

# Cognitive Mobility and Place System (C-MAPS)

An AI-powered tool to revolutionise Urban Mobility Planning

## What is C-MAPS?

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The Cognitive Mobility and Place System (C-MAPS) is a sophisticated AI-powered analysis and forecasting model developed by Vivendi Consulting. It uses deep learning techniques, along with big data, to analyse current and predict future patterns of cycling and walking at a route / street / footpath level.

We believe this is the world's first tool to use AI to predict walking and cycling and understand how urban form influences people's movement.

## Why is it useful?

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The tool provides accurate evidence around how changes to our cities and transport networks alter people's walking and cycling behaviour. It allows city and transport planners to see how their designs will result in walking and cycling patterns at a street-by-street level.

The tool provides a vital 'feedback loop' to planners to help them design liveable, walkable cities and effective transport networks.

Cycle paths and footpaths cost millions of \$ per km, and face extreme levels of scrutiny. Investing a fraction of the capital cost to create a solution that is optimised for all road users, based on robust evidence will be a game-changer for urban and transport planning across the globe.

## Where has it been used?

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The model has been used on a range of projects across Sydney; some of these include:

- The Sydney Opera House to Parramatta Foreshore Link, a 91km long route covering nearly 10,000 links. This includes centres such as Glebe, Annandale, Rozelle, Five Dock, Canada Bay, Rhodes, Rydalmere and Parramatta
- North Sydney
- Westmead
- Bondi Junction
- Bondi
- Bondi Beach

- Waverley

## What do clients think about it?

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Some example client feedback on projects where we've used C-MAPS:

*"There is no other model like this in the world."*

*"Very good capabilities applied to a very challenging project"*

*"Went above and beyond to make sure that the process and product were completed to our satisfaction."*

*"The quality of the report was great"*

## How accurate is it?

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The model predicts with an accuracy of between 80% to 90%<sup>1</sup>. This is exceptional, and significantly higher than traditional transport modelling methods.

## What transport modes does it cover?

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It is currently trained to forecast walking (which is the key indicator of 'placemaking'), and cycling.

Other modes (car, bus, train) are in development. Once this is complete C-MAPS will provide an AI basis for all transport modes. This will provide a complete picture of mobility in a city, and finally an accurate evidence base and tool to optimise cities to balance the need for connection and movement with the need for 'place' and liveability.

## Why was the tool created?

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1. Our frustration at the lack of available models to understand and predict walking and cycling.
2. Major investments need a strong evidence base to justify walking, cycling and placemaking enhancements.
3. The challenge of solving 'wicked' problems; in this case, by using AI in a highly innovative way

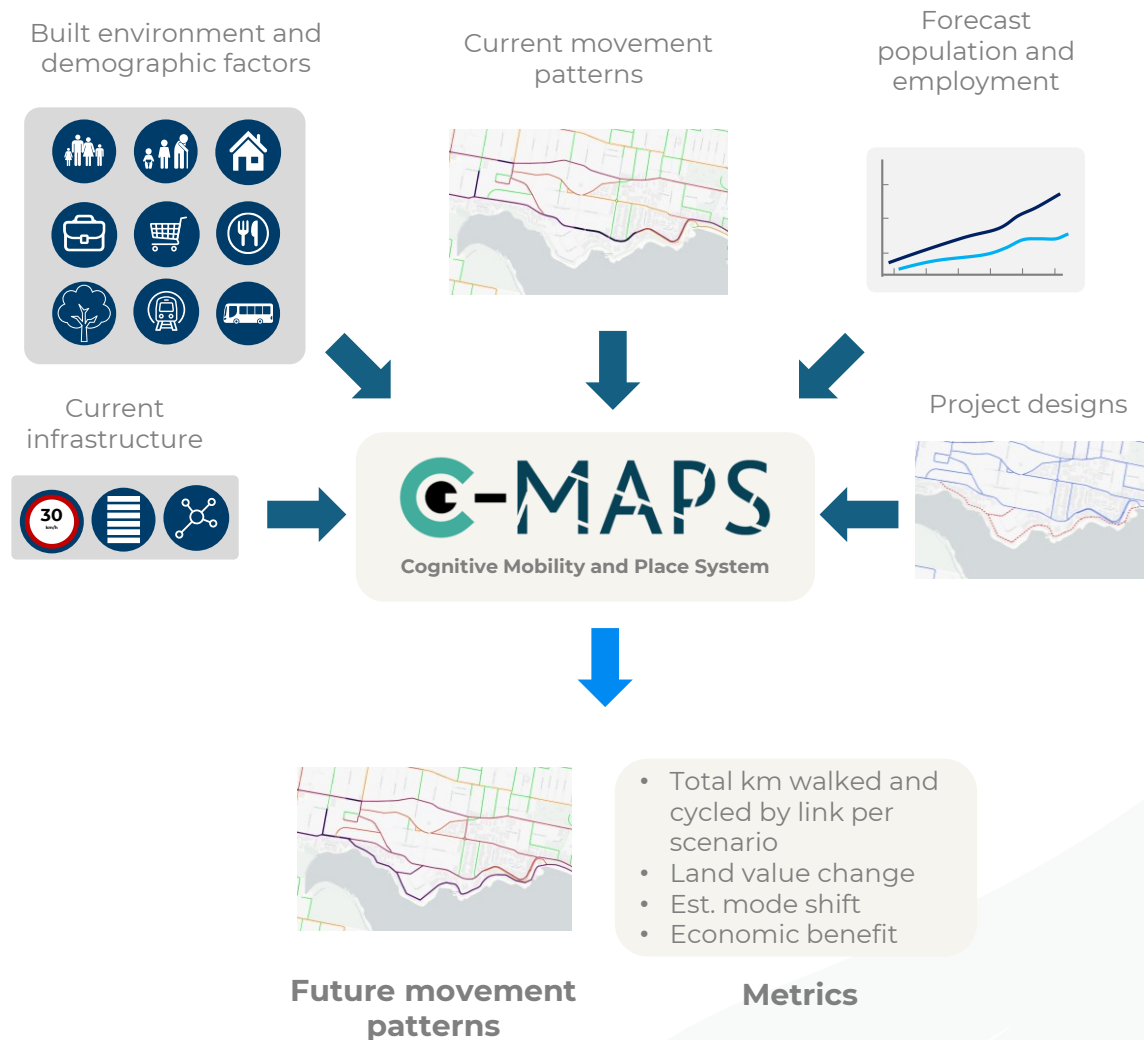
We wrote the Walking Strategy and Cycling Strategy for New South Wales in Australia, and realised quickly that there is a large gap in the field of macro- and meso-level transport models. In a world where every city is considering how to

