

Low-Rank Modular Reinforcement Learning via Muscle Synergy

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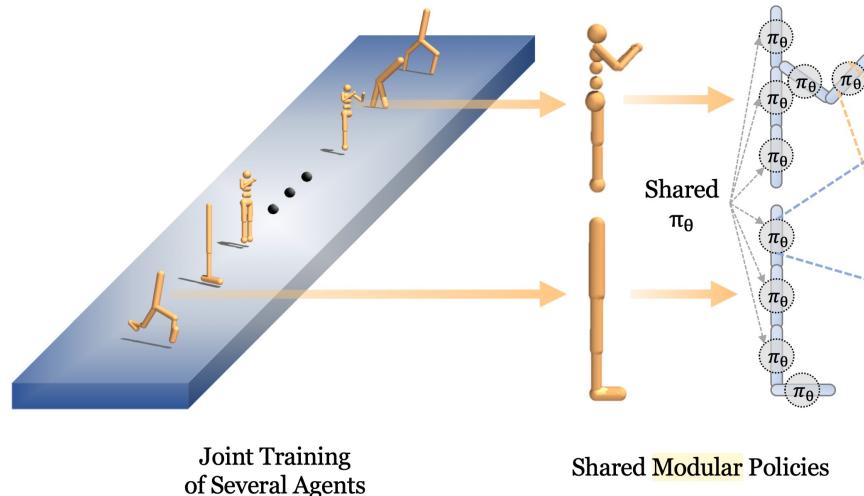
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Modular RL

- To control robots with different number of actuators, previous works proposed an elegant solution: Modular RL.
 - The control policy is decentralized, and each actuator is controlled by a shared local policy.

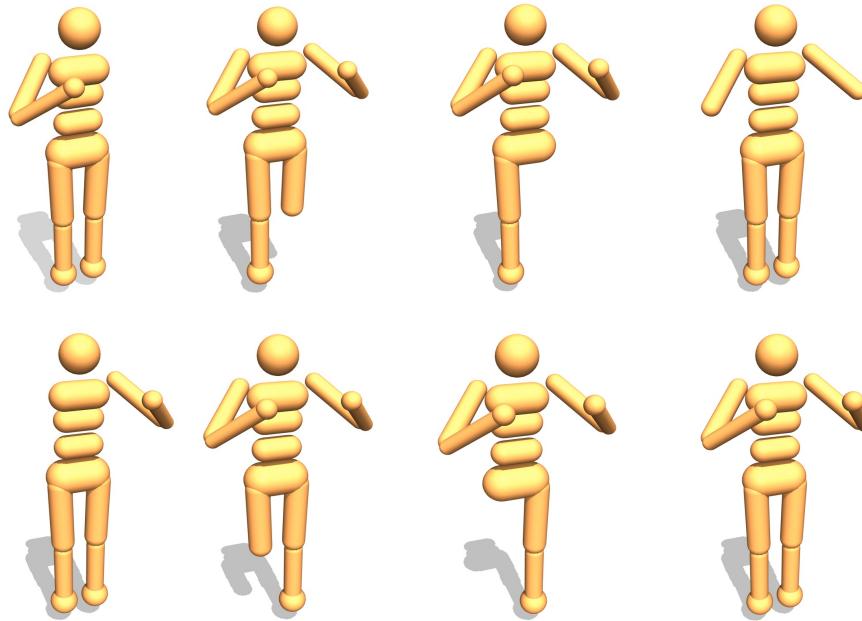


[1] One Policy to Control Them All: Shared Modular Policies for Agent-Agnostic Control



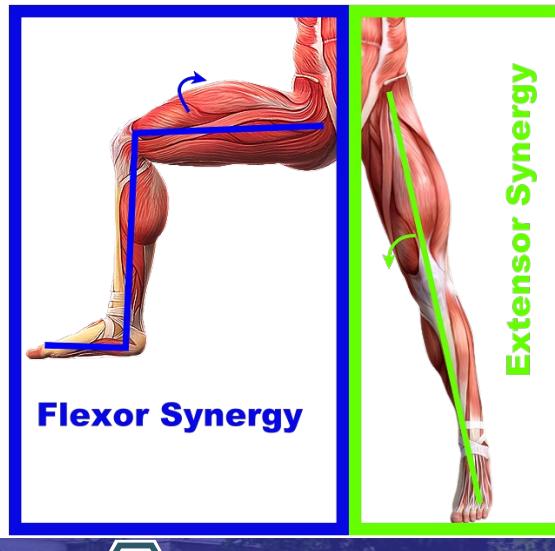
Limitations of Modular RL

- However, Modular RL is still struggled with robots with many joints.
 - The large degree of control freedom presents a major challenge for learning control policies.



Inspirations from Muscle Synergy

- Why humans can control hundreds of muscles?
 - A human central nervous system decreases the control complexity by activating muscles in groups.
 - **Muscle synergy** is the coordination of muscles that are activated in synchrony.

