WON-SEOK CHOI

INFORMATION

Seoul National University, BioIntellgence (BI) Lab. (Ph.D. candidate)

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Birthdate October 30th, 1997 (age 27)

RESEARCH INTERESTS

My current research goal is to design a **cognitive agent that can understand the dynamic environment through active interactions**. To achieve this, an agent should deal with critical problems such as **(1) lack of additional information, (2) data imbalance, (3) distribution shifts**, and **(4) physical embodiment limitations**. Specifically, my research topics belong to:

- **Representation learning in realistic environments (with class-imbalances, distribution shifts, ...)**
- **Self-supervised learning (SSL)**, metric learning
- Online & active learning for embodied agents
- Few-shot generalization
- Score-based models

EDUCATION

02.2026	Expected Graduation (ABD)
09.2022 – 08.2025	Technical Research Personnel (Military service, *전문연구요원*)
09.2019 – **Current**	Ph.D. Candidate in CSE at Seoul National University (Prof. Byoung-Tak Zhang)
03.2015 – 08.2019	Bachelor's degree in CSE at Seoul National University
03.2013 – 02.2015	Graduated Chungnam Science High School

ACADEMIC EXPERIENCES

[AAAI 2025]	Served as Program Committee (Reviewer)
[NeurIPS 2024]	Served as Reviewer (NeurIPS 2024 SSLTheoryPractice Workshop)
2021.S – 2025.F	K-MOOC <*인공지능 만들기*> Online lecture, main TA
2020.S – 2022.S	Samsung NPEX Course, main TA
2020.F, 2022.F	<*Artificial Neural Networks*>, dept. CSE, SNU, TA
2019.F	<*Machine Learning*>, dept. CSE, SNU, TA

PUBLICATIONS (CONFERENCE)

[1] **DUEL: Duplicate Elimination on Active Memory for Self-Supervised Class-Imbalanced Learning**

Won-Seok Choi, Hyundo Lee, Dong-Sig Han, Junseok Park, Heeyeon Koo, Byoung-Tak Zhang

Proceedings of the AAAI Conference on Artificial Intelligence, Vol 38. (AAAI 2024).

[2] **Unveiling the Significance of Toddler-Inspired Reward Transition in Goal-Oriented Reinforcement Learning**

Junseok Park, Yoonsung Kim, Hee bin Yoo, Min Whoo Lee, Kibeom Kim, Won-Seok Choi, Minsu Lee, Byoung-Tak Zhang

Proceedings of the AAAI Conference on Artificial Intelligence. Vol. 38. (AAAI 2024). ***(Oral)***

[3] **Learning Geometry-aware Representations by Sketching**

Hyundo Lee, Inwoo Hwang, Hyunsung Go, Won-Seok Choi, Kibeom Kim, Byoung-Tak Zhang

The IEEE/CVF Conference on Computer Vision and Pattern Recognition 2023 (CVPR 2023)

[4] **Message passing adaptive resonance theory for online active semi-supervised learning**

Taehyeong Kim, Injune Hwang, Hyundo Lee, Hyunseo Kim, Won-Seok Choi, Joseph J Lim, Byoung-Tak Zhang

International Conference on Machine Learning 2021 (ICML 2021)

[5] **Label propagation adaptive resonance theory for semi-supervised continuous learning**

Taehyeong Kim, Injune Hwang, Gi-Cheon Kang, Won-Seok Choi, Hyunseo Kim, Byoung-Tak Zhang

45th International Conference on Acoustics, Speech, and Signal Processing (ICASSP 2020)

[6] **OBSER: Object-Based Sub-Environment Recognition for Zero-Shot Environmental Inference**

Won-Seok Choi, Dong-Sig Han, Suhyung Choi, Hyeonseo Yang, Byoung-Tak Zhang

https://arxiv.org/abs/2507.02929, submitted to Neurocomputing (with modifications)

WORKSHOP PAPERS

[7] **DUEL: Adaptive Duplicate Elimination on Working Memory for Self-Supervised Learning**

Won-Seok Choi, Hyundo Lee, Dong-Sig Han, Junseok Park, Byoung-Tak Zhang

NeurIPS 2022 SSLTheoryPractice Workshop

[8] **ARLET: Adaptive Representation Learning with End-to-end Training**

Won-Seok Choi, Injune Hwang, Byoung-Tak Zhang

NeurIPS 2020 Workshop on BabyMind

SKILL SET

Program Language	**Python**, C (C++, C#), Java, Javascript (, OCamL)
ML framework	**Representation Learning (Metric learning, Self-supervised learning, generative model)** , Computer vision, Semi-supervised learning, Active learning, Adversarial robustness, Reinforcement learning
Self-Supervised Learning Model	SimCLR, SupCon, MoCo-variants, BYOL, SimSiam, Barlow Twins, DINO-variants, VICReg, (SwAV, MEC, JEPA)
ML Theory	**Information geometry, Riemannian manifold, Measure theory** (, Langevin dynamics)
ML-related Library	**PyTorch**, TensorFlow, (numpy, scikit-learn ...)
Scientific Theory	Cognitive science, Neuroscience (Related to NN)
Miscellaneous	Ubuntu, Git, GitHub *(@mkroughdiamond)*

