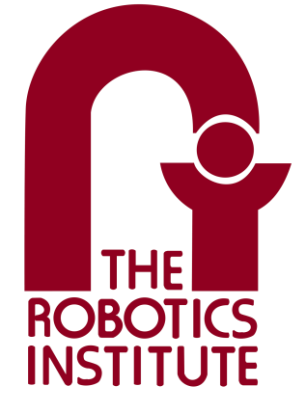
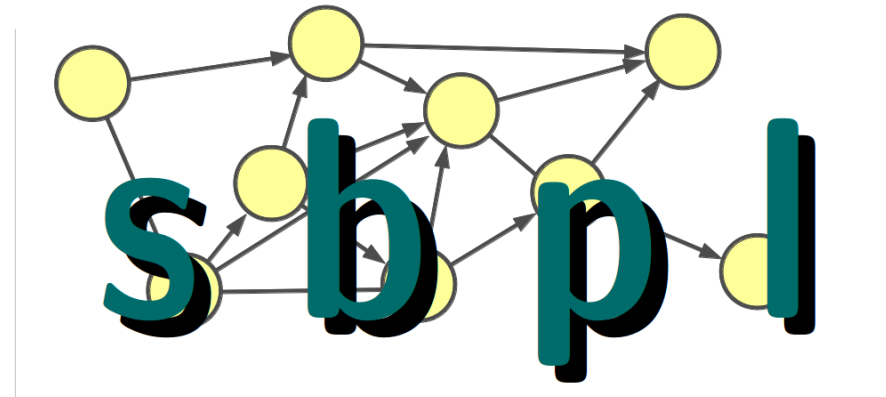


Homotopy-Based Footstep Planning for Humanoid Robots Operating in Complex 3D Spaces



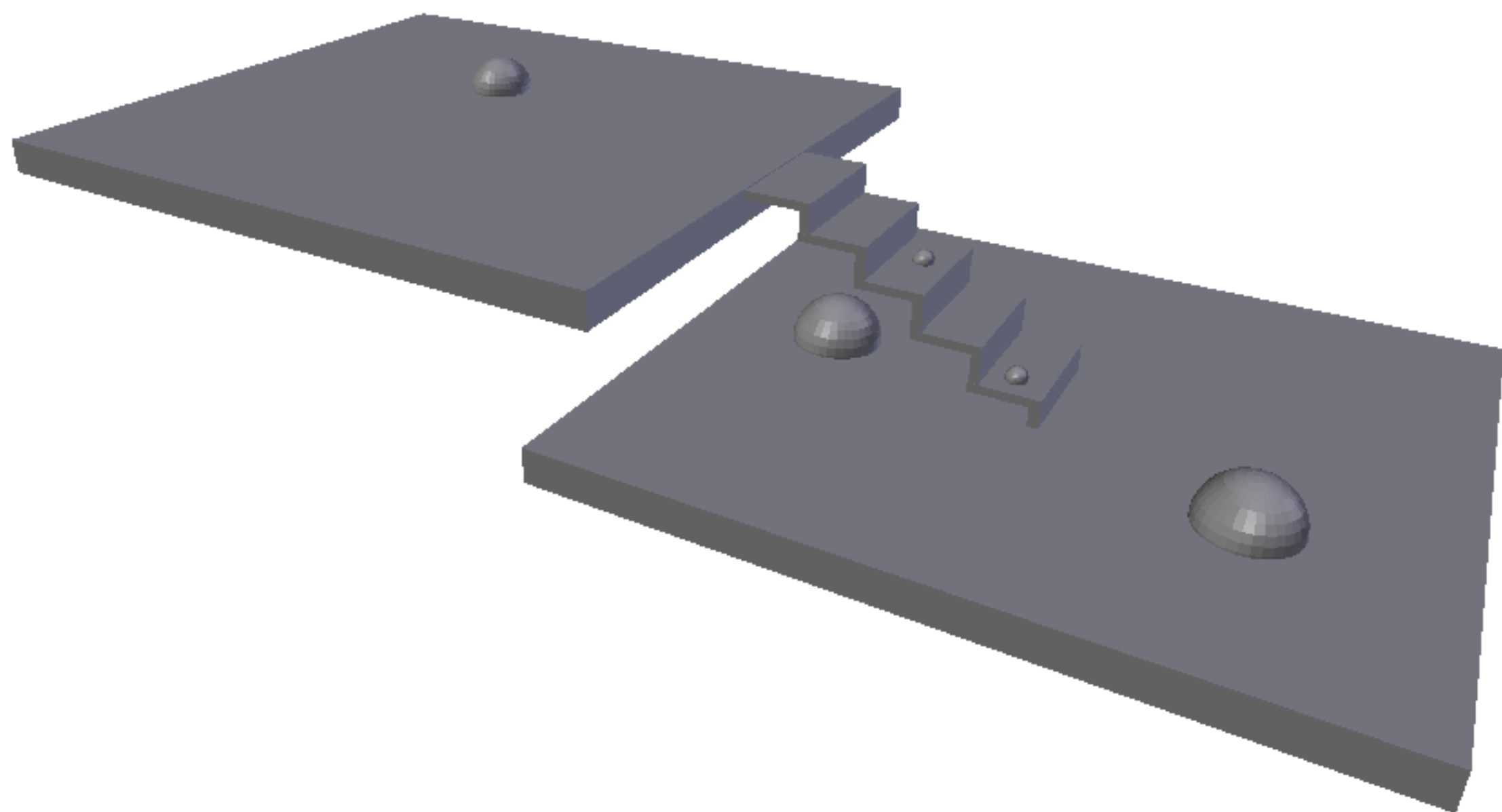
Sahit Chintalapudi, Vinitha Ranganeni & Maxim Likhachev

