

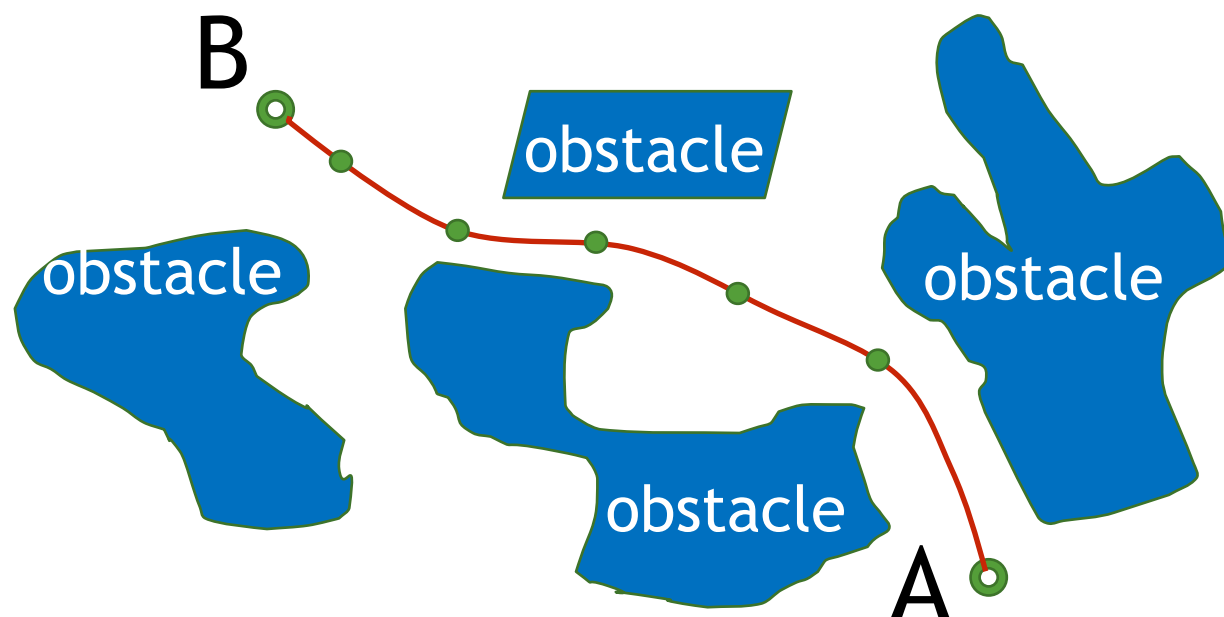
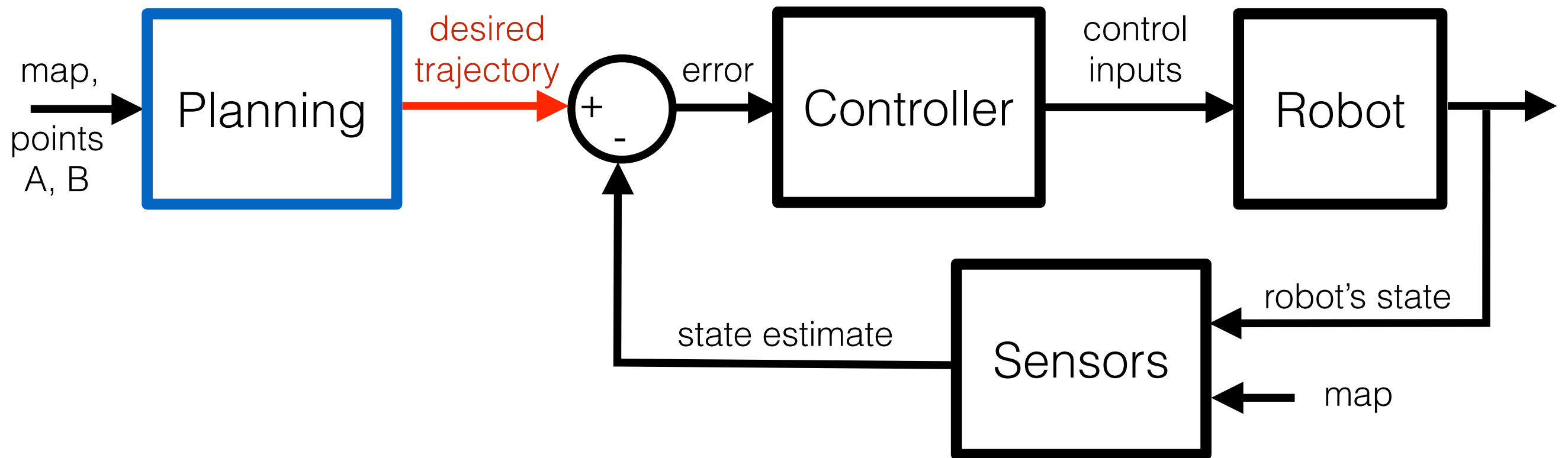
16.485: VNAV - Visual Navigation for Autonomous Vehicles

Lecture 9: Trajectory Optimization

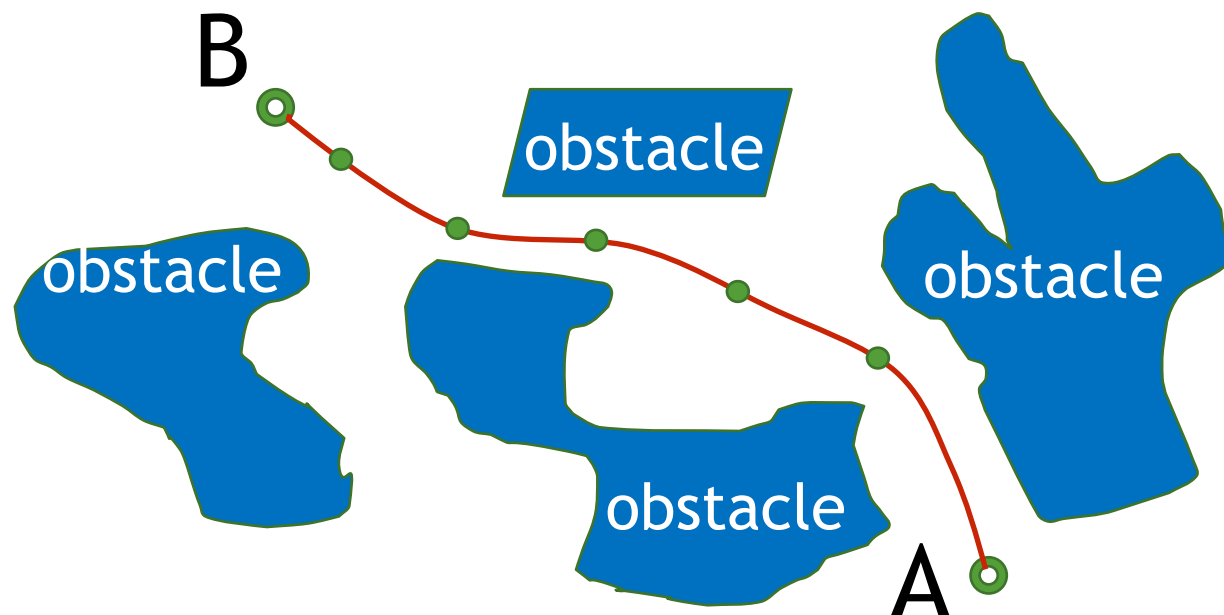
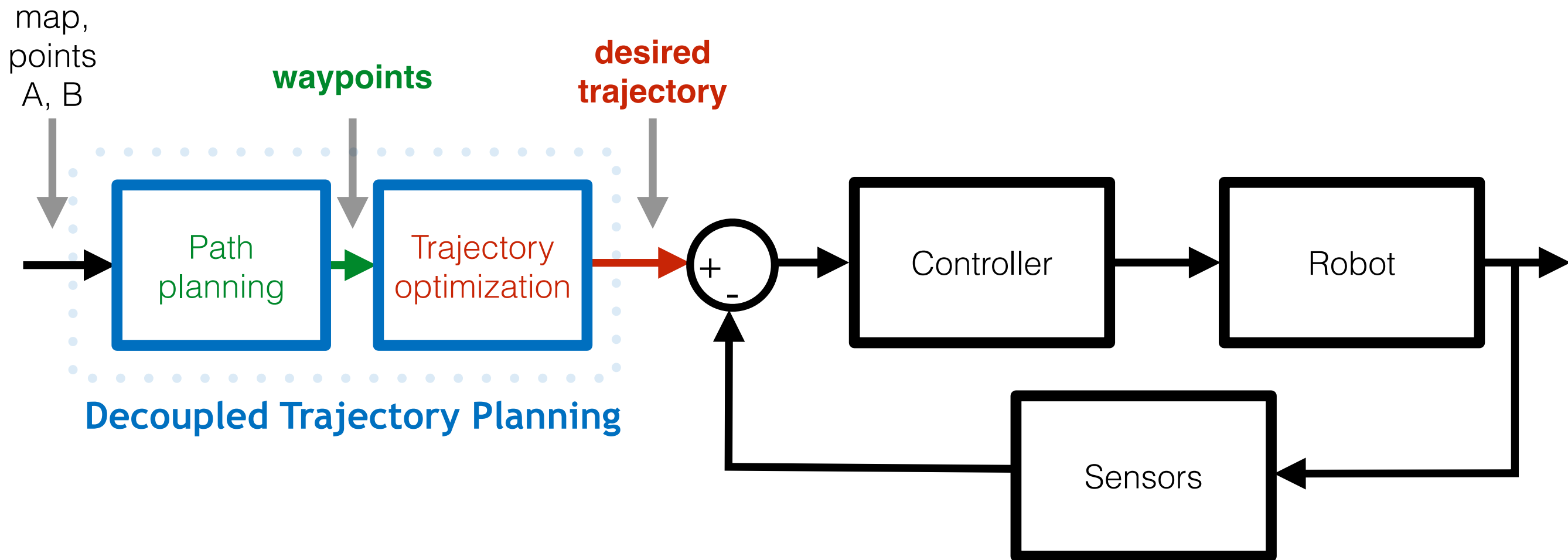
Luca Carlone



