A Public Transit Routing Algorithm to Promote Active Travel and Mitigate Crowding for Future London

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1. Background

Figure 1 active travel contains walking and cycling

People's attitude: People tend to choose cycling and walking

Carbon emission: Governments encourage active travel, such as UK, Denmark and etc.

2. Challenges

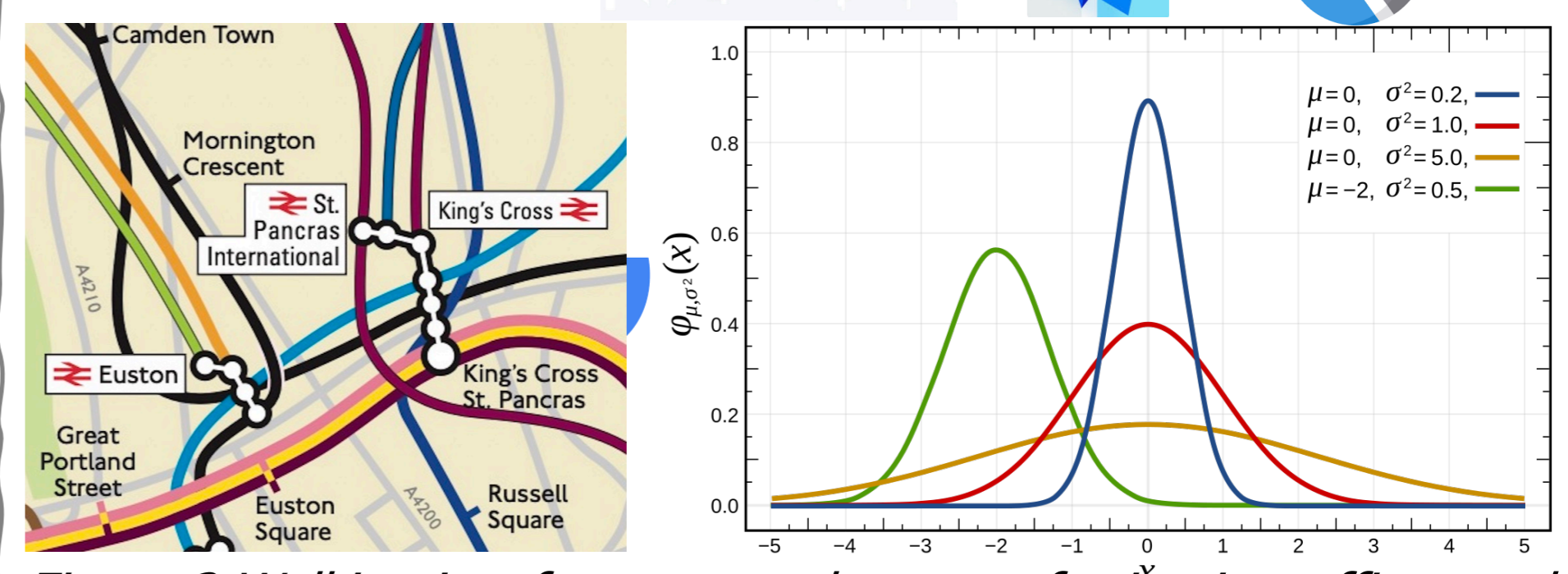Citymapper
Making Cities Usable

Figure 2 Walking is a faster way when transferring in traffic complex

Figure 3 Random crowdedness level
Most of the journey planning tools are based on the **time table searching** algorithm.
Timetable searching methods do not take walking in priority mode

