

Advanced Topics in Social and **Geographic** Data Science

GPS data in transport research



Understanding travel behaviour

- urban transport systems and road networks worldwide are under pressure as a result of a rapid increase in private vehicle ownership and increasingly complex and fragmented travel patterns
- results: environmental costs of fossil-based vehicles, reduced accessibility, accidents
- transport studies: [understanding](#) movement of individuals as well as the interplay between transport and the built environment (e.g. TOD)

Travel demand management I

- traditional transport planning: more demand > more roads (but: [latent](#) or induced demand)
- at some point: realisation that increasing road infrastructure and improvements in car technology are not sufficient to address the transport problems
- shift from supply-side to demand-side transport planning (transport demand management)

Travel demand management II

- management of travel demand is not an undemanding task: "it heavily relies on the agencies' ability to accurately predict future demand, suggest viable improvements and shift the demand away from the automobile to more sustainable transportation modes like walking, biking and transit."
- accurate [individual-level](#) data necessary

Travel data collection

- obtaining accurate data is difficult
- traditional pen and paper survey methods: respondent burden, underreporting, costly administrative processes, variability of travel behaviour
- different challenges in different parts of the world (see Behrens *et al.* 2006, Behrens and Del Mistro 2010)

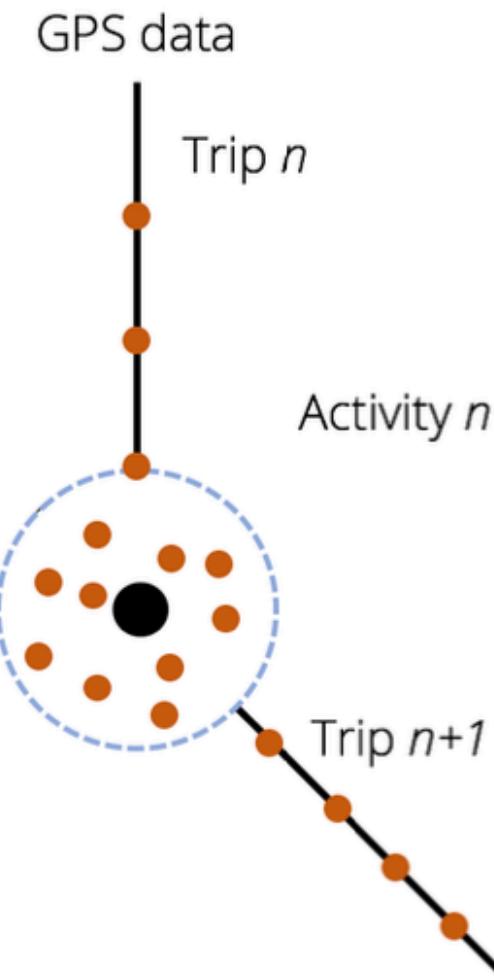
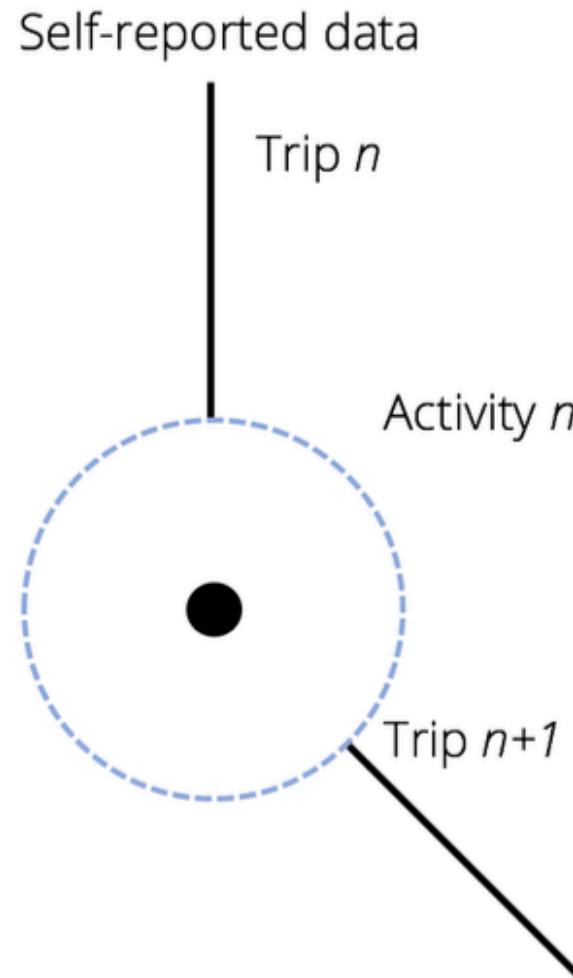
DAY 1	FIRST TRIP	SECOND TRIP	THIRD TRIP	FOURTH TRIP	FIFTH TRIP
1. WHEN DO I LEAVE?hours.....minutes <input type="checkbox"/> AM <input type="checkbox"/> PMhours.....minutes <input type="checkbox"/> AM <input type="checkbox"/> PMhours.....minutes <input type="checkbox"/> AM <input type="checkbox"/> PMhours.....minutes <input type="checkbox"/> AM <input type="checkbox"/> PMhours.....minutes <input type="checkbox"/> AM <input type="checkbox"/> PM
2. WITH WHOM DO I TRAVEL?	<input type="checkbox"/> Alone <input type="checkbox"/> Partner <input type="checkbox"/> Child(ren) <input type="checkbox"/> Others <input type="checkbox"/> How many person(s):.... 	<input type="checkbox"/> Alone <input type="checkbox"/> Partner <input type="checkbox"/> Child(ren) <input type="checkbox"/> Others <input type="checkbox"/> How many person(s):.... 	<input type="checkbox"/> Alone <input type="checkbox"/> Partner <input type="checkbox"/> Child(ren) <input type="checkbox"/> Others <input type="checkbox"/> How many person(s):.... 	<input type="checkbox"/> Alone <input type="checkbox"/> Partner <input type="checkbox"/> Child(ren) <input type="checkbox"/> Others <input type="checkbox"/> How many person(s):.... 	<input type="checkbox"/> Alone <input type="checkbox"/> Partner <input type="checkbox"/> Child(ren) <input type="checkbox"/> Others <input type="checkbox"/> How many person(s):....
3. WHICH MODE OF TRANSPORT DO I USE?	<input type="checkbox"/> Walk <input type="checkbox"/> Bicycle <input type="checkbox"/> Bus <input type="checkbox"/> Minibus <input type="checkbox"/> Train <input type="checkbox"/> Car (Driver) <input type="checkbox"/> Car (Passenger) <input type="checkbox"/> Other i.e.:.... 	<input type="checkbox"/> Walk <input type="checkbox"/> Bicycle <input type="checkbox"/> Bus <input type="checkbox"/> Minibus <input type="checkbox"/> Train <input type="checkbox"/> Car (Driver) <input type="checkbox"/> Car (Passenger) <input type="checkbox"/> Other i.e.:.... 	<input type="checkbox"/> Walk <input type="checkbox"/> Bicycle <input type="checkbox"/> Bus <input type="checkbox"/> Minibus <input type="checkbox"/> Train <input type="checkbox"/> Car (Driver) <input type="checkbox"/> Car (Passenger) <input type="checkbox"/> Other i.e.:.... 	<input type="checkbox"/> Walk <input type="checkbox"/> Bicycle <input type="checkbox"/> Bus <input type="checkbox"/> Minibus <input type="checkbox"/> Train <input type="checkbox"/> Car (Driver) <input type="checkbox"/> Car (Passenger) <input type="checkbox"/> Other i.e.:.... 	<input type="checkbox"/> Walk <input type="checkbox"/> Bicycle <input type="checkbox"/> Bus <input type="checkbox"/> Minibus <input type="checkbox"/> Train <input type="checkbox"/> Car (Driver) <input type="checkbox"/> Car (Passenger) <input type="checkbox"/> Other i.e.:....
4. I ARRIVE AT?	<input type="checkbox"/> Transport location (to question 5) <input type="checkbox"/> Activity location (to question 9)	<input type="checkbox"/> Transport location (to question 5) <input type="checkbox"/> Activity location (to question 9)	<input type="checkbox"/> Transport location (to question 5) <input type="checkbox"/> Activity location (to question 9)	<input type="checkbox"/> Transport location (to question 5) <input type="checkbox"/> Activity location (to question 9)	<input type="checkbox"/> Transport location (to question 5) <input type="checkbox"/> Activity location (to question 9)
TRANSPORT LOCATION					
5. MY TIME OF ARRIVAL?hours.....minutes <input type="checkbox"/> AM <input type="checkbox"/> PMhours.....minutes <input type="checkbox"/> AM <input type="checkbox"/> PMhours.....minutes <input type="checkbox"/> AM <input type="checkbox"/> PMhours.....minutes <input type="checkbox"/> AM <input type="checkbox"/> PMhours.....minutes <input type="checkbox"/> AM <input type="checkbox"/> PM
6. WHAT TYPE OF LOCATION IS THIS?	<input type="checkbox"/> Bus stop <input type="checkbox"/> Taxi stop/location <input type="checkbox"/> Parking lot <input type="checkbox"/> Station	<input type="checkbox"/> Bus stop <input type="checkbox"/> Taxi stop/location <input type="checkbox"/> Parking lot <input type="checkbox"/> Station	<input type="checkbox"/> Bus stop <input type="checkbox"/> Taxi stop/location <input type="checkbox"/> Parking lot <input type="checkbox"/> Station	<input type="checkbox"/> Bus stop <input type="checkbox"/> Taxi stop/location <input type="checkbox"/> Parking lot <input type="checkbox"/> Station	<input type="checkbox"/> Bus stop <input type="checkbox"/> Taxi stop/location <input type="checkbox"/> Parking lot <input type="checkbox"/> Station
