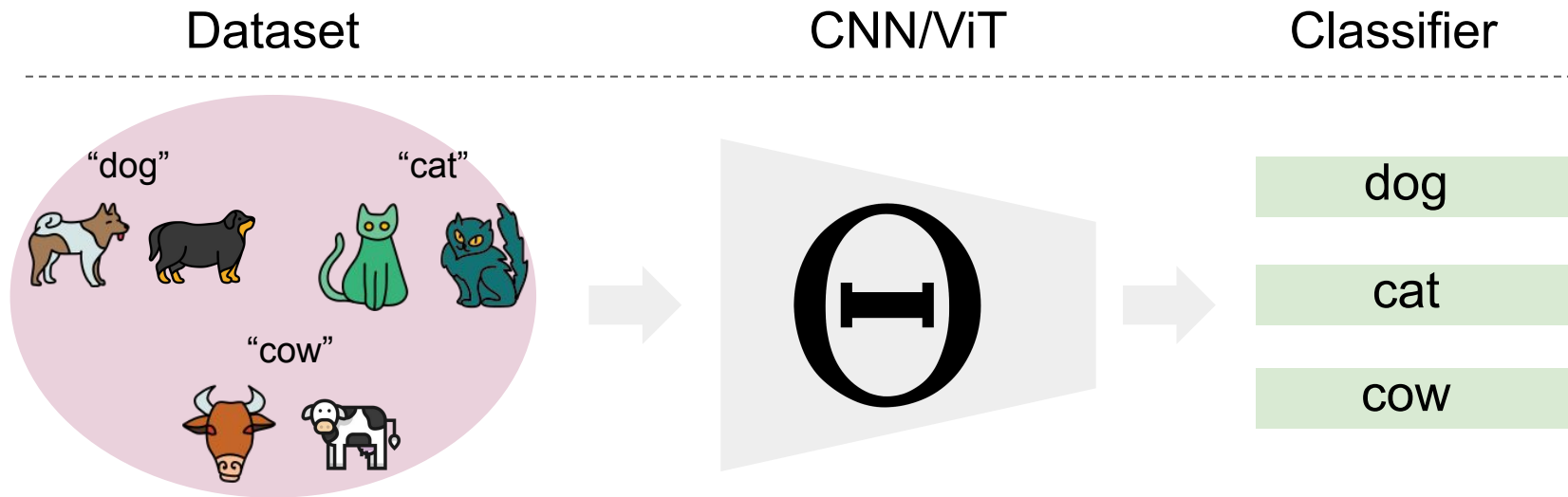


# Towards Label-Efficient Incremental Learning

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# Batch Learning

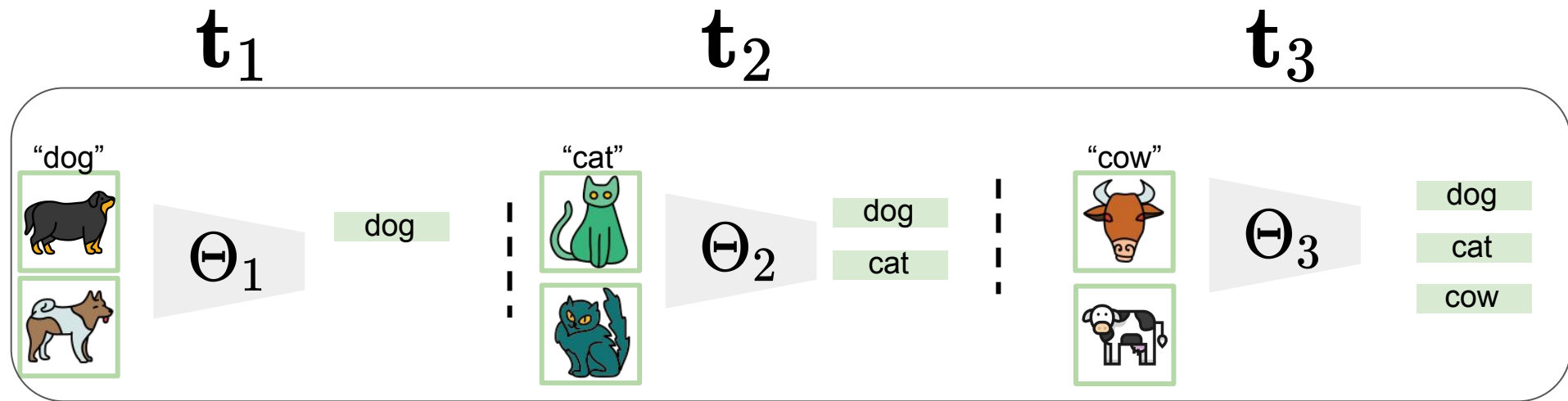


**Static:** Can't adapt & expand



**Privacy:** Data Storage

# Incremental Learning



**Dynamic:** Can adapt & expand



**Forgetful:** Past classes



**Unscalable:** Many-Labels

