

# Figures and discussion

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## 1 Chaotic orbits

### Setup:

- Single step PPO
- (non rotating) Bar potential with:  $M_{bar} = 1e10M_{\odot}, a = 5000pc, b = 1500pc, c = 1000pc, \Omega_p = 0.0$
- Rewards based on the lyapunov exponent, damped when leaving the 1pc box
- initialized in a 1 pc box

### 1.1 Two body orbits

- Point sources
- $1e10 M_{\odot}$

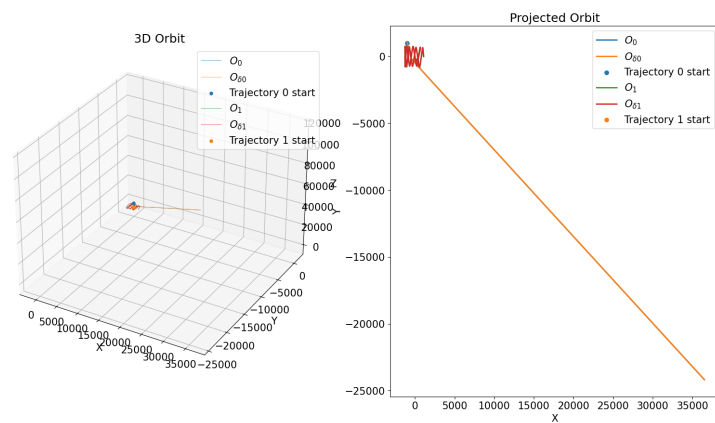


Figure 1: Orbits 1

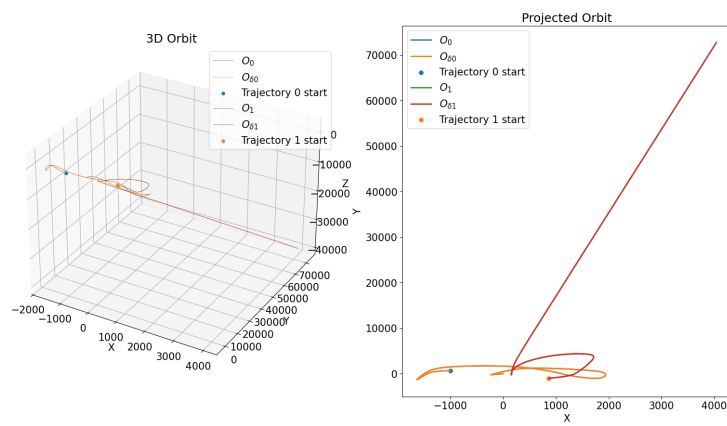


Figure 2: Orbits 2

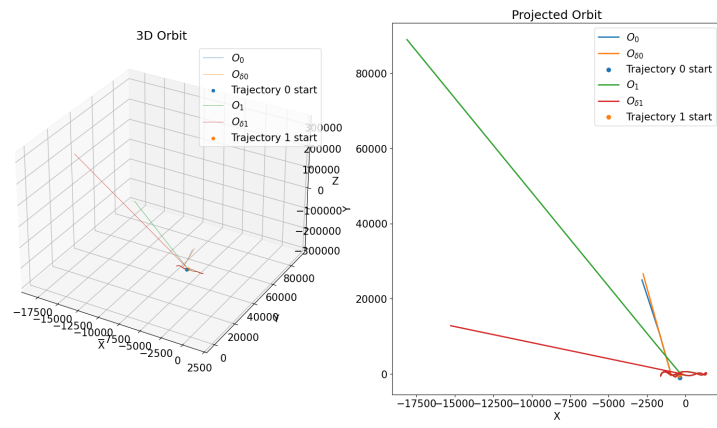


Figure 3: Orbits 3

## 1.2 Two tracer orbits

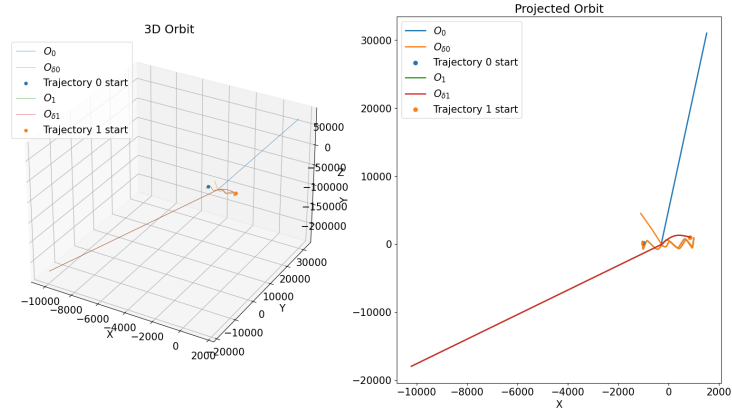


Figure 4: Orbits 1

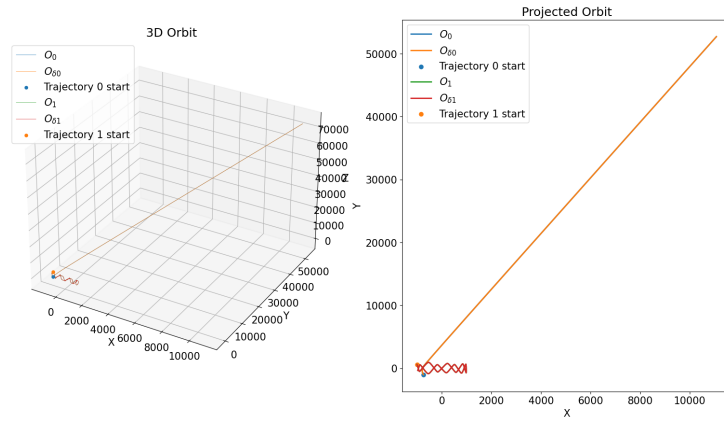


Figure 5: Orbits 2

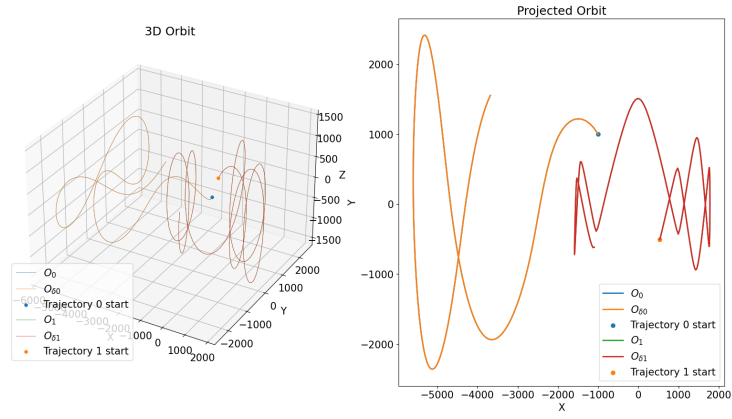


Figure 6: Orbits 3

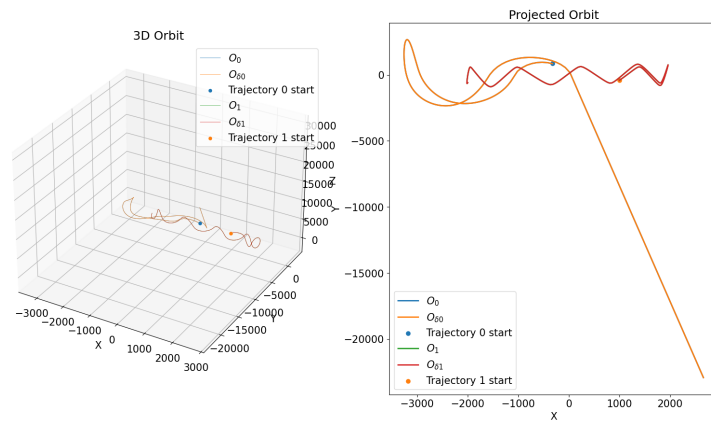


