

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



What's this?

Give him the cards:

Fox



Squirrel



Rabbit



Hamster



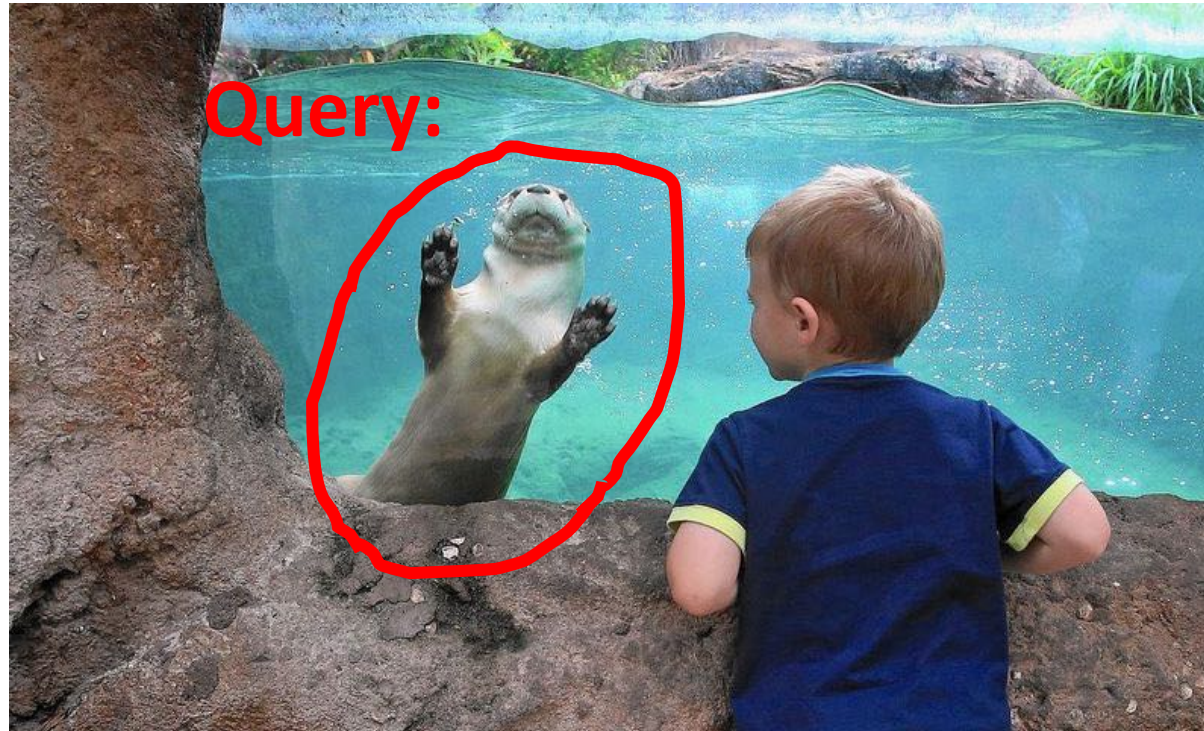
Otter



Beaver



Meta Learning



Support set:

Fox



Squirrel



Rabbit



Hamster



Otter



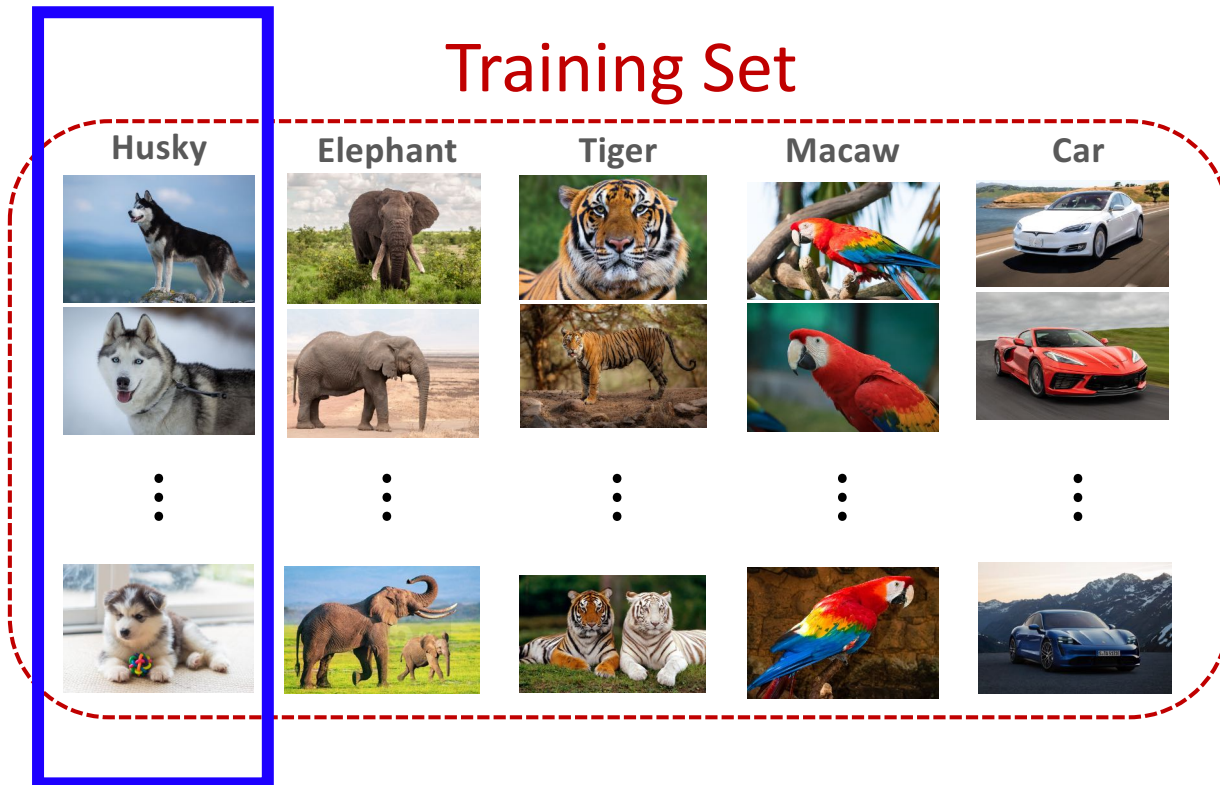
Beaver



Supervised Learning vs. Few-Shot Learning

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

Training Set



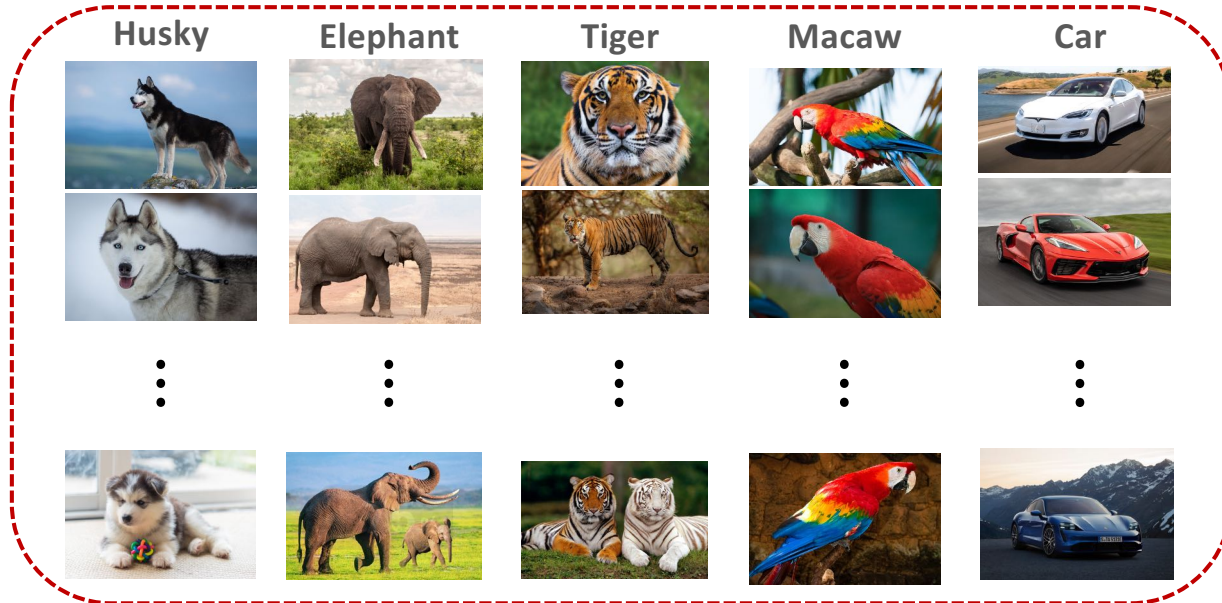
Test Sample



