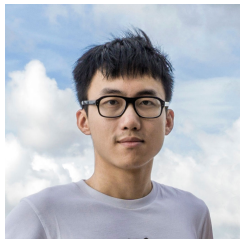
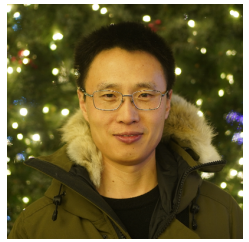
Open Compound Domain Adaptation

Ziwei Liu* Zhongqi Miao* Xingang Pan Xiaohang Zhan Dahua Lin Stella X. Yu Boqing Gong










The Chinese University of Hong Kong


UC Berkeley / ICSI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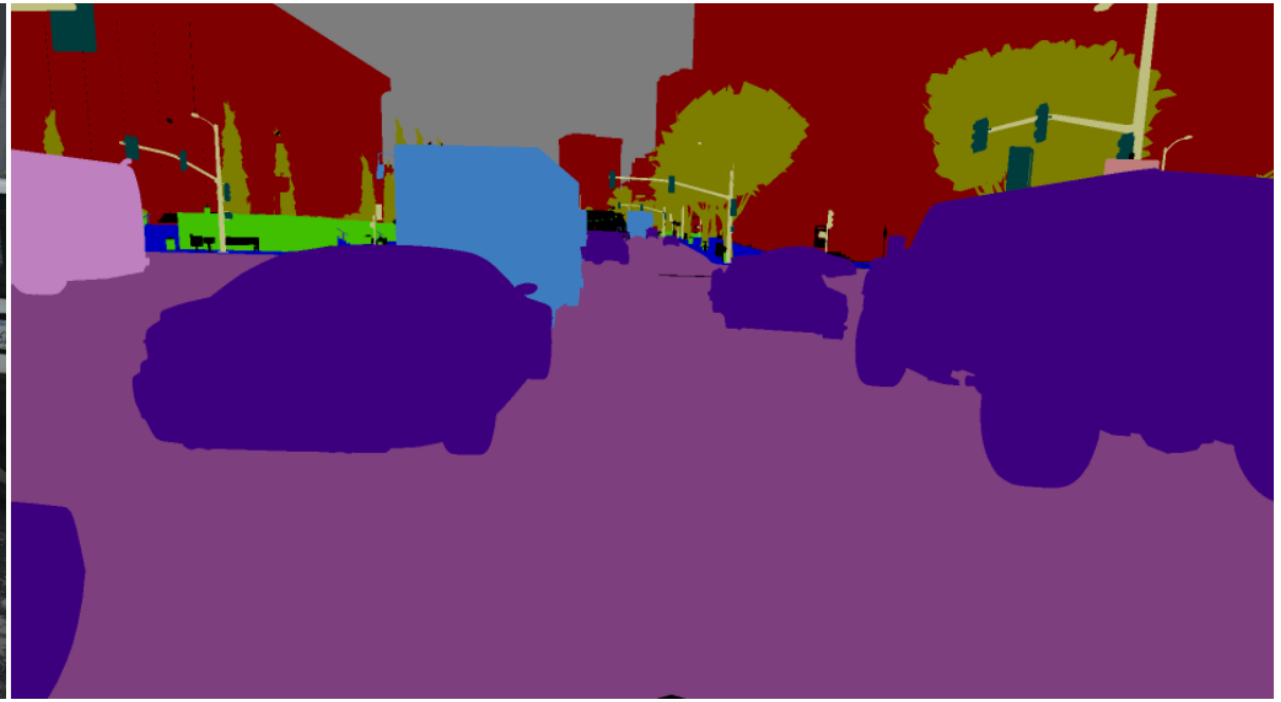
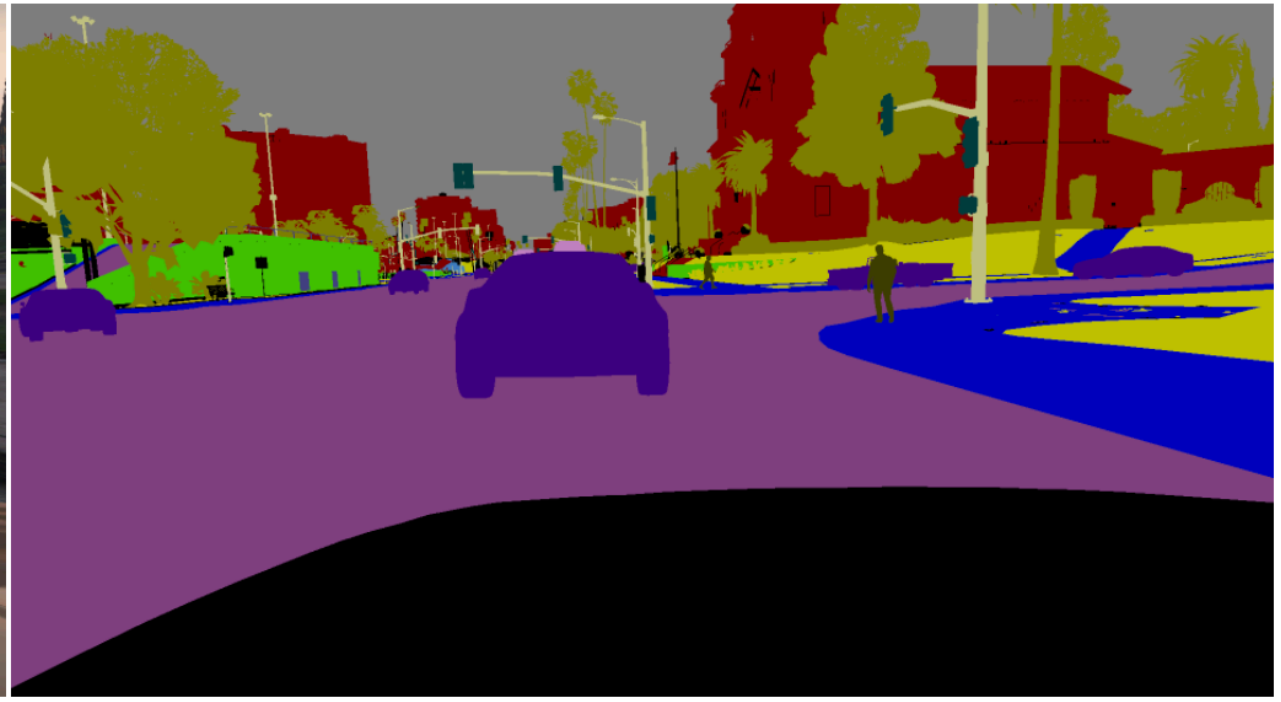
Perception for Autonomous Driving


