Fast High-Quality Tabletop Rearrangement in Bounded Workspace

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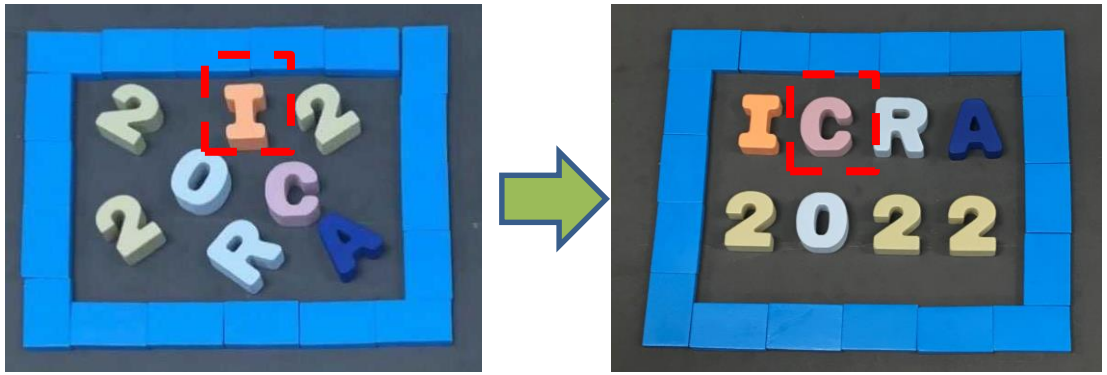
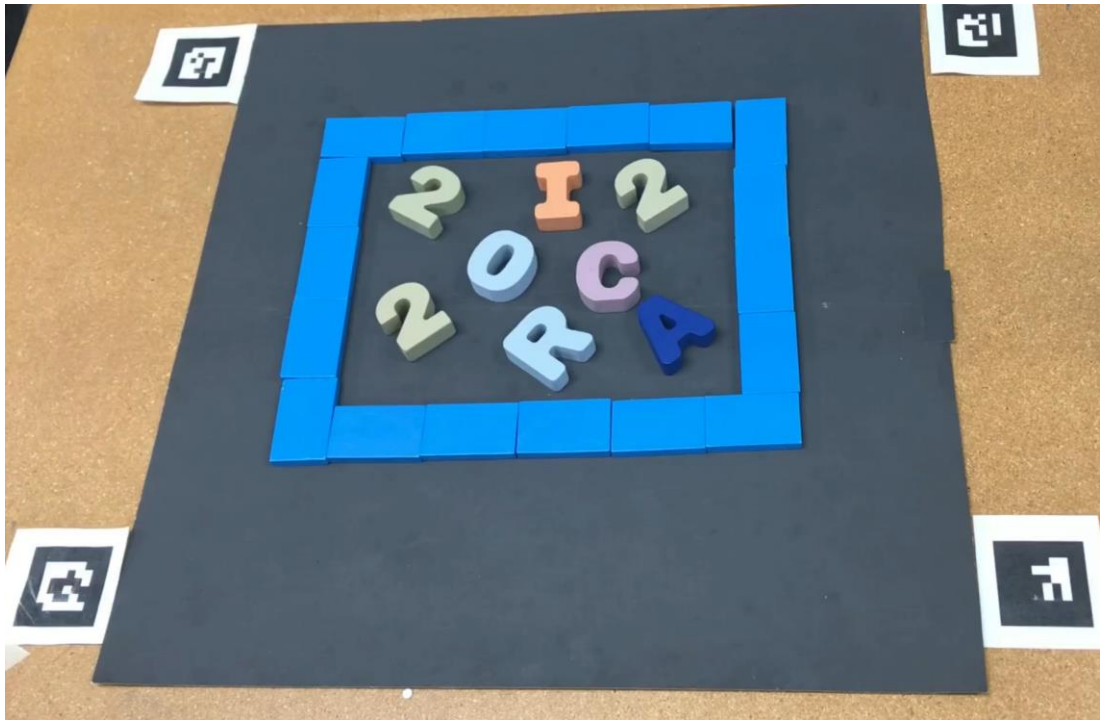
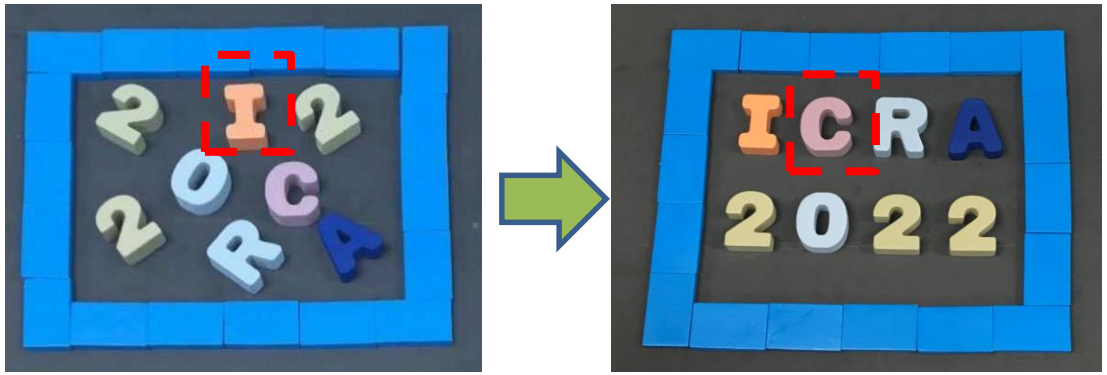
Start Arrangement **Goal Arrangement**



