FORLA: Federated Object-Centric Representation Learning with Slot Attention

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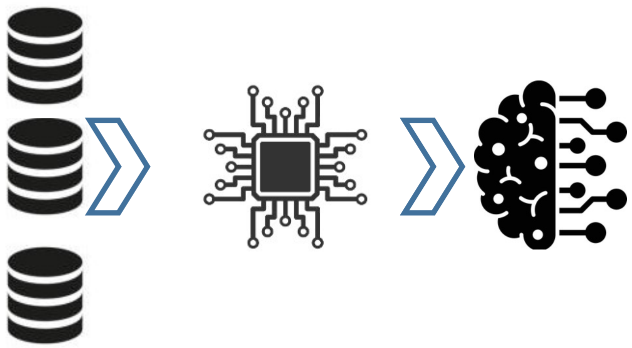
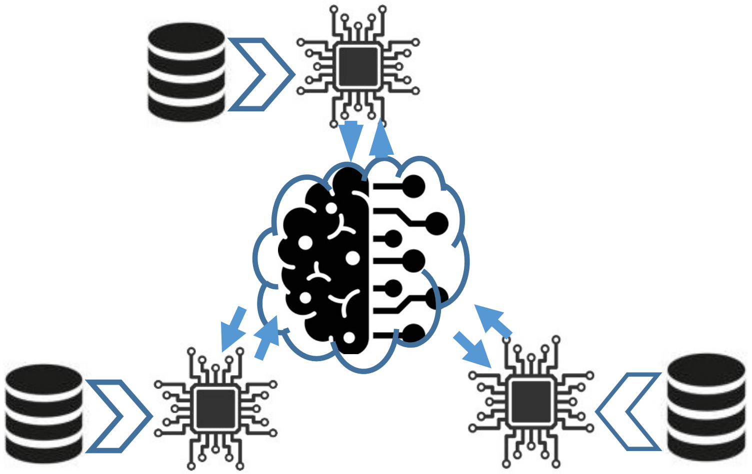
Motivation & Background

Centralized Learning



VS

Federated learning



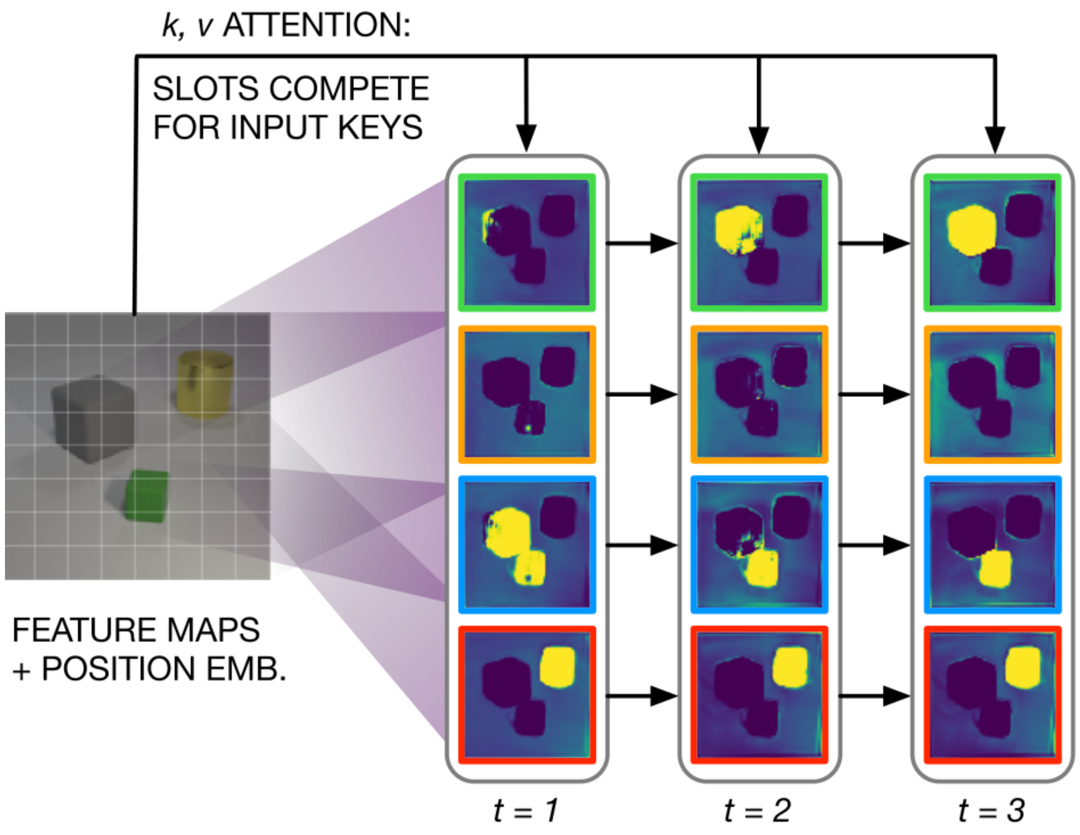
- ❑ Can we learn disentangled universal representations (foundation models) from distributed, non-IID datasets?

