Smartphone PDR Positioning in Large Environments Employing WiFi, Particle Filter & Backward Optimization.

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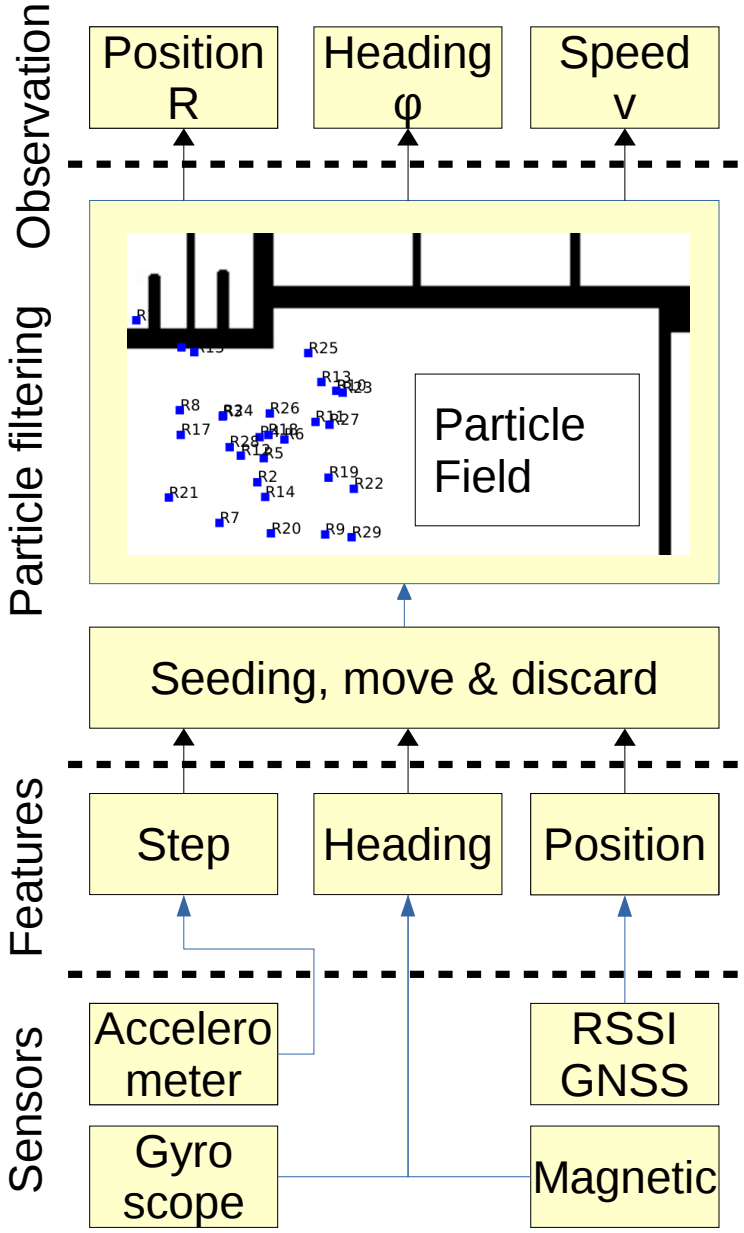
PDR using WiFi, Step detection and Gyro-Magnetic heading. Special features are:

- Particle filter using particles with individual per-particle propagation parameters
- Seeding on existing particles, Backward optimization
- Floor estimation by k-nn fingerprinting using inverse distances instead of RSSI, and scalar product correlation
- Heading gyro/compass fusion algorithm
- Wifi based offset cancellation (heading, steplength)

