

Robots Autónomos

Simultaneous Localization and Mapping (SLAM)

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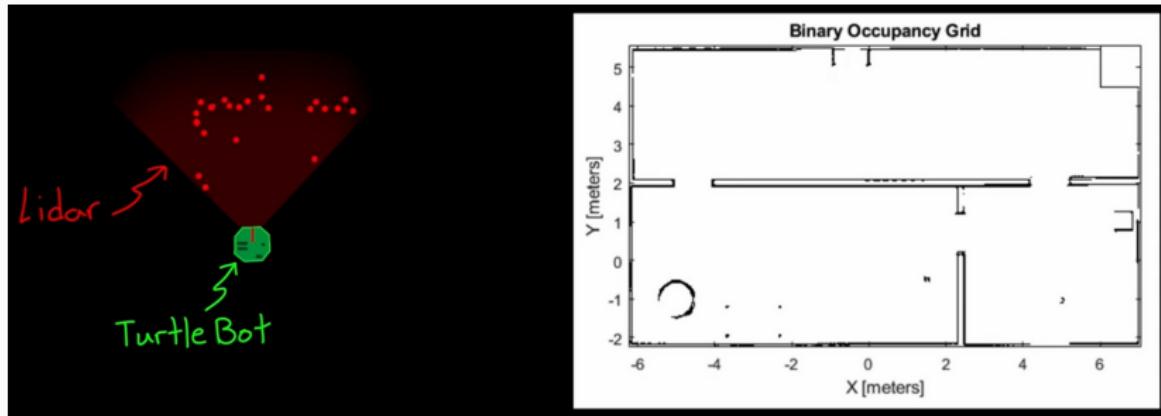
Simultaneous Localization and Mapping (SLAM)

Las técnicas de SLAM intentan resolver dos problemas en robótica autónoma de forma simultánea:

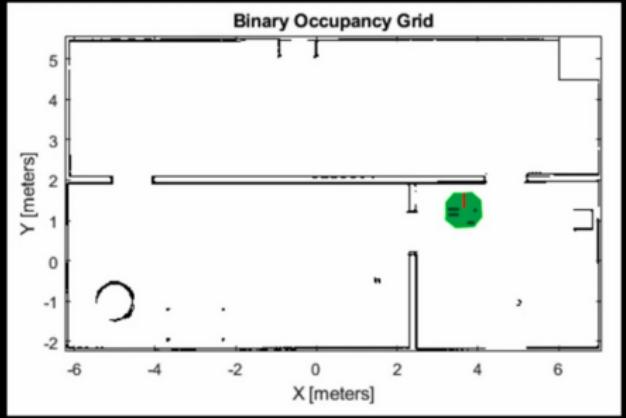
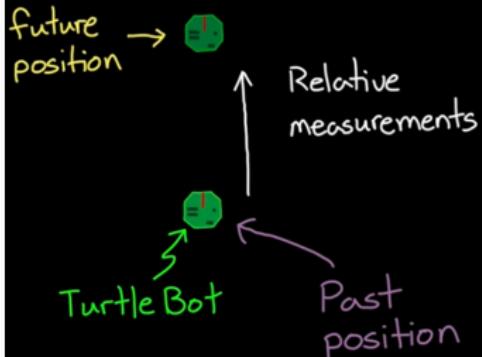
- Situar el robot dentro de un mapa (*localization*)
- Construir un mapa del entorno autónomamente (*mapping*)

Imágenes tomadas de la documentación de Matlab sobre SLAM preparadas por Brian Douglas.

Localización: Información de sensores



Localización: Información de odometría



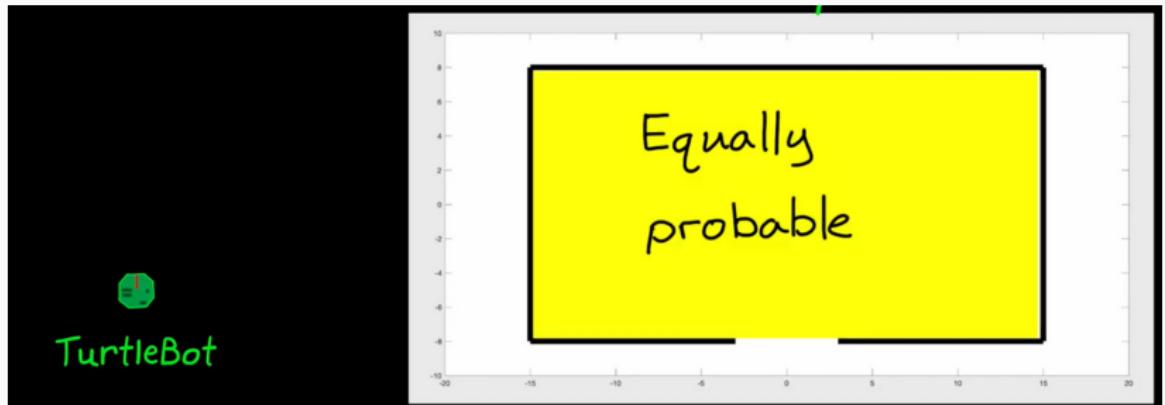
Localización

Los datos captados de los sensores sigue una distribución de probabilidad normal.