3. What we are looking for

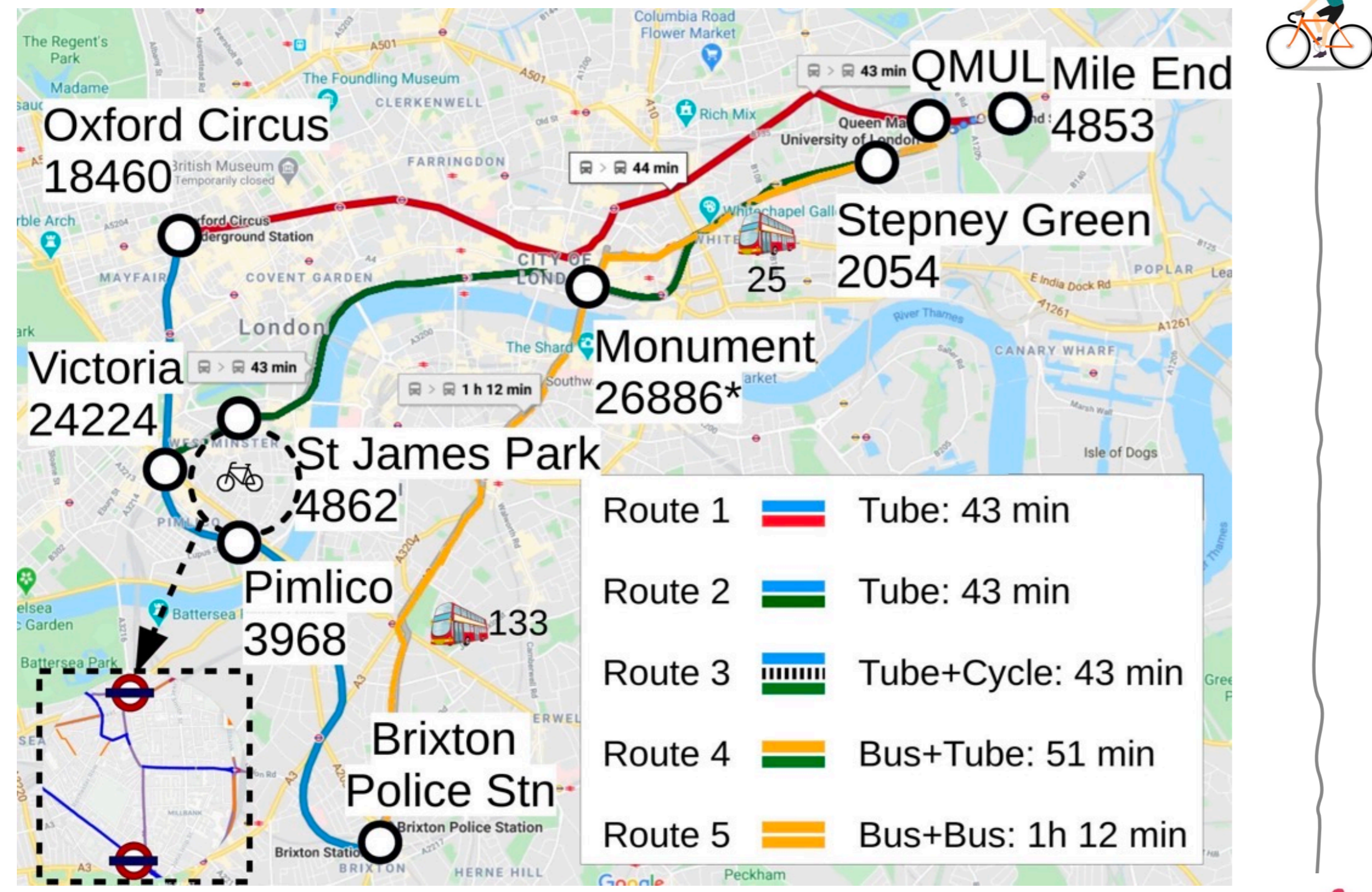