# CBGL: Fast Monte Carlo Passive Global Localisation of 2D LIDAR Sensor

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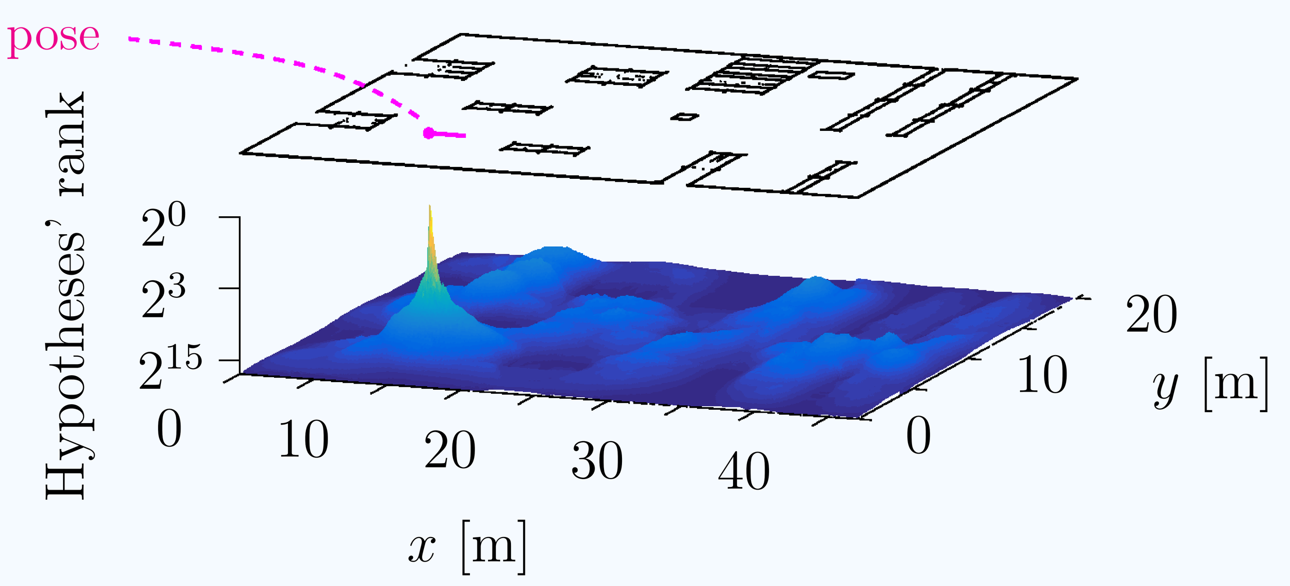
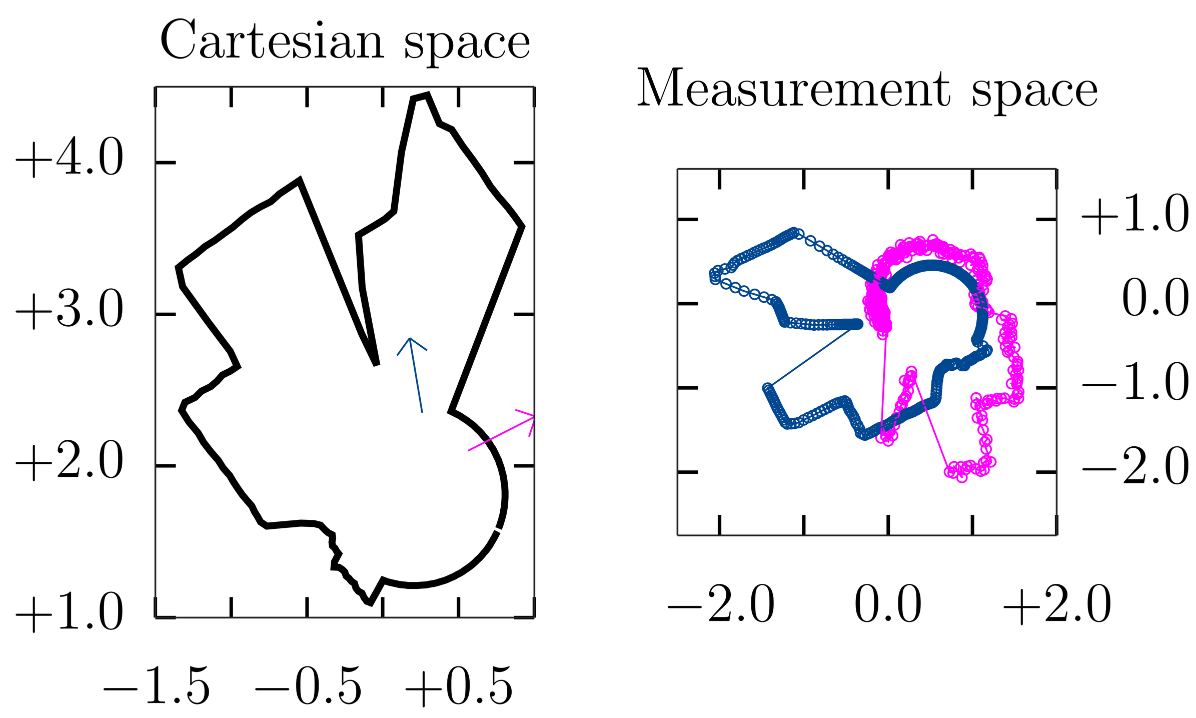
Generate hypotheses randomly → Compute CAER (eq. 1) for each one → Rank them