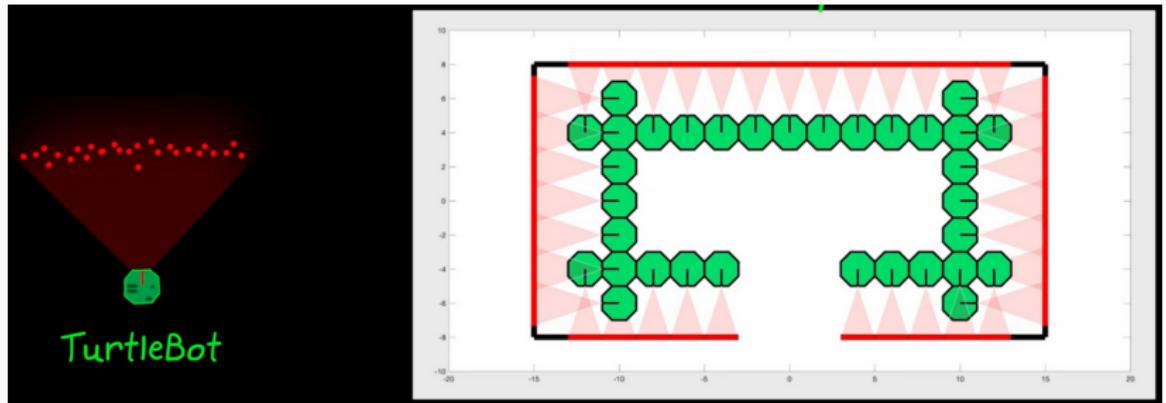
La estimación de la posición del robot mediante odometría también sigue una distribución de probabilidad normal.

Si la estimación de la posición del robot en el mundo siguiera también una distribución de probabilidad normal (no es el caso) la fusión de información sensorial y odometría se podría realizar mediante métodos como el filtro de Kalman.

