

# Few-Shot Learning

Shusen Wang

# Support Set

Armadillo



Pangolin



# Support Set

Armadillo



Pangolin



Query



Armadillo or Pangolin?

# Training Set

Husky



⋮



Elephant



⋮



Tiger



⋮



Macaw



⋮



Car



⋮



# **Are they the same kind of animal?**



# **Are they the same kind of animal?**



# **Are they the same kind of animal?**



# Few-Shot Learning

**Query:**



# Few-Shot Learning

Query:



Support Set:

Fox



Squirrel



Rabbit



Hamster



Otter



Beaver



# Few-Shot Learning and Meta Learning

# Meta Learning

- Few-shot learning is a kind of meta learning.
- Meta learning: learn to learn.

## Reference:

- Fei-Fei, Fergus, & Perona. One-shot learning of object categories. *IEEE Transactions on PAMI*, 2006.

# Meta Learning



What's this?

# Meta Learning



Give him the cards:

Fox



Squirrel



Rabbit



Hamster



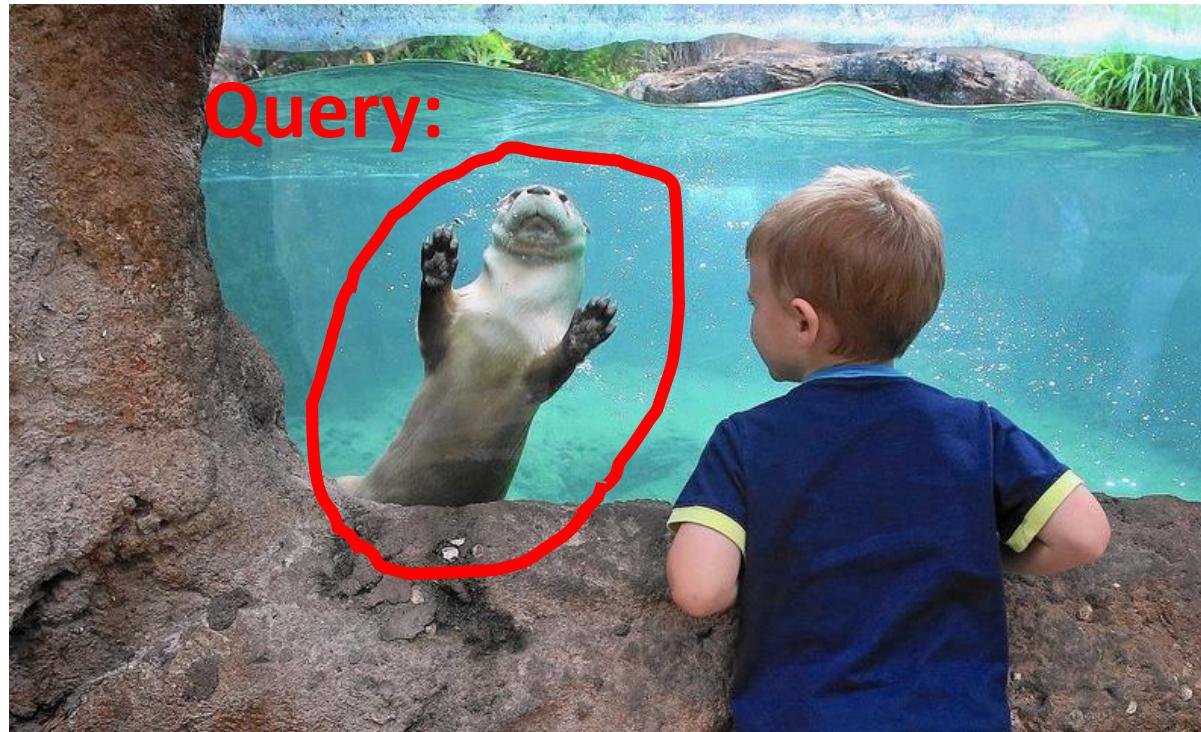
Otter



Beaver



# Meta Learning



Support set:

Fox



Squirrel



Rabbit



Hamster



Otter

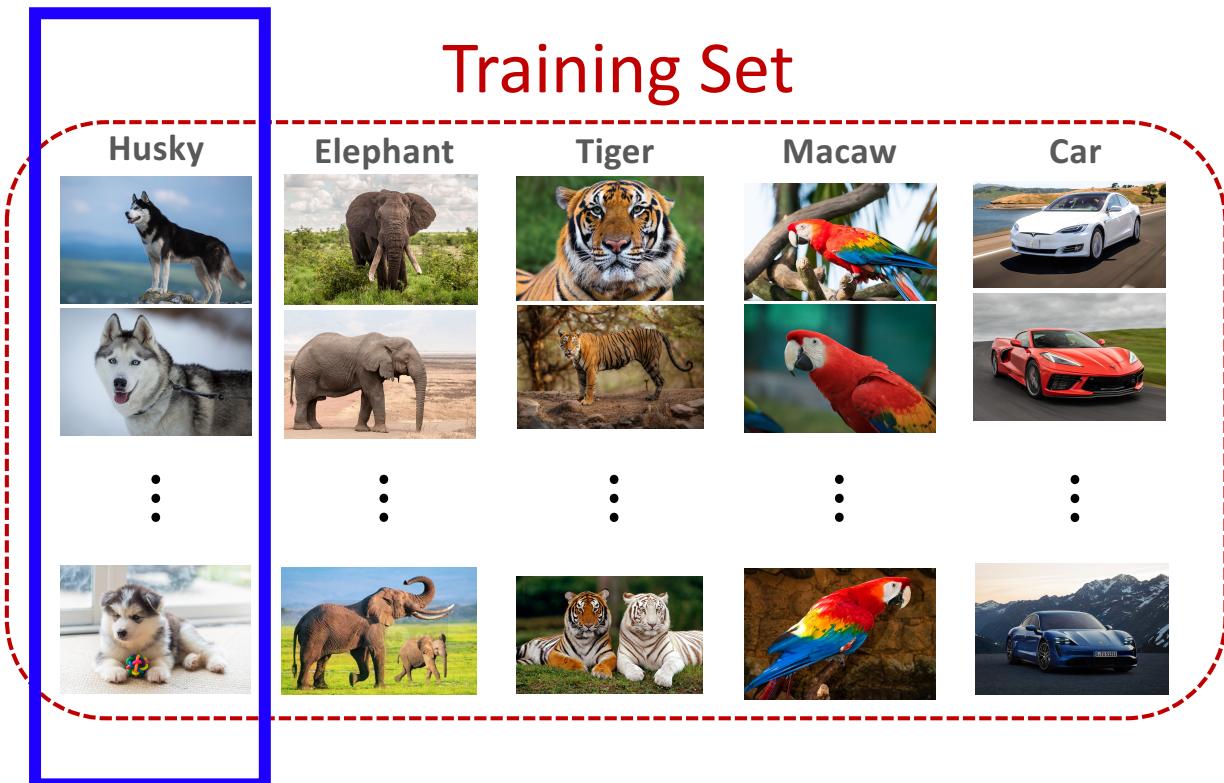


Beaver



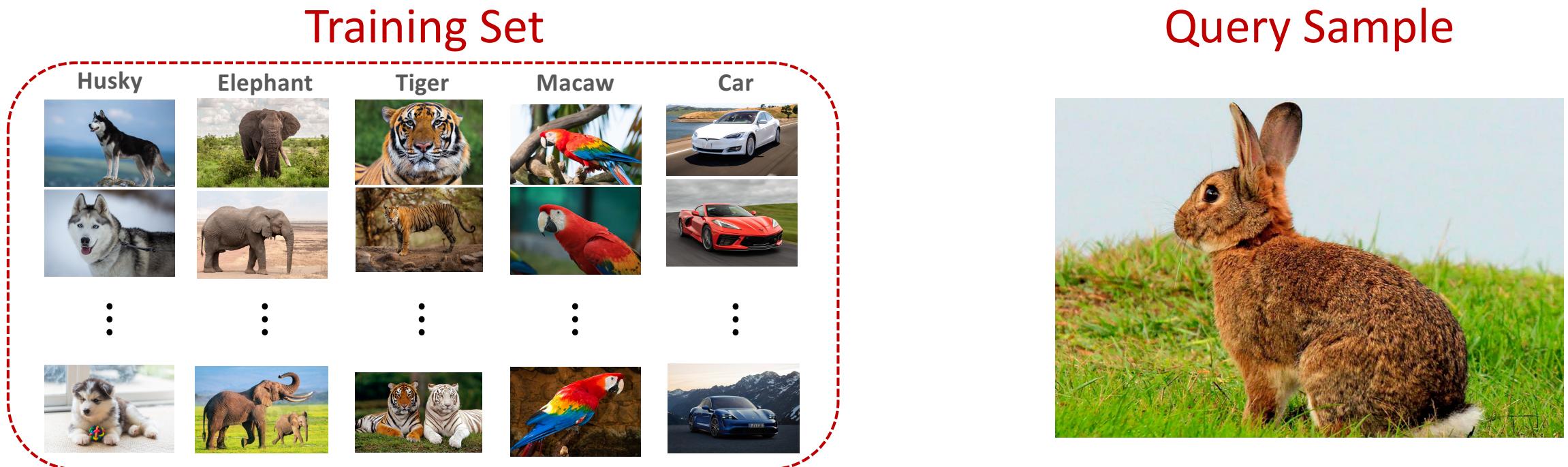
# Supervised Learning vs. Few-Shot Learning

- Traditional supervised learning:
  - Test samples are **never seen before**.
  - Test samples are from **known classes**.



# Supervised Learning vs. Few-Shot Learning

- Few-shot learning:
  - Query samples are **never seen before**.
