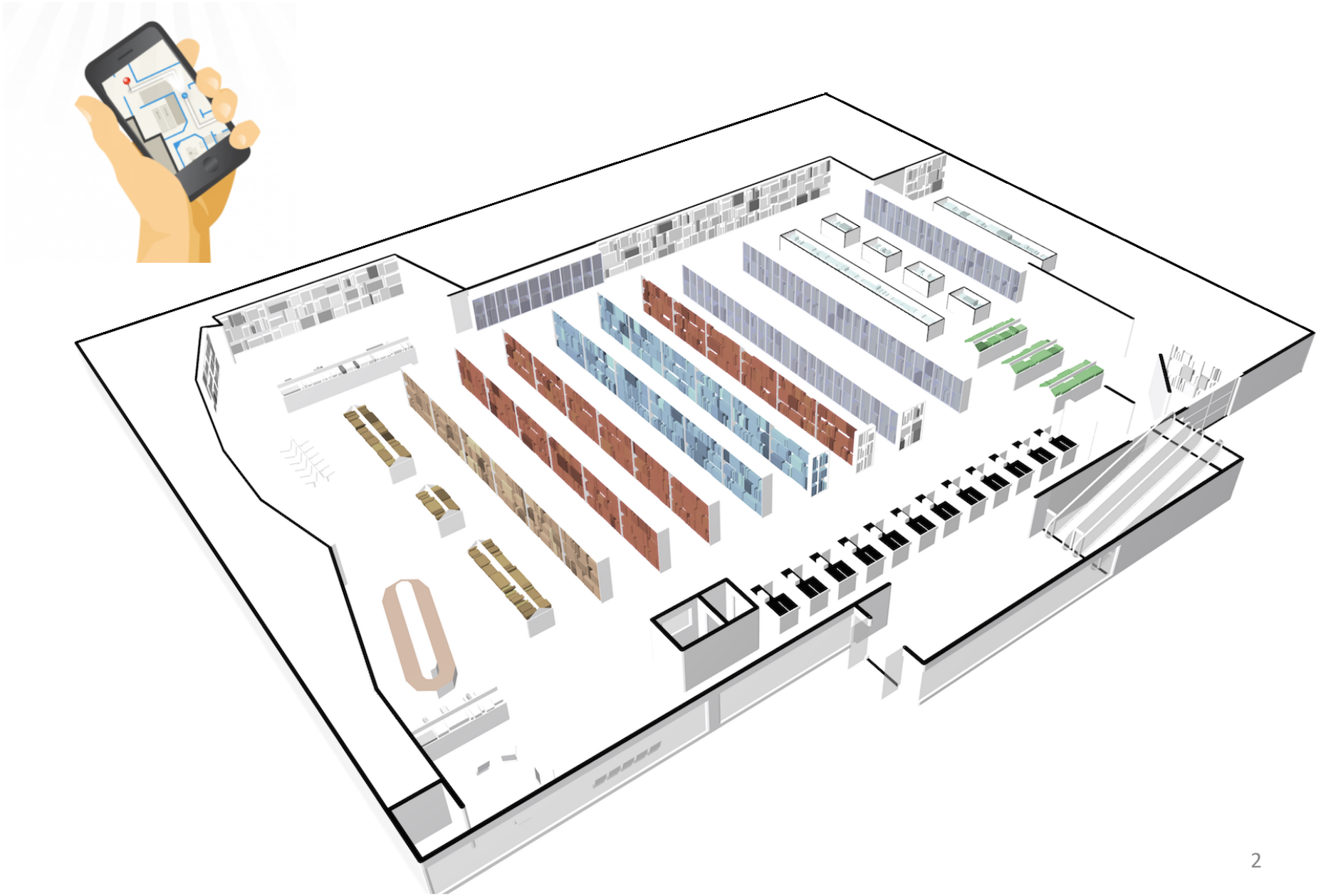
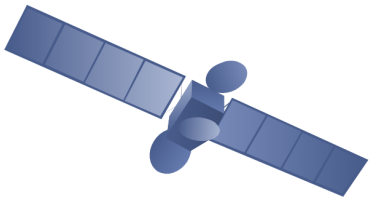
No Need to WarDrive …

Unsupervised Indoor Localization

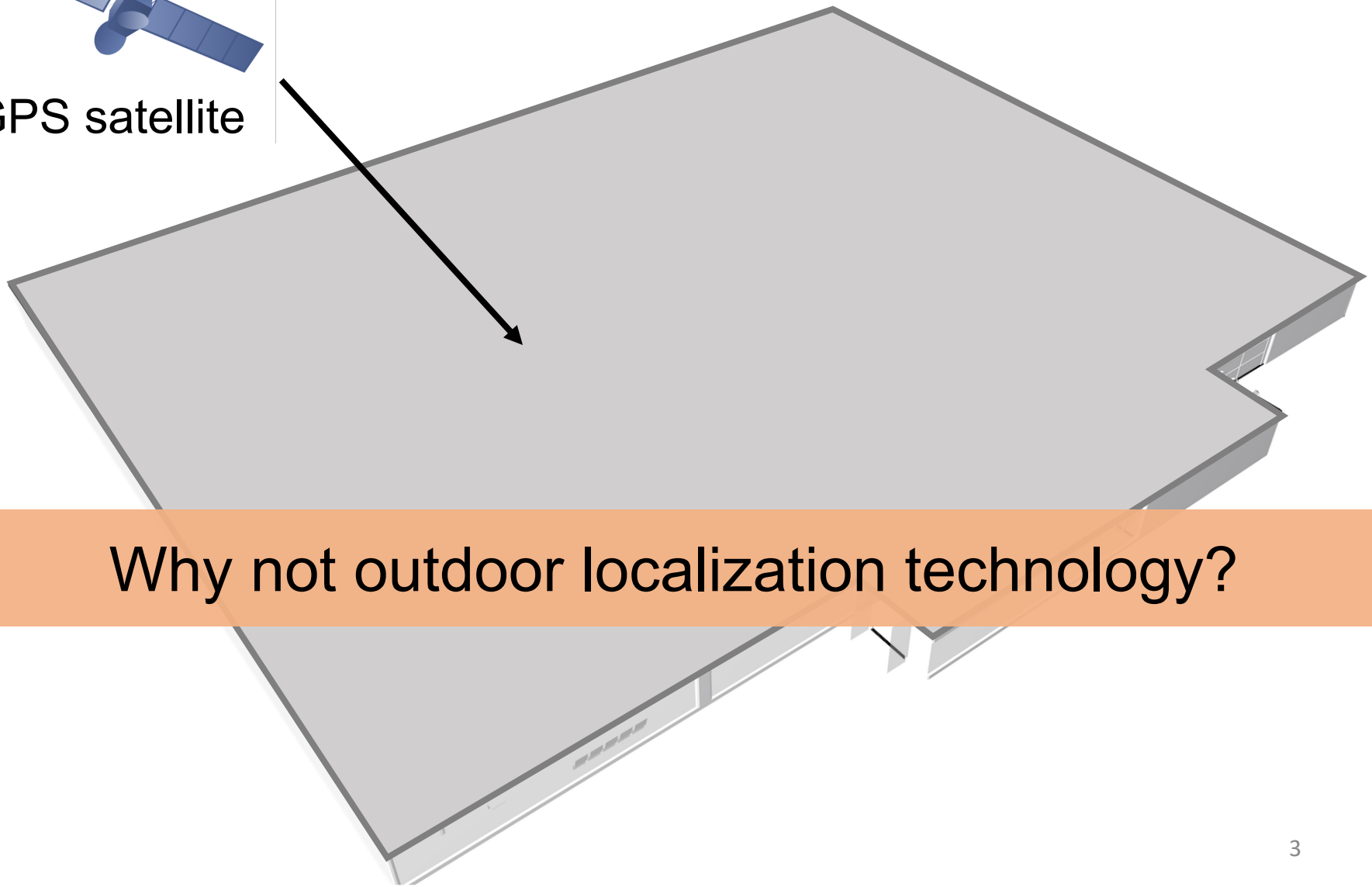
Where am I in a hotel, mall, office, cruise ship?