## Setup & Motivation

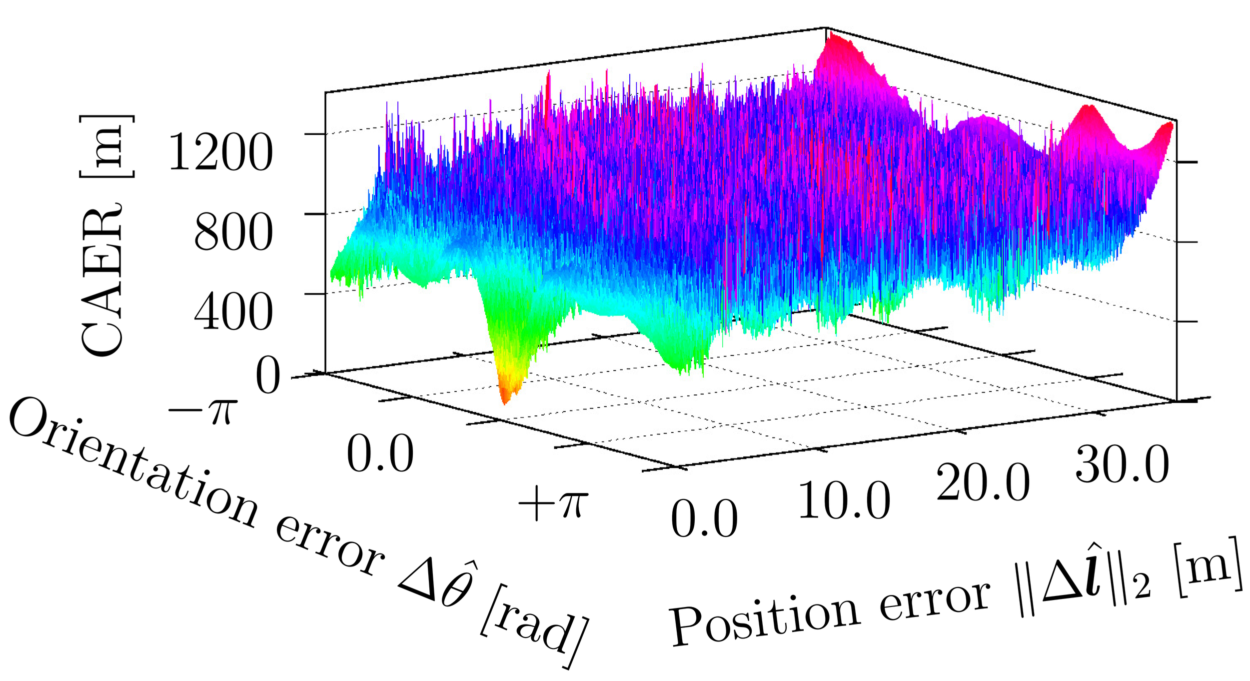


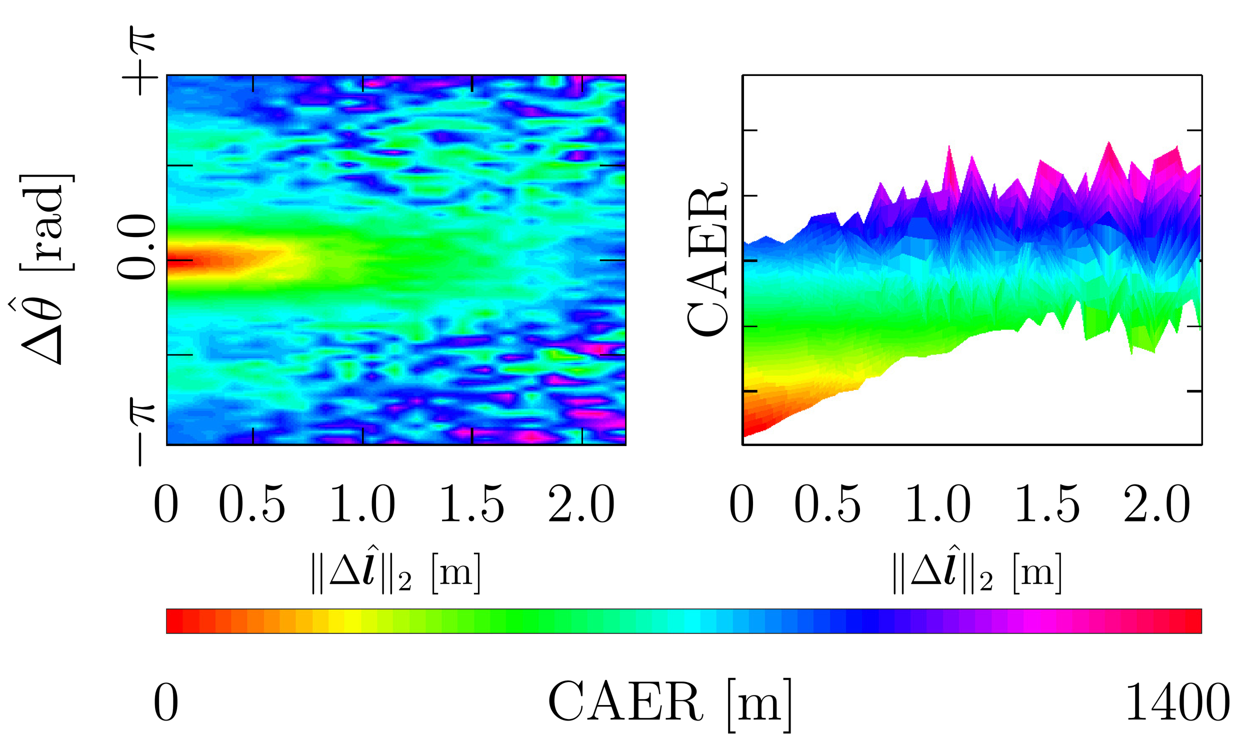

Unknown LIDAR pose $\boldsymbol{p}(x, y, \theta)$ and estimate $\hat{\boldsymbol{p}}(\hat{x}, \hat{y}, \hat{\theta})$. $\boldsymbol{p} - \hat{\boldsymbol{p}} = (\Delta\hat{\boldsymbol{l}}, \Delta\hat{\theta})$

Real $\mathcal{S}_R(\boldsymbol{p})$ and virtual $\mathcal{S}_V(\hat{\boldsymbol{p}})$ scans, in the local coordinate frame of each sensor

**Definition 1.** The Cumulative Absolute Error per Ray (CAER) metric

$$\text{CAER}(\mathcal{S}_R, \mathcal{S}_V) \triangleq \sum_{n=0}^{\text{scan rays}-1} \Big| \mathcal{S}_R[n] - \mathcal{S}_V[n] \Big| \quad (1)$$



