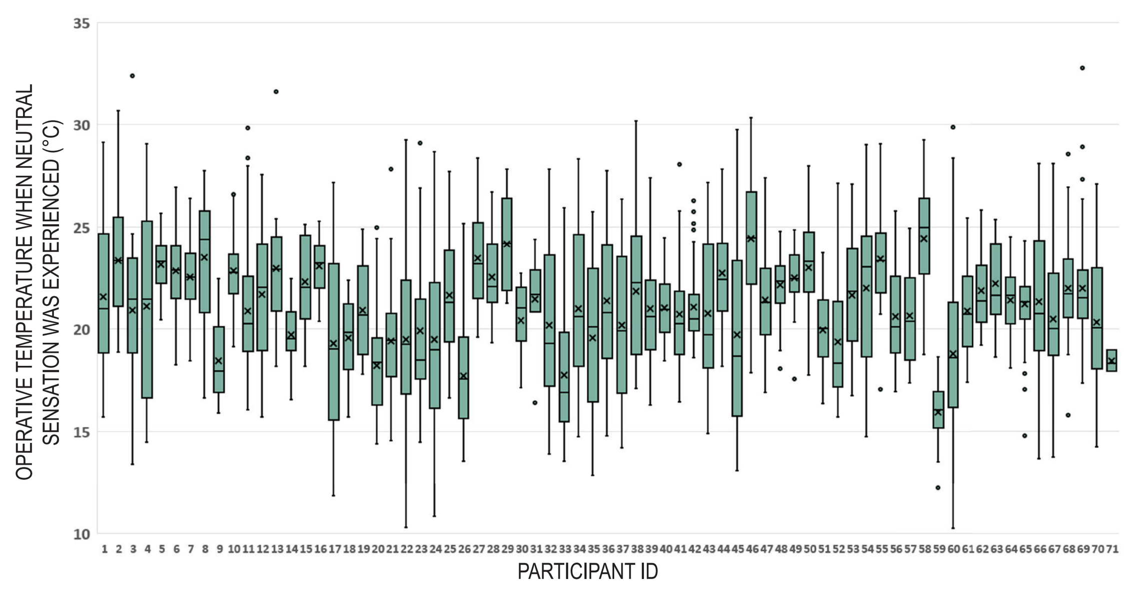
Multiclassification problem

f(x)

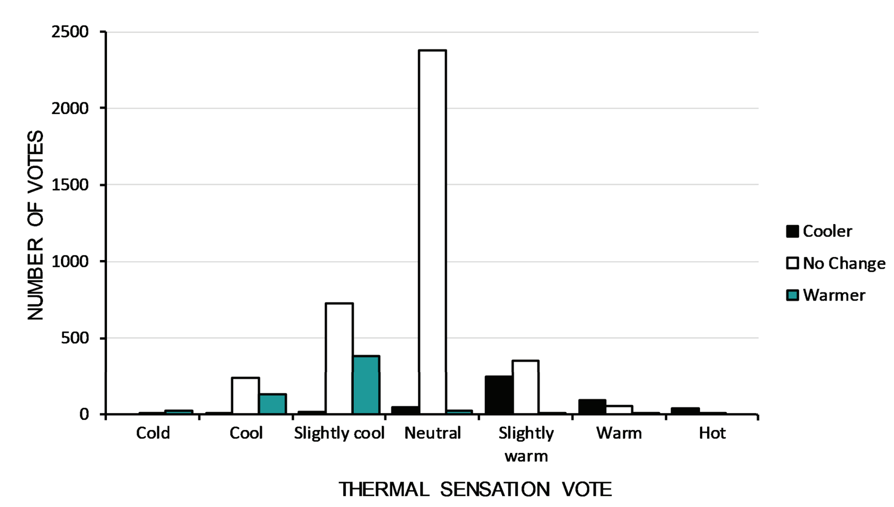
COMFORT AND WELLBEING PREDICTIONS

Predict participant’s thermal comfort sensation and their wellbeing for each combination of environmental and behavioural conditions.

6 PRELIMINARY RESULTS



The range of neeutral temperatures among older people varies greatly.



Thermal neutrality and thermal preference for ‘no change’ are not the same.

On average, the MLPs models for the 4 participants analysed so far improved predictions by 48% compared to the standard PMV models.

7 NEXT STEPS AND REFERENCES

TRAIN/TEST SPLIT

For this preliminary study, a random train/test split was used. A k-fold cross validation would better perform this split.

DATA SIZE

The sample size for the preliminary study was considered small, but it is expected to double by the end of the data collection period, which could potentially enhance the model’s accuracy.

ALGORITHM COMPLEXITY

Analysis was conducted using simplified Feedforward Neural Network techniques. This will be improved with a more complex and better tuned algorithm.

MODEL APPLICATION

The models’ application will be studied to enable more adequate design guidelines and thermal conditioning management for older people’s environments, targeting wellbeing and energy efficiency improvements.

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