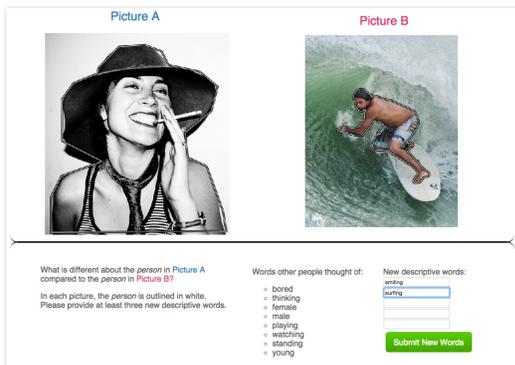


### Objects with Attributes

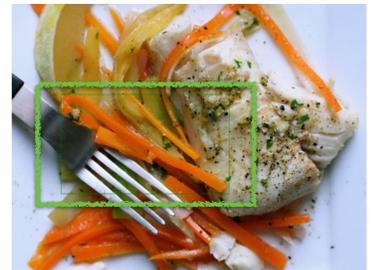
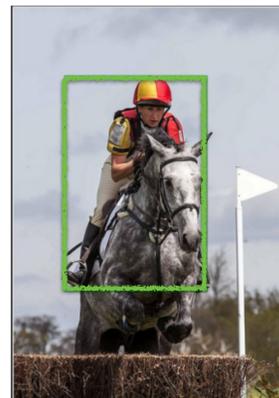


### What attributes are important to humans?



### Which Attribute should we ask about next?

Attribute labels are sparse. The average object has only 9 attributes (out of 196). Given an object's category and known attributes, other attributes are more or less likely to be present.



Person

Food  
Carrot

male, sporty,  
participating, sitting,  
moving, what's next?

healthy,  
tasty/delicious,  
fresh, what's next?

### Efficient Labeling Algorithm (ELA) Exploiting Attribute Correlations

Input: Dataset  $\mathcal{D}$  of unlabeled images, fully labeled training set  $\mathcal{T}$ , labels to annotate  $A$   
Output: Labeled dataset  $\mathcal{D}'$

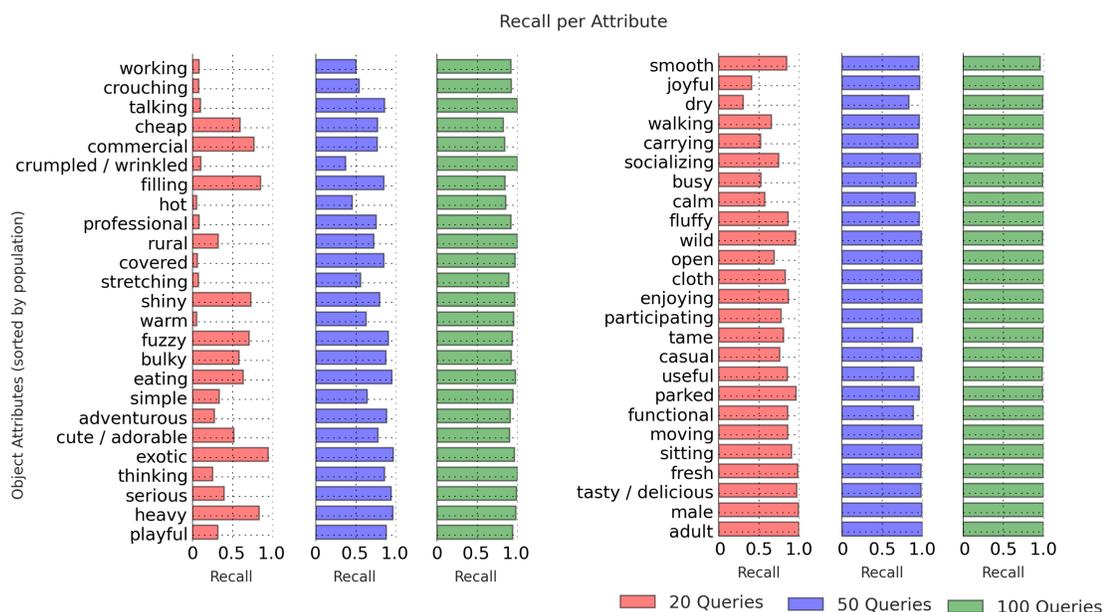
```

1 for  $I_j \in \mathcal{D}$  do
2   while NumLabels( $I_j$ ) <  $N$  do
3      $\triangleright I_j$  is an unlabeled image from  $\mathcal{D}$ 
4      $\triangleright$  Repeat annotation until  $N$  labels are acquired
5      $\mathcal{D}_S = \text{MatchingSubset}(I_j, \mathcal{D})$ 
6     if isEmpty( $\mathcal{D}_S$ ) then
7        $\mathcal{D}_S = \text{AltMatchingMethod}(I_j, \mathcal{D})$ 
8     end
9      $Q_n = \text{SelectAttributeQuery}(\mathcal{D}_S)$ 
10     $I_j[n] = \text{Annotate}(Q_n)$ 
11  end
12 end
13 return  $\mathcal{D}'$ 

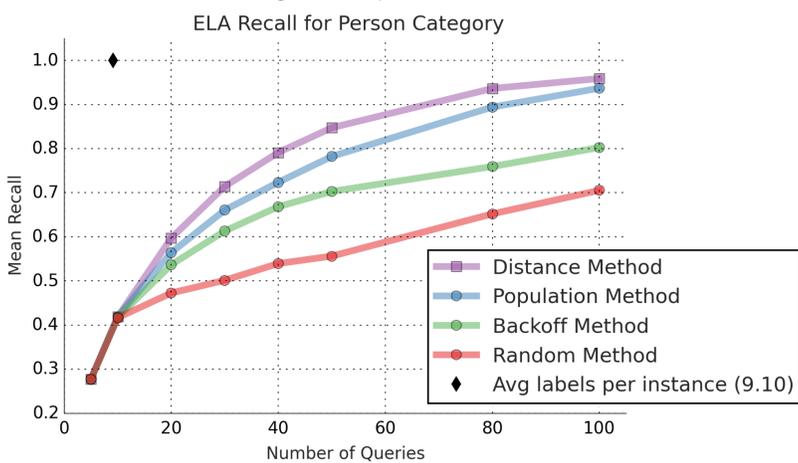
```