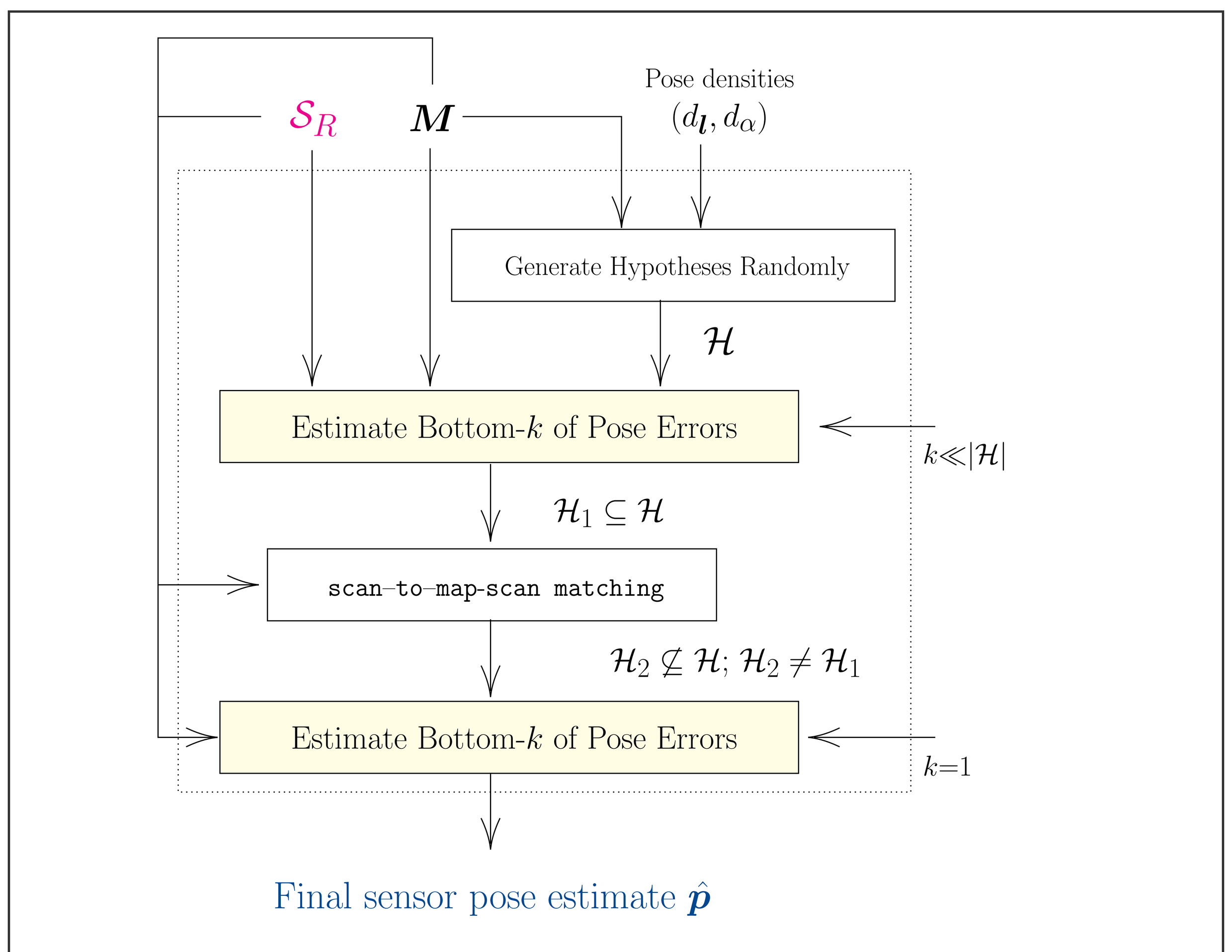

## The gist

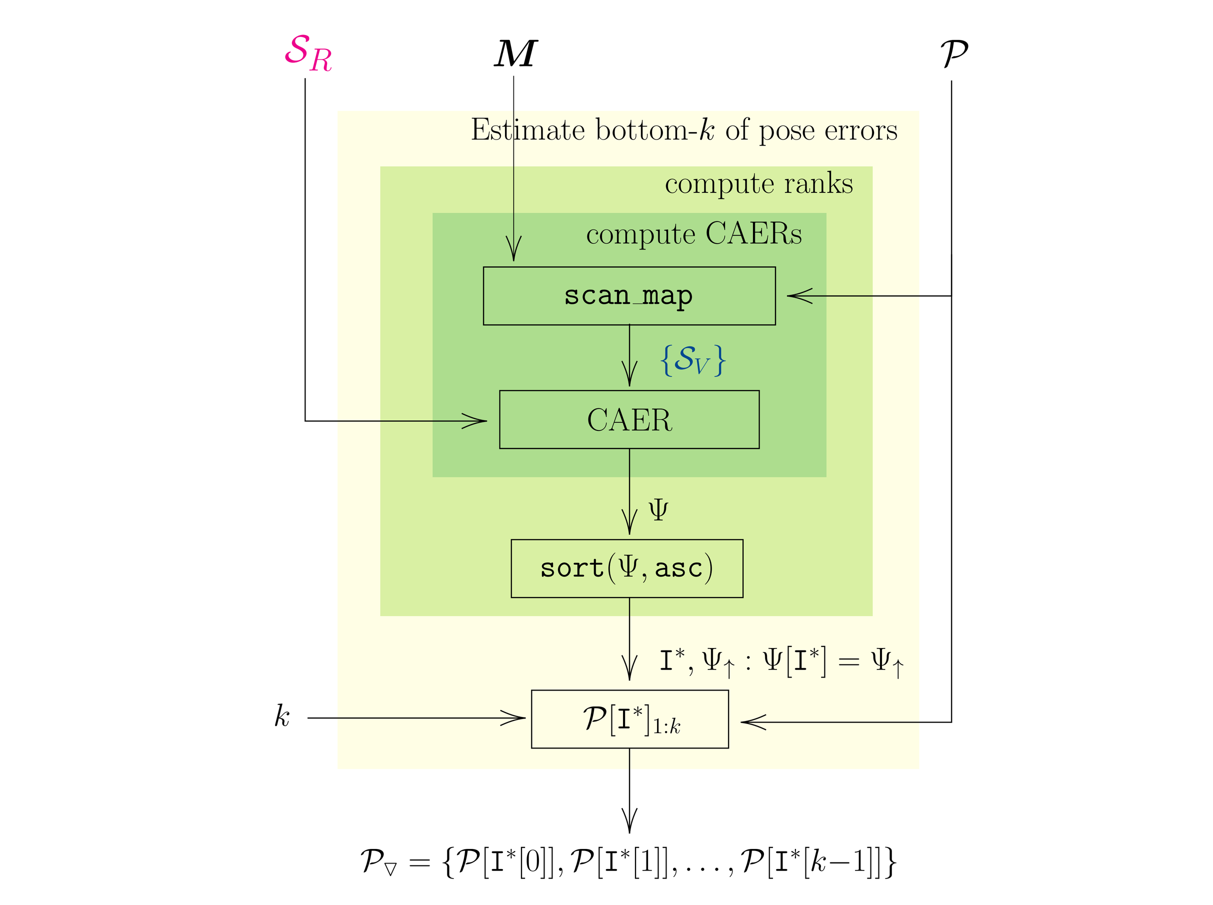
The method estimates the pose of a 2D LIDAR given only a single measurement and the map of the environment, while

- being robust against
  - environment repetitions
  - map distortions
  - sensor noise
  - sensor FOV (radial & angular)
- executing at $\approx$ 1 sec per 100 $\text{m}^2$ of environment area
- requiring no parameters to be tuned
- making no assumptions about the environment

because CAER (eq. (1))