7. WHAT IS THE ADDRESS / OF THE LOCATION?	Address Street Name	Address Street Name	Address Street Name	Address Street Name	Address Street Name
8. WHAT DO IT? (Check more than one if needed)	<input type="checkbox"/> Board / disembark / changeover <input type="checkbox"/> Drop / pick-up persons <input type="checkbox"/> Buy something	<input type="checkbox"/> Board / disembark / changeover <input type="checkbox"/> Drop / pick-up persons <input type="checkbox"/> Buy something	<input type="checkbox"/> Board / disembark / changeover <input type="checkbox"/> Drop / pick-up persons <input type="checkbox"/> Buy something	<input type="checkbox"/> Board / disembark / changeover <input type="checkbox"/> Drop / pick-up persons <input type="checkbox"/> Buy something	<input type="checkbox"/> Board / disembark / changeover <input type="checkbox"/> Drop / pick-up persons <input type="checkbox"/> Buy something
	TO NEXT TRIP	TO NEXT TRIP	TO NEXT TRIP	TO NEXT TRIP	TO NEXT TRIP
ACTIVITY LOCATION					
9. MY ARRIVAL TIME?hours.....minutes <input type="checkbox"/> AM <input type="checkbox"/> PMhours.....minutes <input type="checkbox"/> AM <input type="checkbox"/> PMhours.....minutes <input type="checkbox"/> AM <input type="checkbox"/> PMhours.....minutes <input type="checkbox"/> AM <input type="checkbox"/> PMhours.....minutes <input type="checkbox"/> AM <input type="checkbox"/> PM
10. WHAT TYPE OF LOCATION IS THIS?	<input type="checkbox"/> Home <input type="checkbox"/> Medical <input type="checkbox"/> Work address <input type="checkbox"/> Sport <input type="checkbox"/> Work related <input type="checkbox"/> Recreation <input type="checkbox"/> Child care <input type="checkbox"/> Cultural <input type="checkbox"/> School / Study <input type="checkbox"/> Church <input type="checkbox"/> Supermarket <input type="checkbox"/> Restaurant <input type="checkbox"/> Groceries <input type="checkbox"/> Friends/Family <input type="checkbox"/> Shopping <input type="checkbox"/> Public Park etc. <input type="checkbox"/> Others namely:....	<input type="checkbox"/> Home <input type="checkbox"/> Medical <input type="checkbox"/> Work address <input type="checkbox"/> Sport <input type="checkbox"/> Work related <input type="checkbox"/> Recreation <input type="checkbox"/> Child care <input type="checkbox"/> Cultural <input type="checkbox"/> School / Study <input type="checkbox"/> Church <input type="checkbox"/> Supermarket <input type="checkbox"/> Restaurant <input type="checkbox"/> Groceries <input type="checkbox"/> Friends/Family <input type="checkbox"/> Shopping <input type="checkbox"/> Public Park etc. <input type="checkbox"/> Others namely:....	<input type="checkbox"/> Home <input type="checkbox"/> Medical <input type="checkbox"/> Work address <input type="checkbox"/> Sport <input type="checkbox"/> Work related <input type="checkbox"/> Recreation <input type="checkbox"/> Child care <input type="checkbox"/> Cultural <input type="checkbox"/> School / Study <input type="checkbox"/> Church <input type="checkbox"/> Supermarket <input type="checkbox"/> Restaurant <input type="checkbox"/> Daily shopping <input type="checkbox"/> Friends/Family <input type="checkbox"/> Hardware <input type="checkbox"/> Public Park etc. <input type="checkbox"/> Others namely:....	<input type="checkbox"/> Home <input type="checkbox"/> Medical <input type="checkbox"/> Work address <input type="checkbox"/> Sport <input type="checkbox"/> Work related <input type="checkbox"/> Recreation <input type="checkbox"/> Child care <input type="checkbox"/> Cultural <input type="checkbox"/> School / Study <input type="checkbox"/> Church <input type="checkbox"/> Supermarket <input type="checkbox"/> Restaurant <input type="checkbox"/> Daily shopping <input type="checkbox"/> Friends/Family <input type="checkbox"/> Hardware <input type="checkbox"/> Public Park etc. <input type="checkbox"/> Others namely:....	<input type="checkbox"/> Home <input type="checkbox"/> Medical <input type="checkbox"/> Work address <input type="checkbox"/> Sport <input type="checkbox"/> Work related <input type="checkbox"/> Recreation <input type="checkbox"/> Child care <input type="checkbox"/> Cultural <input type="checkbox"/> School / Study <input type="checkbox"/> Church <input type="checkbox"/> Supermarket <input type="checkbox"/> Restaurant <input type="checkbox"/> Daily shopping <input type="checkbox"/> Friends/Family <input type="checkbox"/> Hardware <input type="checkbox"/> Public Park etc. <input type="checkbox"/> Others namely:....
11. WHAT IS THE ADDRESS?	Address Street Name	Address Street Name	Address Street Name	Address Street Name	Address Street Name
12. WHAT DO I DO HERE?	<input type="checkbox"/> Home business (To Home Dairy) <input type="checkbox"/> Paid work <input type="checkbox"/> Volunteer work <input type="checkbox"/> Drop / Pick-up persons <input type="checkbox"/> Drop / Pick-up goods <input type="checkbox"/> Other namely:....	<input type="checkbox"/> Home business (To Home Dairy) <input type="checkbox"/> Paid work <input type="checkbox"/> Volunteer work <input type="checkbox"/> Drop / Pick-up persons <input type="checkbox"/> Drop / Pick-up goods <input type="checkbox"/> Other namely:....	<input type="checkbox"/> Home business (To Home Dairy) <input type="checkbox"/> Paid work <input type="checkbox"/> Volunteer work <input type="checkbox"/> Drop / Pick-up persons <input type="checkbox"/> Drop / Pick-up goods <input type="checkbox"/> Other namely:....	<input type="checkbox"/> Home business (To Home Dairy) <input type="checkbox"/> Paid work <input type="checkbox"/> Volunteer work <input type="checkbox"/> Drop / Pick-up persons <input type="checkbox"/> Drop / Pick-up goods <input type="checkbox"/> Other namely:....	<input type="checkbox"/> Home business (To Home Dairy) <input type="checkbox"/> Paid work <input type="checkbox"/> Volunteer work <input type="checkbox"/> Drop / Pick-up persons <input type="checkbox"/> Drop / Pick-up goods <input type="checkbox"/> Other namely:....
	ON LEAVING THIS LOCATION GO TO FOLLOWING TRIP	ON LEAVING THIS LOCATION GO TO FOLLOWING TRIP	ON LEAVING THIS LOCATION GO TO FOLLOWING TRIP	ON LEAVING THIS LOCATION GO TO FOLLOWING TRIP	ON LEAVING THIS LOCATION GO TO FOLLOWING TRIP