schintalapudi@gatech.edu, vinitha@cs.uw.edu,
maxim@cs.cmu.edu

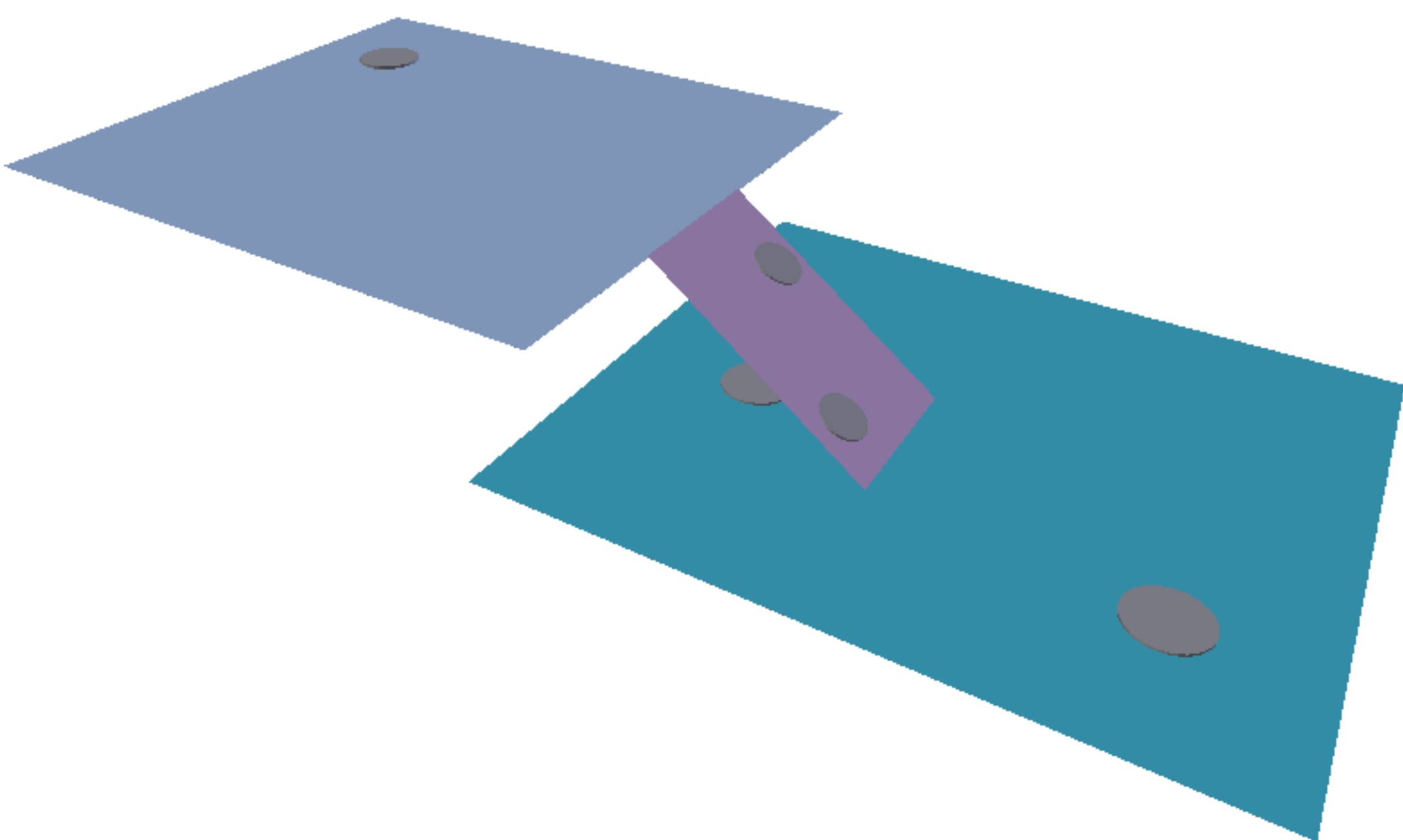


Humanoid Footstep Planning Across Surfaces

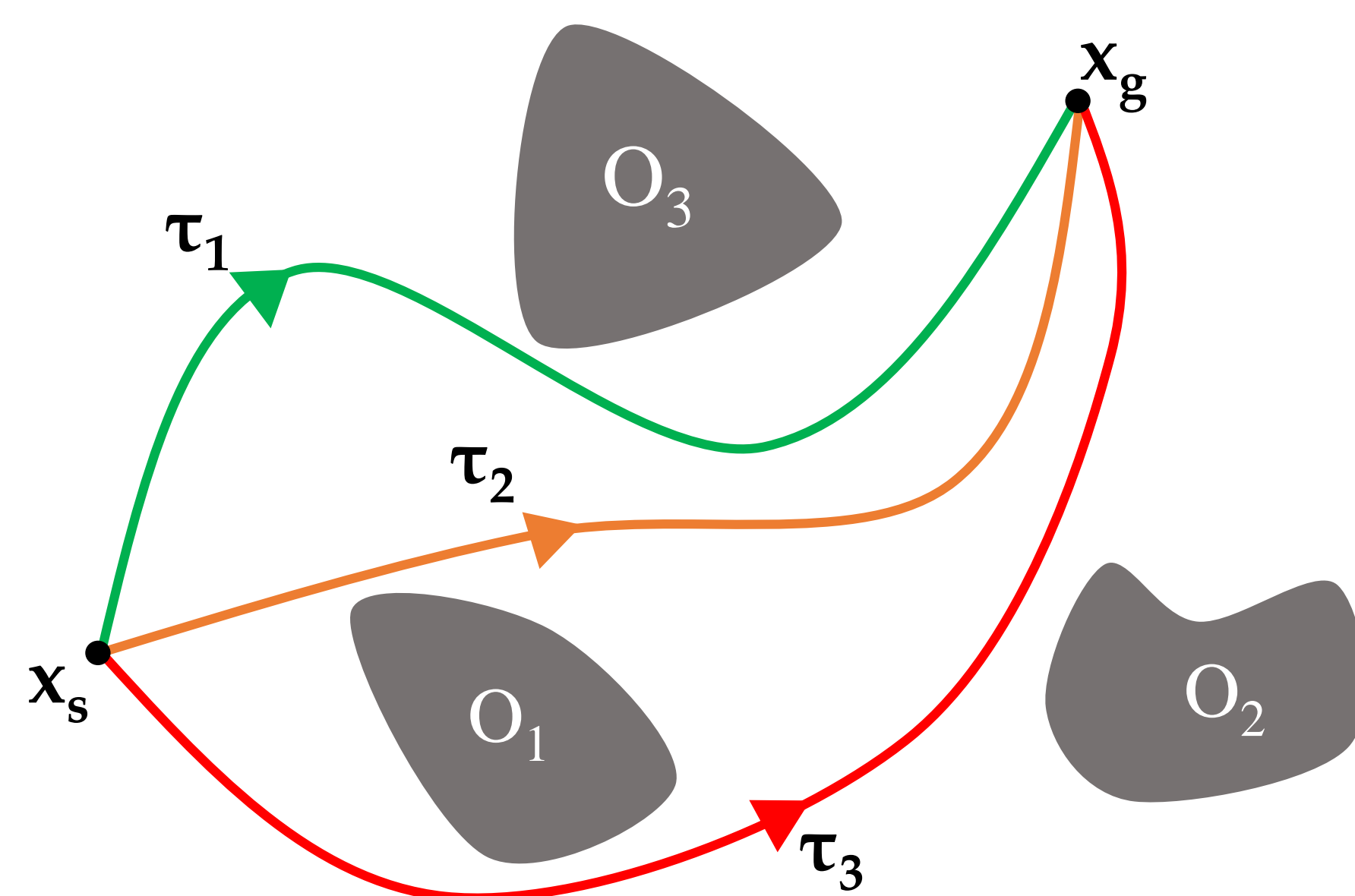