- ➢ Self-supervised object-centric learning offers the right inductive bias for learning semantically meaningful representations.

- ➢ Federated learning across curated datasets integrates local, object-level knowledge across clients.

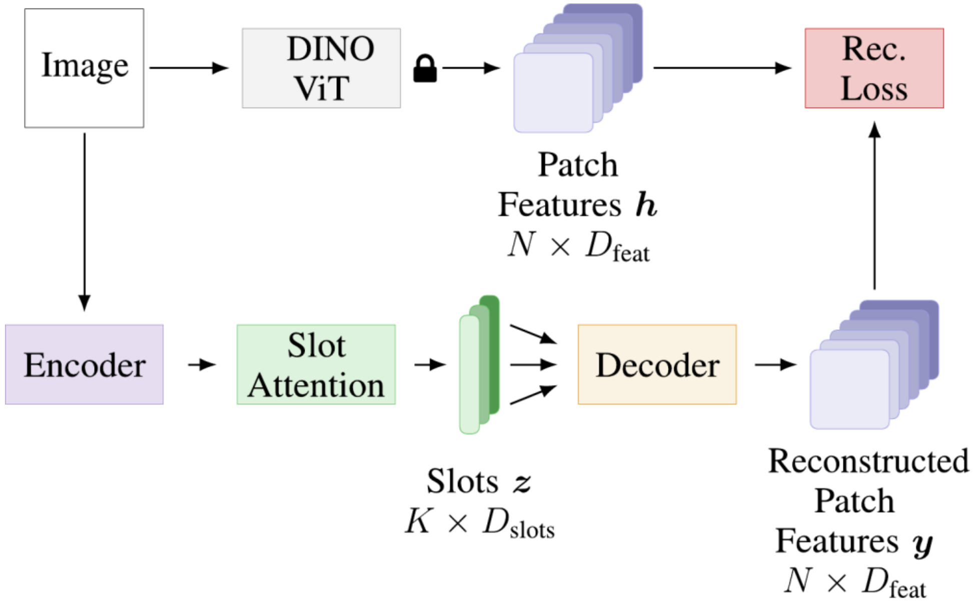
Motivation & Background

- Slot Attention model groups input pixels into slots via iterative attention
- Learning follows a reconstruction objective without labels

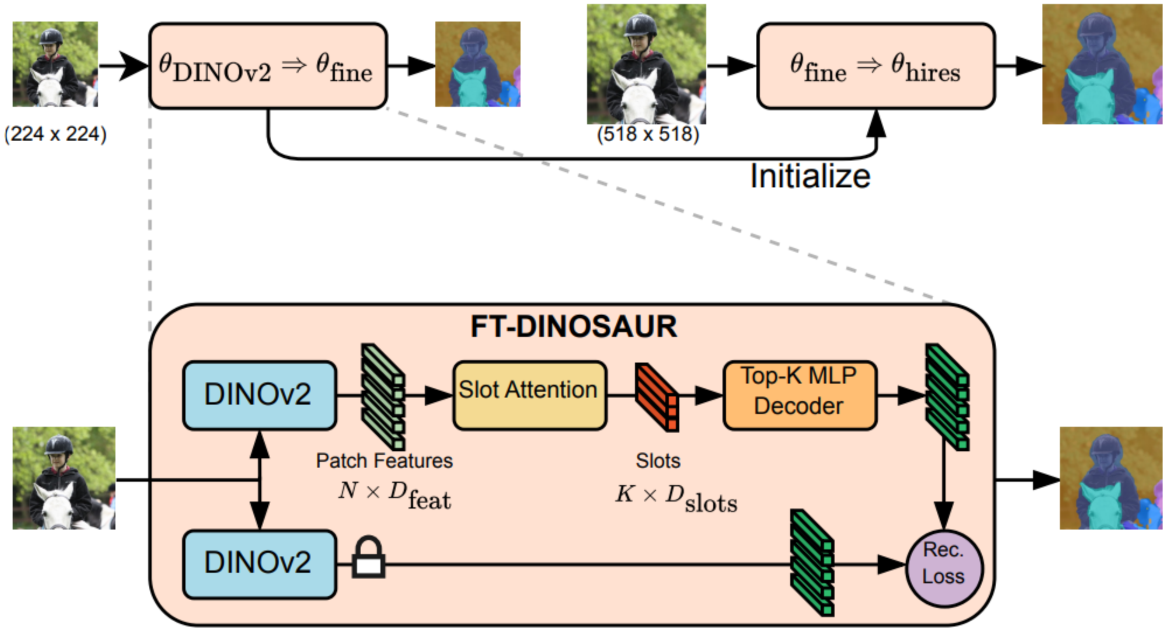


Vanilla slot attention module. Locatello, Francesco, et al., "Object-centric learning with slot attention." NeurIPS 2020.

Motivation & Background



DINOSAUR. Maximilian Seizer, et al., ICLR 2023.