GPS



GPS satellite

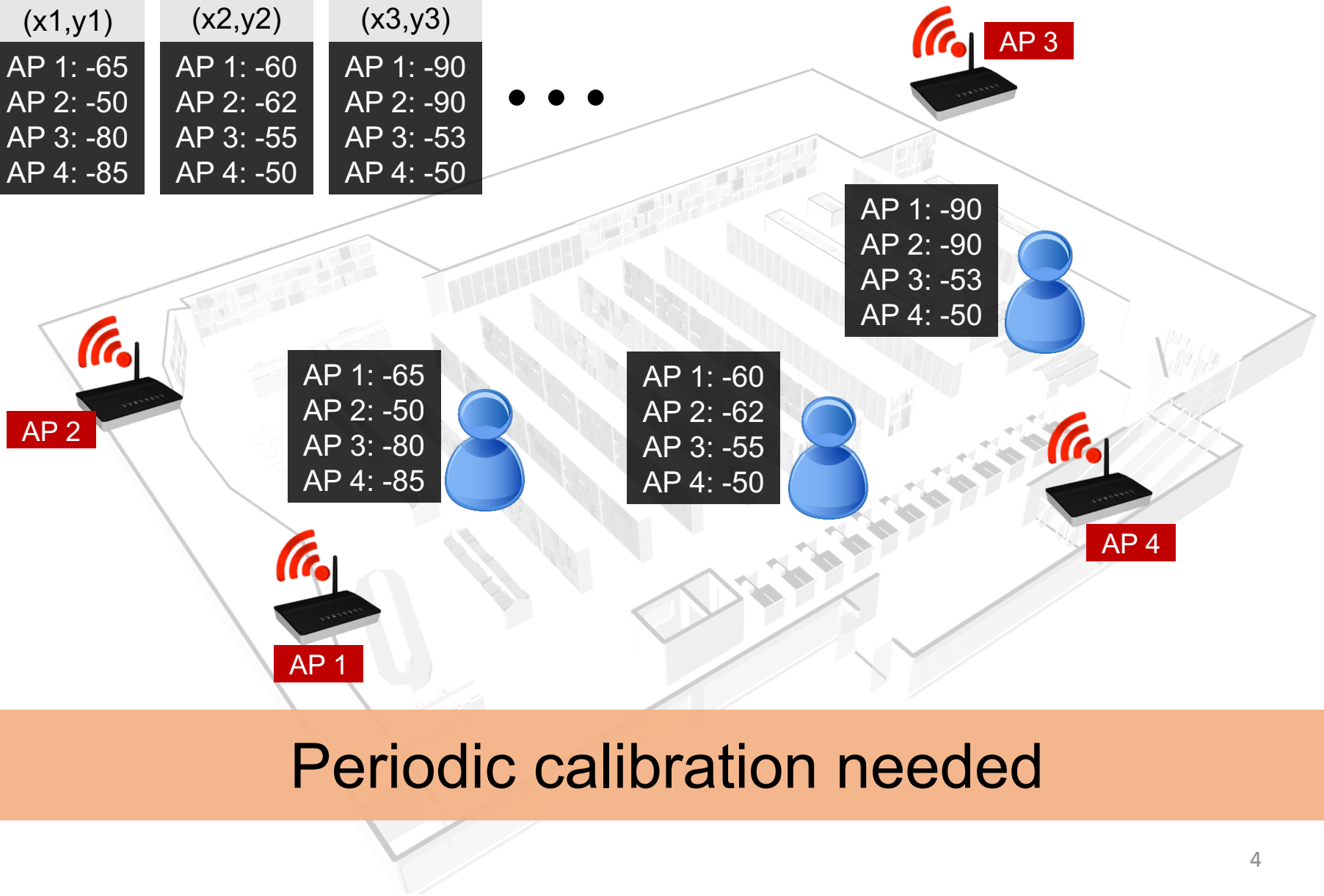


Why not outdoor localization technology?

Wi-Fi

(x1,y1)	(x2,y2)	(x3,y3)
AP 1: -65	AP 1: -60	AP 1: -90
AP 2: -50	AP 2: -62	AP 2: -90
AP 3: -80	AP 3: -55	AP 3: -53
AP 4: -85	AP 4: -50	AP 4: -50

• • •



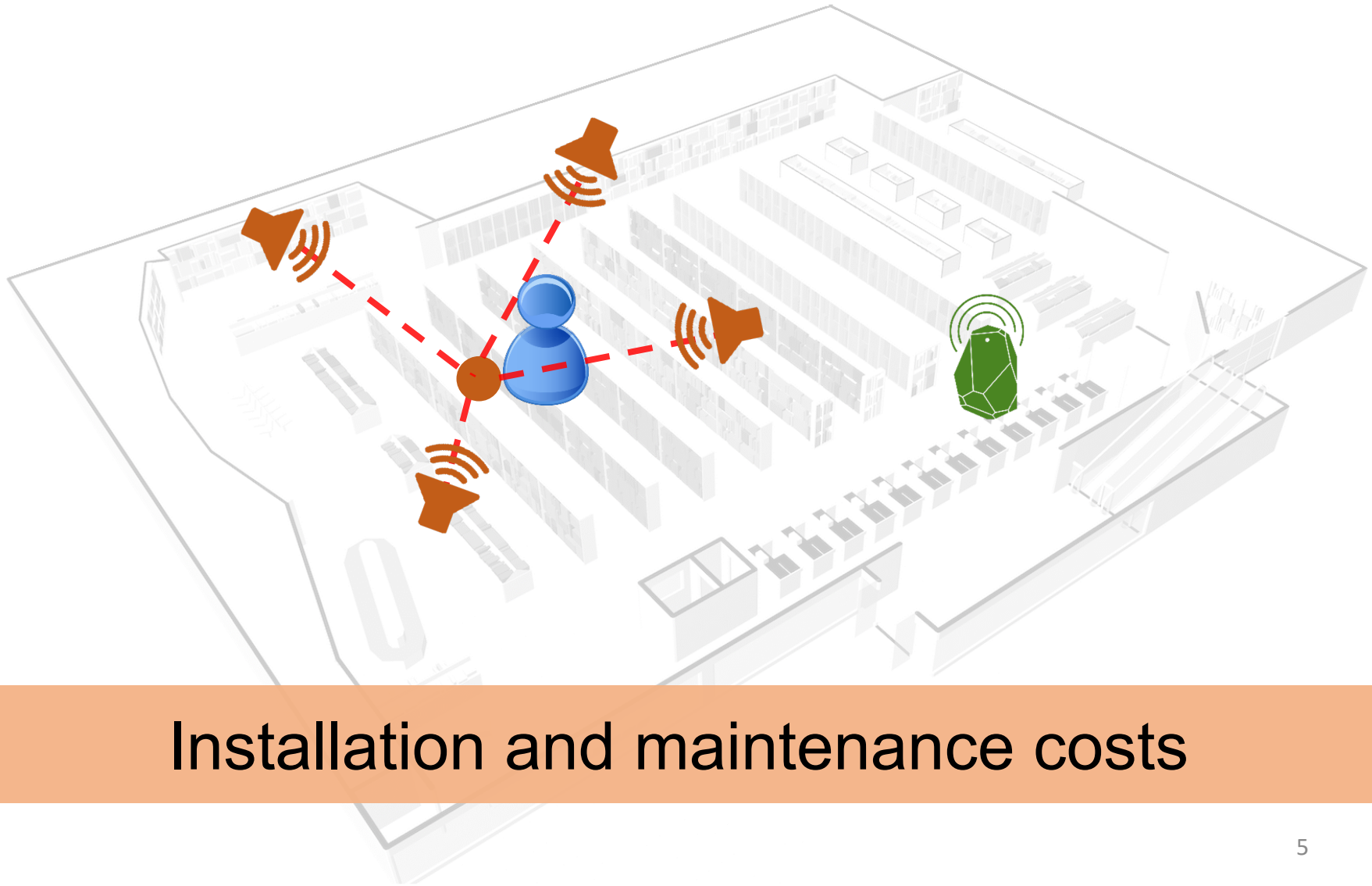
Periodic calibration needed

Beacon

sound beacon

listener

Bluetooth beacon



Installation and maintenance costs

We do not want to rely on infrastructure

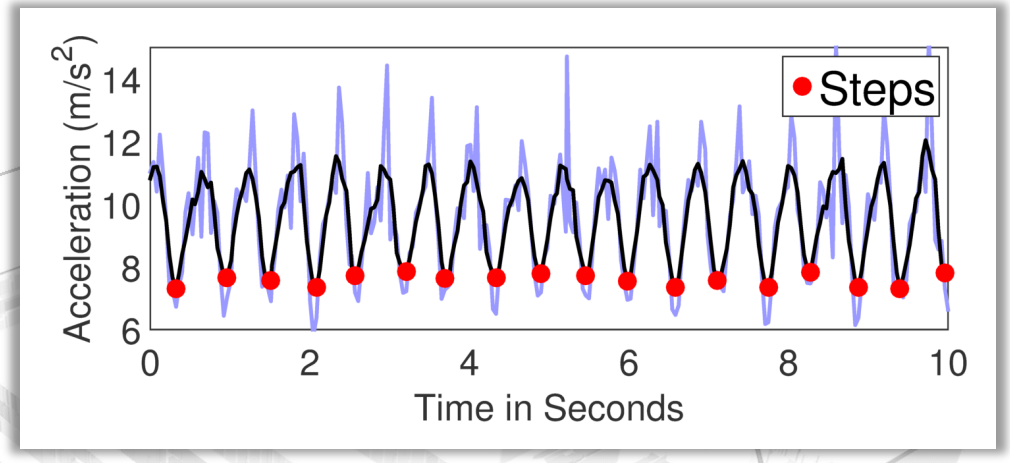
We want a ***scalable software solution***