Supervised Learning vs. Few-Shot Learning

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

Training Set

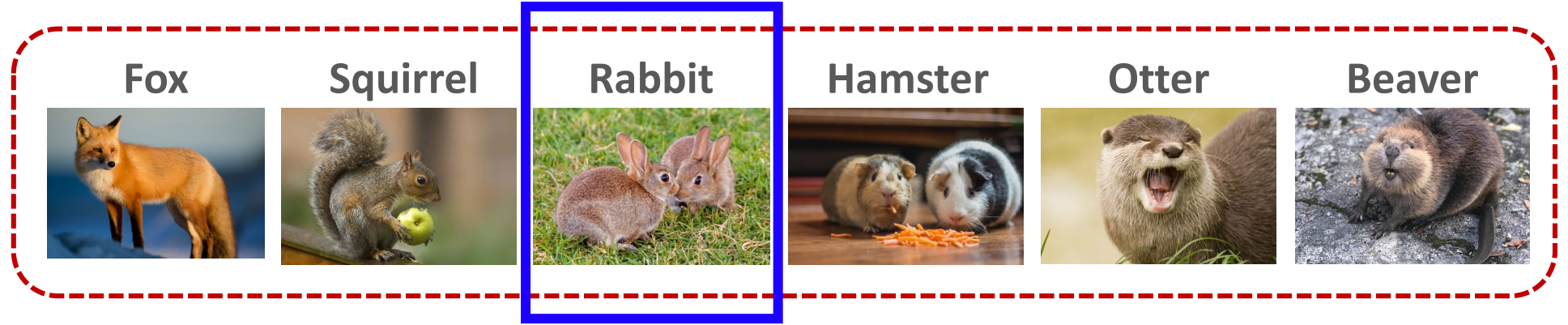


Query Sample

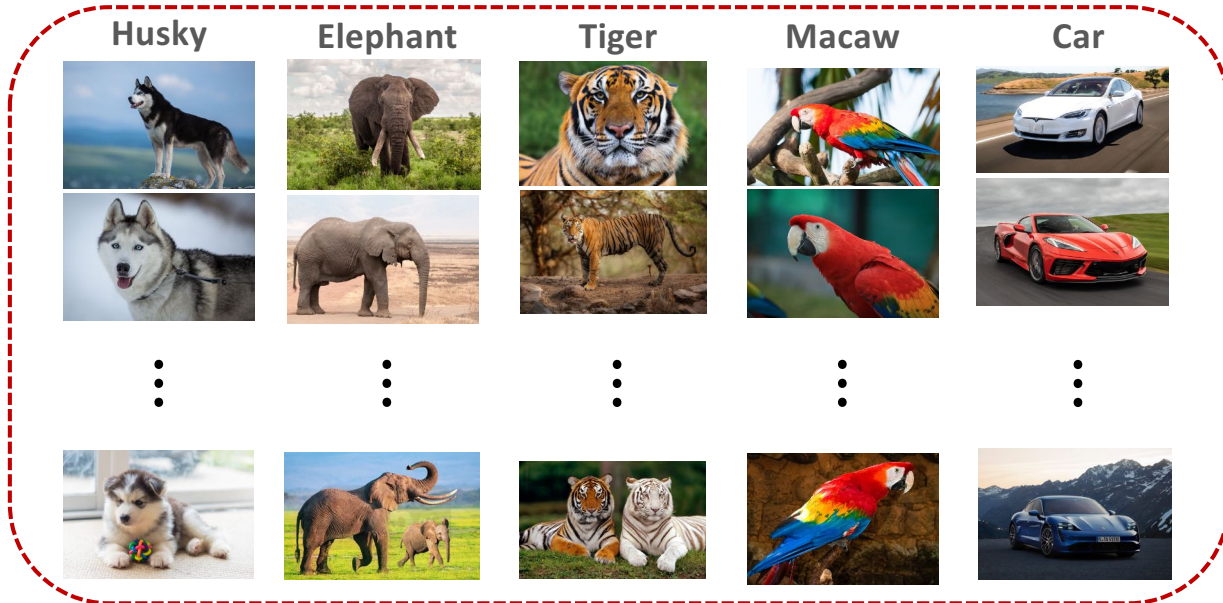


Training Set, Support Set, and Query

Support Set:



Training Set

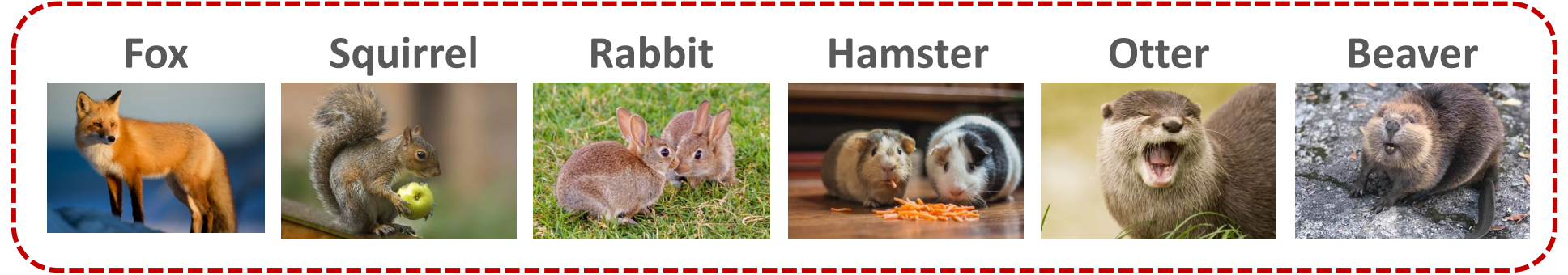


Query Sample



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



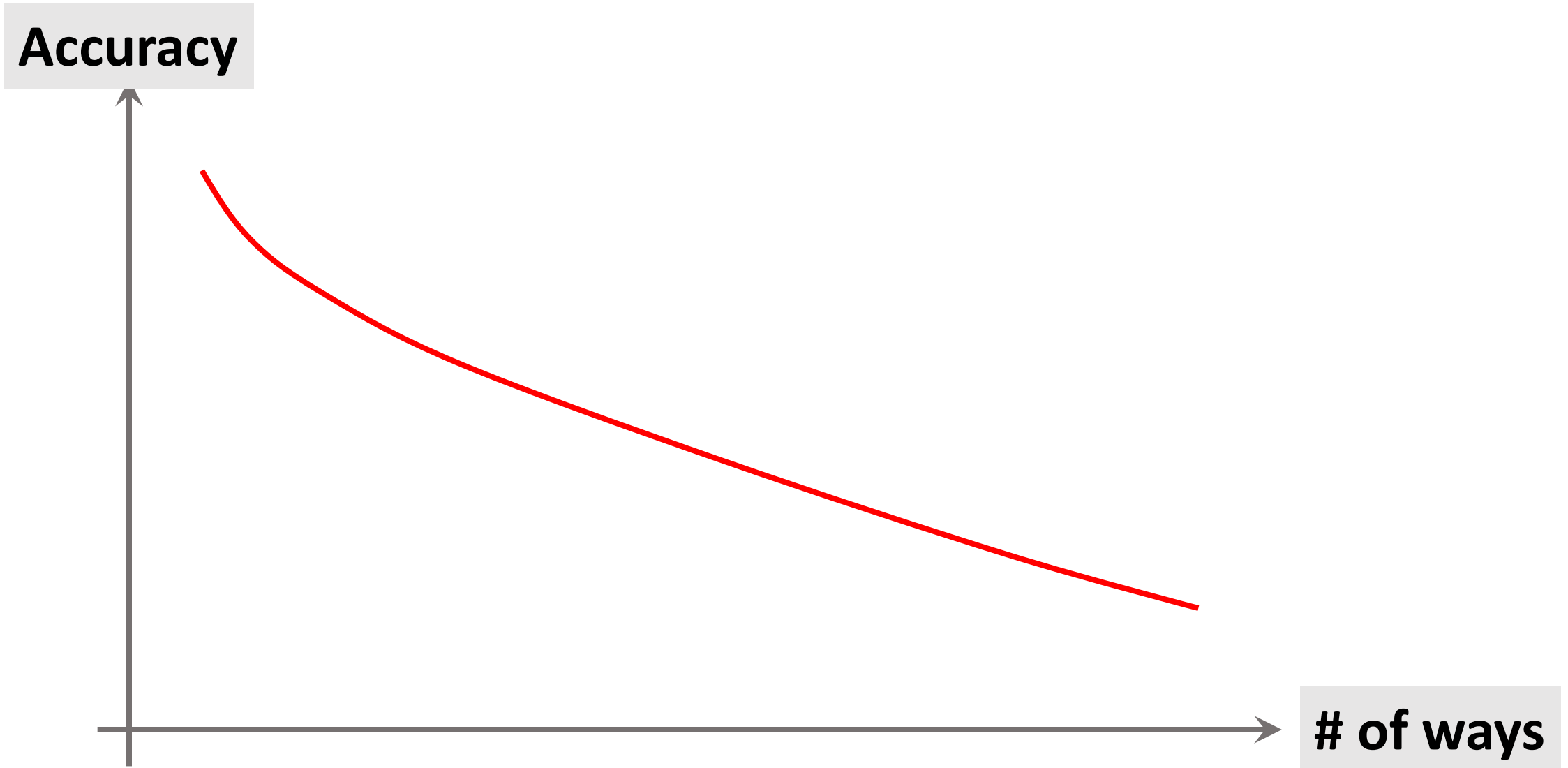
Otter



2-shot

4-way

Prediction Accuracy



Squirrel



Rabbit



Otter



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

Fox



Squirrel



Rabbit



Hamster