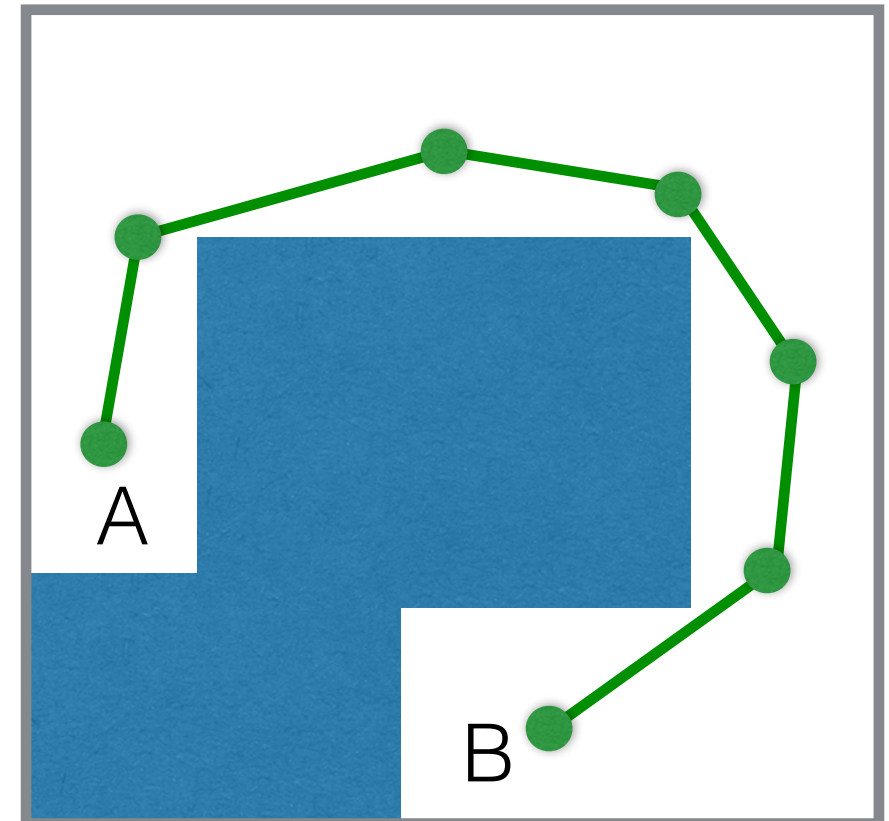
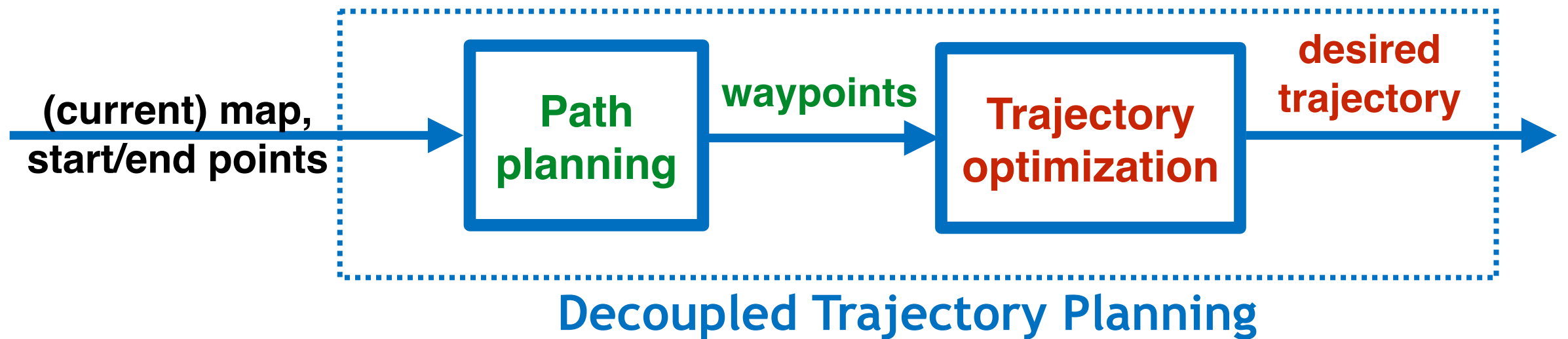
Planning vs. Control