We don't have to annotate all the attributes!

### Does the ELA work for every Attribute?

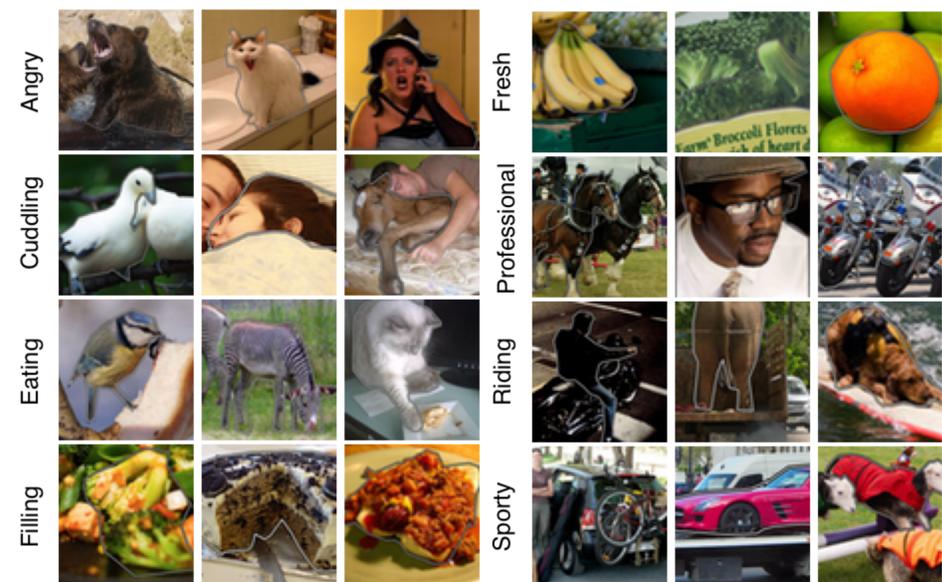


### Estimating Next Attribute Query when there are No Matching Examples in Exhaustive Set



### COCO Attribute Dataset Statistics:

- 84,000 images
- 180,000 unique objects
- 196 attributes
- 29 object categories
- 3.5 Million objection-attribute pairs



### Comparing Classification: 1 vs. Rest and Multi-attribute estimation

