Supplementary File

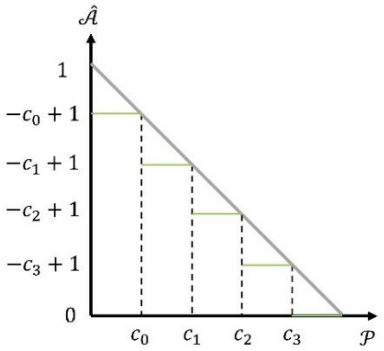


Fig. S1. Relationship between $\tilde{\mathcal{A}}$ and $\mathcal{P}$ in Eq. 8.

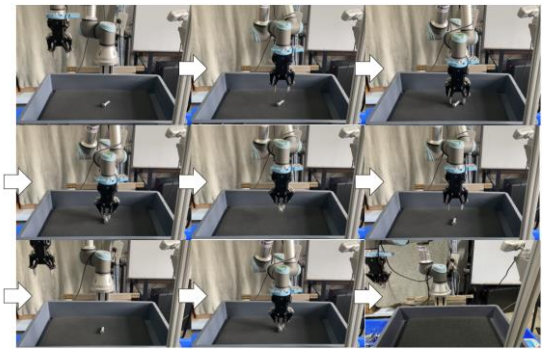


Fig. S2 A snapshot of restorative sampling of UR3's grasp.

Algorithm A1 Restorative Sampling

Capture I_i and obtain $\mathcal{O}_i$.
Obtain $\mathcal{G}_i$ given $\mathcal{O}_i$.
// Perform restorative manipulation M_i next.
Gripper moves first to T_i^l and rotates ϕ_i around Z-axis.
Gripper moves to T_i along $\mathcal{T}_i$.
Close Gripper.
if the grasp is successful **then**
  Gripper moves backward to T_i^l along $\mathcal{T}_i^-$.
  if the object is held during the return **then**
    Places the object back to T_i along $\mathcal{T}_i$.
    Set $g_i = 1$, capture $\mathcal{O}_i^+$, and calculate $\mathcal{S}_i$.
    Perform $\mathcal{G}_i$ again to take the object to its goal place.
  else
    Set $g_i = 0$ and $\mathcal{S}_i = 0$.
  end if
else
  Set $g_i = 0$ and $\mathcal{S}_i = 0$.
end if
Robot goes backs to its home.
Store $(\mathcal{O}_i, \mathcal{G}_i, \mathcal{S}_i)$ into D.

Algorithm A2 Training of FAGL

Initialize RA-Net Q_θ and Target RA-Net Q_{θ^-}.
Set hyperparameters $\alpha = 10^{-3}$, batch size B=16, $step_{max} = 2500$, $\epsilon = 0.5$, $\tau = 3$, $D = \emptyset$, and $step = 0$.
while $step < step_{max}$ **do**
  Obtain $\mathcal{O}_i$.
  $\epsilon = explore\_schedule(), p = rand()$.
  $$\mathcal{G}_i = \begin{cases} \underset{\mathcal{G}}{argmax} Q_\theta(\mathcal{O}, \mathcal{G}) & if\ p \leq 1 - \epsilon \\ random\ policy & if\ p > \epsilon \end{cases}$$
  Obtain $\mathcal{A}_i$, g_i, and $\mathcal{S}_i(\hat{\mathcal{A}}_i, g_i)$.
  $D = D \cup \{(\mathcal{O}_i, \mathcal{G}_i, \mathcal{S}_i)\}$.
  $step = step + 1$.
  if $|D| > B$ **then**
    Random sample $\{(\mathcal{O}_i, \mathcal{G}_i, \mathcal{S}_i)\}_{i\in[0,B]}$ in D.
    Update $Q_\theta(\mathcal{O}, \mathcal{G})$ on $\{(\mathcal{O}_i, \mathcal{G}_i, \mathcal{S}_i)\}_{i\in[0,B]}$.
  end if
  if $step$ % τ == 0 **then**
    $\theta^- = \theta$.
  end if
end while
$Q_\theta^*(\mathcal{O}, \mathcal{G}) = Q_\theta(\mathcal{O}, \mathcal{G})$.
Output: optimal action-value function $Q_\theta^*(\mathcal{O}, \mathcal{G})$.

