Project Summary - LCC_2022_99

Computer vision applications to derive a spatial index of access to social services

Short title	The Urban Access Study		
Start date	16-Oct-2022	End Date	15-Oct-2023

Plain English summary

Rapid urbanisation presents challenges for the equitable delivery of services to disadvantaged populations, including access to public transport, education and health services. Governments are responding to rapid urbanisation by investing significantly in affordable housing, as illustrated by a $5.3 billion investment in Victoria, alone. A challenge with delivering such investment is the inability to provide equitable access to social services, especially as affordable housing is increasingly developed in the peri-urban areas of our cities. Our study will develop a novel approach and dynamic tool to assess access to transport, education and health services.

Relevance to Centre

The proposed study will support the Life Course Centre's vision and mission to improve the lives of Australia's most vulnerable people, by providing an effective measure of how where you live affects your opportunities. First, it focuses on disadvantaged populations in large metropolitan areas and enumerates access to important social services across the life course. Second, we will apply unique analytical methods not previously used to capture social service access. Finally, the application, when validated, is likely to have considerable application in planning social services across large urban agglomerations.

Centre program	Confidential?
2. Places	No

Project Information

Project background, approach and methodology

Background and Aim:
Rapid urbanisation presents significant challenges for the equitable delivery of services to populations around the world, including in Australia (United Nations Department of Economic and Social Affairs, 2018). Government and non-government agencies are increasingly aware of these challenges, but effective responses require the ability to observe and document rapid changes in both the built environment and the socio-demographic profile of a given location. Having the ability to do this would complement the array of government investments in affordable housing currently being implemented in Australia; for example, the ability to assess the equity of access to services associated with the Victorian State Government's "Big Housing Build". This would inform whether the policies and investments will perpetuate or mitigate disadvantage, with respect to important social services for vulnerable populations. We know, in relation to access to health services, recent urban gentrification has resulted in new amenities and services for increasingly affluent residents, while displacing poorer minority residents, whose usual health services have either closed or been replaced by services that are not publicly funded (Cole and Franzosa, 2022).

In a submission to the Australian Government, the Australian Human Rights Commission (2012) emphasised the importance of principles of equality and inclusion in service access. Since unequal access to services such as education, health and transport is reproduced spatially (Dikeç, 2001), applying spatially-derived indices that quantify access to services is paramount to achieving equitable service provision – particularly for populations with long-term experiences of social and economic disadvantage.

Until now, modelling access to social services has not taken account of the dynamic nature of services. The former models have well-defined benefits, such as their simplicity, transparency, ease of communication, and speed to deliver findings; however, they typically fail to capture real-world considerations, such as the variation in inputs and outputs over time or complex feedback mechanisms that arise when delivering a social service. Dynamic models have the ability to capture these elements and provide greater insight into the changing mechanisms involved in delivery of social services; however, they are time consuming and resource-intensive to develop, and findings can be difficult to interpret.

To overcome the constraints of these existing approaches, we propose a new approach which uses computer vision applications to assess access to social services. Computer vision applications process digital images and extract high-dimensional data from the real world to produce unique insights. In the proposed project, we will apply machine learning and neural network applications of computer vision to assess access to social services (specifically, education, health and transport services) in selected disadvantaged local government areas of Melbourne and Perth. Access to high dimensional longitudinal data arising from the Play Spaces and Environments for Children's Physical Activity (PLAYCE) Study (involving children aged 2-5 years at recruitment) in Perth, and the Household, Income and Labour Dynamics (HILDA) Study (involving households across Australia), will also ensure we can capture insights from across the life course. From the proposed approach, we will derive a spatially enhanced 'Social Services Access Index' that will have considerable utility.

Approach:
Recent advances in computer vision methodology have enabled analyses to be scaled efficiently over large areas. These analytical pipelines can ingest spatial data from different sources, including:
i) urban imagery, namely, satellite, aerial and Google Map imagery, and
ii) geographic information system (GIS) data in different layers, available from sources such as the Australian Urban Research Infrastructure Network (AURIN).

Additionally, and unique to our proposed approach, we will integrate micro-level analysis of individual record-level data; in the first instance, this will be from data attained as part of the Victorian Population Health Survey, the Western Australia Health and Wellbeing Surveillance System, PLAYCE

(Western Australia) and HILDA (Australia-wide) Studies. We propose to incorporate both spatial data (in the forms mentioned above) along with vector type data (such as demographic and social parameters). In conjunction, these pipelines perform analysis merging multiple distinct data sources covering both spatial and social elements as shown in Figure 1 (attached).

This analysis will lead to the development of a metric, the Social Services Access Index (SSAI), which captures the relative accessibility of social services within a given location. We intend to present the SSAI in a stratified manner, such that it captures varying priorities for social services across different life stages; the specificity of the SSAI will be enhanced by availability of high-dimensional data. Ultimately, for each defined geographic area would have a Child SSAI, an Adult SSAI and/or an Older Australian SSAI. For the purpose of this funding round however, we intend to develop a SSAI that is a composite measure of the various social services observed; however, an extension of this research under future grant funding could explore indices for specific services, such as health services and age strata.

