Refactoring Policy for Compositional Generalizability using Self-Supervised Object Proposals

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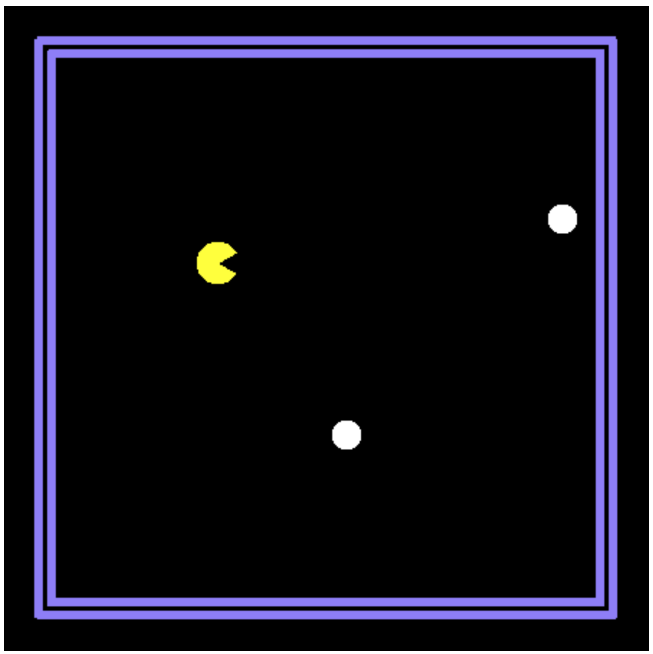
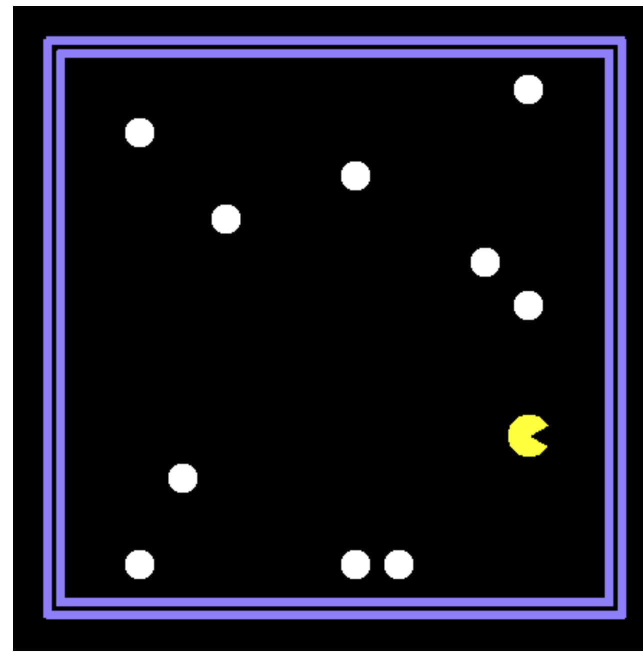
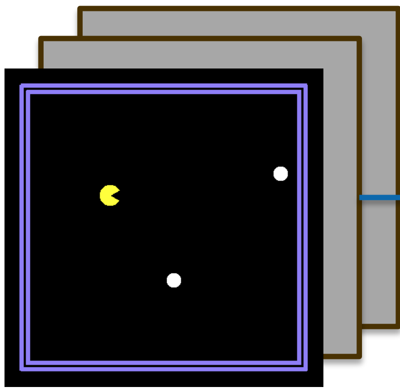
Compositional Generalization

Generalize?