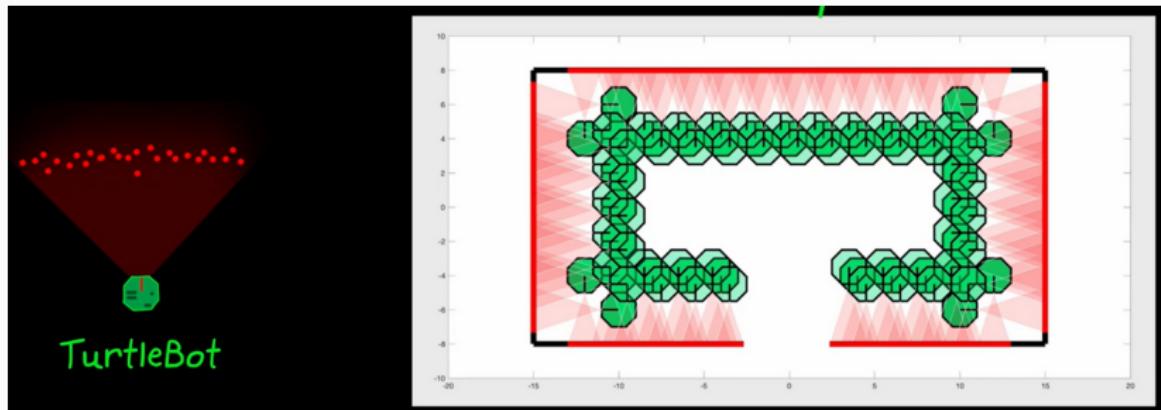
Localización: Planteamiento



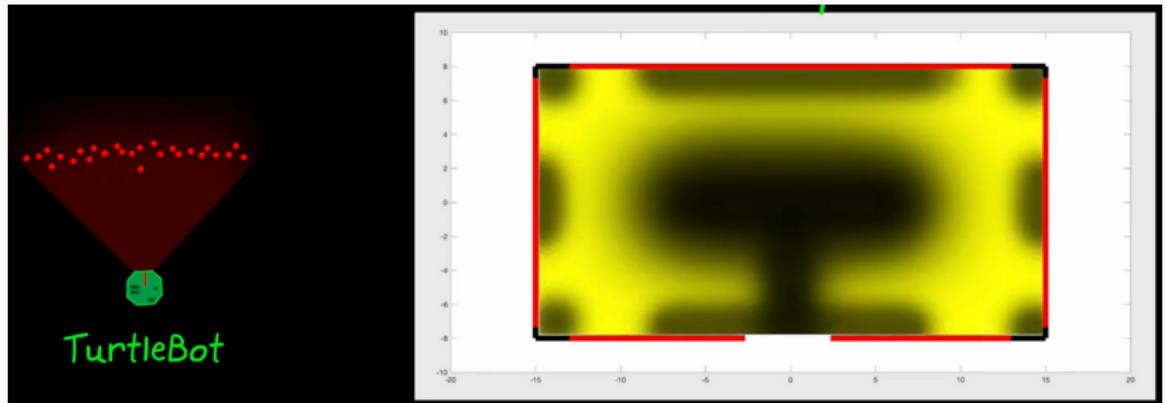
Localización: Planteamiento



Localización: Planteamiento



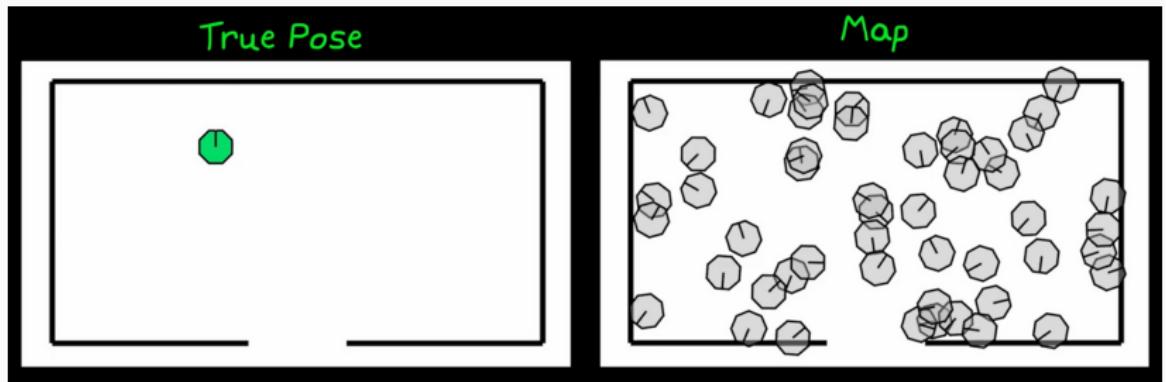
Localización: Planteamiento



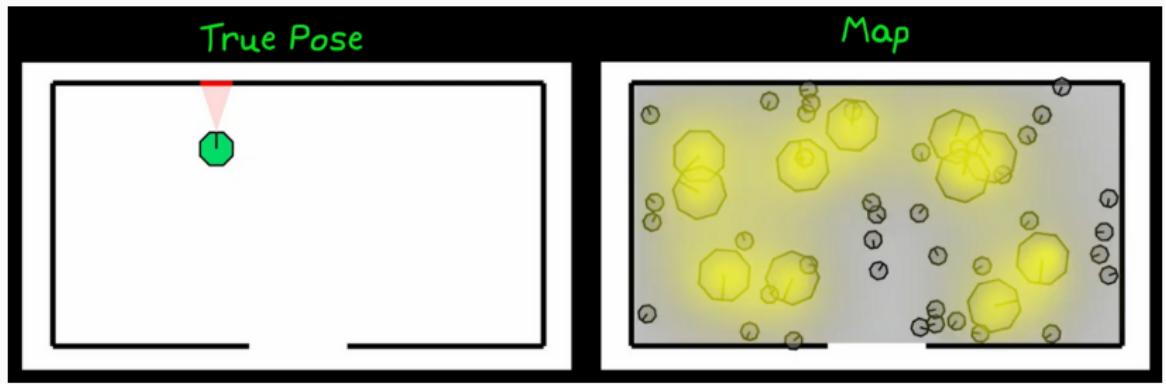
Localización: Filtro de partículas



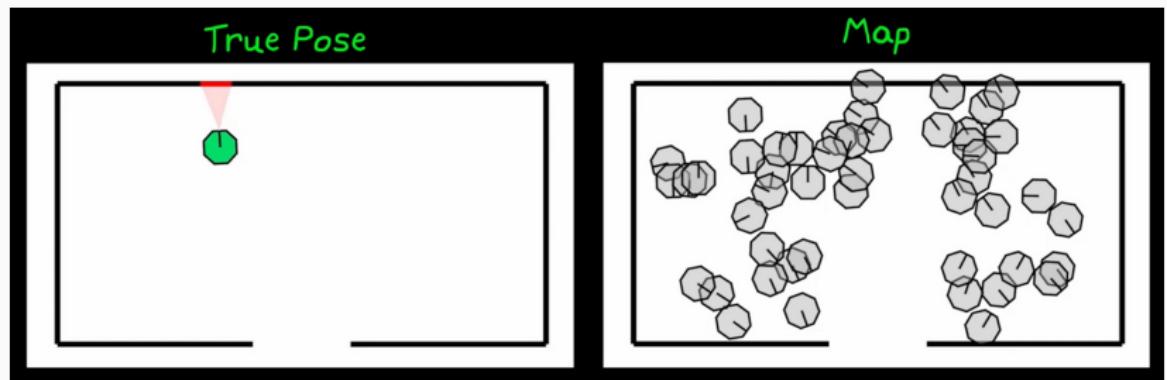
Localización: Filtro de partículas



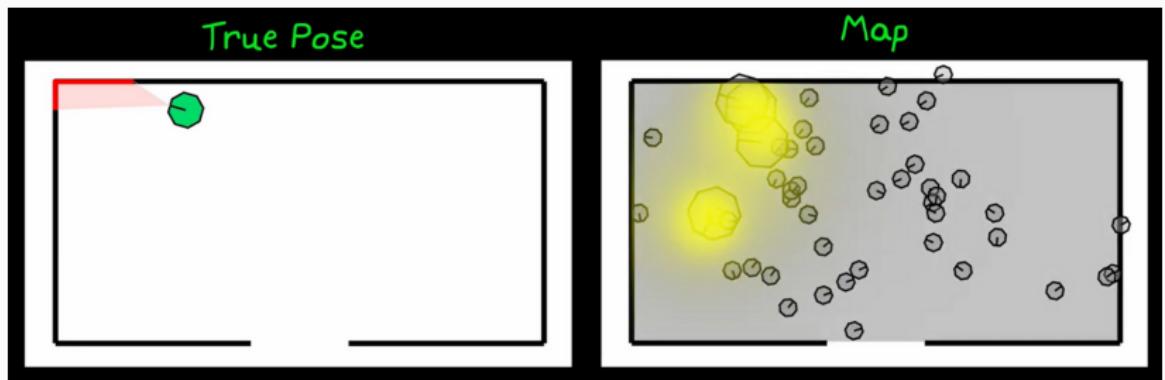