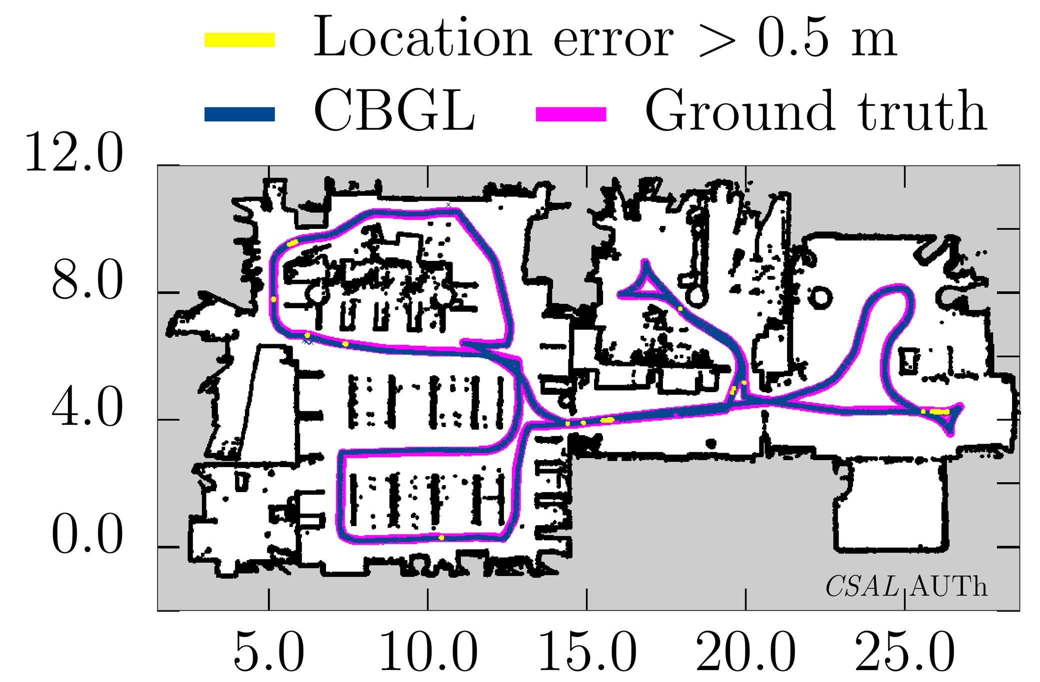
- scales with position and orientation error
- is computationally cheap at $\sim O(\text{sensor rays})$

