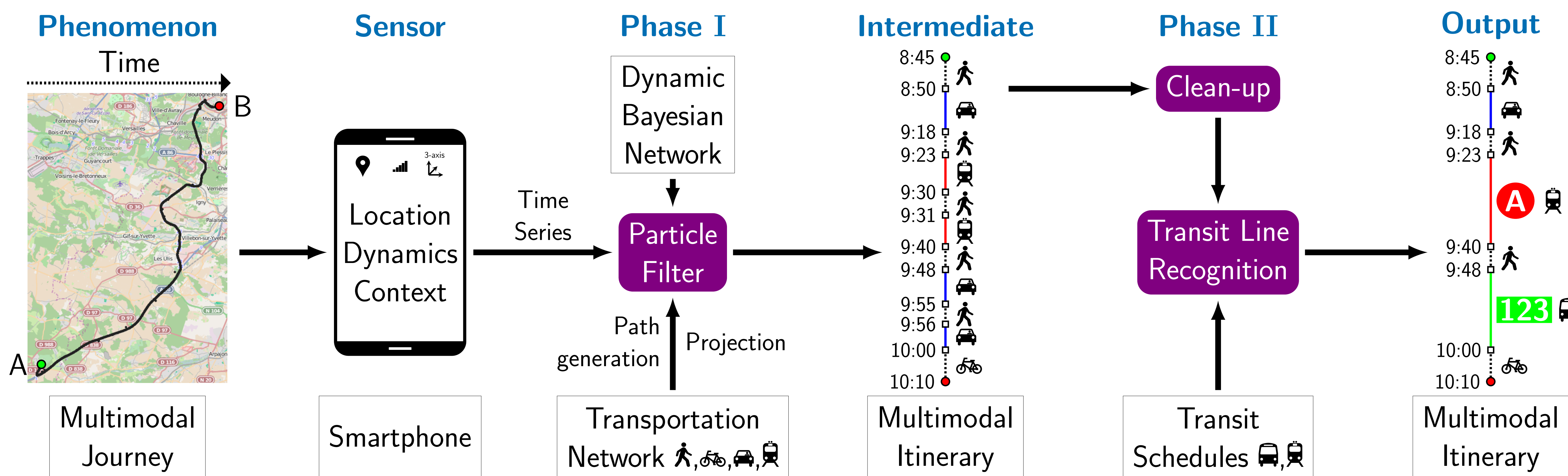
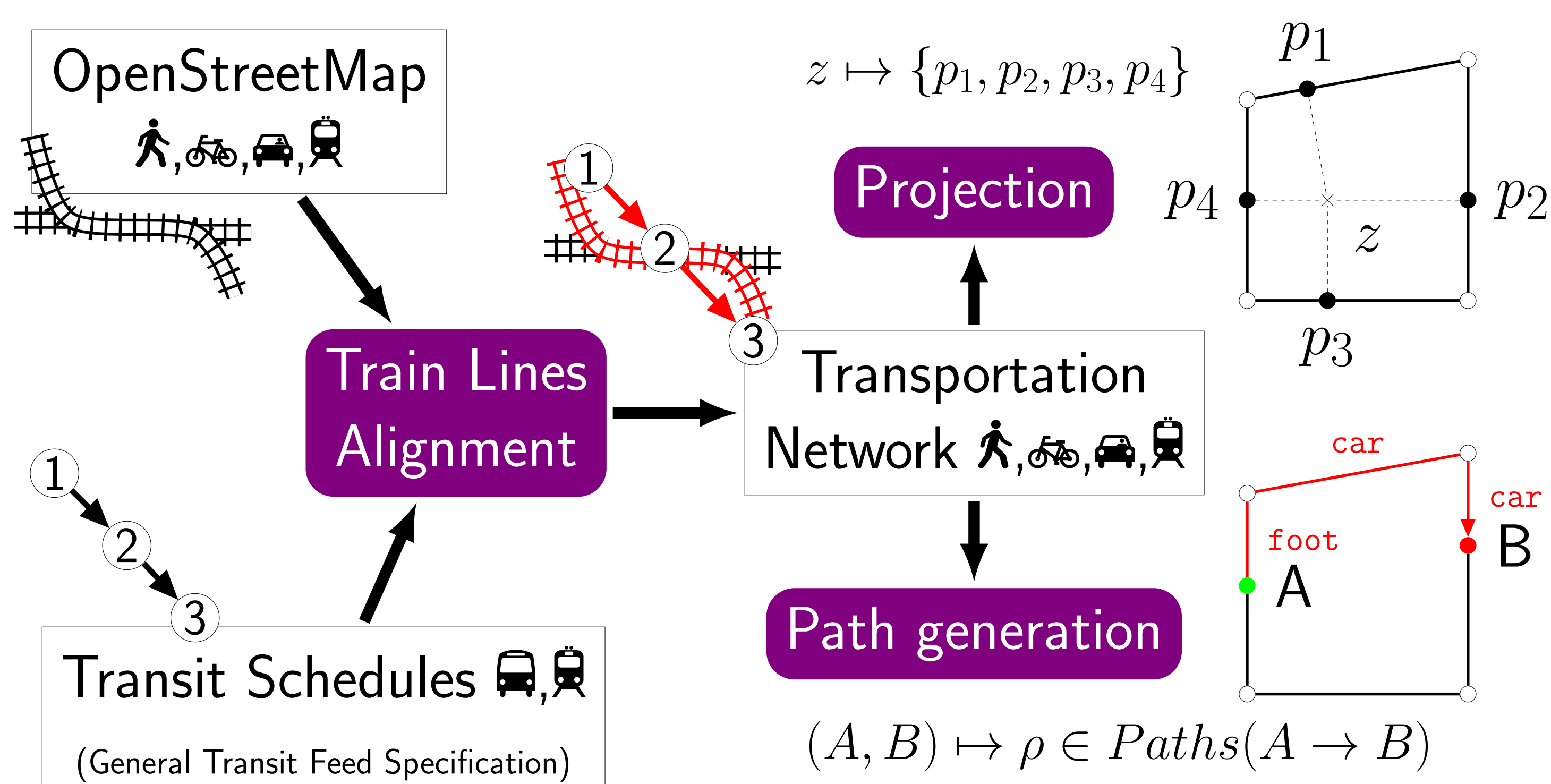


