Reconfiguring Procedural Knowledge for Compositional Robot Skill Adaptation

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NEURAL INFORMATION PROCESSING SYSTEMS

SUNG KYUN KWAN UNIVERSITY (SKKU)

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MOTIVATION

What if robots become capable?

Behavior models now consolidate broad procedural knowledge at training time, leaving deployment to local adaptation.

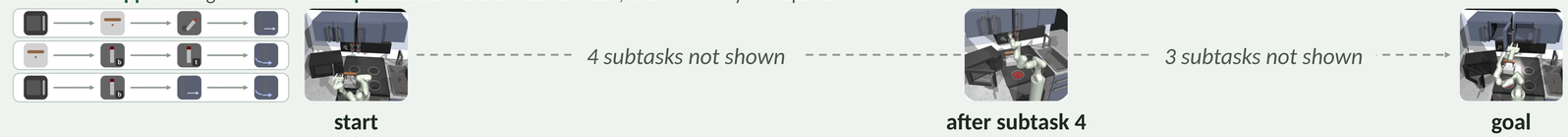
Constraints of real-world use	Learning: retrain weights	Reconfiguration: recompose knowledge
Fast, lightweight	✗	✓
Editable, inspectable	✗	✓
Sparse specification	–	?

Adaptation → Reconfiguration

SPARSE GOVERNING INFORMATION

Procedure support length 4

Task specification the evaluation task, shown in only 3 snapshots



Evaluation task
length 7,
unseen context combination

microwave · kettle · bottom burner · top burner · light switch · slide cabinet · hinge cabinet

Skill retrieval
scores each record independently

Structured skill graph
chains skills by endpoint similarity

both match

RecPo
reads each view, then composes partial homomorphisms

Similarity alone surfaces a look-alike record that does not realize the demanded subtask. ✗

One endpoint pair per skill mixes contexts, so the chained skill carries the wrong effect. ✗ ✓

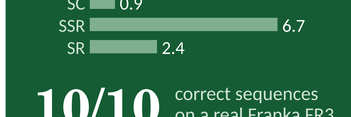
RecPo stores skill records task-agnostically and **composes them through views only when a task arrives.**

RESULTS

We propose RecPo, which reconfigures stored skills through multiple views.

It outperforms retrieval and structured skill graphs given **the same views**.

91.9% subtasks in order, over 196 settings



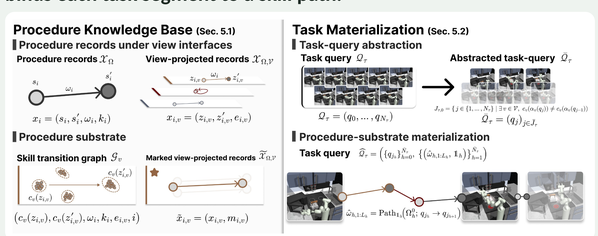
1.0 ms task inference time



10/10 correct sequences on a real Franka FR3

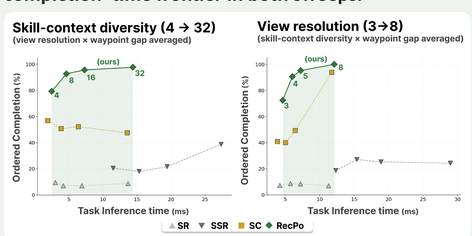
Store & materialize

Method RecPo stores records as per-view transition graphs and binds each task segment to a skill path.

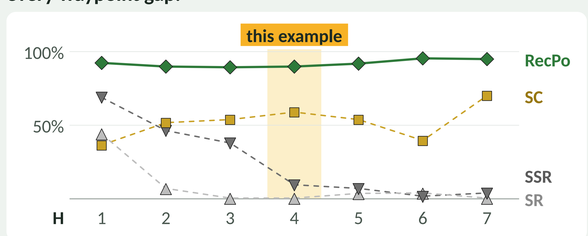


Sparse procedure support & task specification

Procedure support RecPo stays at the upper left of the completion–time frontier in both sweeps.



Task specification RecPo keeps 89–95% ordered completion at every waypoint gap.



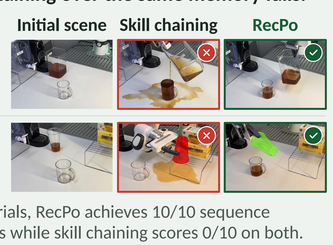
Real robot use case

Real world Local memory updates let RecPo succeed on a Franka FR3 where skill chaining over the same memory fails.

Memory update

Extend the views
+ target-fill view
+ stop record

Append a record
+ pour record
collected in another scene



Over ten record-appending trials, RecPo achieves 10/10 sequence success and 7/10 task success while skill chaining scores 0/10 on both.