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Autonomous Vehicles Team Star Tech Stack

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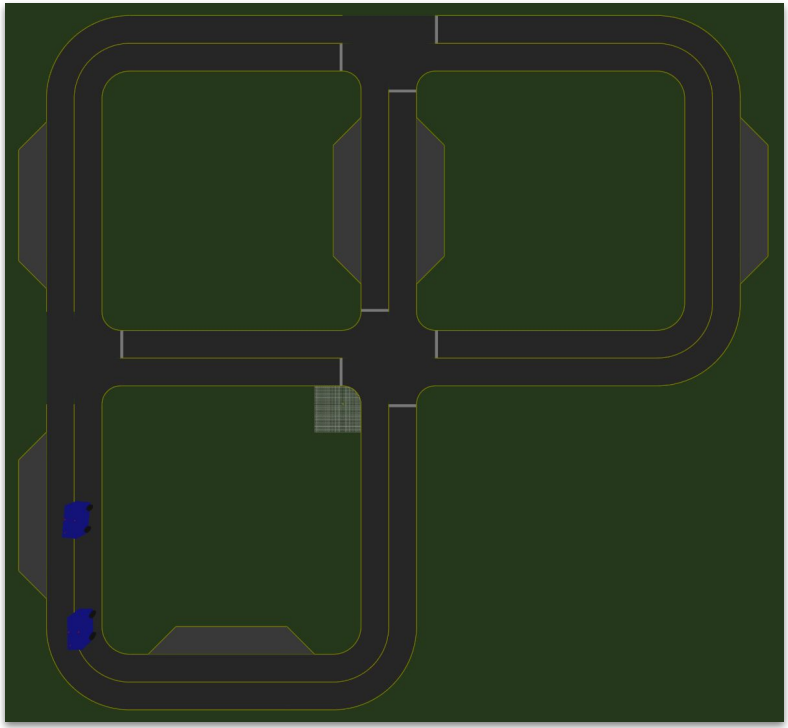
Challenge Overview

Objective: Have a fully autonomous vehicle operate within a defined city-like environment and pick up passengers as instructed.