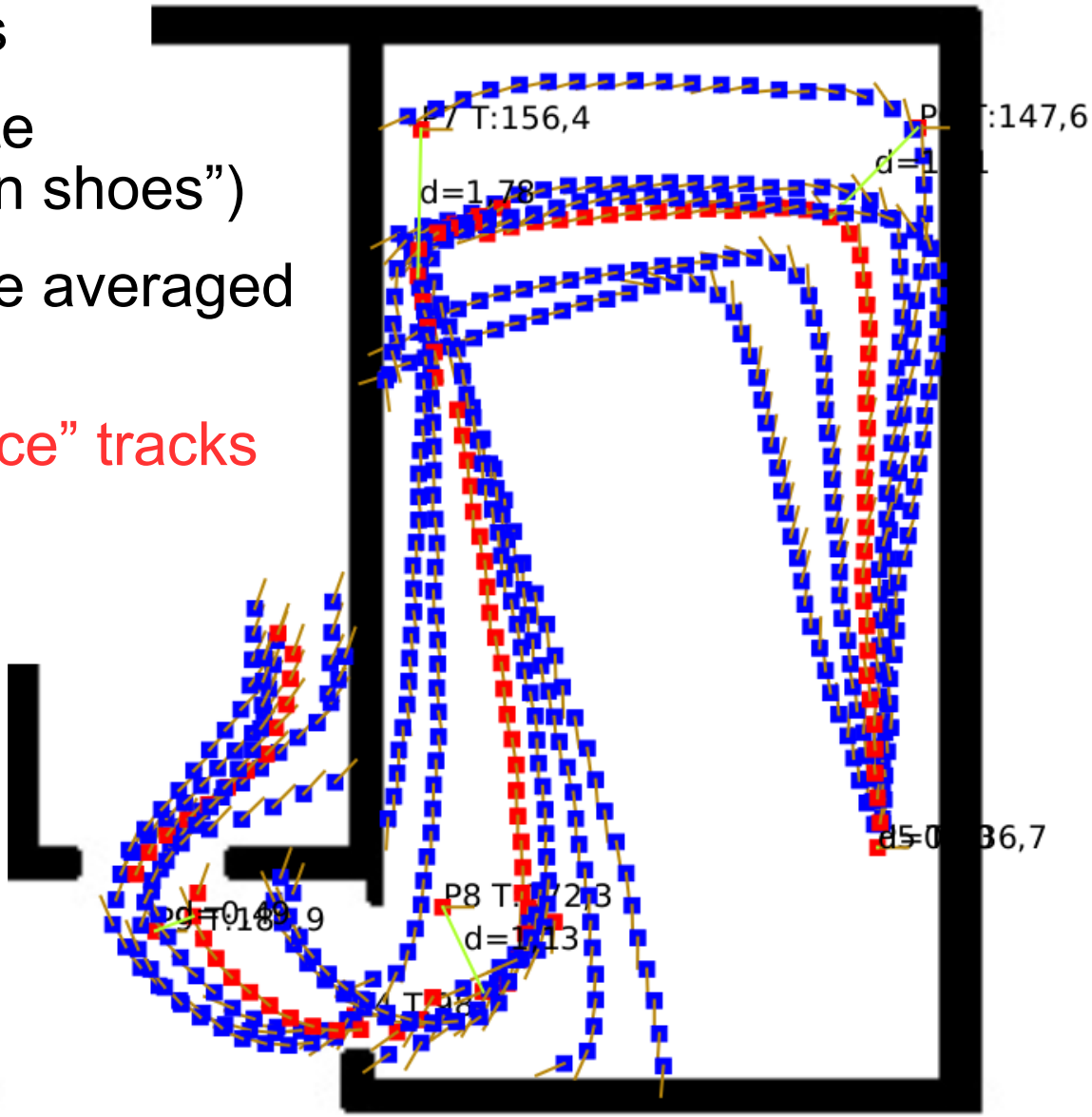
Particle Filter

- Constant particle number
- No weights
- Resampling after each step event:
- Wall colliding particles are replaced with new ones:
  - Seed on positions of existing particles (randomly selected)
  - Individual heading- and step length (random)
- Typical Randomness
  - +-20 deg. of heading
  - +- 20% of step length