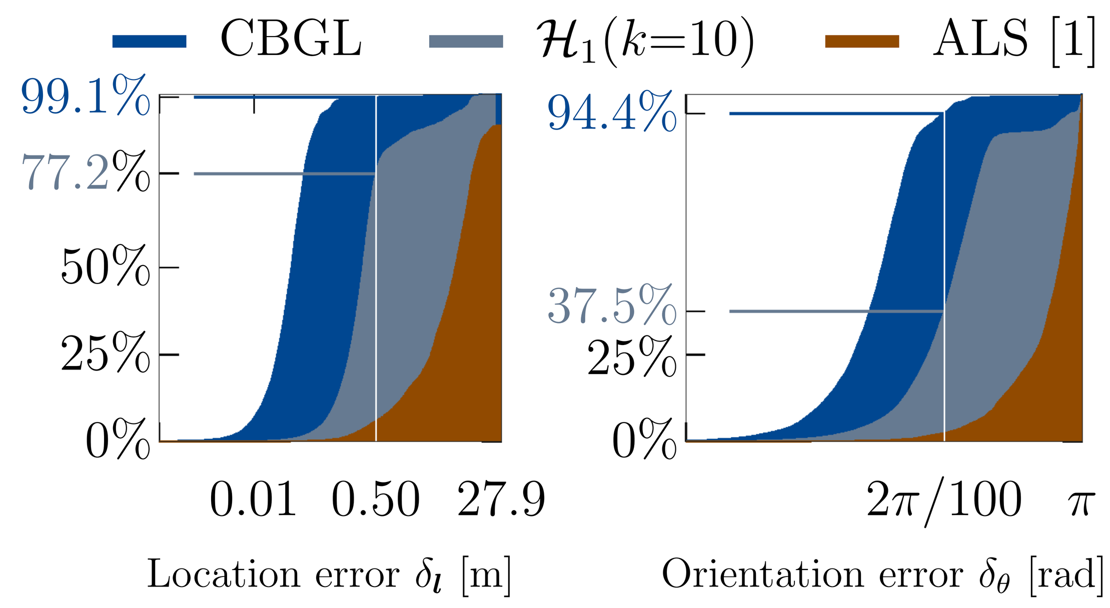


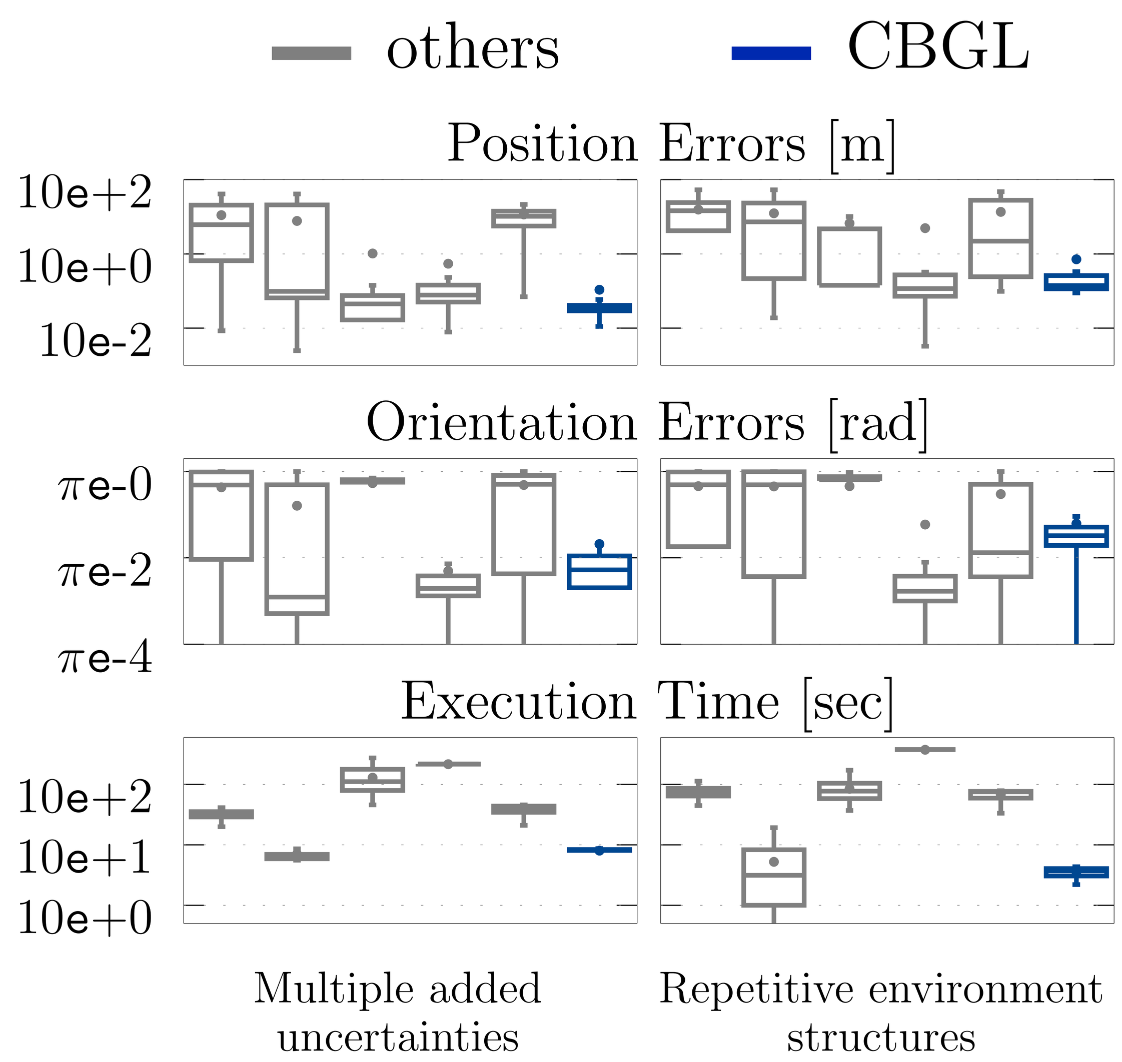




## Experiments with real and synthetic data

| In > 6000 attempts | Mean Position Error [m] | Mean Orientation Error [rad] | Mean Execution Time [sec] |
|---|---|---|---|
| ALS [1] | 0.500 | 1.956 | 6.15 |
| CBGL | **0.041** | **0.011** | **1.61** |




[1] Naoki Akai, “Reliable Monte Carlo Localization for Mobile Robots”, *Journal of Field Robotics*, 2023