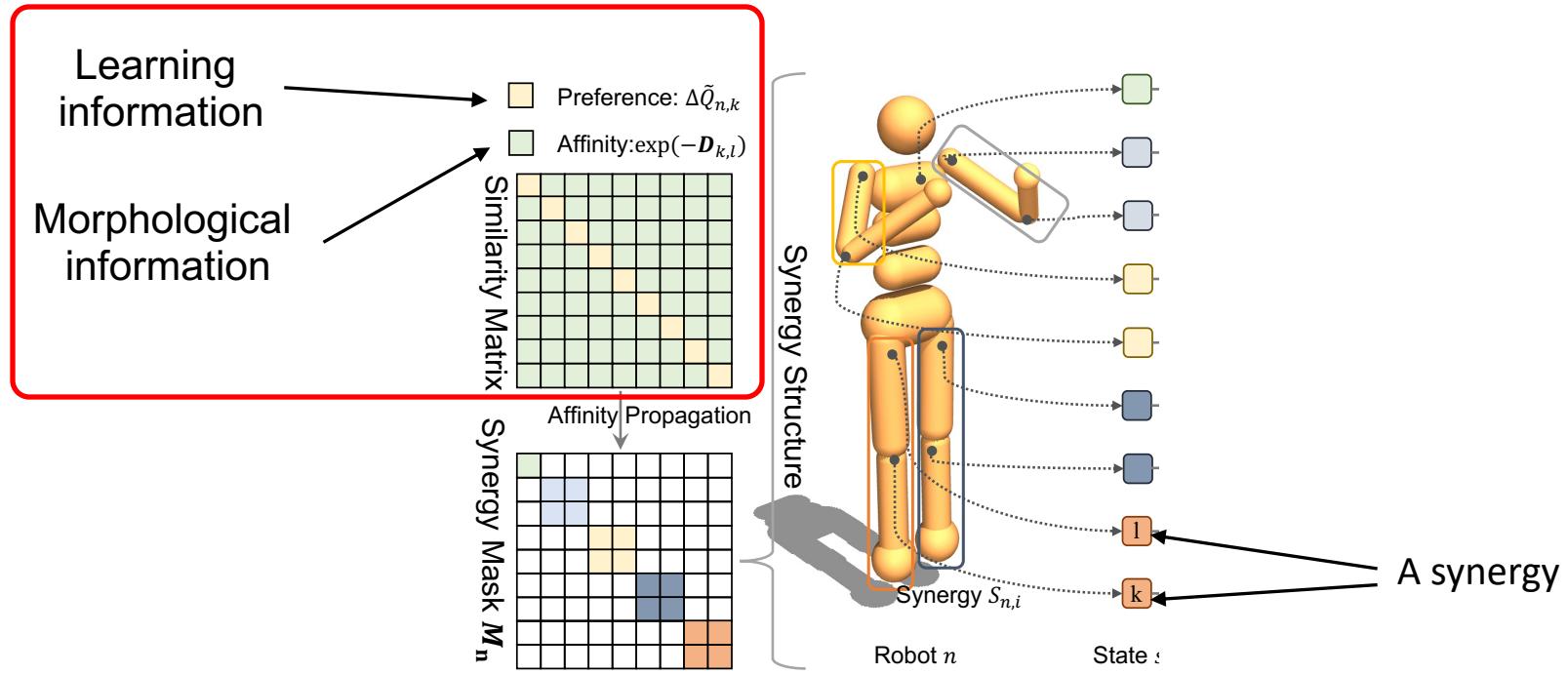


Incorporate Synergy into Robot Control

- Can we incorporate the idea of muscle synergy into robot control?
- Challenges
 - How to discover the synergy structures of different robots.
 - How to exploit the learned synergy structures.
- SOLAR: Synergy-Oriented LeARning framework