OTHER ACTIVITIES

- BabyMind Project (**Chief Student Researcher**, 2021.03 – 2022.12)
- Research project with Juvis Diet Korea (2019.F ~ 2020.Spring)
- Book seminar organizers (in BI)
  - <Pattern Recognition and Machine Learning> (2020)
  - <Cognitive Dynamic Systems> (2024)
- Diffusion model seminar organizer (in BI, 2023)
- *Miscellaneous*
  - *BI lab server manager (2020 - 2023), chief student in Bldg. 138 (2024 - 2025)*

DUEL: Duplicate Elimination on Active Memory for Self-Supervised Class-Imbalanced Learning

Abstract. Recent machine learning algorithms have been developed using well-curated datasets, which often require substantial cost and resources. On the other hand, the direct use of raw data often leads to overfitting towards frequently occurring class information. To address class imbalances cost-efficiently, **we propose an active data filtering process during self-supervised pre-training in our novel framework, Duplicate Elimination (DUEL).** This framework integrates **(1)** an active memory inspired by human working memory and introduces **(2)** distinctiveness information, which measures the diversity of the data in the memory, to optimize both the feature extractor and the memory. **(3)** The DUEL policy, which replaces the most duplicated data with new samples, aims to enhance the distinctiveness information in the memory and thereby mitigate class imbalances. We validate the effectiveness of the DUEL framework in class-imbalanced environments, demonstrating its robustness and providing reliable results in downstream tasks. We also analyze the role of the DUEL policy in the training process through various metrics and visualizations.

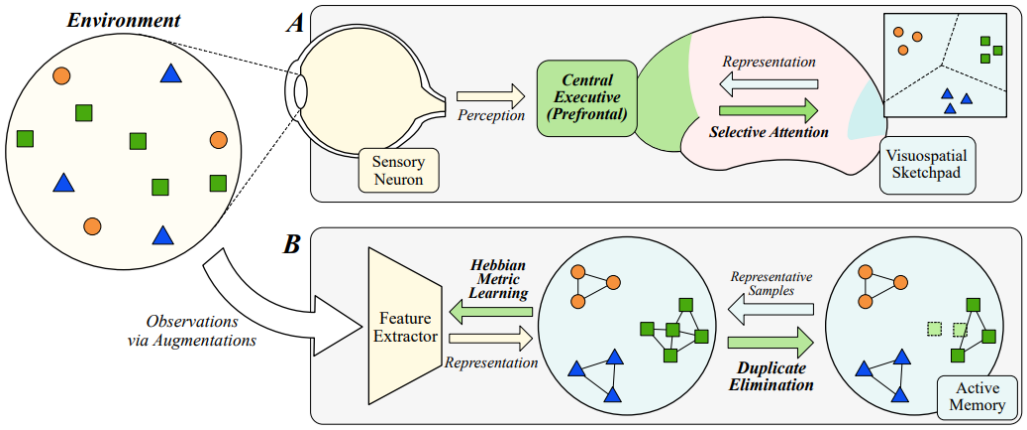
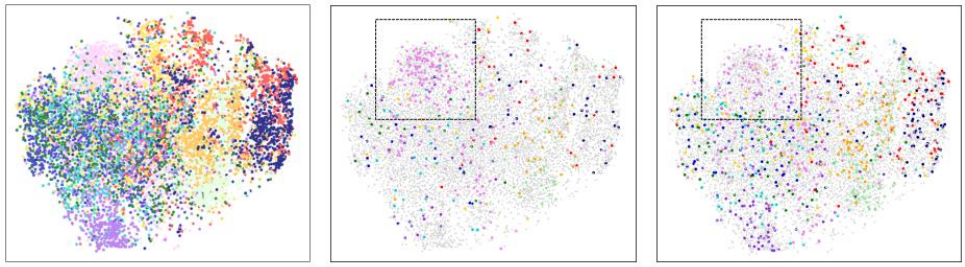


Figure 1: Visualizations of the concepts of working memory and our proposed DUEL framework. (A) Real-world agent perceives data from the environment and maps the representation to solve the task. Working memory finds semantically duplicated signals and reduces them to maximizes the total amount of information. (B) Inspired by this cognitive process, we design the Duplicate Elimination (DUEL) framework. With mutual duplication probability, the representations form a graph structure (center) and are filtered out (right) to gradually maximize the distinctiveness information.



(a) t-SNE (D-MoCo). (b) Batch-wise observation with $\mathcal{D}'$. (c) Updated memory with π_{DUEL}.

