SCALING MULTI-AGENT REINFORCEMENT LEARNING WITH SELECTIVE PARAMETER SHARING

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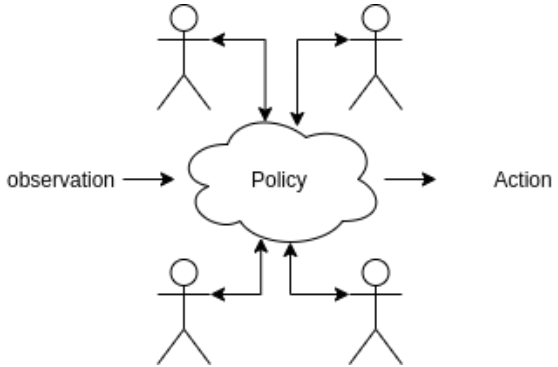
SCALING MARL TO MANY AGENTS

Scaling MARL to many agents?

Typical numbers in works like MADDPG range from 2 to 10 agents (e.g. centralised critics = large inputs scaling with the number of agents).

PARAMETER SHARING

Parameter sharing: agents share parameters in their policy or critic networks.



In the literature, parameter sharing is typically applied indiscriminately across all agents, which we call *naive.*

PARAMETER SHARING

Can *naive* parameter sharing work when applied across heterogeneous agents?

PARAMETER SHARING

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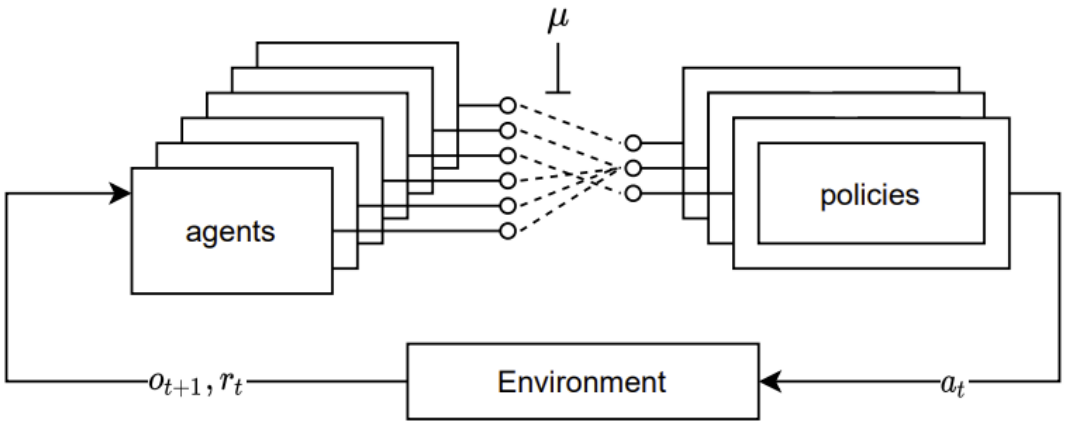
… not really.

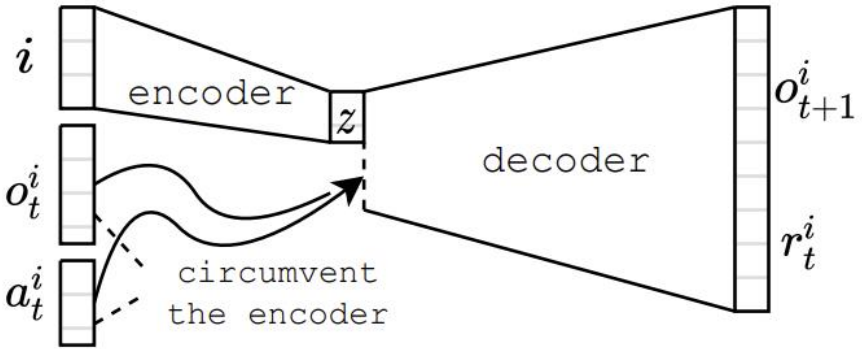
SELECTIVE PARAMETER SHARING

But we can apply it selectively.