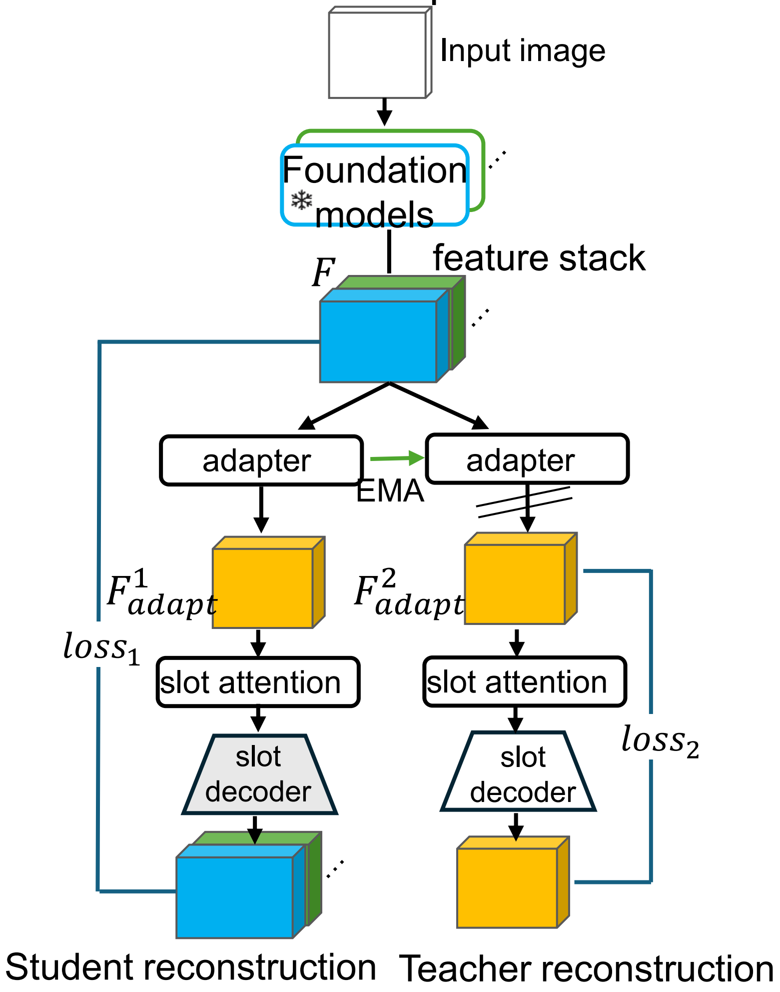
FT-DINOSAUR. Aniket Didolkar, et al, ICLR 2025.

- Slot Attention in real-world images with a foundation model
- Slot Attention can be used to fine-tune DINO-based foundation models

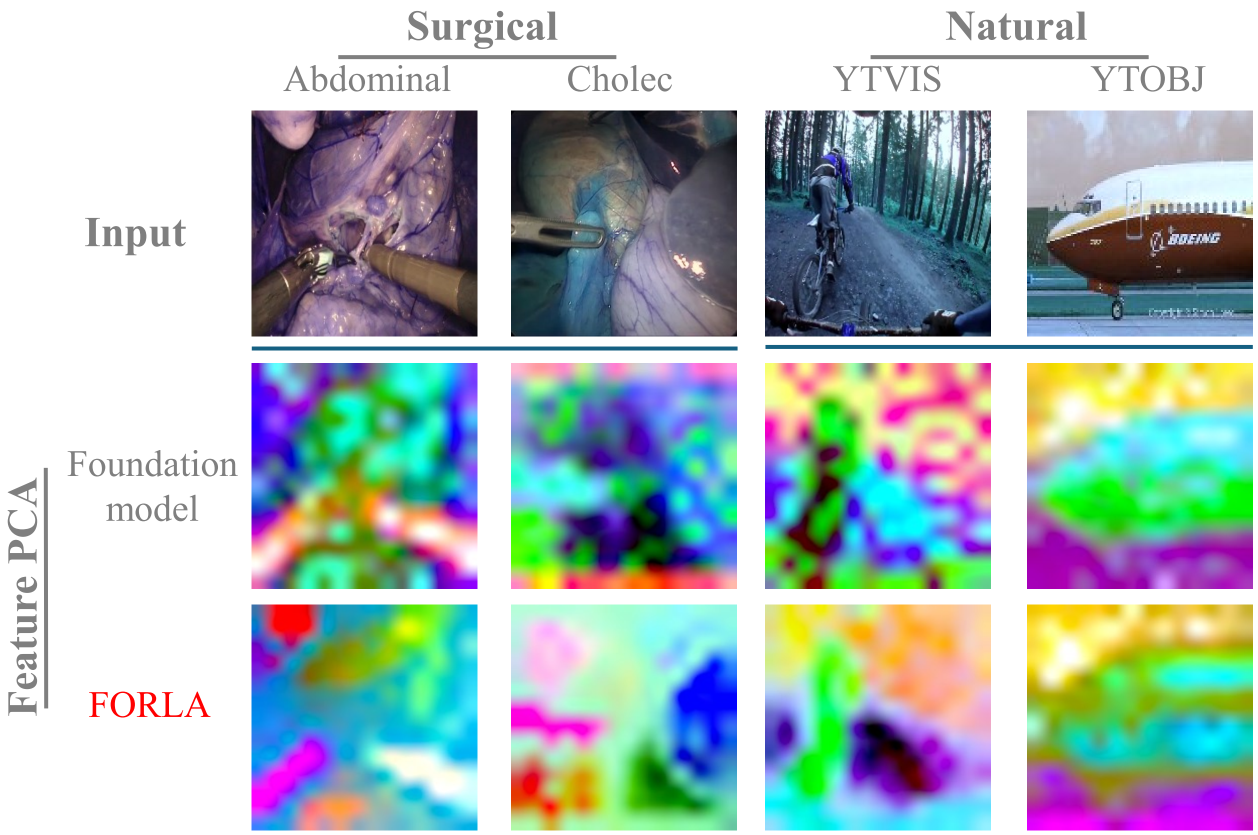
➢ Our key novelty: Bridging Federated Learning and Object-centric Representation Learning