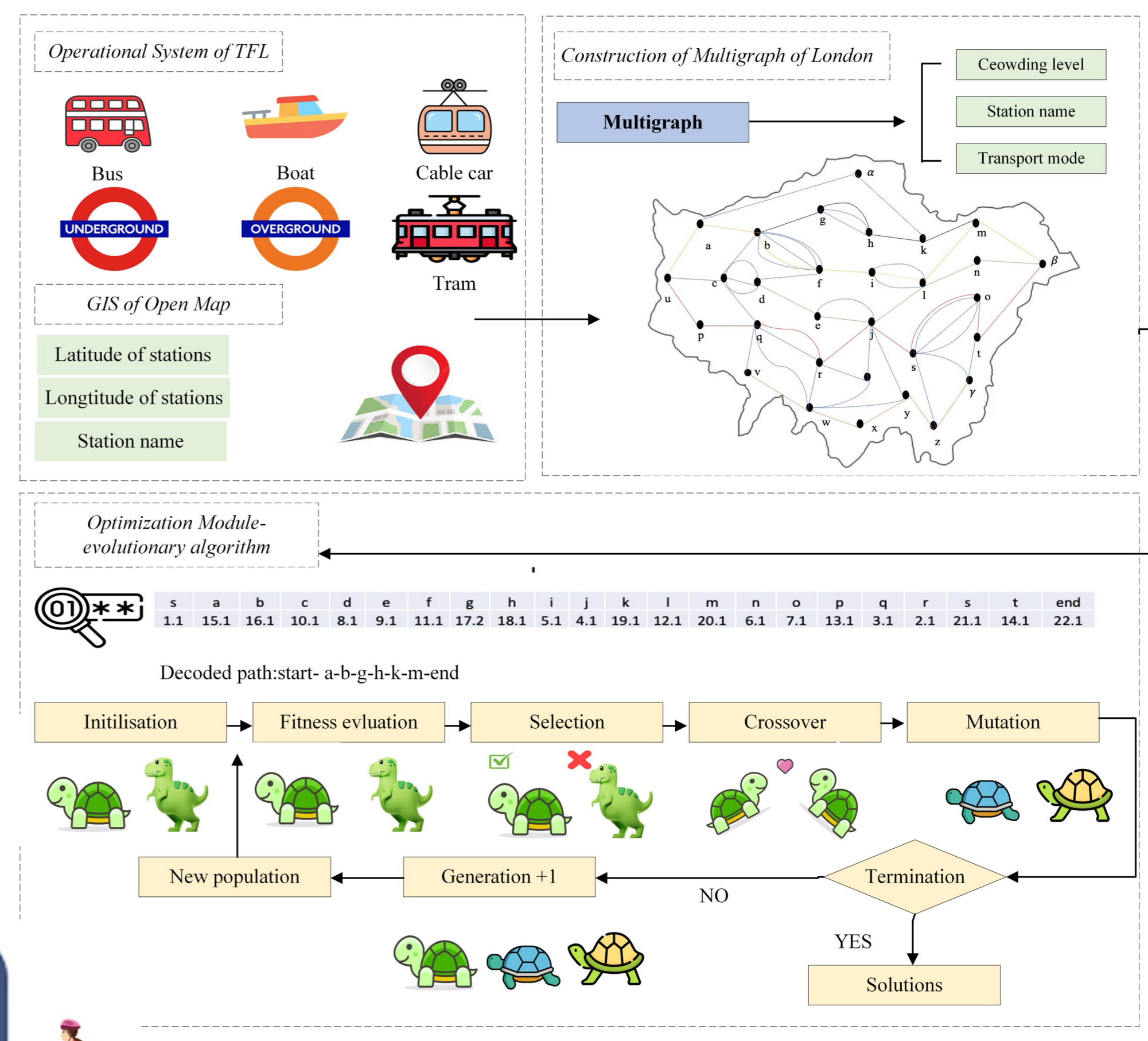Hidden optimized solutions in multi-modal transportation network