Problem Modules

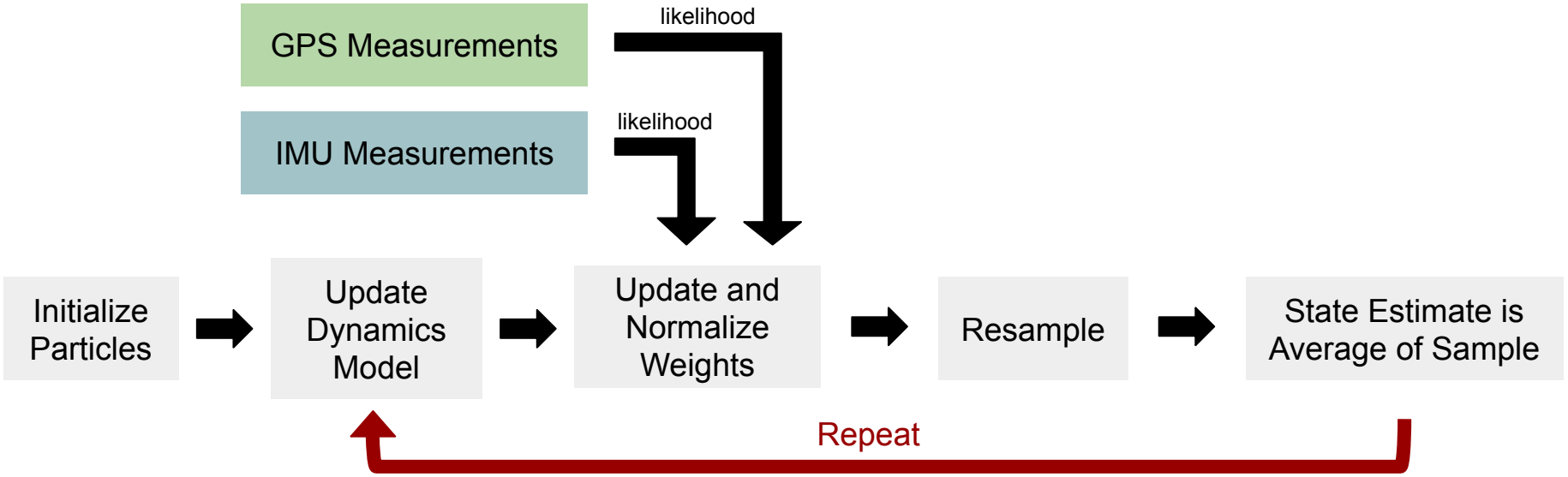
Localization

Motion Planning

Routing

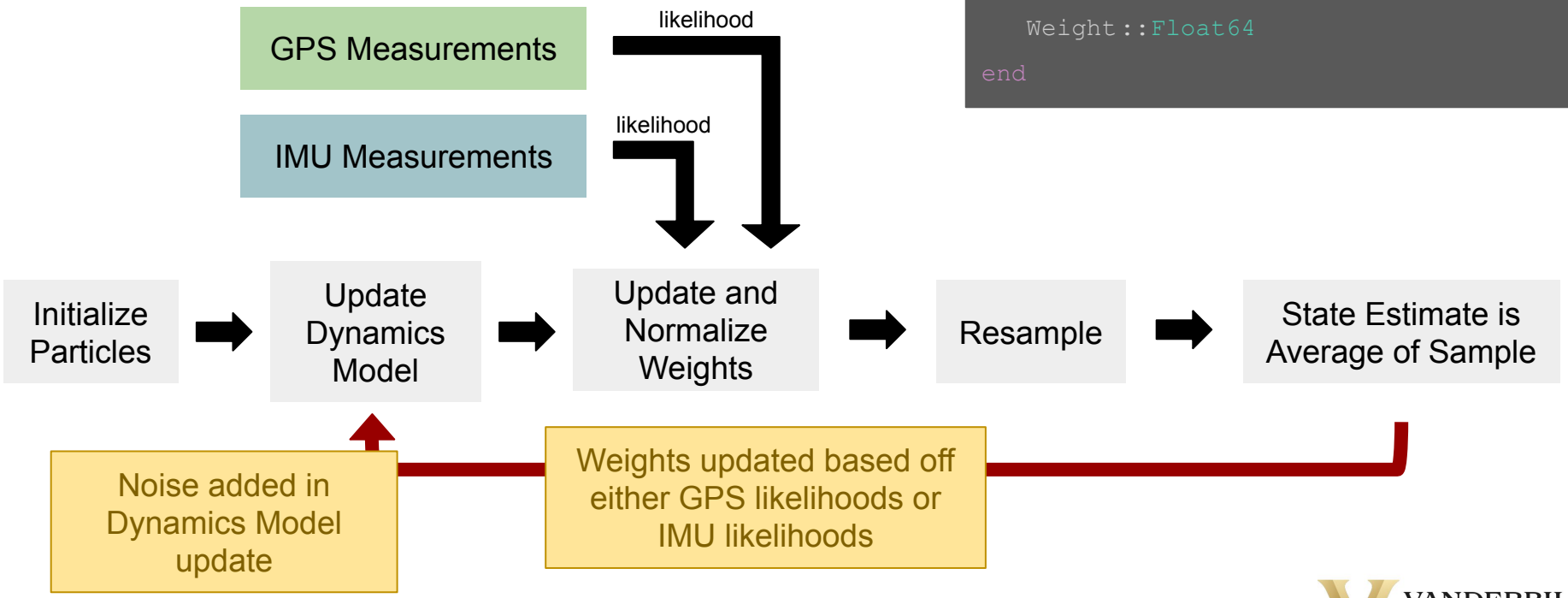
Perception

Particle Filtering for Localization



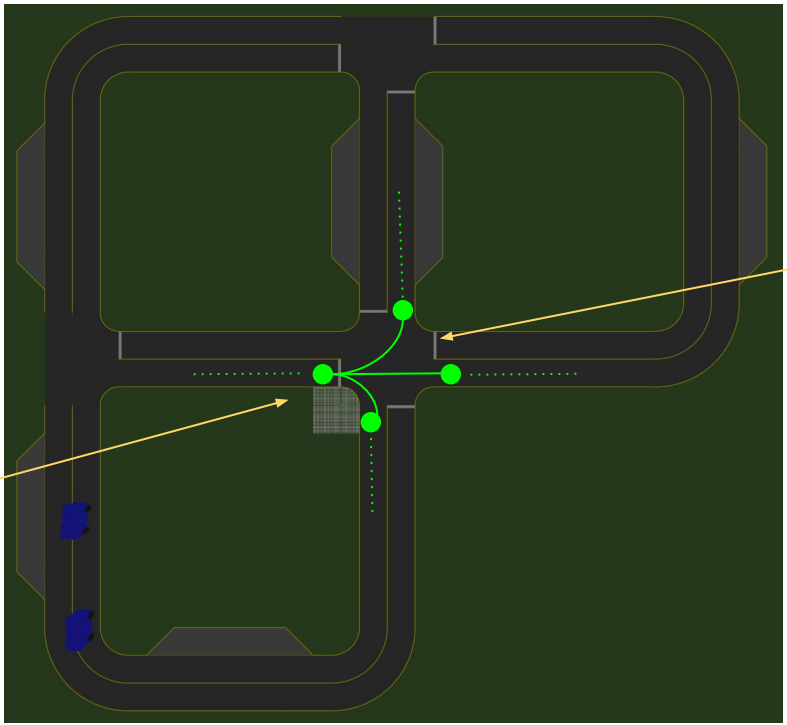
Particle Filtering for Localization

```
mutable struct VehicleState
