Columbia University UPC BSC VILYNX

More cat than cute ?

Interpretable Prediction of Adjective-Noun Pairs

ACM Multimedia 2017 Workshop
Multimodal Understanding of Social, Affective and Subjective Attributes (MUSA2)






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Motivation

Problem: The **AFFECTIVE GAP** between low-level visual features and the emotional content of an image.

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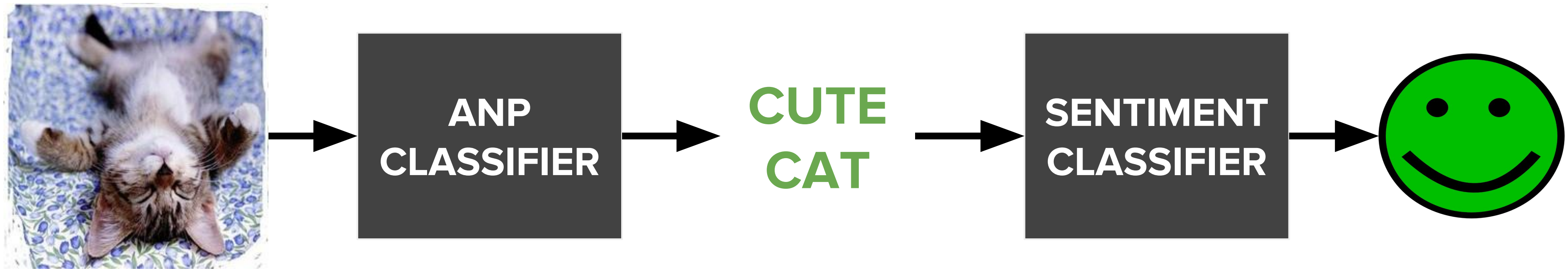
Motivation

Adjective-Noun Pairs (ANPs) provide detectable mid-level affective representations.



[3] Damian Borth,Rongrong Ji,Tao Chen,Thomas Breuel, and Shih-Fu Chang. Large-scale visual sentiment ontology and detectors using adjective noun pairs. ACM MM 2013

Motivation

➜ Observation [16]: Name provides visual grounding, Adjective an affective bias.

➜ Our Hypothesis: For some ANPs, adjective carry most visual cues.

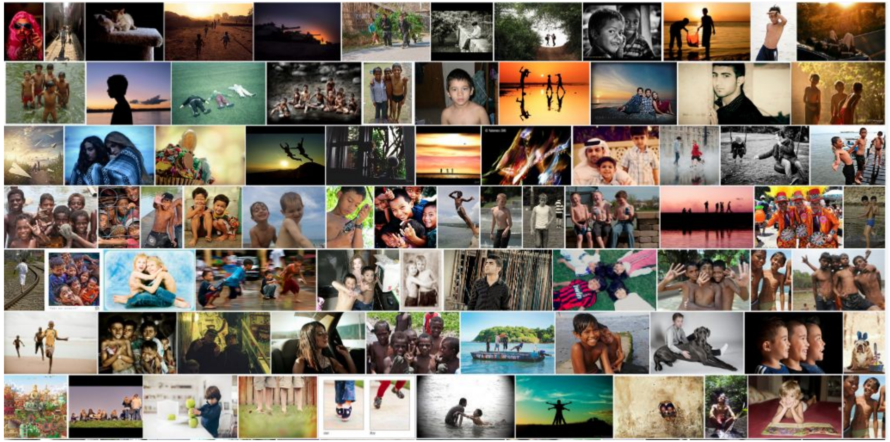
Cute dog

Dark night

[16] Brendan Jou, Tao Chen, Nikolaos Pappas, Miriam Redi, Mercan Topkara, and Shih-Fu Chang. Visual affect around the world: A large-scale multilingual visual sentiment ontology. ACM MM 2015.