  - Query samples are from **unknown classes**.



# Training Set, Support Set, and Query

Support Set:

Fox



Squirrel



Rabbit



Hamster



Otter



Beaver



Training Set

Husky



Elephant



Tiger



Macaw



Car

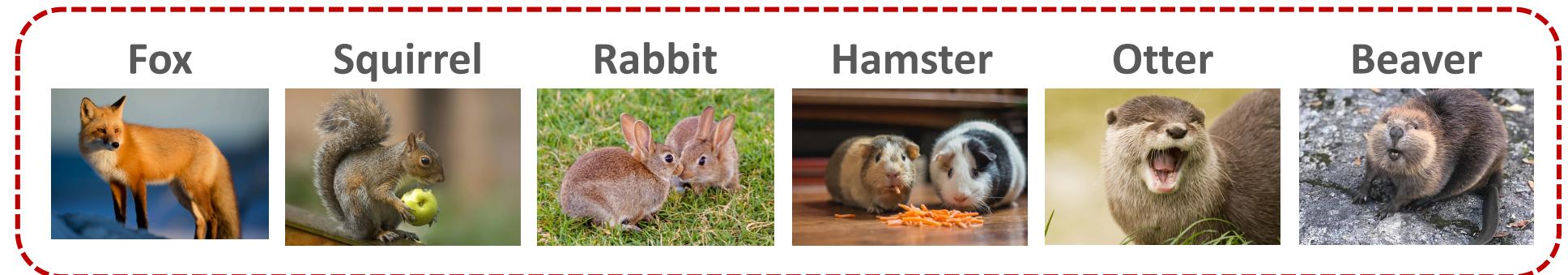


Query Sample



# *k*-way *n*-shot Support Set

Support Set:



- *k*-way: the support set has *k* classes.
- *n*-shot: every class has *n* samples.