GPS in transport studies I

- need for [better](#) data; also in recognition of travel being a derived demand and necessity of activity-based methods
- early 2000s: Global Positioning System (GPS) technology was introduced as a method for augmenting or (partly) substituting traditional travel surveys method
- one of first implementations of GPS: PhD dissertation by Jean Wolf (2000)
- developments followed the US lifting selective availability

GPS in transport studies II

- GPS offers several potential advantages for researchers to collect precise data on trip origin, trip destination, trip duration, trip timing, and route choice; also useful to corroborate quality of other data sources
- widespread availability of GPS-enabled personal devices ([smartphones](#))
- smartphones can source data as well as give real-time feedback
- potentially much more reliable than self-reported data



Challenges in GPS data collection

- any trip, activity details need to be [derived](#) from raw GPS trajectories (either full imputation from raw data or combination with user input)
- issues of privacy, battery life, accuracy, measurement frequency, urban canyoning



A **GHD** company

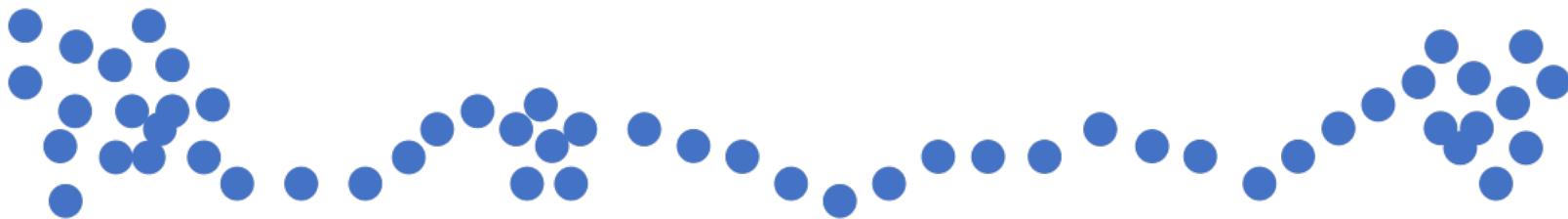
Inferring transport mode using GPS data

Partner: [Movement Strategies](#)

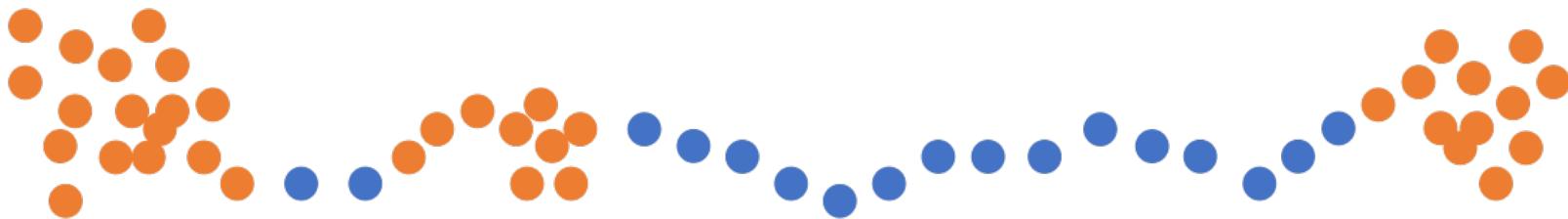
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[View Project Details](#)