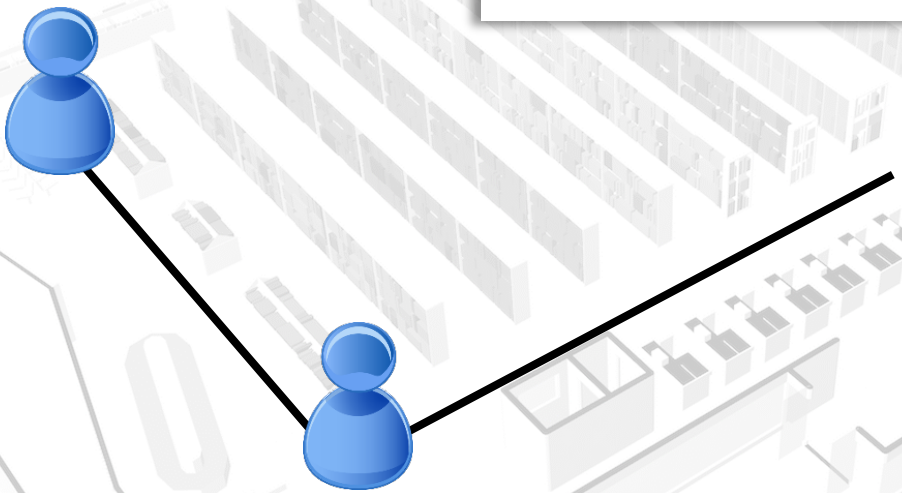
Infrastructure-less Localization

accelerometer

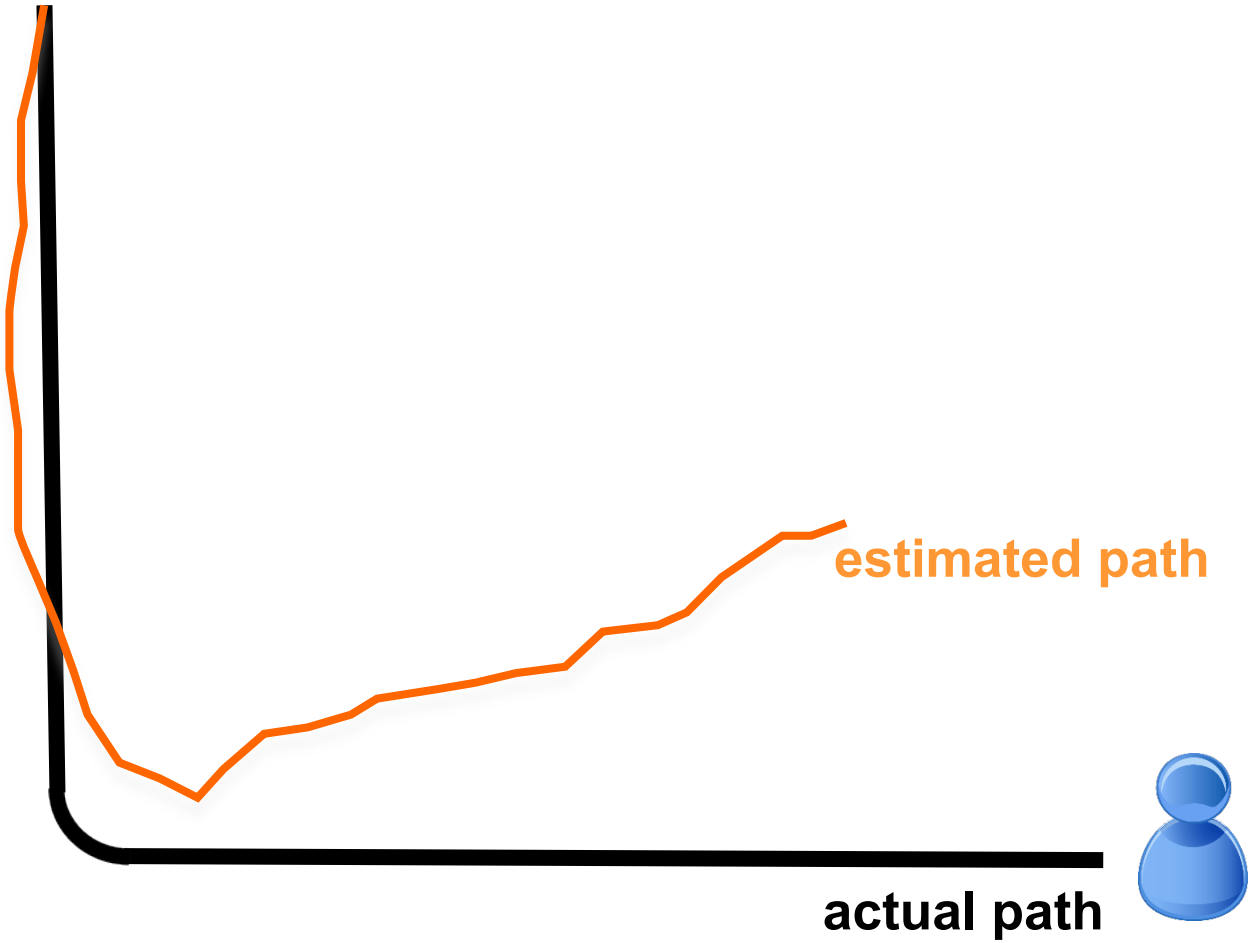
compass

gyroscope





Dead reckoning

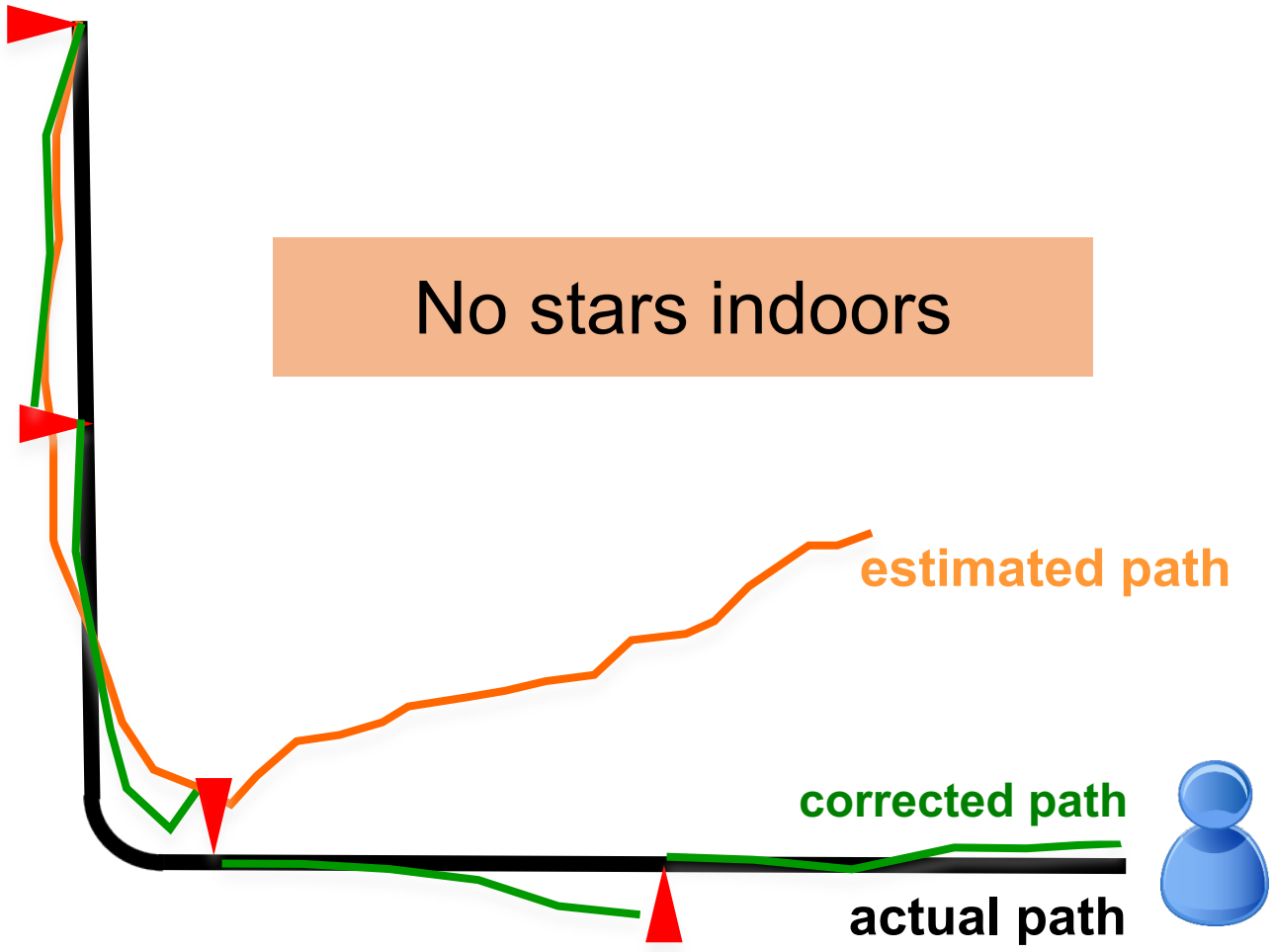


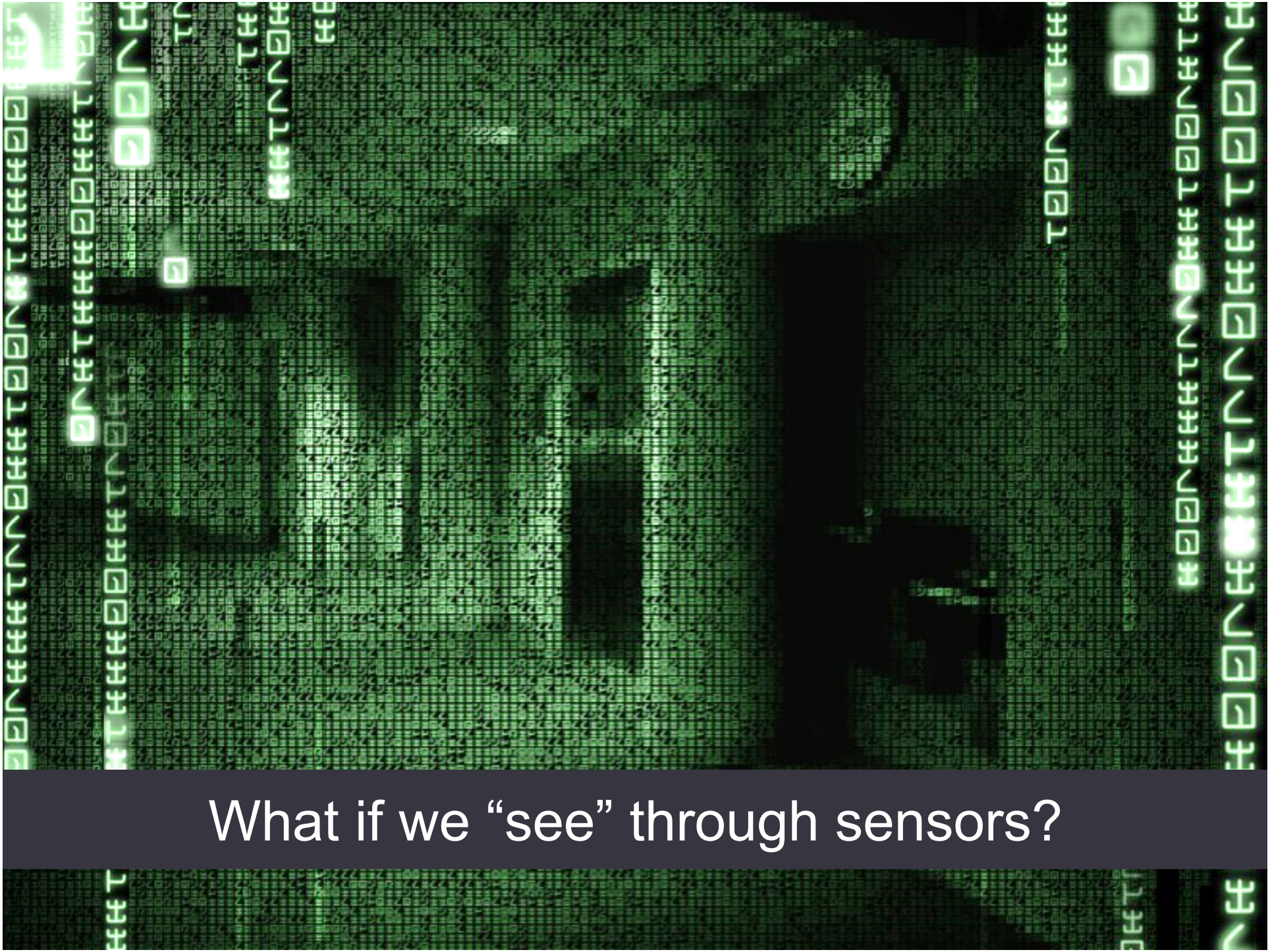
Charles Lindbergh landed in Paris from New York.