Dataset: Subset of VSO

Query search on Flickr API:
Happy Kids



VSO Dataset [3]
2,089 ANPs

Subset

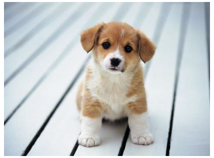
MT-VSO Dataset [14]
553 ANPs
384,258 images
(80% train - 20% tes)

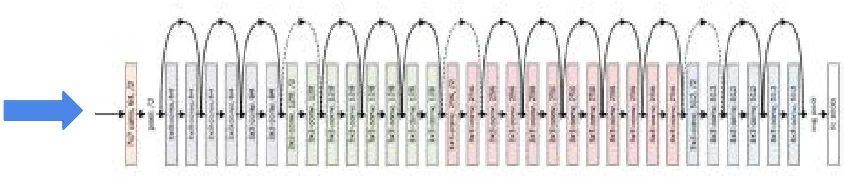
[3] Damian Borth,Rongrong Ji,Tao Chen,Thomas Breuel, and Shih-Fu Chang. Large-scale visual sentiment ontology and detectors using adjective noun pairs. ACM MM 2013
[14] Brendan Jou and Shih-Fu Chang. Deep Cross Residual Learning for Multi- task Visual Recognition. In ACM MM 2016

AdjNet & NounNet

Two ResNet-50 CNNs are trained independently to predict adjectives and nouns.

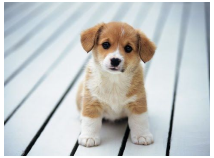
AdjNet

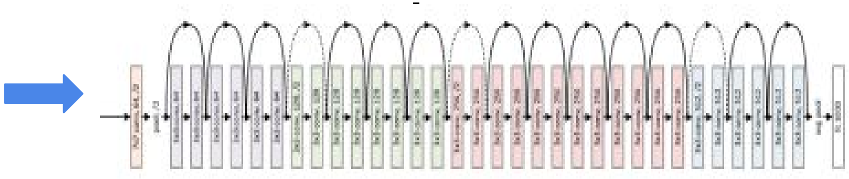




$$\hat{y}_{adj} = f_{adj}(x)$$

NounN





$$\hat{y}_{noun} = f_{noun}(x)$$

[9] Kaiming He, Xiangyu Zhang, Shaoqing Ren, and Jian Sun. Deep residual learning for image recognition. CVPR 2016.