Method

Architecture per client

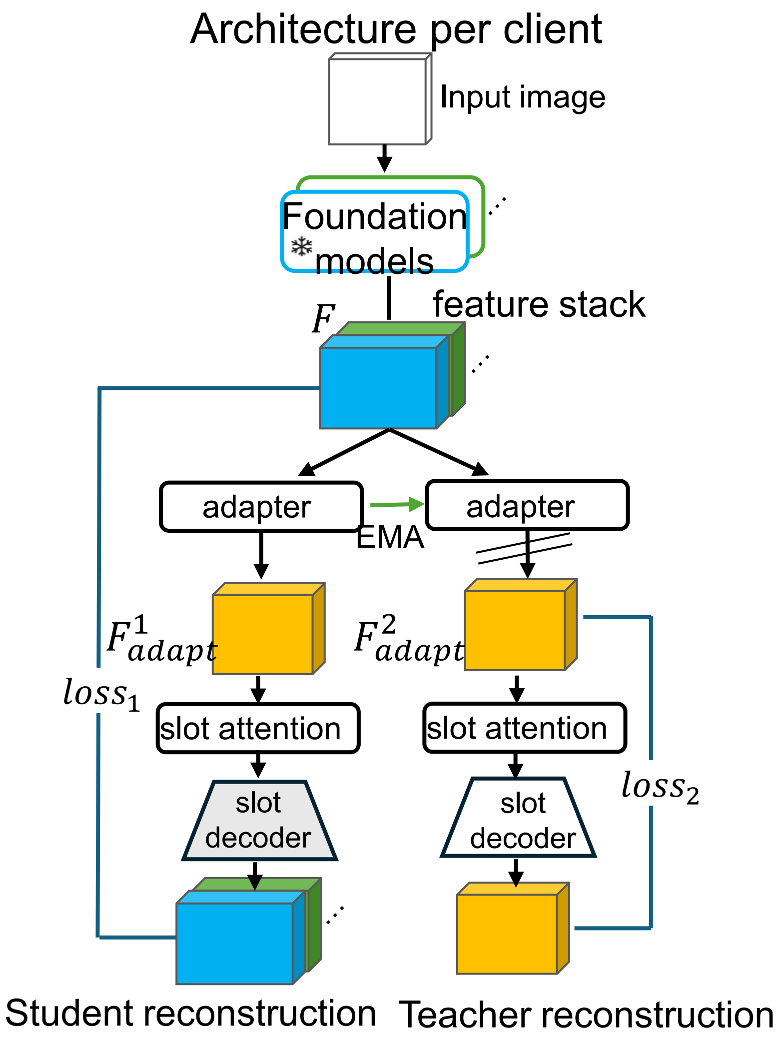


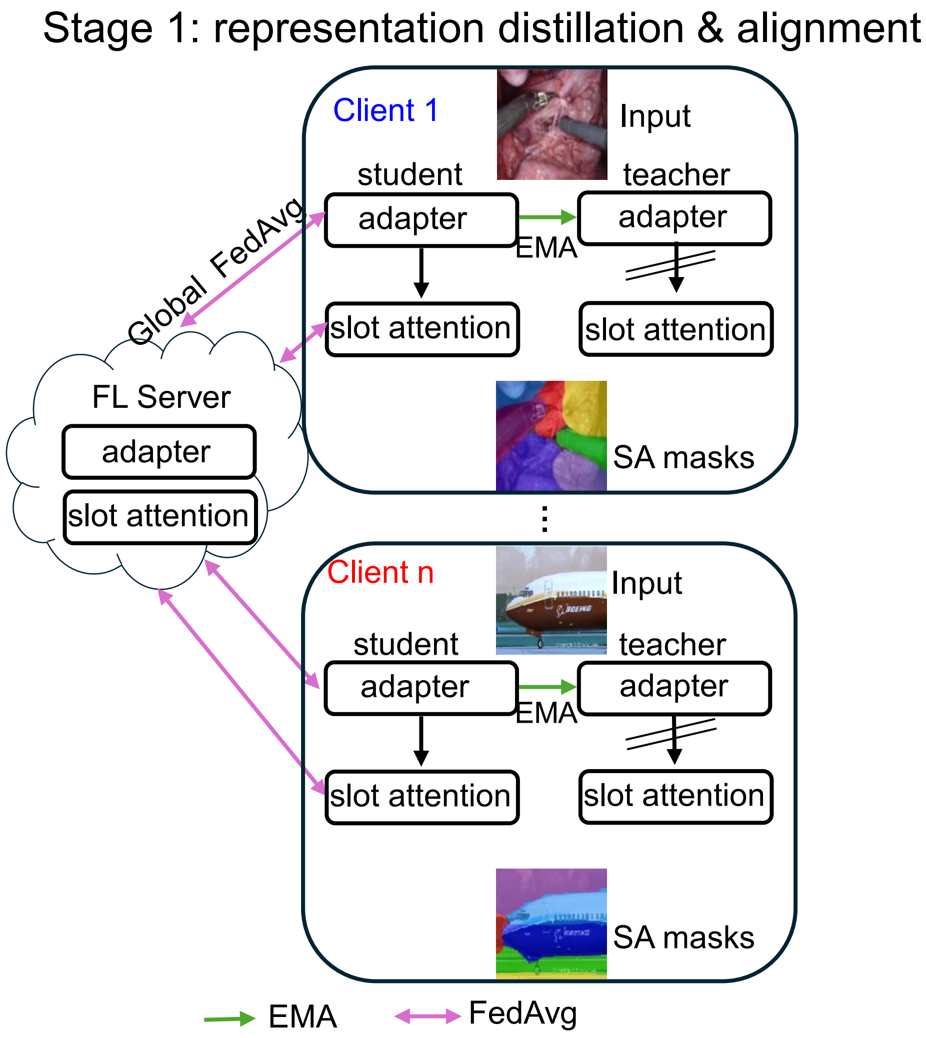
Feature adaptation results



- ➢ Observation: Slot attention can adapt the feature to better decompose images into different objects
- ▪ Inspired design: Another branch learns to reconstruct the adapted feature