No GPS

He used dead reckoning
and obtained fixes from the stars.

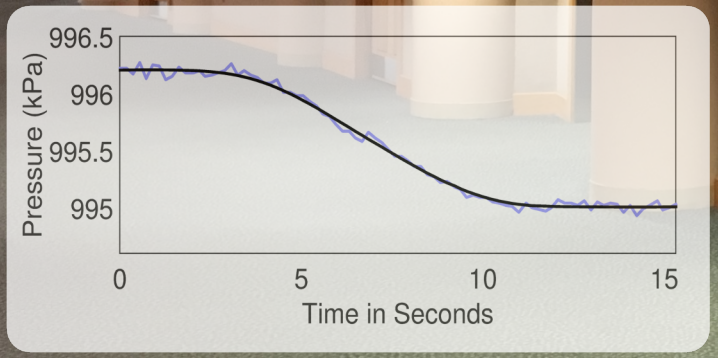
Dead reckoning




What if we “see” through sensors?

Acceleration pattern

Pressure change



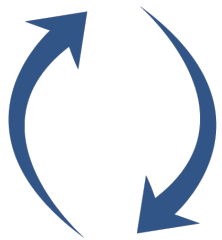
Cellular pattern

We use this core idea to design
UnLoc: Unsupervised Indoor Localization

We use this core idea to design UnLoc: Unsupervised Indoor Localization

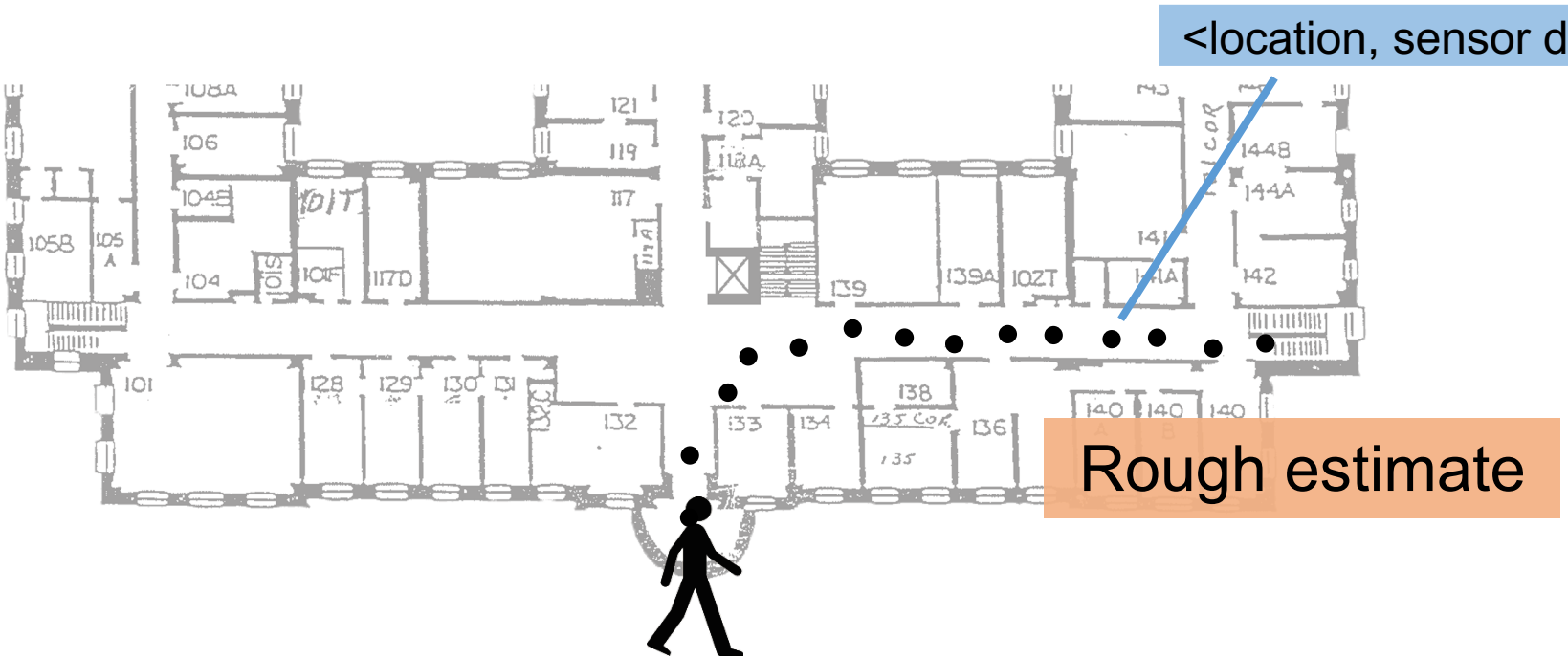
3 main design questions:

1. How to automatically detect landmarks
2. How to localize the landmarks
3. How to localize users

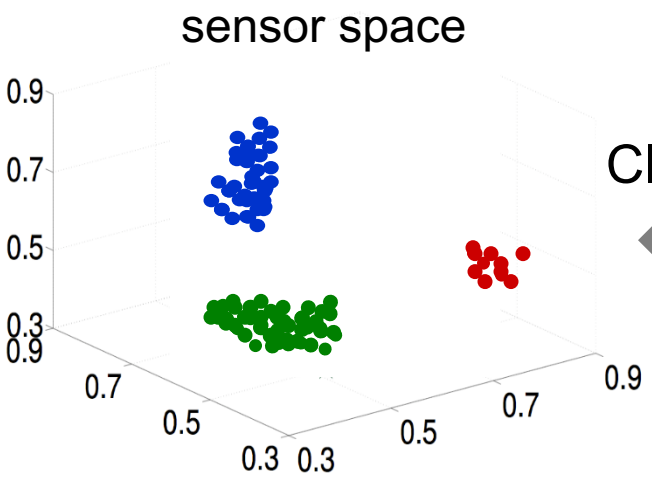


1. How to automatically detect landmarks

Raw Sensor → Landmarks



Raw Sensor → Landmarks

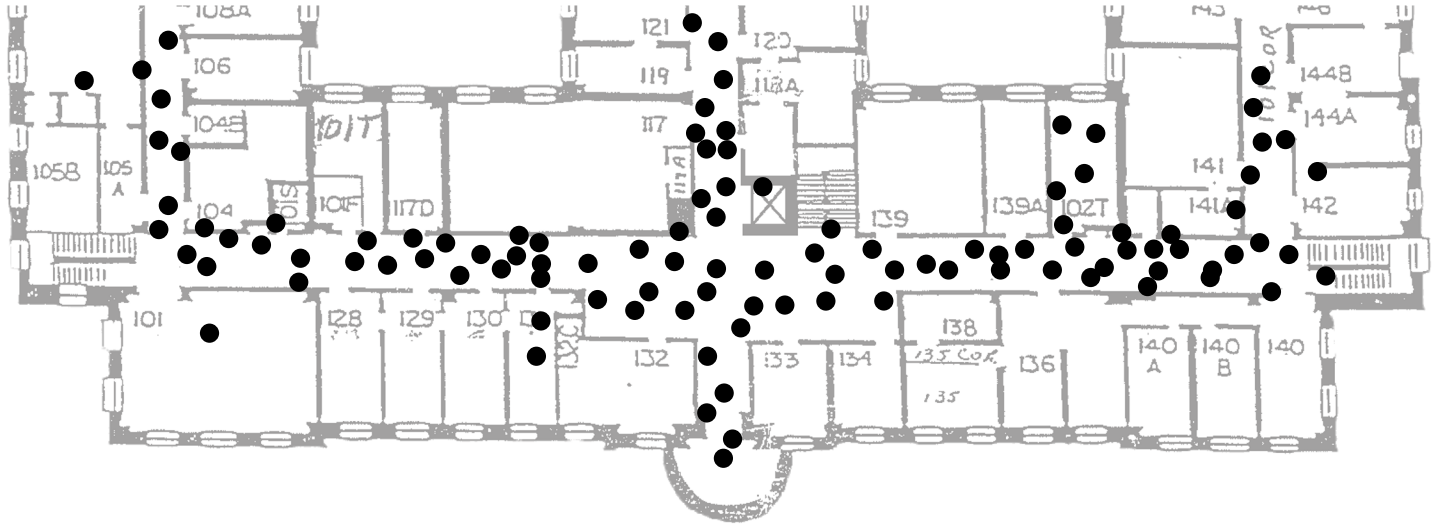


Clustering

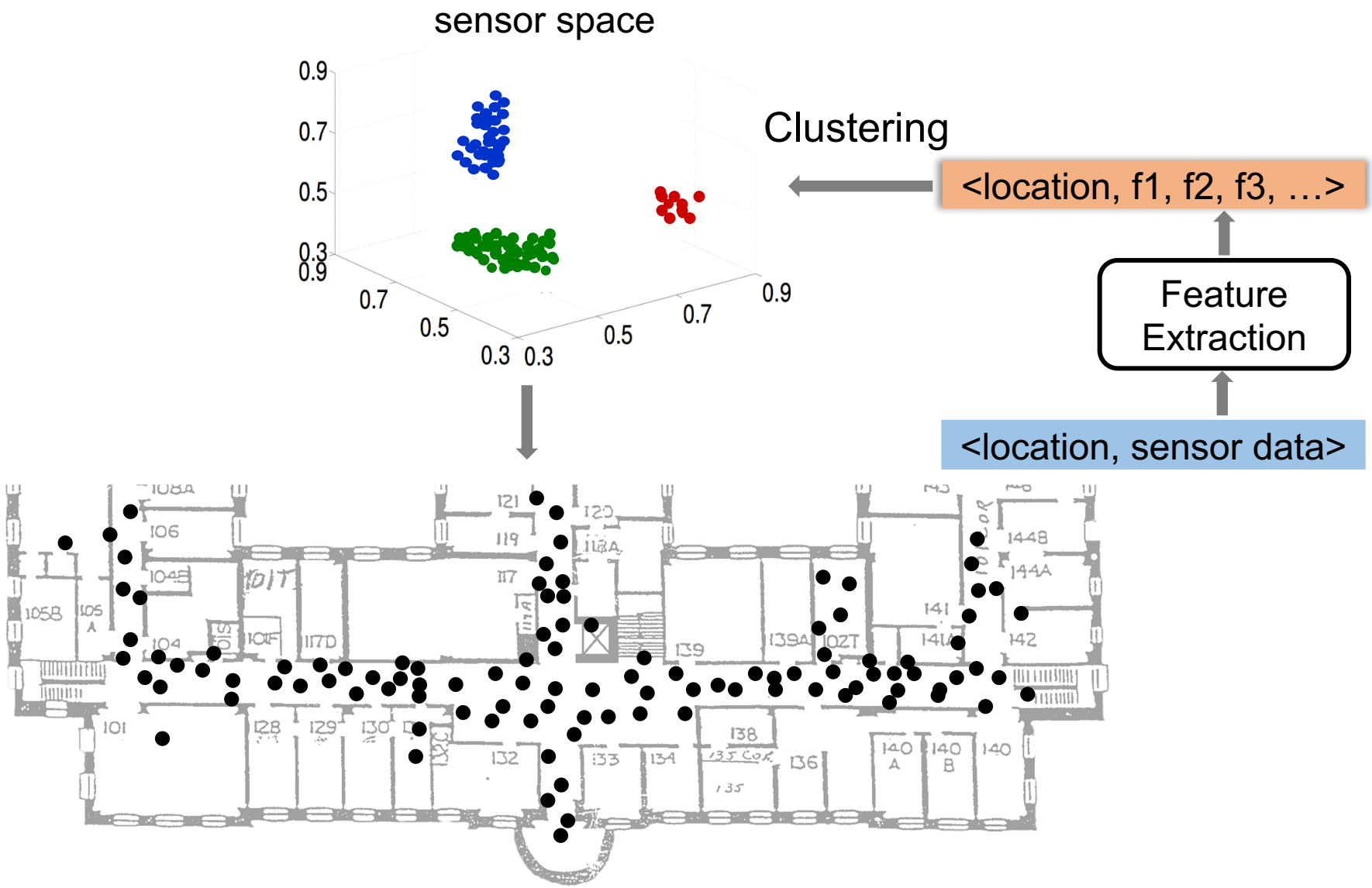
<location, f1, f2, f3, …>

Feature Extraction

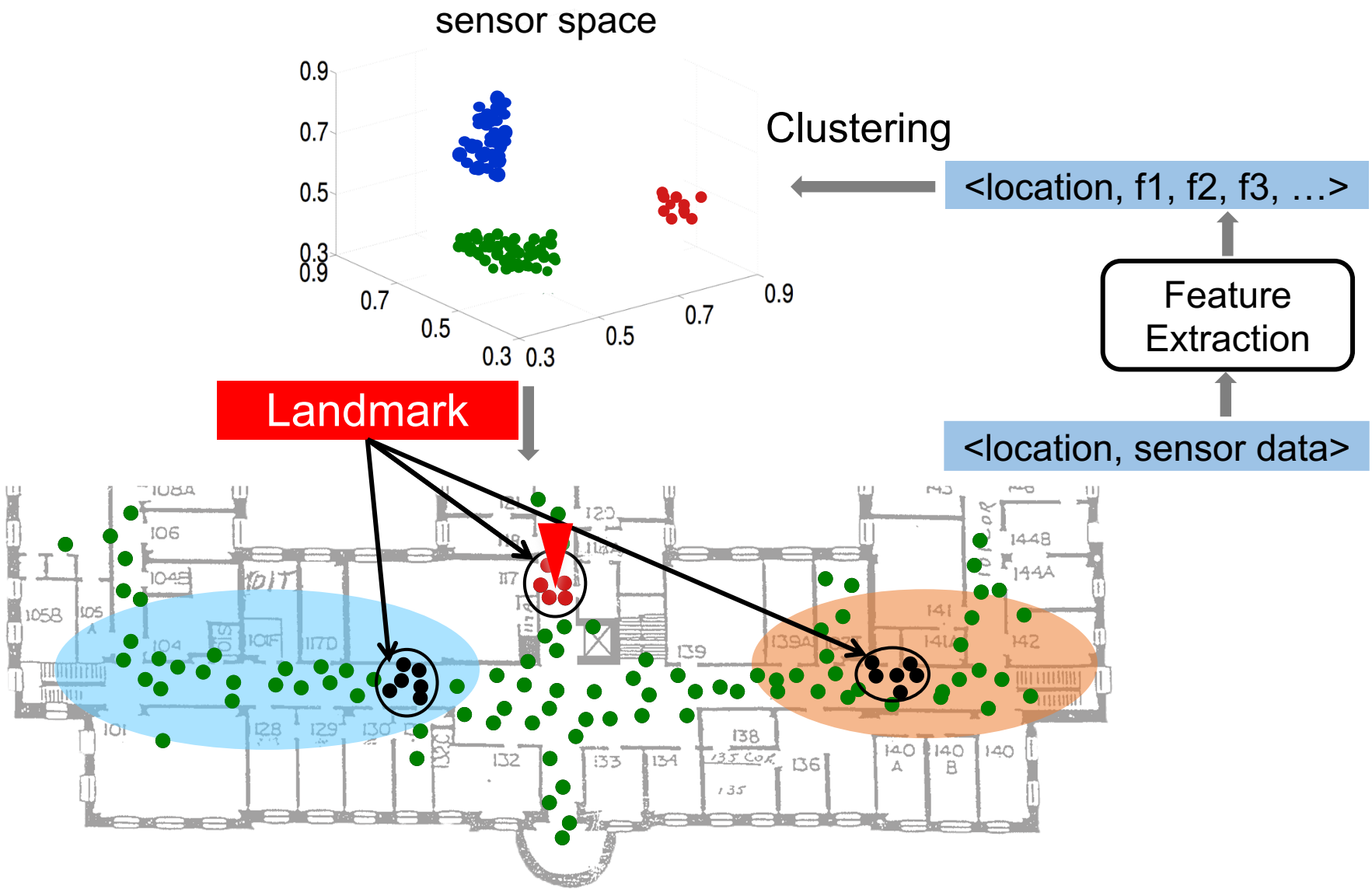
<location, sensor data>



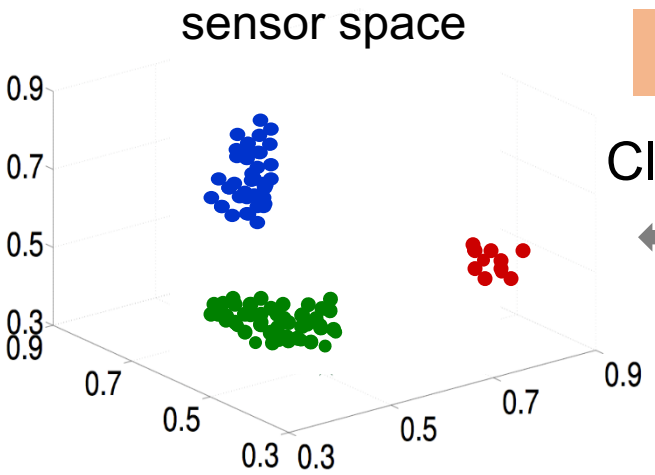