    Position::SVector{3,Float64}
    Orientation::SVector{3,Float64}
    Velocity::SVector{3,Float64}
    AngularVelocity::SVector{3,Float64}
    Weight::Float64
end
```



A* Algorithm for Routing

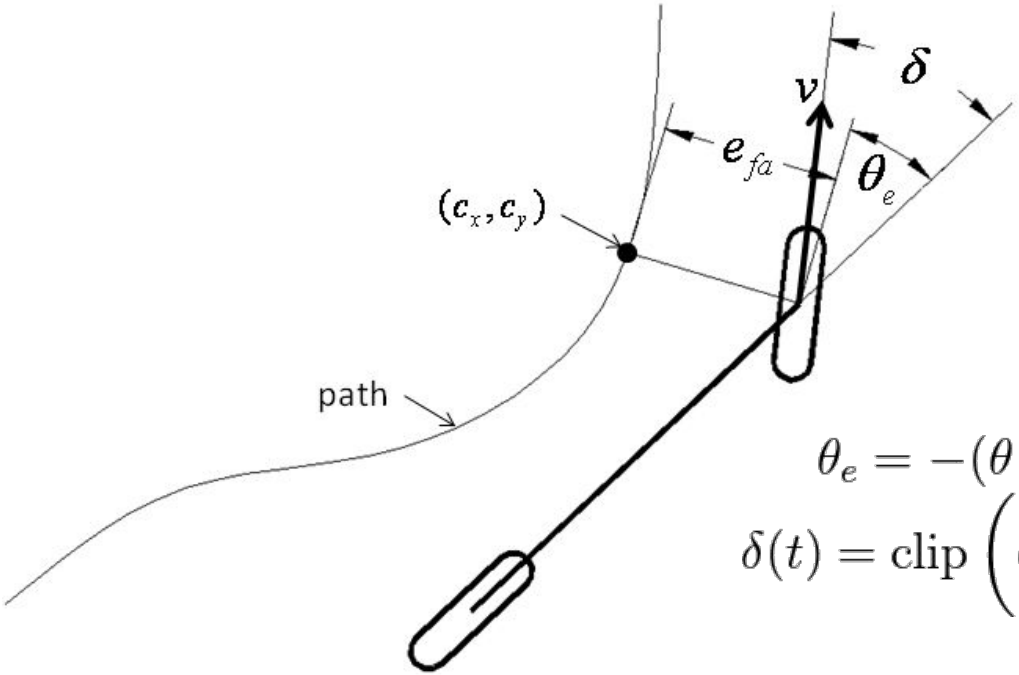
Graph Representation of all Road Segments