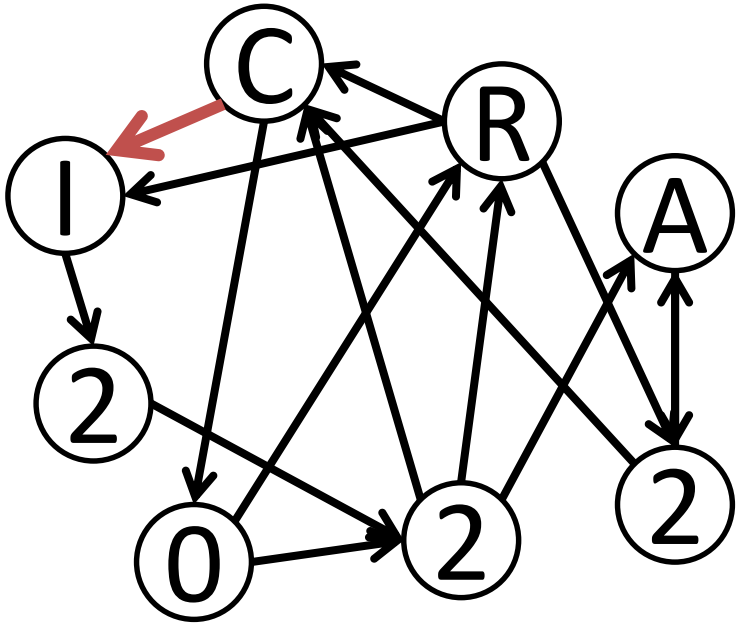


Tabletop Object Rearrangement

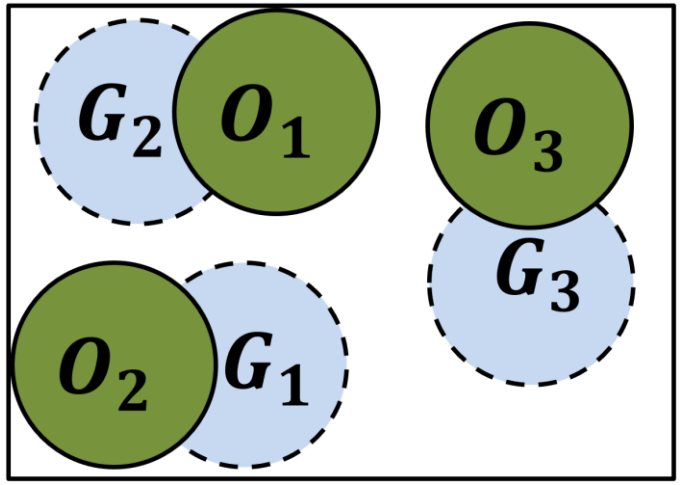
Start Arrangement **Goal Arrangement**



Dependency Graph



Lazy Buffer Allocation



Instance

Primitive Plan

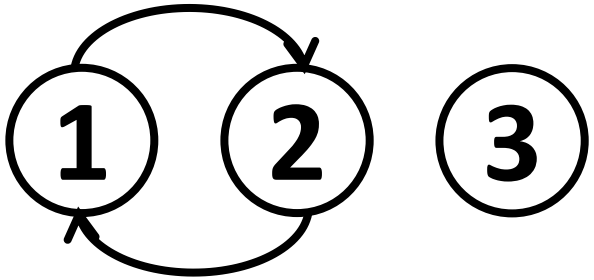
1. Move O_1 to a buffer
2. Move O_2 to the goal
3. Move O_1 to the goal
4. Move O_3 to the goal