Simulation

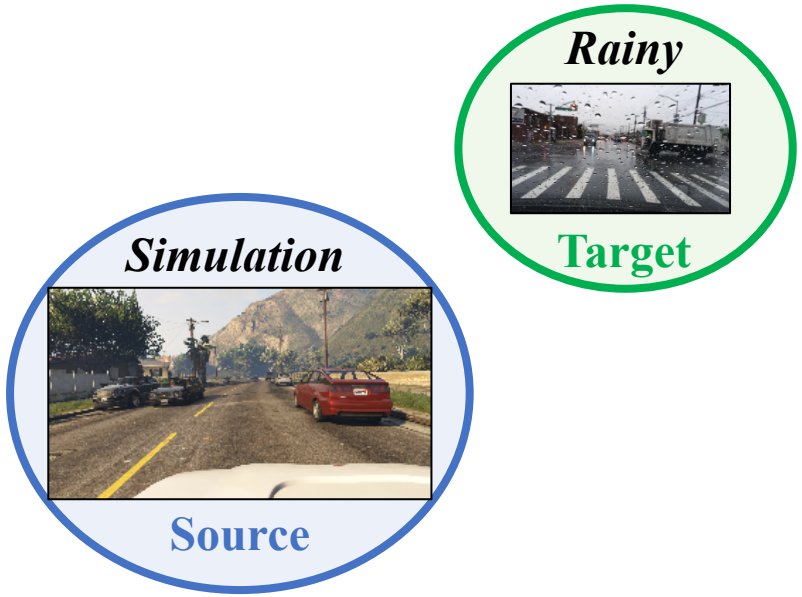



Simulation

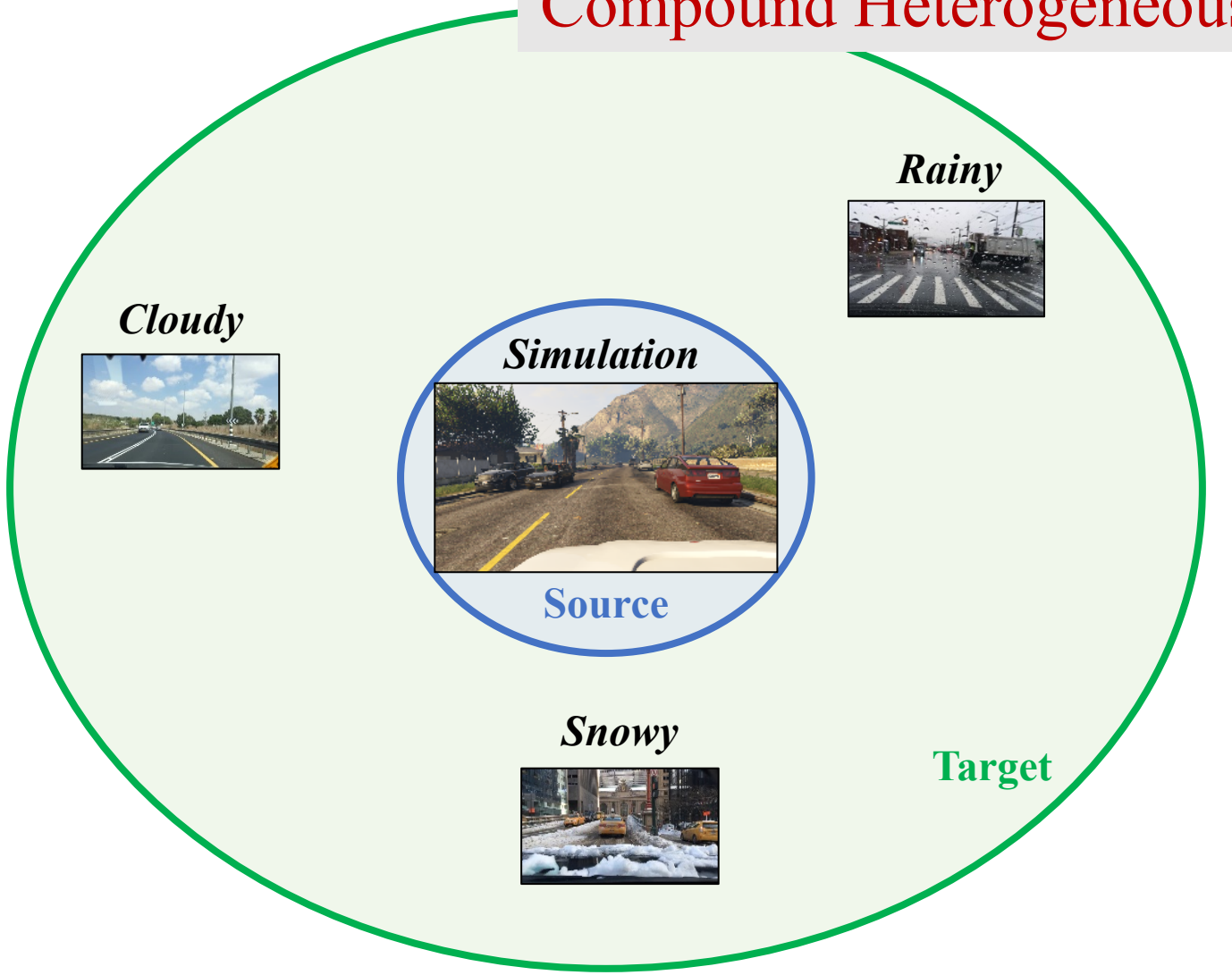


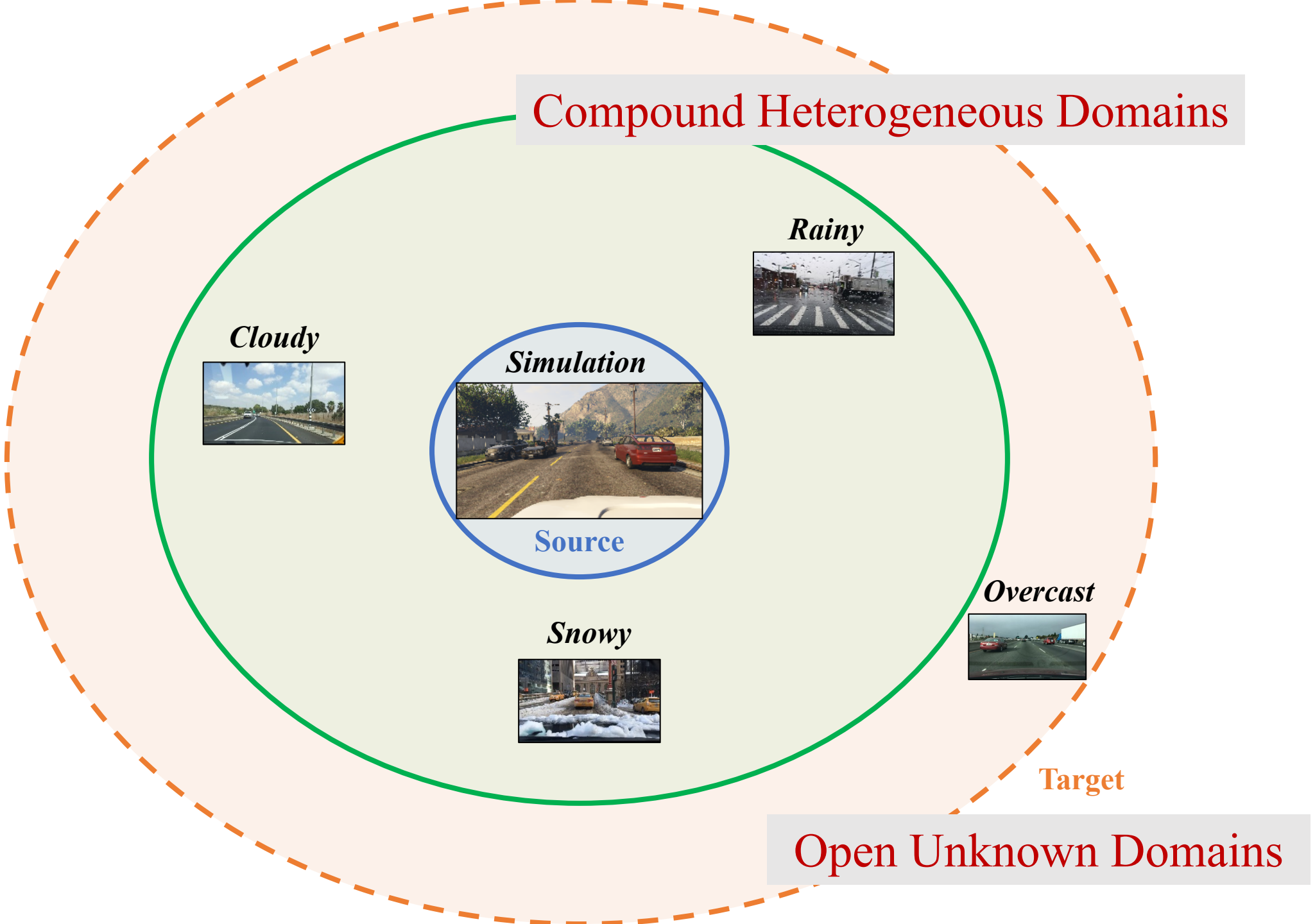
Simulation

Open World Driving Conditions


Rainy
Target
Simulation
Source

Compound Heterogeneous Domains




Compound Heterogeneous Domains
Rainy
Cloudy
Simulation
Source
Overcast
Snowy
Target
Open Unknown Domains