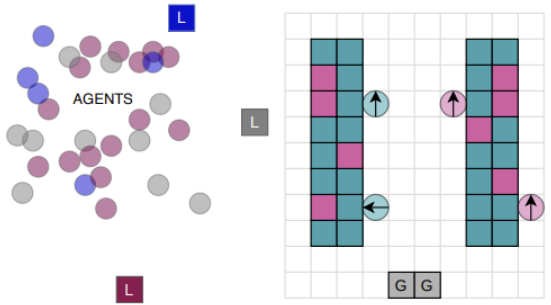


SELECTIVE PARAMETER SHARING

We identify agents with similar reward and observation transition functions and have them share parameters.

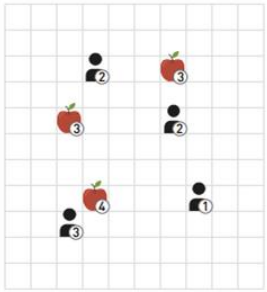


EXPERIMENTS: ENVIRONMENTS



(a) Blind-Particle Spread

(b) Coloured Multi-Robot Warehouse



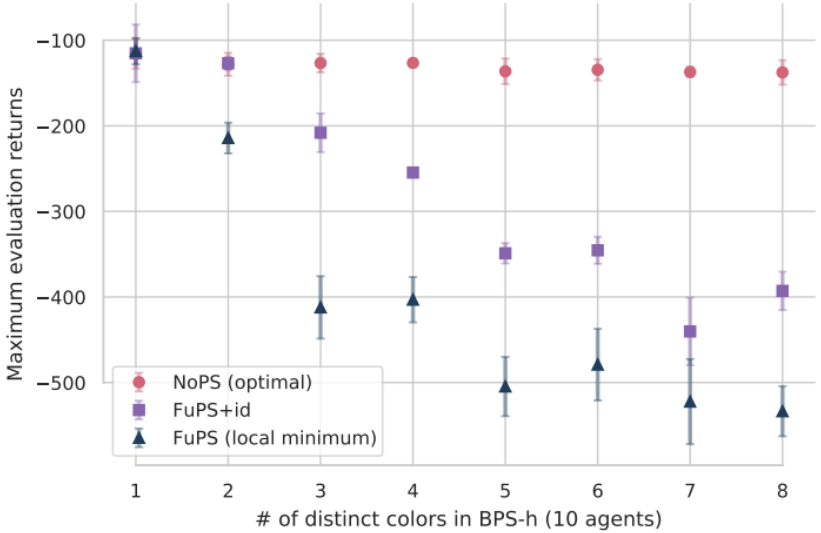
(c) Level-based Foraging

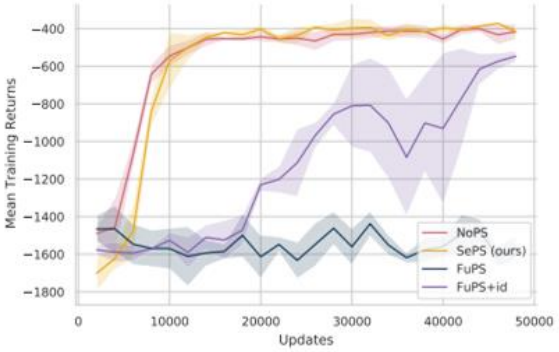
(d) SMAC

	# Agents	# Types	Type Distribution
BPS (1)	15	3	5–5–5
BPS (2)	30	3	10–10–10
BPS (3)	30	5	6–6–6–6–6
BPS (4)	30	5	2–2–2–15–9
BPS-h (1)	15	3†	5–5–5
BPS-h (2)	30	5†	6–6–6–6–6
BPS-h (3)	200	4†	50–50–50–50
C-RWARE (1)	4	2‡	2–2
C-RWARE (2)	8	2‡	4–4
C-RWARE (3)	16	2‡	8–8
LBF	12	3	4–4–4–4
MMM2	10	3§	7–2–1

