Where2Explore: Few-shot Affordance Learning for Unseen Novel Categories of Articulated Objects

[Audio Included]

Difficulties in Manipulating Articulated Objects

- Diversity of articulated object categories

- Large-scale dataset

  Time-consuming to perform interactions in the real world

  Costly to obtain 3D models of a large number of objects

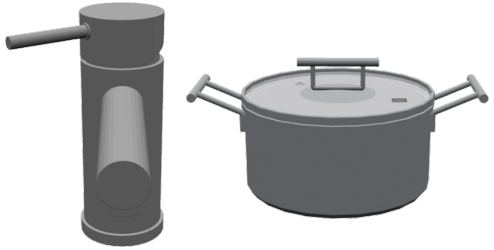
- Few-shot learning approaches

  Require test-time interactions

  Inefficient and unsafe

Similar Local Geometries Across Categories

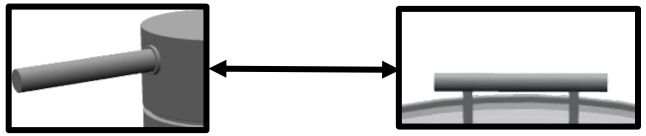
Training categories



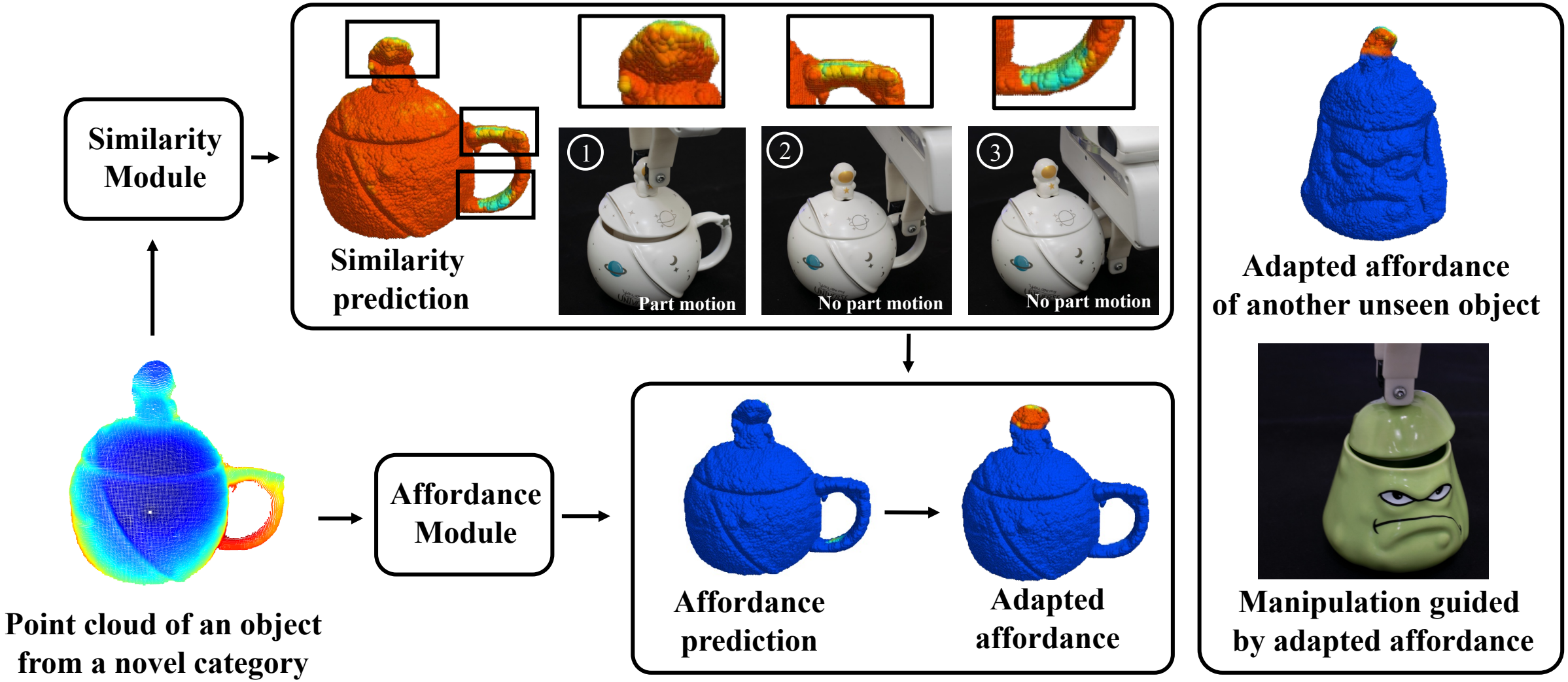
Other categories

Similar local geometries across categories

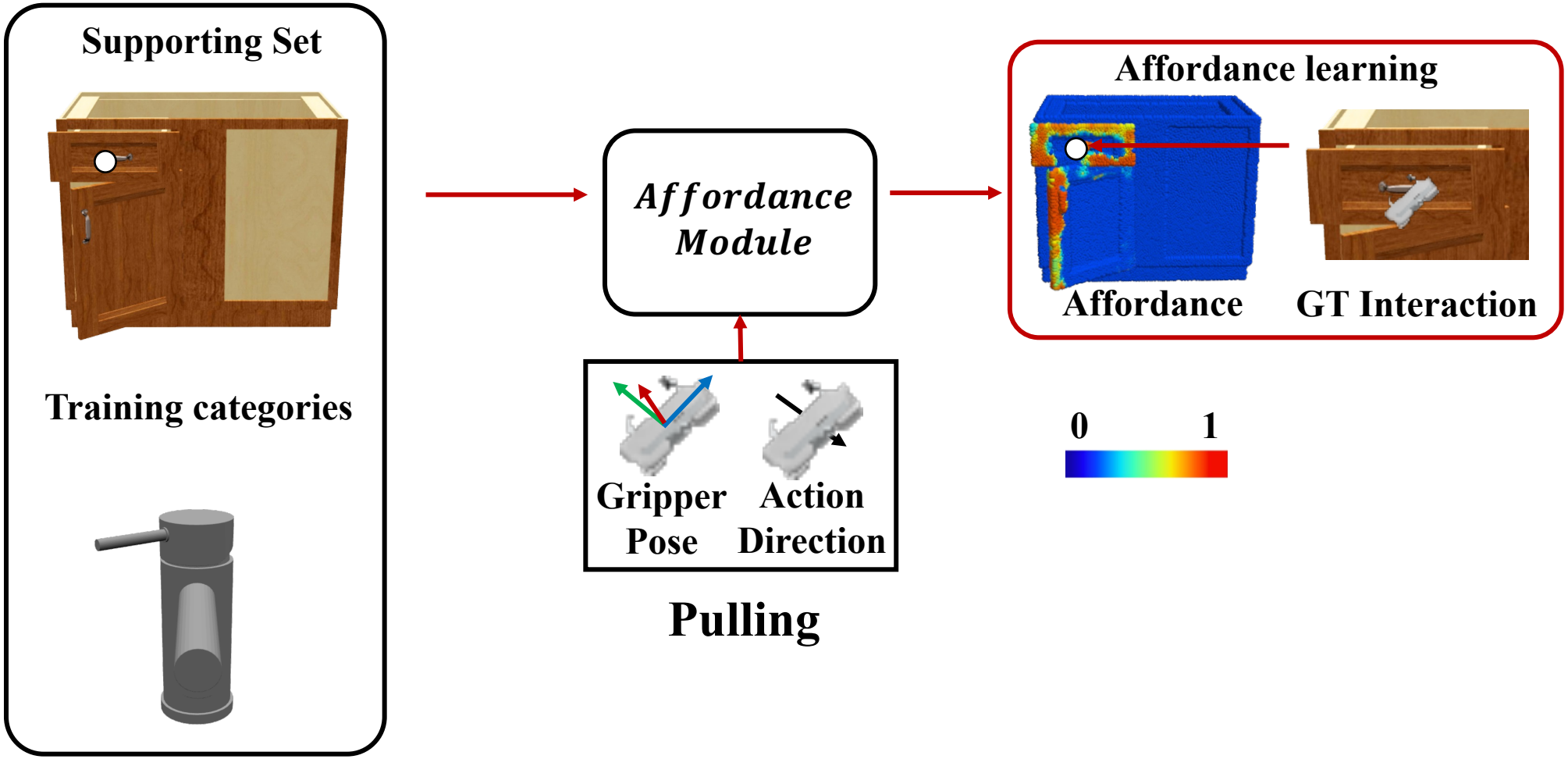
Known geometry



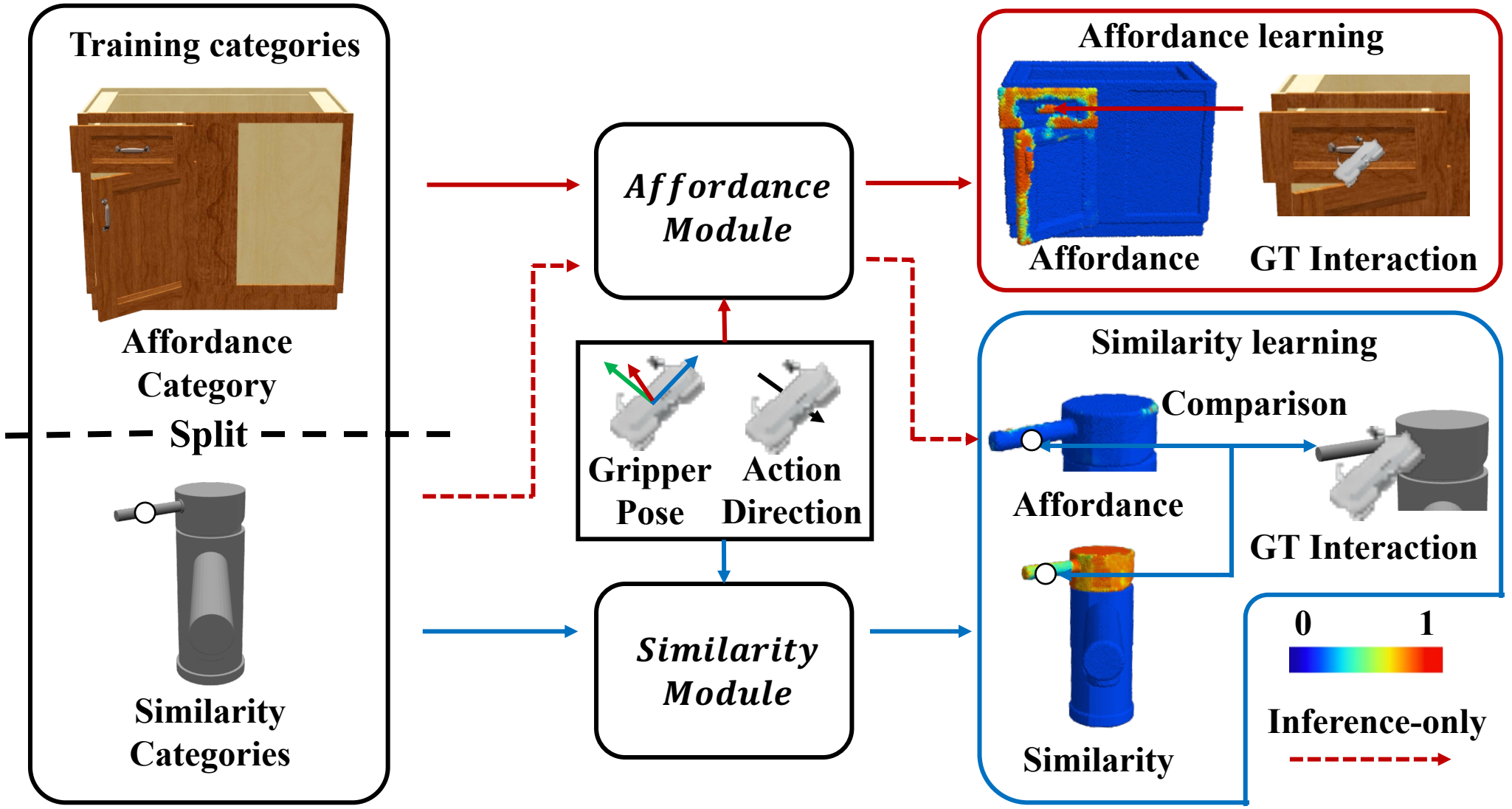
Where2Explore: Cross-category Few-shot Learning