The 3D workspace the robot operates in.



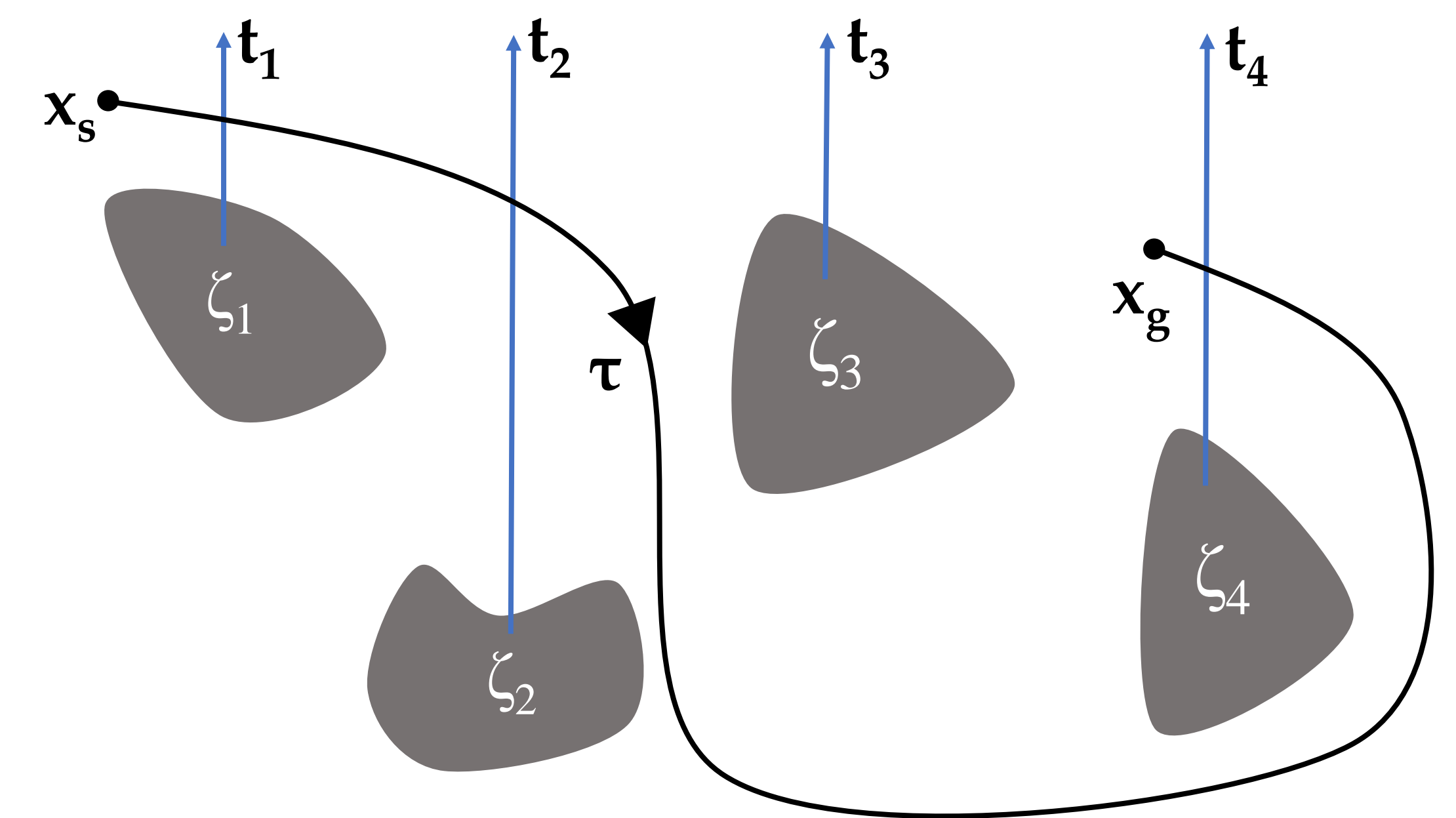
Approximated 2D planes (surfaces) used for calculating heuristic functions.