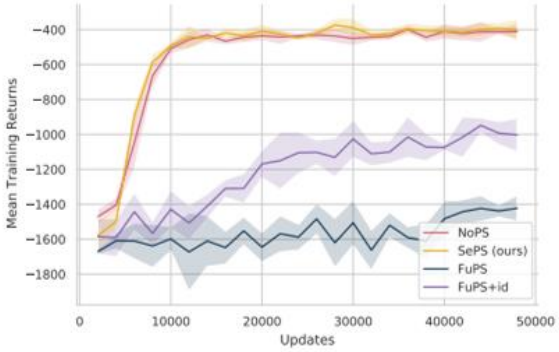
EXPERIMENTS: RESULTS

Can naive parameter sharing work?

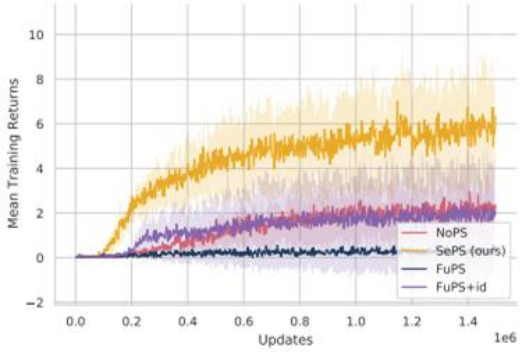




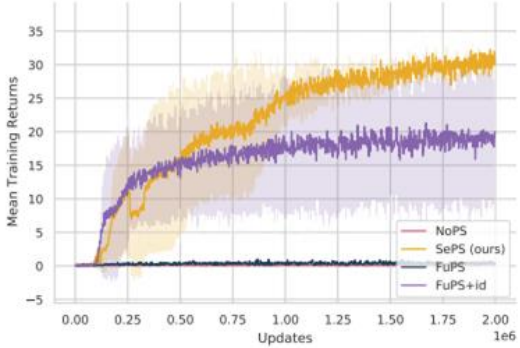
(a) BPS (3)



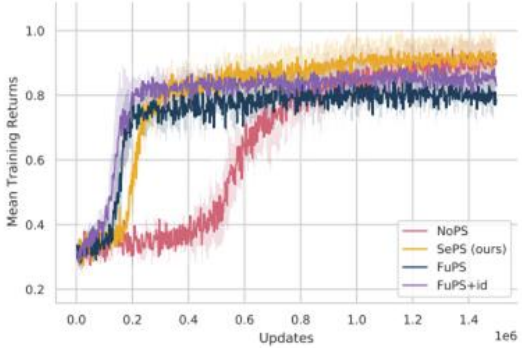
(b) BPS-h (2)



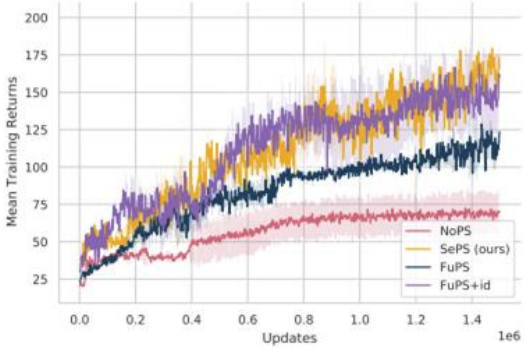
(c) C-RWARE (1)



(d) C-RWARE (3)

