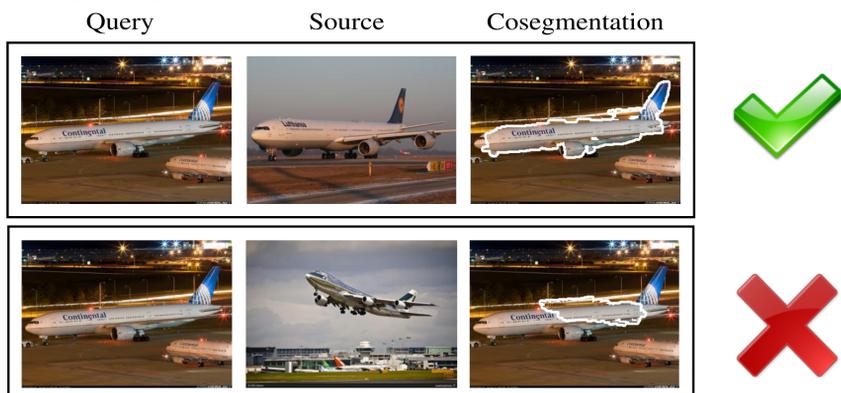


### Motivation



**Not every image pair is mutually compatible for cosegmentation.**

### Our Idea



We propose to predict which pairs of images are likely to successfully cosegment together.

Learn to rank successful “partners” more highly than those that would cosegment poorly, based on inter-image features revealing compatibility.

### Approach

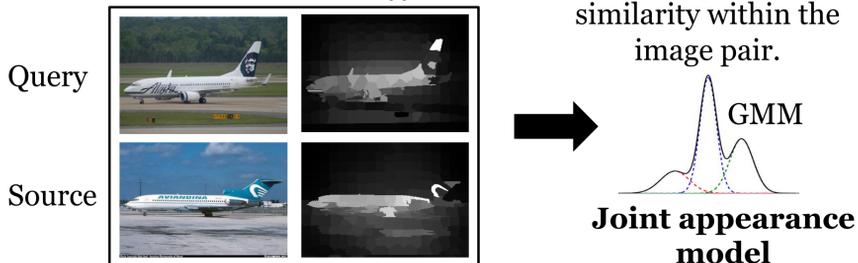
#### Paired-image cosegmentation:

$$E_{coseg}(L^{qs}) = E_{sing}(L^q) + E_{sing}(L^s) + \Theta_{app}^{qs}(L^{qs}) + \Theta_{match}^{qs}(L^{qs})$$

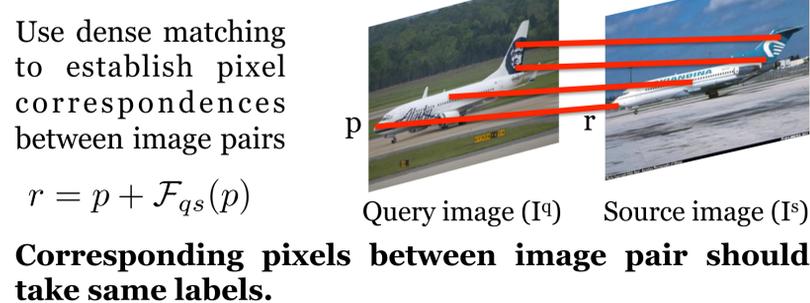
#### Single image cost ( $E_{sing}$ ):



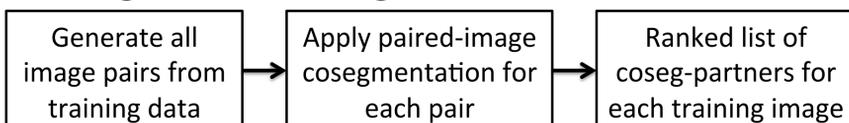
#### Joint appearance cost ( $\Theta_{app}$ ):



#### Dense matching cost ( $\Theta_{match}$ ):



#### Training data for ranking:



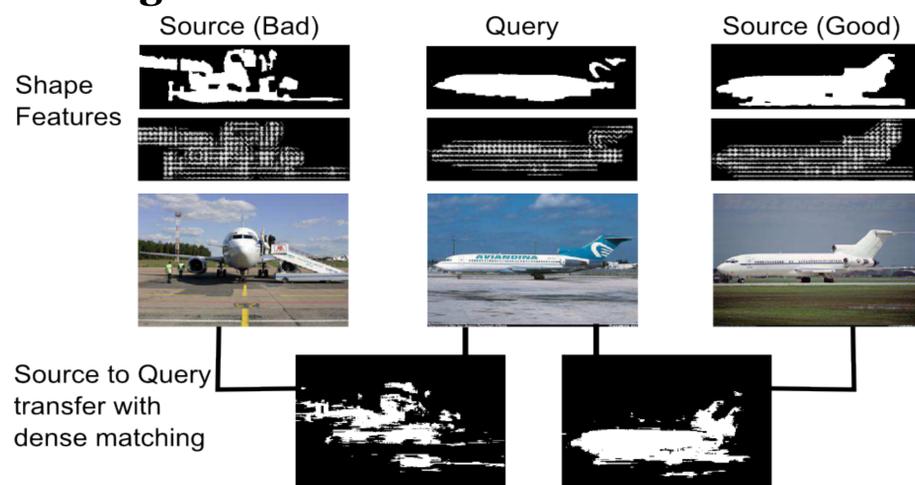
#### Source image features:

