ObjectReact: Learning Object-Relative Control for Visual Navigation

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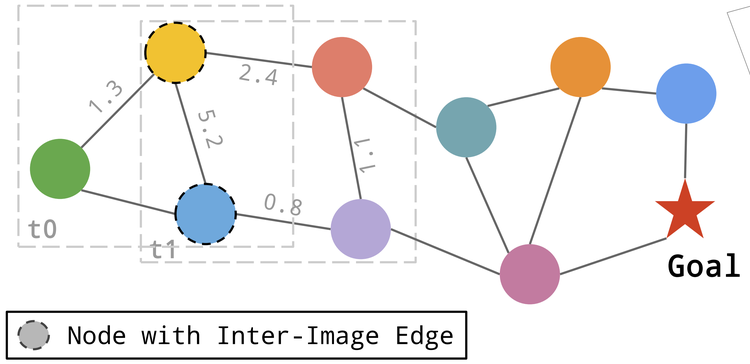
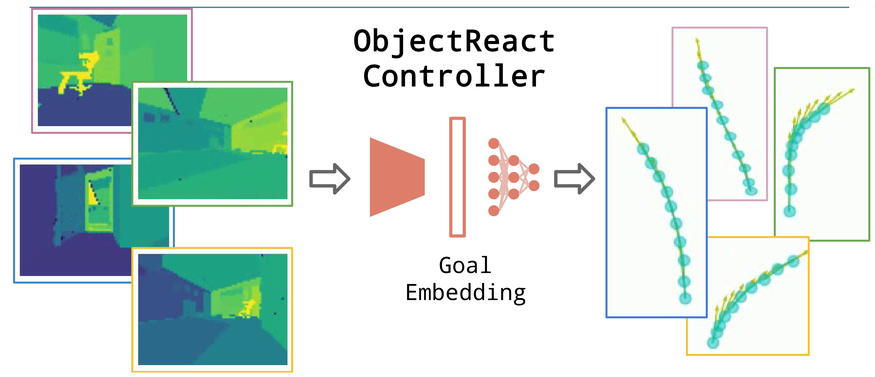
Mapping



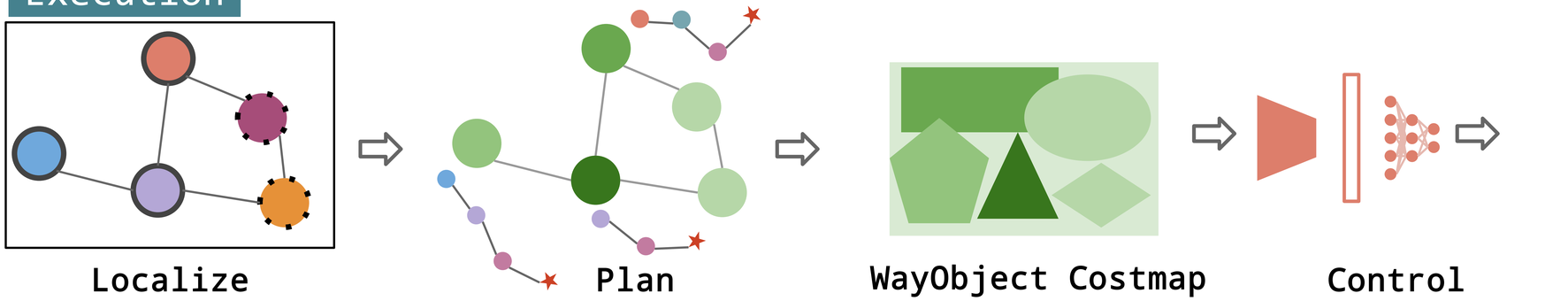
We construct a ***topometric*** map as a ***relative*** **3DSG** (scene graph), where image segments are used as object nodes, which are connected intra-image using 3D Euclidean distances and inter-image using object association.

Training



We train a model in simulation (HM3D) using geodesic paths to learn a controller, dubbed ***ObjectReact***, that predicts trajectory rollouts, conditioned on high-level "WayObject Costmap" representation, without an explicit RGB input.

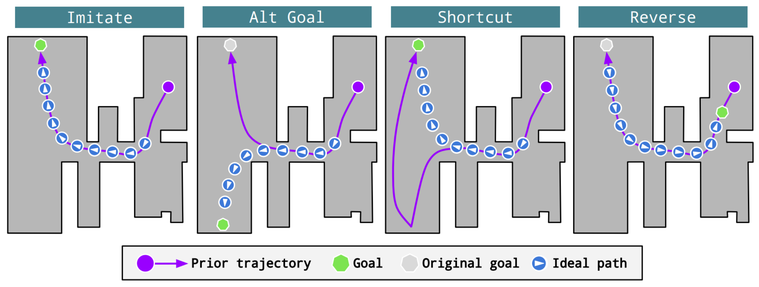
Execution



Given the map, we localize each of the query objects and compute its path to the goal node; we assign these path lengths to the object's segmentation mask, forming a ***WayObject Costmap*** for control prediction.

Tasks

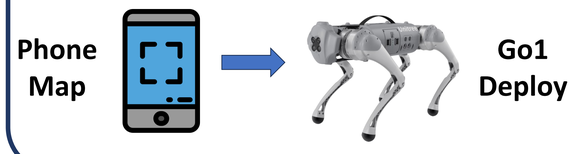
We benchmark on 4 tasks: **Imitate** (akin to teach-and-repeat); **Alt-Goal** (reaching previously seen but unvisited goals); **Shortcut** (through an extended prior map); and **Reverse** (navigating in the opposite direction).

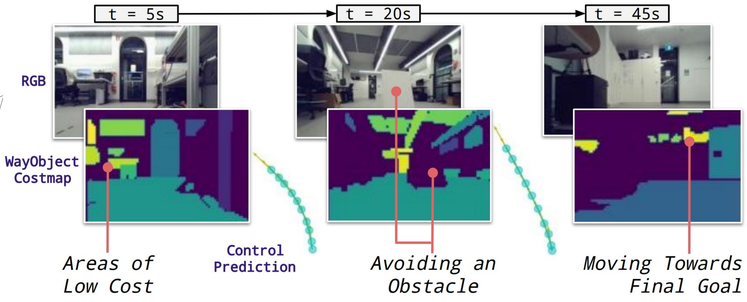


Method	Imitate		Alt Goal		Shortcut		Reverse	
	SPL	SSPL	SPL	SSPL	SPL	SSPL	SPL	SSPL
Image Relative: GNM [3]	57.58	**66.15**	2.17	13.54	7.69	18.40	11.60	23.59
Object Relative: ObjectReact (Ours)	**59.08**	64.62	**21.74**	**27.40**	**23.08**	**39.56**	**26.67**	**36.69**

Deploy

Object-relative navigation enables cross-embodiment deployment in terms of varying camera heights, e.g., a quadruped robot can navigate to different goals using a prior map constructed from a phone video.





Method / Robot Height	0.4m		1.3m		|Δ| (↓ better)	
	SPL	SSPL	SPL	SSPL	SPL	SSPL
Image Relative	33.33	45.93	81.82	86.38	48.49	40.45
Object Relative	60.60	68.51	57.56	60.72	**3.04**	**7.79**

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Project page: https://object-react.github.io/