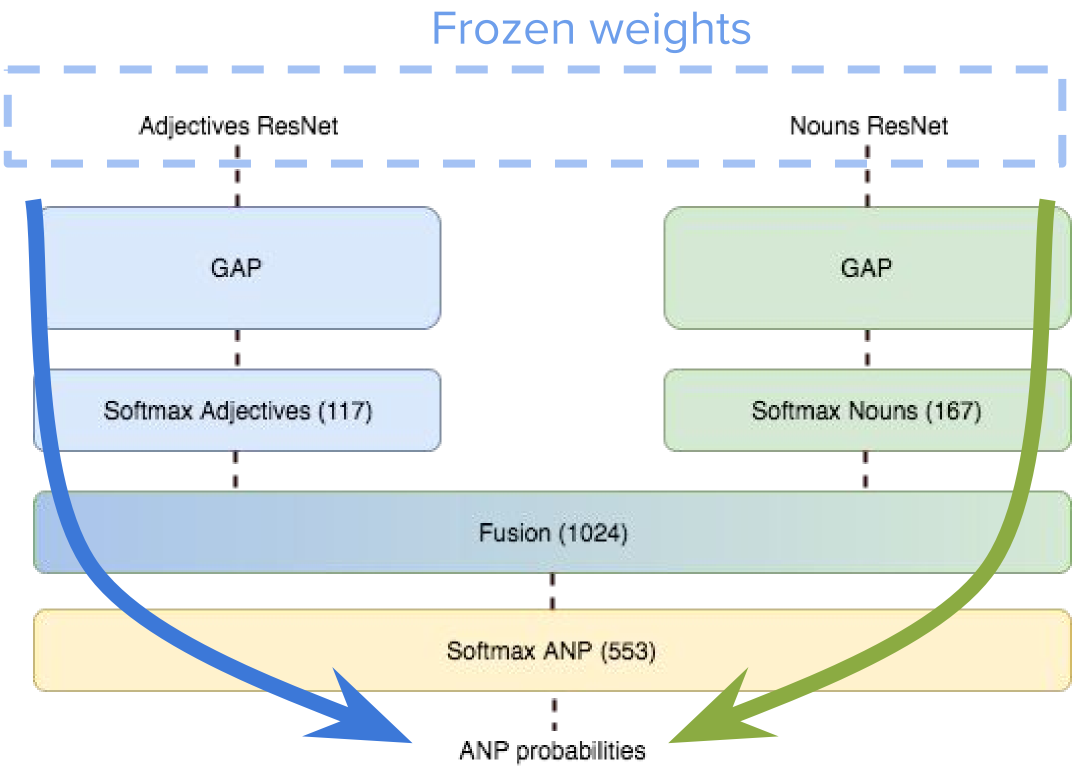
AdjNet & NounNet

Our implementation reproduces [14]:

Model	Task	Classes	top-1	top-5
AdjNet [14]	Adj	117	28.45	57.87
AdjNet	Adj	117	27.70	57.00
NounNet [14]	Noun	167	41.64	69.81
NounNet	Noun	167	41.50	69.20

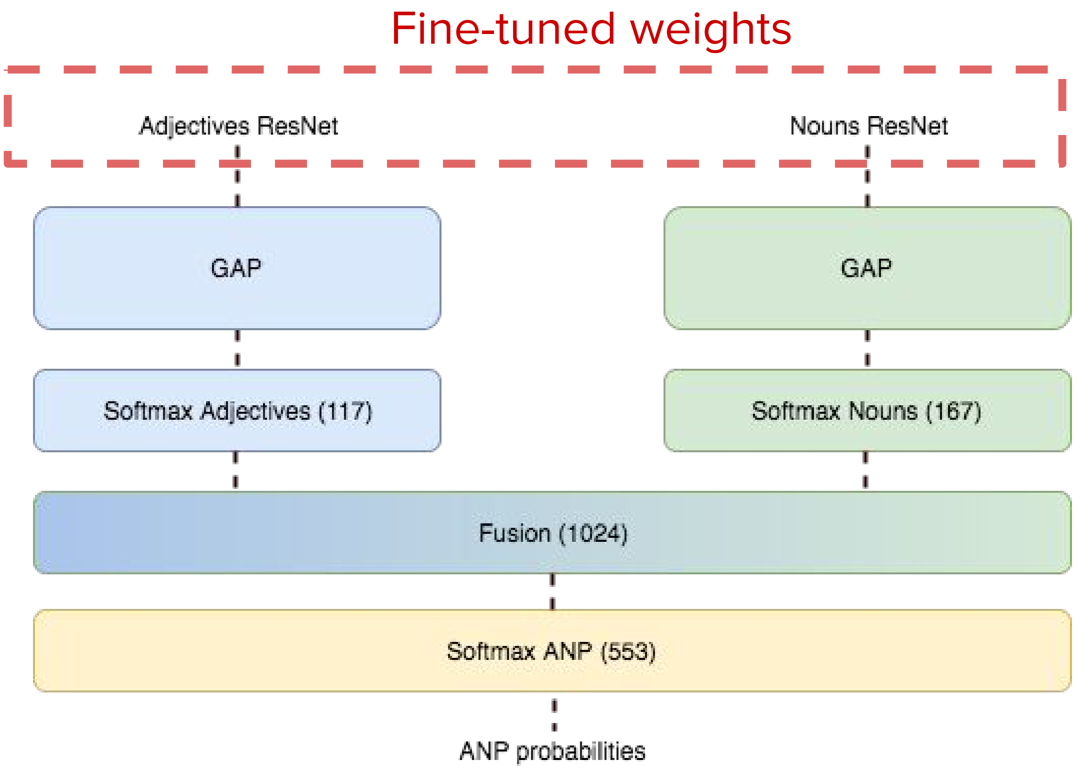
[14] Brendan Jou and Shih-Fu Chang. Deep Cross Residual Learning for Multi- task Visual Recognition. In ACM MM 2016