Localización: Filtro de partículas



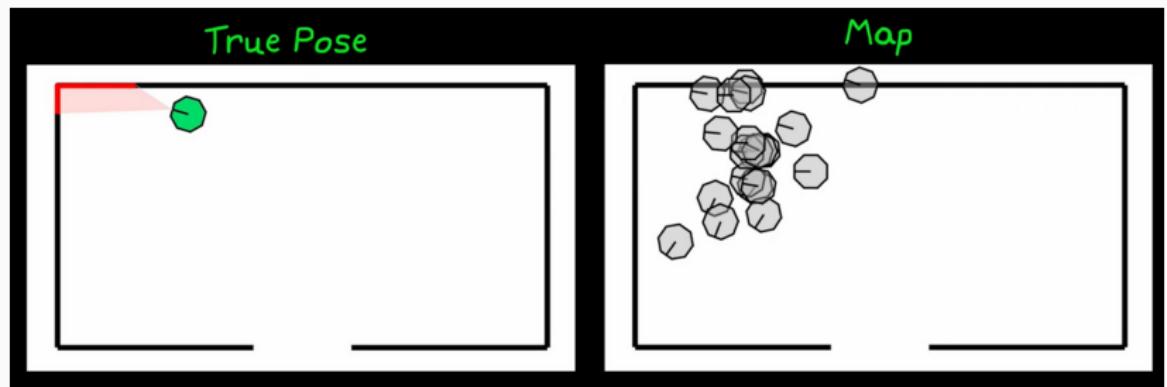
Localización: AMCL (Adaptive Monte Carlo Localization)



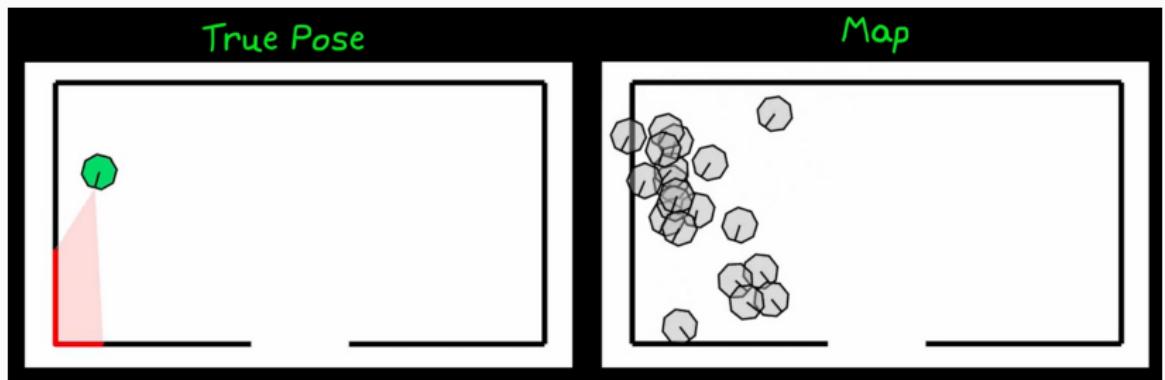
Localización: AMCL (Adaptive Monte Carlo Localization)



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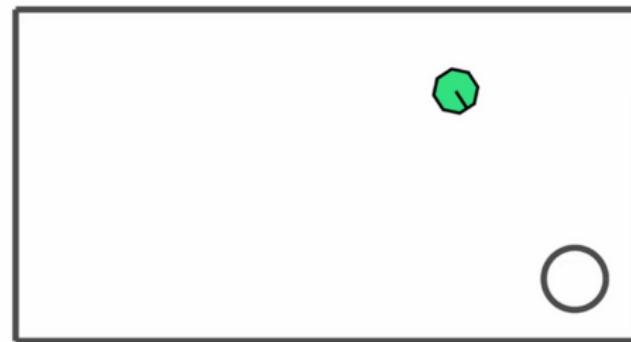


En el caso general, el mapa del entorno no se conoce por lo que el planteamiento es localizar al robot en el mapa *a la vez que se crea*.