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<sup>1</sup> C-MAPS has a Mean Average Percent Error (MAPE) of typically around 80% - 85% and an R<sup>2</sup> of over 90%. This validation is calculated after the model training process, and the quoted accuracies have been achieved in work on multiple centres around Greater Sydney,

become sustainable and encourage healthy citizens, this is a significant hole – and in a world with big data and AI, we wanted to create a tool to address this.

## How does it work?



C-MAPS has been trained to understand the relationship between actual walking and cycling and the dozens of factors that determine this activity. These factors typically include:

- Number, type and spatial location of cycleway and footpath connections
- Land use and built environment
- Population and employment
- Housing type
- Public transport provision e.g. train stations and bus stops
- Other points of interest e.g. cafes, restaurants, gyms, museums
- Population demographics

- Proximity to attractive 'green and blue' areas such as parks, lakes, harbour etc.
- Pedestrian and cycle crossings, signal timing
- General traffic volumes

This model training has been conducted across Sydney, ongoing over the last 2 years. The training data that is used will depend upon the area that the model is being used to compare 'like for like' centres. The model's predictions are tested using withheld test data, to validate the model's accuracy.

The model is then shown future scenarios – notably any new urban designs, along with expected population and employment growth. The model provides accurate, route-based forecasts of walking and cycling patterns based on the new design.

The model will shortly also be able to provide car, bus and train patronage; this functionality is currently in development.

## What AI technology does it use?

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- **Deep Learning:** a sophisticated machine learning technique that involves creating neural networks with many layers. These layers are capable of learning features and patterns from data by progressively extracting and combining lower-level features into more complex patterns. Deep learning models can automatically learn representations from a range of types of data (such as images, qualitative values or text) without requiring manual feature extraction.
- **Computer Vision Techniques:** a field of AI that enables computers and systems to derive information from digital images of streets, footpaths and cycle paths.
- **Convolutional Neural Networks (CNNs):** a class of deep neural networks, that are extremely capable at tasks such as image recognition, classification, and object detection. CNNs are designed to automatically and adaptively learn spatial about features from input images – such as cycleways and footpaths.
- **Other Deep Learning Architectures:** the model draws on a number of other deep learning techniques. These help to ensure that the final output is as accurate as possible.

## How many routes / links can it forecast?

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As many as required. Even building a single new cycleway will have affects across the transport network. Typically there are hundreds of links that can experience some (even minor) impact. For one project, the model analysed and predicted **nearly 10,000 separate links.**

The benefit of using AI is that the model can analyse all of these as an integrated whole; it would be impractical to analyse these manually.