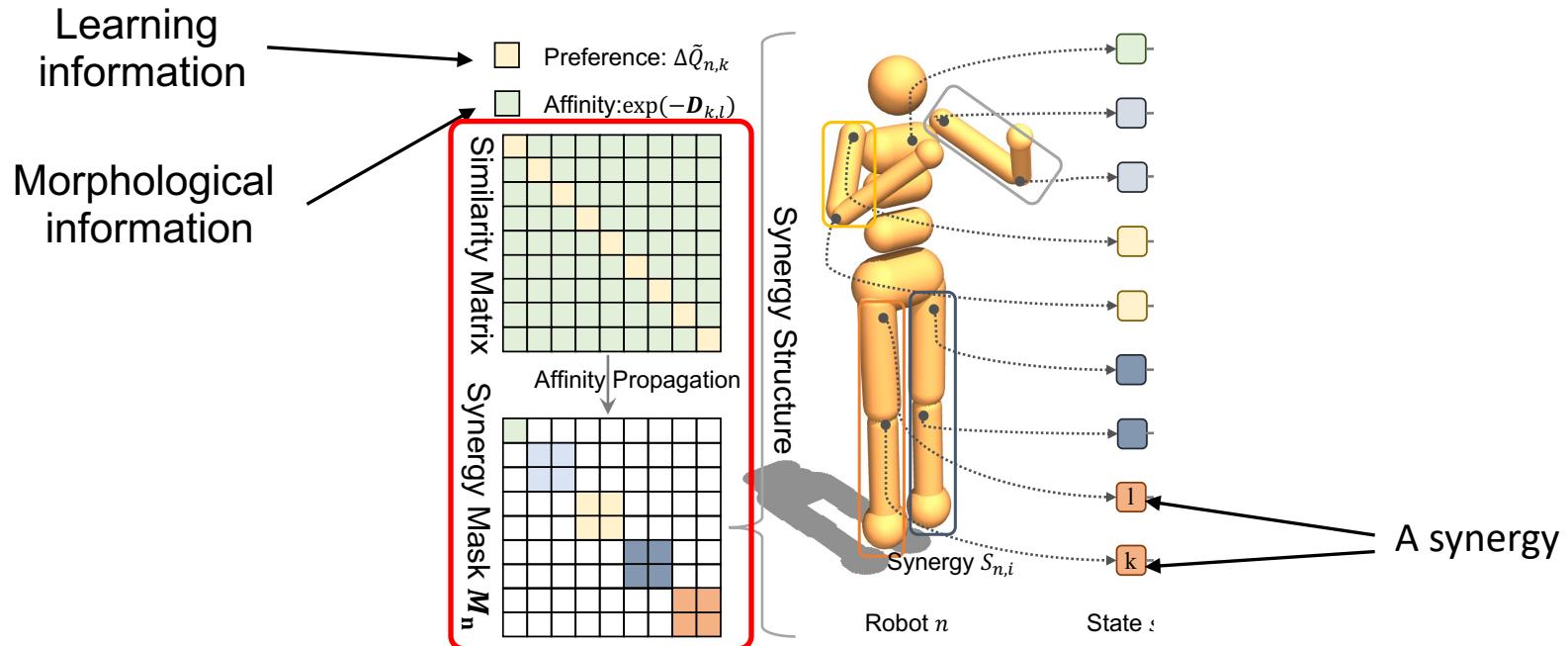
Discover Synergy Structure

- An unsupervised learning method



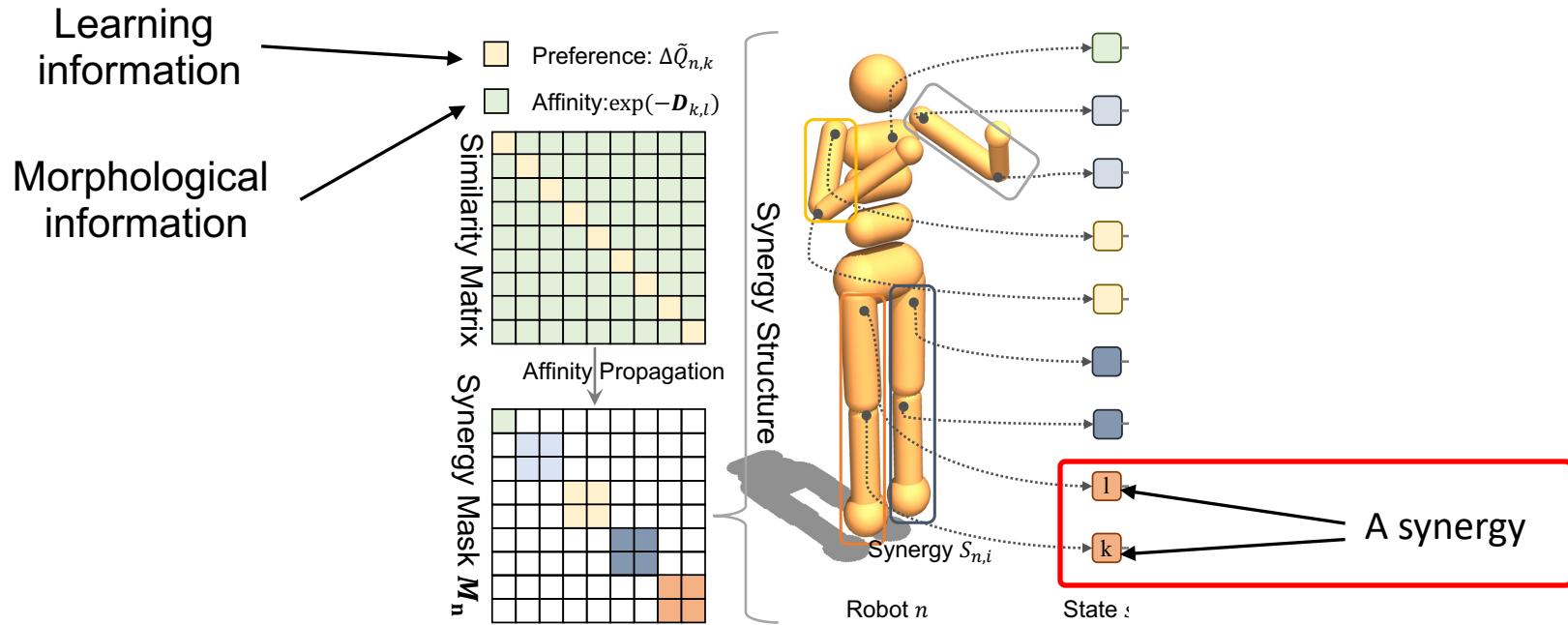
Discover Synergy Structure