Homotopy Classes

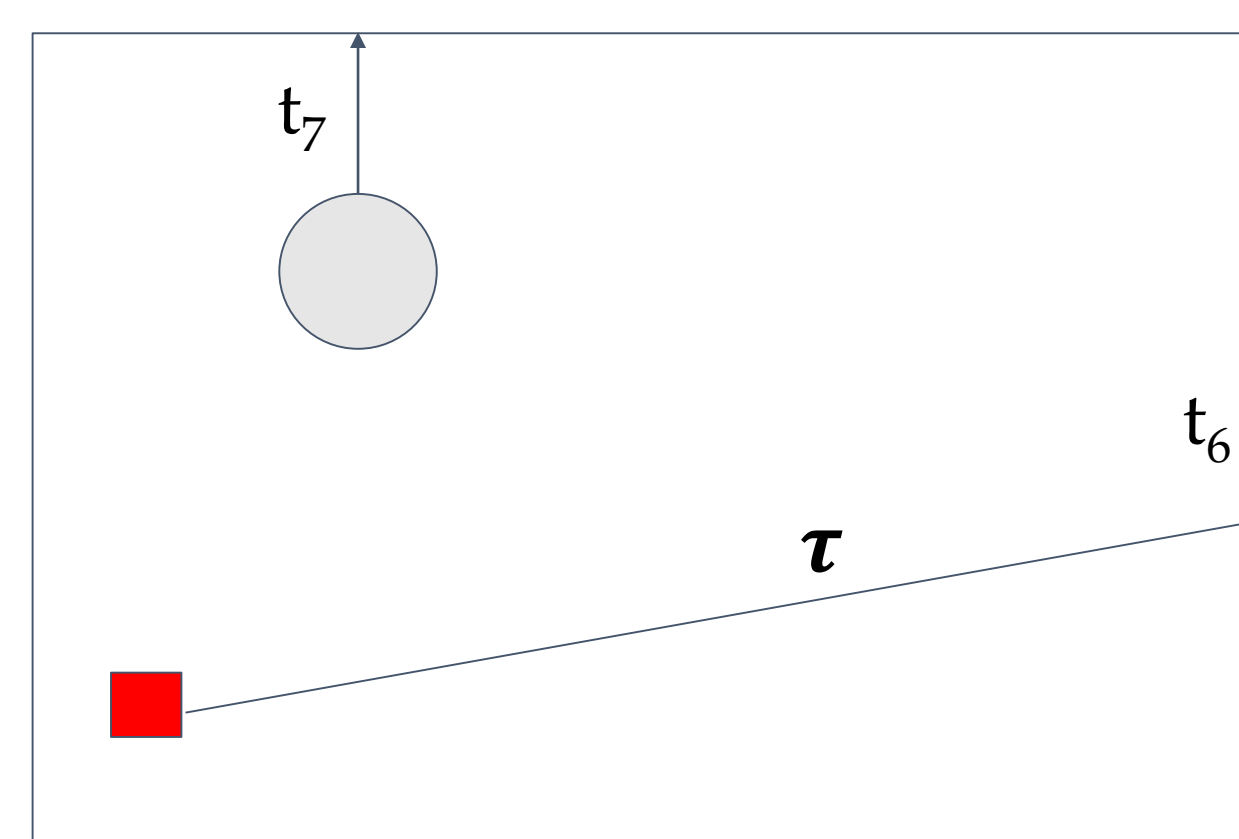


τ_1 and τ_2 are in the same homotopy class but τ_3 is not because of obstacle O_1 .

