Zero-Shot Learning with Semantic Output Codes

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CONTENTS

1. Highlights

1. Why did they develop this?
   - They wanted to predict a word with a neural activity image.
   - There are more unlabeled data than labeled data.

2. How does it work?
   - $\mathcal{H} = \mathcal{L}(\mathcal{S}(\cdot))$

3. Experimental Results of their work.

4. Possible new ideas related to Zero-Shot Learning.

Zero-Shot Learning with Semantic Output Codes

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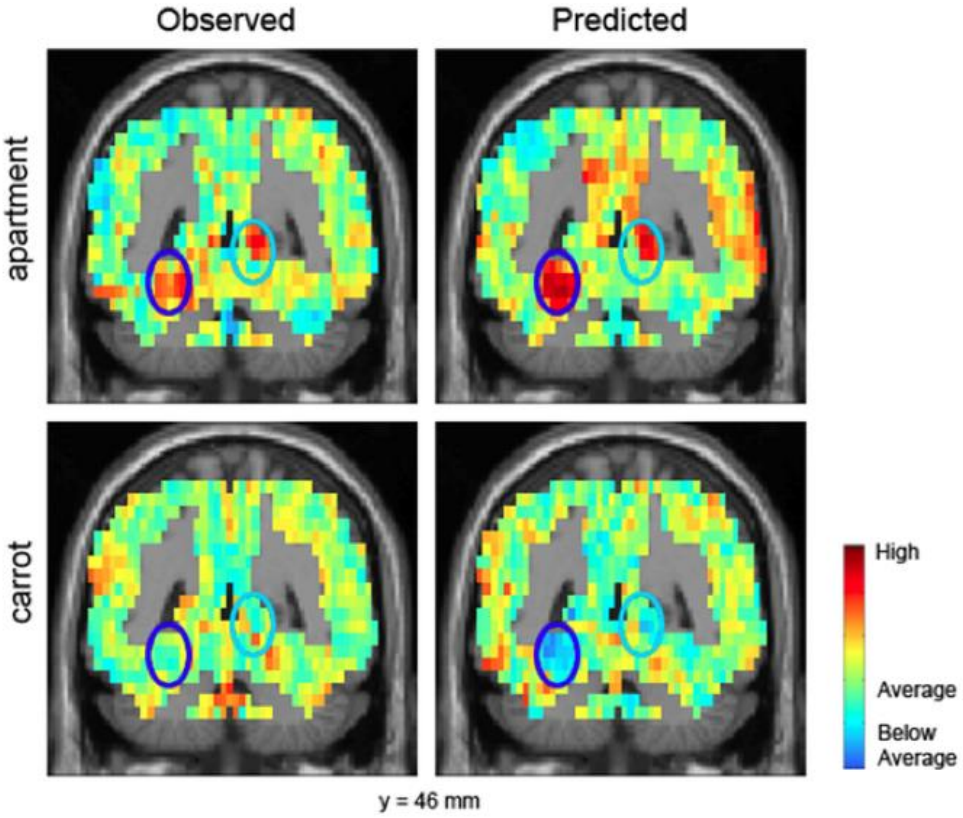
- Published at 2009

Neural activity dataset (fMRI)

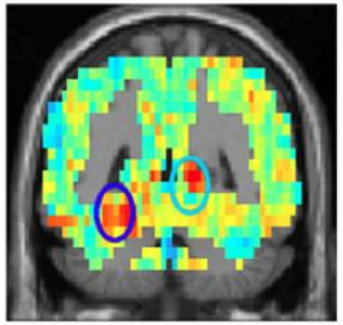


- 60 different concrete words(5 examples from 12 different categories

  ex) Animals: bear, dog, cat, cow, horse
  Vehicles: truck, car, train, airplane, bicycle

Neural activity dataset (fMRI)

fMRI



x

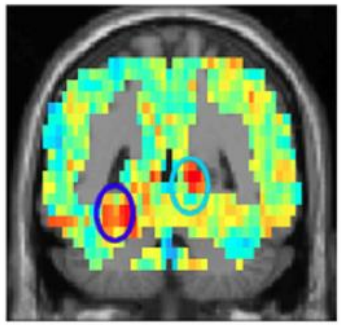
Word

“Dog”

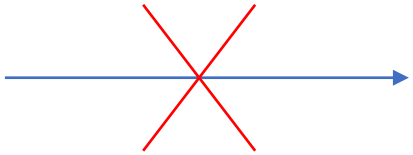
label

Neural activity dataset (fMRI)

fMRI



x



Word

“Dog”

label

Only 60 words are labeled

2. Zero-Shot Learning

Human218 (Semantic knowledge base)