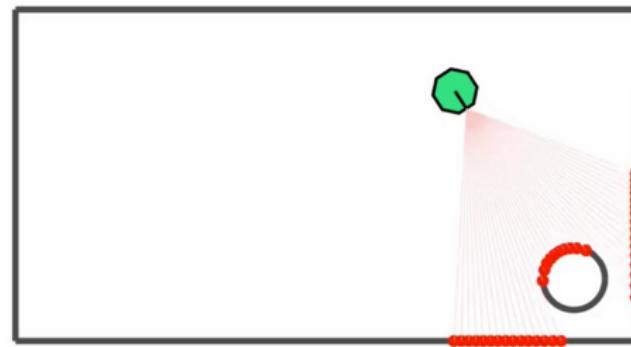
Existen dos familias de métodos:

- **Filtrado**: el estado se estima a partir de las medidas más recientes (filtro de Kalman extendido, filtro de partículas).
- **Optimización o suavizado**: el estado y las trayectorias se estiman usando todas las medidas (*pose graph optimization*).

Pose Graph Optimization: Caso ideal



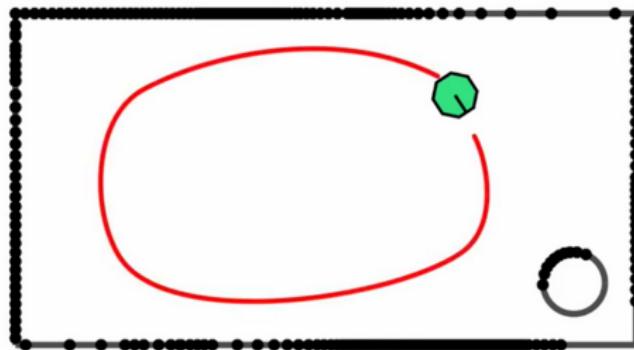
Pose Graph Optimization: Caso ideal



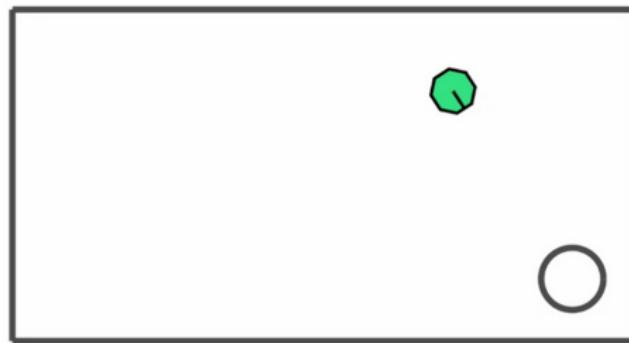
Pose Graph Optimization: Caso ideal



Pose Graph Optimization: Caso ideal



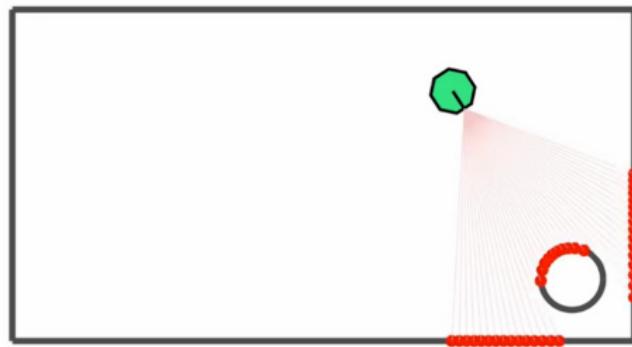
Pose Graph Optimization: Odometría real



Real and Estimated Robot Poses



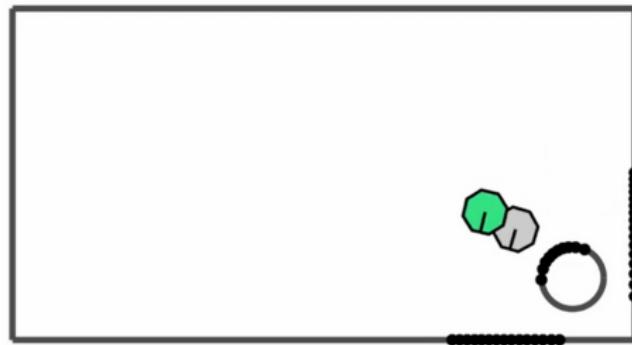
Pose Graph Optimization: Odometría real



Real and Estimated Robot Poses

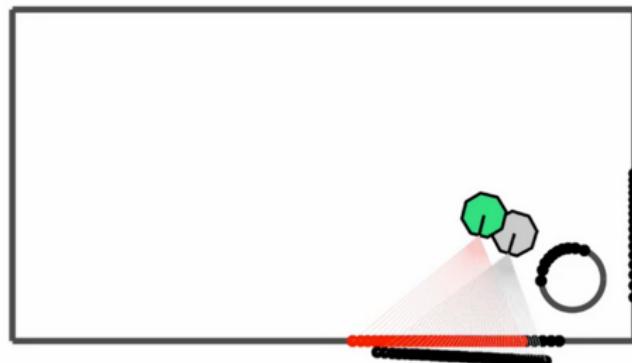


Pose Graph Optimization: Odometría real



Real and Estimated Robot Poses

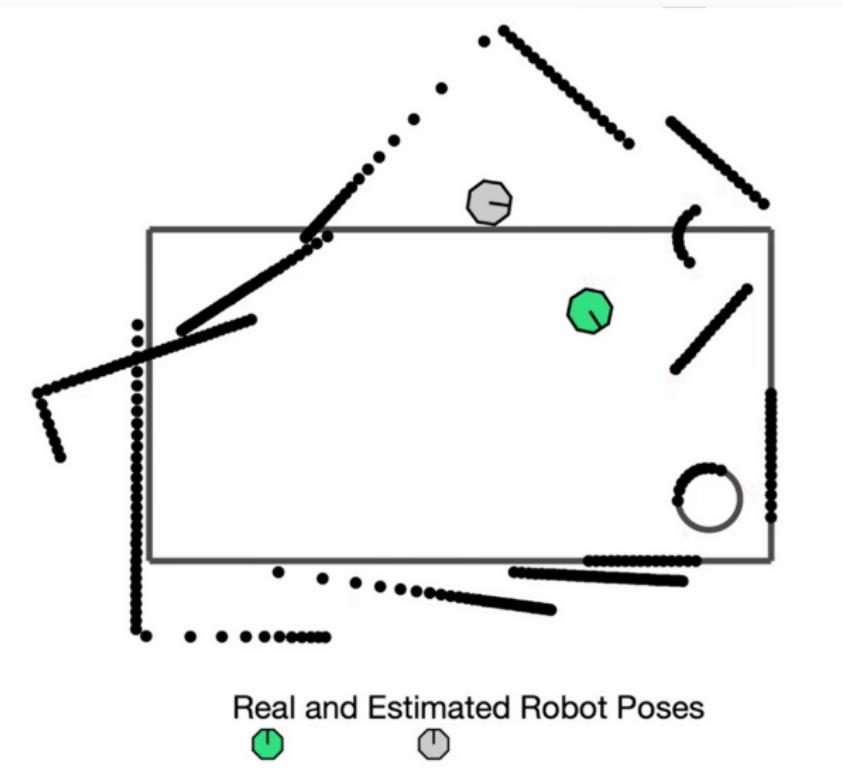
Pose Graph Optimization: Odometría real



Real and Estimated Robot Poses