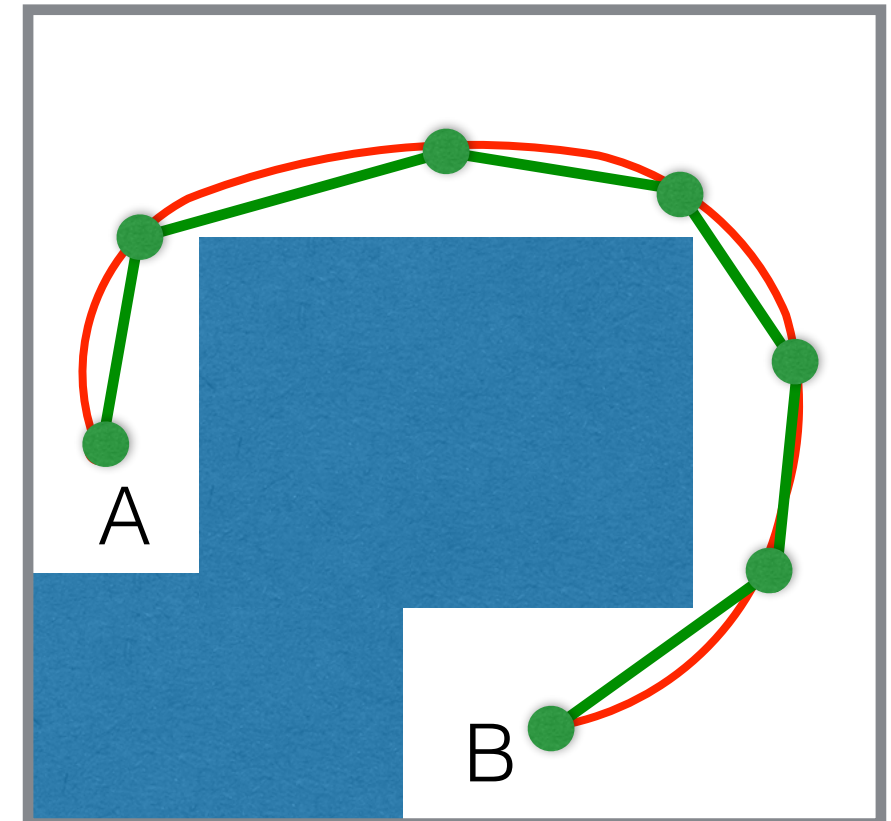
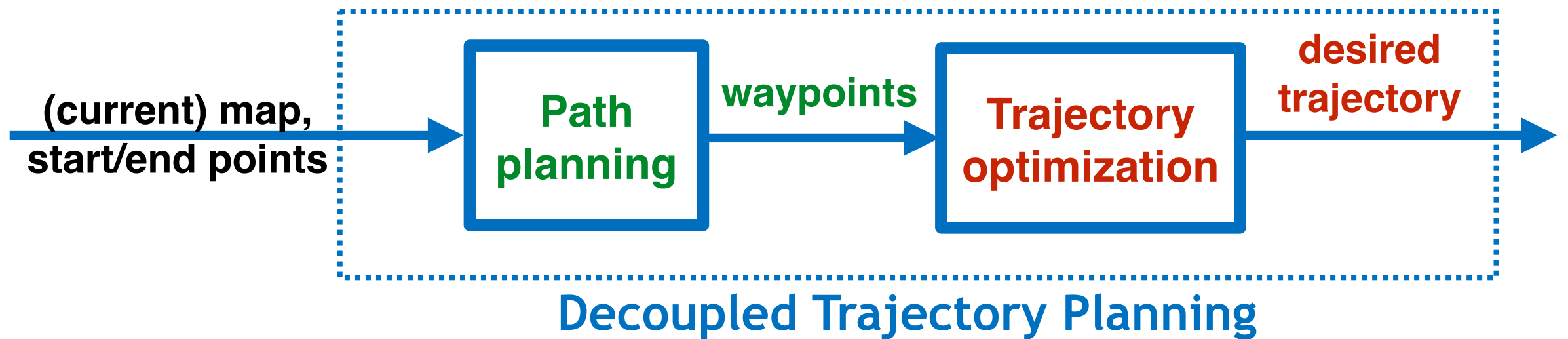
Decoupled Trajectory Planning