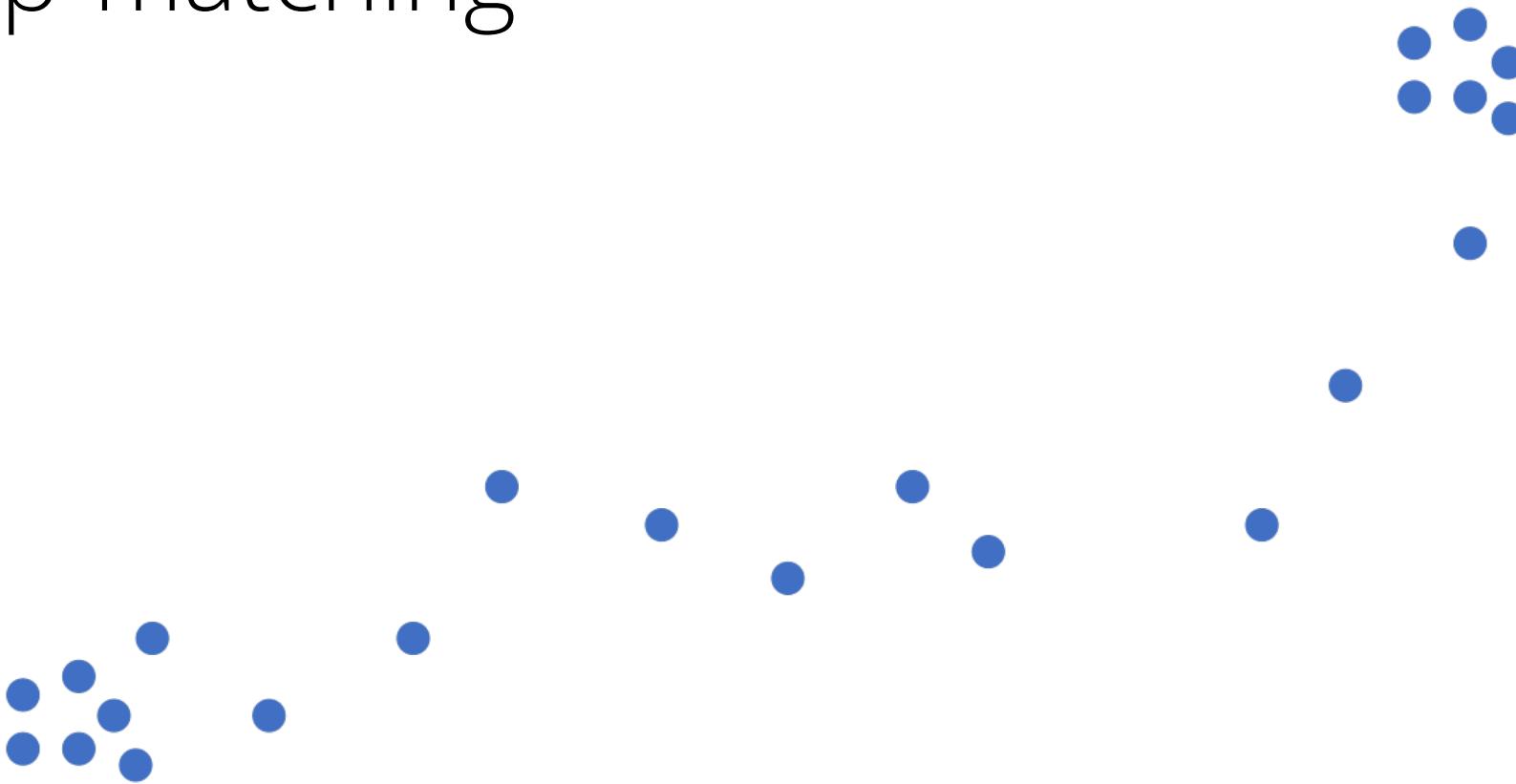
Identifying activities



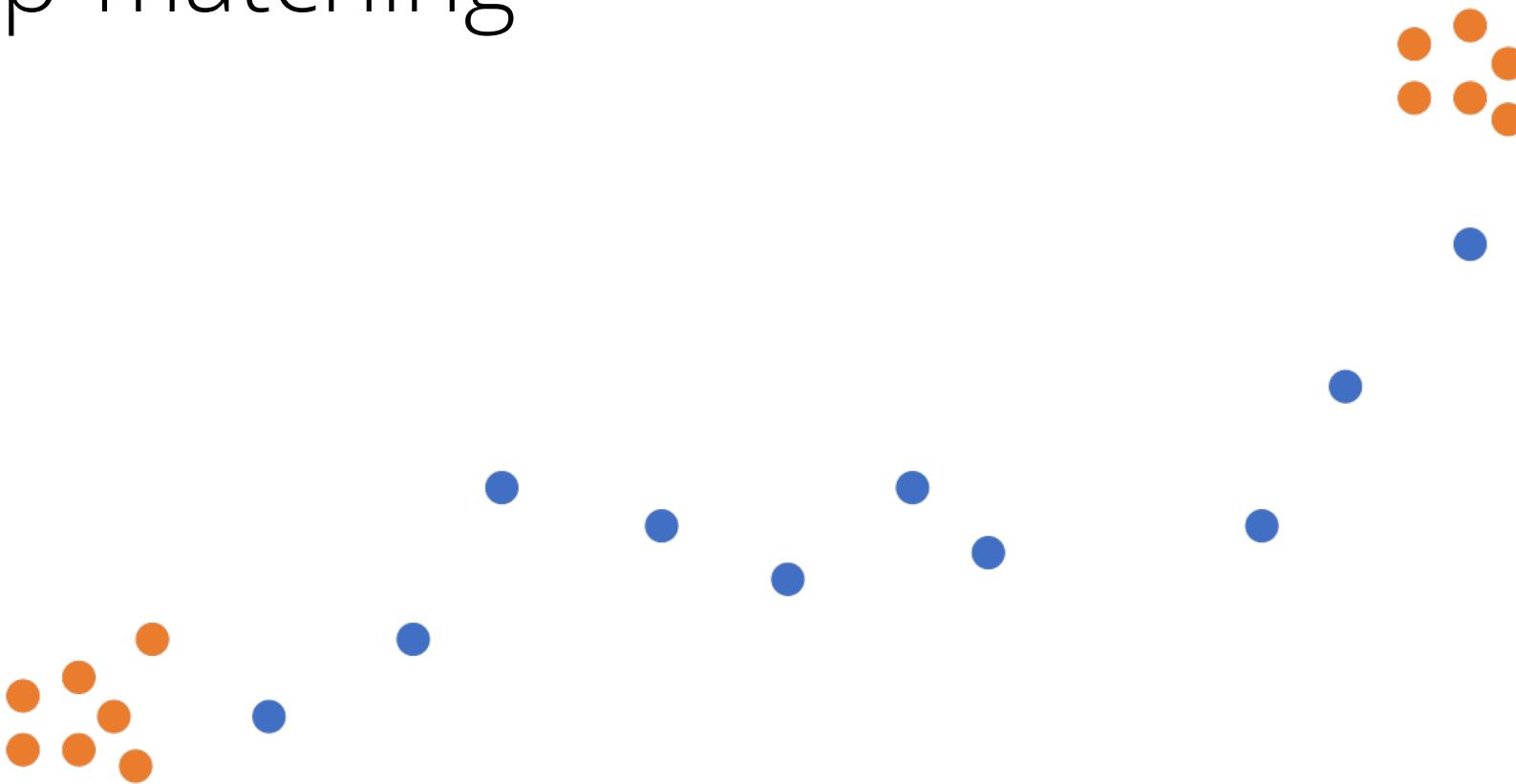
Identifying activities



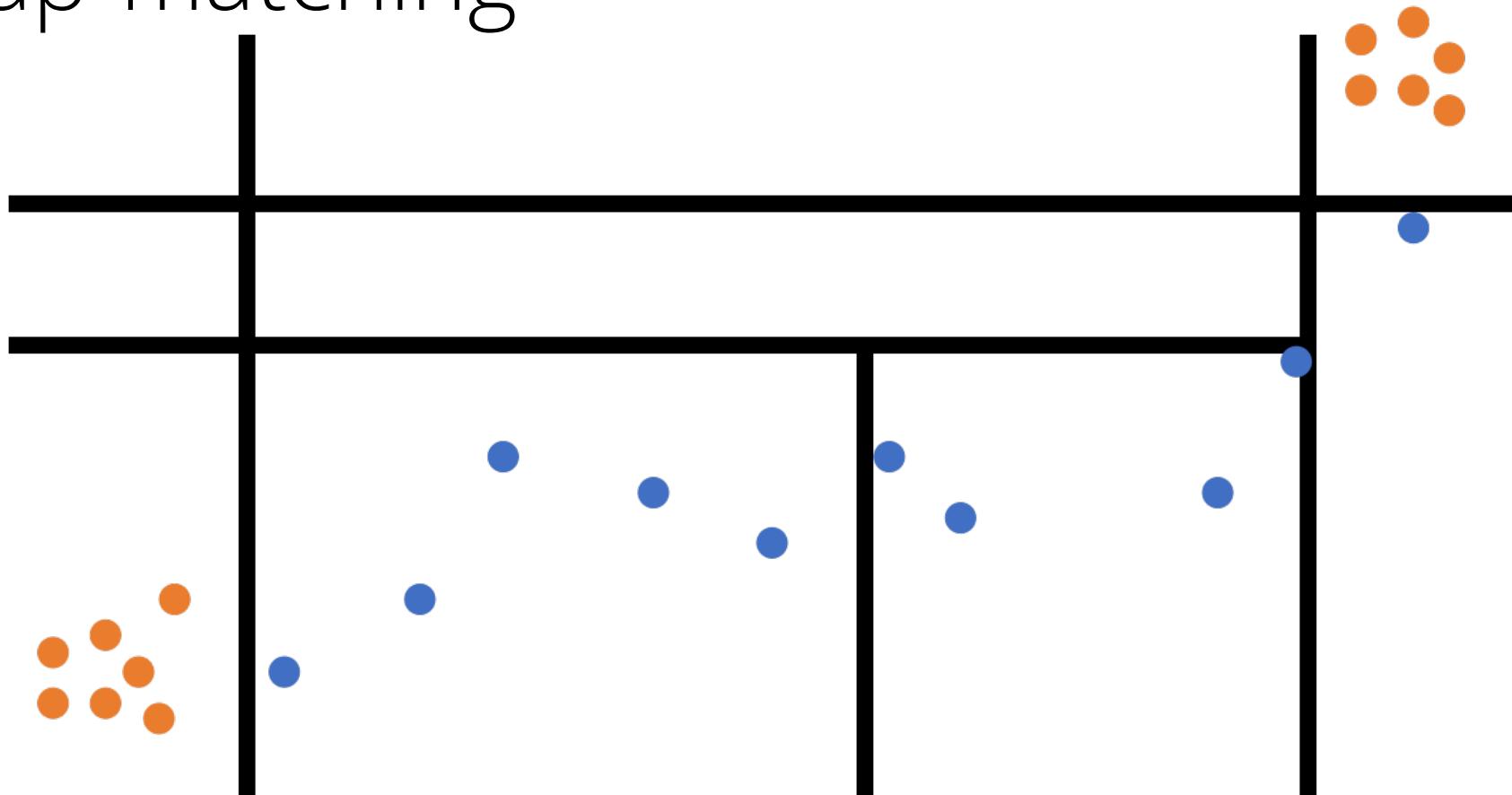