Raw Sensor → Landmarks



Raw Sensor → Landmarks



Landmarks from Multiple Sensors



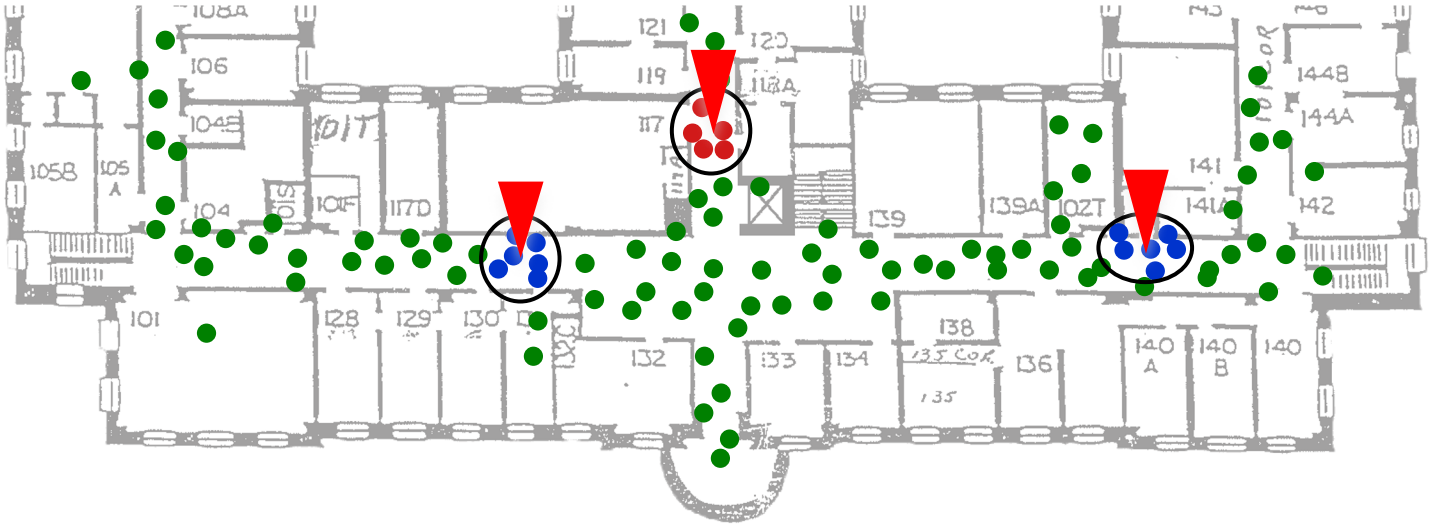
Inertial, Magnetic, Wi-Fi

Clustering

<location, f1, f2, f3, …>

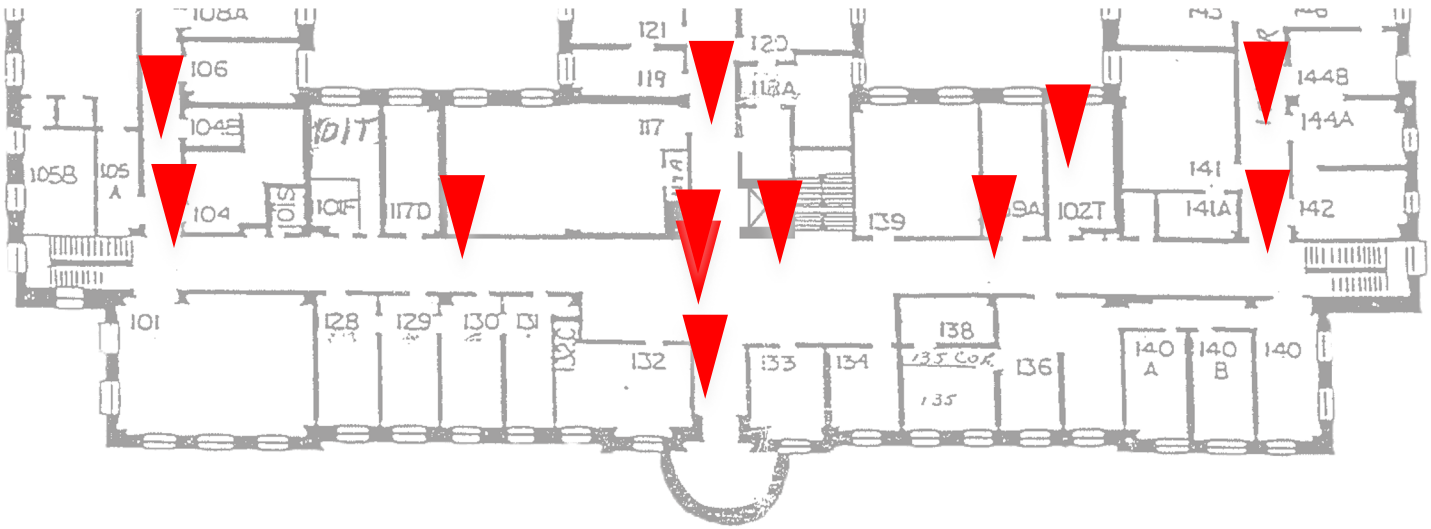
Feature Extraction

<location, sensor data>

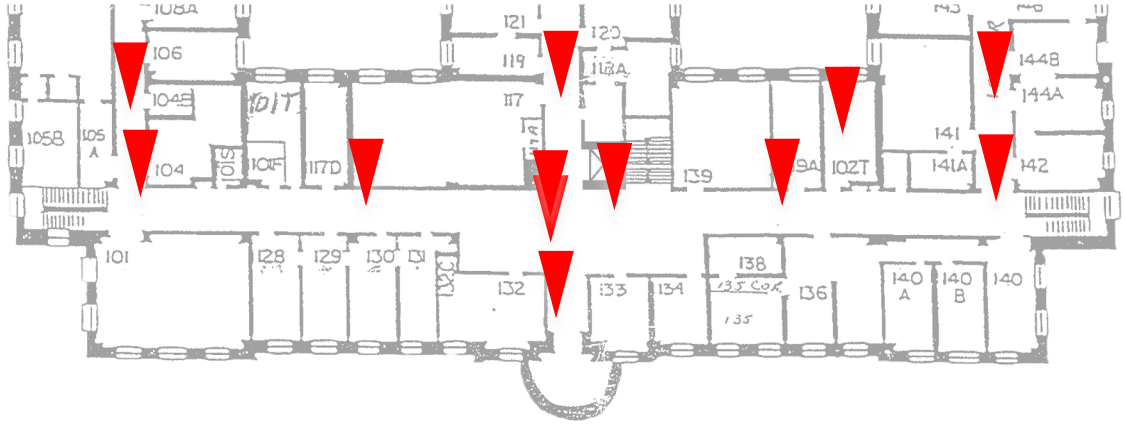


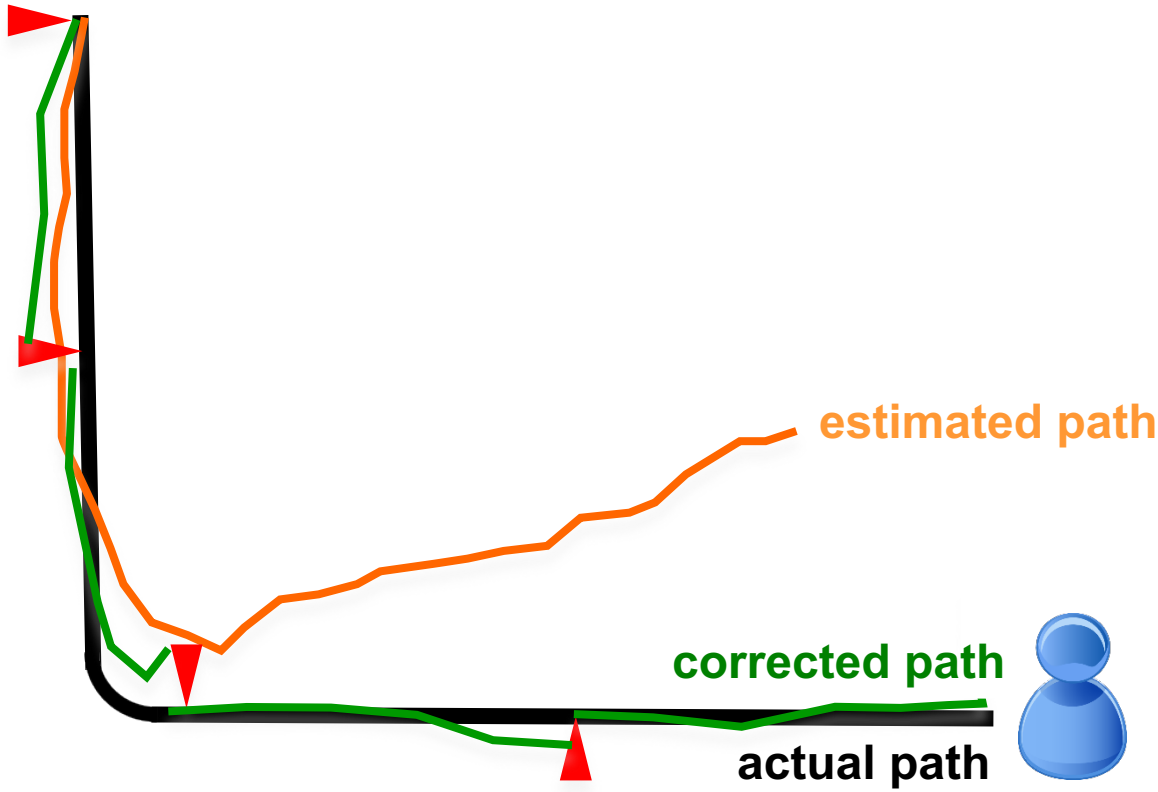
Our Hypothesis

Indoor environments have adequate landmarks.



We have found “stars”!