- An unsupervised learning method



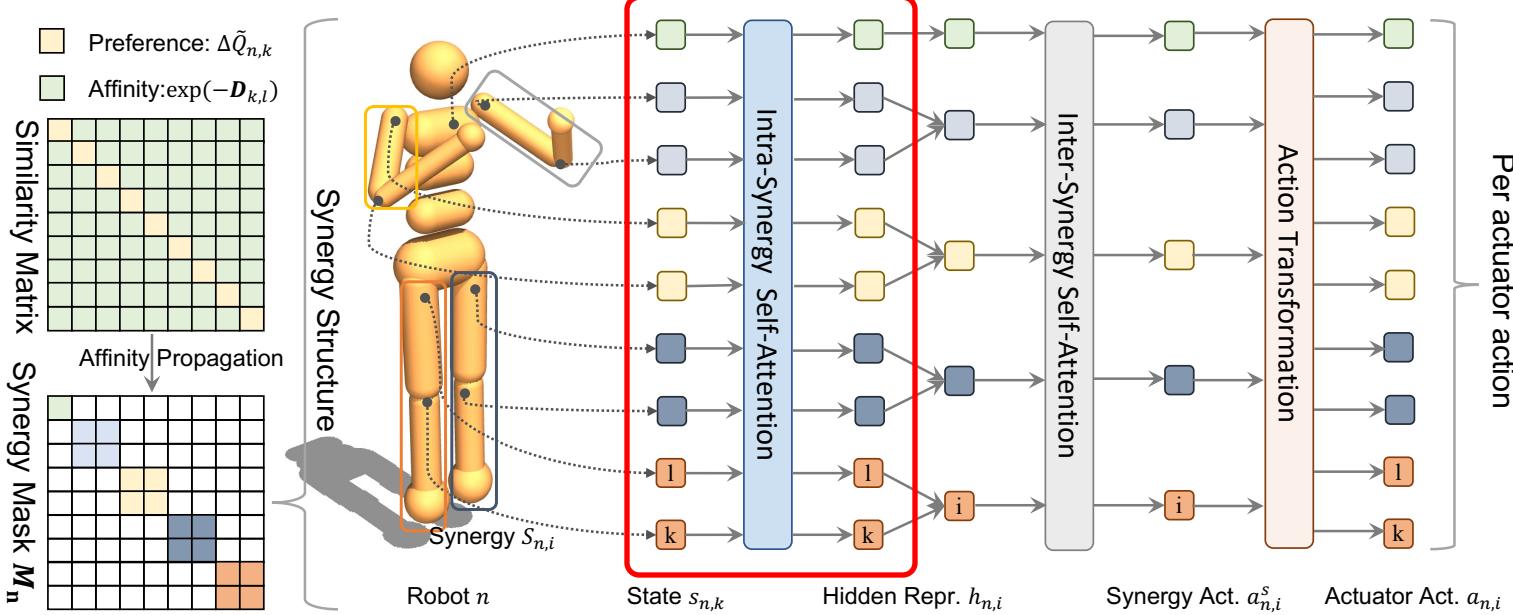
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- An unsupervised learning method



