On the Sensory Commutativity of Action Sequences for Embodied Agents

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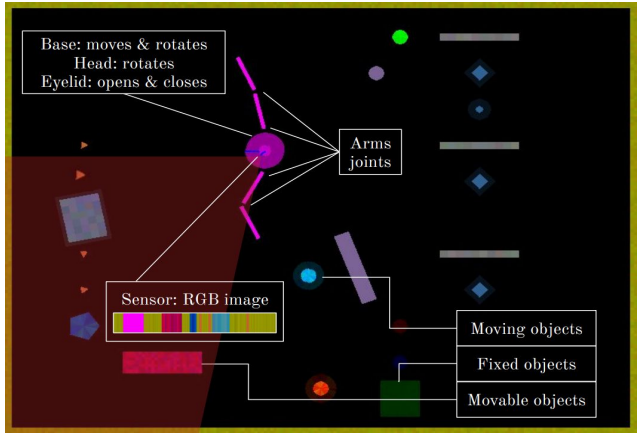
Embodied agent scenario.



Sensory Commutativity of Action Sequences:

$$a_1 \circ a_2 \circ a_3 =^{sensors}_{m,\epsilon} a_3 \circ a_1 \circ a_2$$

"produces the same sensors when played from the starting point"

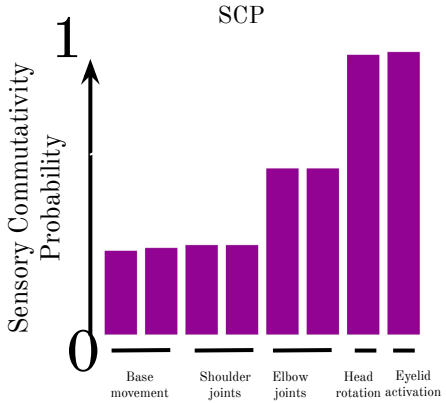
Sensory Commutativity Probability (SCP).

Definition 2 (Sensory commutativity probability of a degree of freedom)**.** *Let $Seq(\mathcal{M}_k)$ be the set of motor commands (or action) sequences of finite length for the k^{th} degree of freedom of $\mathcal{M}$ (motor state space). Let $h \in Seq(\mathcal{M}_k)$ and let h_p be a random permutation of h (same sequence but different order).*

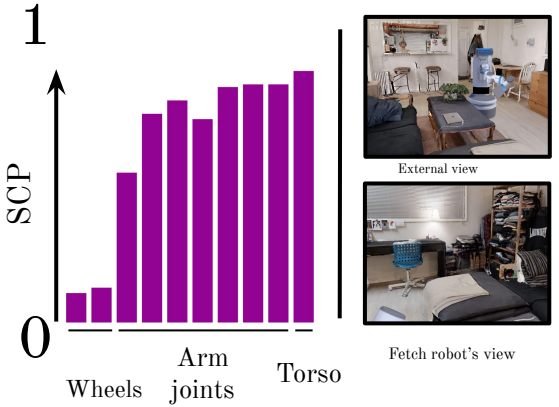
The Sensory Commutativity Probability of the k^{th} degree of freedom $SCP(\mathcal{M}_k)$ is defined as:

$$SCP(\mathcal{M}_k) = \mathbb{P}_{m_t,\epsilon_t,h}[h \sim_{m_t,\epsilon_t} h_p]$$

SCP creates a hierarchy of the degrees of freedom of the agent.



SCP scales to complex 3D robotics environments.



SCP can be useful for RL.