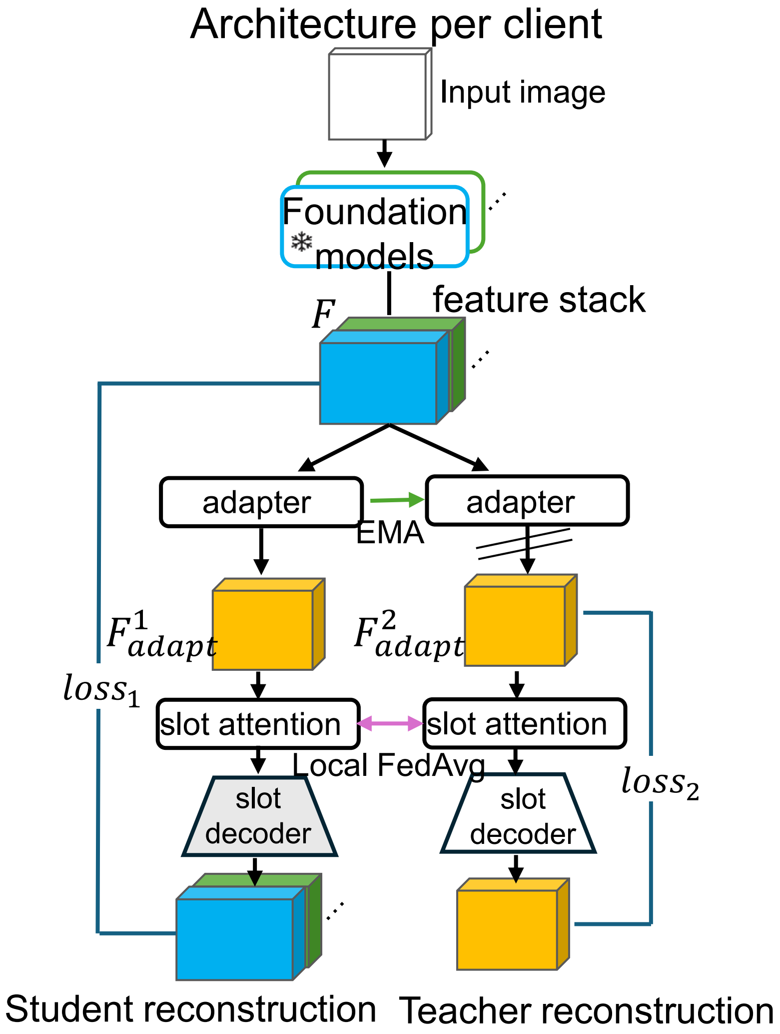
Method

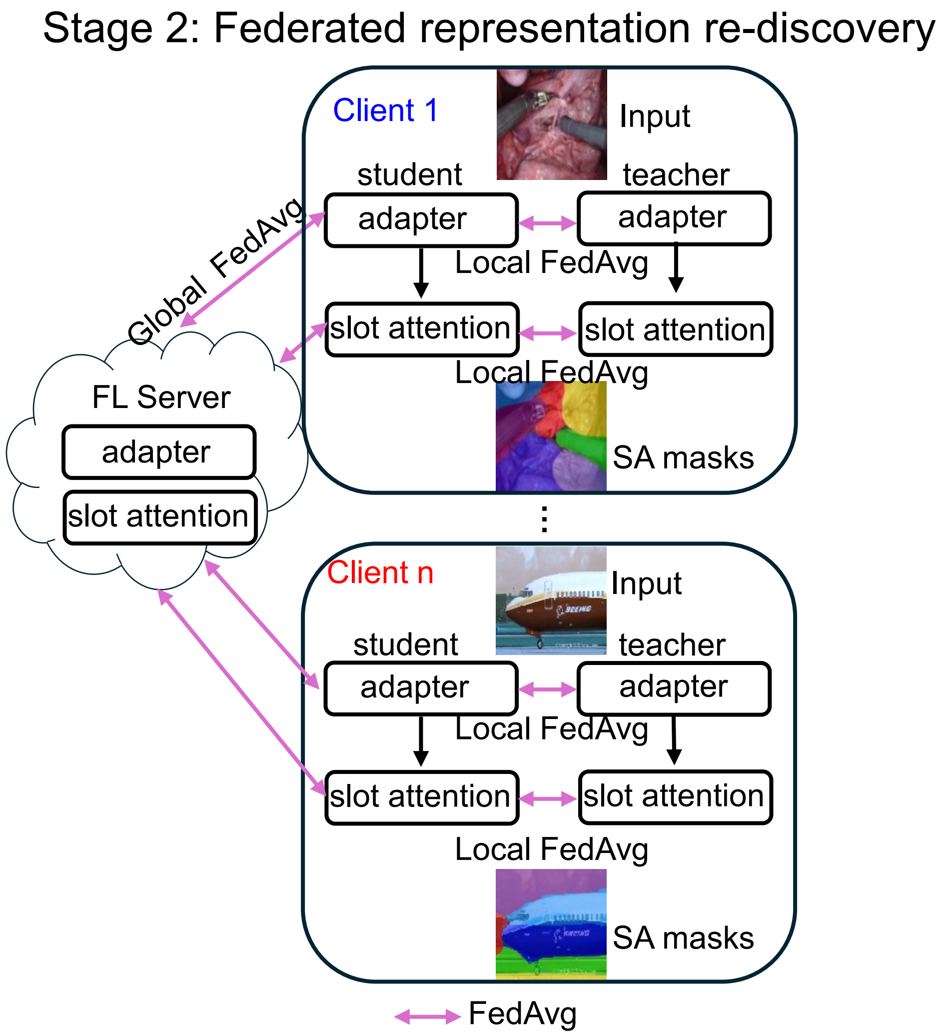




- A two-stage framework for federated object-centric representation learning