Children are feasible road segments

Road Segments are vertices

Stanley Controller for Motion Planning



Build Polyline Representation to Target

Follow the Stanley Control Law

$$\theta_e = -(\theta - \theta_p)$$

$$\delta(t) = \text{clip}\left(\theta_e(t) + tan^{-1}\frac{ke(t)}{v(t)},\ \delta(t)_{min},\ \delta(t)_{max}\right)$$

https://medium.com/roboquest/understanding-geometric-path-tracking-algorithms-stanley-controller-25da17bcc219

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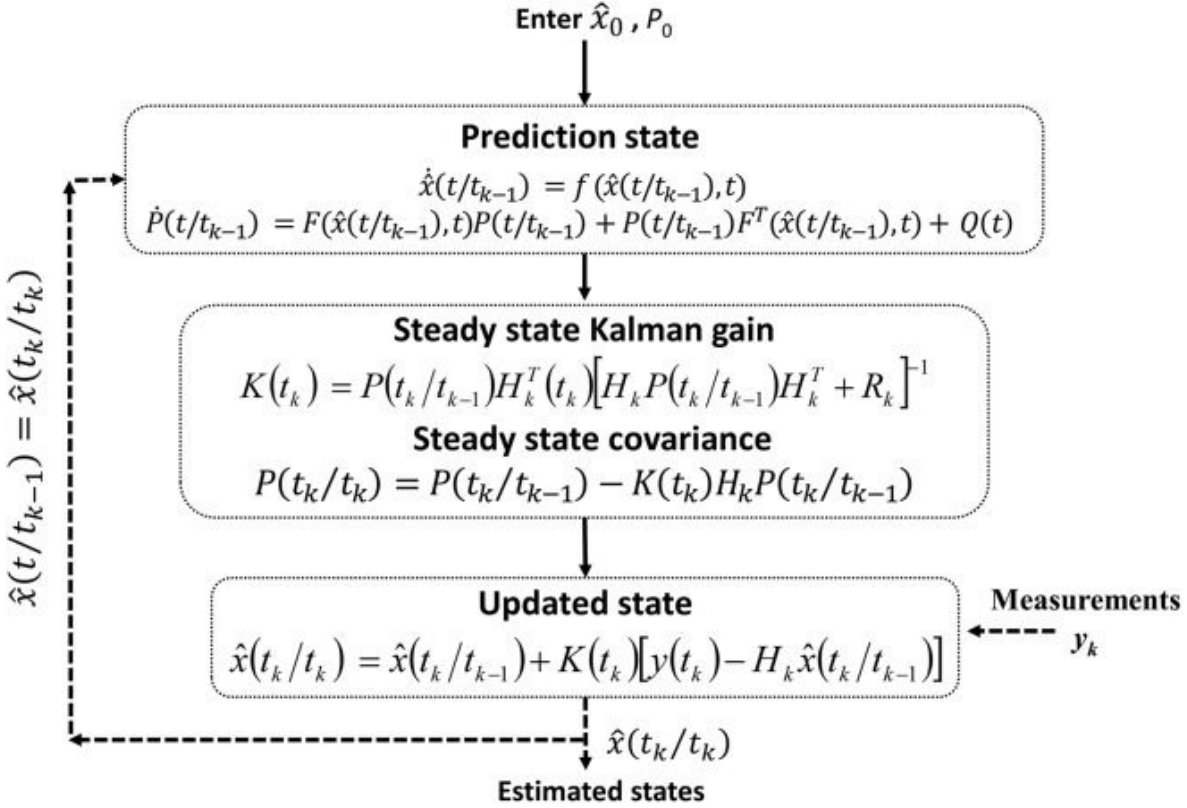
EKF for Perception