# Label-Efficient Incremental Learning

## **Semi-Supervision:**

Combine labeled data with unlabeled data

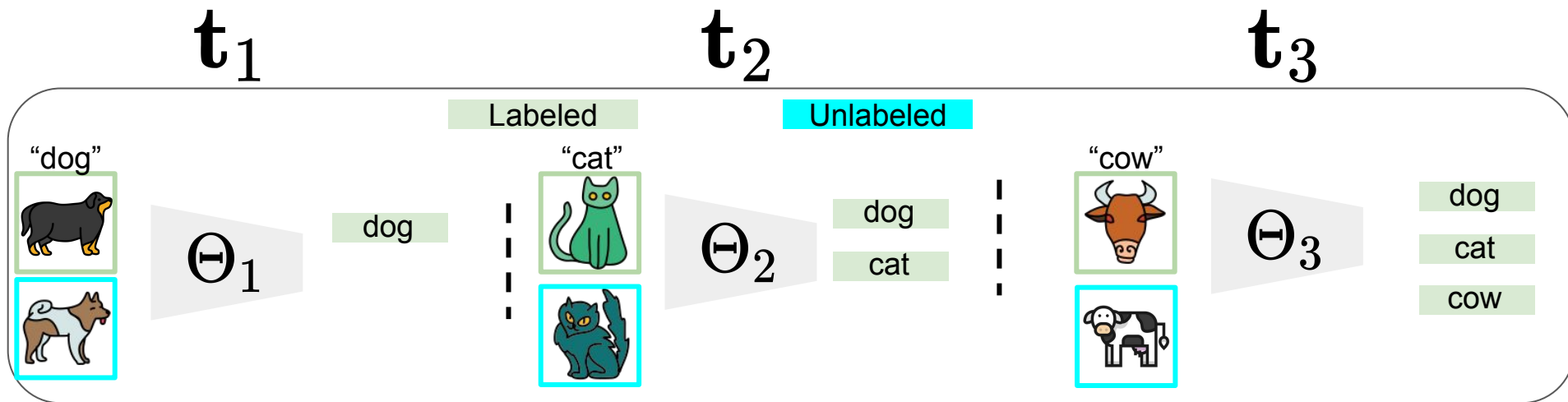
## **Few-shot-Supervision:**

Expand a pre-trained classifier with only few labeled data

## **Self-Supervision:**

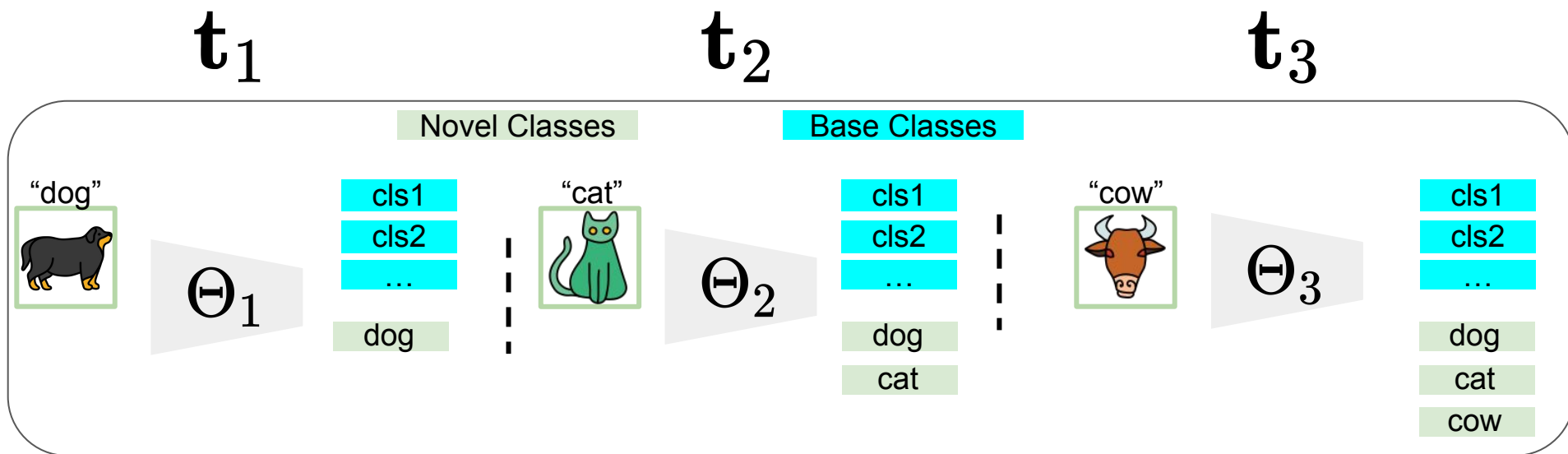
Omit the need for label-supervision by designing pre-text tasks