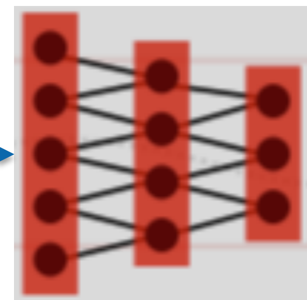




Challenges of Classical RL



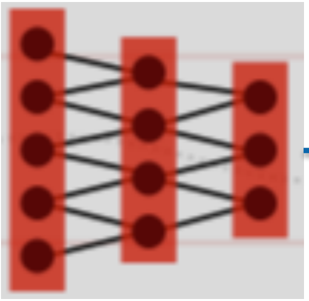
Training environments



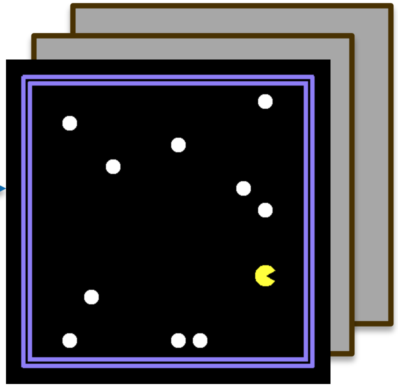
Neural Network

Optimization Challenge

Challenges of Classical RL



Neural
Network



Test
environments

Generalization
Challenge

Refactorization

Teacher Policy

Demonstration Dataset

Stage 1

RL algorithms
Heuristic algorithms
…

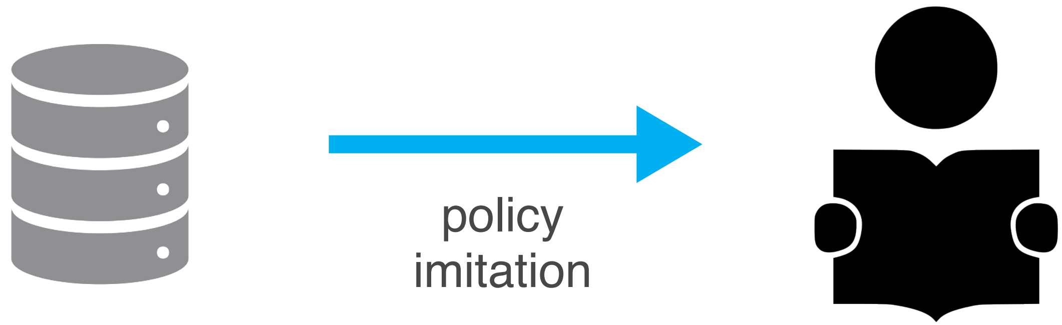
Demonstration Acquisition
without Generalizability Concerns

Refactorization

Stage 2

Demonstration Dataset

Student Policy

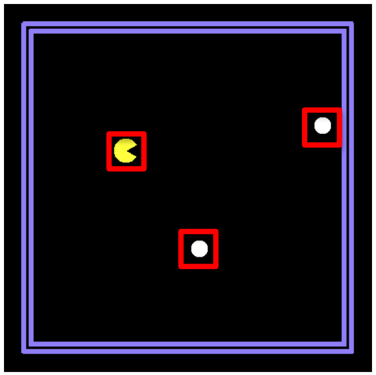


Strong inductive bias
for generalization

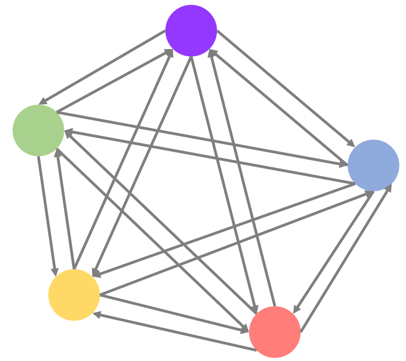
Refactorize Demonstration into
Compositional Generalizable Policy

Object-centric Policy

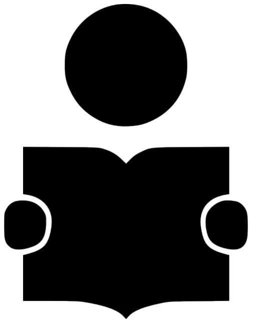
Self-Supervised
Object Detector



Graph Neural Network



Student Policy



Strong inductive bias:
Object-centric Scene Graph

Experiments

- Flexible number of objects
- Random object arrangement
- Composition of foreground/background