Figure 2: t-SNE visualization of the active data filtering process with DUEL policy. (a) The representations extracted by the trained model along with their corresponding class. (b) The agent faces a dominant class (pink) that occurs more frequently than others. (c) The DUEL policy π_{DUEL} replaces duplicated data with newer data and maximizes the distinctiveness information.

OBSER: Object-Based Sub-Environment Recognition for Zero-Shot Environmental Inference (Arxiv version)

Abstract. We present the Object-Based Sub-Environment Recognition (OBSER) framework, a novel Bayesian framework that infers three fundamental relationships between sub-environments and their constituent objects. **In the OBSER framework, metric and self-supervised learning models estimate the object distributions of sub-environments** on the latent space to compute these measures. Both theoretically and empirically, we **validate the proposed framework by introducing the (Epsilon,Delta) statistically separable (EDS) function** which indicates the alignment of the representation. Our framework reliably performs inference in open-world and photorealistic environments and outperforms scene-based methods in chained retrieval tasks. The OBSER framework enables zero-shot recognition of environments to achieve autonomous environment understanding.

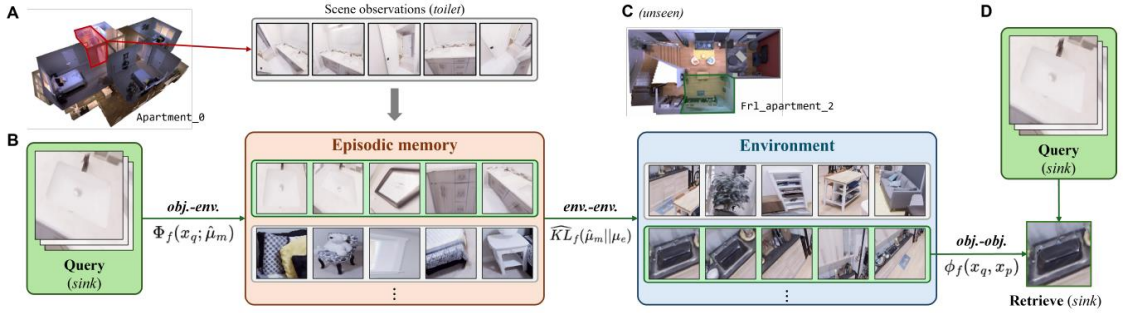


Figure 1: Visualization of chained inference using the OBSER framework in the Replica environment. (A) Scene observations are gathered from each room, and object observations are then extracted. (B) When a query is provided in the form of object observations, the framework first retrieves the corresponding room from its memory. (C) For inference in unseen environments, the rooms similar to the selected room are identified within that environment. (D) Finally, the framework retrieves the target object corresponding to the given query.

	CLIP (V)	CLIP (V+L)	SupCon	SimCLR	MoCo-v2	MoCo-v3	DINO-v1	DINO-v2
Seen (obj-obj)	0.98	**1.00**	0.98	0.94	0.94	0.82	0.98	**1.00**
Seen (Top-1 room)	0.24	0.34	0.66	0.42	0.68	0.68	**1.00**	0.90
Seen (Top-3 rooms)	0.38	0.42	0.76	0.58	0.80	0.74	**1.00**	0.94
Unseen (obj-obj)	0.82	**0.96**	0.80	0.88	0.80	0.70	0.90	0.88
Unseen (Top-1 room)	0.30	0.32	0.20	0.20	0.62	0.50	0.44	**0.78**
Unseen (Top-3 rooms)	0.54	0.60	0.46	0.50	0.54	0.64	0.52	**0.78**

Table 1: Accuracy of chained object retrieval task in Replica environment. We have queried 10 different objects and have computed accuracies with top-5 retrieved objects. Compared to CLIP-based retrieval, the proposed OBSER framework with DINO variants can perform robustly while visiting a limited number of related rooms.

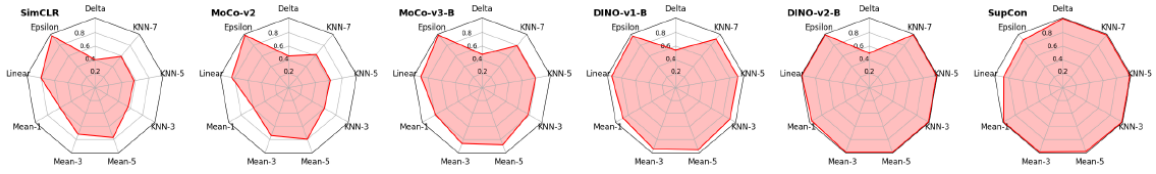


Figure 2: Radar chart of EDS values (τ = 0.5) and down-stream task accuracies for metric learning and self-supervised learning models. The separability value ($1 - \epsilon$) is reported instead of ϵ for the ease of comparison. Each score is normalized within the interval [0, 1]. In this paper, we analyze that a feature extractor with optimized EDS values can successfully measure object-wise, environment-wise and object-environment relationships.