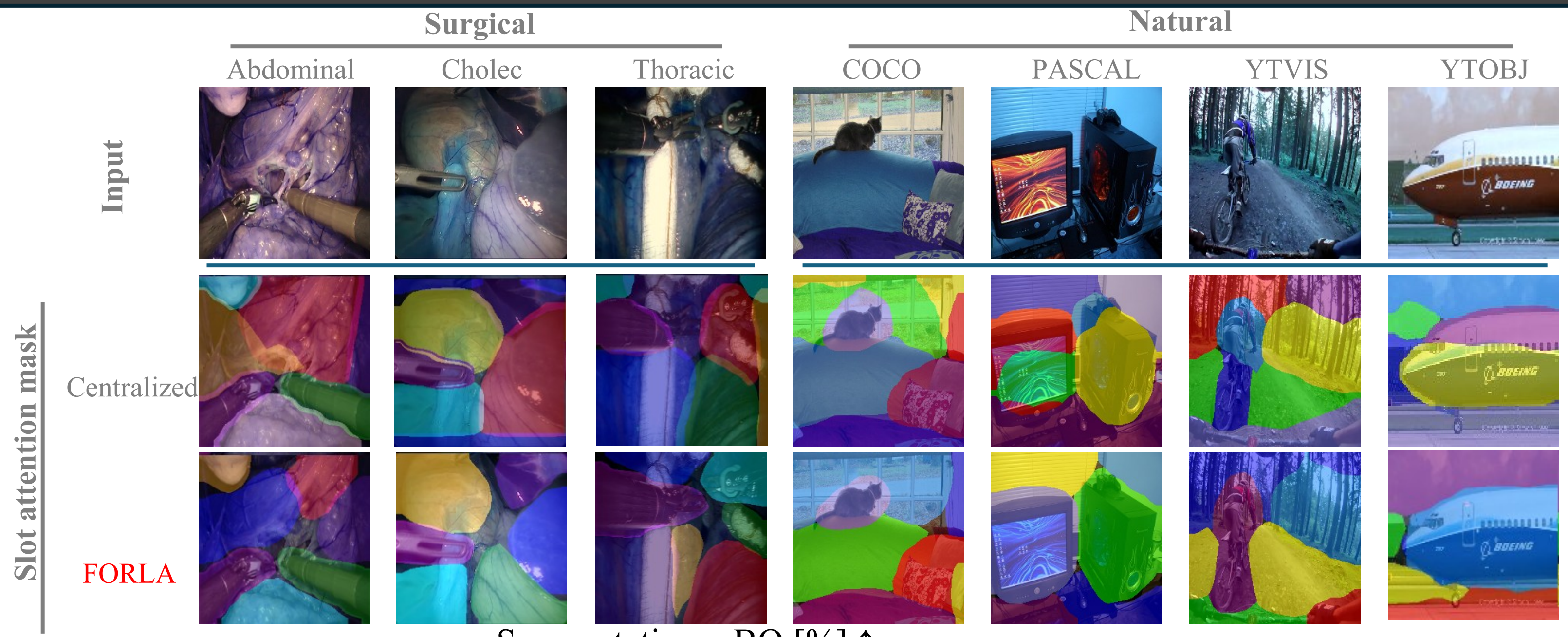
Method





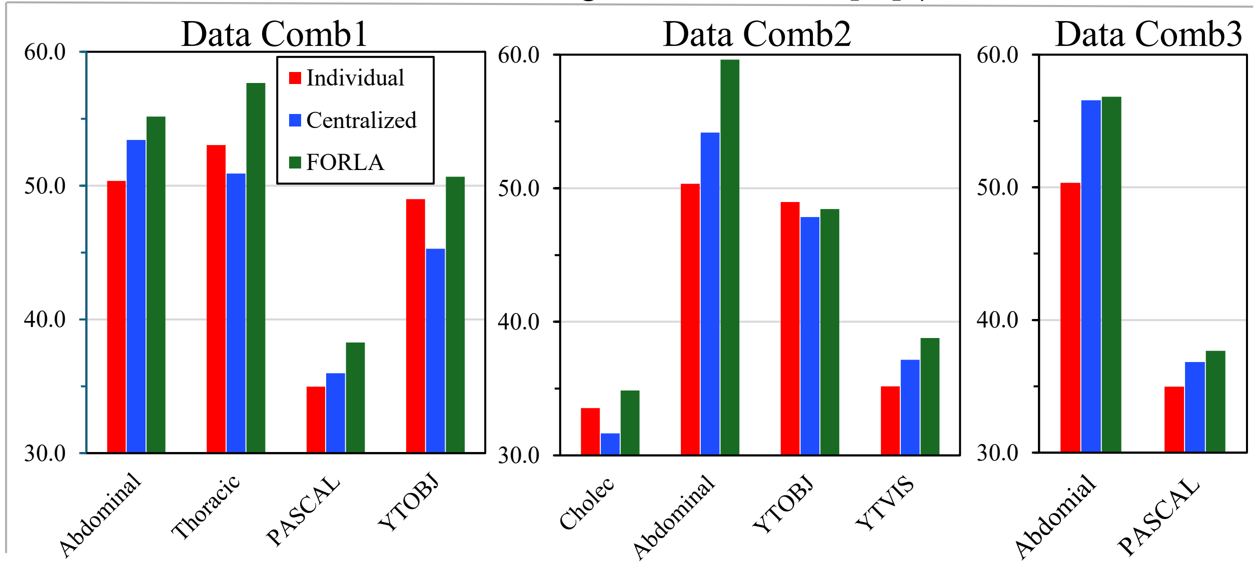
- A two-stage framework for federated object-centric representation learning