Pose Graph Optimization: Odometría real



Pose Graph Optimization

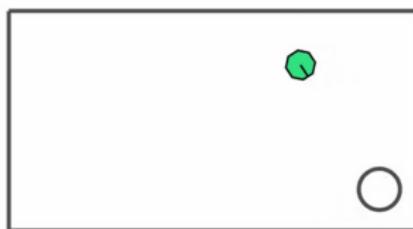


Real and Estimated Robot Poses



Pose Graph

Pose Graph Optimization



Real and Estimated Robot Poses



Pose Graph

Pose Graph Optimization

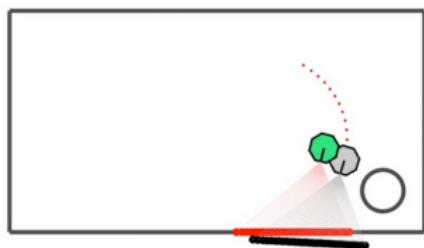


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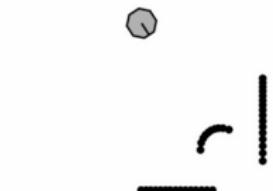


Pose Graph

Pose Graph Optimization



Real and Estimated Robot Poses

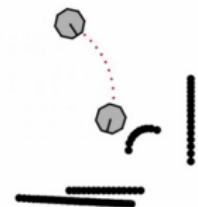


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Pose Graph Optimization

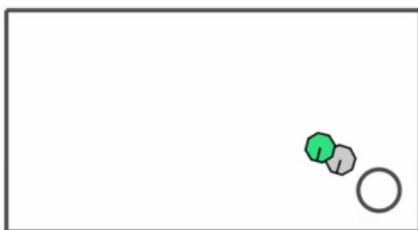


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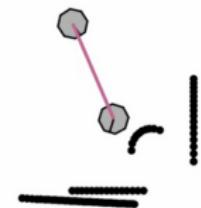


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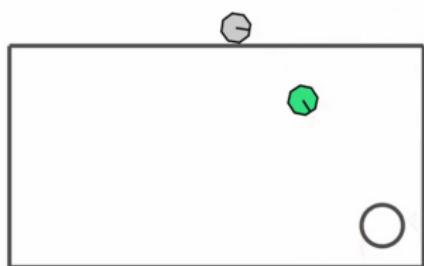


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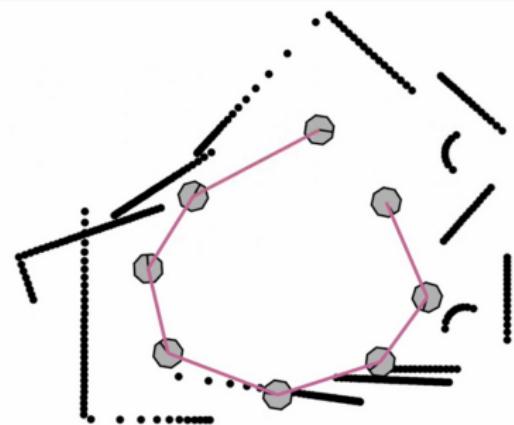


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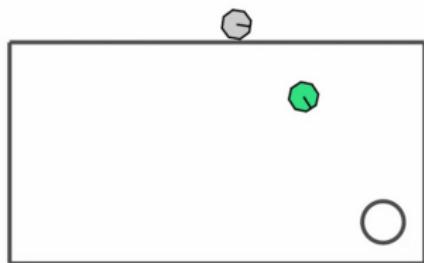