# Semi-Supervision for Incremental Learning



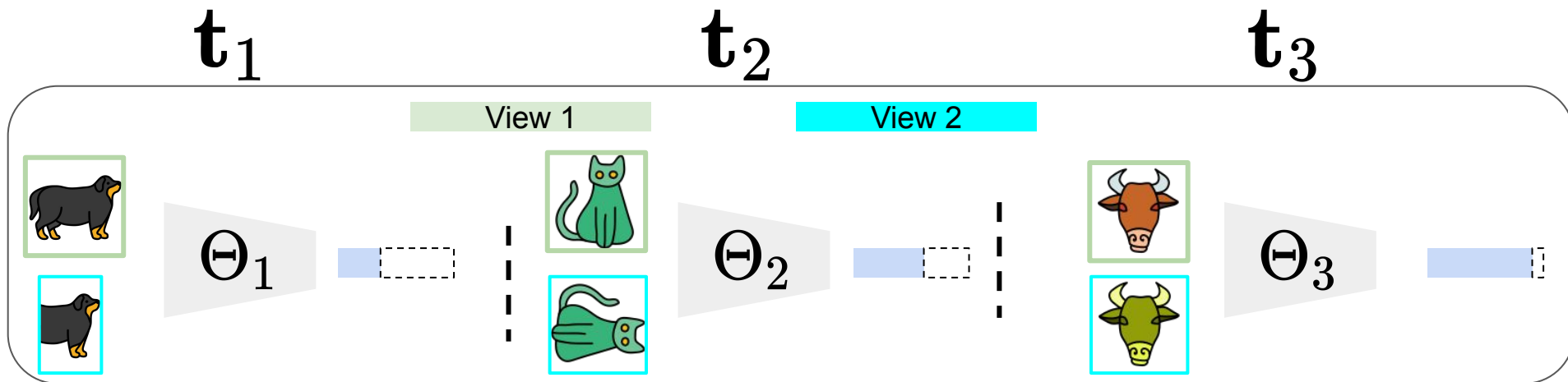
**What:** Train a classifier on labeled data | Generate pseudo-supervision on unlabeled data | Combine & Iterate

# Few-shot-Supervision for Incremental Learning



**What:** Learn to expand a pre-trained (base) category with novel classes with few examples (i.e. 1-shot)

# Self-Supervision for Incremental Learning



**What:** Pre-train a backbone via contrastively matching different image views (i.e. crop, rotation, color jitter)

# Summary

Settings	Subgroups	Supervision	Reference
<b>Incremental Learning (IL)</b>		Label-only	LwF [Li and Hoiem, 2017]
<b>Semi-Supervised IL</b>	Within-data	Pseudo & Label	CNLL [Baucum <i>et al.</i> , 2017]
	Auxiliary-data	Pseudo & Label	DMC [Zhang <i>et al.</i> , 2020]
	Test-data	Pseudo-only	CoTTA [Wang <i>et al.</i> , 2022]
<b>Few-shot-Supervised IL</b>	Graph-based	Label-only (Few)	TOPIC [Tao <i>et al.</i> , 2020]
	Clustering-based	Label-only (Few)	IDL-VQ [Chen and Lee, 2020]
	Architectural-based	Label-only (Few)	FSSL [Mazumder <i>et al.</i> , 2021]
<b>Self-Supervised IL</b>	Pre-training	Label-only	SSL-OCL [Gallardo <i>et al.</i> , 2021]
	Auxiliary-training	Self & Label	PASS [Zhu <i>et al.</i> , 2021]
	Main-training	Self-only	CaSSLe [Fini <i>et al.</i> , 2022]



# Algorithms

## Semi-Supervision

Algorithm	Data	Pre-training	Replayed Entity
CNNL	Within	✗	Pseudo-labels
DistillMatch	Within	✗	Pseudo-labels
ORDisCo	Within	✗	Pseudo-labels & Data
MetaCon	Within	✗	Pseudo-labels & Data
PGL	Within	✗	Pseudo-gradients
DMC	Auxiliary	✓	Pseudo-labels
CIL-QUd	Auxiliary	✓	Pseudo-labels
CoTTA	Test	✓	Pseudo-labels
NOTE	Test	✓	Data

## Few-shot-Supervision

Algorithm	Method	Regularization	Replay	Semantic
TOPIC	Graph	Anchor Loss	✗	✗
CEC	Graph	✗	✗	✗
IDL-VQ	Clustering	Center Loss	✓	✗
SA-KD	Clustering	✗	✓	✓
SUB-REG	Clustering	$\ell_1$ Loss	✓	✓
FACT	Clustering	Augmentation	✗	✗
FSL	Architectural	$\ell_1$ Loss	✗	✗
C-FSCIL	Architectural	Orthogonal Loss	✓	✗

## Self-Supervision

Algorithm	Setting	Self-Supervision
SSL-OCL	Pre-training	MOCO/SwAV
PASS	Auxiliary-training	SLA
Buffer-SSL	Main-training	SimSiam
LUMP	Main-training	SimSiam/Barlow-Twins
CaSSLe	Main-training	SimCLR/Barlow-Twins/etc.
PFR	Main-training	Barlow-Twins

# Limitations



## Semi-Supervision:

Pseudo-supervision

Still many labeled examples

## Few-shot-Supervision:

Only few-shots per-class

Requires large-scale pre-training

## Self-Supervision:

No labels at train-time

Labels needed for evaluation

# Future Directions

Incremental Dense Learning

Incremental Active Learning

Incremental Object Discovery