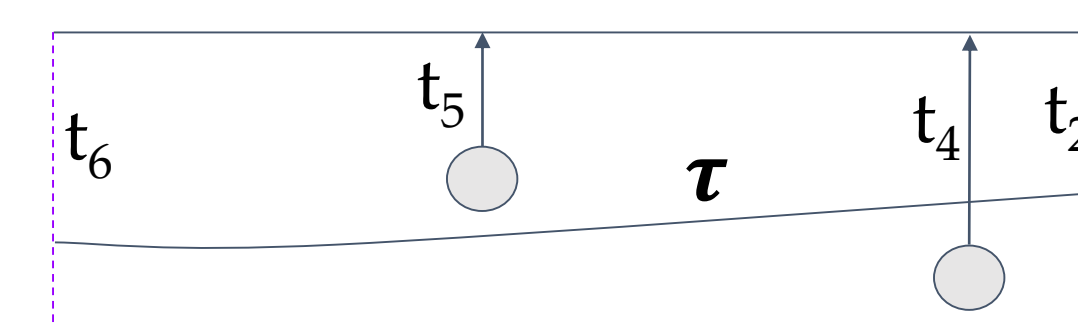


The signature s of path τ is $t_1 t_2 t_4^{-1}$

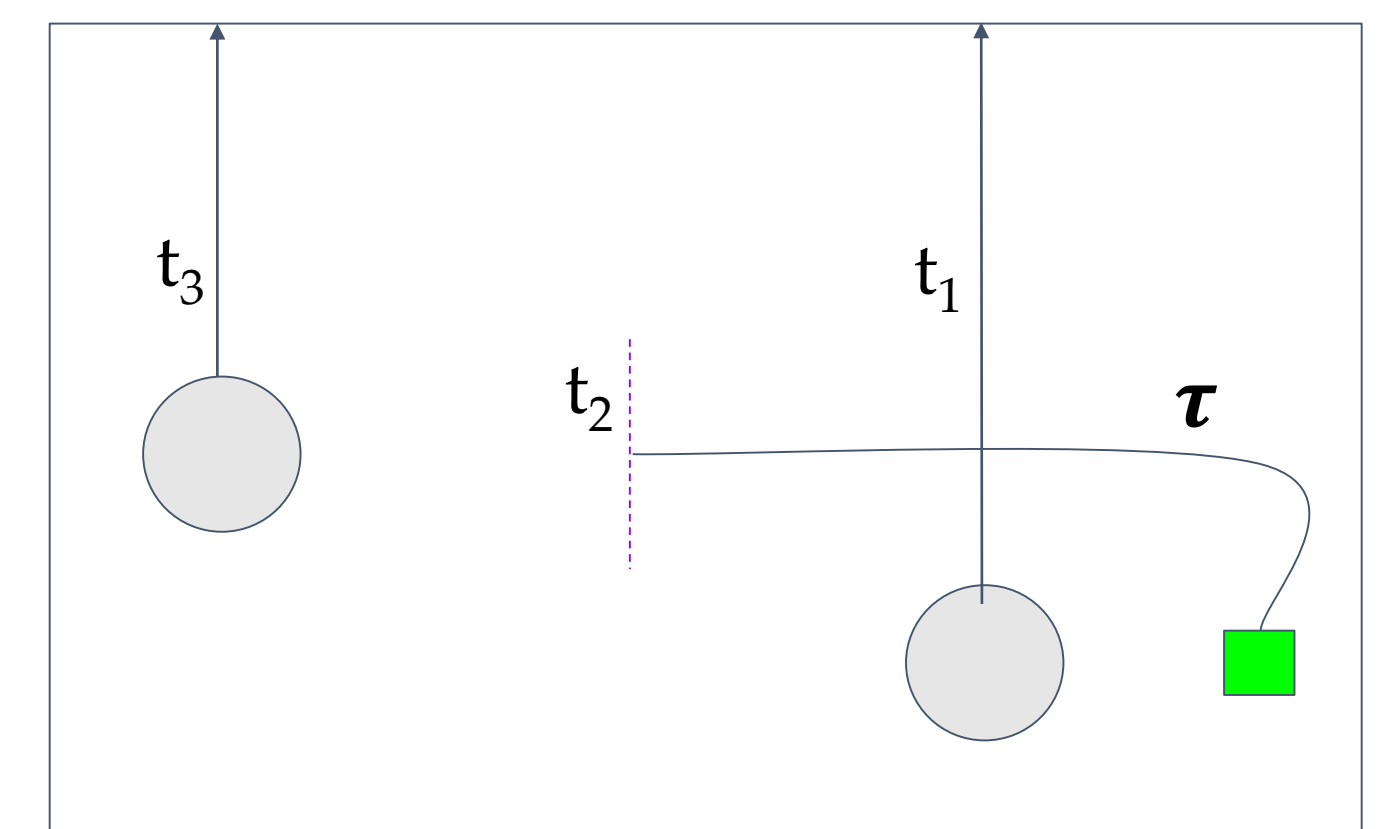
Representing Homotopy Classes in Complex 3D Environments



