State Space

Definition:
The state space in this project represents the current configuration of the objects within the container. Each state captures the position, orientation, and type of each object involved in the mixing process. Additionally, the state may include properties such as the relative distances between objects, which can indicate the level of mixing achieved so far. This representation allows the agent to “see” the current distribution and determine its next steps towards even mixing.

Justification:
This definition of state space is crucial because the agent’s understanding of object locations and their distribution directly impacts its ability to assess the effectiveness of its actions. Knowing the precise locations and types of objects allows the agent to evaluate how evenly mixed the objects are at any given time. By having access to these attributes, the agent can make decisions that progressively lead to a more uniform distribution, which is the goal of the task. Without this detailed state information, the agent would struggle to identify necessary actions for achieving optimal mixing.

Action Space

Definition:
The action space consists of all possible movements and rotations the agent can perform to mix the objects. This may include moving objects in specific directions (e.g., up, down, left, right) or applying forces to initiate motion. The agent might also have the ability to rotate objects or shake the container to promote mixing. Each action is designed to manipulate the positions and orientations of objects in the container.

Justification:
The defined actions are crucial for achieving the goal of even mixing. By allowing movement and rotation, the agent has a diverse set of options to alter the positions of objects and to disrupt any existing clusters or patterns that prevent even distribution. The ability to move in multiple directions and rotate objects ensures that the agent has sufficient flexibility to explore different mixing configurations. This comprehensive action set increases the likelihood that the agent can discover effective strategies for creating a uniform mix of objects.

Reward Function

Reward Function Definition:
The reward function is designed to incentivize the agent to achieve a uniform mix of the two types of objects. At each time step, the agent receives a reward based on the level of evenness in the distribution of the objects. The closer the distribution is to a perfectly mixed state, the higher the reward. Conversely, if objects remain clustered or poorly mixed, the reward will be lower. An additional small penalty can be applied to each action to encourage the agent to reach an even distribution more efficiently.

Justification:
This reward function aligns with the project’s goal by promoting configurations that are closer to an even mix. By rewarding states that approach a uniform distribution, the agent is guided to perform actions that incrementally improve the mixing quality. The inclusion of a step penalty encourages the agent to mix the objects as efficiently as possible, reducing unnecessary steps. This reward design helps the agent prioritize actions that contribute meaningfully to the goal, reinforcing behaviors that result in a well-mixed state.