https://www.sciencedirect.com/topics/computer-science/extended-kalman-filter

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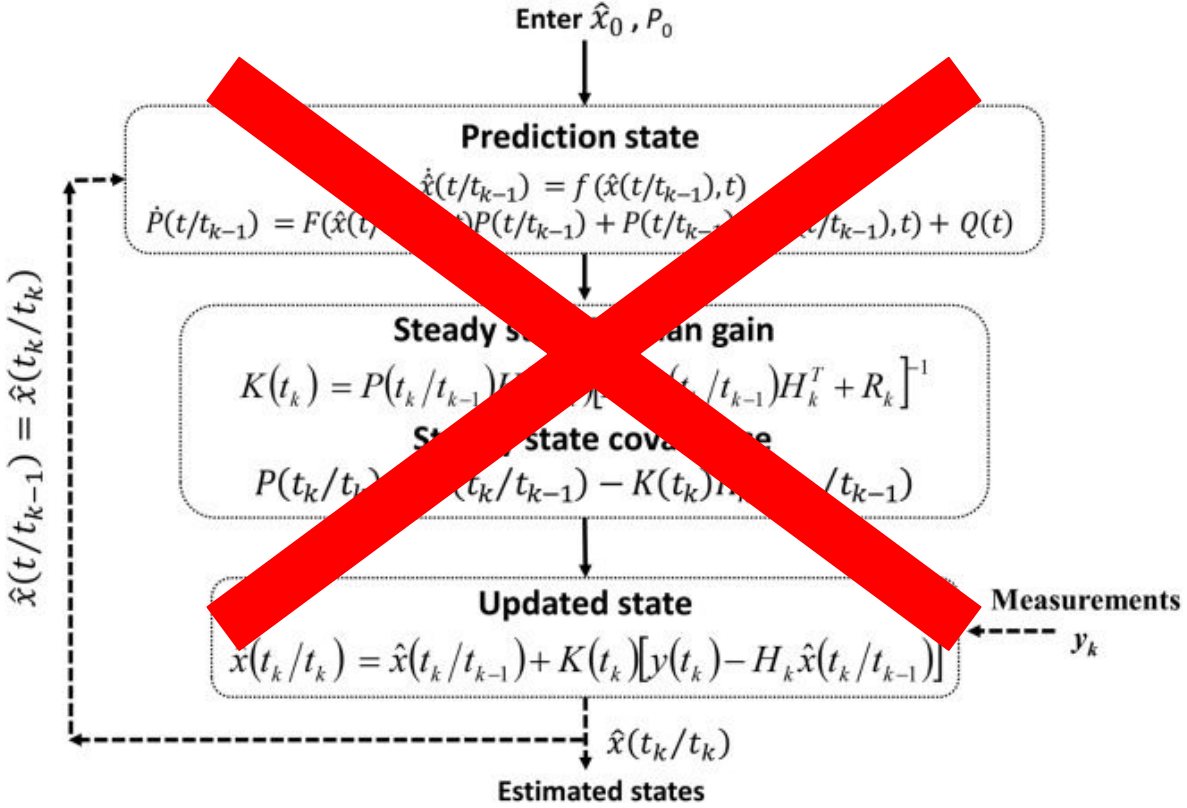
EKF for Perception