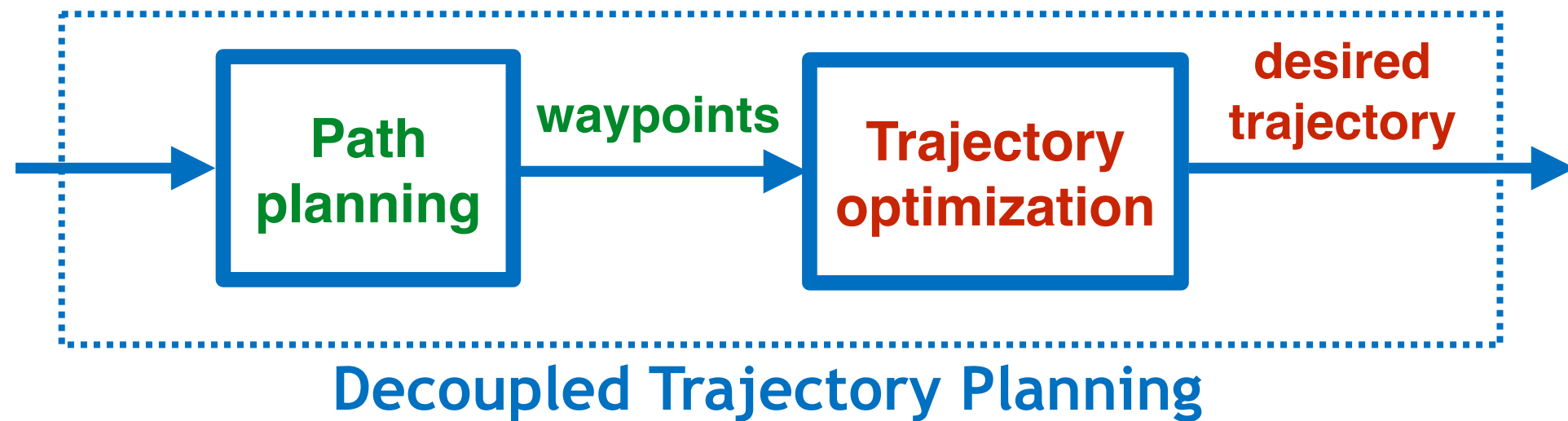
Decoupled Trajectory Planning



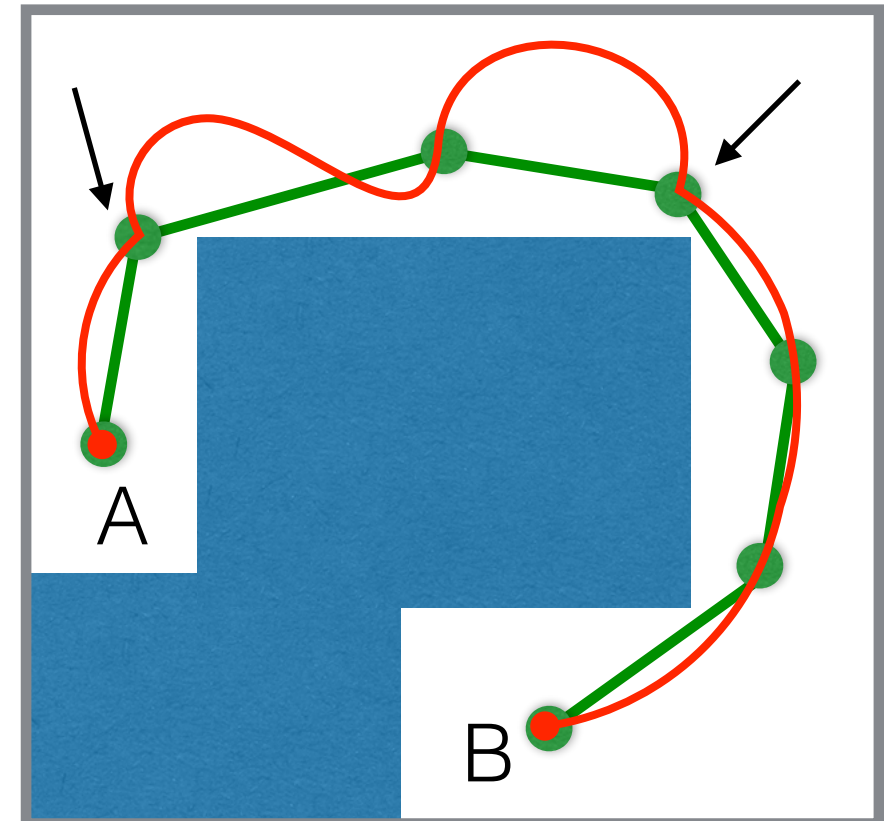
Decoupled Trajectory Planning



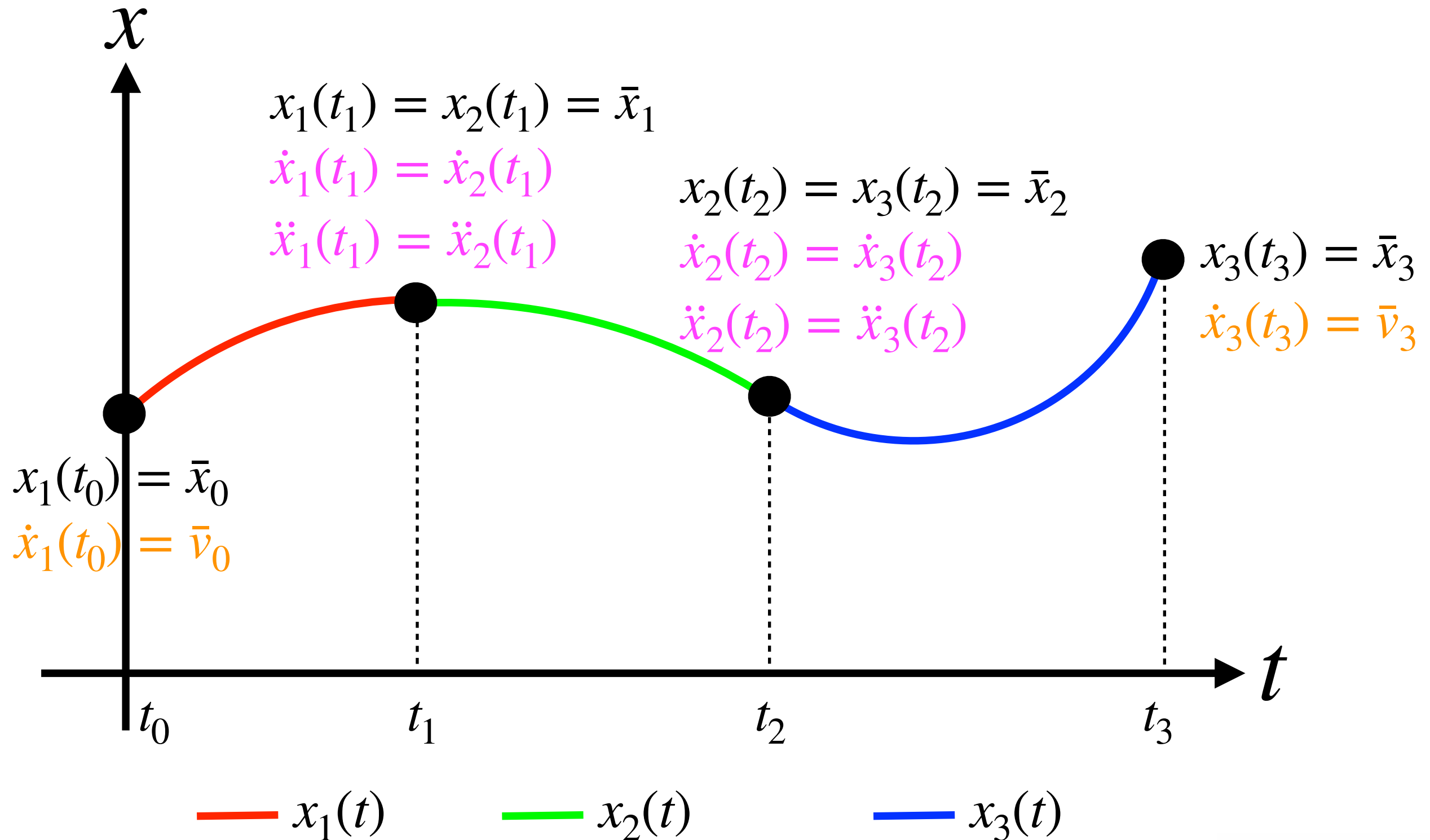
Decoupled Trajectory Planning



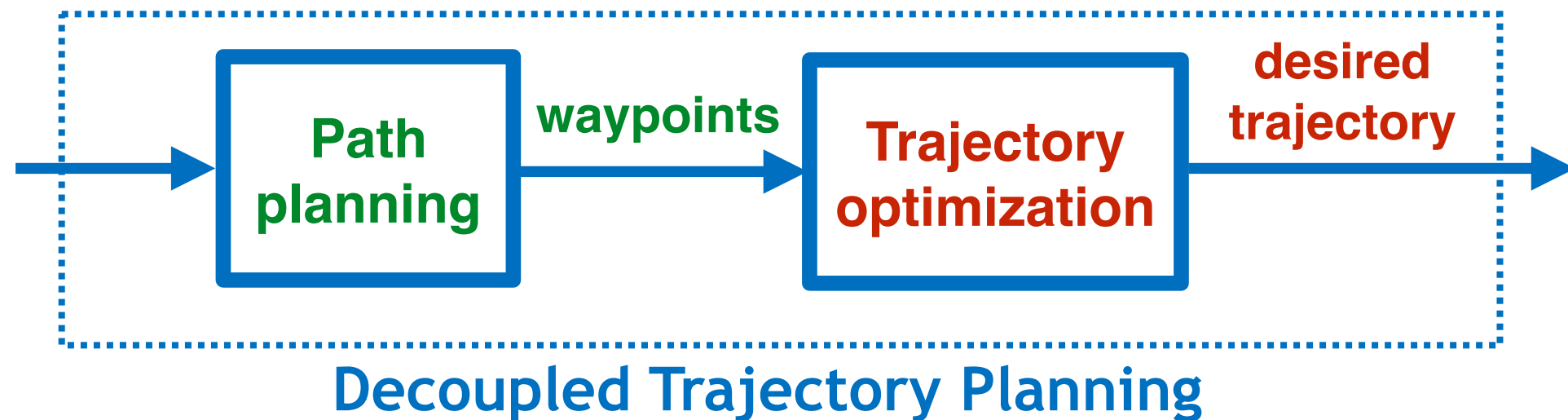
- Need to enforce “**continuity**” between segments for smooth trajectory



Continuity constraints for trajectory opt.