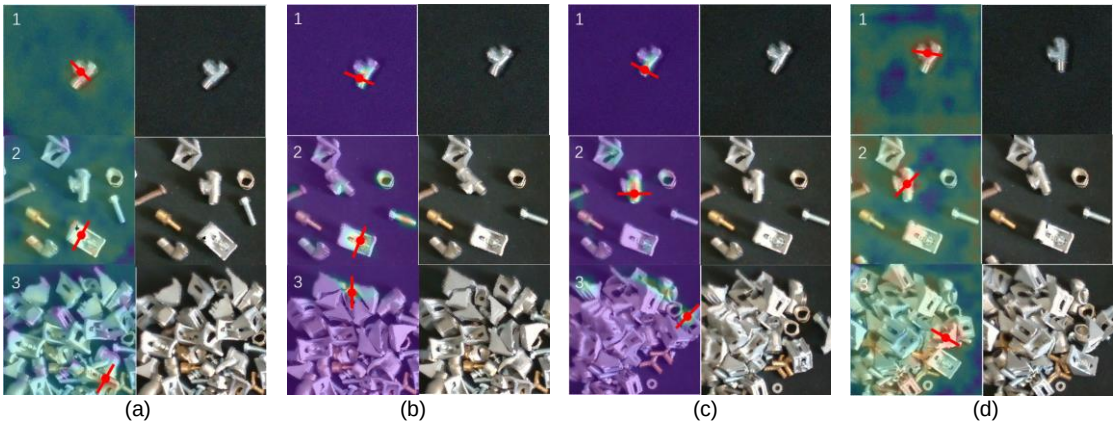
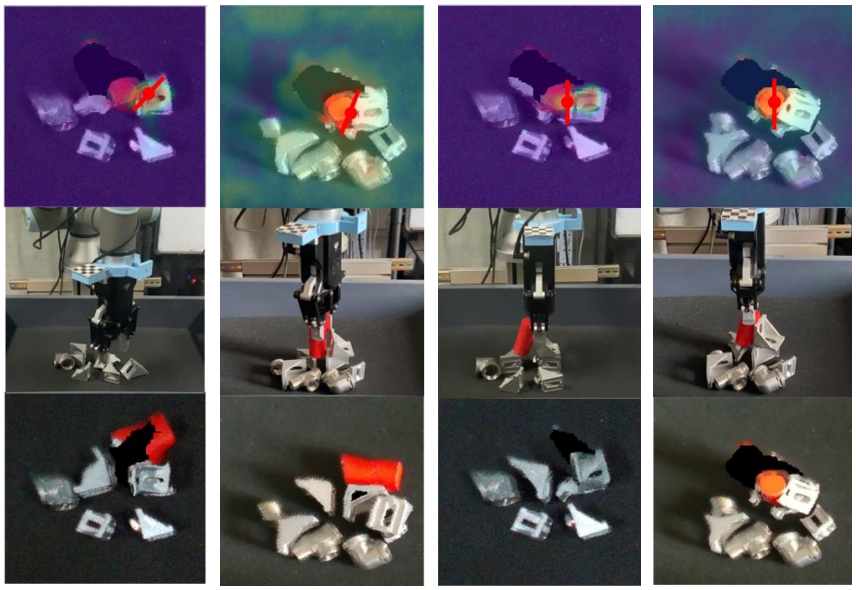


Fig. S3 Grasp affordances generated by different methods in different scenarios. (a)-(d) show the grasp affordance maps (in each first column) and the color heightmaps after restorative manipulation (in each second column) using FAGL, AIN, ASPN, and VGL in different scenarios with a single object (1), scattered objects (2), and cluttered objects (3), respectively.



(a) (b) (c) (d)

Fig. S4 Grasp affordances generated by AIN, VGL, ASPN, and FAGL in an adversarial scene. (a). (b), (c), and (d) show the grasp affordances generated by AIN, VGL, ASPN, and FAGL in turn. The first, second, and third row in (a). (b), (c), and (d) are grasp affordances, snapshot of grasping, and the color heightmap after a restorative manipulation, respectively. The red lines and points in the first row denote the pose and position of an optimal grasp, respectively.

TABLE S-I
COMPARISON OF METHODS IN DIFFERENT SCENARIOS

Scenarios	Single object			Scattered objects			Cluttered objects		
Metrics / Methods	*GSR*	*AADG*	*F*	*GSR*	*AADG*	*F*	*GSR*	*AADG*	*F*
VGL	0.89	0.48	0.69	0.85	0.21	0.53	0.72	0.09	0.41
FC-GQ-CNN	**0.95**	0.88	**0.92**	**0.88**	0.64	0.76	0.81	0.37	0.59
AIN	0.91	0.82	0.87	0.86	0.48	0.67	0.79	0.21	0.50
ASPN	0.94	0.66	0.80	0.85	0.37	0.61	0.77	0.15	0.46
FAGL	0.93	**0.89**	0.91	0.87	**0.66**	**0.77**	**0.82**	**0.56**	**0.69**

TABLE S-II
COMPARISON OF METHODS IN GRASPING UNSEEN OBJECTS

Scenarios	Single object			Scattered objects			Cluttered objects		
Metrics / Methods	*GSR*	*AADG*	*F*	*GSR*	*AADG*	*F*	*GSR*	*AADG*	*F*
VGL	0.90	0.38	0.64	0.78	0.19	0.49	0.69	0.09	0.39
FC-GQ-CNN	**0.94**	0.78	0.86	**0.83**	0.54	0.69	0.75	0.39	0.57
AIN	0.93	0.78	0.86	0.78	0.51	0.65	0.74	0.17	0.46
ASPN	0.91	0.61	0.76	0.81	0.32	0.57	0.69	0.13	0.41
FAGL	0.93	**0.81**	**0.87**	0.82	**0.62**	**0.72**	**0.78**	**0.48**	**0.63**

TABLE S-III
PERFORMANCE COMPARISON OF FAGL UNDER DIFFERENT DESTRUCTION TOLERANCE

Scenarios	Single object			Scattered objects			Cluttered objects		
Metrics / Destruction Tolerance	*GSR*	*AADG*	*F*	*GSR*	*AADG*	*F*	*GSR*	*AADG*	*F*
$\mathcal{C}_t$	0.93	0.66	0.80	0.88	0.35	0.62	0.84	0.21	0.53
$\mathcal{C}_r$	0.91	0.54	0.73	0.71	0.44	0.58	0.75	0.18	0.47

TABLE S-IV
Comparison of Methods in Adversarial Scenarios

Metrics / Methods	*GSR*	*AADG*	*F*
VGL	0.74	0.08	0.41
FC-GQ-CNN	0.81	0.33	0.57
AIN	0.79	0.23	0.51
ASPN	0.77	0.11	0.44
FAGL	**0.82**	**0.55**	**0.69**