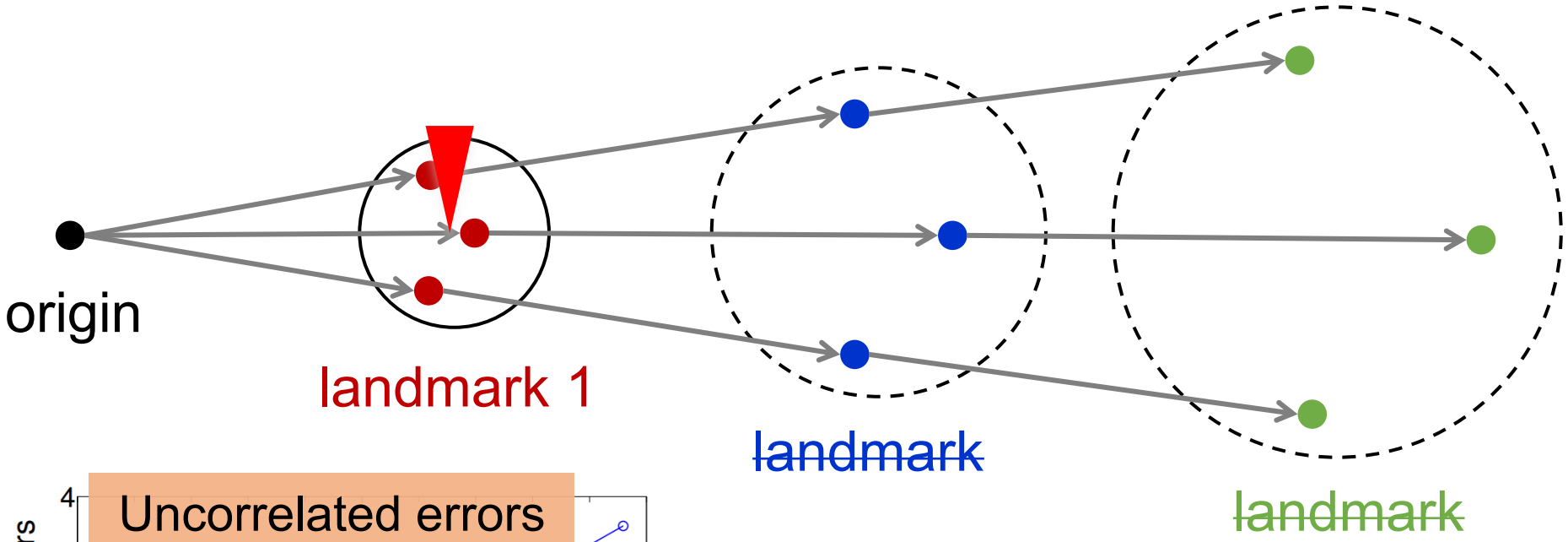


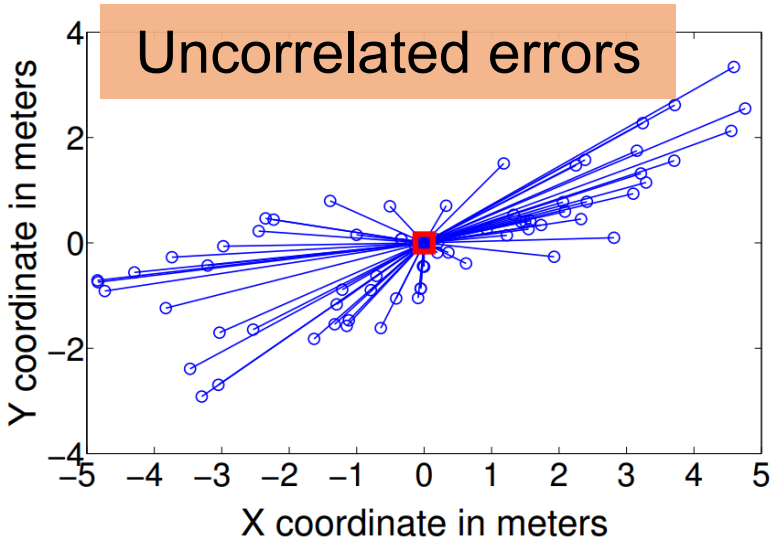


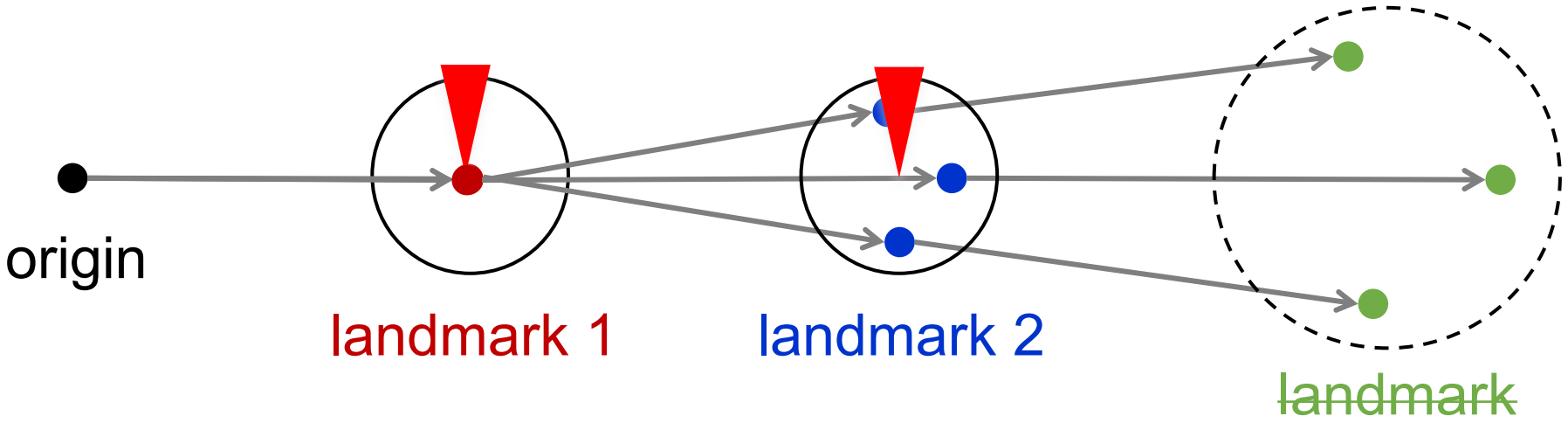
But, wait …

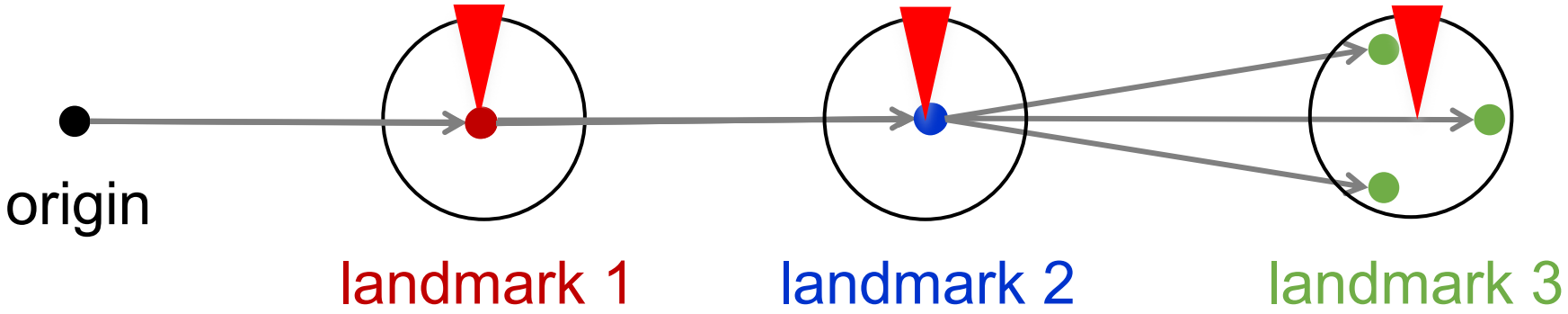
We assumed dead reckoning is not too bad …
But in reality it diverges poorly.

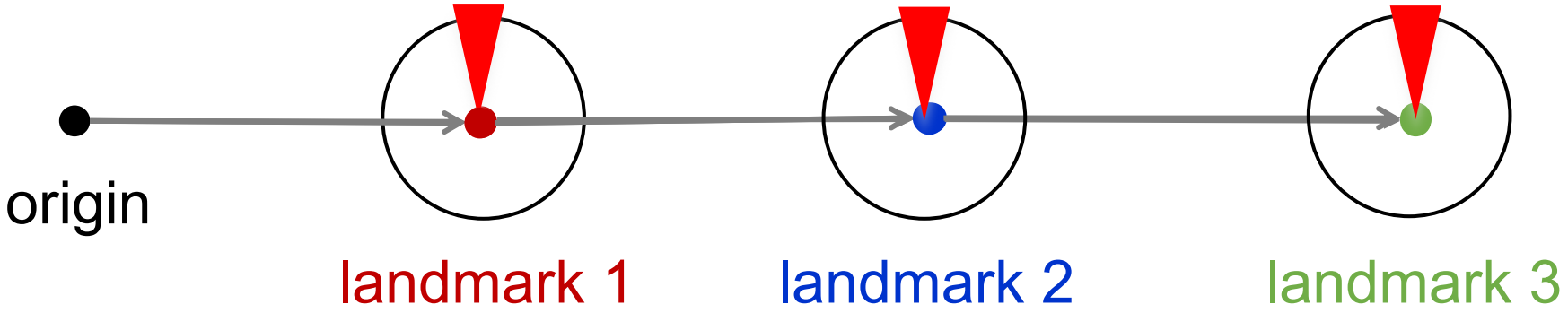
What happens then?


origin
landmark 1
landmark
landmark

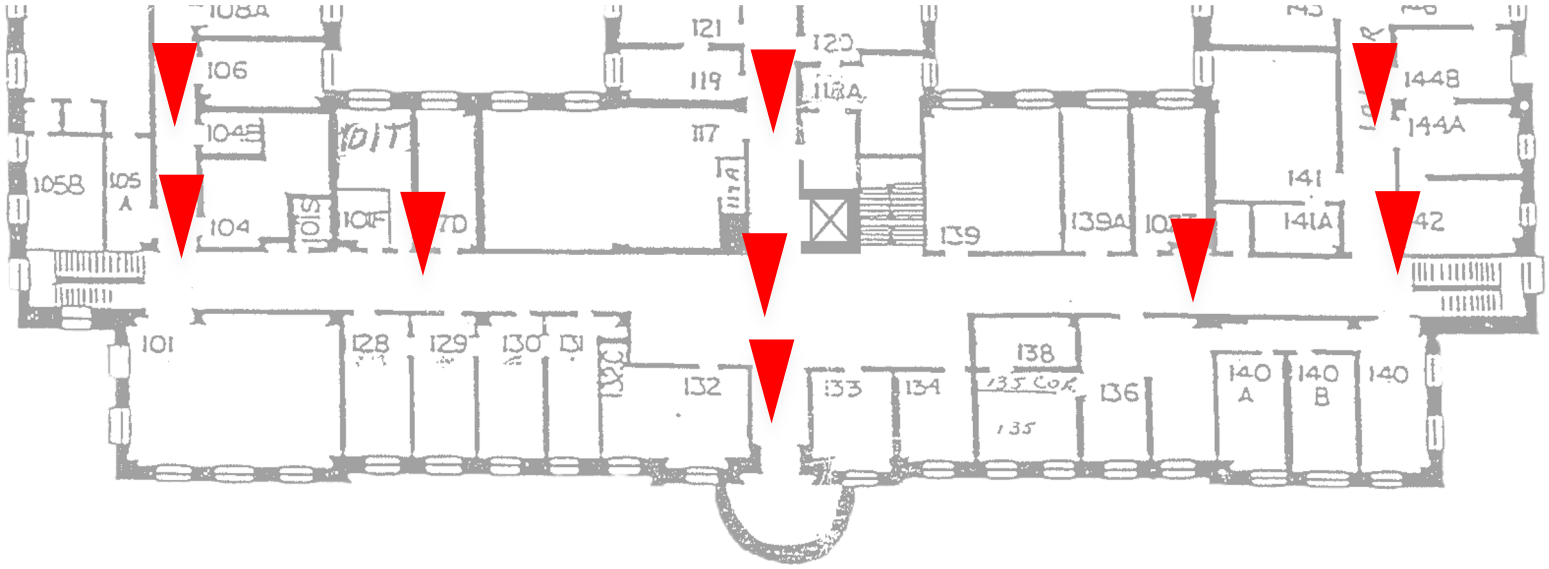

Uncorrelated errors
Y coordinate in meters
X coordinate in meters
4
2
0
−2
−4
−5
−4
−3
−2
−1
0
1
2
3
4
5