Map-matching



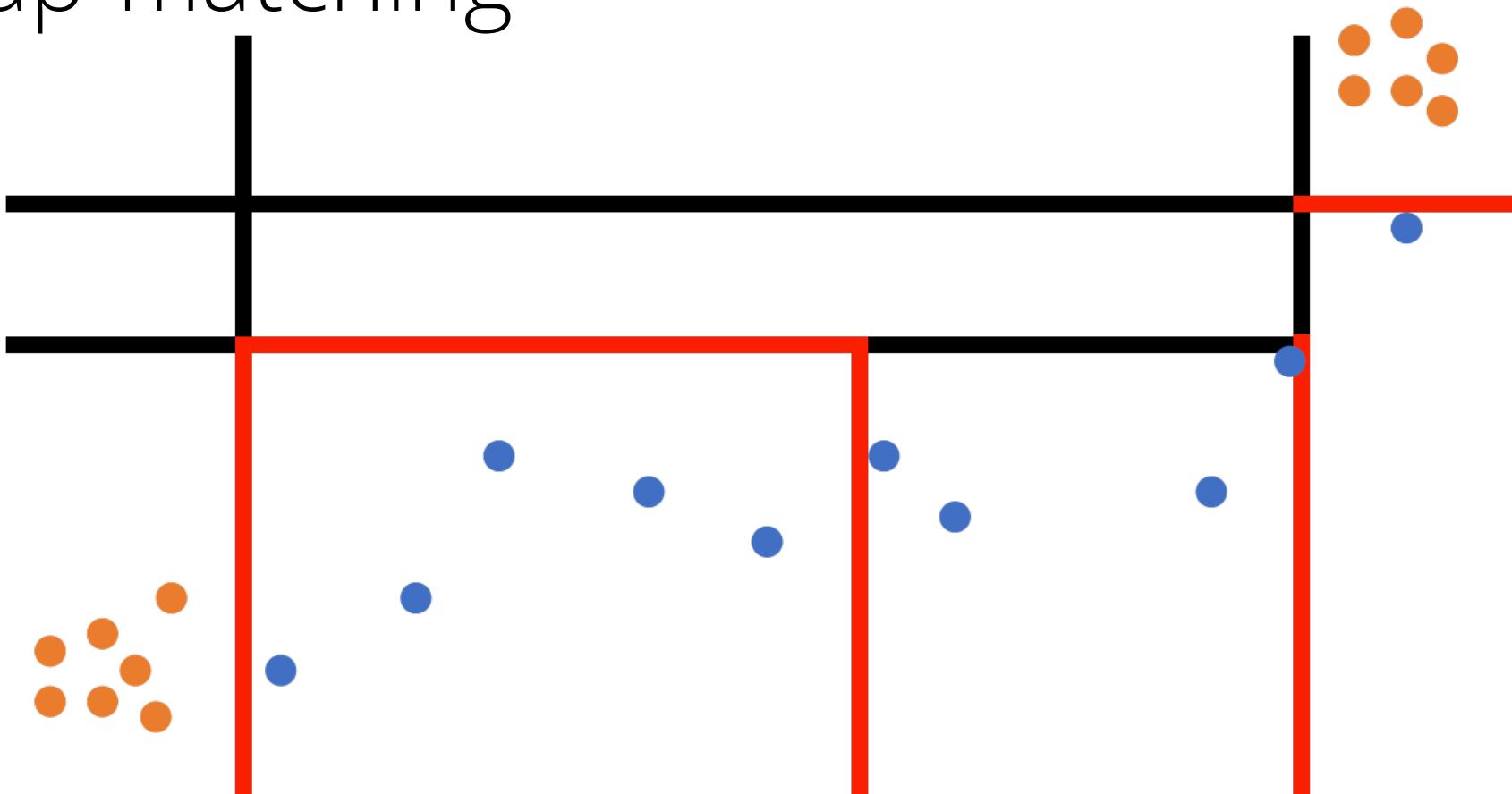
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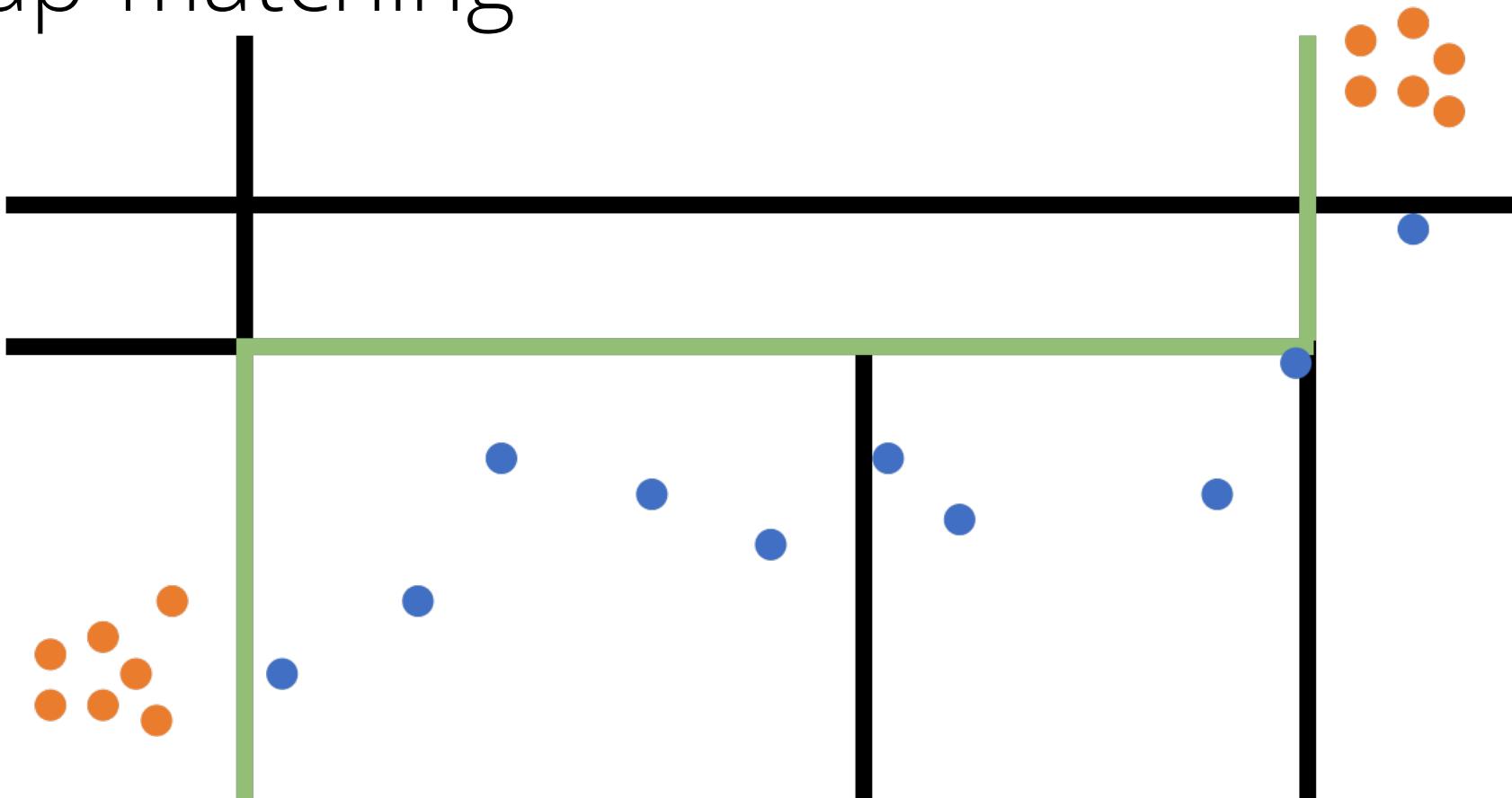