W_{23}



W_{22}

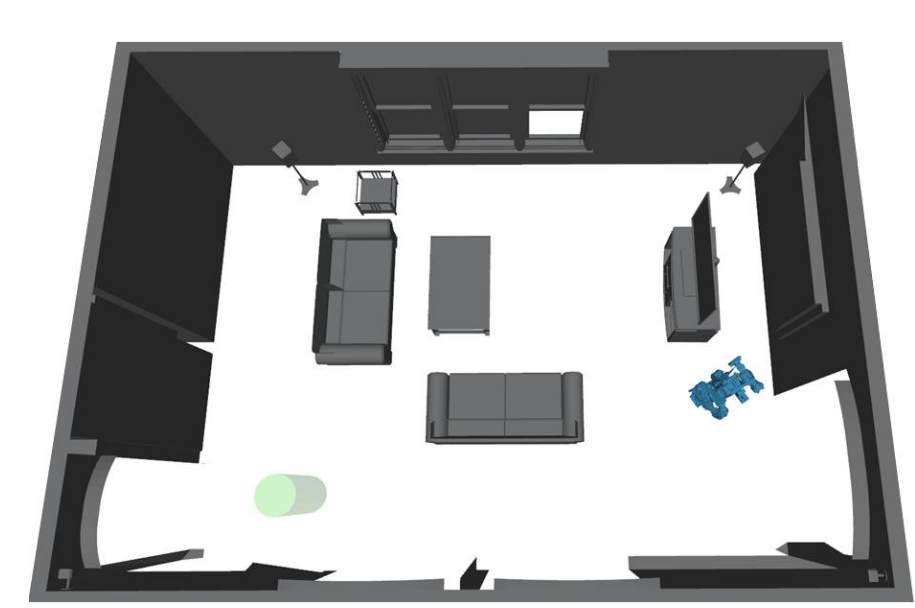


W_{21}

The dashed line represents the intersection between 2 planes (i.e. a *gate*).
The Trajectory τ has signature $t_1 t_2 t_4 t_6$

Generating Heuristics Using Homotopy-Based Shortest Path (HBSP)