ANPnet



$$\hat{y}_{ANP} = g\left(\hat{y}_{adj}, \hat{y}_{noun}\right)$$

Non-interpretable variation



$$\hat{y}_{ANP} = g\left(\hat{y}_{adj}, \hat{y}_{noun}\right)$$

ANPnet: Top-5 Accuracy

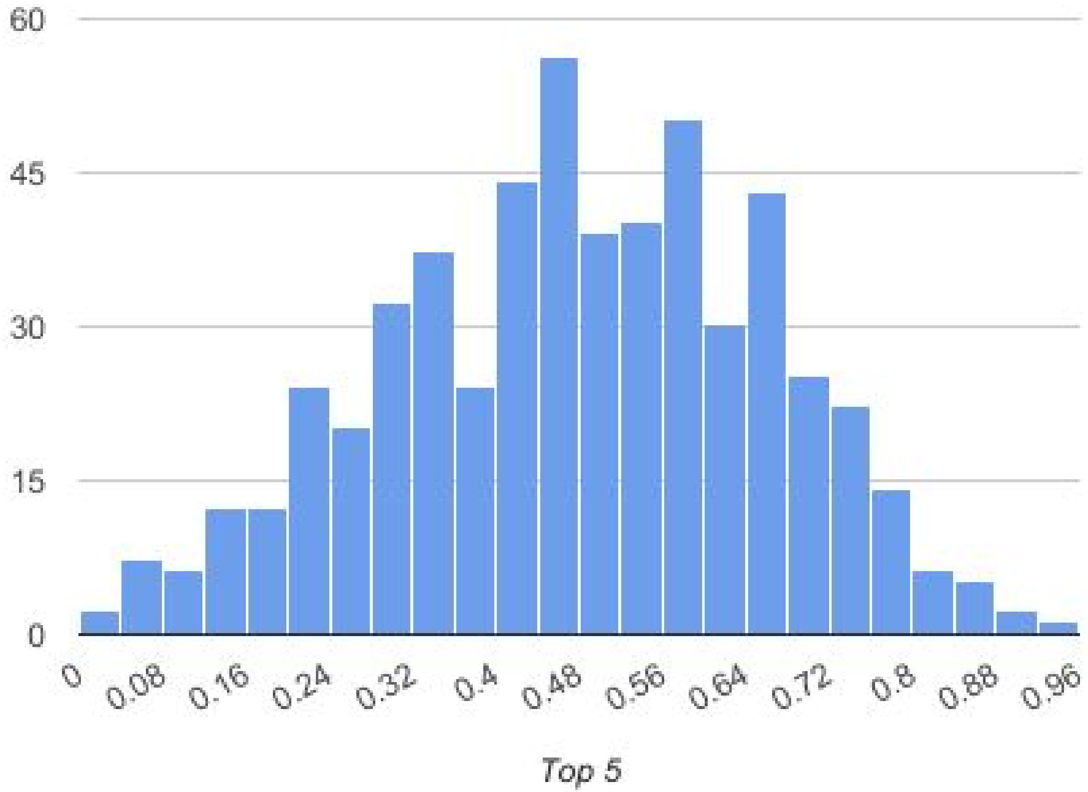
Interpretability comes at the cost of a decrease in prediction accuracy.

Model	Task	Classes	top-1	top-5
ResNet-50 [14]	ANP	553	22.68	47.82
ResNet-50	ANP	553	23.40	48.20
Non-Interpretable	ANP	553	21.80	46.00
ANPNet	ANP	553	20.67	43.28

[14] Brendan Jou and Shih-Fu Chang. Deep Cross Residual Learning for Multi- task Visual Recognition. In ACM MM 2016

ANPnet: Top-5 Accuracy

Distribution of accuracies across ANPs.

