The function TrajectoryGenerator generates the reference trajectory for the end-effector frame {e}. This trajectory consists of eight concatenated trajectory segments,

1. End_effector initial configuration to standoff from cube initial configuration in 4 seconds
2. Standoff from cube initial configuration to cube initial configuration in 4 seconds
3. Gripper close in 1 second
4. Cube initial configuration to standoff from cube initial configuration in 4 seconds
5. Standoff from cube initial configuration to standoff from cube goal configuration in 4 seconds
6. Standoff from cube goal configuration to cube goal configuration in 4 seconds
7. Gripper open in 1 second1
8. Cube goal configuration to standoff from cube goal configuration in 4 seconds

The starting and end configurations of each segment are calculated by multiplying the Transforms to get the required end_effector position with the {s} frame. The end configuration of one segment is the start configuration of the next segment. This starts with the Tse_intial and moves to Tsc_intial*Tce_standoff, then to Tsc_intial*Tce_gripper, then gripper close, then back to Tsc_intial*Tce_standoff, then to Tsc_final*Tce_standoff, then to Tsc_final*Tce_gripper, then gripper open, then back to Tsc_final*Tce_standoff.

These screw trajectories move the end effector through these points. Using the ScrewTrajectory from the modern_robotics library we can get these values. The code is split into 2 parts. One part has the function which can be called with the following inputs:

- Tse_initial : the initial configuration of the end effector
- Tsc_initial : the initial configuration of the cube
- Tsc_final : the final configuration of the cube
- Tce_grasp : the grasping orientation of end effector
- Tce_standoff : the standoff configuration of the end effector
- K : the number of steps per 0.01 seconds of calculation

The final output is a N*13 array where N = (4+4+1+4+4+4+1+4)*(k/0.01) = 2600 when k = 1. The 13 columns correspond to r11,r12,r13,r21,r22,r23,r31,r32,r33,p1,p2,p3 of the Tse calculated from the ScrewTrajectory function and the 13th column is the gripper state.

To use the code, run the example.py in python. In this file you can find the initial and goal configurations chosen. These can be altered to calculate trajectories. Running this file generates a .csv file that can be run in Coppeliasim.