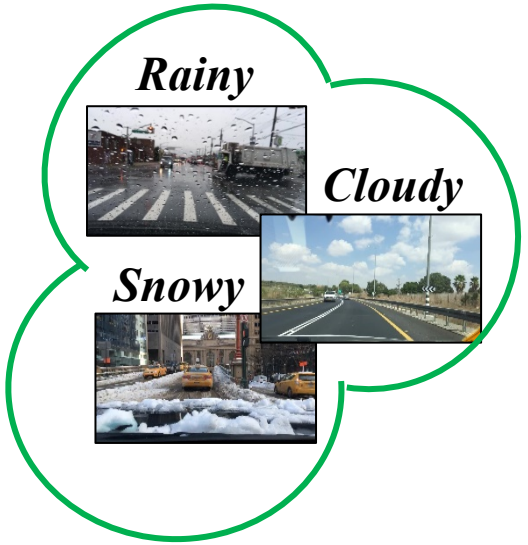
Source domain

Single target domain

(a) Unsupervised Domain Adaptation

Multiple target domains

(b) Multi-Target Domain Adaptation



A compound target domain

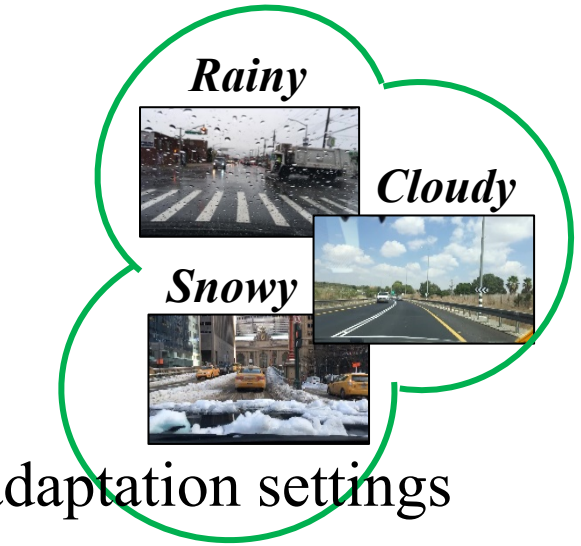
Unseen weather and more

Open Compound Domain Adaptation

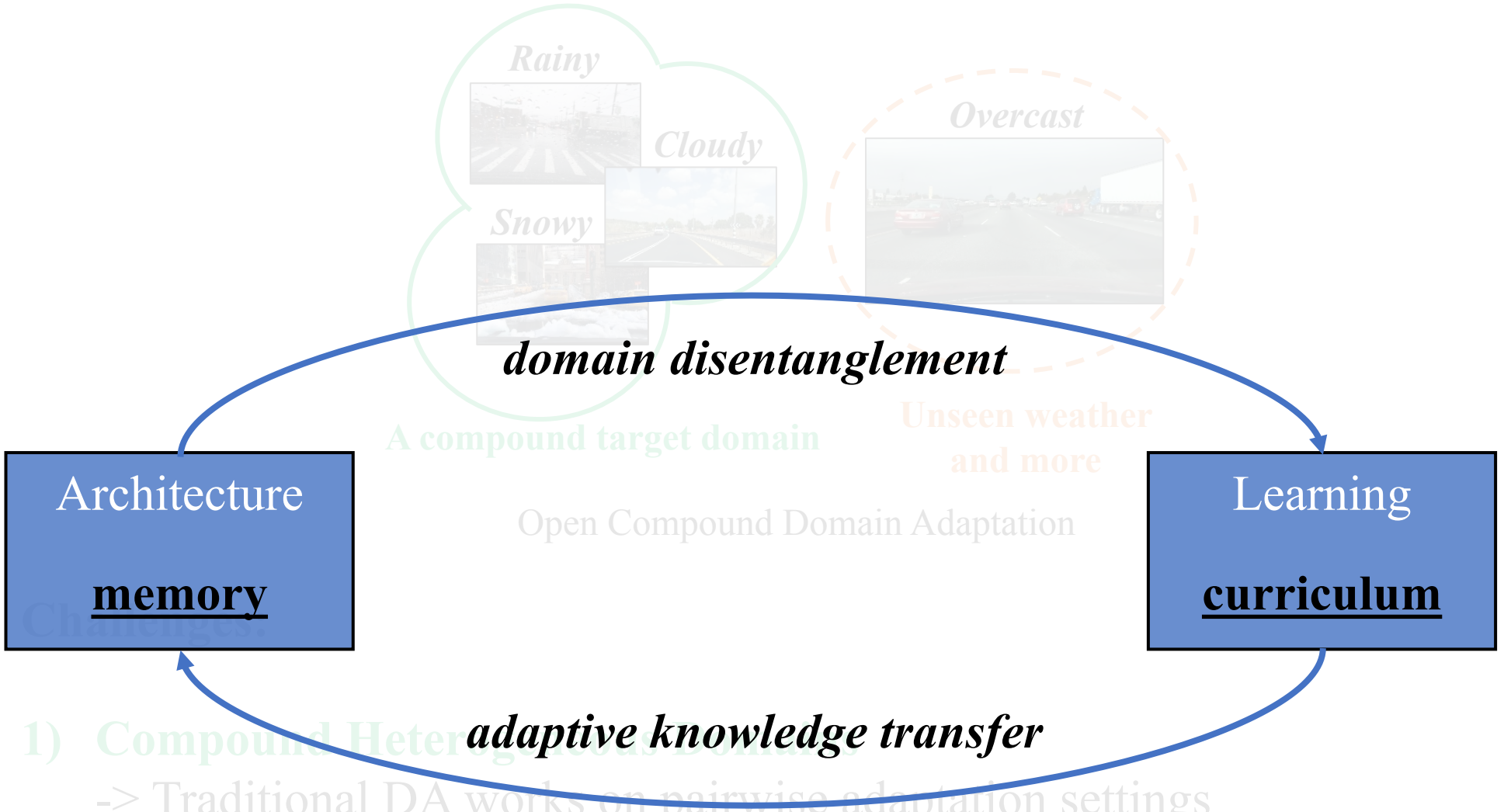
Challenges:

1) **Compound Heterogeneous Domains**
   -> Traditional DA works on pairwise adaptation settings

1) **Open Unknown Domains**
   -> Traditional DA assumes prior access to domain data during training



Open Compound Domain Adaptation


Rainy
Cloudy
Snowy
Overcast
domain disentanglement
Architecture
memory
Learning
curriculum
adaptive knowledge transfer

Simulation

Open World Driving Conditions

Source ***Compound Targets*** ***Open Targets***

Simulation

Open World Driving Conditions

...

...

Cloudy Rainy Overcast

Continuous Adaptation

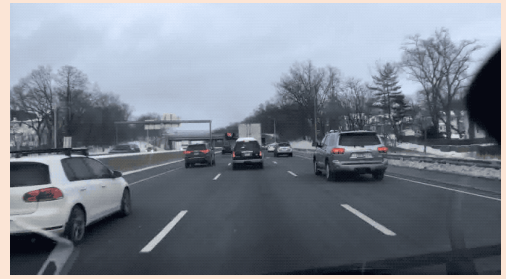
Source ***Compound Targets*** ***Open Targets***

Simulation

Open World Driving Conditions

...