Real and Estimated Robot Poses
● ●

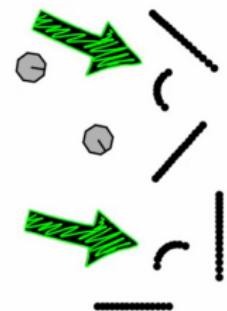


Pose Graph

Pose Graph Optimization

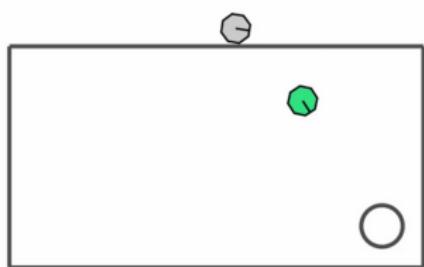


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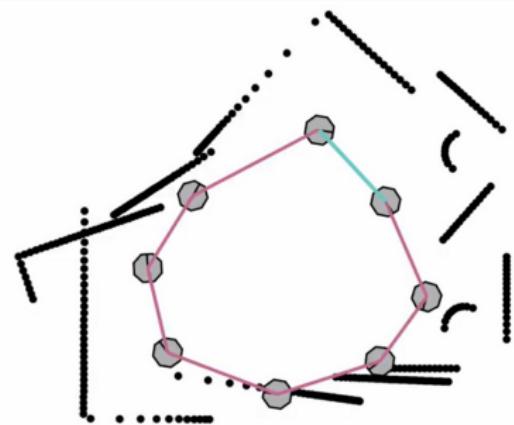


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Pose Graph Optimization

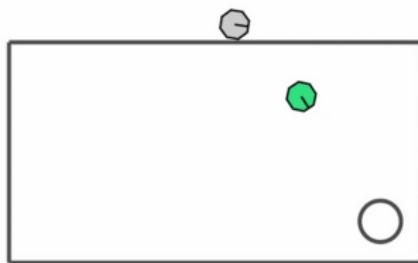


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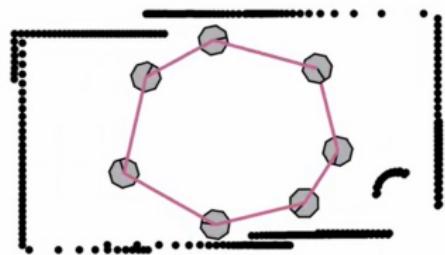


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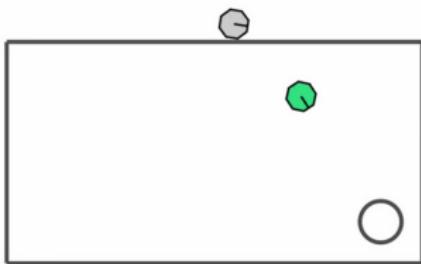


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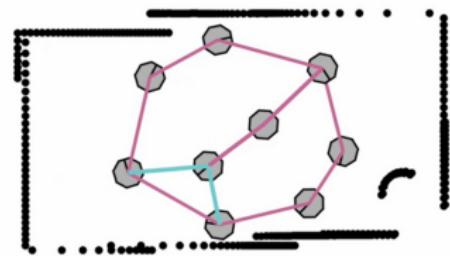


Pose Graph
Optimization

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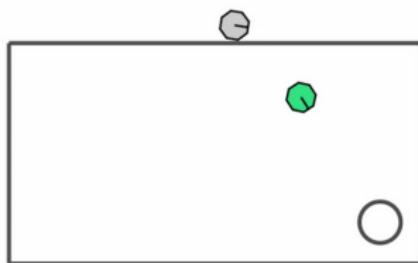


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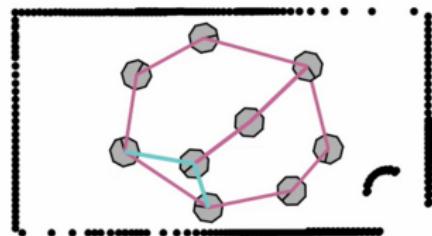


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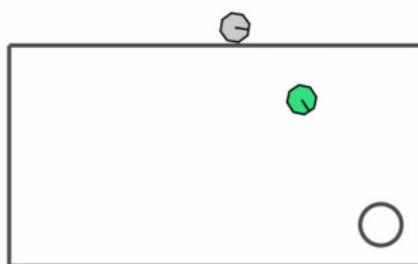


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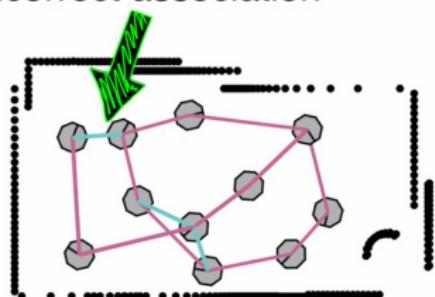
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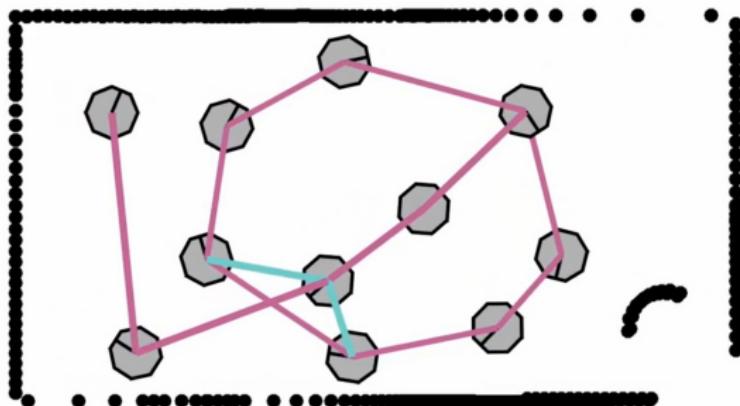
Real and Estimated Robot Poses
● ●