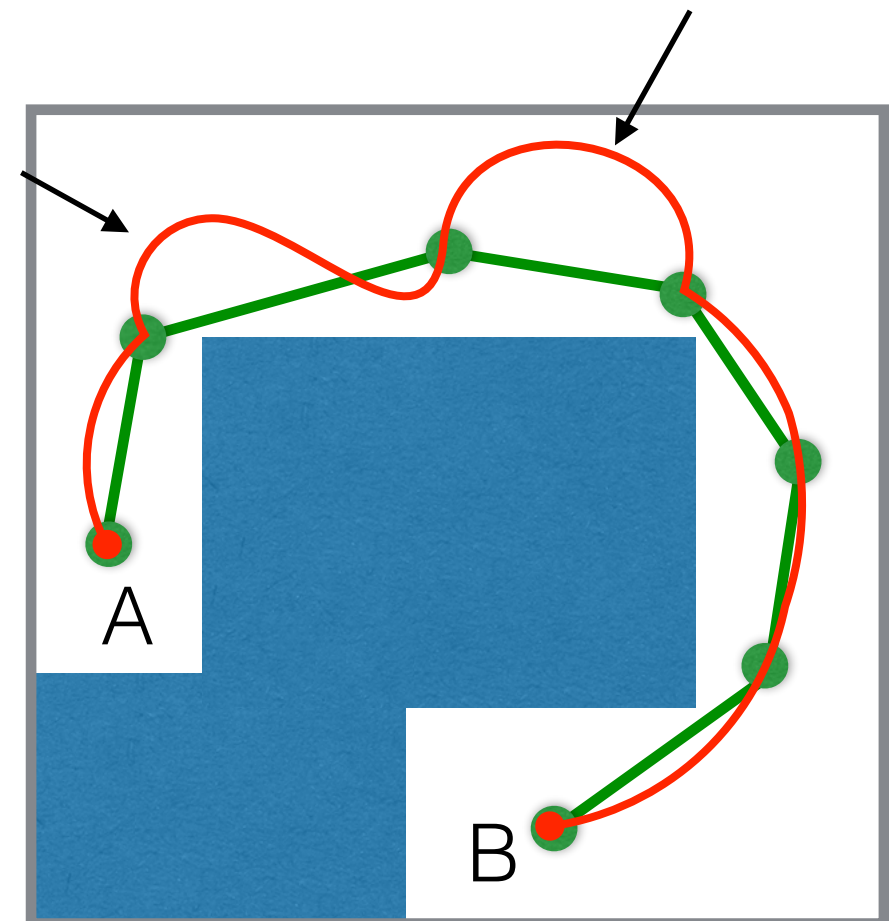


Decoupled Trajectory Planning

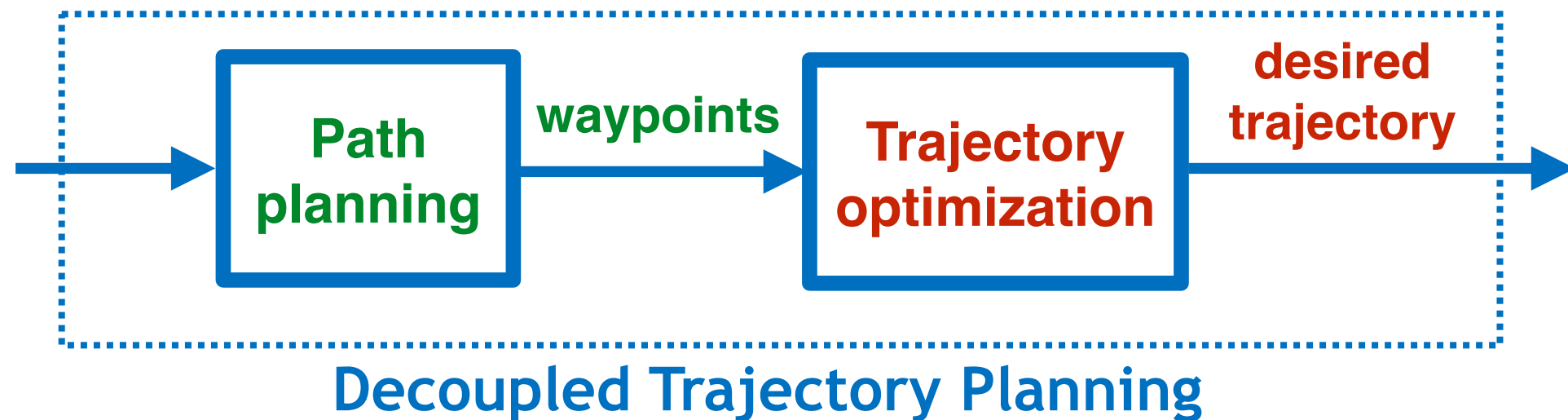


- Need to enforce “**continuity**” between segments for smooth trajectory

- Need to ensure “**minimal**” motion



Decoupled Trajectory Planning

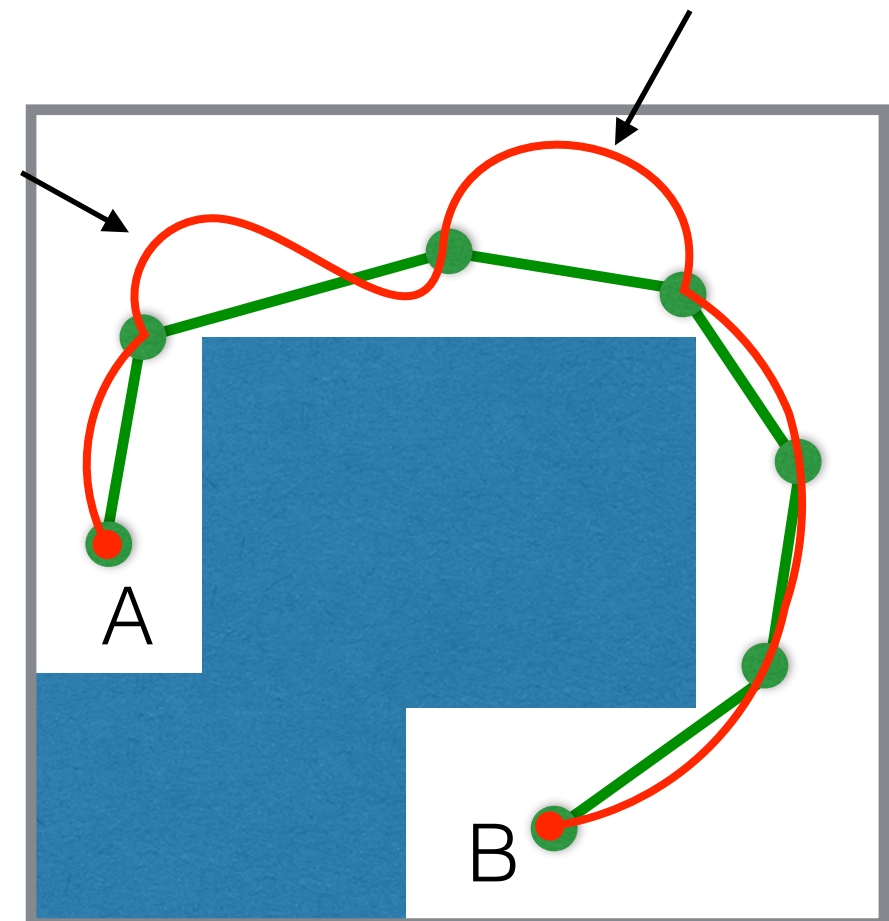


- Need to enforce “**continuity**” between segments for smooth trajectory

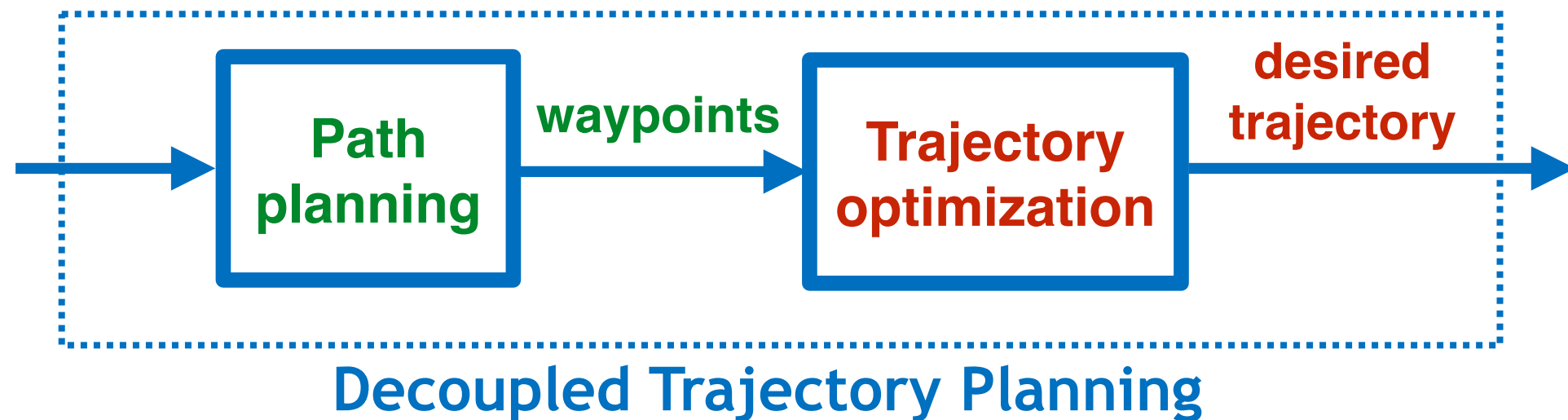
- Need to ensure “**minimal**” motion

$$\min_{x(t), u(t)} J(t_A, t_B, x(t), u(t))$$

$$= \min_{\sigma(t)} J(t_A, t_B, \sigma(t))$$