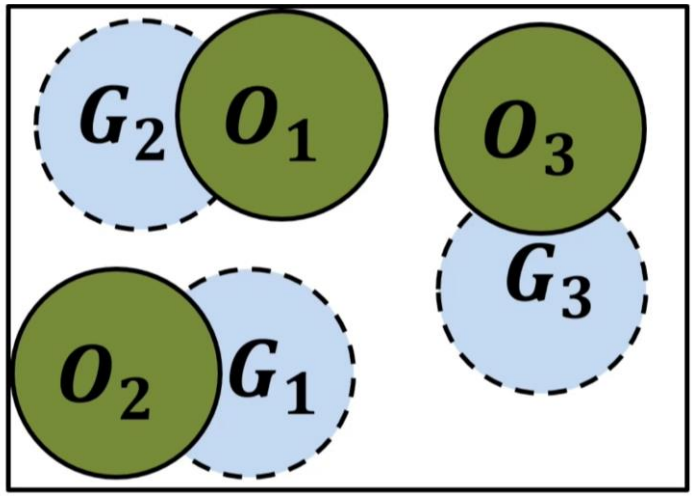
Primitive Planning

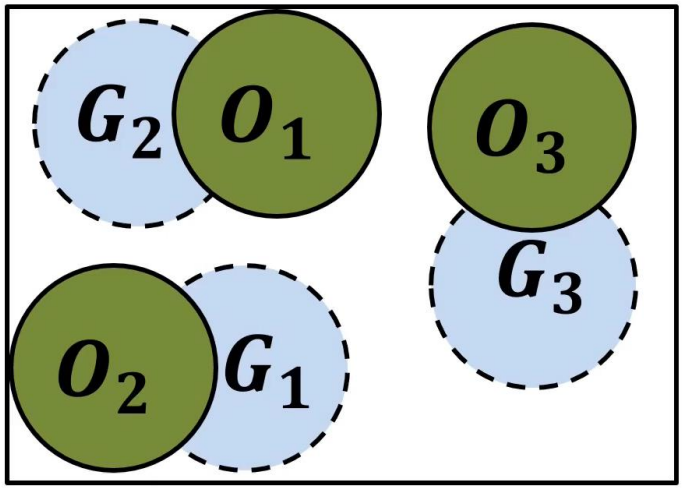
Rearrangement Plan

1. **Move O_1 to (4.6, 1.1)**
2. **Move O_2 to (1.2, 2.7)**
3. Move O_1 to (2.2, 1.1)
4. Move O_3 to (4.5, 2.0)

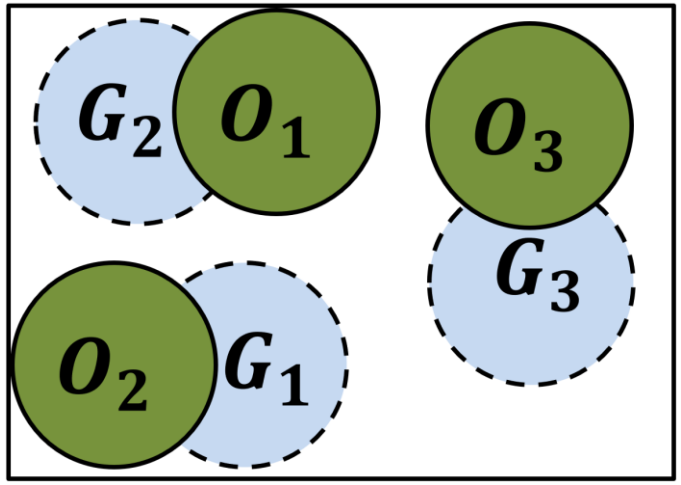
Buffer Allocation







Lazy Buffer Allocation



Instance

Primitive Plan

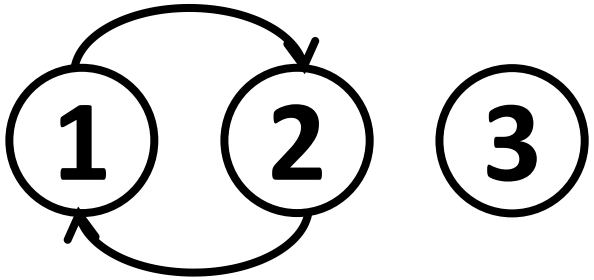
1. Move O_1 to a buffer
2. Move O_2 to the goal
3. Move O_1 to the goal
4. Move O_3 to the goal

