# Carnegie Mellon University

# Learning Compositional Representations for Few-Shot Recognition

# Category distribution in the wild



## Compositional representations



- Given a set of **frequent** categories, what representation learned on it will transfer better to the **rare** ones?
- **Compositionality** is the key property for generalization in humans [Fodor, Harvard Univ. Press'75]
- Can we enforce compositionality in deep representations using part annotations?

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# **Compositionality regularization**

- On **base** categories, embed images and attributes into a feature space
- Force image embedding to be equal to the sum of attribute embeddings
- Train jointly with the image classification loss to constrain model selection
- Relax the hard constraint to allow for **non-exhaustive** attribute annotations









Just the classification loss on the **novel** categories!

### Datasets

- Support a wide spectrum of attributes, from concrete to highly abstract
- Attributes are annotated on the **category** level
- Collect 150 attributes for a subset of ImageNet categories







CUB-200-2011









### SUN397

# network depth increases









# Ablation analysis



# Comparison to the state of the art

	Novel		All			Novel		All	
	1-shot	5-shot	1-shot	5-shot		1-shot	5-shot	1-shot	5-shot
Prototypical networks	43.2	67.8	55.6	64.1	Prototypical networks	37.1	63.1	51.3	66.4
Matching Networks	48.5	69.2	50.6	62.6	Matching Networks	41.0	60.4	50.3	60.2
Relational networks	39.5	67.1	51.9	63.1	Relational networks	35.1	63.7	51.0	66.5
Cos w/ comp	52.5	73.8	62.6	74.0	Cos w/ comp	43.4	65.9	54.9	66.3
Cos w/ comp + data aug	53.6	74.6	63.1	74.5	Cos w/ comp + data aug	45.9	67.1	56.3	67.3
CUB-200-2011					SUN397				

COB-200-2011

	No	ovel	A		
	1-shot	5-shot	1-shot	5-shot	
Prototype Matching Networks w/ G	45.8	69.0	57.6	71.9	-
Prototype Matching Networks	43.3	68.4	55.8	71.1	
Prototypical networks	39.3	66.3	49.5	69.7	
Matching Networks	43.6	66.0	54.4	69.0	
Cos w/ comp	46.6	68.5	55.4	71.2	-
Cos w/ comp + data aug	49.3	69.7	57.9	71.9	•

ImageNet

# Analysis of representations



ImageNet



Code available: sites.google.com/view/comprepr/home

- Cosine classifier with compositionality constraint outperforms complex methods across the board
- Our ImageNet annotations are effective
- Data augmentation is important

[Bau et al., CVPR'17]