## What outputs does it provide?

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- **Heat maps** of current and future walking and cycling at route level. Future forecasts are based on both a 'do nothing' scenario and a range of project cases.
- **Total km walked and cycled** by year (with capability to model specific seasonal/ weekly travel patterns)
- **Total number of trips** by year with capability to model specific seasonal/ weekly travel patterns)
- Evaluation of the **impact of specific project changes**, separate from organic 'do nothing' population/employment growth
- Effect of **traffic signal timing** changes on cycling and walking volumes
- **Economic benefit metrics** to generate economic benefit analyses, including:
  - Total km walked and cycled
  - Expected mode shift from car
  - Monetised health benefits
  - Land value uplift
  - Uplift in place value<sup>2</sup>

## What data does the model need?

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It depends on the specific questions being asked. In general, C-MAPS can use as much (or little) data as is available. We generally find our clients have some real-world pedestrian or cycling counts in the study area which are typically sufficient for the model; if not, these are easily arranged.

C-MAPS can also normalise Strava data<sup>3</sup> (done carefully) to gain a picture of recreational walking and cycling. C-MAPS uses these various data sources to make accurate predictions about current walking and cycling across the centre, which are then validated with client SMEs.

C-MAPS can even analyse and evaluate cities for walking and cycling configuration and design 'standalone' – that is, without current walking and cycling estimates. This can highlight areas of the city that are generally poorly configured for walking and cycling, and can provide interesting highlights of where walking and cycling requires greater support.

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<sup>2</sup> The tool integrates with other detailed place-based analytical tools such as VASP and PERS

<sup>3</sup> Clients require a Strava Metroview membership, which is free of charge

## **Why is this different from existing tools?**

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Conventional transport models typically use a 4-stage approach that estimates:

1. How many trips there will be
2. Where these will take place
3. Which mode people will use
4. Assigns the total trips to each transport mode.

While these are widely used for car, bus and train, this approach doesn't work for active transport. This is because:

- Walking and cycling are done for complex reasons
- Trips can be very short and linked together
- People can (counter-intuitively) opt to take longer routes and more time.
- There are significant data privacy issues in tracking individuals; metal boxes (cars, buses) tend to be easier to count and track.

Our models don't know (or need to know) what people's origins and destinations are - but do know that, based on patterns found elsewhere in the city, walking and cycling can be accurately predicted by looking at each street and understanding how the design and features of the surrounding area, demographics and connections result in the amount of activity seen.

In effect, this is like playing the game 'Sim City' – if we know what a city looks like, what type of people live there and how our transport links are configured, we can accurately estimate and forecast the movement patterns on each street.

## **Can it be used for Placemaking / Place planning / Movement and Place studies?**

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Yes; it is the only model (of which we are aware) that provides reliable evidence for place-based improvements, at an accuracy well above conventional transport models.

## **What sort of uplift does it show?**

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Like all other transport modes, people will walk and cycle if the infrastructure is provided and well-designed. Depending on the project, C-MAPS forecasts uplifts anywhere from 2% to 300% growth for both walking and cycling.

## **How long does it take to provide analyses?**

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Anywhere from a few days to several weeks. A simple analysis of an area for which we already have trained the model could be a few days. More extensive analyses that look at a range of scenarios and forecasts, or for which more unusual projects are proposed, will take longer.

However, the benefit of AI is that the model is automated to analyse many routes, and to improve its accuracy even further as it is more widely used. As the model is used in different cities and countries, its predictive abilities will increase significantly.

## **Is it accepted by key decision makers in government?**

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Yes. C-MAPS and its outputs have been used on various business cases for the NSW government and has successfully undergone a range of assurance reviews. We undertake these regularly, and are happy to explain more about the model and its outputs as required.

## **Is this AI going to put people out of a job?**

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No. C-MAPS is designed to support human experts in creating better plans and making better decisions. It is emphatically intended to work in conjunction with experts by providing them with much richer data, information and feedback.

We also stress that any output from the C-MAPS model should be rigorously sense checked, ideally working in collaboration with our clients. AI is still evolving, and spending time to understand and challenge some of model's predictions, adopting some empirical scepticism, is always worthwhile.

## **Are there any ethical issues with using the AI in C-MAPS?**

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C-MAPS was built, and is operated, for a noble purpose: to enable people to make more objective decisions about our cities. Despite this noble intent, we acknowledge and are highly sensitive to any potential ethical issues – particularly where we are gathering a large volume of data about people and places.

We use measures to address this, including:

- ensure absolute confidentiality for individuals in our data collection
- sensitivity about, and measures to avoid AI bias around extrapolating from the current world into the future
- transparency: we work in a highly transparent manner with our clients. We are transparent about how the AI works, we conduct sensitivity tests, and are happy to acknowledge areas where we feel the analysis has to be treated with caution.