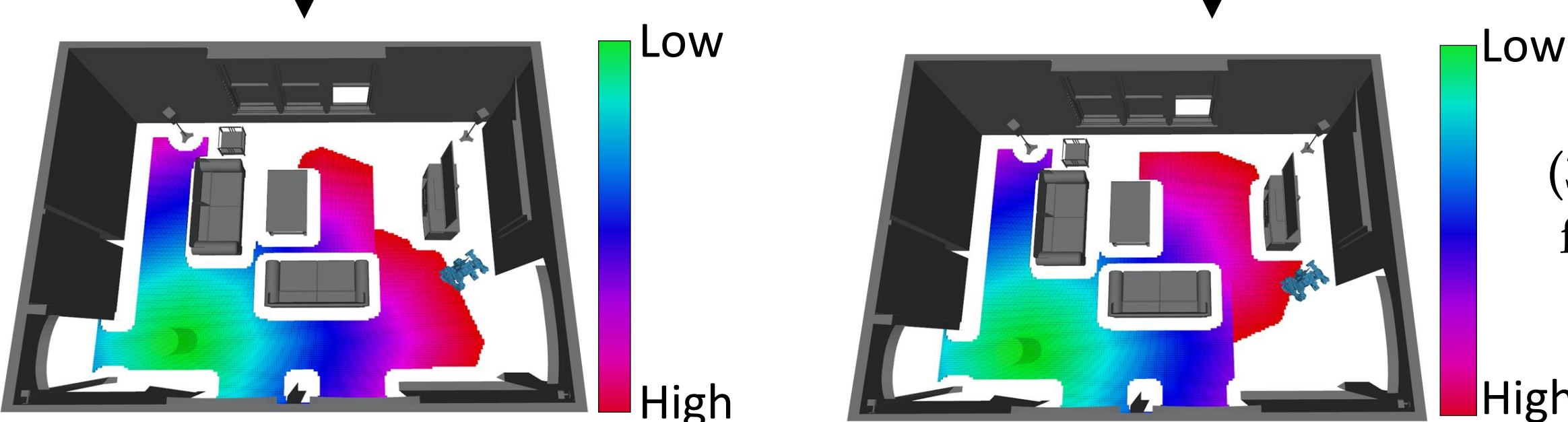
Single 2D Workspace



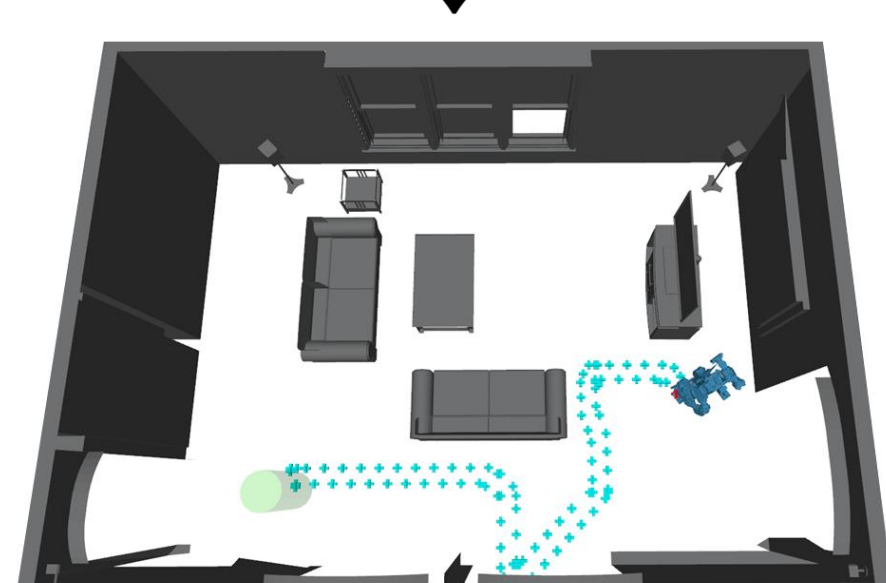
(1) 3D workspace the robot operates in



(2) User guidance in 2D workspace



(3) Heuristic generation for each user provided homotopy class



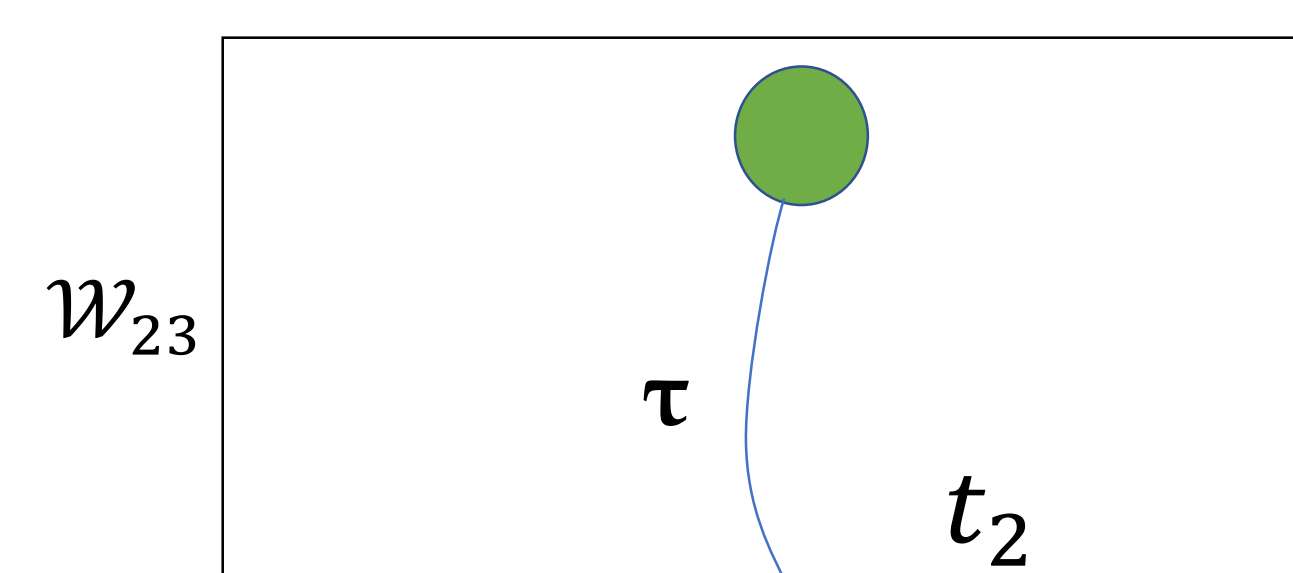
(4) Path produced by planner when simultaneously using multiple heuristic functions

Series of 2D Workspaces

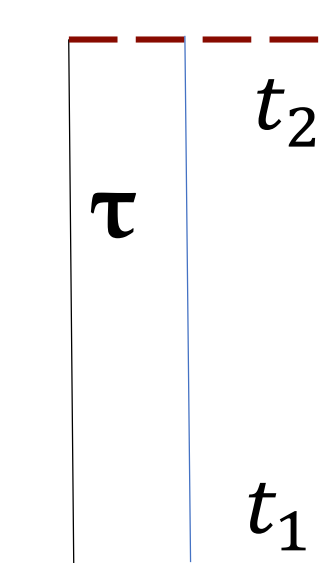
(1) 3D workspace the robot operates in overlaid with its respective surfaces