Route 1		Tube: 43 min
Route 2		Tube: 43 min
Route 3		Tube+Cycle: 43 min
Route 4		Bus+Tube: 51 min
Route 5		Bus+Bus: 1h 12 min

Figure 4 Cycling as transfer saves the total travel time and avoids crowding

4. Methods

Operational System of TFL

Bus   Boat   Cable car

UNDERGROUND   OVERGROUND   Tram

GIS of Open Map
Latitude of stations
Longtitude of stations
Station name

Construction of Multigraph of London
Multigraph → Ceowding level / Station name / Transport mode

Optimization Module- evolutionary algorithm

s	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	end
1.1	15.1	16.1	10.1	8.1	9.1	11.1	17.2	18.1	5.1	4.1	19.1	12.1	20.1	6.1	7.1	13.1	3.1	2.1	21.1	14.1	22.1

Decoded path:start- a-b-g-h-k-m-end

Initilisation → Fitness evluation → Selection → Crossover → Mutation

New population ← Generation +1 ← NO ← Termination → YES → Solutions

5. Case study – Practical perspective

Benchmark solution

Journey Summary
Start: The Spinney (15:43)
End: Putney Exchange (16:32)
Duration: 49 minutes
Transport Modes:
• Bus Service (2 segments)
• Walking (8 segments)
Crowding Levels:
• First Bus: 52.25%
• Second Bus: 66.61%

Journey Summary (Solution 2)
Start: The Spinney (15:50)
End: Putney Exchange (16:32)
Duration: 42 minutes
Transport Modes:
• Bus Services:
• Bus 216 (66.61% crowded)
• Bus 232 (43.14% crowded)
• Walking (8 segments)

Journey Summary (Solution 3)
Start: The Spinney (15:50)
End: Putney Exchange (16:32)
Duration: 42 minutes
Transport Modes:
• Bus Service:
• Bus 216 (66.61% crowded)
• Walking (9 segments)
Key Features:
• More walking segments
• Single bus service
• Via Dover House Road
• Alternative route to Putney

Key Differences from Solution 1:
• Later start time
• Different bus route (232)
• Shorter total duration

Journey Summary (Solution 4)
Start: The Spinney (15:51)
End: Putney Exchange (16:32)
Duration: 41 minutes
Transport Modes:
• Bus Service:
• Bus 216 (48.16% - 66.61% crowded)
• Walking (8 segments)
Key Features:
• Two consecutive Bus 216 segments
• Via Church Road
• Mixed crowding levels
• More walking at start and end

Journey Summary (Solution 5)
Start: The Spinney (15:51:49)
End: Putney Exchange (16:32:03)
Total Trip Time: 46.18 minutes
Transport Modes:
• Bus Service:
• Bus 216 (48.16% crowded)
• Walking (9 segments)
Key Features:
• Mostly walking route
• Single bus segment
• Passes through Church Road
• Moderate bus crowding

Journey Summary (Solution 6)
Start: The Spinney (15:51:49)
End: Putney Exchange (16:32:03)
Total Trip Time: 47.01 minutes
Transport Modes:
• Bus Service:
• Bus 216 (48.16% crowded)
• Bus 232 (43.14% crowded)
• Walking (8 segments)
Key Features:
• Two different bus routes
• Single bus segment
• Passes through Barnes
• Multiple transport modes

Journey Summary
Start: The Spinney (15:55:18)
End: Putney Exchange (16:32:03)
Total Trip Time: 42.7 minutes
Transport Modes:
• Bus Service:
• Newport Road (52.25% crowded)
• Church Road (40.60% crowded)
• Ranelagh Avenue (48.16% crowded)
• Barnes (66.61% crowded)
• Walking Segments:
• Initial walk: 4.7 min
• Mid-journey: 4.3 min
• Final segments: 18.2 min total