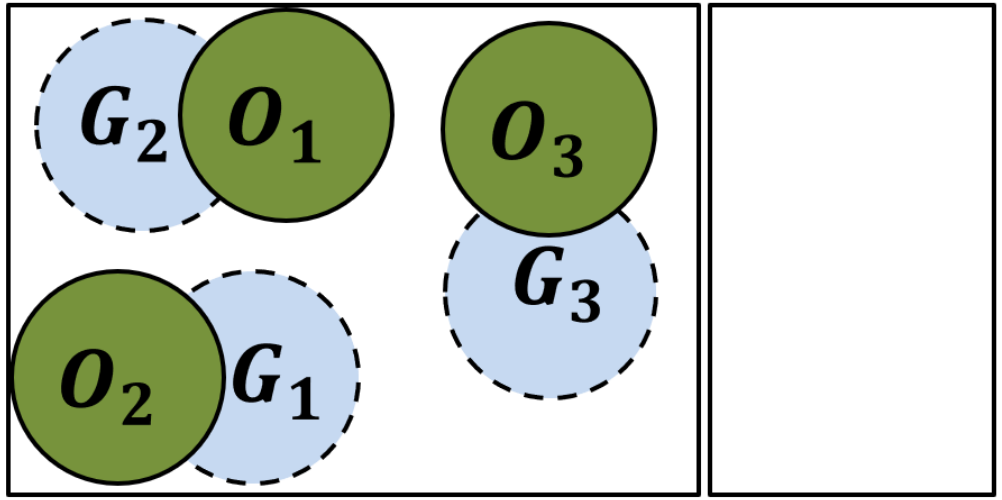
Primitive Planning

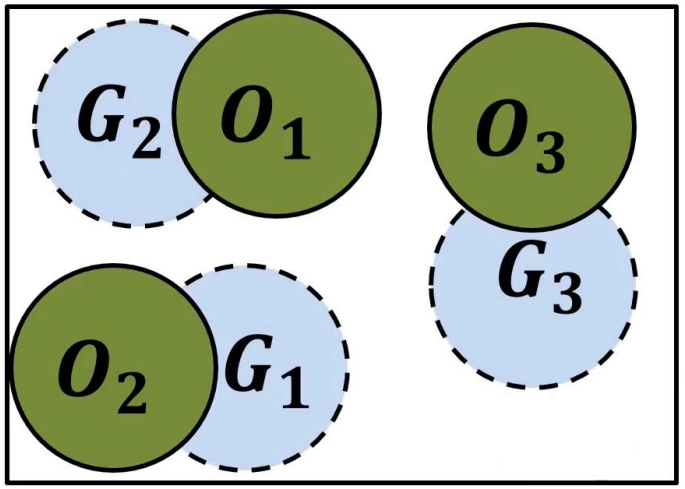
Rearrangement Plan

1. **Move O_1 to (4.6, 1.1)**
2. **Move O_2 to (1.2, 2.7)**
3. Move O_1 to (2.2, 1.1)
4. Move O_3 to (4.5, 2.0)