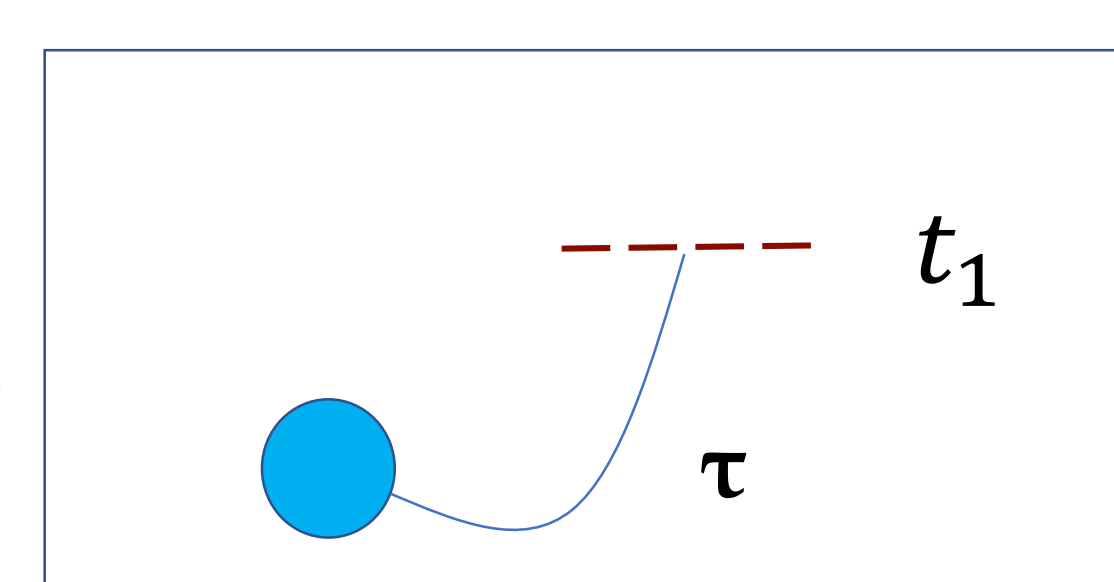
(2) User guidance in series of 2D workspaces



W_{23}

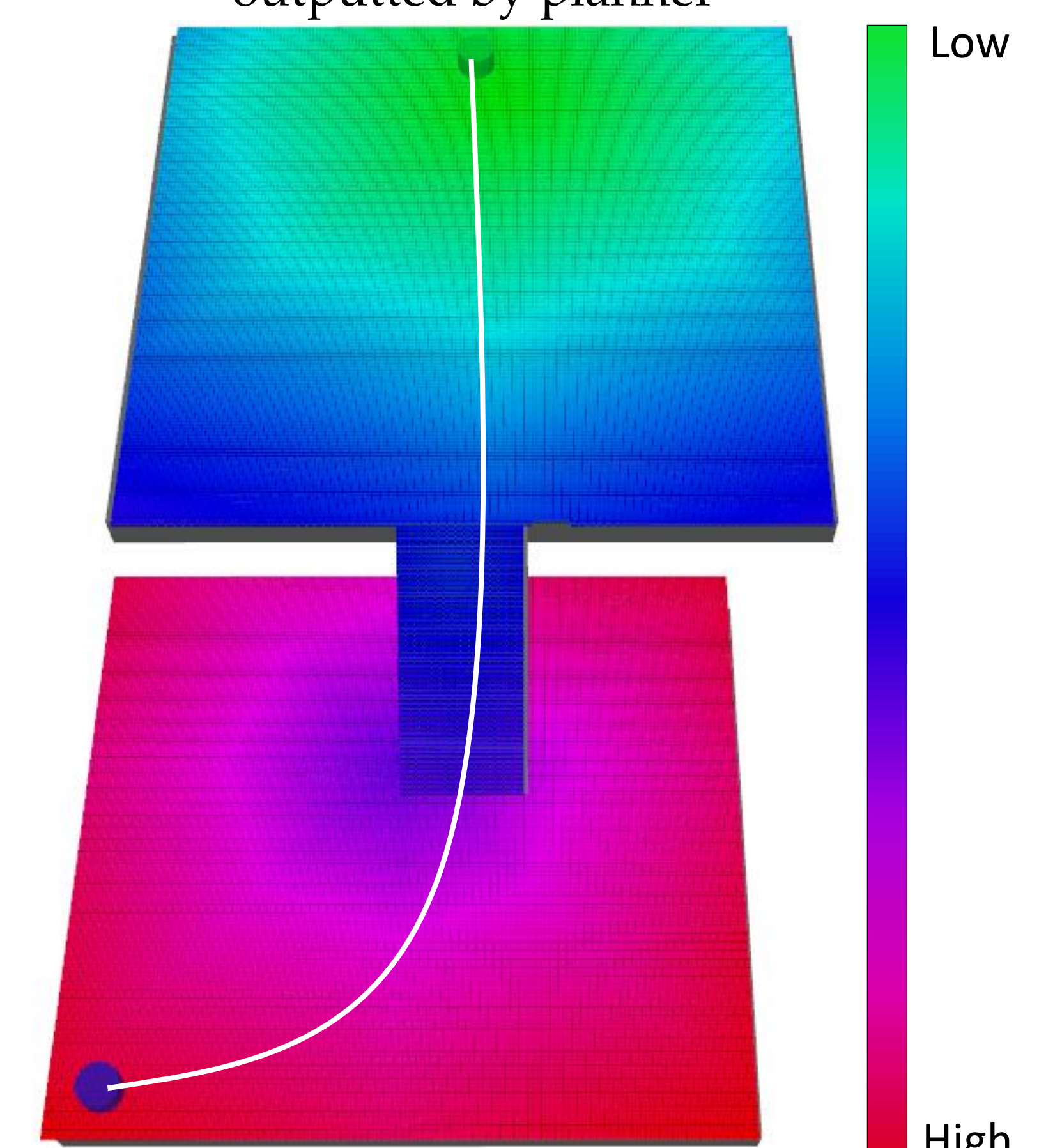


W_{22}



W_{21}

(3) Heuristic generation for user provided homotopy class and path outputted by planner



Low
High