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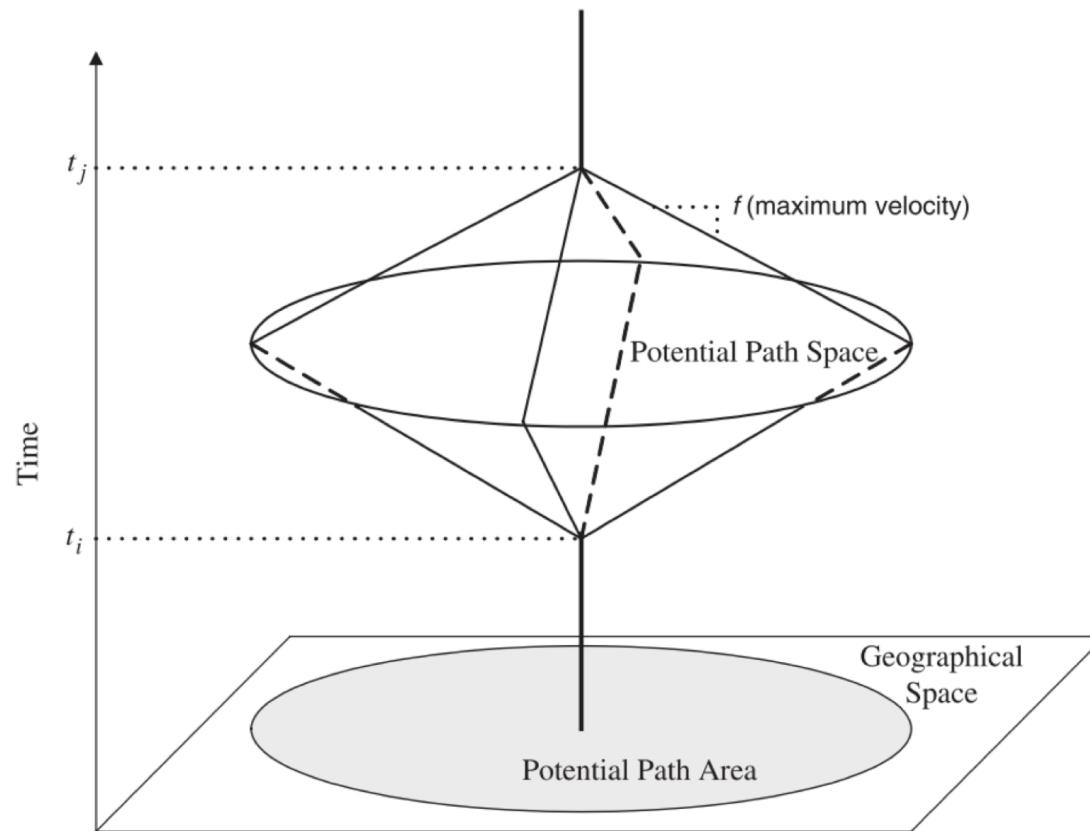
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