Multi-MNIST

FallingDigit

BigFish

Multi-MNIST

Object-centric graph can be a strong inductive bias for compositional generalizability

Training Set

Test Set

Method	Train Acc	Test Acc
CNN	90.5(2.9)	12.0(2.1)
Relation Net	96.4(0.8)	8.4(4.7)
Ours	80.2(0.2)	**51.2(1.2)**

FallingDigit

The student network with object-centric graph inductive bias can refactorize the teacher policy into a compositional generalizable policy

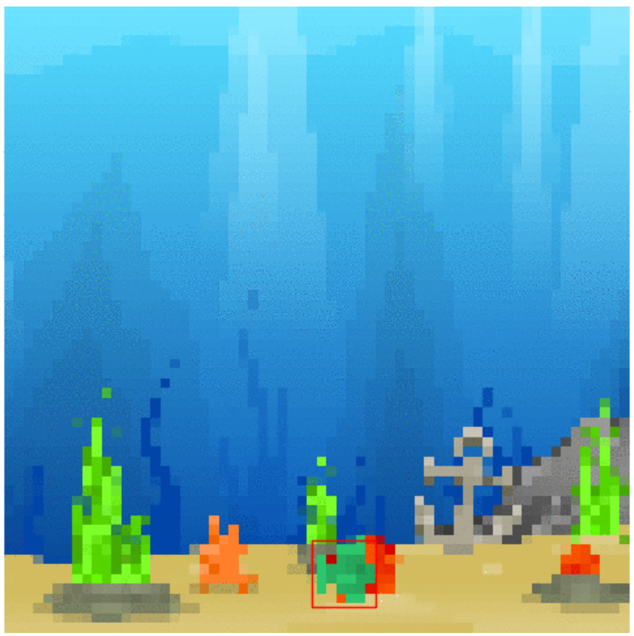
Train on 3 digits

CNN-based RL policy fails to generalize to 9 digits

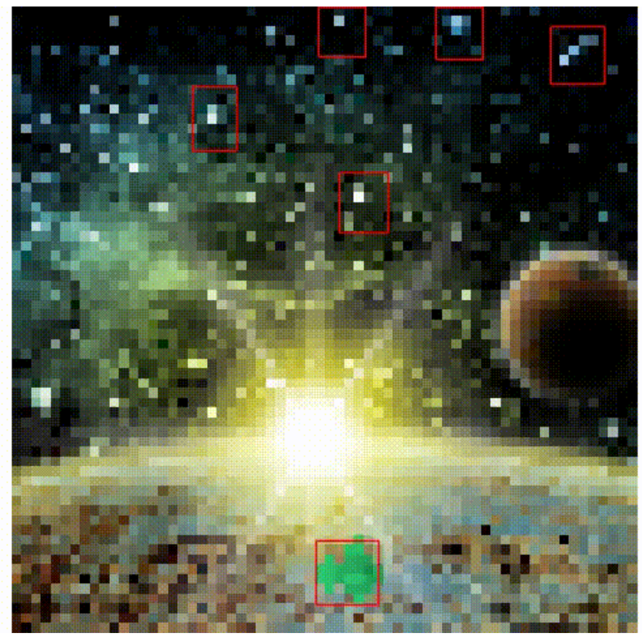
GNN-based refactorized policy generalizes to 9 digits

BigFish

More robust to different composition of foreground and background



Training Environments



Test Environments

Conclusion

- Refactorization through a proper student network with strong inductive bias can ease optimization and achieve compositional generalizability.

- In difficult environments with sophisticated reasoning, long-range interaction, or unfamiliar background, GNN-based student policy shows stronger performance and robustness.

- We implement an effective object-centric policy learning framework with an improved self-supervised object detector.

Thank you!