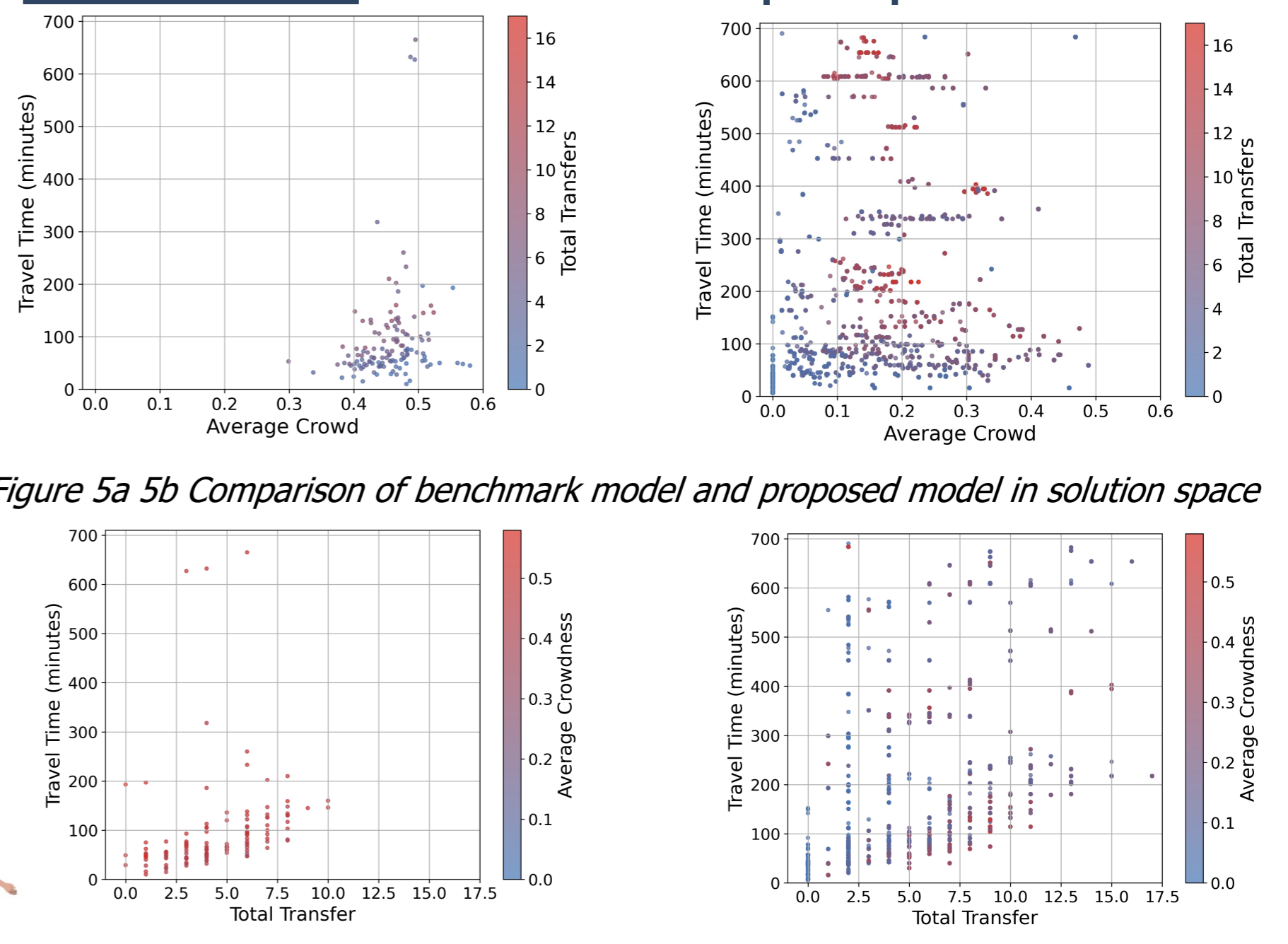## 6. Results – theoretical perspective

Figure 5a 5b Comparison of benchmark model and proposed model in solution space

Figure 6a 6b Comparison of benchmark model and proposed model in crowding level

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