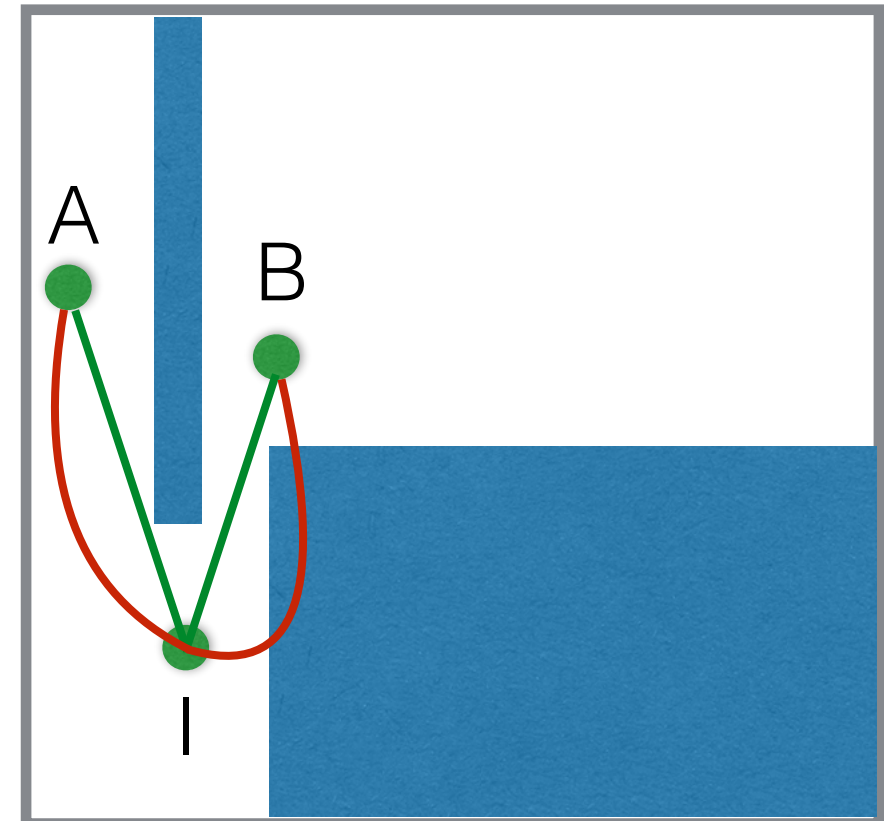
Decoupled Trajectory Planning



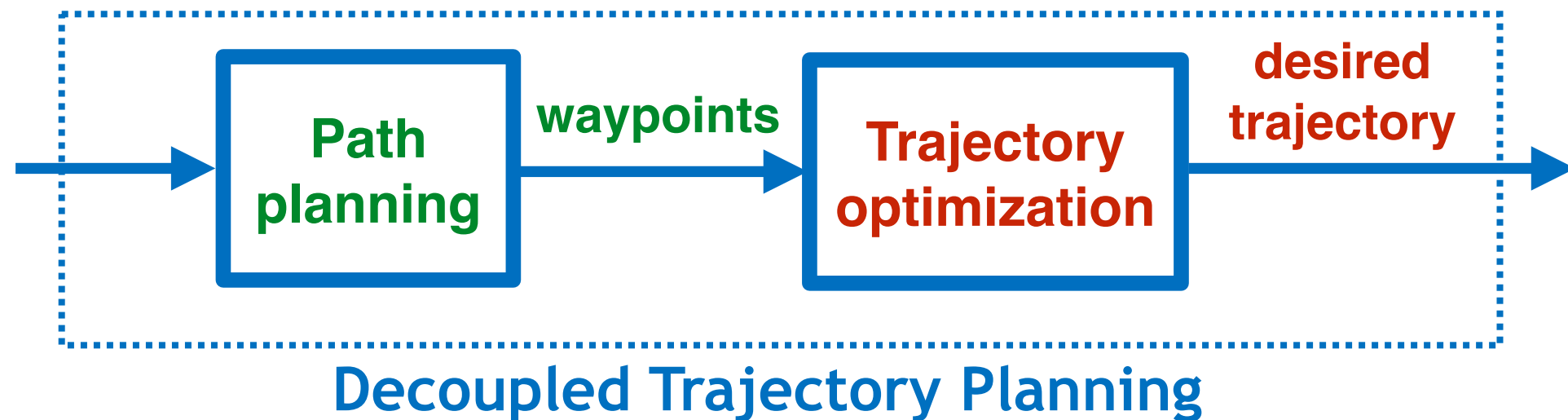
- Need to enforce “**continuity**” between segments for smooth trajectory

- Need to ensure “**minimal**” motion

- Need to ensure **feasibility**; e.g.:
 - Hit no obstacles



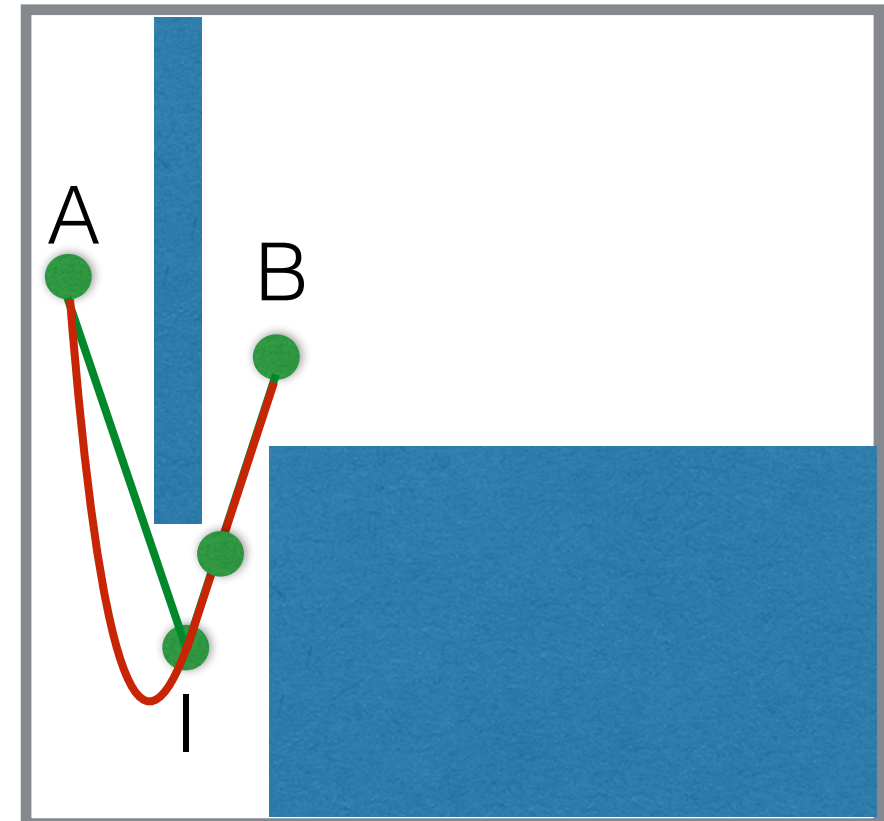
Decoupled Trajectory Planning



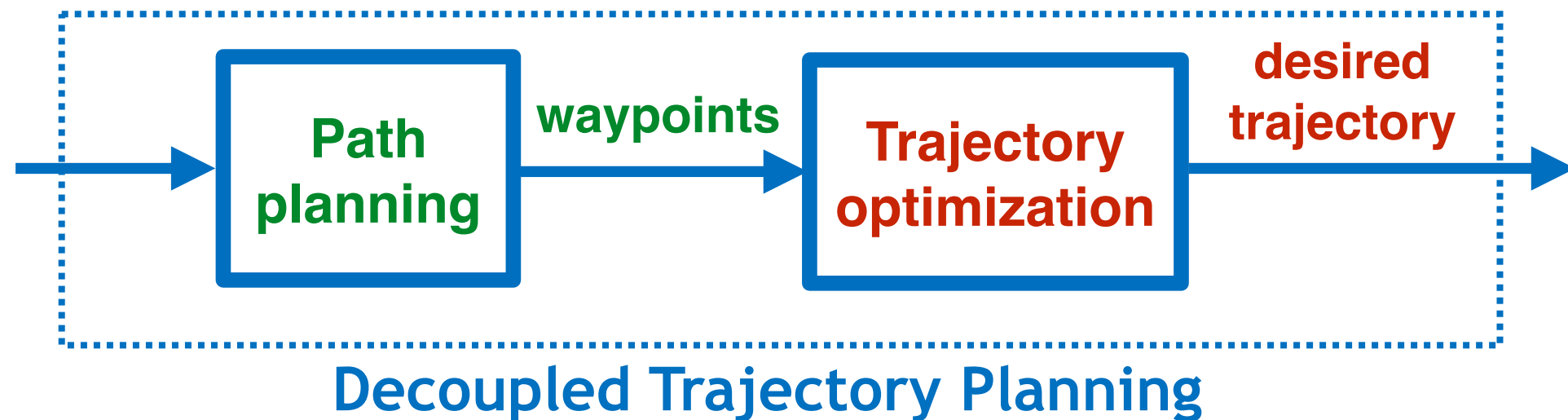
- Need to enforce “**continuity**” between segments for smooth trajectory

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- Need to ensure **feasibility**; e.g.:
 - Hit no obstacles