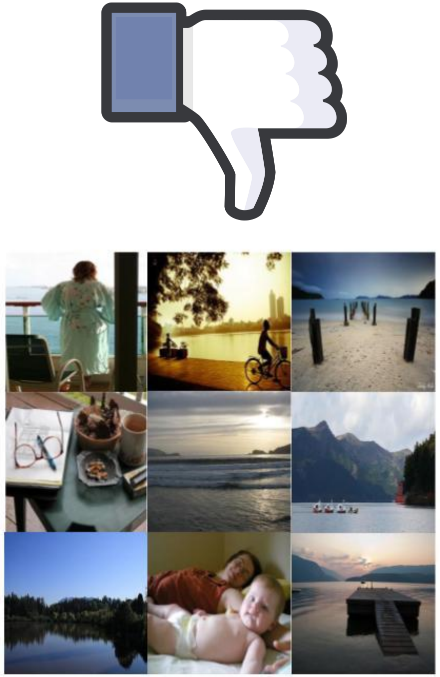


ANPnet: Top-5 Accuracy

dying rose

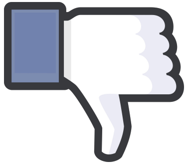
young deer

nice scene



peaceful morning

ANPnet: Top-5 Accuracy



	Top-5 accuracies for best ANPs				Top-5 accuracies for worst ANPs		
	Adj	Noun	ANP		Adj	Noun	ANP
gentle river	72.22	55.97	92.45	**abandoned places**	84.58	33.93	8.21
tiny bathroom	70.82	88.35	91.26	**beautiful landscape**	60.49	42.68	7.41
young deer	52.49	89.04	89.81	**beautiful earth**	60.49	5.00	5.71
wild deer	64.34	89.04	86.49	**charming places**	4.46	33.93	5.36
misty road	79.42	80.16	86.49	**bad view**	38.83	67.86	5.22
dying rose	68.12	80.07	85.00	**peaceful morning**	26.22	53.18	4.96
icy grass	78.29	69.31	84.16	**peaceful places**	26.22	33.93	4.59
tiny mushrooms	70.82	82.52	84.00	**nice scene**	45.20	25.65	4.39
golden statue	64.56	77.12	83.61	**serene scene**	18.93	25.65	3.60
empty train	69.72	65.42	76.60	**bright sky**	52.84	67.93	3.20

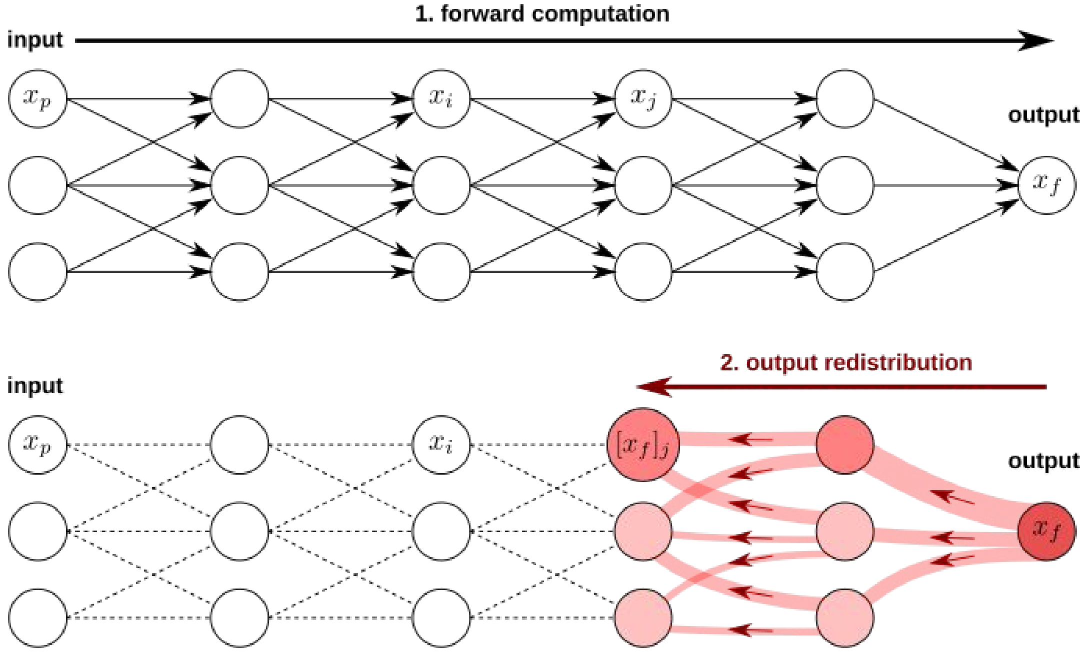
"Object oriented" "Scene oriented"