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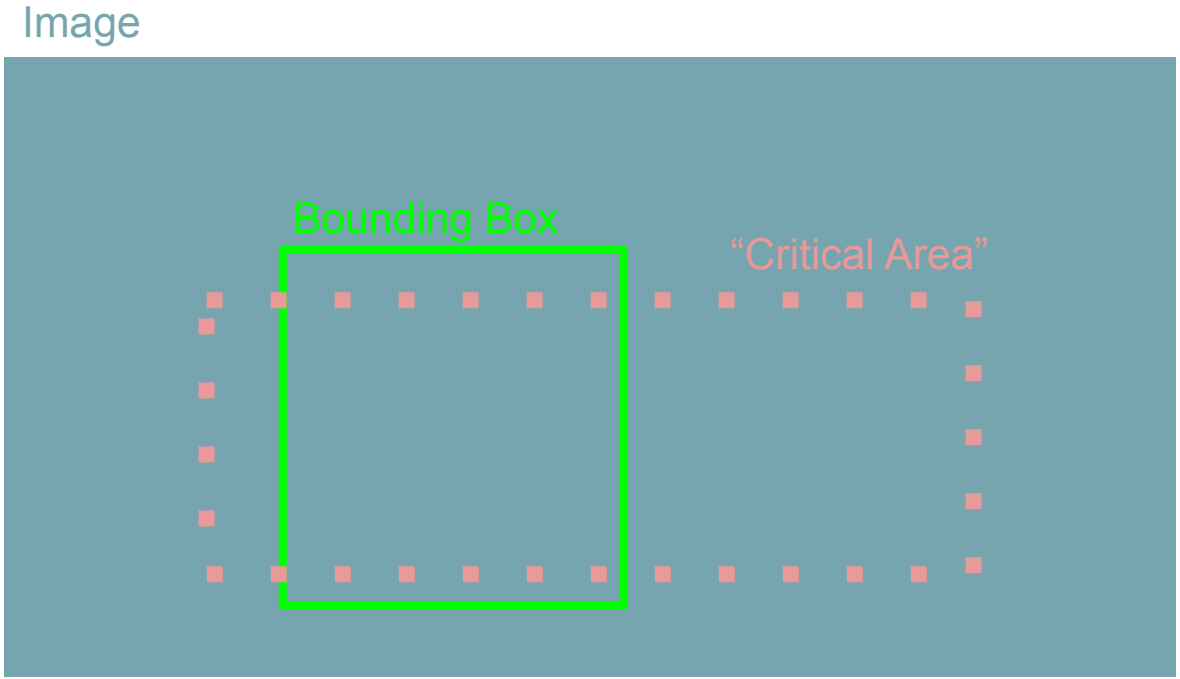
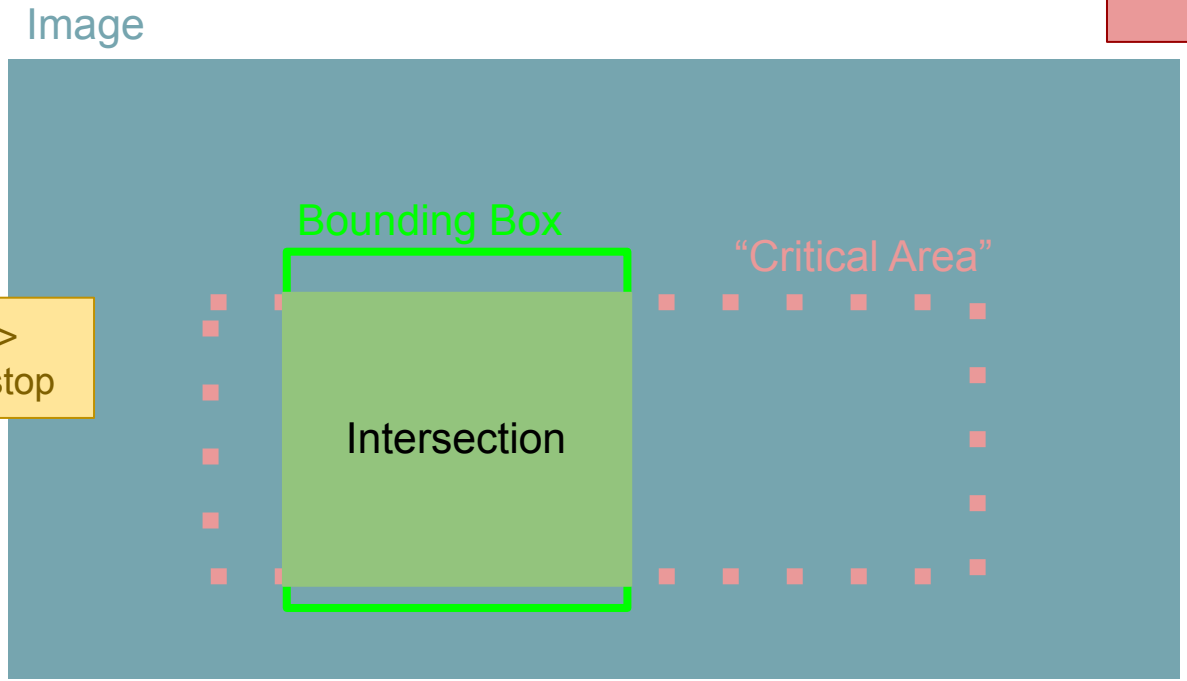
“Big Box == Stop” for Perception



“Big Box == Stop” for Perception

Not real world safe, but works in context of our problem



If intersection > threshold, then stop

Testing and Evaluation

Implement/test the Modules separately

Ensure that every module works on its own

Observe the Simulations

Routing: Is ego vehicle moving in the right direction?

Motion Planning: Is ego vehicle moving in the right direction? Stopping when appropriate?

Perception: Do we identify other vehicles are in front of us?

Compare to Ground Truth

Localization, Routing, Motion Planning, Perception