# *k-way* *n-shot* Support Set

Support Set:

Squirrel



Rabbit



Hamster



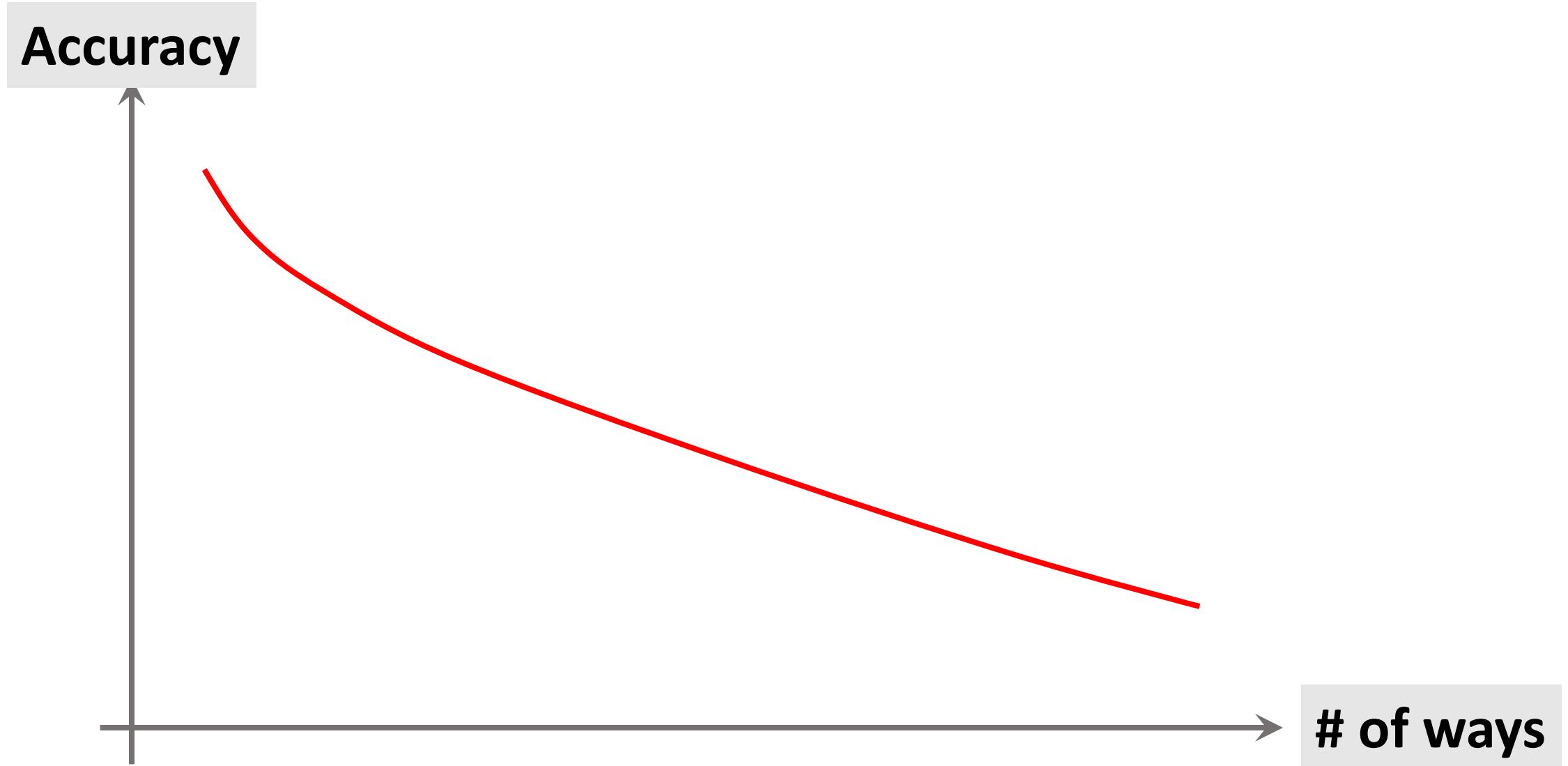
Otter



2-shot

4-way

# Prediction Accuracy



Squirrel



Rabbit



Otter



**3-way is easier than 6-way**

Fox



Squirrel



Rabbit



Hamster



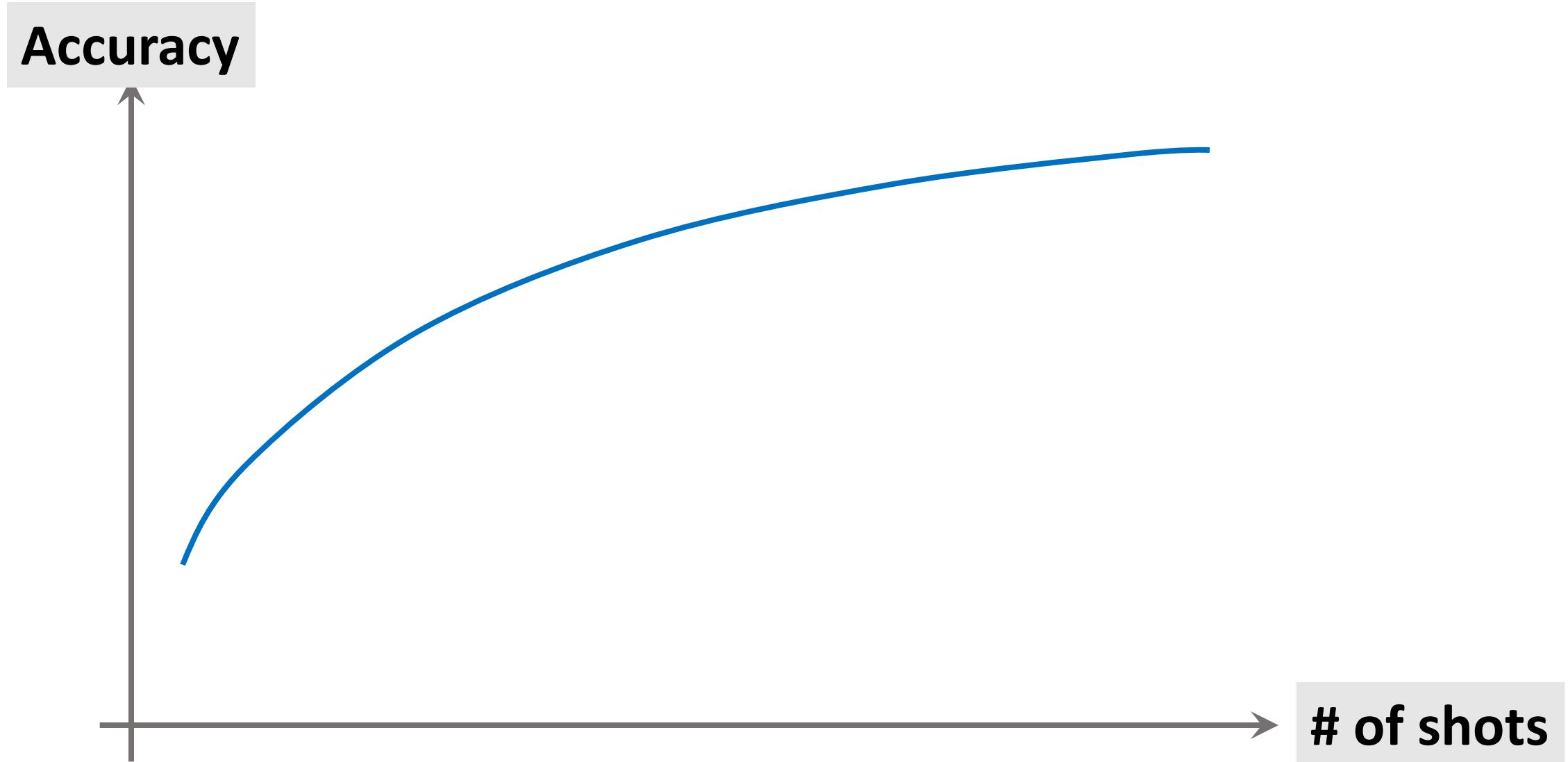
Otter



Beaver



# Prediction Accuracy



Squirrel



Rabbit



Hamster



Otter



2-shot is easier than 1-shot

Squirrel



Rabbit



Hamster



Otter



**Idea: Learn a Similarity Function**

# Basic Idea

- Learn a similarity function:  $\text{sim}(\mathbf{x}, \mathbf{x}')$ .