...



Cloudy Rainy Overcast

instance-wise curriculum

domain memory

Continuous Adaptation

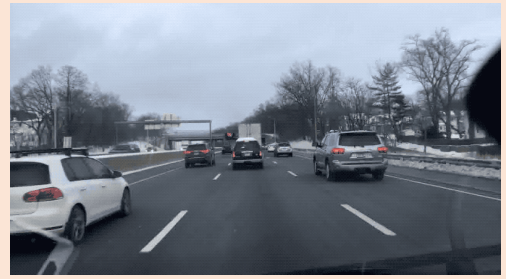
Source ***Compound Targets*** ***Open Targets***

Simulation

Open World Driving Conditions

...

...



Cloudy Rainy Overcast

instance-wise curriculum

domain memory

Domain Disentanglement

Adaptive Knowledge Transfer

Continuous Adaptation

Source ***Compound Targets*** ***Open Targets***

Open Compound Domain Digits Classification


SVHN

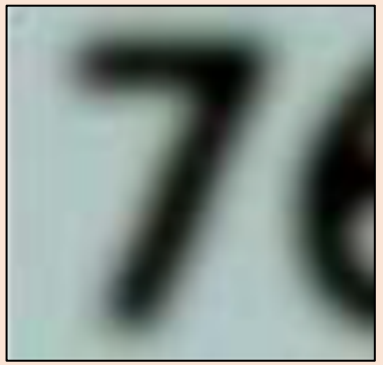
...


MNIST-M


MNIST


USPS

...


SymNum

instance-wise curriculum

domain memory

Domain Disentanglement

Adaptive Knowledge Transfer

Continuous Adaptation

Adversarial Domain Characteristics Disentanglement

$$\min_{E_{domain}} \quad -\sum_i z^i_{random} \log D(E_{domain}(x^i))$$

$$\min_{D} \quad -\sum_i y^i \log D(E_{domain}(x^i))$$

Source

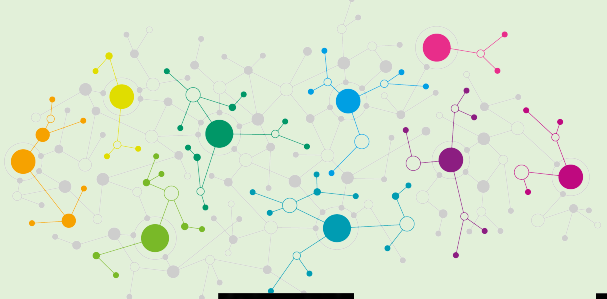
Compound Targets

instance-wise curriculum

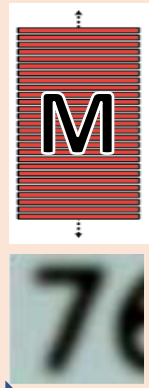
Open Targets

domain memory

Domain Disentanglement



Adaptive Knowledge Transfer



...

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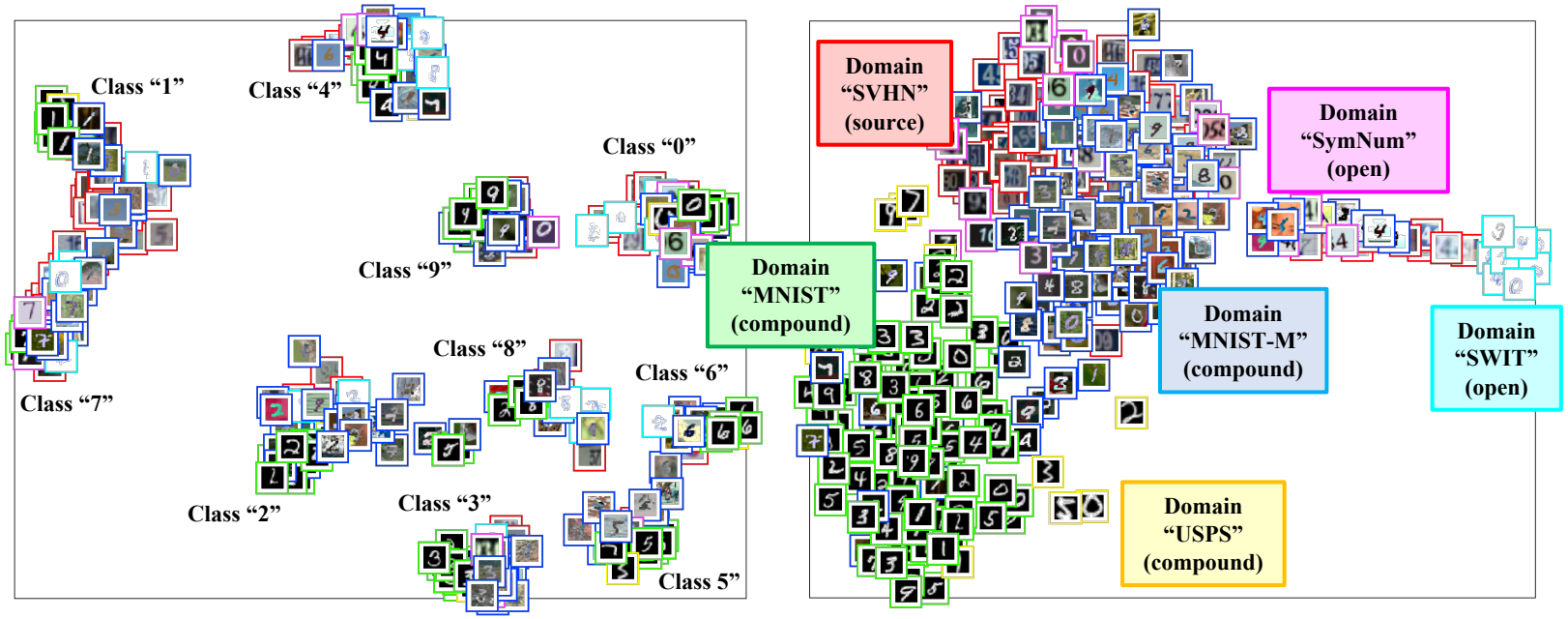
Continuous Adaptation



Source

Compound Targets

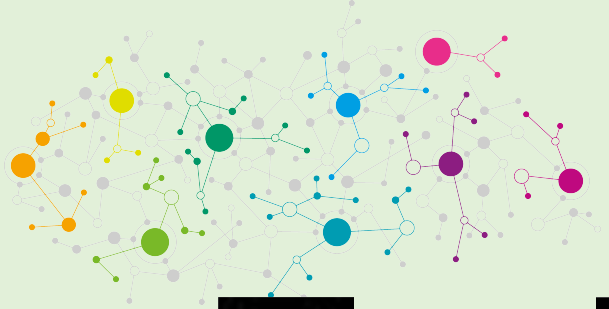
instance-wise curriculum

Open Targets

domain memory

Domain Disentanglement

Adaptive Knowledge Transfer



...