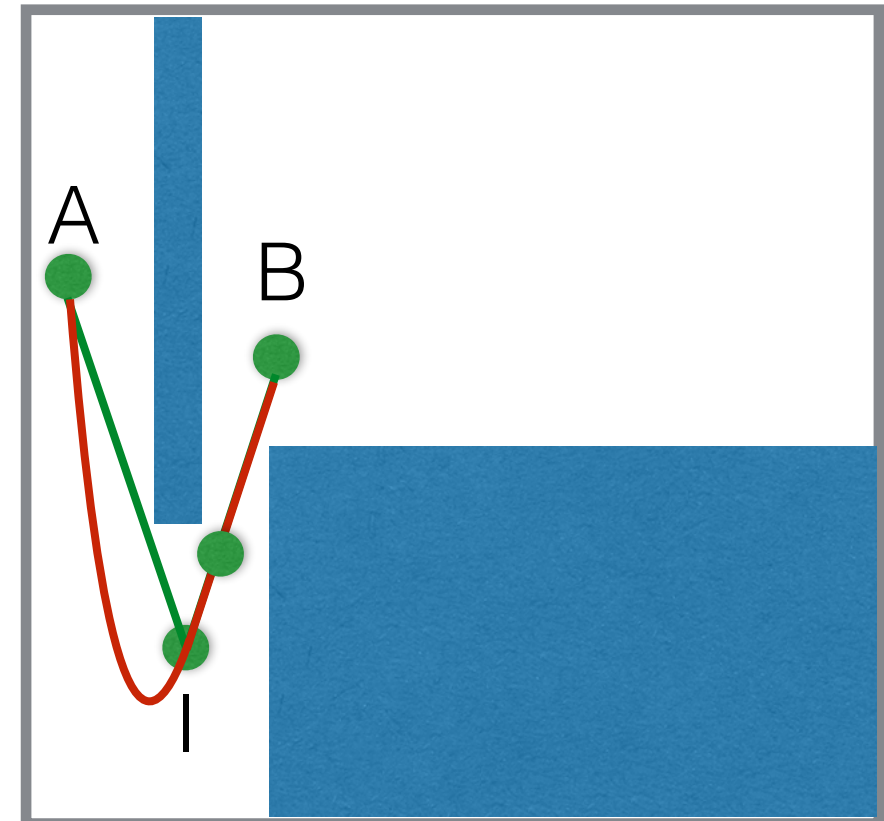
Decoupled Trajectory Planning



- Need to enforce “**continuity**” between segments for smooth trajectory

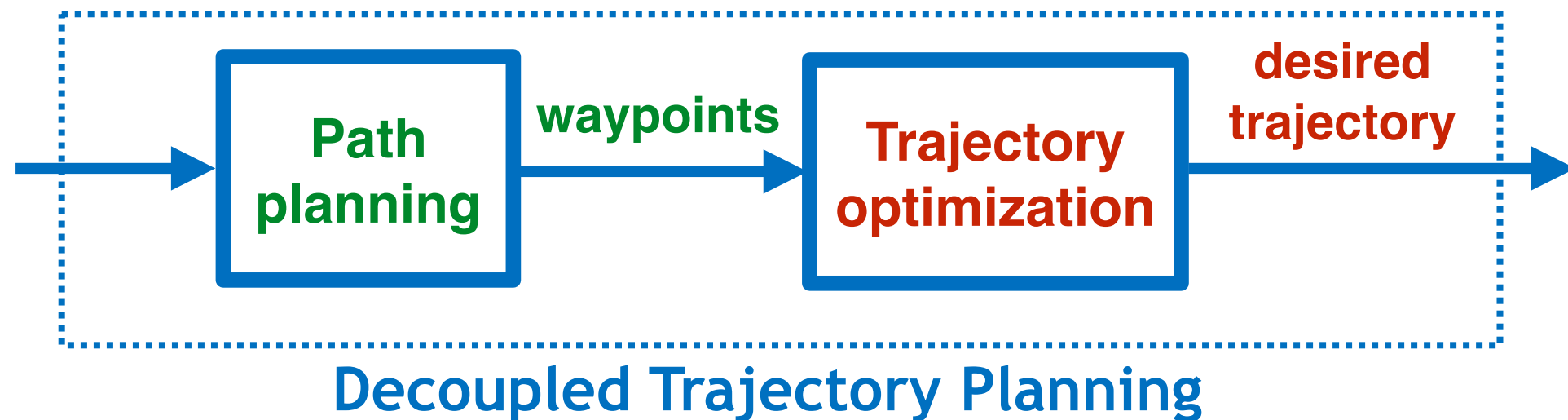
- Need to ensure “**minimal**” motion

- Need to ensure **feasibility**; e.g.:
 - Hit no obstacles



this lecture...

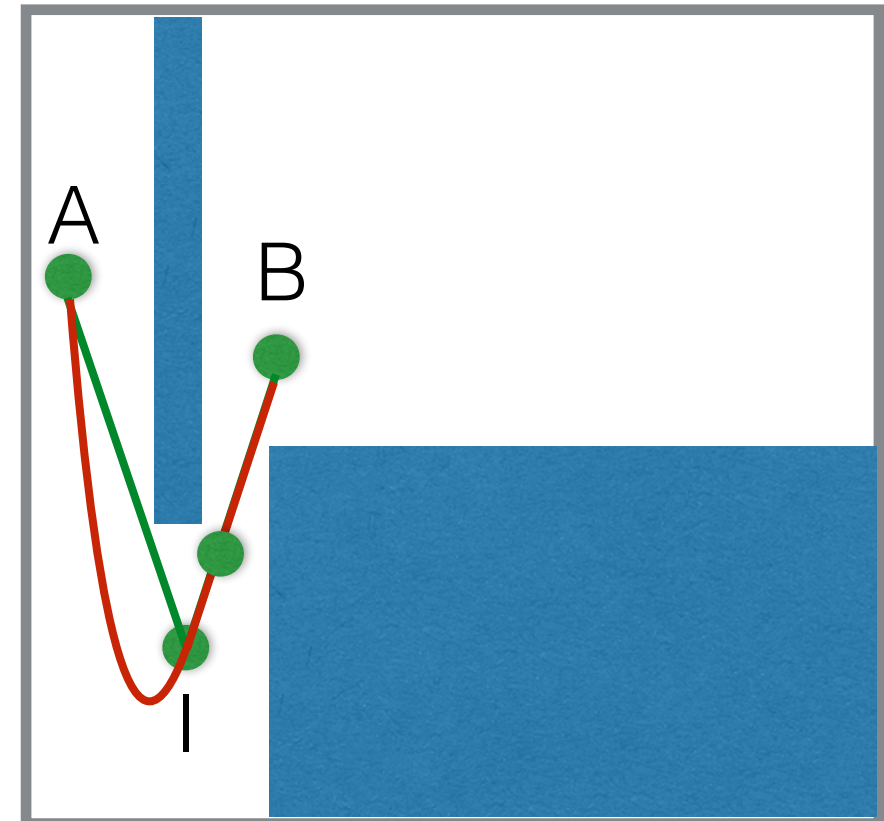
Decoupled Trajectory Planning



- Need to enforce “**continuity**” between segments for smooth trajectory

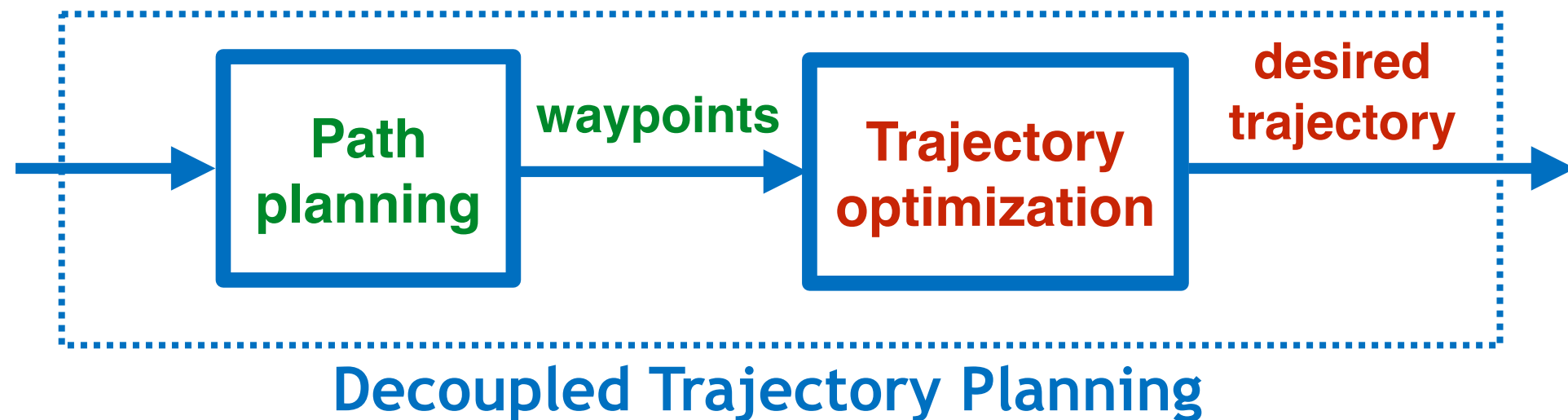
- Need to ensure “**minimal**” motion

- Need to ensure **feasibility**; e.g.:
 - Hit no obstacles (**done**)



this lecture...