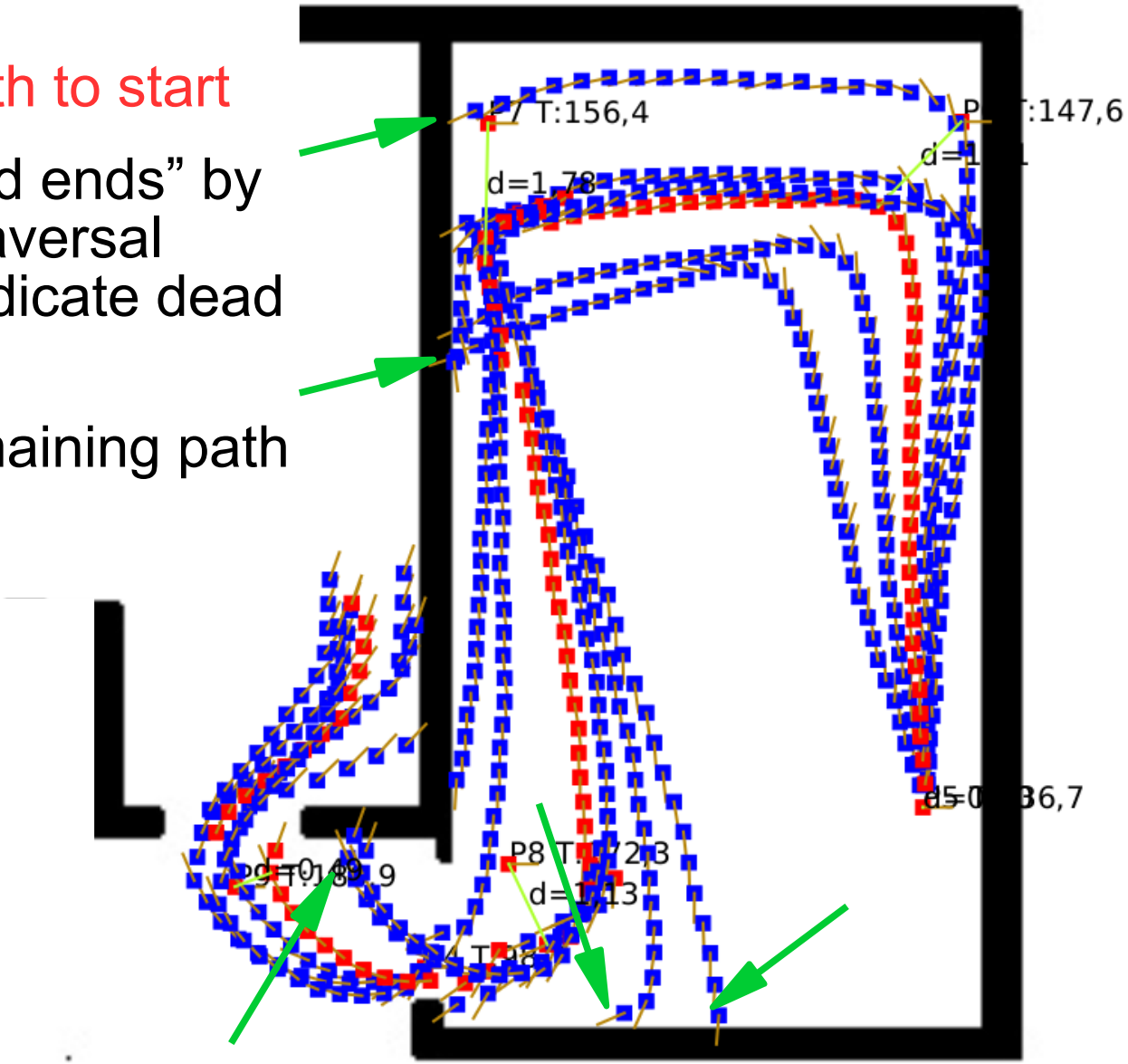
Particle Filter

- Example: 5 Particles
- Blue squares indicate footprint (“blue ink on shoes”)
- Red squares indicate averaged position
- Always complete “nice” tracks