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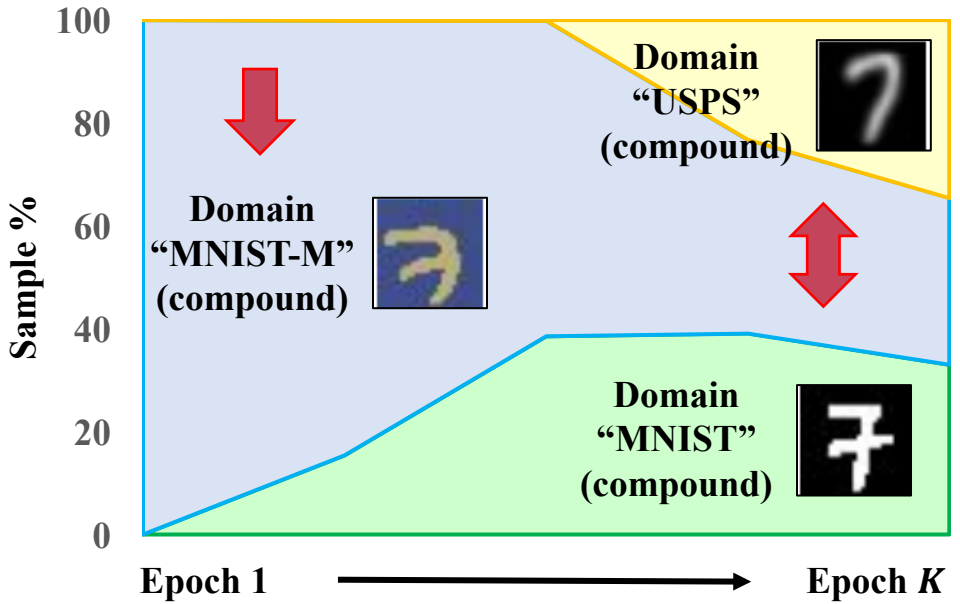
Continuous Adaptation

Curriculum according to Domain Characteristics

Domain "SVHN" (source)



Source

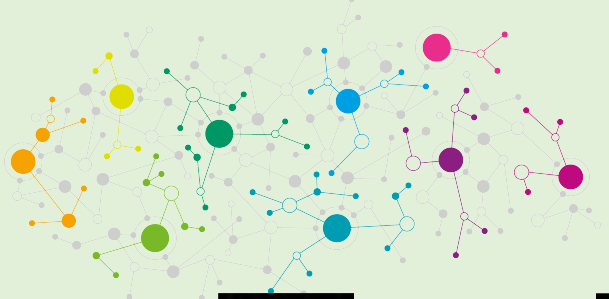
Compound Targets

instance-wise curriculum

Open Targets

domain memory

Domain Disentanglement



Adaptive Knowledge Transfer

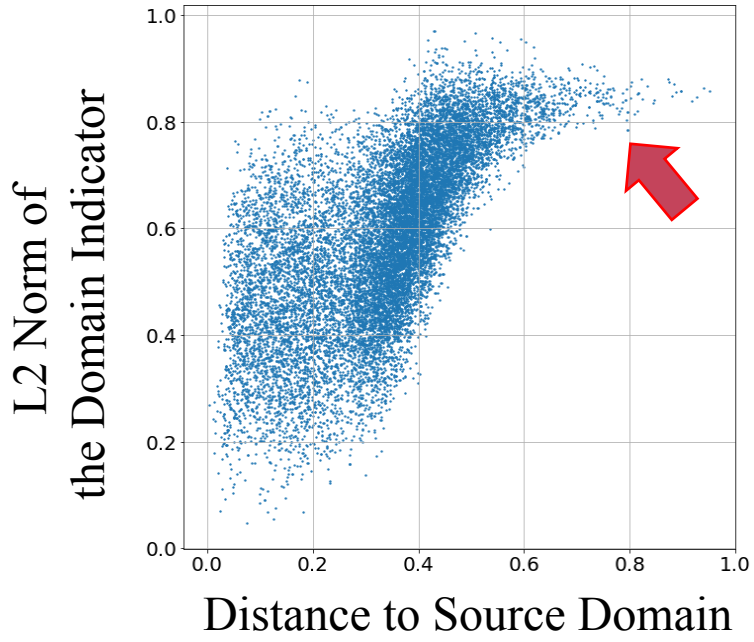
...

...