Results

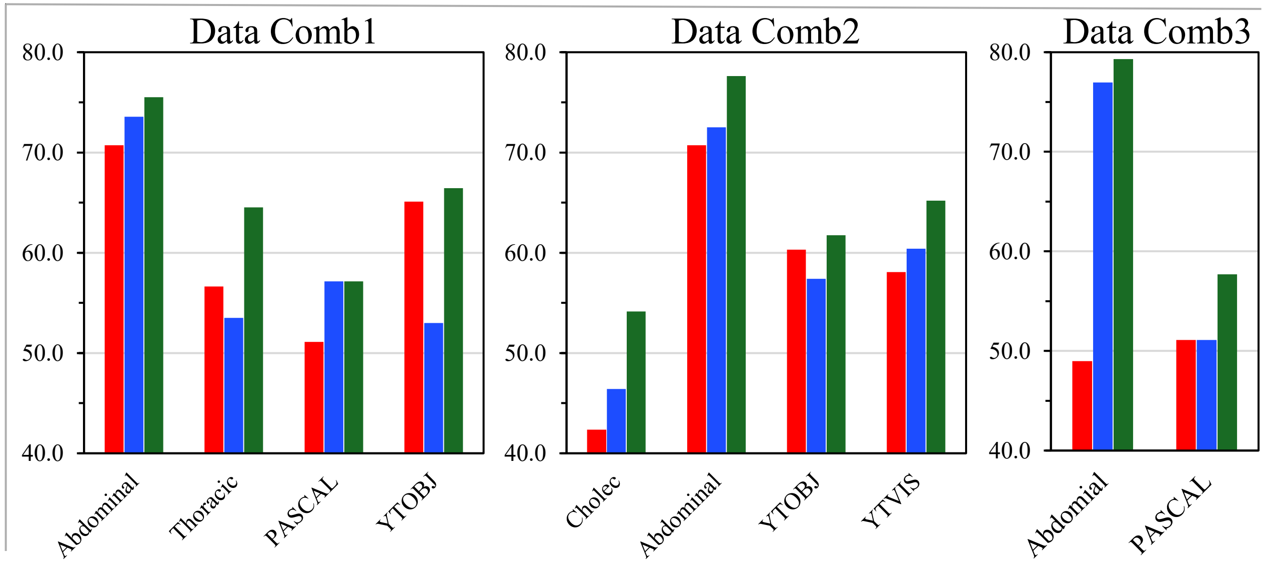


- FORLA outperforms centralized training
- Robust to different domain combinations