Interpretability

Backpropagating contributions with Deep Taylor Decomposition [20]

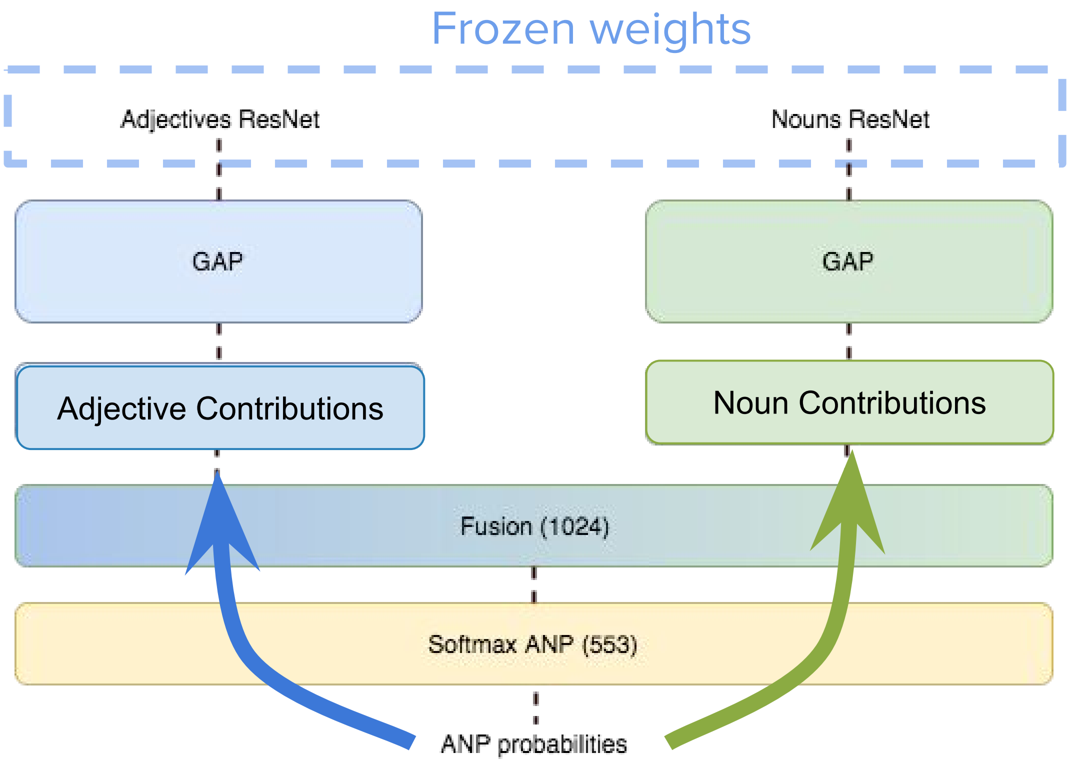
Contribution Analysis:

- Backpropagate contributions
- Adjective and Noun relevance



[20] Grégoire Montavon, Sebastian Lapuschkin, Alexander Binder, Wojciech Samek, and Klaus-Robert Müller. Explaining nonlinear classi cation decisions with deep taylor decomposition. Pattern Recognition (2017)

Interpretability



$$\hat{y}_{ANP} = g\left(\hat{y}_{adj}, \hat{y}_{noun}\right)$$

Interpretability

$$\text{Adjective-to-Noun Ratio (ANR)} = \frac{\text{AVERAGE[Adj contributions]}}{\text{AVERAGE[Noun contributions]}}$$

Interpretability

Top Adjective-oriented ANPs

(ANR > 1)

Sexy model

Misty trees

Abandoned places

Sexy body

Wild horse

Top Noun-oriented ANPs

(ANR < 1)

Innocent eyes

Incredible view

Tired eyes

Laughing baby

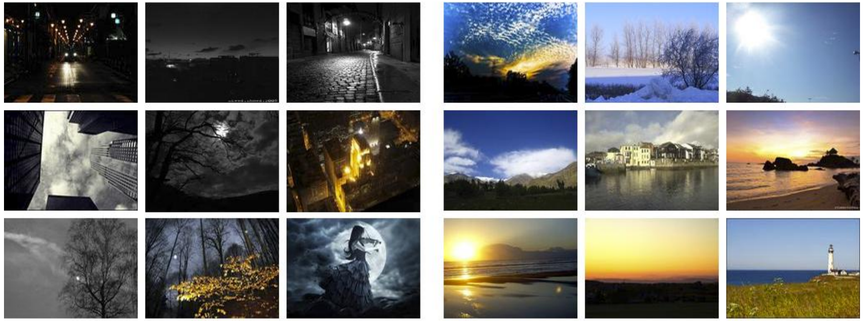
Chubby baby

Interpretability

Noun oriented ANPs

a) cute dog b) delicious cupcake

Adjective oriented ANPs



c) dark night d) bright day

Interpretability

	Adjective-to-Noun Ratio (ANR)					Top-5 Accuracy		
	Correct predictions				All top-5 predictions			
	ANP	ANP + Adj	ANP + Noun	ANP + Adj + Noun	ANP	Adj	Noun	ANP
sexy model	1.161	1.162	1.163	1.163	1.122	76.52	62.77	59.63
misty trees	1.139	1.140	1.138	1.139	1.146	79.42	71.74	71.88
abandoned places	1.121	1.121	1.033	1.033	1.018	84.58	33.93	8.21
sexy body	1.118	1.118	1.117	1.117	1.110	76.52	57.89	56.44
wild horse	1.117	1.117	1.116	1.117	1.109	54.04	88.50	58.06
innocent eyes	0.787	0.788	0.787	0.788	0.788	43.23	76.44	16.07
incredible view	0.785	0.786	0.785	0.786	0.809	30.71	67.86	39.02
tired eyes	0.776	0.778	0.776	0.788	0.784	56.13	76.44	37.50
laughing baby	0.769	0.769	0.769	0.769	0.773	72.57	83.74	69.03
chubby baby	0.764	0.764	0.764	0.764	0.786	48.00	83.74	45.60

ResNet-50 was trained with Nouns (ImageNet)

Visually equivalent ANPs

Top-5 contributing adjectives and nouns are identical.