origin
landmark 1
landmark 2
landmark

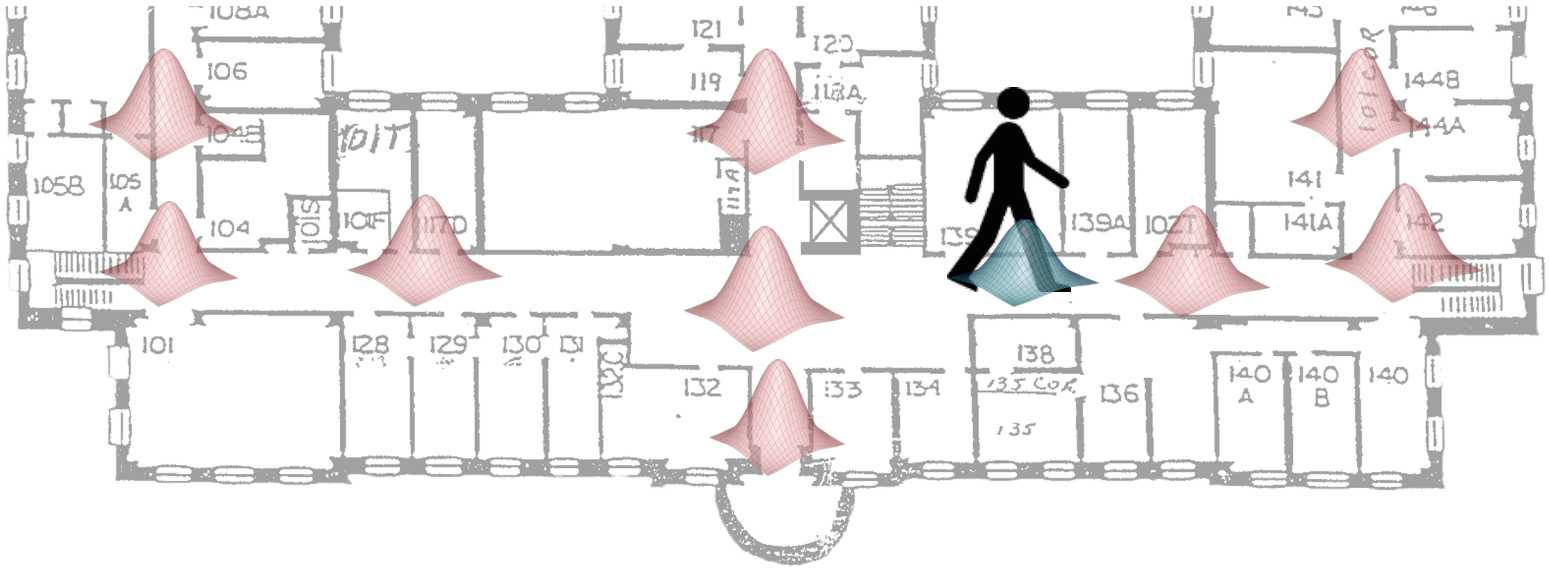

origin
landmark 1
landmark 2
landmark 3


origin
landmark 1
landmark 2
landmark 3

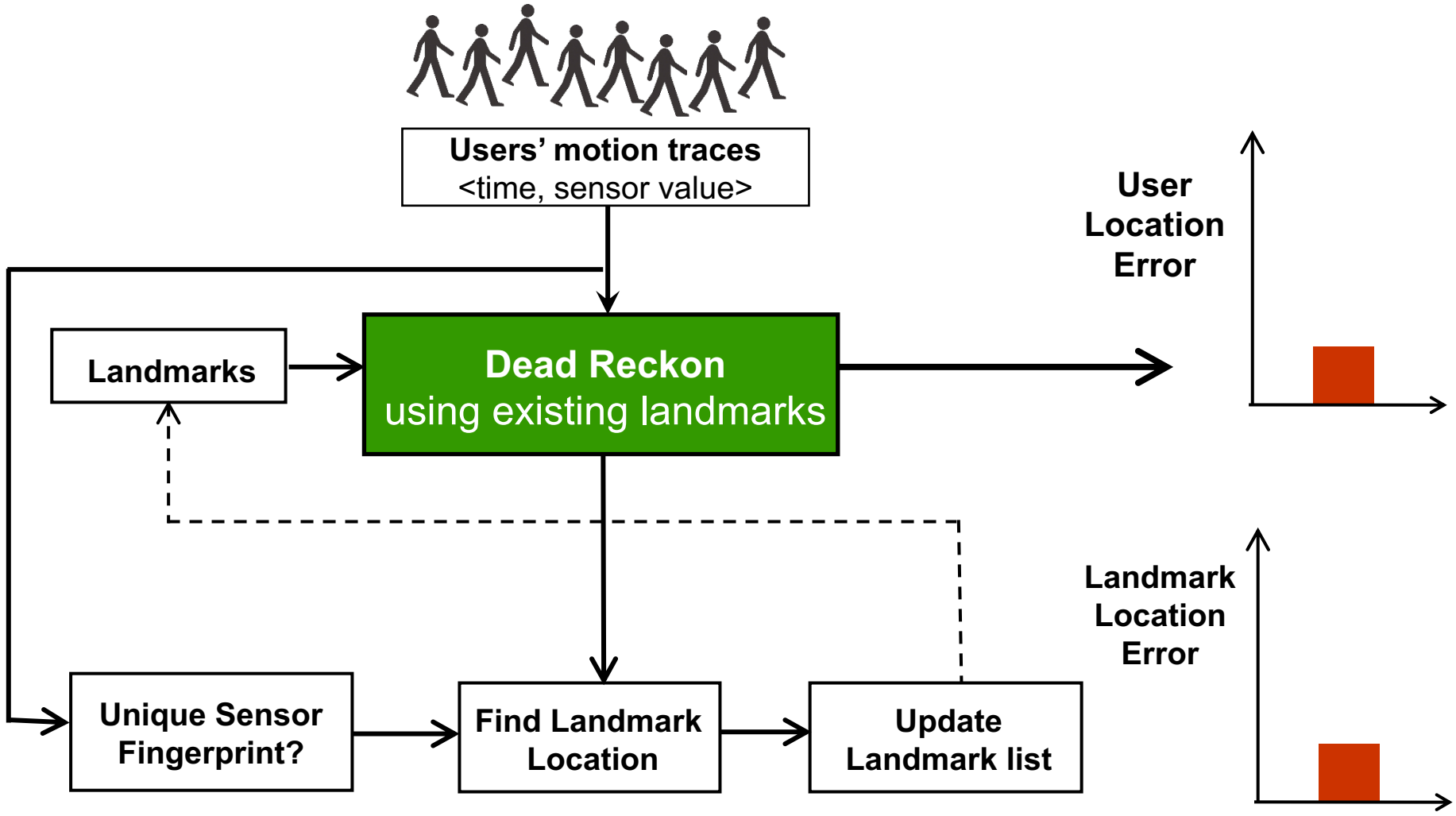
Growing landmarks gradually



Growing landmarks gradually



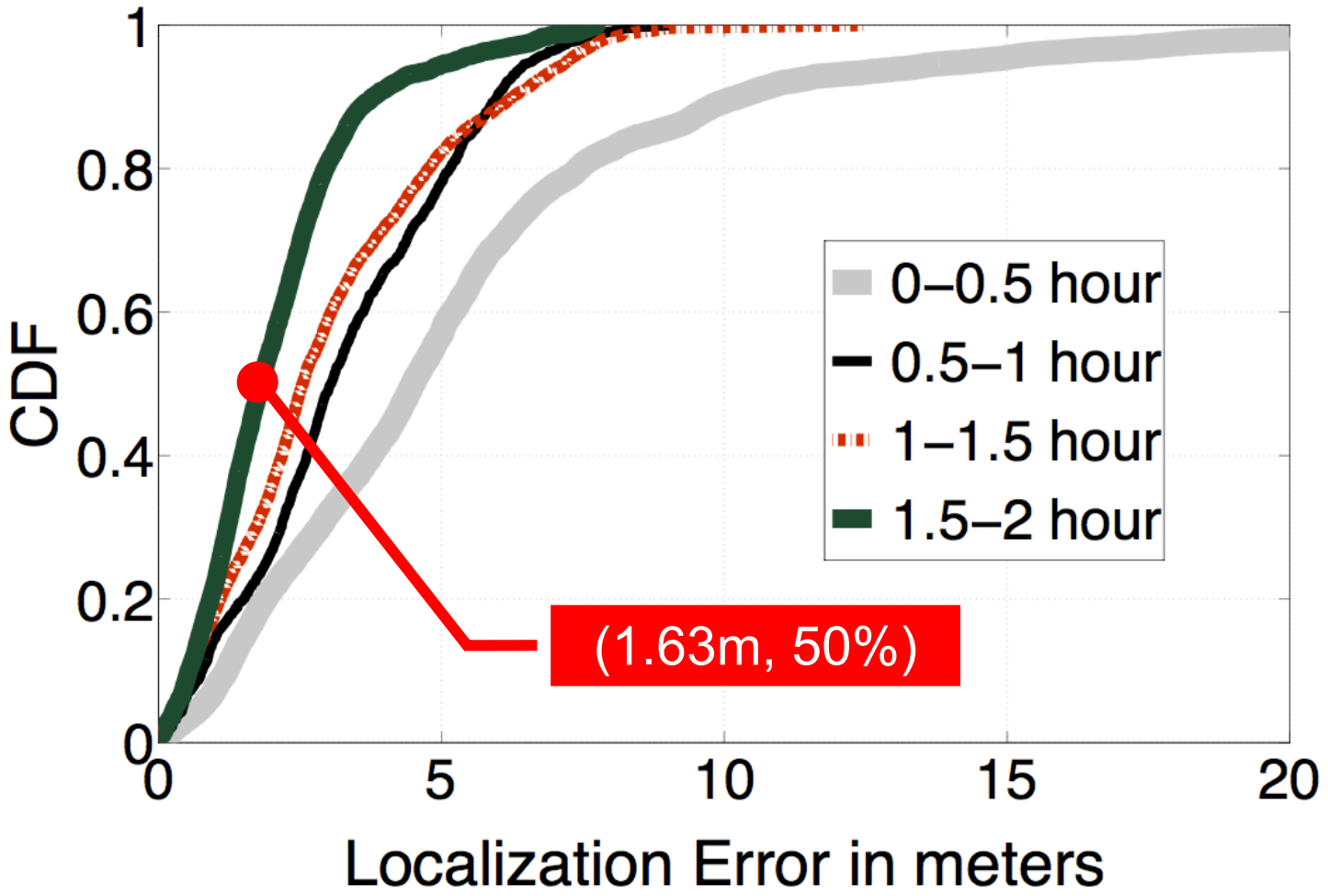
Recursive Algorithm



Performance

Experimentation on 8000 sq. meters

Shopping mall, ECE and CS buildings



Indoor environments rich in landmarks