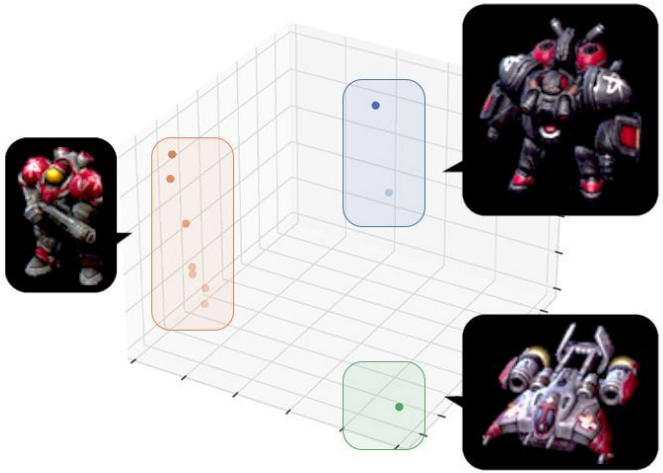


(e) LBF



(f) SMAC (MMM2)

VISUALIZING THE EMBEDDING SPACE

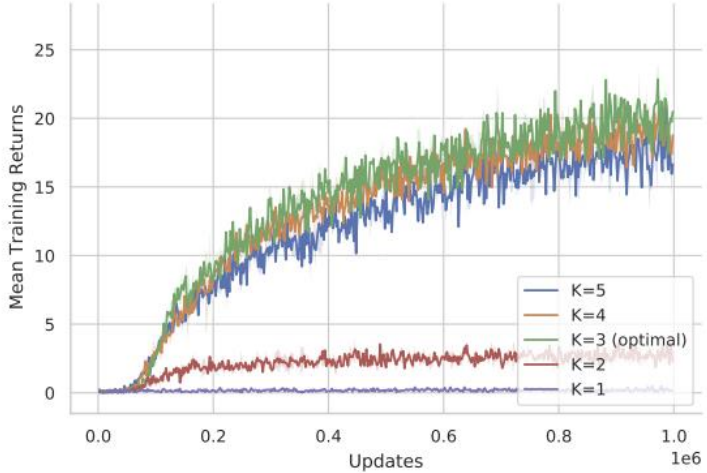


HOW DO WE DECIDE THE NUMBER OF CLUSTERS?

1. Manually
2. As a hyperparameter
3. Well-studied heuristics (e.g. DB-index)

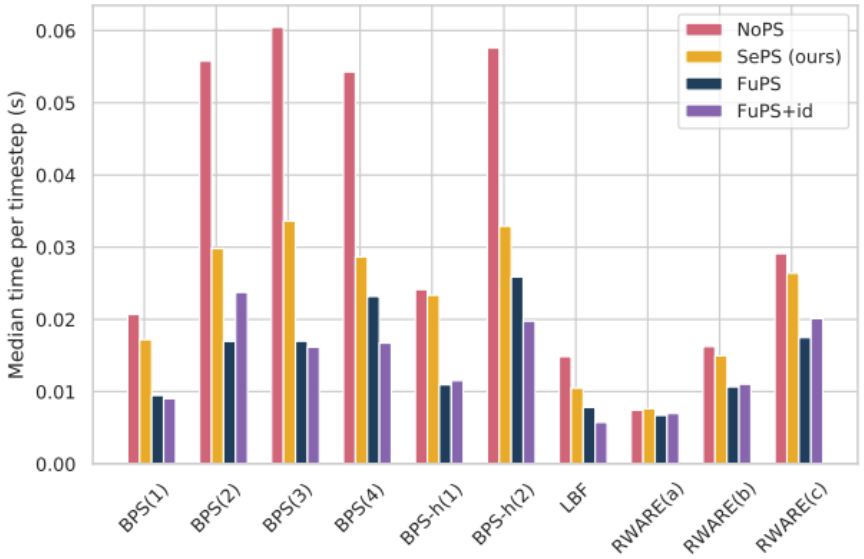
…

But does it matter?



COMPUTATIONAL BENEFITS

of parameters scale with the number of clusters (not the number of agents).



Scaling Multi-Agent Reinforcement Learning with Selective Parameter Sharing

https://arxiv.org/abs/2102.07475

Contributions:

1. We demonstrate the impact of parameter sharing methods (converged returns and training speed)
2. We propose a method to automatically identify agents that benefit from parameter sharing.

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