1) Project outline

Assessing and designing walkable environments using generative adversarial networks

The perception of urban form has various health and wellbeing impacts, for example, associations have been found with cardiovascular disease (Pereira et al., 2012), heat exhaustion (Smith and Levermore, 2008) and violent crime (Salesses et al., 2013). Urban form also significantly influences the frequency of active transport (Frank and Engelke, 2001) providing health benefits through walking and cycling (Turrell et al., 2013). Streetscape features, such as the proportion of windows and street furniture (Ewing et al., 2016) and the perceived confinement of space and sense of intimacy (Yin and Wang, 2016) all affect the amount of pedestrian activity. Further, pavement conditions are related to physical activity levels, especially for elderly pedestrians (Stradling et al., 2007) along with the length, size and connectivity of pedestrian paths and accessibility to public transport. Consequently, various drivers of walkability have been identified in previous research albeit much of the research is limited to single case studies that cover small urban areas within cities. Until now, these limitations have been due to limitations in urban analytic approaches and data availability.

The availability of large streetscape datasets such as Google Street View (GSV) imagery now enables data-driven methods based on artificial intelligence to study walkability of large areas in a comparative approach for different cities globally. Among the data-driven approaches, specifically, generative adversarial networks (GANs) (Goodfellow et al., 2014) allow for image style transfer to transform, for example, daytime images to night (Isola et al., 2017). Further, recent research now allows for the transformation of high-resolution images (Karras et al., 2018). Using the recent advances in artificial intelligence and standardised global imagery we propose this unique project.

The objectives of the collaborative project are:

i) To use advances in artificial intelligence (AI) methods to identify and systematize the criteria for highly walkable urban environments in two international cities namely, Melbourne, Australia and Berlin, Germany;

ii) To explore the possibility of AI methods for generating amendments to streetscape design that is likely to increase walking in urban settings; and

iii) To develop a large project proposal based on the findings of the collaborative project to submit to an international funding agency.

2) Methods

We propose to undertake a comparative study of two cities namely, Berlin and Melbourne to assess the perception of the urban environment regarding walkability. The GSV will be stratified by urban structure to ensure we attain sufficient randomly selected streetscapes from varying urban structure types, e.g. densely built high-rise inner-city areas through to single-family homes in residential areas in Berlin and Melbourne. The perception of the urban environment will be quantified by rating Google Street View (GSV) images using Amazon Mechanical Turk where online workers will be paid to label 50,000 GSV streetscapes in Berlin and Melbourne for conduciveness to walking. This provides a direct link between the streetscape and human perception of walkable streetscapes. After ranking images from least to most walkable, the images will be split into two domains to train a high-resolution Generative Adversarial Network (GAN). The GAN is then used to translate streetscape images with low perceived walkability to streetscapes perceived to be highly walkable. The results of the GAN will be computer-generated design interventions that provide amendments to the urban environment to improve walkability. Importantly, by feeding translated images back to

workers in Amazon Mechanical Turk, the improvement in perceived walkability will also be quantified, validating the results of the experiment.

3) Expected Outcomes:

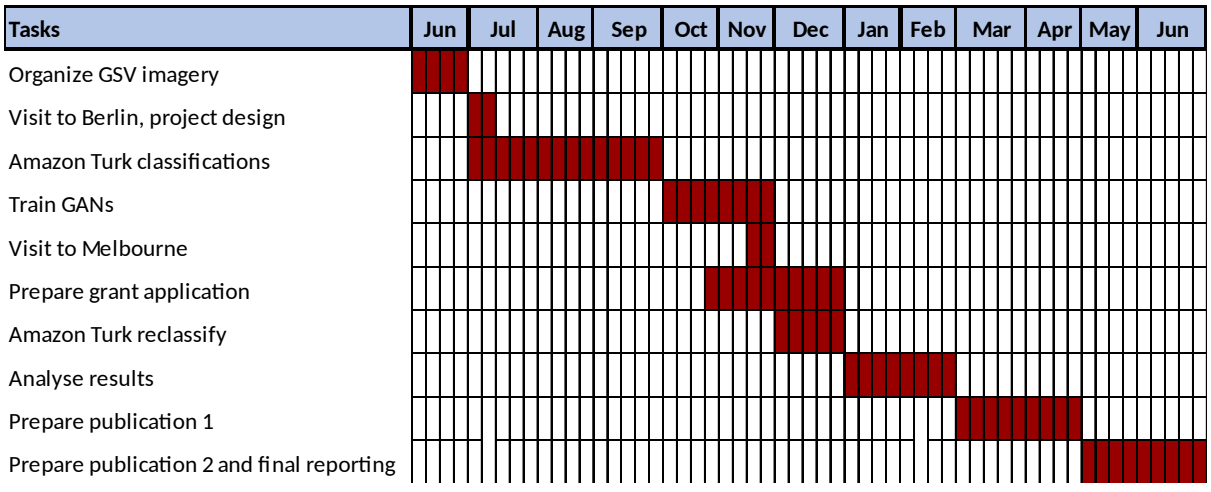
Research outcomes: we anticipate a number of peer-review publications will be developed from objectives 1 and 2 including papers on the i) criteria for enhancing the walkability of urban environments in two international cities and ii) evaluation of AI methods for generating amendments to streetscape design that enhance walkability in urban settings. A number of joint conference papers will also be submitted.

Attracting future funding: The collaboration and the outcomes of the proposed project will be integral to a large international grant that will be submitted in Q4 2019 to the Wellcome Trust in the United Kingdom. Professor Stevenson will lead an international consortium of academics across the United Kingdom, the United States, Europe, Asia and Australasia as part of the Wellcome Trust's Our Planet, Our Health initiative. The initiative will focus on cities and population health and we anticipate a grant budget of approximately £15m.

Collaboration combines mutual areas of interest and builds research capacity: the two research groups collaborating on this project namely, the Transport, Health and Urban Design Research Lab in the Melbourne School of Design, The University of Melbourne and the ??? in the School of Geography, Humboldt University are combining resources to lead this innovative research project. The two research groups focus on similar research areas related to the modelling of health impacts of urban environments using machine learning. By sharing knowledge through this collaboration, it is expected that …….

We anticipate hosting research meetings in both Melbourne and Berlin. During each of the research meetings, we will host a student workshop on urban analytics. The visits will also be aimed at establishing joint PhD opportunities: Humboldt University has nominated three PhD students, while the University of Melbourne has nominated two PhD students to support this collaboration. Importantly, the research is being led by early-career researchers and doctoral students supported by internationally eminent professors.

4) Time Schedule:



5) Additional Resources:

Various additional resources will be funded by the research labs at Humboldt University and the University of Melbourne, namely researcher salaries, secretary and project management, office space, computers, notebooks, and library access.

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