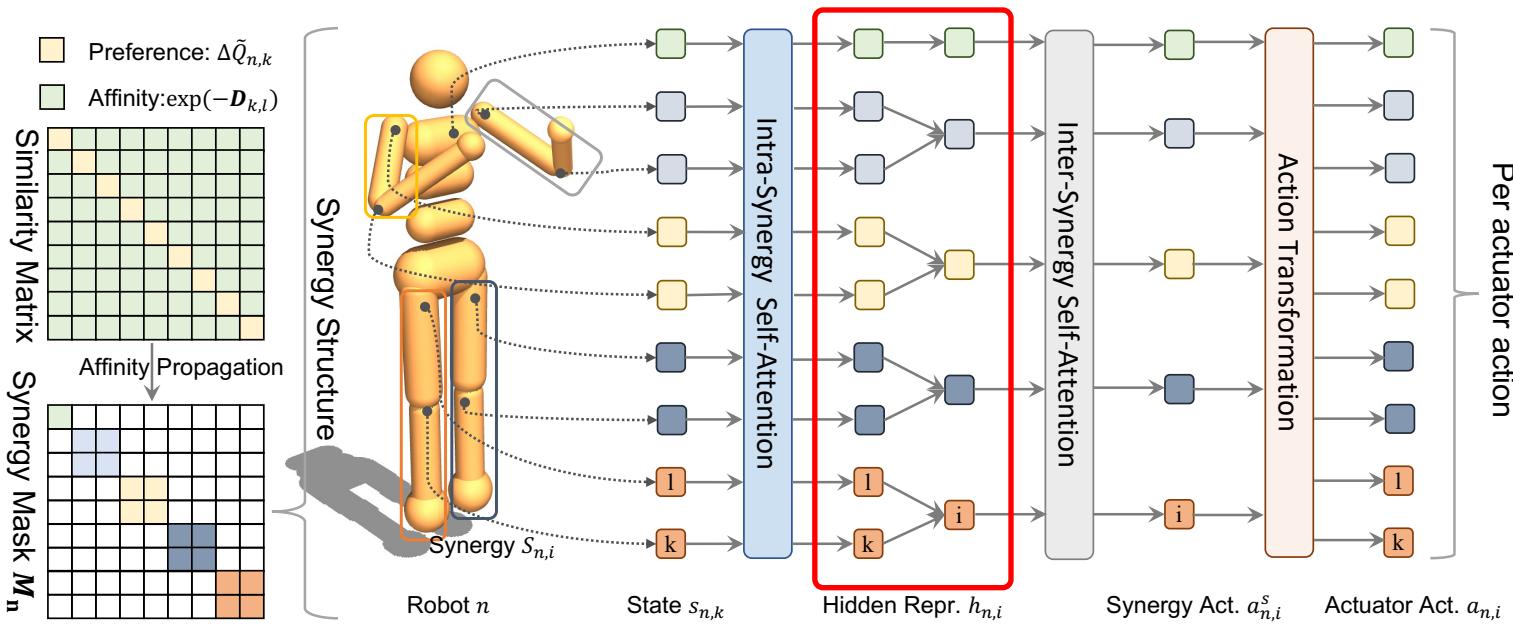
Learn Synergy-Aware Policy

■ Synergy-Aware Actor-Critic



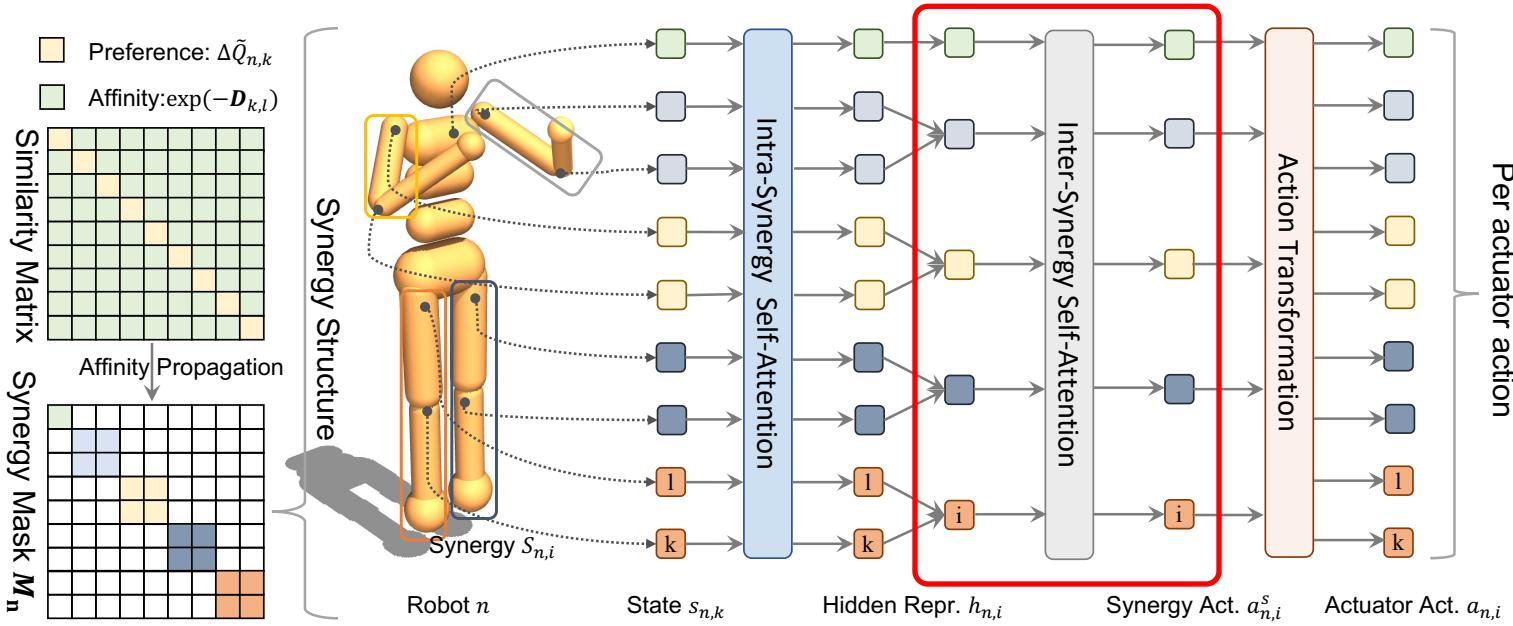
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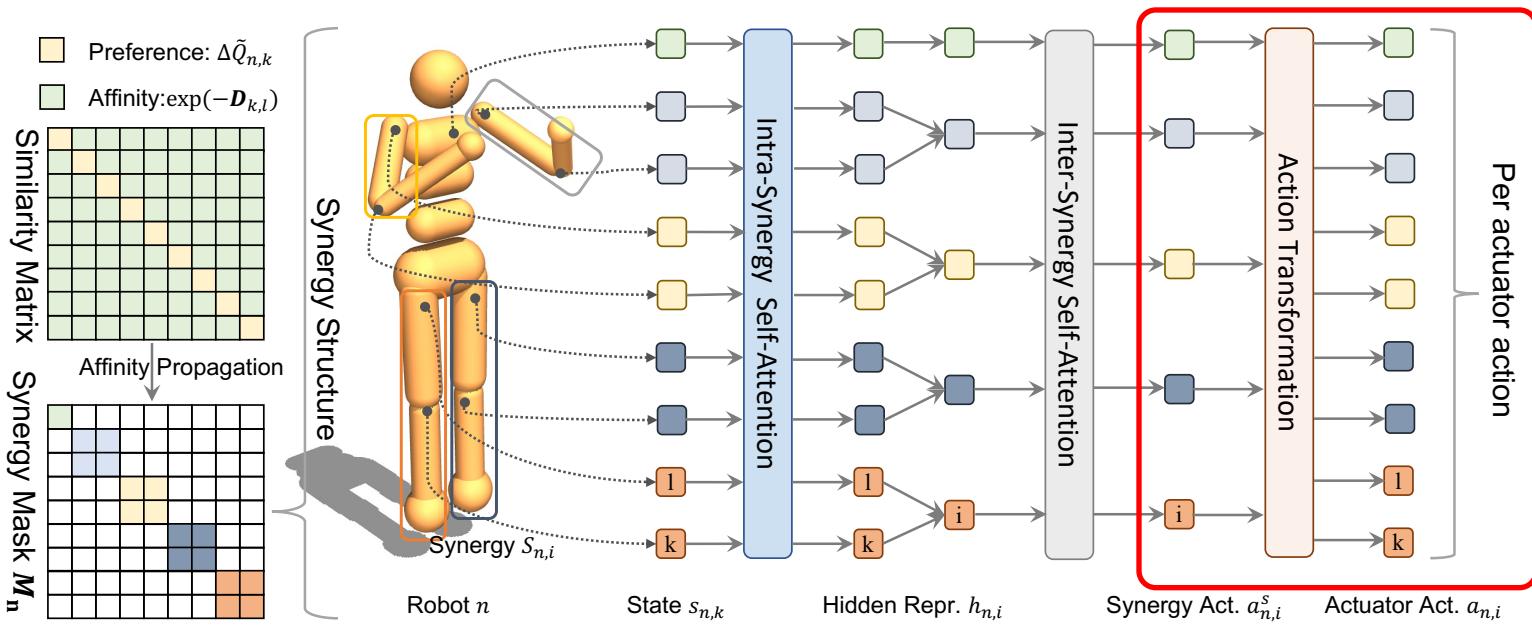