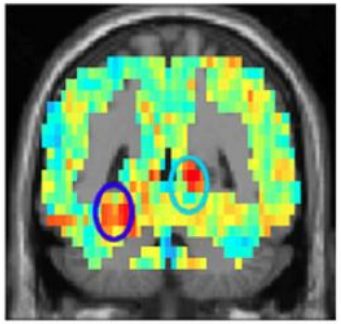
• Is it manmade?	→	No	→	0
• Can you hold it?	→	Yes	→	1
• Is it furry?	→	Yes	→	1
• Does it have a tail?	→	Yes	→	1
• Can it breathe underwater?	→	No	→	0

Example of a instance “dog”

{0,1,1,1,0} “dog”

x y

2. Zero-Shot Learning

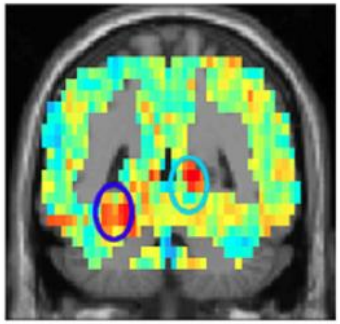
Image	Semantic Feature	Label
	{0,1,1,1,0}	dog
⋮	⋮	⋮
60	60	60

2. Zero-Shot Learning

Image

Semantic Feature

Label



{1,0,1,0,0}

dog

x f y

$S(\cdot)$ $L(\cdot)$

2. Zero-Shot Learning

$$\mathcal{H} = \mathcal{L}(\mathcal{S}(\cdot))$$
$$\mathcal{S} : X^d \rightarrow F^p$$
$$\mathcal{L} : F^p \rightarrow Y$$

$\mathcal{H}$: Semantic output code classifier

$\mathcal{S}$: A collection of linear classifiers

$\mathcal{L}$: 1-nearest neighbor classifier

2. Zero-Shot Learning

Training phase

$$S(\{x, f\}_{1:N})$$

$$L(\{f, y\}_{1:M})$$

N : number of questions (feature dimension)
M : number of classes

- N >> M : class has been expanded to larger space which is feature space.