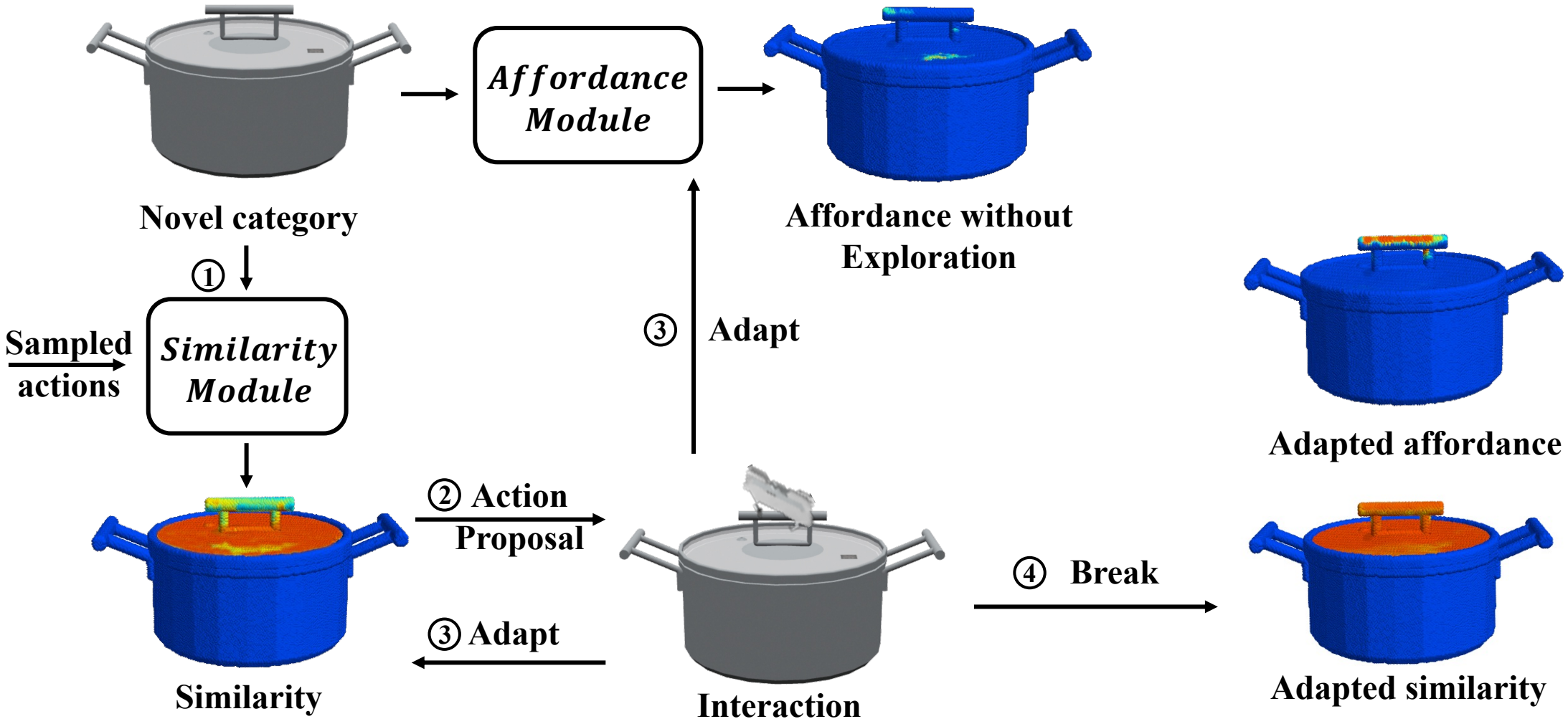
Affordance Learning for Building Supporting Set