Our objective approach to assessing access has enormous utility as it does not require observational research, but can capture dynamic changes in service access over time. It provides a metric which can be incorporated into decision-making tools, such as land use models which can inform significant policy initiatives; this tool would be invaluable to decision-makers responsible for delivering Victoria's "Big Housing Build" in which 25% of the funds are to deliver social housing.

Methods:
We will apply computer vision methods, namely deep learning with neural networks. This approach will involve an ensemble of computer vision models, operating in parallel to generate individual insights on different types of data (i.e. imagery, GIS data, population based surveys PLAYCE and HILDA data). Once this is modelled, we will aggregate the data and apply specific weights to develop the Social Service Access Index for selected geographic locations in Melbourne and Perth. The size of the spatial unit of analysis for the index (for example, 400 x 400 square metres) will be decided empirically, to provide the best balance between utility and granularity.

Once the Social Service Access Index (SSAI) is derived, it can be updated whenever needed and or when changes in the environment occur. After compiling relevant images across the selected socially disadvantaged urban locales, we will assess the level of intra- and inter-city variation in the SSAI – including exploring contrasts between areas with high levels of socio-economic disadvantage in inner-city and fast-growing outer suburban locations. The geographic focus will be determined in partnership with the National Growth Areas Alliance, incorporating insights on planned social infrastructure and social housing developments and existing indicators of locational (dis)advantage, (e.g. Socio-Economic Indexes for Areas).

Project description

Figure_and_References.pdf

Objectives

To integrate spatial data (urban imagery and geographic information system (GIS) data) and vector type data (sociodemographic parameters) to model access to selected social services in disadvantaged locations in Melbourne and Perth.

To derive a metric which reflects the relative accessibility of social services at an empirically determined spatial unit level (the Social Services Access Index).

To work with relevant stakeholders, including the National Growth Areas Alliance, and wider members of the Life Course Centre to refine the metric and consider its utility in guiding planning and decision-making.

Project deliverables

Output	Anticipated completion date
Finalise development of the Social Services Access Index and present findings to key stakeholders in Melbourne and Perth	31-May-2023
Submit journal article	31-Jul-2023
Knowledge translation output – training for the use of the SSAI	31-Aug-2023
Present method and SSAI at National Growth Areas Alliance 2023 symposium	31-Aug-2023

Anticipated project outcomes

The proposed research will derive a spatially-enhanced Social Services Access Index that could be adopted by LCC stakeholders in their various jurisdictions. We propose to host a final workshop to illustrate the value of the Index and the pragmatic application of its use for the partner on this grant, the National Growth Areas Alliance. We will also publish a paper on the methods and application of the derived tool and ensure that the LCC digital communication officer facilitates access to the tool via the LCC website. We anticipate that this project could serve as the basis for an element of a larger externally-funded study, such as an ARC Discovery Project.

Personnel

Type of team member	Name	Organisation	Percent time on project
Lead	Prof Mark Stevenson	The University of Melbourne	20
Investigator	A/Prof Hayley Christian	The University of Western Australia	10
Investigator	Dr Sachith Seneviratne	The University of Melbourne	20
Investigator	Dr Kerry Nice	The University of Melbourne	10

Type of team member	Name	Organisation	Percent time on project
Investigator	Dr Andrea Nathan	The University of Western Australia	10
Investigator	Dr Julia de Bruyn	The University of Melbourne	5

Are there students involved?	Name	Details of student involvement	Estimated date all staff appointed
No			16-Oct-2022

Data, ethics and intellectual property

Data accessed	HILDA	Other data sets	Urban imagery from Metromap; GIS data from AURIN; will also use PLAY Spaces and Environments for Children's Physical Activity (PLAYCE) Cohort Study	Estimated data access date	16-Nov-2022	Data management plan	true
Will your project generate data?	Yes			Data ownership / access rights	A/Prof Hayley Christian (Telethon Kids Institute, University of Western Australia (UWA)) owns the PLAYCE Cohort Study data set. A/Prof Christian will provide access to the dataset for the purposes of this research, once the UWA Human Research Ethics Committee amendment is approved (see below). Agreements are in place for Prof Stevenson and Dr Seneviratne and Dr Nice to access Metromaps for the purposes of research such as this. We will also be able to access data from AURIN. The SSAI, when developed will be a publicly available tool via the LCC. Such application could also be made available to AURIN for use by researchers across Australia		
What are the ethics requirements for your project?	Low, negligible risk application			Who will you apply to for ethics approval / exemption	University of Western Australia		
Please provide any other relevant ethics information	This project will not involve human participants, but will incorporate a longitudinal survey dataset owned by A/Prof Hayley Christian. We will apply for an amendment to the existing ethics approval through the University of Western Australia, to utilise the dataset in this project.			Estimated ethics approval date	16-Nov-2022		
Will people who identify as Aboriginal and/or Torres Strait Islander be the focus of the research or be identified as a discreet category in your analysis?	No						
Are you using background IP?	No						
Special arrangements?	No						
Is this a standard IP arrangement?	Standard						
Commercialisable?	Yes			A layered special index that could be incorporated into Land Use models used for planning, for example.			
Publication limitations?	No						

Resources

Project funding	Assets purchase?	Estimated assets expenditure amount	Funded Project title
No external funding – Centre funding and in-kind support only	false		