Continuous Adaptation

Memory-Augmented Domain Indicator

$$v_{transfer} = v_{direct} + e_{domain} \otimes v_{enhance}$$



Source

Compound Targets

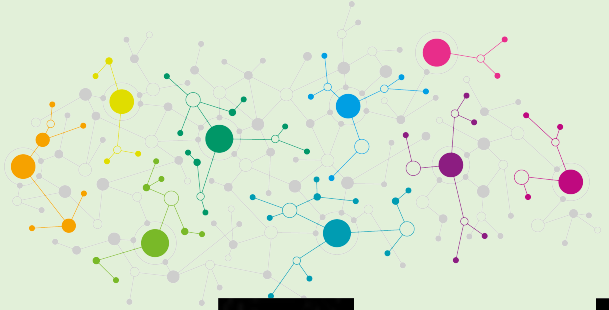
instance-wise curriculum

Open Targets

domain memory

Domain Disentanglement

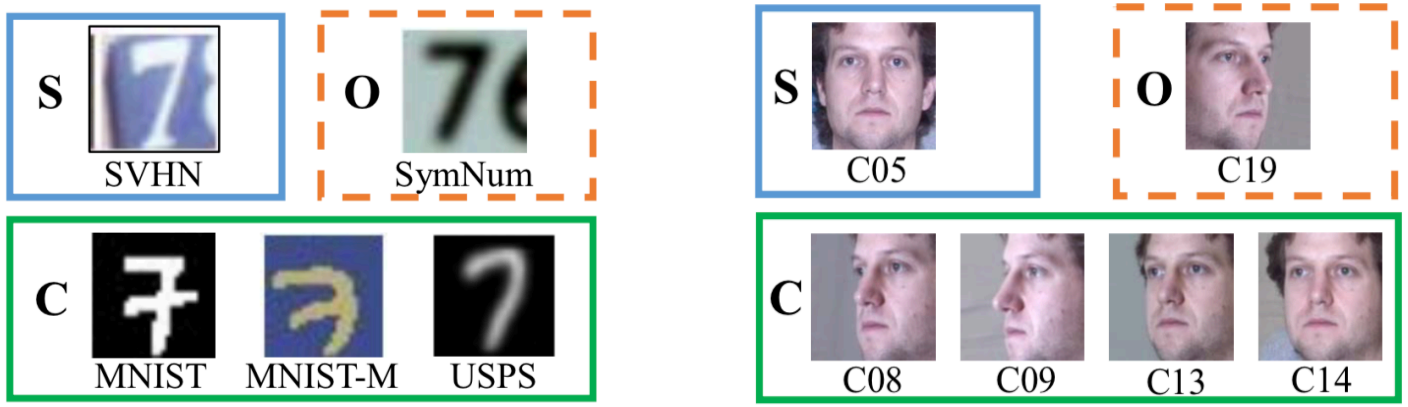
Adaptive Knowledge Transfer



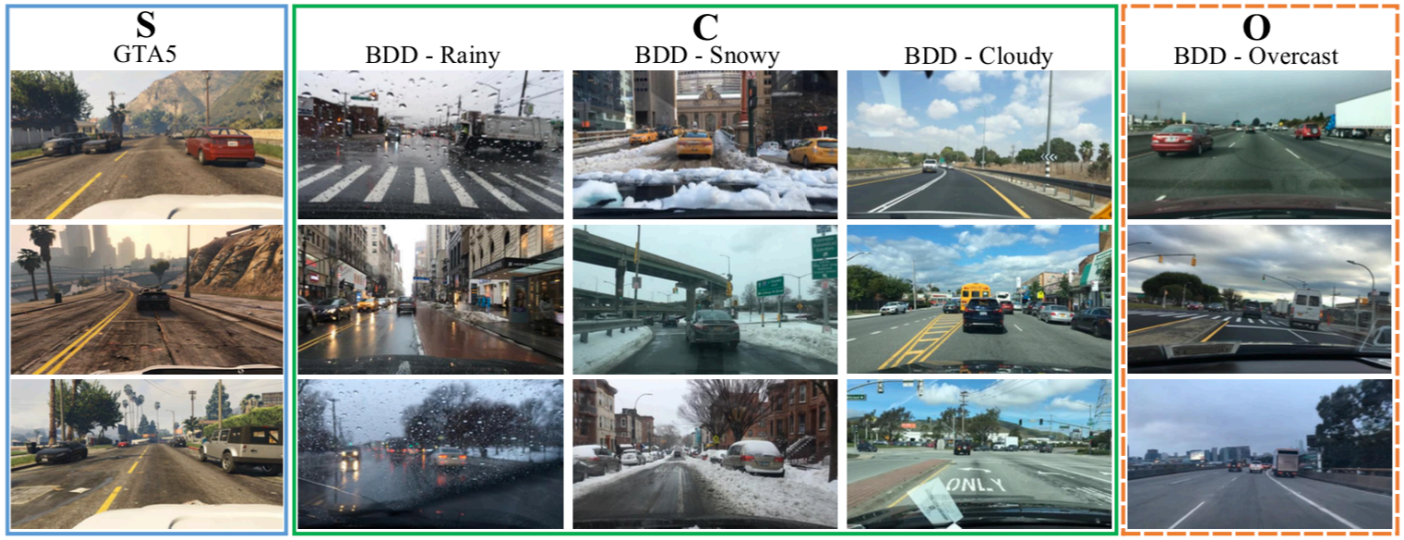
Continuous Adaptation

C-Digits Benchmark
Absolute Performance Gain: ~5%

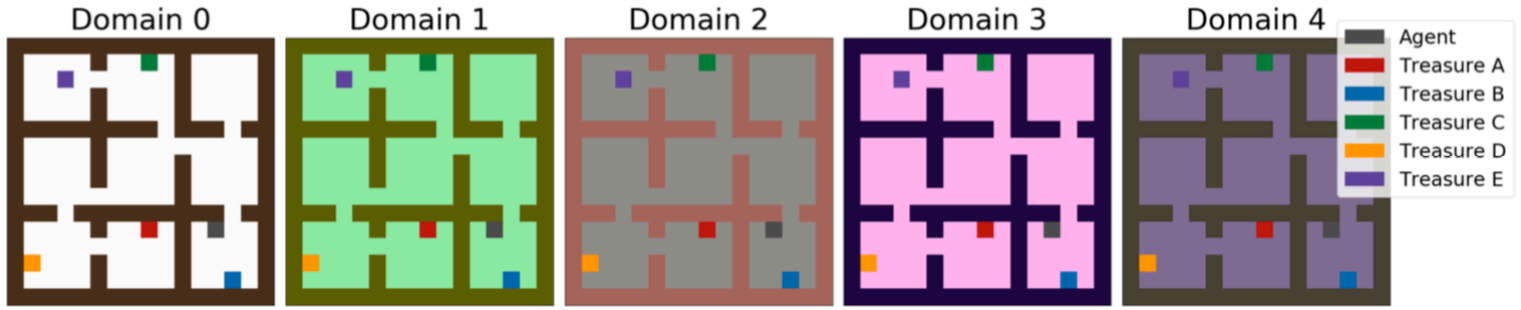
C-Faces Benchmark
Absolute Performance Gain: ~10%



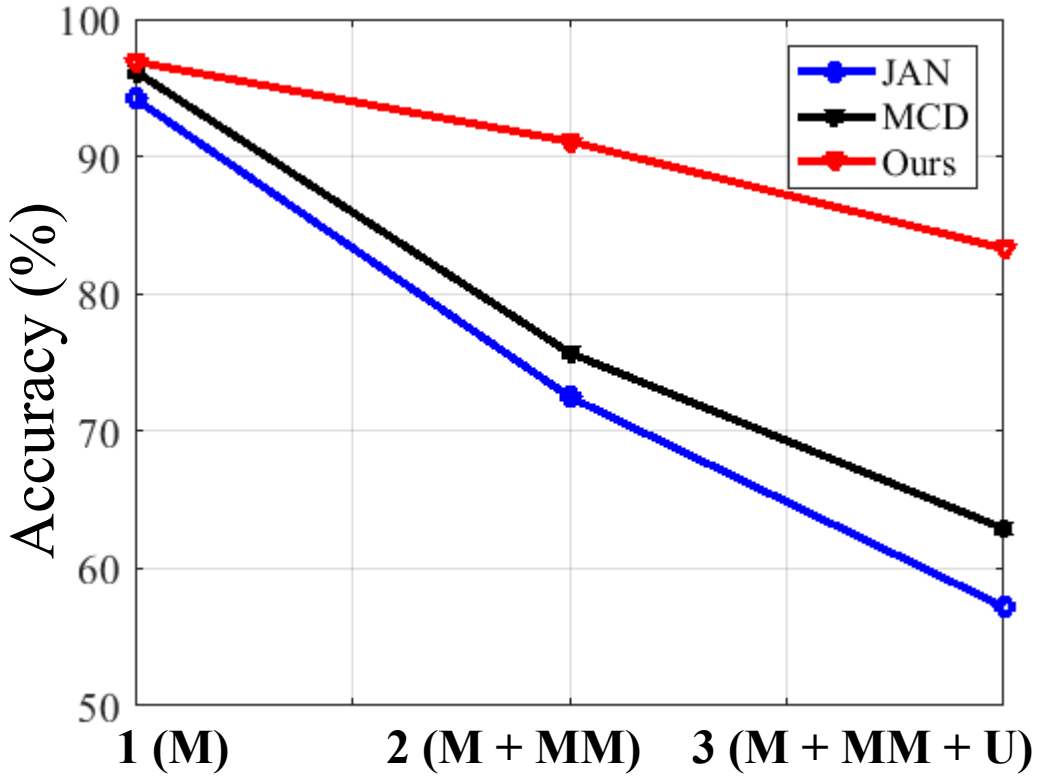
C-Driving Benchmark
Absolute Performance Gain: ~2%



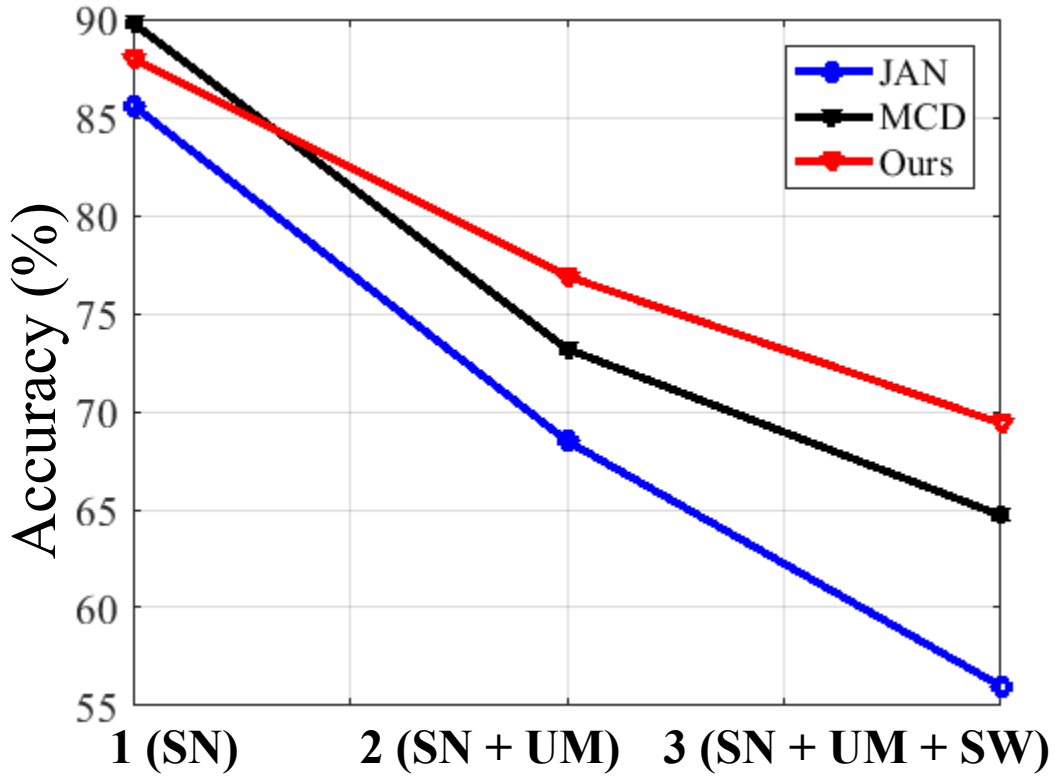
C-Mazes Benchmark
Absolute Performance Gain: ~30%