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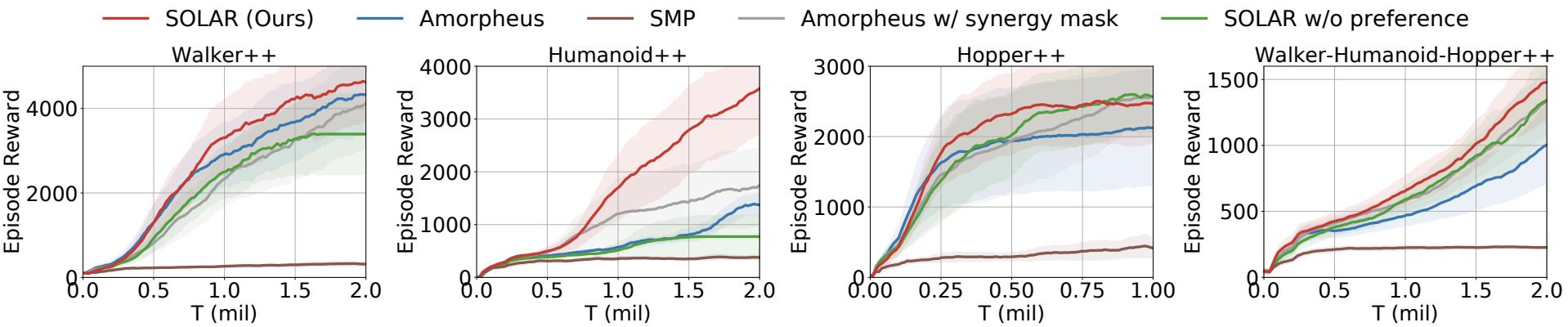
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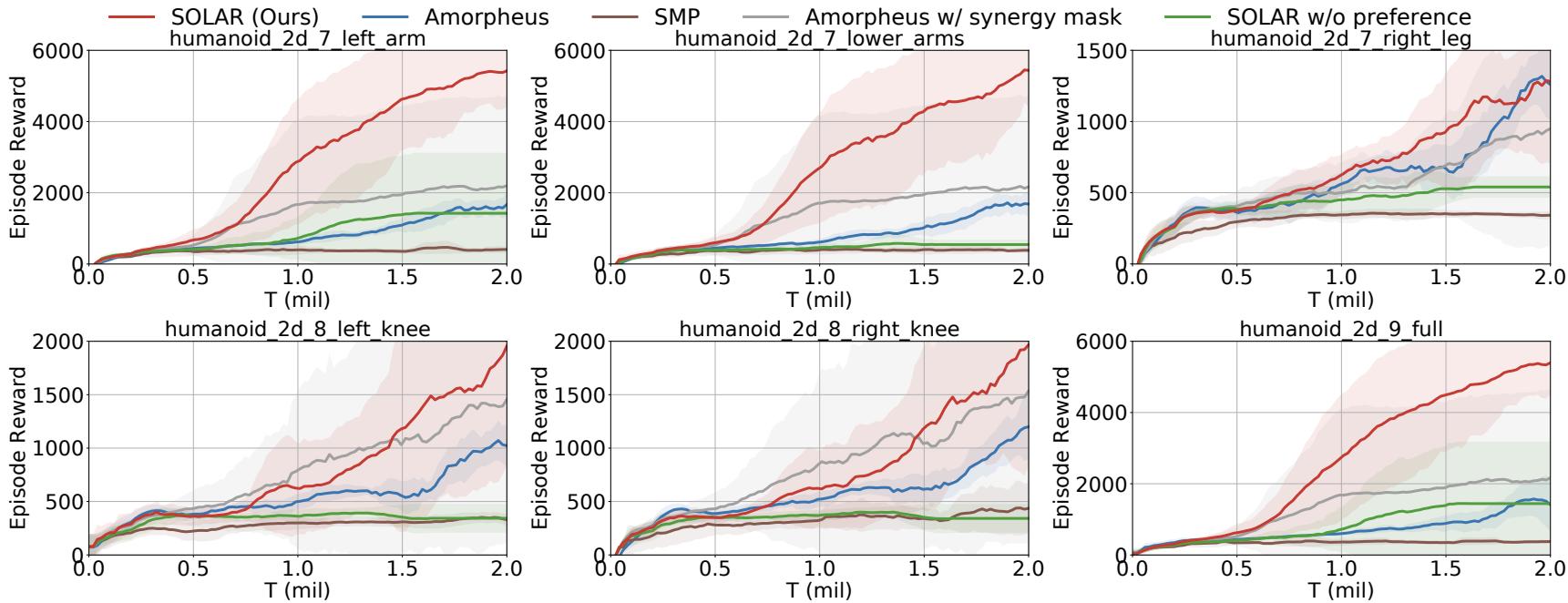
Multi-Task Performance