Segmentation mBO [%] ↑

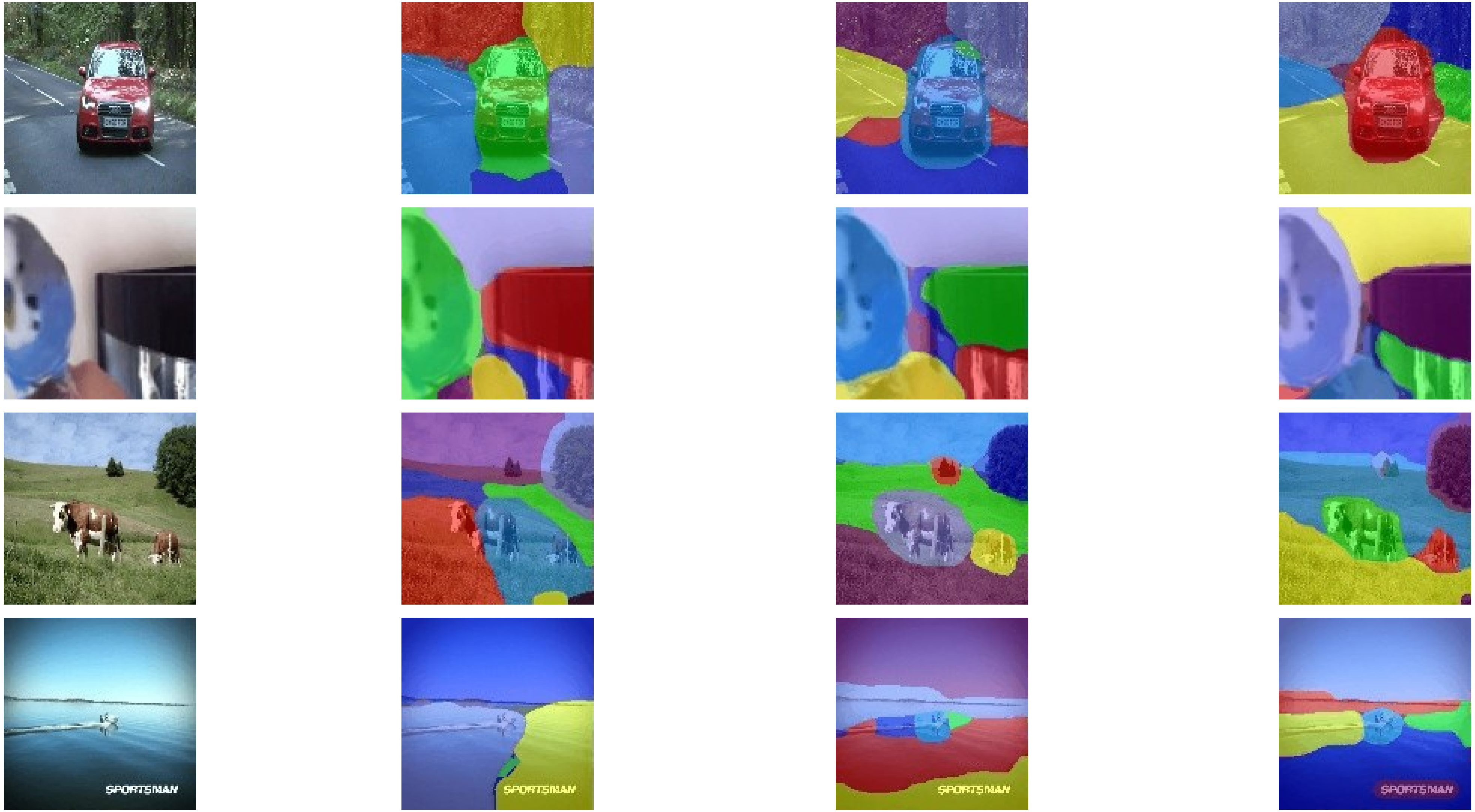


Localization CorLoc [%] ↑



Results

Input | SAM – SA adapted | DINO – SA adapted | FORLA



Conclusion & Future work

- Conclusion

- FORLA is the first to explore federated object-centric learning.
- Mixing all datasets for centralized unsupervised object discovery does not necessarily improve scalability.
- FL can also be a powerful algorithm for knowledge distillation (KD) through teacher–student collaboration.

- Future work

- Incorporate dynamic slot numbers
- Extend FORLA to video-based Slot Attention models

Check our project page: https://forla-research.github.io/