Figure 7: Orbits 4

## 2 Rocket mission

- Solar system in 2D\*
- 3 body system with circular orbits\*
- Rocket deployed from LEO (low earth orbit, earth radius + 300 km)
- Agent chooses thrust magnitude and direction
- Targets with increasing difficulties:
  1. GEO (geostationary orbit, 35768 km) -i sanity check to make sure agent is learning
  2. L1 point (between the earth and the Sun)
  3. Venus
  4. Mars
  5. Jupiter
- Three destination types: radius to be exceeded, destination planet, destination coordinates
- Rocket science where- thrust decreases rocket mass, with limited usable mass
- Rocket captured when too close to a planet
- solve\_ivp calls between timesteps

### 2.1 Trials without agent

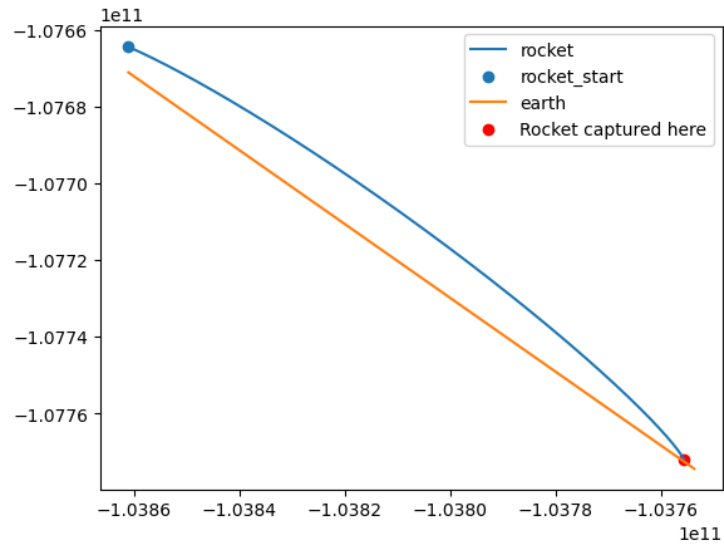


Figure 8: Rocket capture

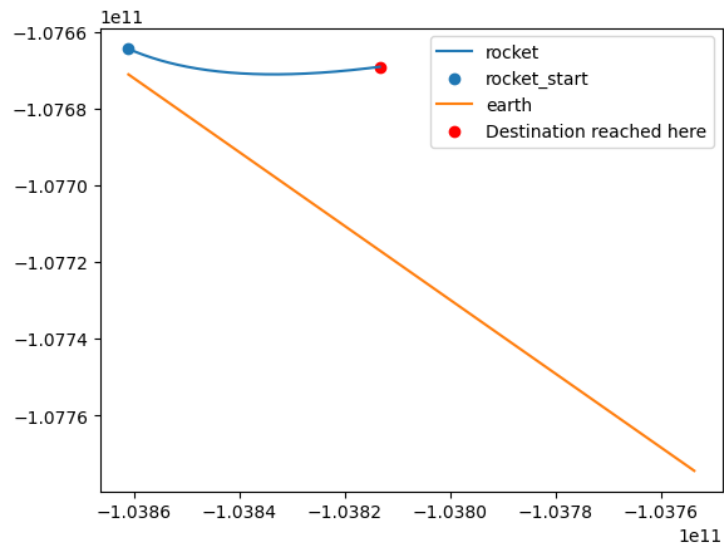


Figure 9: GEO reached