# Basic Idea

- Learn a similarity function:  $\text{sim}(\mathbf{x}, \mathbf{x}')$ .
- Ideally,  $\text{sim}(\mathbf{x}_1, \mathbf{x}_2) = 1$ ,  $\text{sim}(\mathbf{x}_1, \mathbf{x}_3) = 0$ , and  $\text{sim}(\mathbf{x}_2, \mathbf{x}_3) = 0$ .

Bulldog



$\mathbf{x}_1$

Bulldog



$\mathbf{x}_2$

Fox



$\mathbf{x}_3$

# Basic Idea

- First, learn a similarity function from large-scale **training dataset**.



# Basic Idea

- First, learn a similarity function from large-scale training dataset.
- Then, apply the similarity function for prediction.
  - Compare the **query** with every sample in the **support set**.
  - Find the sample with the highest similarity score.

## Support Set:

Greyhound



Bulldog



Armadillo



Pangolin



Otter



Beaver



# Basic Idea

What is in the image?

Query:



Support Set:

Greyhound



Bulldog



Armadillo



Pangolin



Otter



Beaver



# Basic Idea

What is in the image?

Query:



sim = 0.2

Greyhound



Bulldog



Armadillo



Pangolin



Otter



Beaver



# Basic Idea

What is in the image?

Query:



sim = 0.2

sim = 0.1

Greyhound



Bulldog



Armadillo



Pangolin



Otter



Beaver



# Basic Idea

What is in the image?

Query:



sim = 0.2

sim = 0.1

sim = 0.03

Greyhound



Bulldog



Armadillo



Pangolin



Otter



Beaver



# Basic Idea

What is in the image?

Query:



sim = 0.2

sim = 0.1

sim = 0.03

sim = 0.05

sim = 0.7

sim = 0.5

Greyhound



Bulldog



Armadillo



Pangolin



Otter



Beaver



# Basic Idea

What is in the image?

Query:



sim = 0.2

sim = 0.1

sim = 0.03

sim = 0.05

sim = 0.7

sim = 0.5

Greyhound



Bulldog



Armadillo



Pangolin



Otter



Beaver



# Datasets

# Omniglot

- Official website: <https://github.com/brendenlake/omniglot/>
- TensorFlow: <https://www.tensorflow.org/datasets/catalog/omniglot>



# Omniglot

50 alphabets:

Hebrew

Greek

Latin

...

# Omniglot

50 alphabets:

Hebrew

Greek

Latin

...

characters:

$\alpha$

$\beta$

$\gamma$

...

$\omega$



# Omniglot

50 alphabets:

Hebrew

Greek

Latin

...

characters:

$\alpha$

$\beta$

$\gamma$

...

$\omega$

samples:

$\alpha$

$\beta$

$\gamma$

$w$

$\alpha$

$\beta$

$\gamma$

$w$

$\alpha$

$\beta$

$\gamma$

$w$

⋮

⋮

⋮

⋮

# Omniglot

- 50 different alphabets. (Every alphabet has many characters.)
- 1,623 unique characters (i.e., classes).
- Each character was written by 20 different people (i.e., each class has 20 samples.)
- The samples are  $105 \times 105$  images.
- Training set:
  - 30 alphabets, 964 characters (classes), and 19,280 samples.
- Test set:
  - 20 alphabets, 659 characters (classes), and 13,180 samples.

# Mini-ImageNet

100 classes:

600 samples

Mushroom



Orange



Corn



Bird



Snake



**Thank you!**