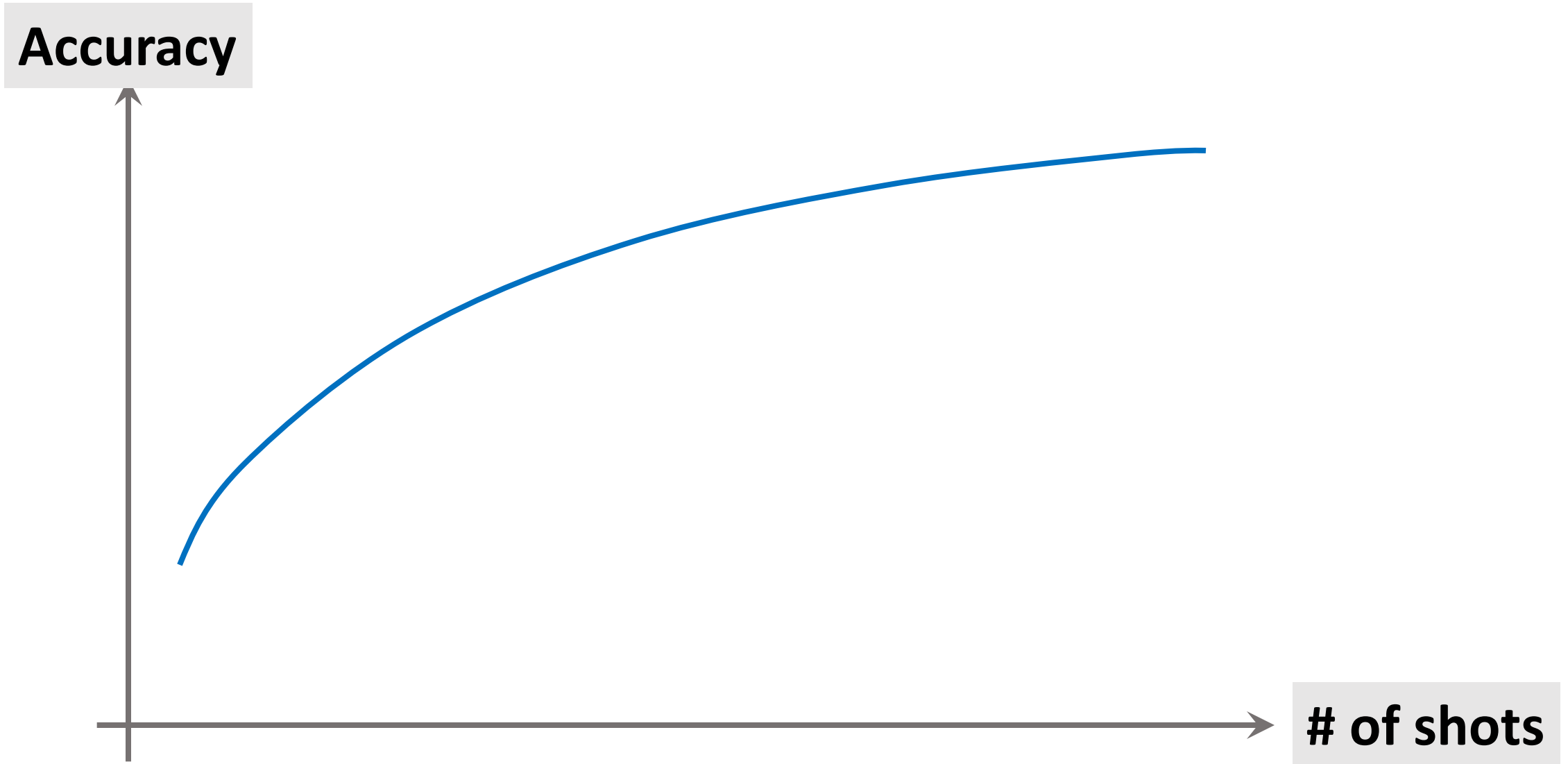
Otter



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:

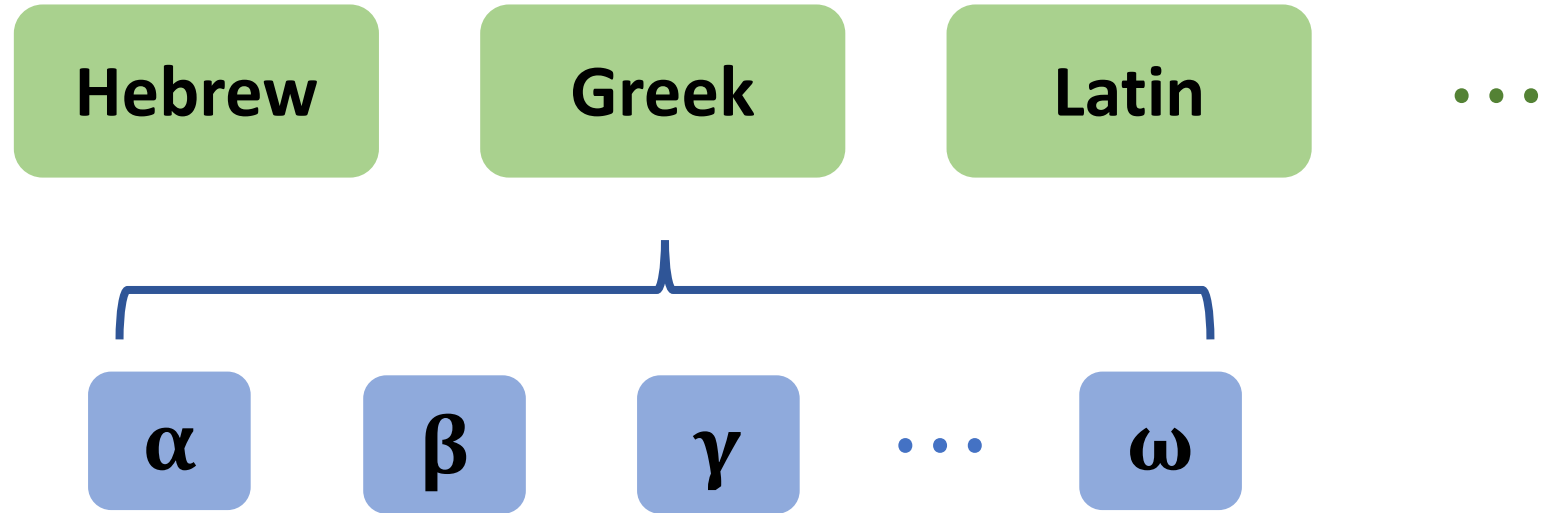
α

β

γ

...

ω



Omniglot

50 alphabets:

Hebrew

Greek

Latin

...

characters:

α

β

γ

...

ω

samples:

α

β

γ

ω

α

β

γ

ω

α

β

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ω

⋮

⋮

⋮

⋮

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 105×105 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:

Mushroom

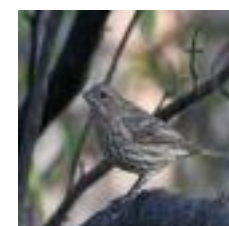
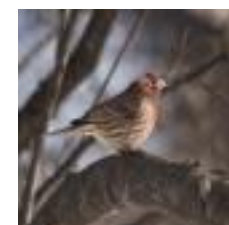
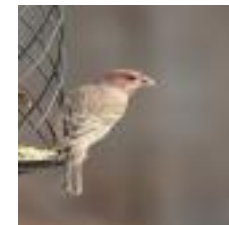
Orange

Corn

Bird

Snake

600 samples



⋮

⋮

⋮

⋮

⋮

Thank you!