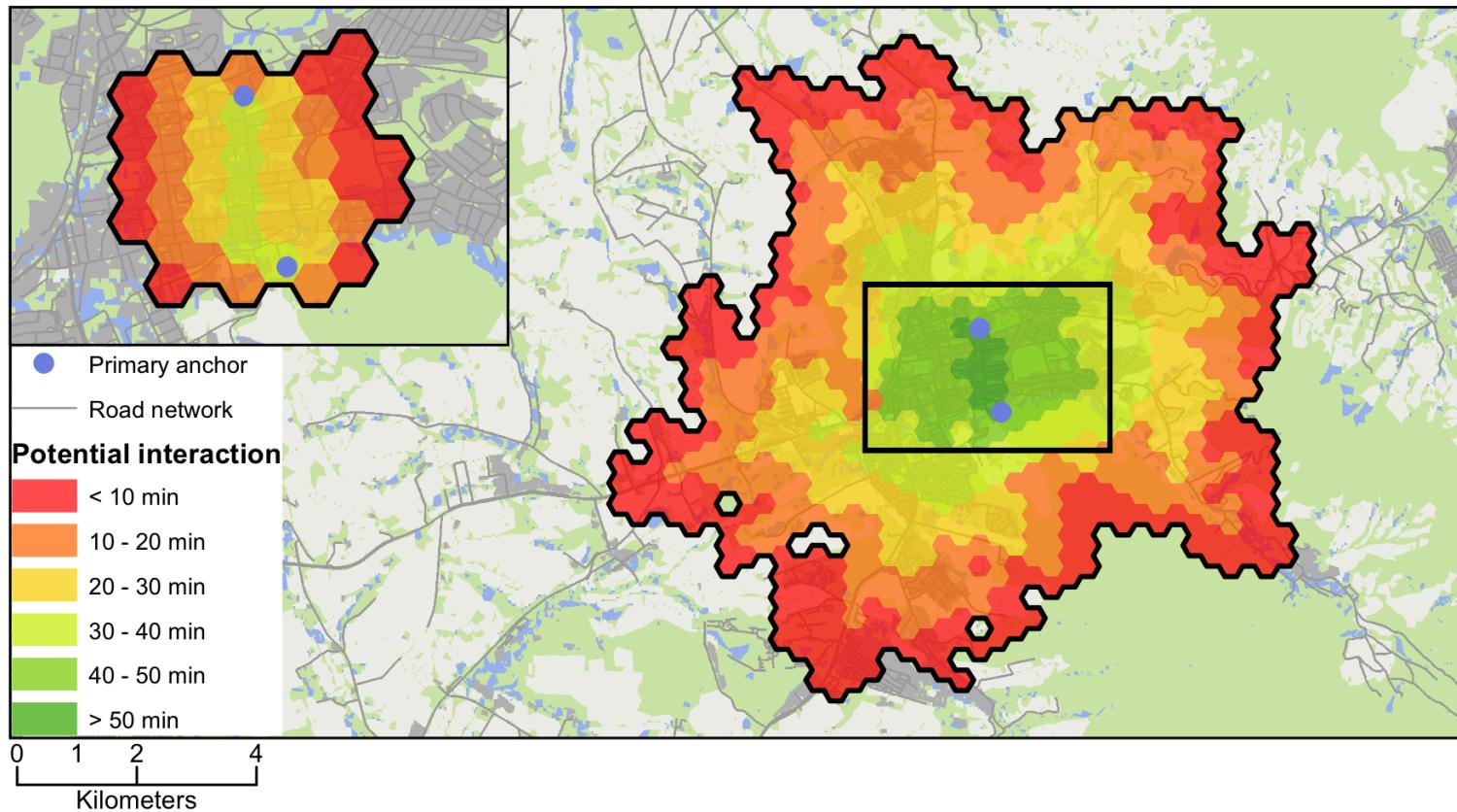
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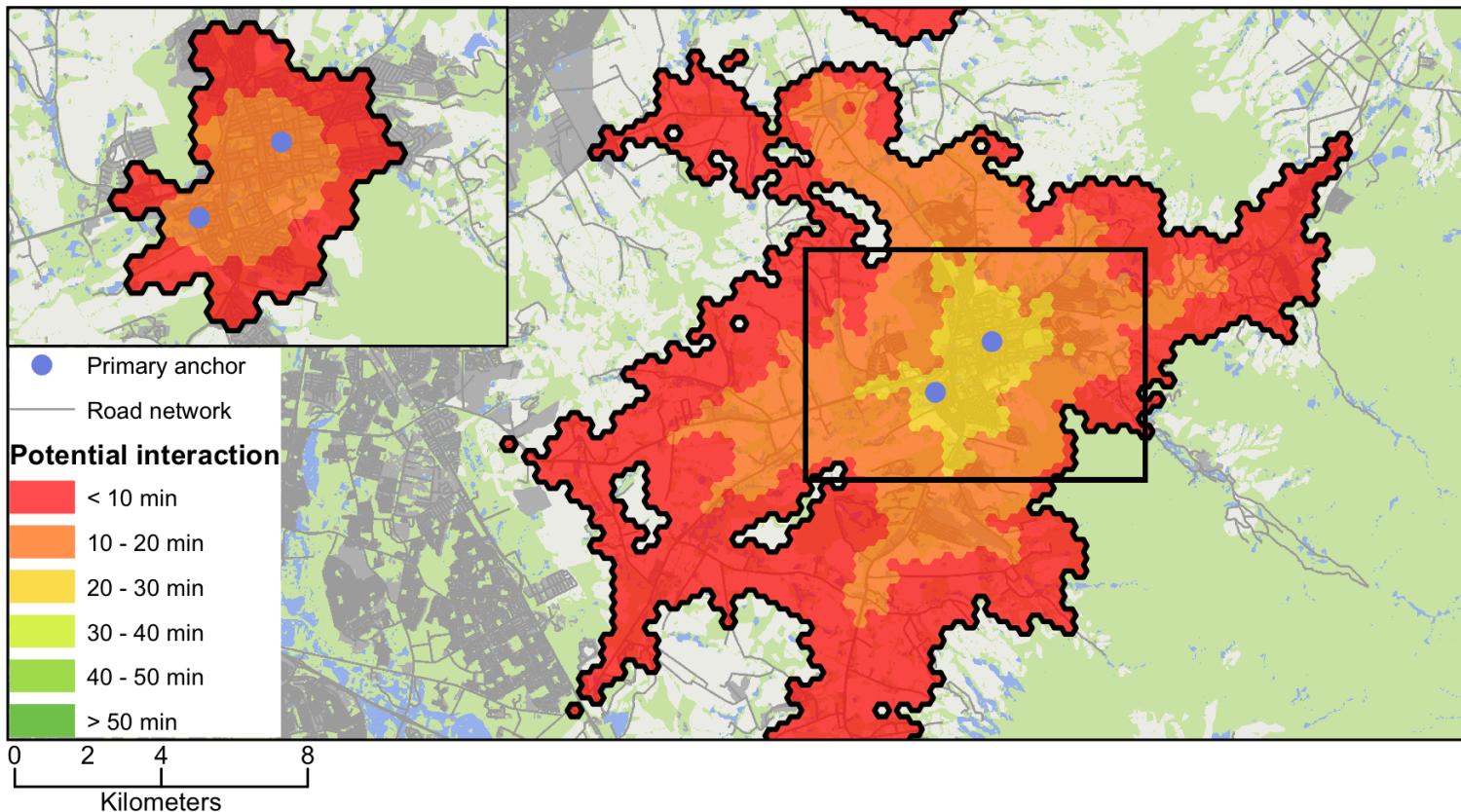
Potential for changing behaviour