Happy Dog		Smiling Dog	
top-5 adjectives	**top-5 nouns**	**top-5 adjectives**	**top-5 nouns**
happy	dog	smiling	dog
smiling	animals	happy	eyes
friendly	pets	friendly	pets
playful	grass	funny	blonde
funny	eyes	playful	animals


Golden Autumn		Golden Leaves	
top-5 adjectives	**top-5 nouns**	**top-5 adjectives**	**top-5 nouns**
golden	autumn	golden	leaves
sunny	leaves	sunny	autumn
colorful	trees	falling	trees
falling	sunlight	colorful	sunlight
bright	tree	bright	tree

Related Adjectives and Nouns

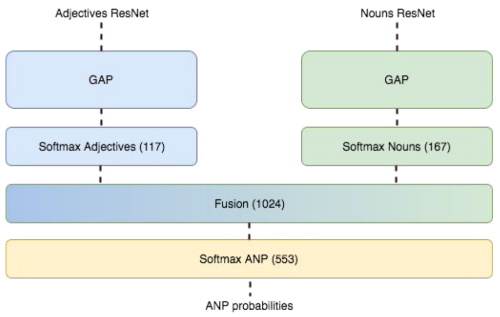
ANP tags can be extended with the most contributing adjective and nouns.

Randomly selected images

a) Elegant Wedding		**b) Charming Places**	
top-5 adjectives	**top-5 nouns**	**top-5 adjectives**	**top-5 nouns**
elegant	wedding	charming	hotel
outdoor	cake	comfortable	places
fresh	rose	excellent	house
tasty	dress	traditional	home
delicious	lady	expensive	food

Conclusions

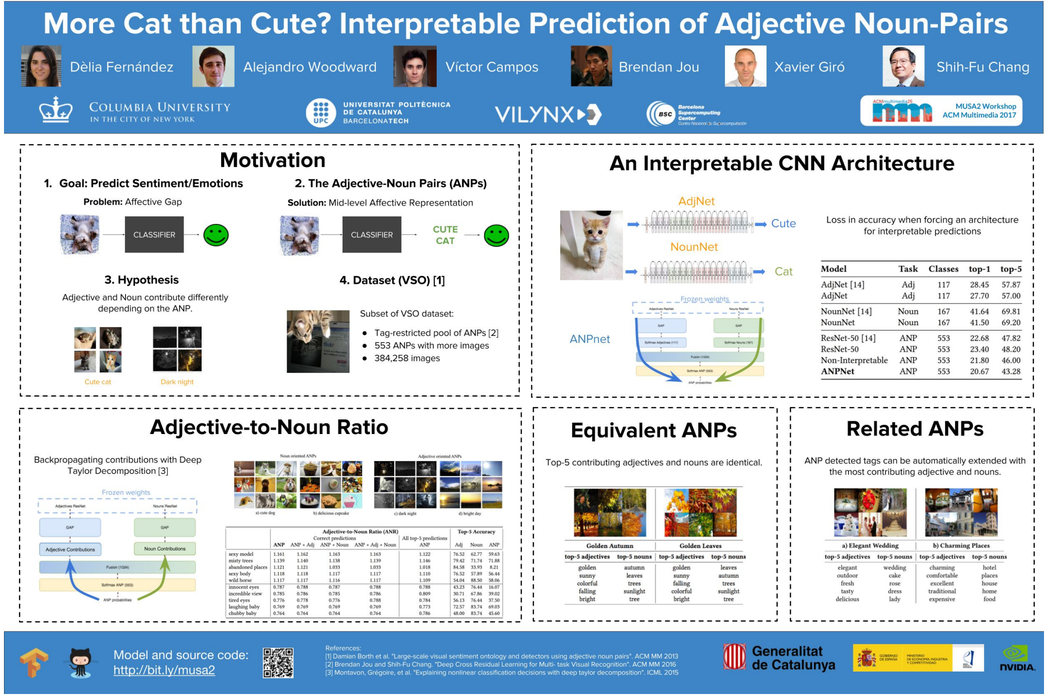
- ANPNet as an interpretable model for disentangling adjective and nouns contributions.
- Adjective-to-Nouns Ratio (ANR) as a metric to discriminate between adjective- and noun-oriented names.
- Adjective-oriented ANPs are harder to detect.
- Side products: Visually equivalent ANPs and Tag expansion.
- Interpretable model applicable to other domains.



Conclusion

ANR(Cute cat) = 0.870

A cute cat is more cat than cute



http://bit.ly/acmmm17musa2