① System overview



② Transportation Network



③ Smartphone Data

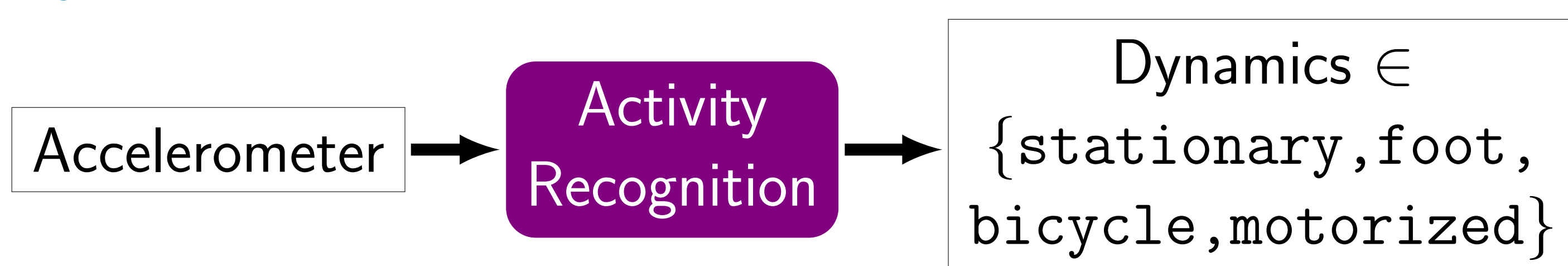
Observation sequence $o_{1:T}$, one per second

$$o_t \in \text{Location} \times \text{Dynamics} \times \text{Context}$$

■ Location

	GPS	Wi-Fi	GSM
Accuracy	10m	100m	1000m
Availability	Mostly outdoors	Populated areas	Most areas

■ Dynamics



■ Context

Underground/Indoors:

indicated by the availability of GPS/GLONASS signal

Public Transportation:

suggested by the number of nearby Bluetooth devices

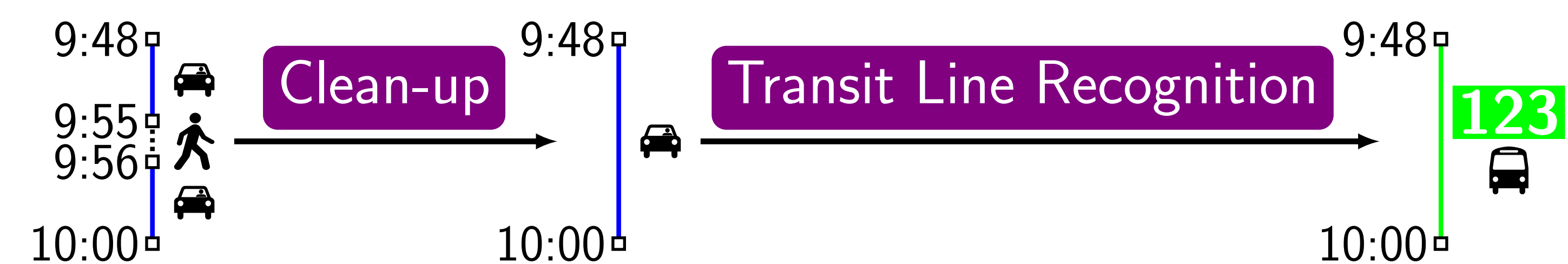
④ Algorithm

■ Phase I

- Dynamic Bayesian Network with time-span T
 $y_t \in \text{Edge} \times \text{Direction} \times \text{Mode} \times \text{Speed} \times \text{Path} \times \dots$
 finite-domain random variable describing the traveler's state
- $x_t \in \mathbb{R}$ the traveler's position (offset) on an edge
- Rao-Blackwellized particle filter sampling $y_{1:t}$, while keeping x_t in closed form using a Kalman Filter
- Output: $y_{1:T}$'s MAP estimate $\sim y_{1:T}$ maximizing:

$$\Pr(y_{1:T} = y_{1:T} \mid o_{1:T}) = \int_{x_T} \Pr(y_{1:T}, x_T \mid o_{1:T}) dx_T$$

■ Phase II



⑤ Evaluation

42.5 hours of annotated journeys from users in the Paris region

■ Confusion matrix by transportation mode

		Predicted mode accuracy (%)						Time (min)
		foot	bike	car	bus	train	tram	
Actual mode	foot	87	8	1	1	2	1	1068
	bike	2	98	0	0	0	0	69
	car	5	2	82	10	0	0	718
	bus	4	5	0	90	1	0	419
	train	12	0	2	3	83	0	149
tram	15	3	6	1	0	75	129	
Precision		91	36	96	80	81	92	2552

■ Transit Line recognition rates

	bus	train	tram
Accuracy (%)	95	78	99
Total Time (min)	381	127	98