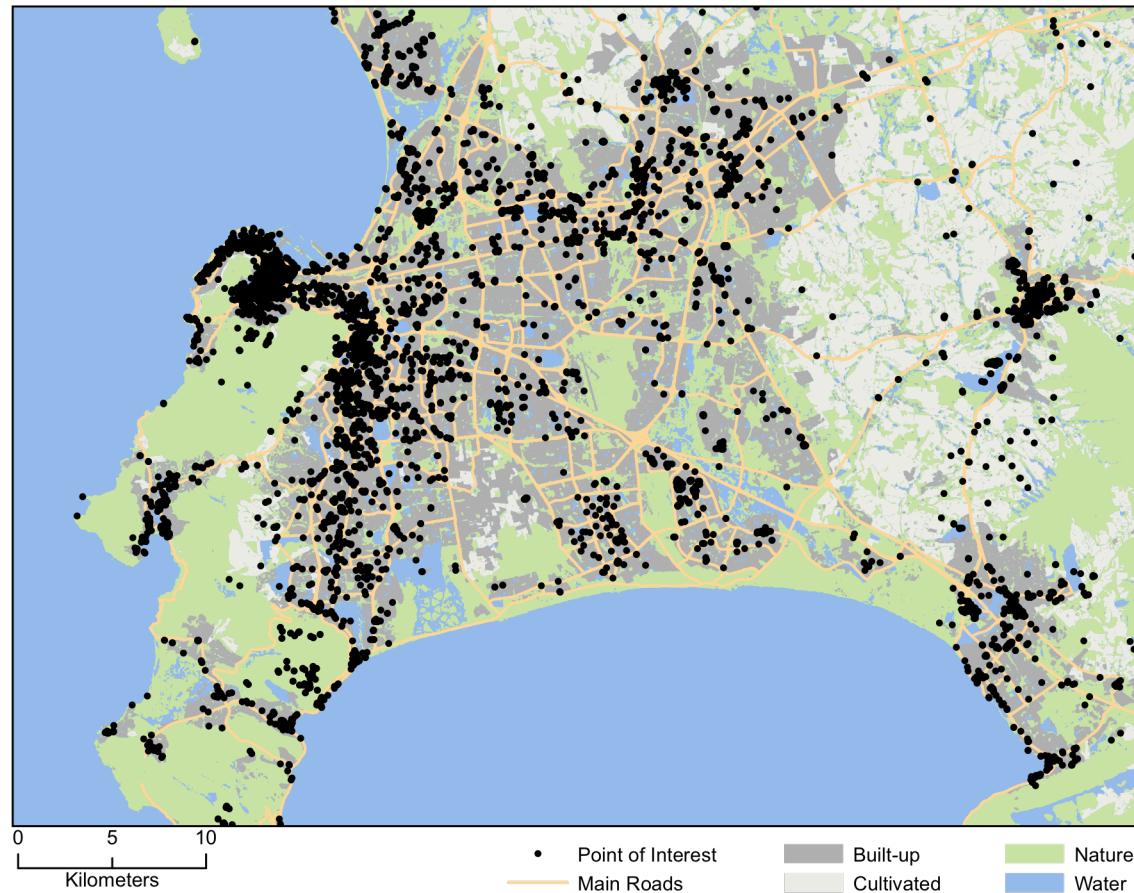
Potential for changing behaviour



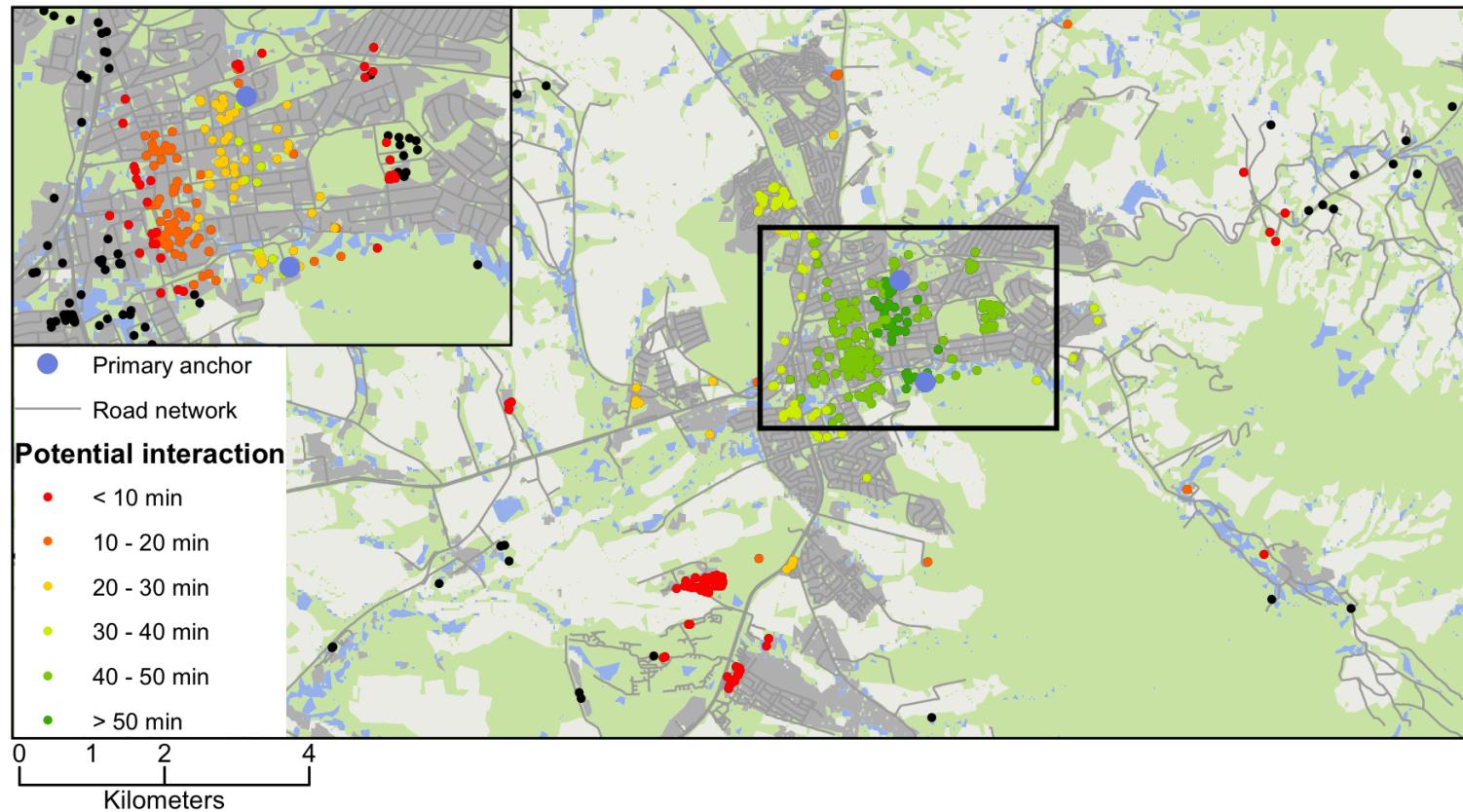
Potential for changing behaviour



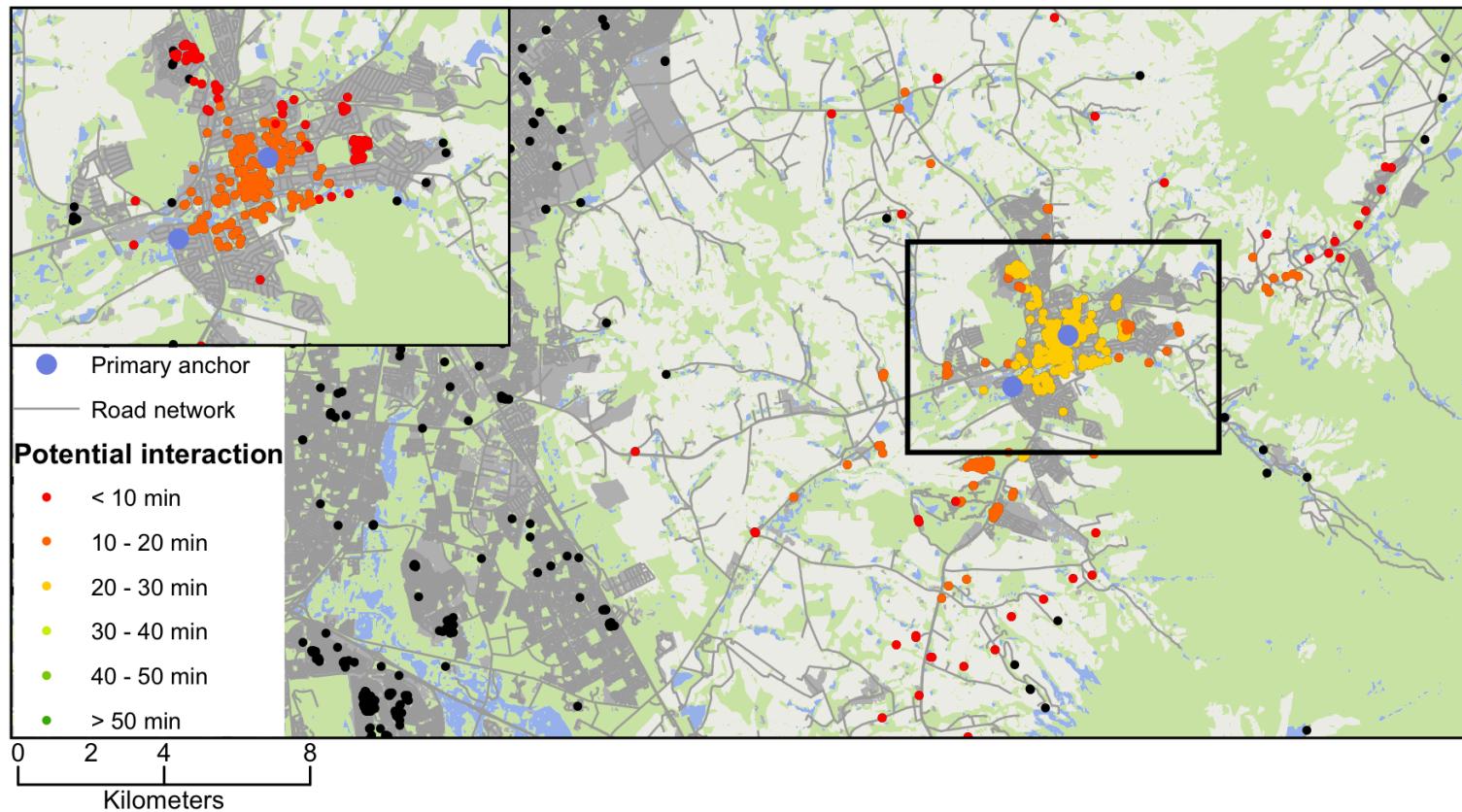
Potential for changing behaviour



Potential for changing behaviour



Potential for changing behaviour



Mode: car and bike (inset), window of 30 minutes

GPS data in transport research

- GPS can be used to collect data on individual travel behaviour
- much more detailed than activity diaries
- not without challenges; privacy, imputation of travel characteristics
- on top of 'normal' challenges (e.g. day-to-day variability of travel behaviour, seasonal impacts)