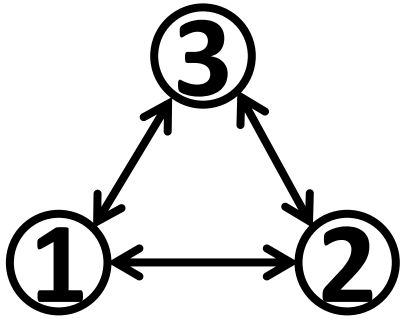
Buffer Allocation

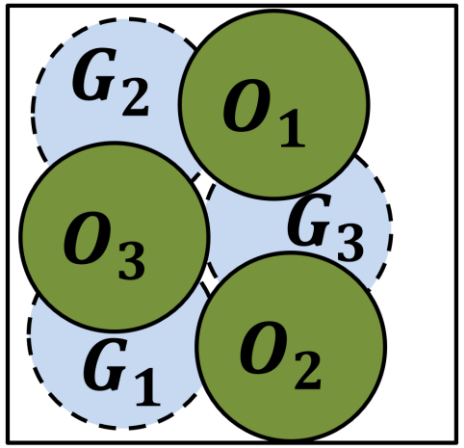






Tabletop Rearrangement with Lazy Buffer Allocation





Primitive Plan

1. Move O_1 to a buffer
2. Move O_3 to a buffer
3. Move O_2 to the goal
4. Move O_1 to the goal
5. Move O_3 to the goal

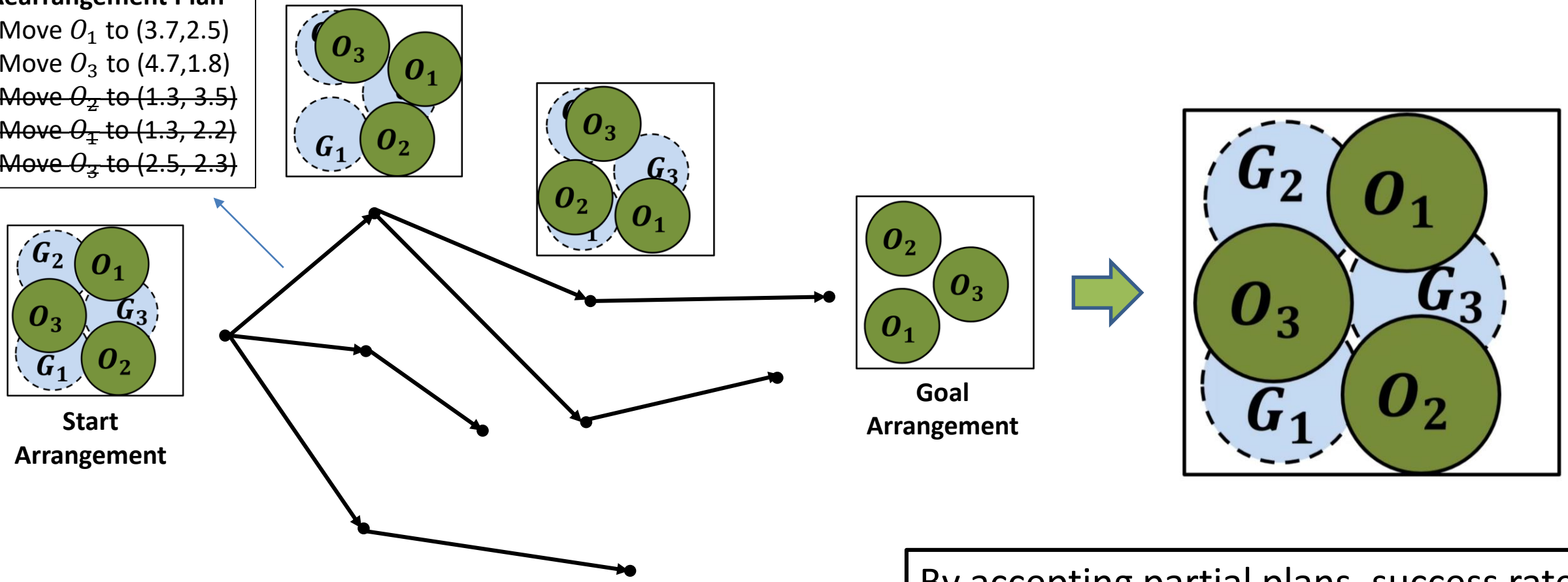
Rearrangement Plan

1. Move O_1 to (3.7,2.5)
2. Move O_3 to (4.7,1.8)
3. ~~Move O_2 to (1.3, 3.5)~~
4. ~~Move O_1 to (1.3, 2.2)~~
5. ~~Move O_3 to (2.5, 2.3)~~

Tabletop Rearrangement with Lazy Buffer Allocation

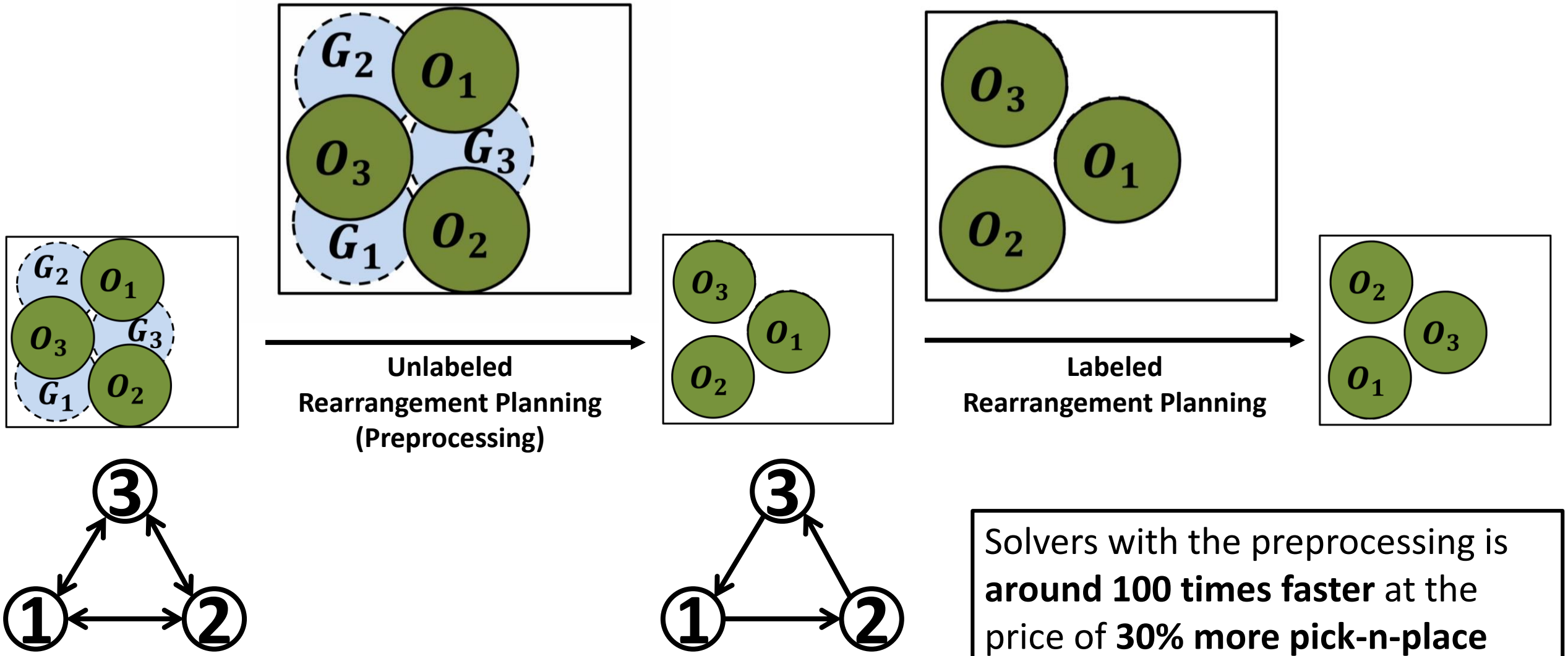
Rearrangement Plan

1. Move O_1 to (3.7,2.5)
2. Move O_3 to (4.7,1.8)
3. ~~Move O_2 to (1.3, 3.5)~~
4. ~~Move O_1 to (1.3, 2.2)~~
5. ~~Move O_3 to (2.5, 2.3)~~