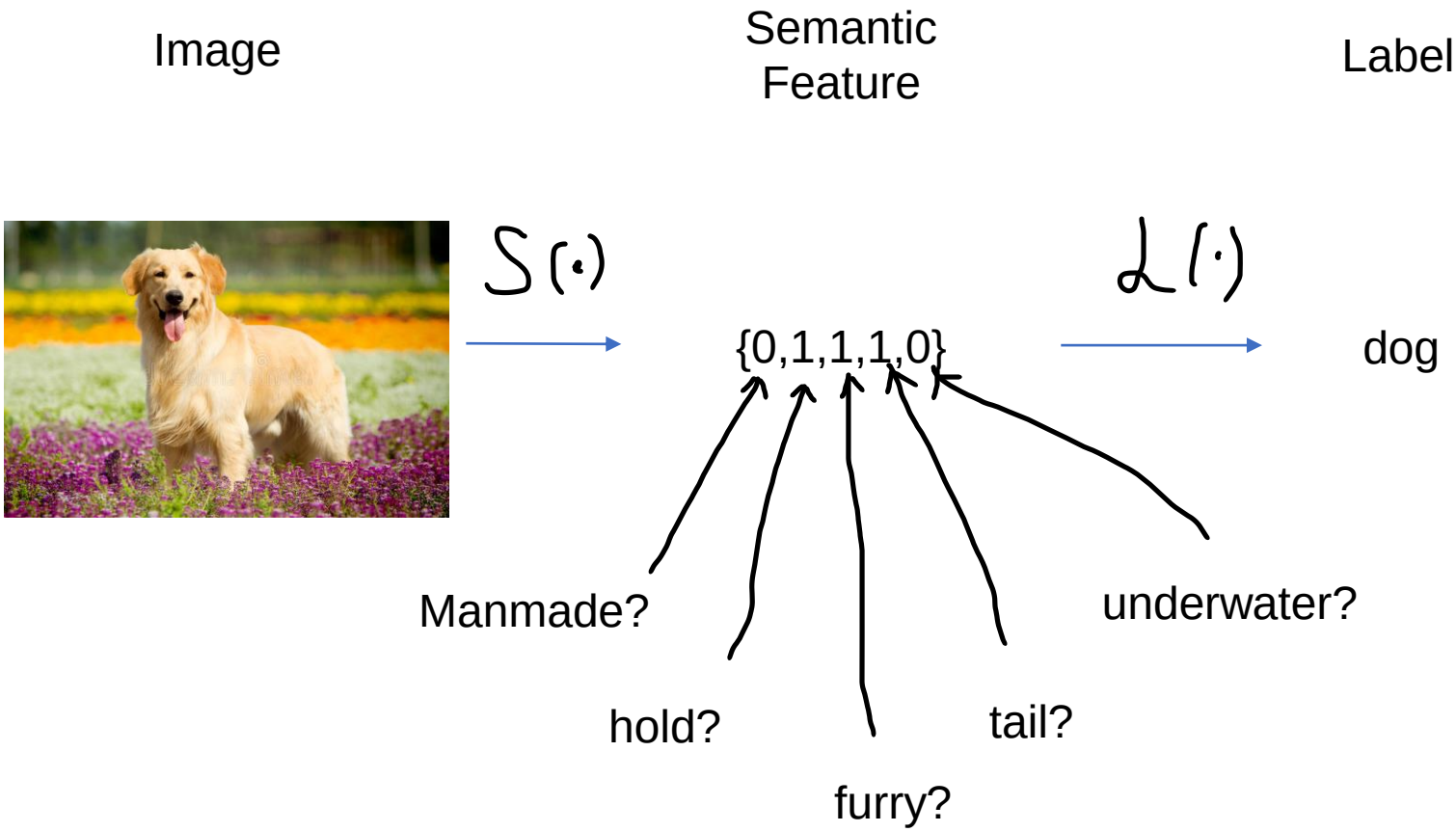
Testing phase

$$S(x) = \hat{f}$$

$$L(\hat{f}) = \hat{y}$$

- S(·) classifies whether the input x has each feature or not.
- L(·) clusters where the feature belongs to.

Example of Testing phase

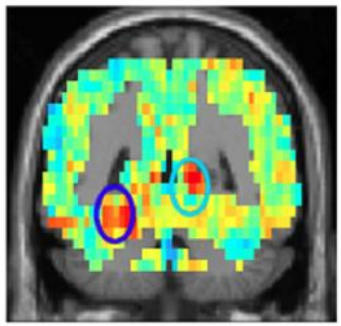


What they did is :