## **What's the difference between Vivendi Consulting's other model - PAWS - and C-MAPS?**

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We also have the Place and Walking System (PAWS) model. This works at an area or macro level, analysing the strategic factors that influence walking and cycling.

C-MAPS works at a 'micro' level on street- or route-level. We typically find that both macro- and micro- analyses work well together for clients.

## **Use cases**

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C-MAPS is the only tool (of which we are aware) that can provide high levels of accuracy to support the following use cases:

### **1. Planning urban centres and precincts**

C-MAPS (along with PAWS) diagnoses areas of cities that tend to suppress walking and cycling and highlight opportunities to enhance more walking and cycling.

The tool provides vital insights and predictions into how people will use urban space and transport networks. These unique insights can inform urban planning – from major long-term masterplans to smaller enhancements at a local level.

The tool enables planners to design precinct and place plan options that are optimised for all transport modes, or – increasingly – ones that are specifically designed to optimise walking and cycling.



C-MAPS provides a range of metrics and accurate heat maps showing how different place plans compare for walking and cycling.

## 2. **Planning a cycleway network:**

Urban and transport planners can use C-MAPS to plan and design cycleways – either at single route level or the long-term rollout of an entire network.

C-MAPS accurately predicts the volume of cycling on each new cycle route, and can analyse multiple scenarios about how networks could be developed, in a dynamic manner. The model is sensitive to connections into existing cycleways, with high density of current cycle networks a key variable in cycling demand.

## 3. **Developer plans and Planning Applications**

Real estate developers can use C-MAPS to develop specific plans for new developments. The tool outlines how urban form influences walking and cycling behaviour, enabling developers to design optimised pedestrian-friendly and bike-friendly spaces that are sustainable and vibrant.

C-MAPS also gives developers the evidence to present to decision-makers about how their designs will impact the urban environment. This is a vital tool to help provide evidence for increased, but better planned density, including identifying features that support 'density done well'.

## 4. **Business Cases**

C-MAPS is the only tool that provides accurate forecasts of walking and cycling, drawing on a wide range of variables. Councils and government agencies can therefore use C-MAPS to provide accurate and robust forecasts for how investment in better places and better cycle connections will generate benefits.

This provides the demand forecasts for business cases to propose projects, apply for grant funding, and quantify the potential benefits. The benefits include mode shift, health benefits and economic impacts. C-MAPS provides valuable evidence to justify investments in active transportation infrastructure. This helps secure funding and support from key stakeholders and decision-makers.

## 5. **Movement and Place Studies and Transport Plans**

Many cities have grown up in a car-centric world and are currently optimised for private vehicles. Any change to this optimal world will generally tend to impact private vehicles. Moreover, decades of conventional traffic modelling

has created an extensive evidence base that articulates how these change could negatively affect traffic. Conversely, there has been no reliable data that forecasts how projects could increase the uptake of walking and cycling.

These factors have led to a long-term imbalance in discussions around urban development and the tradeoffs between modes. Decision-makers (understandably) tend to favour stronger evidence.

C-MAPS provides the 'missing evidence' for how walking and cycling volumes could be enhanced in future. This enables a balanced discussion to take place to understand tradeoffs and impacts between different modes.

Note that we are not anti-car, but we are pro-evidence based decision and policy making.

## **6. Housing and urban form policy and prioritisation**

Our models (both PAWS and C-MAPS) contain an enormous amount of data about how land use in centres affects walkability – which is a key metric for 'place', liveability and hence economic productivity.

This data, and the relationships between them that the AI reveals provides a robust evidence base to enable logical decisions about housing development and density to be made.

For example, our work with PAWS shows that housing type is a key determinant of walkability: centres that have at least 70% of flats and apartments experiencing a notably stronger uplift in walking .

This allows decision makers to make informed, objective decisions about where to build greater density housing. The models can be used not just to forecast how greater density could generate more vibrancy, but the underlying data in the model – such as schools, doctors, train and bus services, parks – are invaluable to understand which locations have potential capacity for high density.

## **About Vivendi Consulting**

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Vivendi Consulting provide strategic decision support, operations improvement, complex program delivery and change management services – all underpinned by advanced AI-powered data analytics.

We have a reputation for delivering exceptionally challenging projects that require significant innovation and collaboration. We are proud to have delivered a number of ‘world first’ projects that have made a material difference to millions of people.

We recruit the highest-performing consultants who work in an environment designed to enable us to focus on client delivery without the distractions found in many firms.

We have over a decade’s experience of providing trusted advice, capability and delivery support to a range of clients, with a 100% record of client satisfaction.

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