Cross-category Similarity Learning



Few-shot Learning Loop



Quantitative Evaluation

- Setting

  Only **3** training categories

  Few-shot learning on **11** novel categories

  Only **10** objects per category for few-shot learning

  Test on **unseen** objects in novel categories

- Results

Method	F-score ↑ Pushing	F-score ↑ Pulling	Sample successful rate ↑ Pushing	Sample successful rate ↑ Pulling
Where2Act	25.6 / 28.0 / 30.4	6.4 / 7.5 / 8.5	15.7 / 17.0 / 19.9	3.9 / 4.3 / 6.2
AdaAfford	27.5 / 29.7 / 32.0	3.7 / 4.0 / 4.4	27.2 / 31.3 / 37.1	9.1 / 9.4 / 11.1
PointEncoder	19.4 / 19.4 / 29.9	2.9 / 4.6 / 5.9	11.6 / 10.9 / 29.9	1.8 / 3.1 / 9.2
Ours	**35.4 / 38.5 / 41.6**	**12.1 / 12.5 / 24.2**	**31.3 / 37.3 / 39.5**	**11.5 / 13.4 / 14.9**

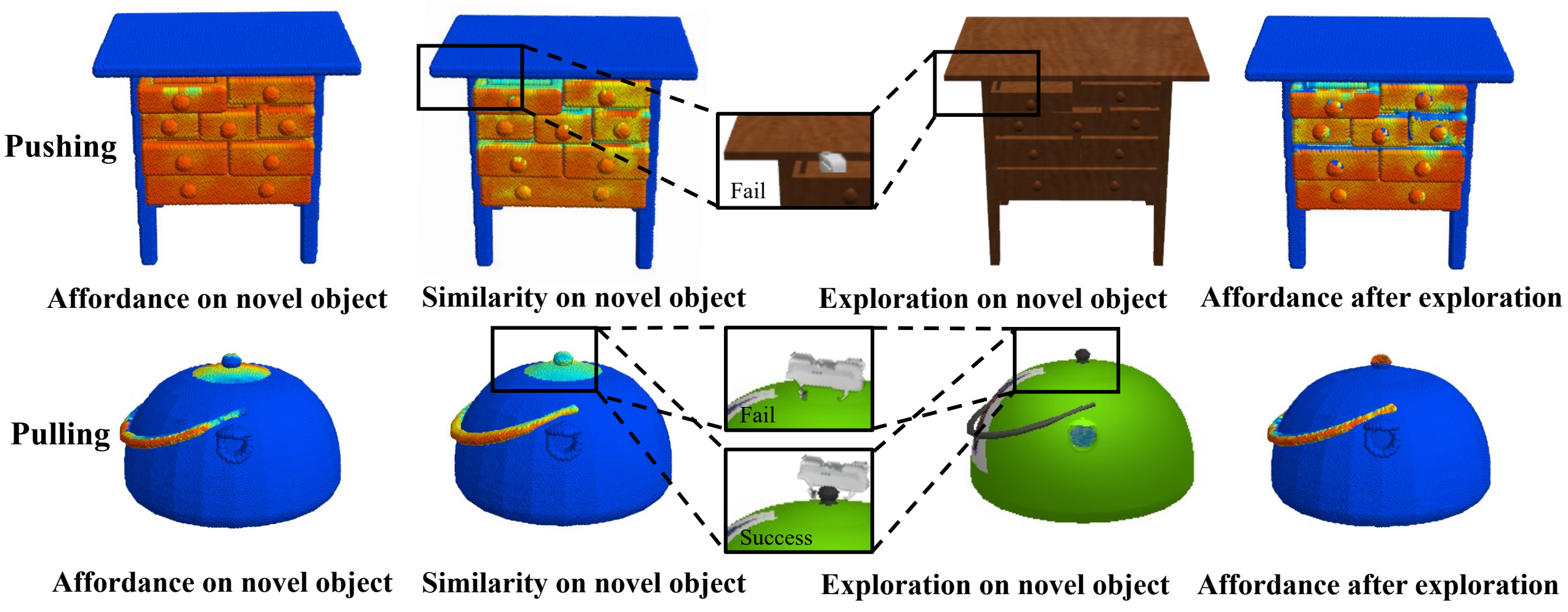
Few-shot learning on novel categories using different interaction budget (1, 2, 5).

