

PreAfford: Affordance-based Pre-grasping across Objects and Scenes

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Motivation



Can't grasp directly



Push

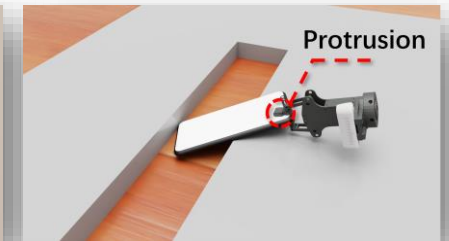


Grasp



Grasp steadily with pre-grasping manipulation

Adaptability



Adapt across object categories and environments

Deployability

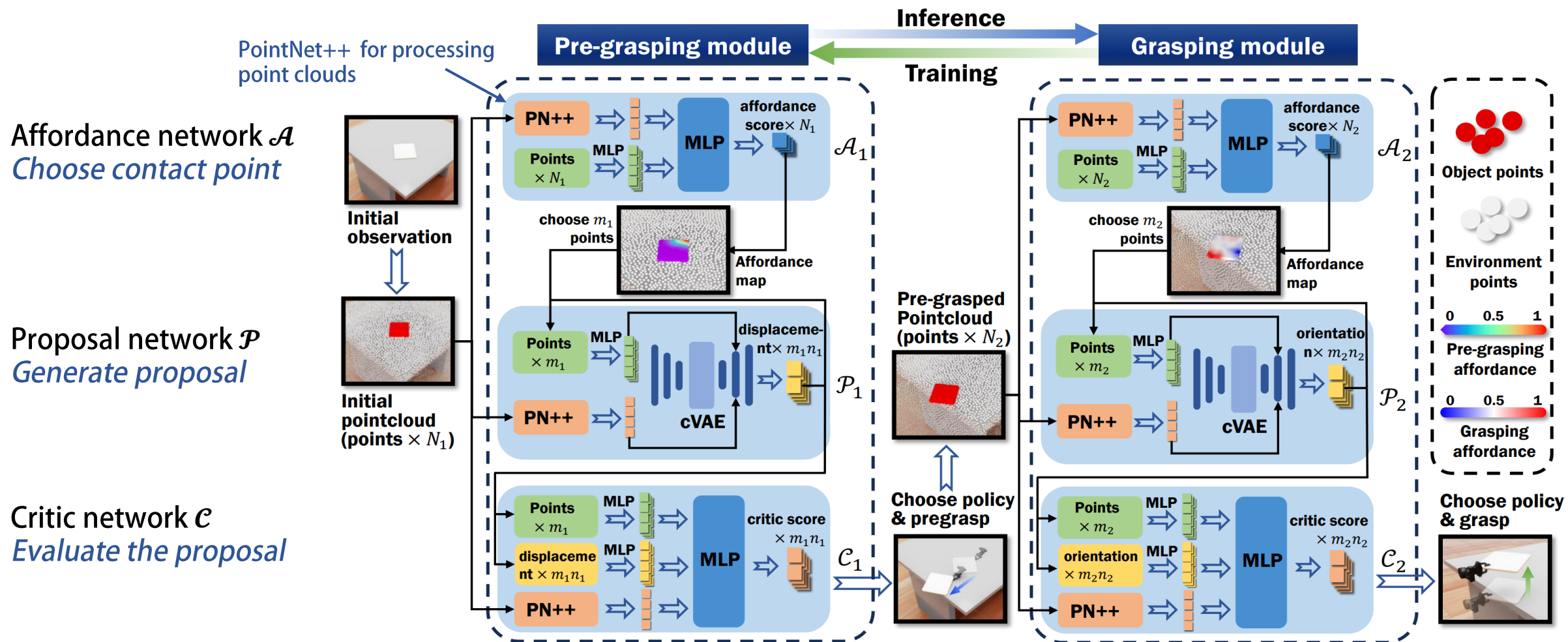
No need to customize representation for experimental setups
Easy to transfer to **real-world experiments**

Compatibility

Compatible with easy-to-grasp objects
Able to check the necessity of pre-grasping