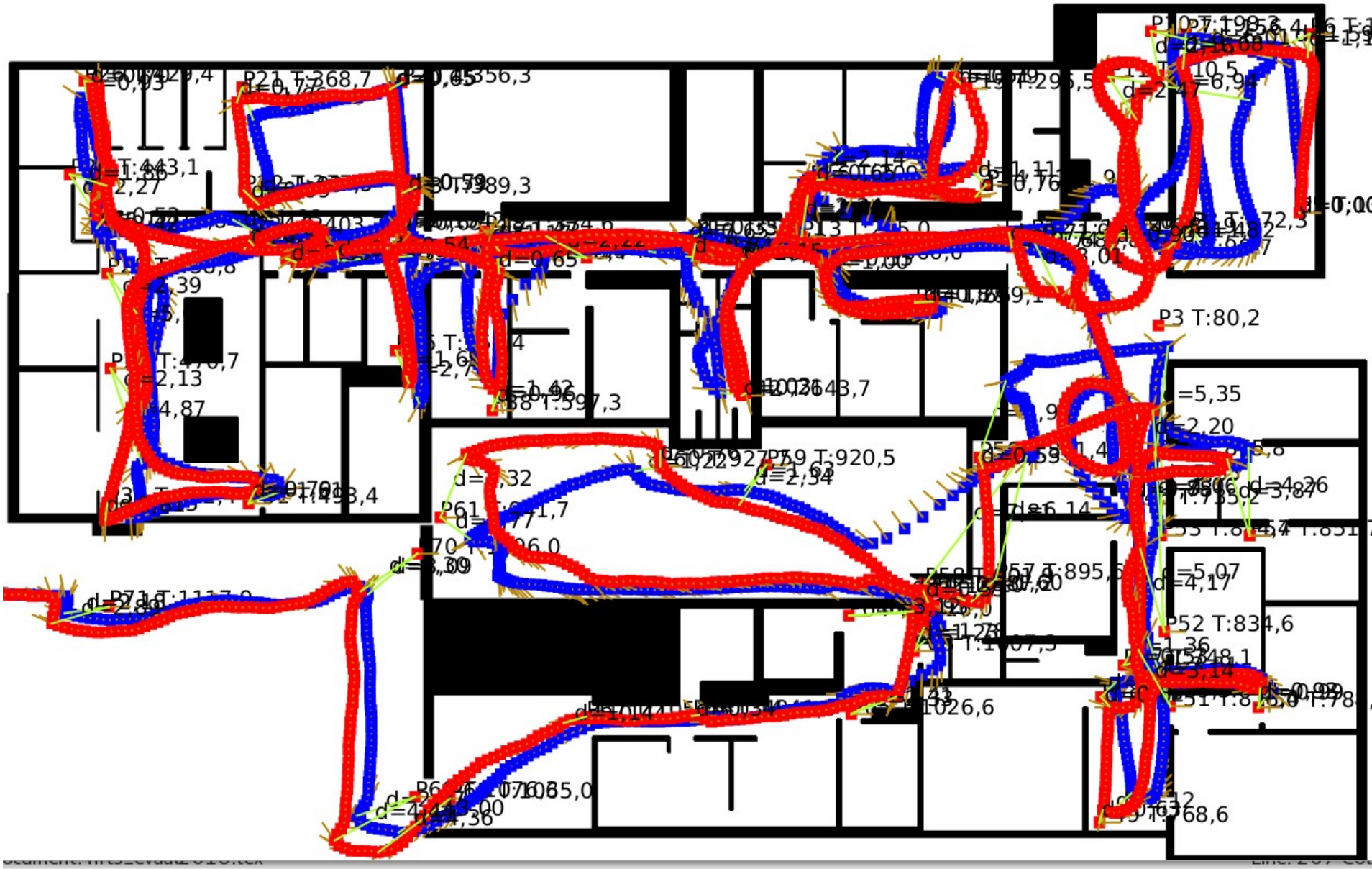


Backtracking optimization

- Always complete uninterrupted path to start
- Removal of “dead ends” by reverse graph traversal (green arrows indicate dead ends)
- Averaging of remaining path