Image

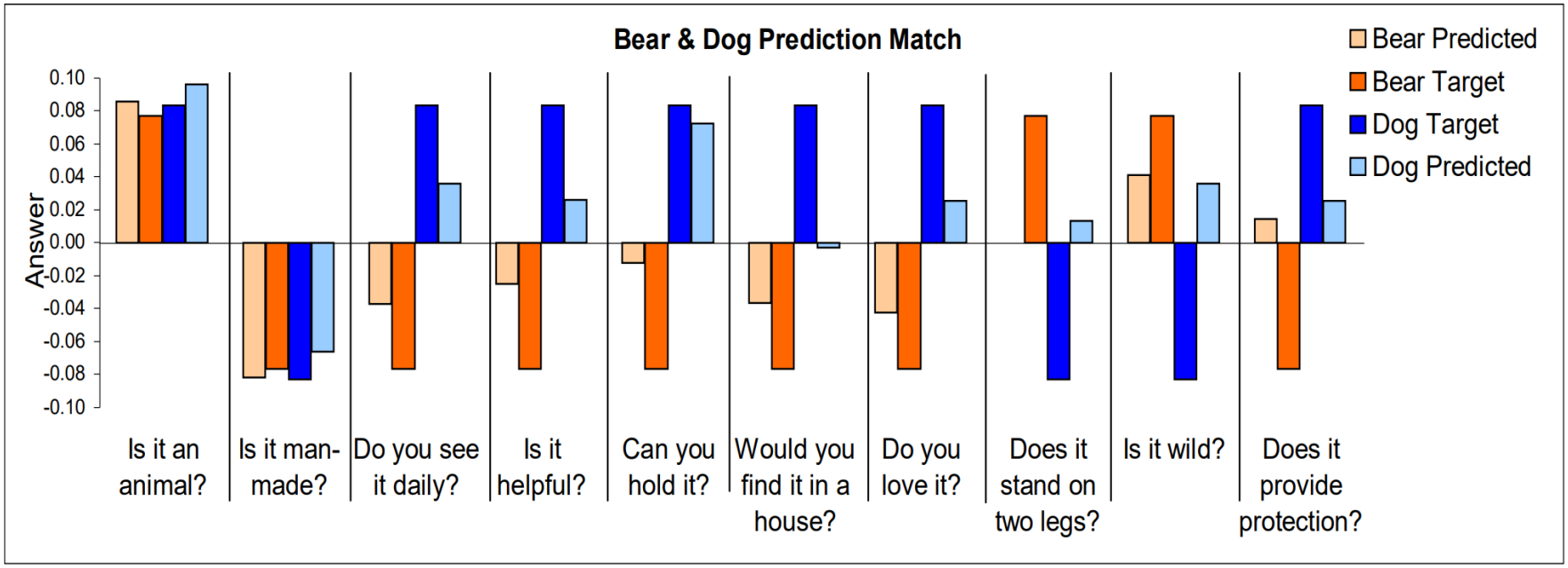
Semantic Feature

Label

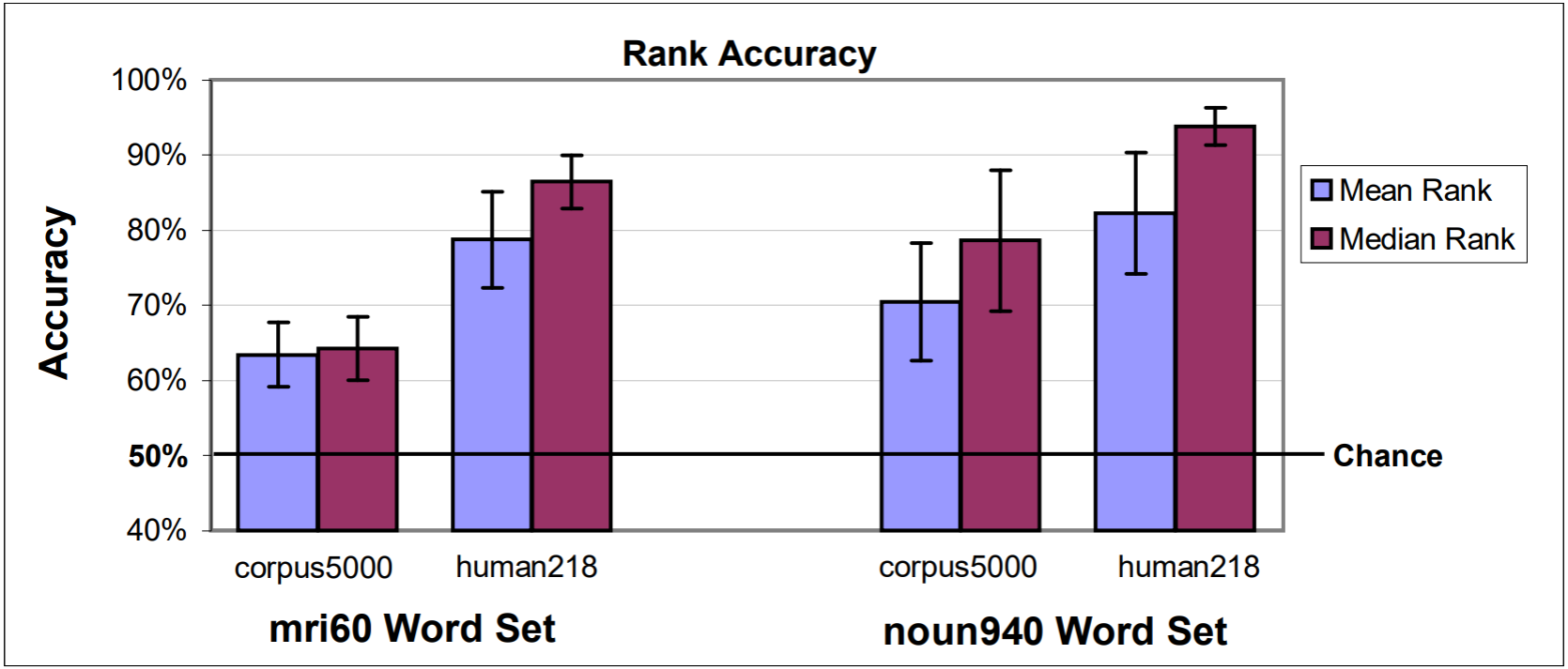


$S(\cdot)$ → {0,1,1,1,0} → $L(\cdot)$ → dog

3. Experimental Results



3. Experimental Results



3. Experimental Results

Bear	**Foot**	**Screwdriver**	**Train**	**Truck**	**Celery**	**House**	**Pants**
(1)	(1)	(1)	(1)	(2)	(5)	(6)	(21)
bear	*foot*	*screwdriver*	*train*	jeep	beet	supermarket	clothing
fox	feet	pin	jet	*truck*	artichoke	hotel	vest
wolf	ankle	nail	jail	minivan	grape	theater	t-shirt
yak	knee	wrench	factory	bus	cabbage	school	clothes
gorilla	face	dagger	bus	sedan	*celery*	factory	panties

4. Conclusion and Discussion

- They have made a model that classifies novel data which have omitted from dataset.
- Is it possible to adopt Zero-Shot learning to other areas?
- Is it possible to adopt Zero-Shot learning to NAS?

References

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- Zero-Shot Learning -- A Comprehensive Evaluation of the Good, the Bad and the Ugly https://paperswithcode.com/paper/zero-shot-learning-a-comprehensive-evaluation
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Thank you

Q & A