Robustness to the complexity of compound domains and open domains



The Number of Compound Domains



The Number of Open Domains

Adaptation Results on C-Driving

(semantic segmentation)

Source Domain (Simulation)

Source Only

Ours

Compound Target Domain (Rainy)

Source Only

Ours

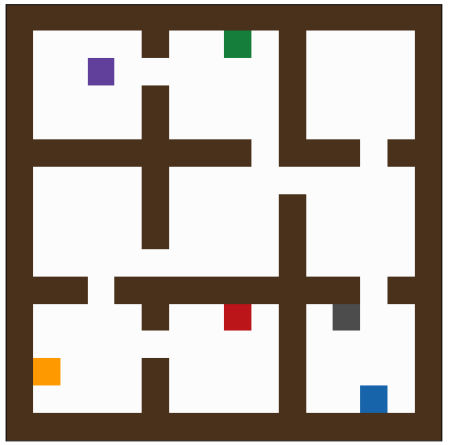
Open Target Domain (Overcast)

Source Only

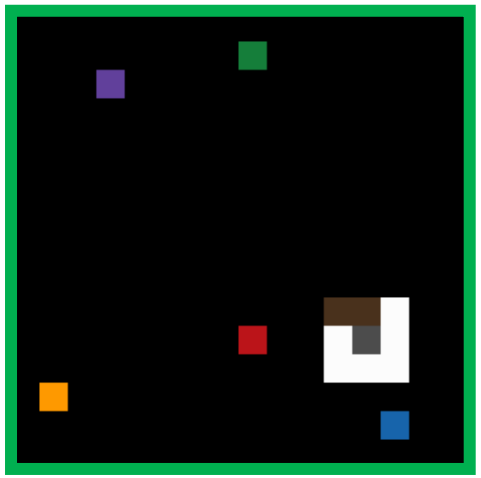
Ours

Adaptation Results on C-Mazes

(reinforcement learning)

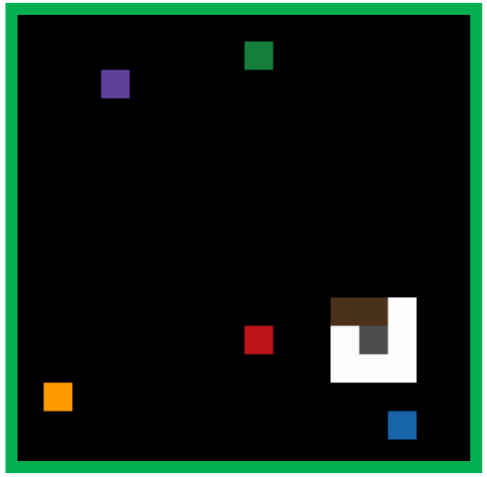


Source Domain



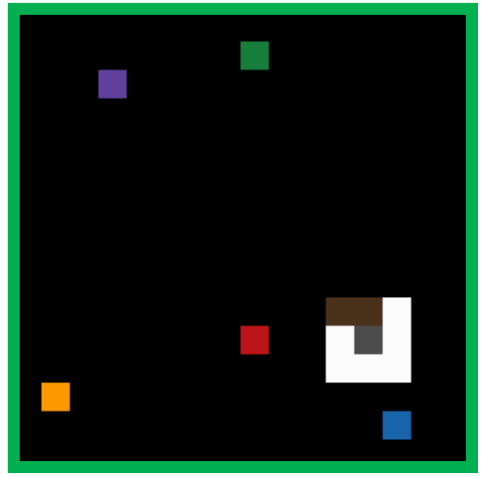
MTL

(succeed)



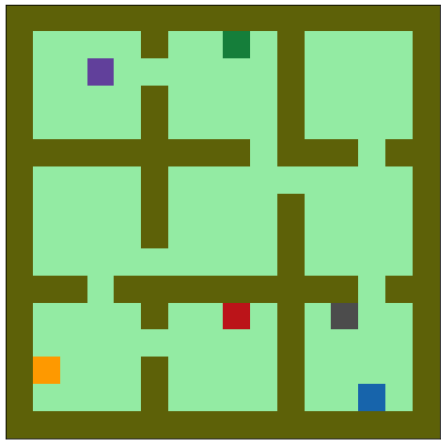
SynPo

(succeed)

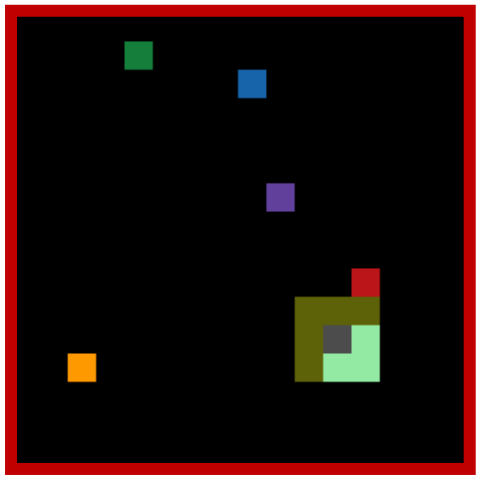


Ours

(succeed)

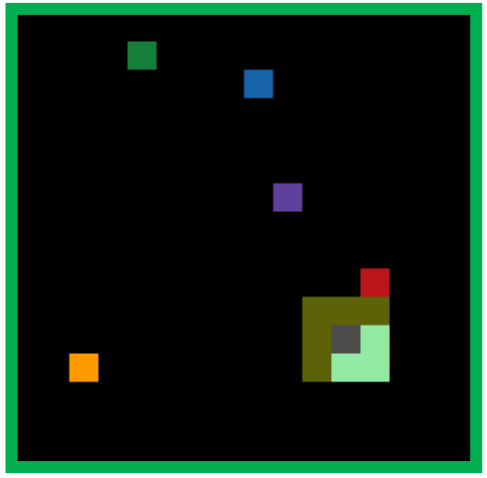


Open Target Domain 1



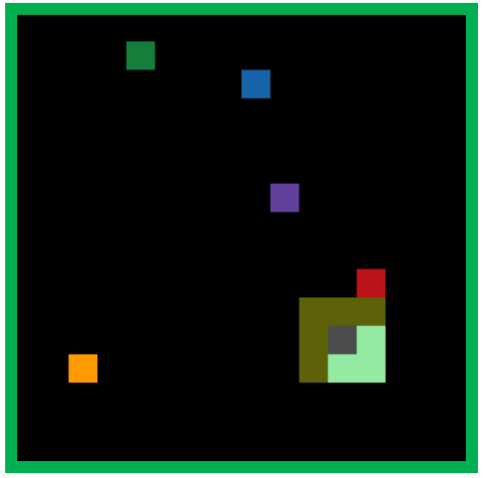
MTL

(fail)