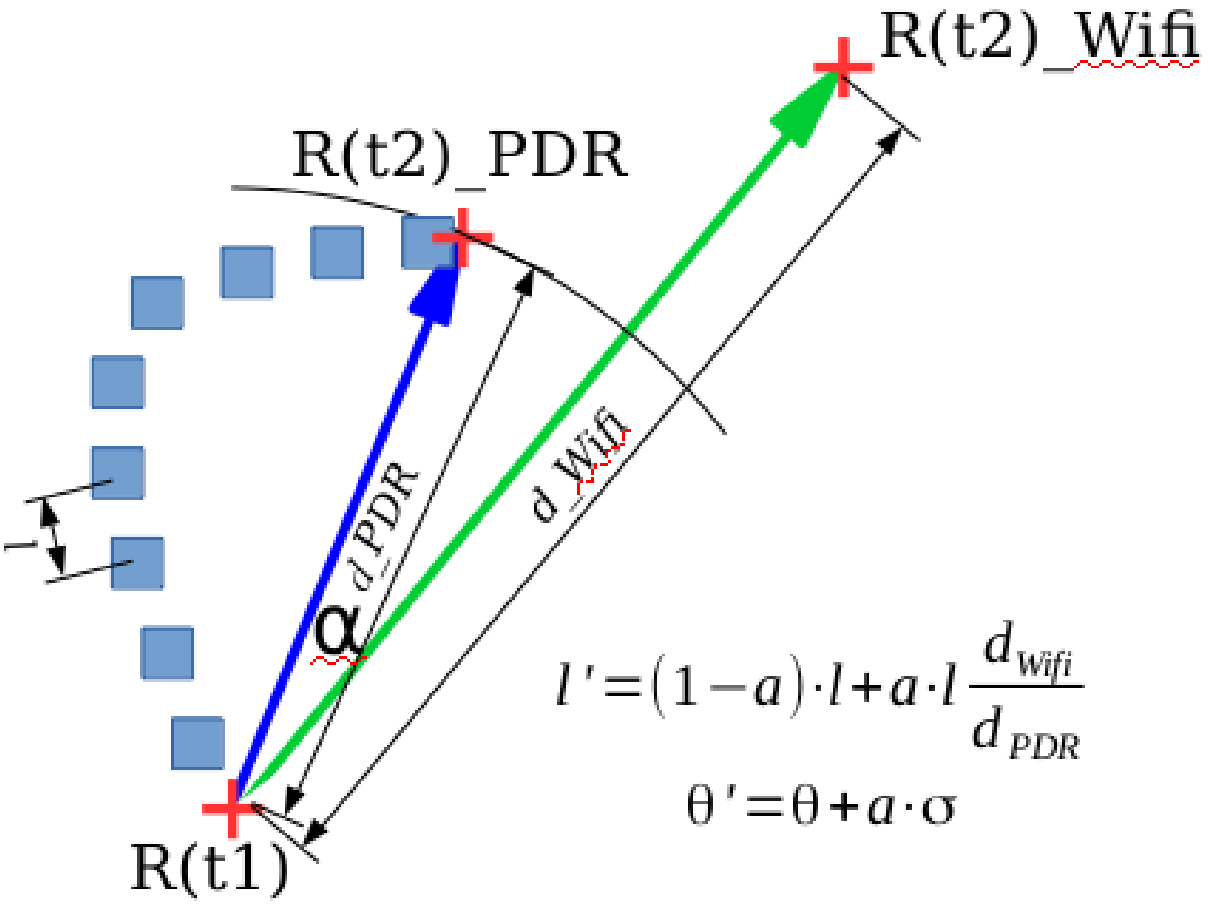


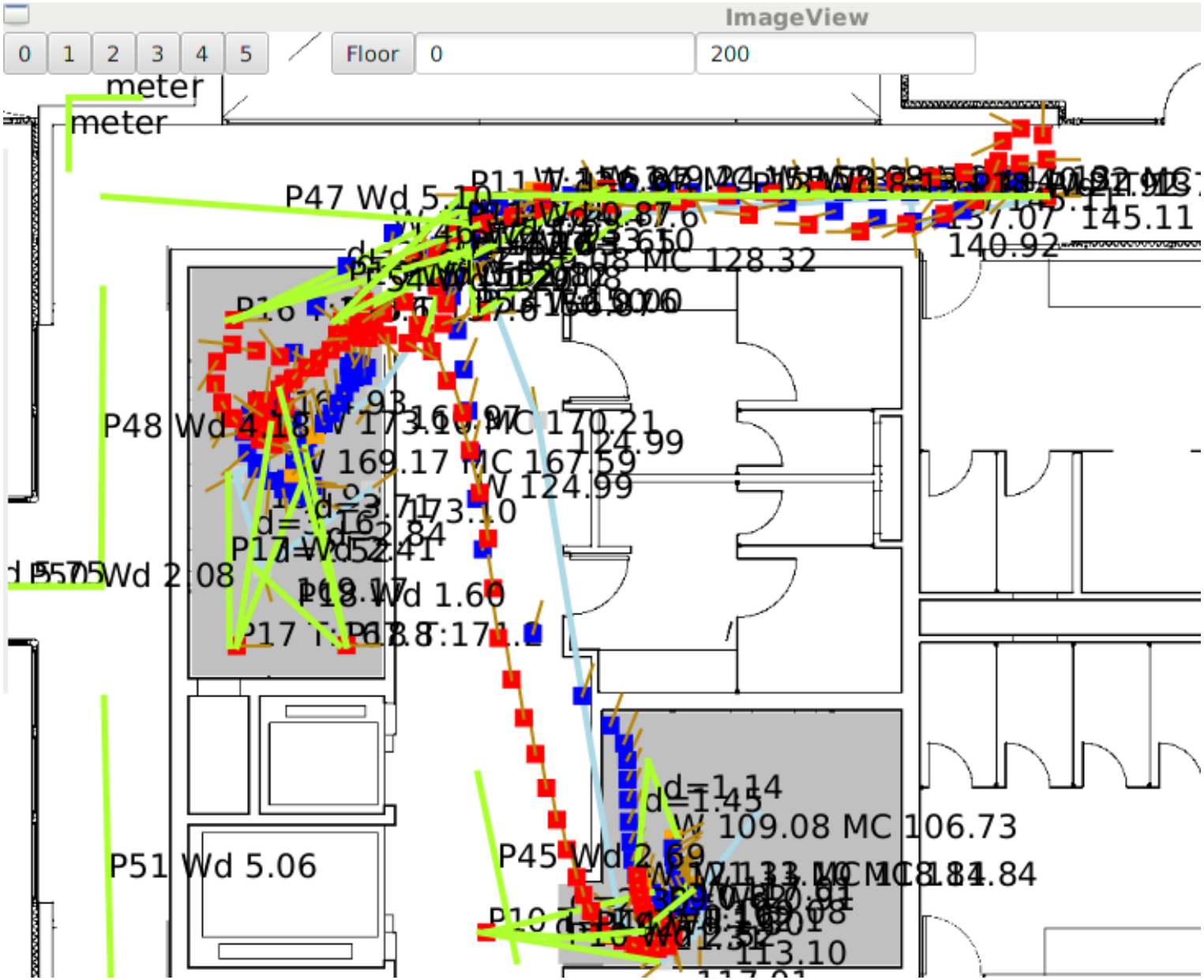
CAR building sample



PDR Wifi Mixing

- Use Wifi estimation to adjust step length and heading
- Coupling parameter, balances between PDR and Wifi
  $a = 0 .. 1$




ImageView
0
1
2
3
4
5
Floor
0
200
meter
meter
P47 Wd 5.10
P48 Wd 4.18
P51 Wd 5.06
P45 Wd 2.69
MC 128.32
MC 170.21
124.99
W 169.17 MC 167.59
W 124.99
W 109.08 MC 106.73
137.07
145.11
140.92
113.10

HFTS team approach:
PDR using WiFi, Step detection and Gyro-Magnetic heading.

Four particular features:

- PF: individual per-particle propagation parameters
- Seeding on existing particles, backward optimization
- k-nn: inverse distances instead of RSSI, cosine metric
- Heading: immediate gyro, long term compass
- Test results: IUB: 3.6 m, ITI: 2.5 m, CAR: ?? (3m..>10 m)

  successful in buildings with information-rich floor plan

- Offsite Competition and Datasets VERY useful for developing and performance evaluation
- We all should publish our measurements and check our algorithms against available databases ...