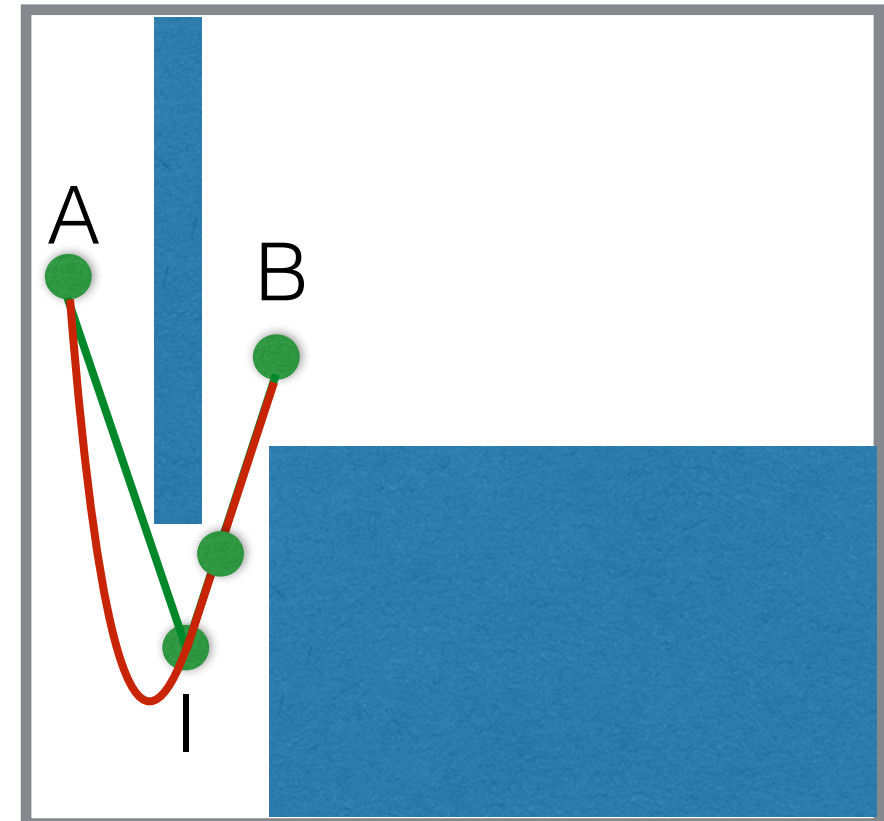
Decoupled Trajectory Planning



- Need to enforce “**continuity**” between segments for smooth trajectory

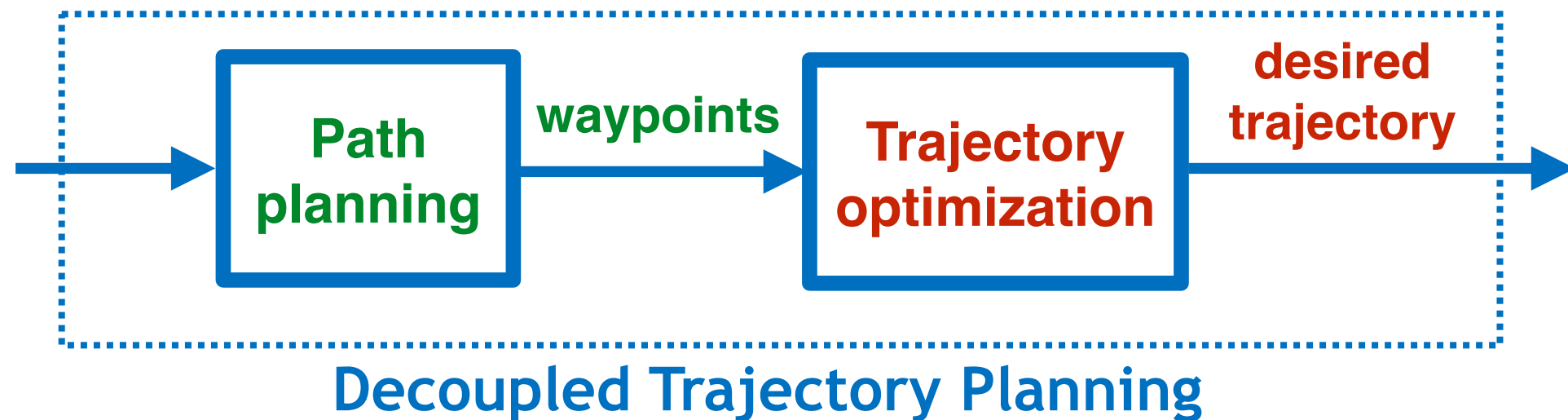
- Need to ensure “**minimal**” motion

- Need to ensure **feasibility**; e.g.:
 - ▶ Hit no obstacles
 - ▶ Don't saturate controller



Friday's lecture...¹⁴

Decoupled Trajectory Planning

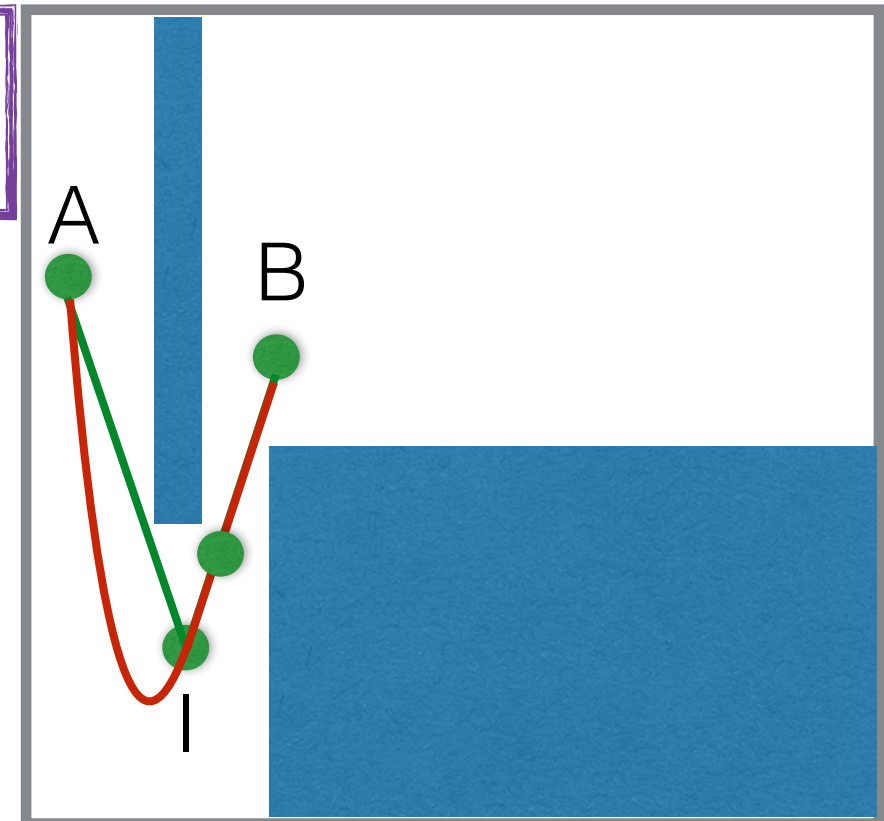


- Need to **optimize** “**continuity**” between segments to ensure **numerical stability** of solution

- Need to ensure “**minimal**” motion

- Need to ensure **feasibility**; e.g.:
 - ▶ Hit no obstacles
 - ▶ Don't saturate controller

- Need to control **time-length of trajectory**



Friday's lecture...

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16.485 Visual Navigation for Autonomous Vehicles (VNAV)
Fall 2020

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