Foreground-background separability

Graph cuts uncertainty

Connected components count

#### Inter image features:



#### Learning to rank cosegmentation partners:

Learn a ranking function to predict the compatibility score for a given image pair:  $f(\phi(I^q, I^s)) = \mathbf{w}^T \phi(I^q, I^s)$

**Training:** SVM rank formulation [Joachims 2002]:

$\mathcal{O}$ : Set of pairs of all training tuples  $\{(i, j), (i, k)\}$  s.t.  $o_{ij} > o_{ik}$   
 minimize  $\frac{1}{2} \|\mathbf{w}\|_2^2 + C \sum \xi_{ijk}^2$   $o_{ij}$ : overlap score for pair  $(i, j)$   
 s.t.  $\mathbf{w}^T \phi(T^i, T^j) \geq \mathbf{w}^T \phi(T^i, T^k) + 1 - \xi_{ijk} \quad \forall (i, j, k) \in \mathcal{O}$

**Testing:** Given a query image  $I^q$  and candidate set  $\mathbf{P}$

$$I^{p^*} = \arg \max f(\phi(I^q, I^s)) \quad \forall I^s \in \mathbf{P}$$

Partner with the highest compatibility is selected for cosegmentation

### Results

#### MIT Object Discovery dataset:

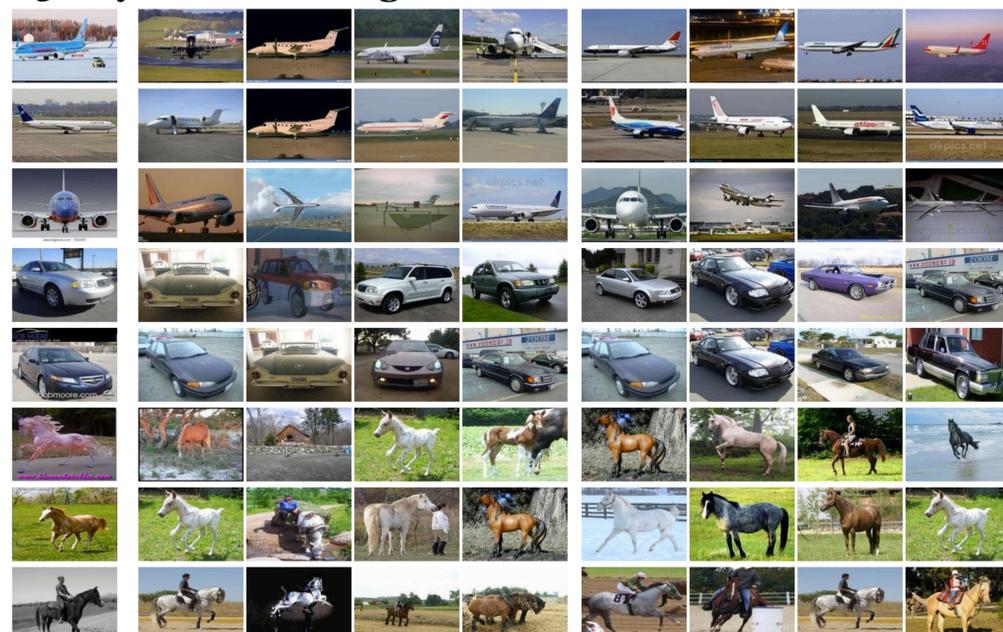
Class	Single Seg	Random	GIST	Joulin [CVPR 2010]	Ours	Ours-k	Upper bound
Airplane	39.14	42.22	42.34	15.26	<b>45.81</b>	46.26	57.39
Car	46.76	52.47	50.95	37.15	<b>53.63</b>	54.31	61.81
Horse	49.82	51.69	<b>52.73</b>	30.16	50.18	52.86	63.52

#### Caltech-28 dataset:

Class	Single Seg	Random	GIST	Ours	Ours-k	Upper bound
brain	73.31	72.43	72.54	<b>75.73</b>	76.09	76.22
ferry	54.99	55.87	55.23	<b>57.64</b>	57.71	58.02
joshua tree	53.04	54.05	54.45	<b>56.21</b>	57.12	57.52
motorbike	57.38	55.86	55.79	<b>57.21</b>	58.12	58.59
lotus	76.71	75.98	<b>78.38</b>	77.59	79.51	80.16

**Our method outperforms the baselines in most cases which shows that carefully choosing cosegmentation partners is important**

#### Query Gist Neighbors Our Ranked Partners



**Our method chooses partners that have more fine-grained compatibility with the query image**