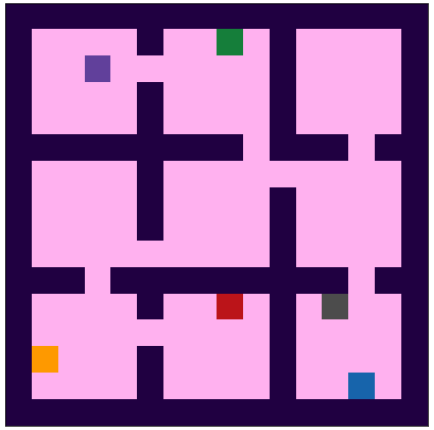
SynPo

(succeed)

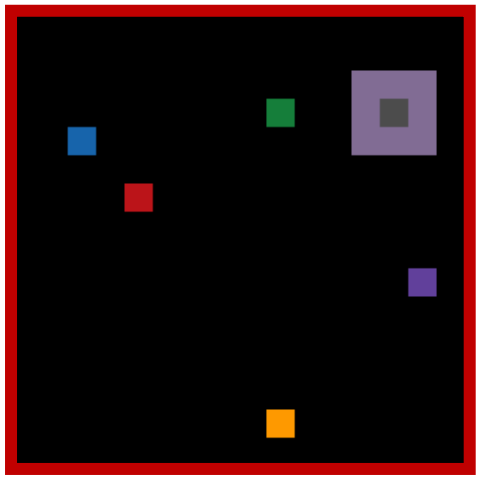


Ours

(succeed)

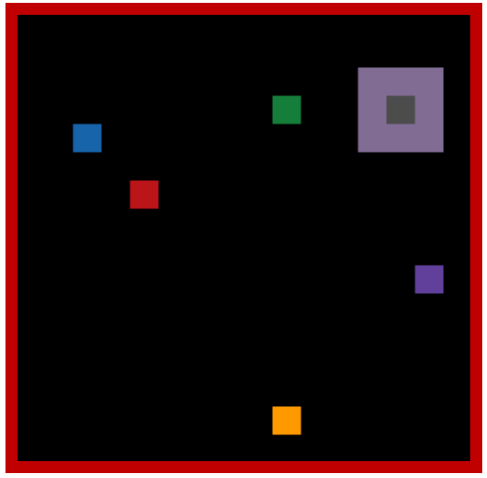


Open Target Domain 2



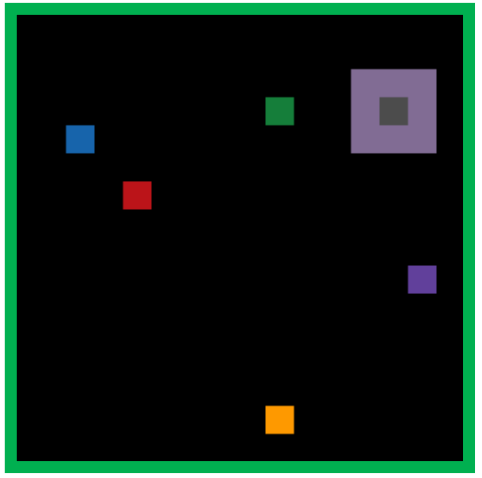
MTL

(fail)



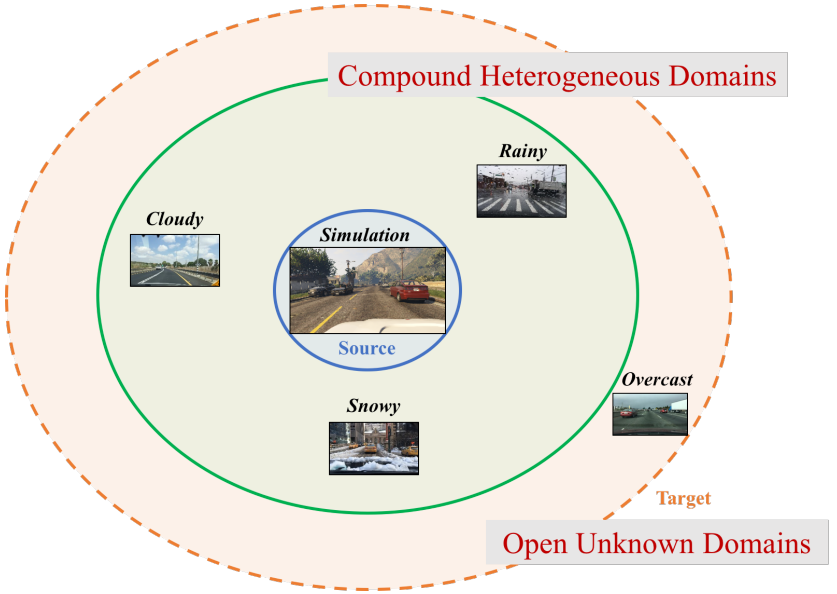
SynPo

(fail)



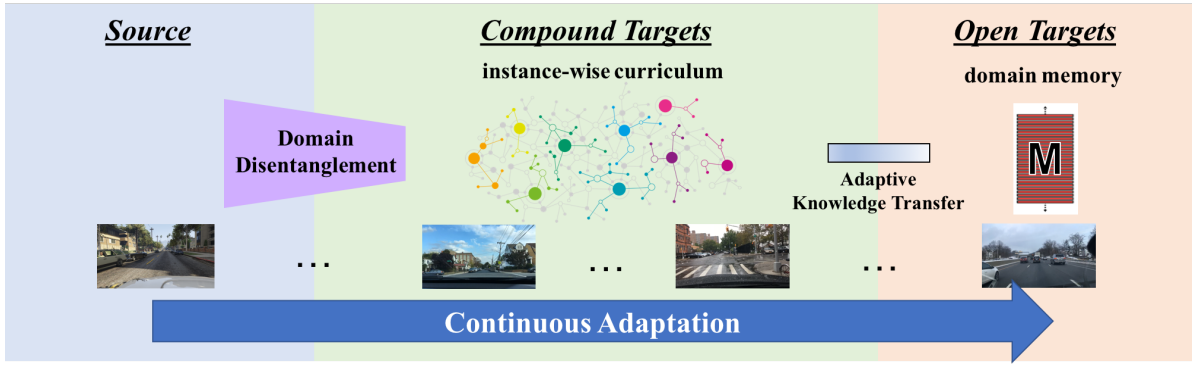
Ours

(succeed)



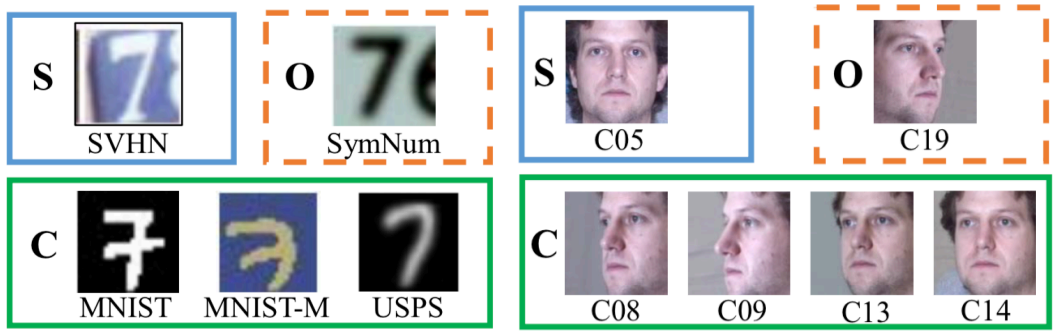
New Task

Open Compound Domain Adaptation(OCDA)



New Approach

Instance-wise Curriculum + Domain Memory



New Benchmarks

C-Digits, C-Faces, C-Driving, and C-Mazes

Thanks!

Code, models and benchmarks are available at

Project Page: https://liuziwei7.github.io/projects/CompoundDomain.html