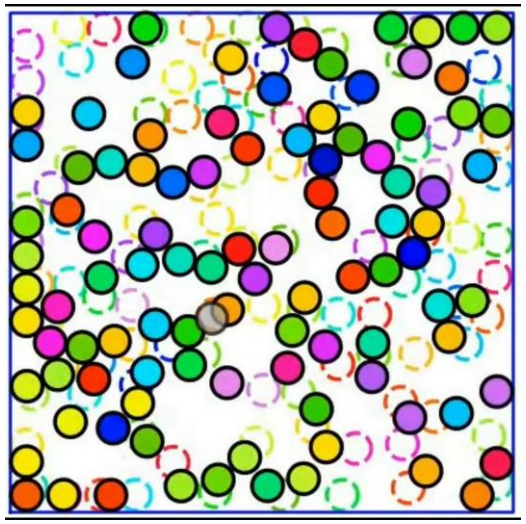
By accepting partial plans, success rate increases significantly in hard cases.

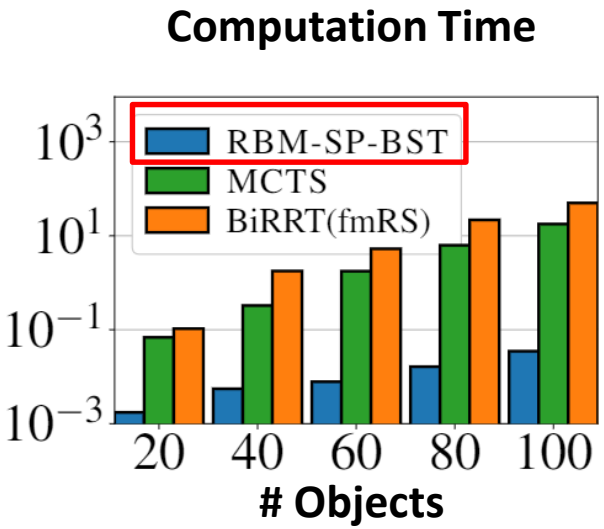
Processing Routine

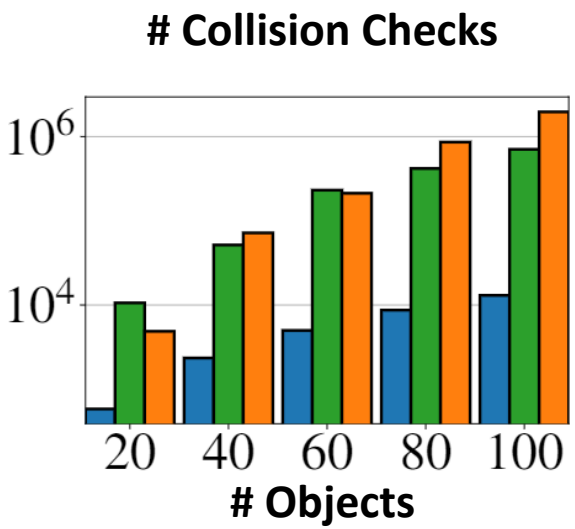


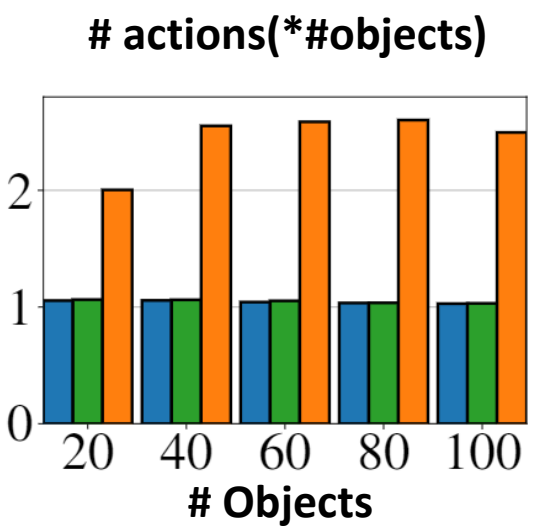
Solvers with the preprocessing is **around 100 times faster** at the price of **30% more pick-n-place actions**