If this is an incorrect association



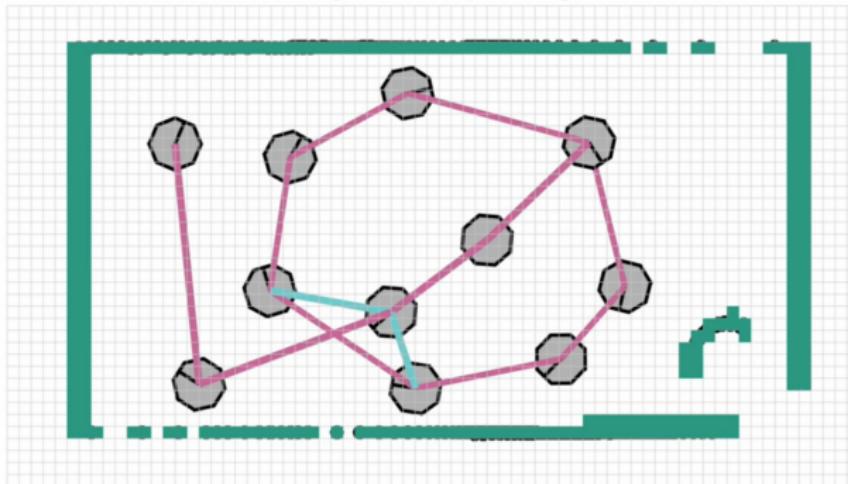
Pose Graph
Optimization

Occupancy Grids



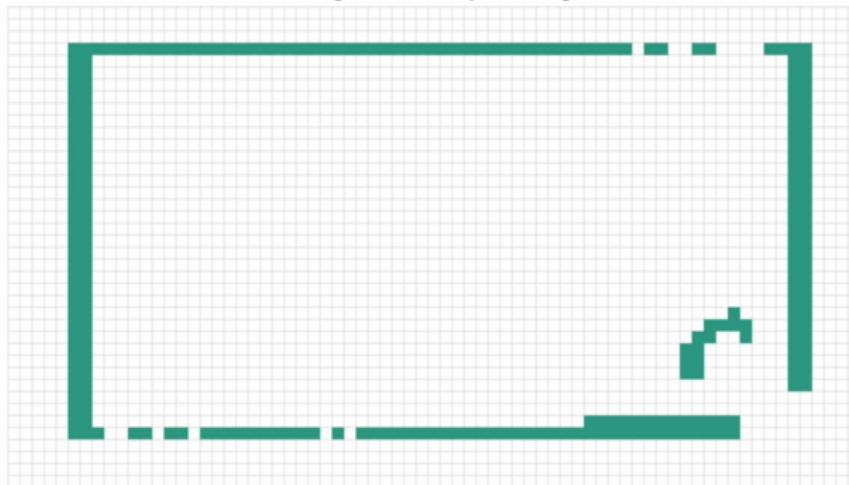
Occupancy Grids

Binary Occupancy Grid



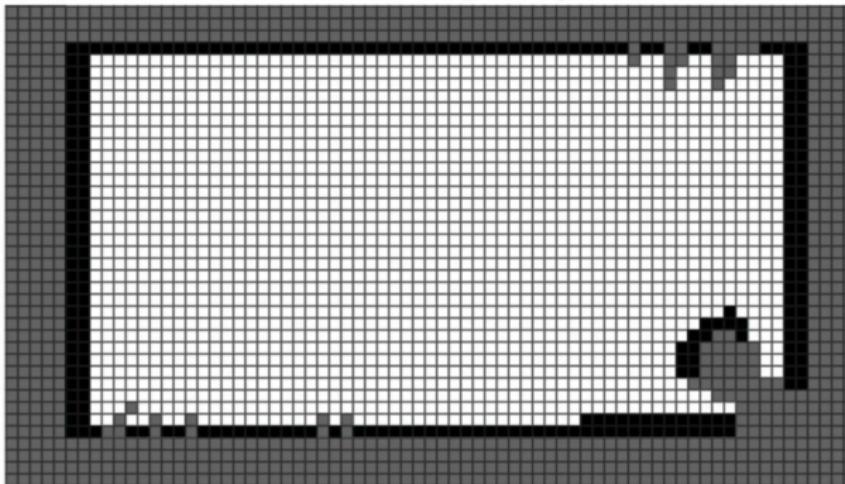
Occupancy Grids

Binary Occupancy Grid



Occupancy Grids

Probabilistic Occupancy Grid



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