Previous works' limitations

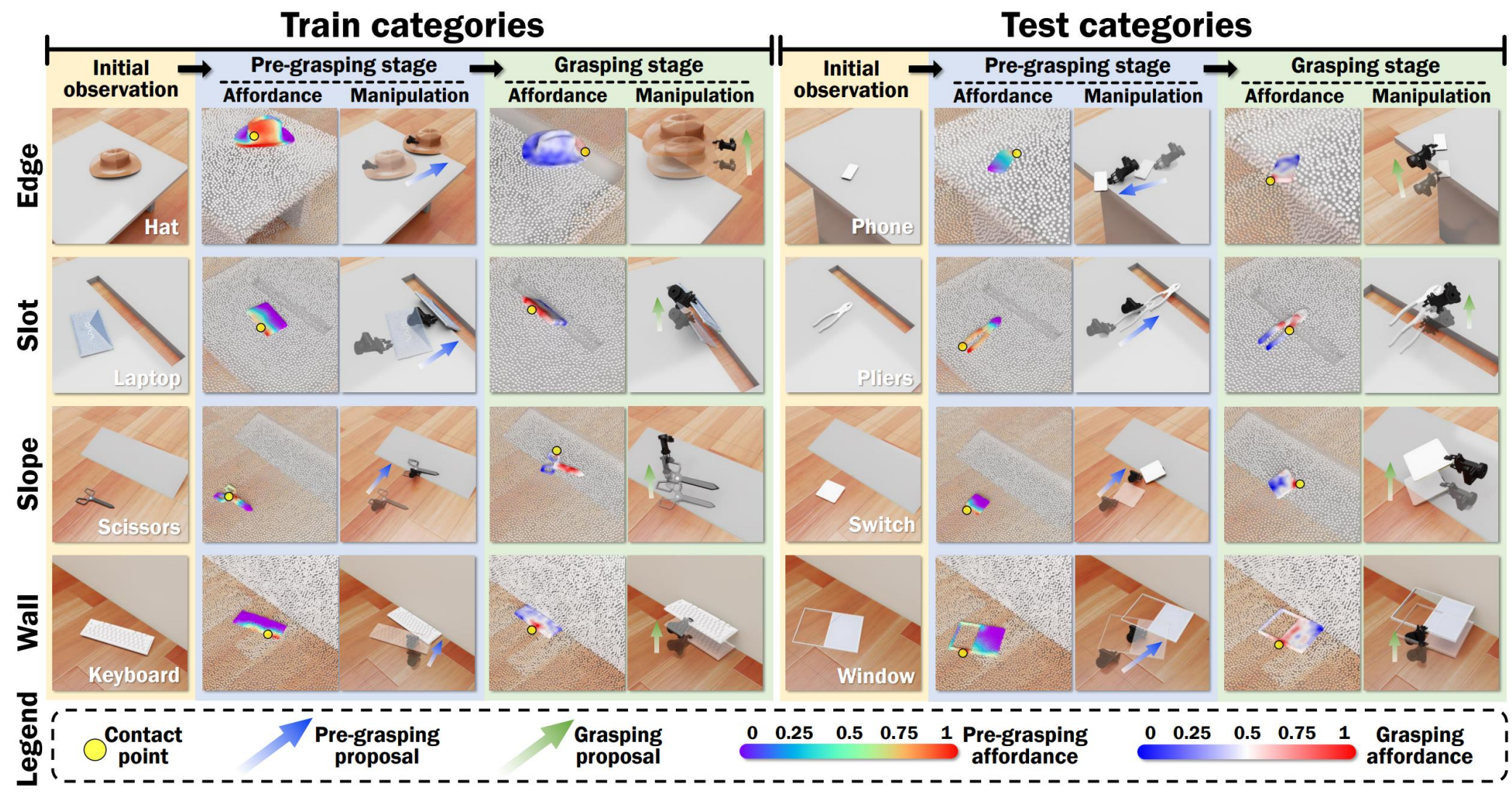
Framework



- Inference: two modules process point clouds to devise strategies for pre-grasping and grasping.
- Training: the grasping module generates rewards to train the pre-grasping module.

Experiment in simulator

Affordance maps illustrate potential effective interaction areas
Higher the score, more suitable the contact point is



Aware of environment: Choose suitable policies given the point cloud of the surrounding environment
Aware of dynamics: Tend to propose push on the. The pushing direction roughly pass the center of mass

Qualitative Result

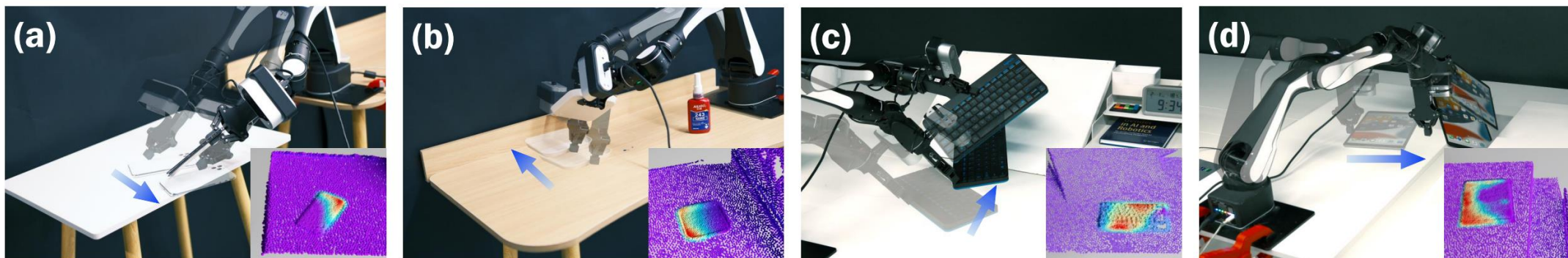
Comparison with baselines

Setting	Train object categories						Test object categories					
	Edge	Wall	Slope	Slot	Multi	Avg.	Edge	Wall	Slope	Slot	Multi	Avg.
W/o pre-grasping	2.3	3.8	4.3	3.4	4.0	3.6	6.1	2.3	2.9	5.7	6.0	4.6
Random-direction Push	21.6	10.3	6.4	16.8	18.1	14.6	24.9	17.2	12.1	18.4	23.0	19.1
Center-point Push	32.5	23.7	40.5	39.2	39.0	35.0	25.1	17.4	28.0	30.2	21.5	24.4
Ours w/o closed-loop	67.2	41.5	58.3	76.9	63.6	61.5	56.4	37.3	62.6	75.8	55.4	57.5
Ours	81.4	43.4	73.1	83.5	74.1	71.1	83.7	47.6	80.5	83.0	74.6	73.9

18 categories of objects; 5 scenes
1000 test cases for each object

Demonstrate Adaptability

Real world experiment



10 categories of objects across 4 scenes. Hot map indicates potential contact point.

Real world experiment

Setting	Seen categories						Unseen categories					
	Edge	Wall	Slope	Slot	Multi	Avg.	Edge	Wall	Slope	Slot	Multi	Avg.
W/o pre-grasping	0	0	0	0	0	0	10	0	5	0	0	3
With pre-grasping	70	45	80	90	85	74	80	30	75	90	85	72

Easy to deploy