- Our method **SOLAR** outperforms the previous state-of-the-art algorithms.



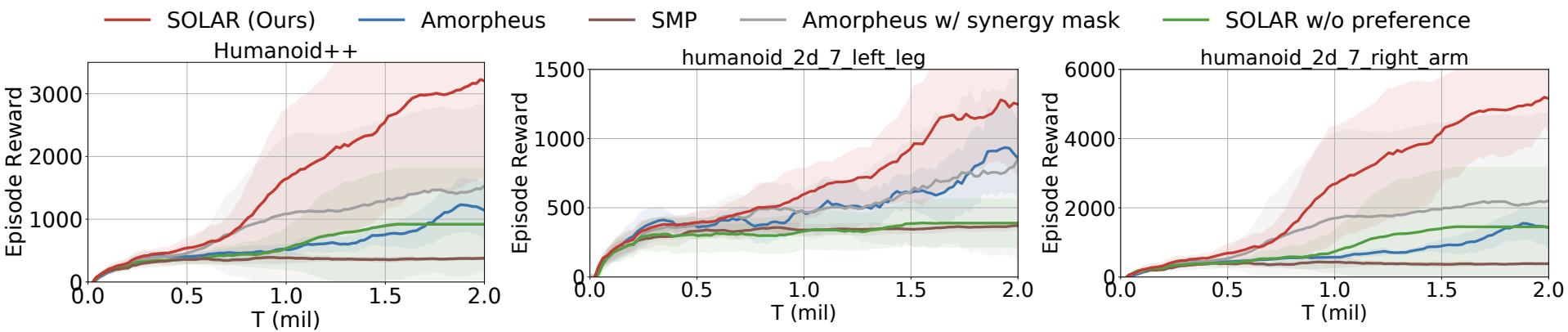
Multi-Task Performance

- Our method **SOLAR** is especially effective in Humanoids
 - They have the maximum number of joints among the tested settings.