Quantitative Evaluation

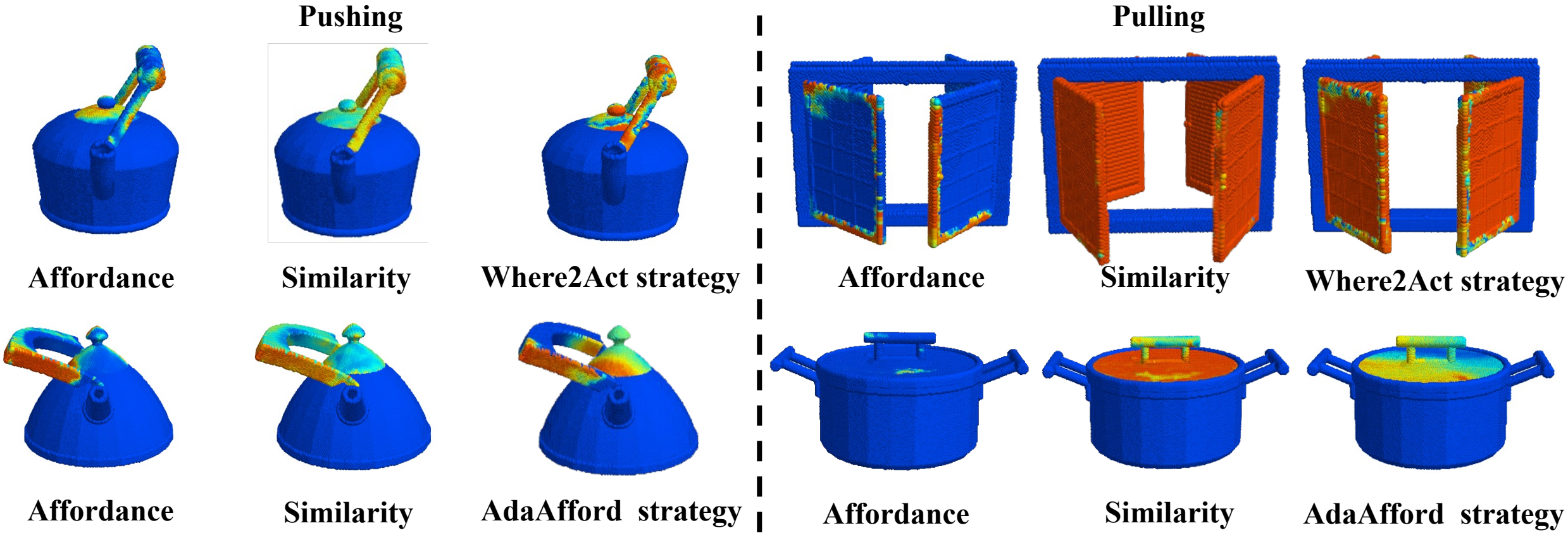
- Results

Methods	Pushing unseen instances in novel categories							Pulling unseen instances in novel categories						
														
Where2Act	22.1	10.5	42.8	43.4	31.2	47.4	51.7	8.9	6.0	13.1	12.1	2.5	5.4	8.3
AdaAfford	24.4	7.5	50.1	**48.8**	25.5	44.3	52.2	9.2	4.3	14.0	11.3	2.7	7.8	9.2
PointEncoder	20.4	14.2	29.3	24.1	22.7	26.8	29.8	3.9	9.6	7.7	7.8	4.7	8.9	9.0
Ours	**36.5**	**15.6**	**60.5**	48.5	**39.7**	**61.5**	**66.0**	**26.6**	**15.8**	**28.8**	**19.1**	**8.7**	**16.4**	**13.8**
F-score (%)														
Where2Act	14.1	5.9	42.4	35.7	22.2	34.8	39.4	7.4	5.3	18.2	18.2	1.5	3.0	4.5
AdaAfford	14.4	7.5	47.1	**47.4**	24.2	40.4	43.2	7.7	7.5	25.0	11.3	1.3	3.1	5.4
PointEncoder	13.1	3.4	18.7	17.3	12.4	17.5	21.0	3.0	3.9	4.3	7.8	0.6	4.3	3.6
Ours	**29.5**	**9.6**	**54.5**	41.9	**32.8**	**49.2**	**54.7**	**17.1**	**16.0**	**35.5**	**11.4**	**15.1**	**11.3**	**15.4**
Sample successful rate (%)														

Similarity-guided Explorations



Compared with Other Exploration Strategies



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Thank you for Watching!