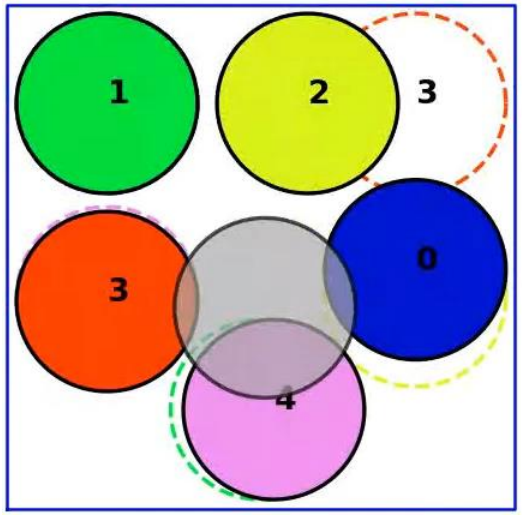
Comparison with other Methods

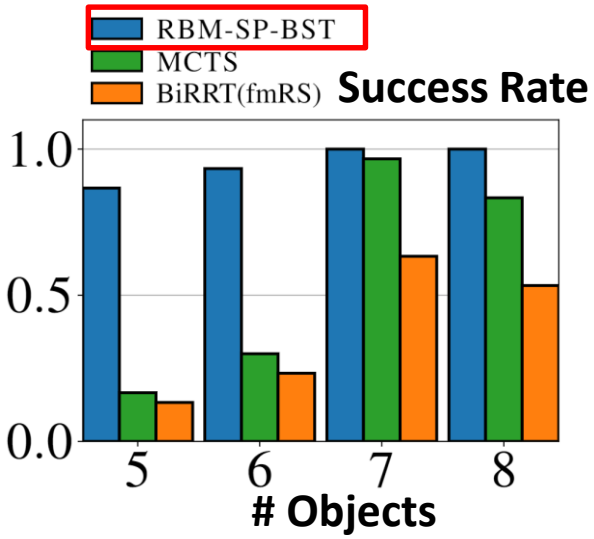


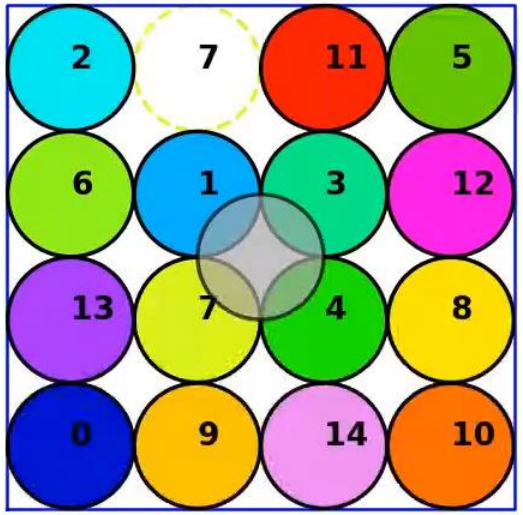


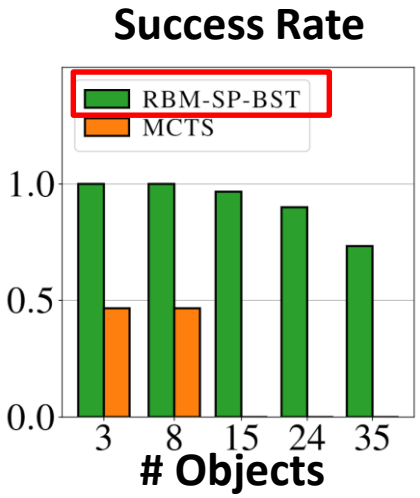




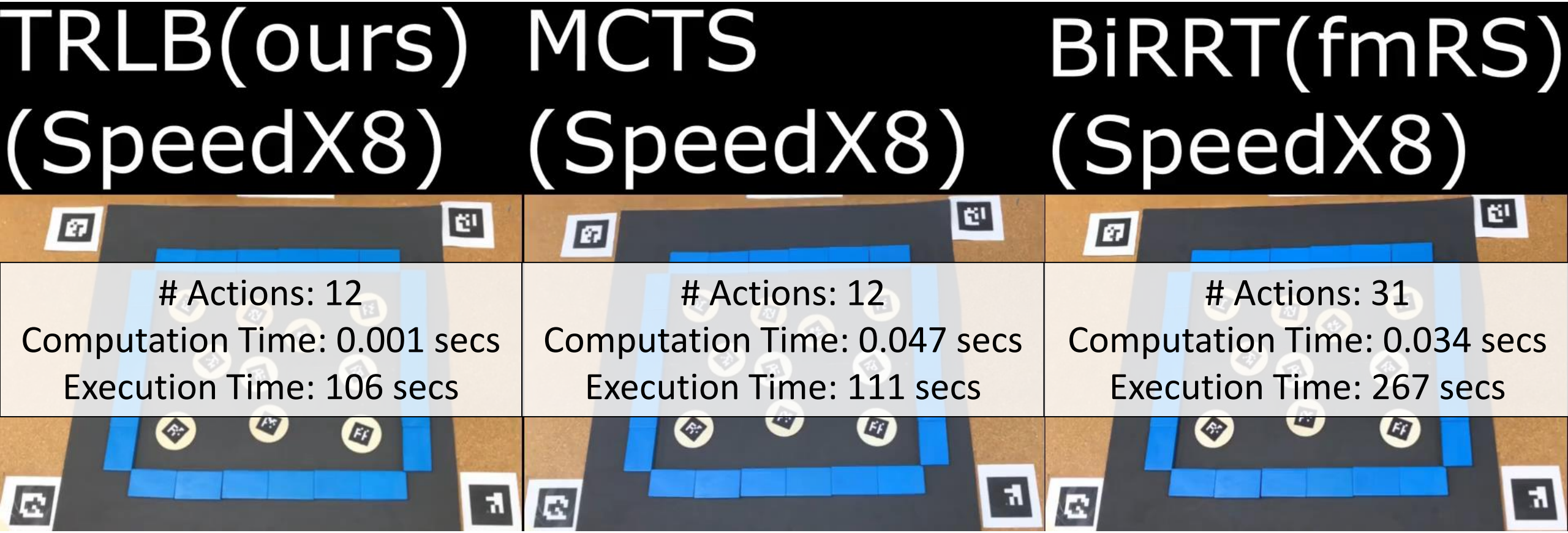






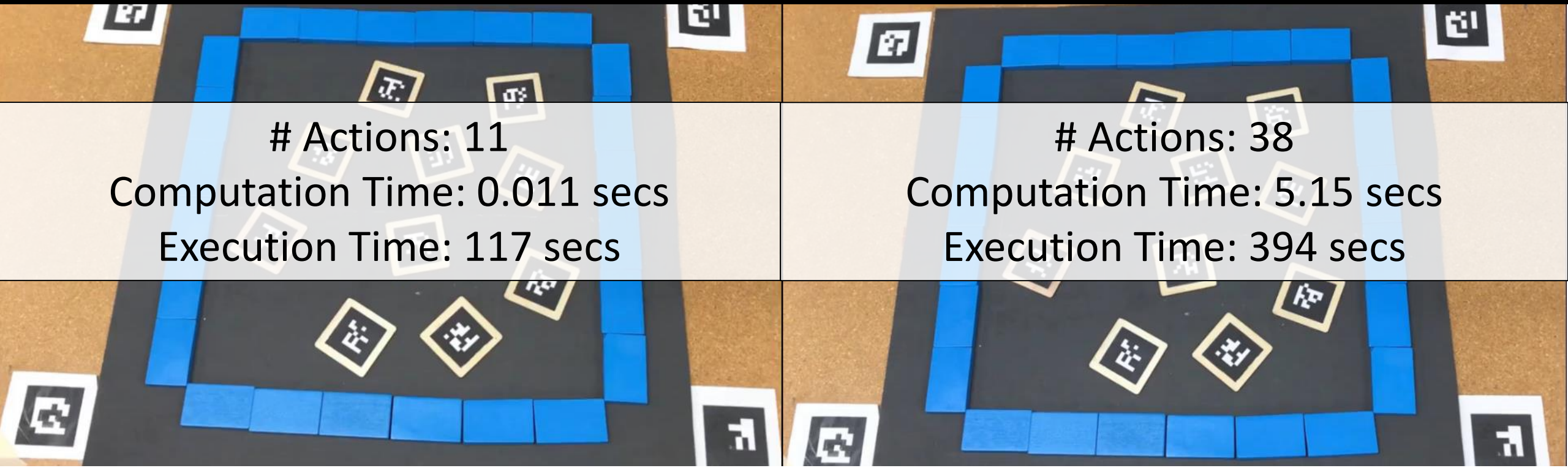


Comparative Study: Cylindrical Objects



Comparative Study: Cuboids

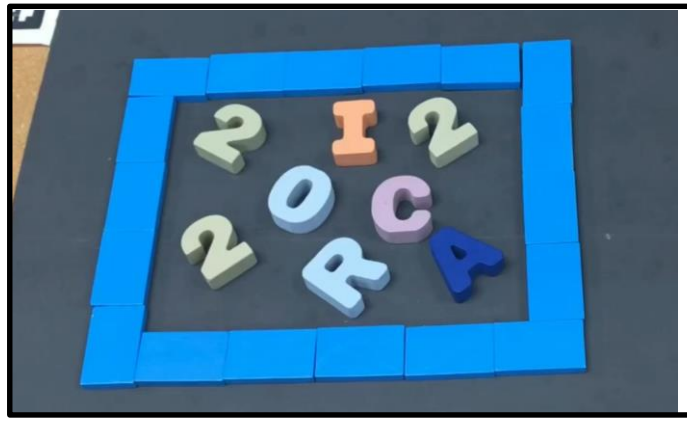
TRLB(ours) (SpeedX8)	BiRRT(fmRS) (SpeedX8)
# Actions: 11 Computation Time: 0.011 secs Execution Time: 117 secs	# Actions: 38 Computation Time: 5.15 secs Execution Time: 394 secs



TRLB Performance on Challenging Cases

20-Cylinder Instance
Actions: 22
Computation Time:
0.0023 secs

20-Cuboid Instance
Actions: 26
Computation Time:
0.15 secs



ICRA 2022
Actions: 15
Computation Time:
0.33 secs

Rutgers Robotics
Actions: 17
Computation Time:
0.022 secs

Thank you for listening!

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