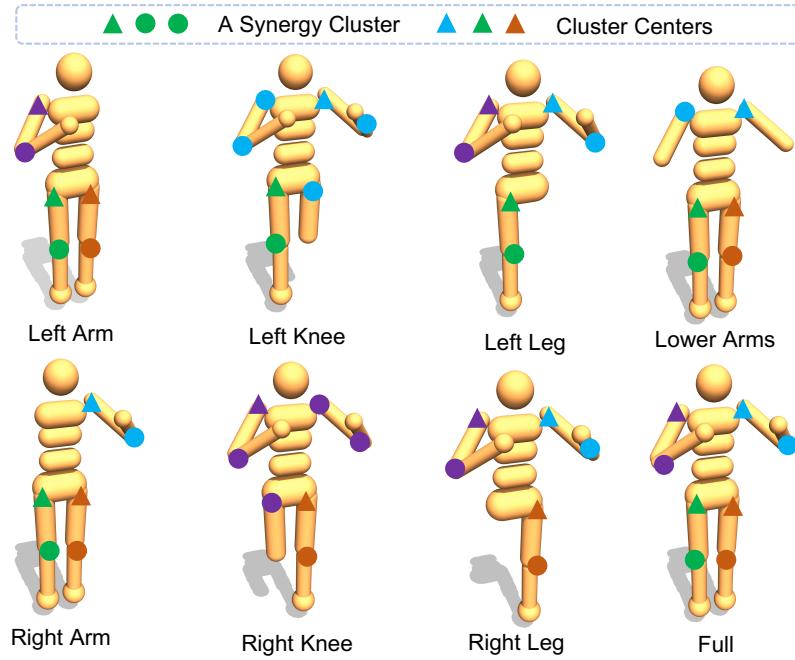
Zero-Shot Generalization

- Our method **SOLAR** also has zero-shot generalizations in some tasks.



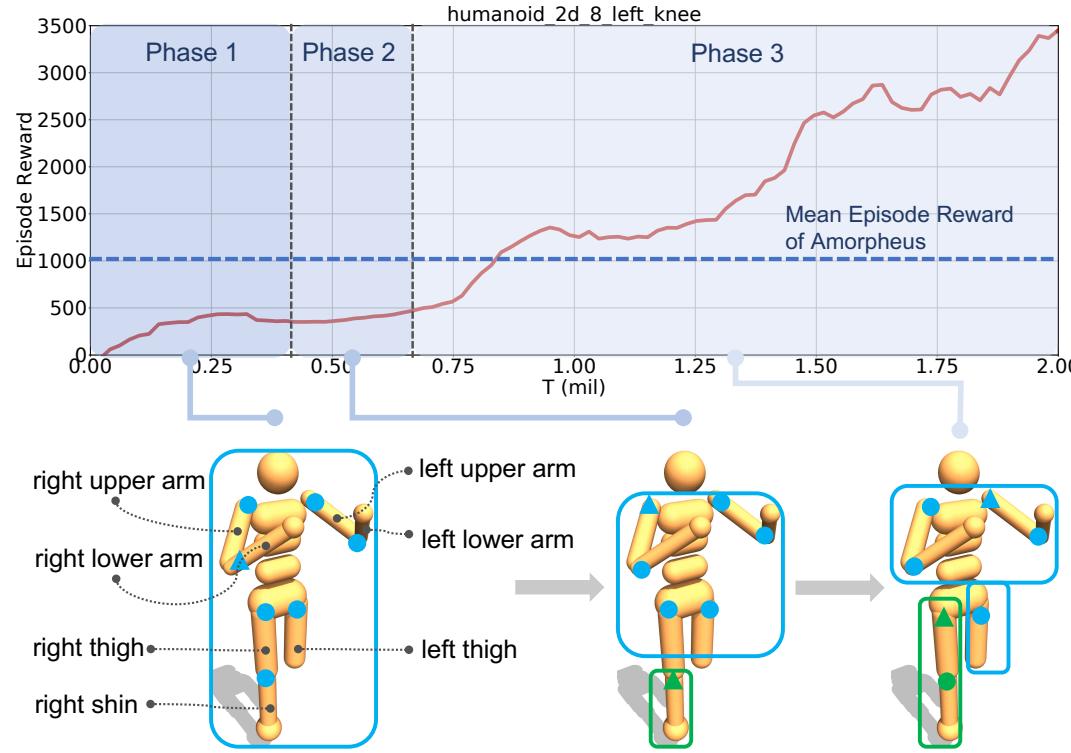
Analysis of Synergy

- Visualization of the synergy clusters learned by SOLAR



Analysis of Synergy

- Visualization of the evolutionary process of synergy clusters.





Thanks for your listening



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