



Counterfactuals in a Multiagent Domain



Alexandra Bejarano
The University of Tulsa
alb146@utulsa.edu

Connor Yates
Oregon State University
yatesco@oregonstate.edu

Golden Rockefeller
Oregon State University
rockefeg@oregonstate.edu

Kagan Tumer
Oregon State University
kagan.tumer@oregonstate.edu

Introduction

What are Counterfactuals?

They are distinct hypothetical changes made to the current state of a domain.

Why Do They Matter?

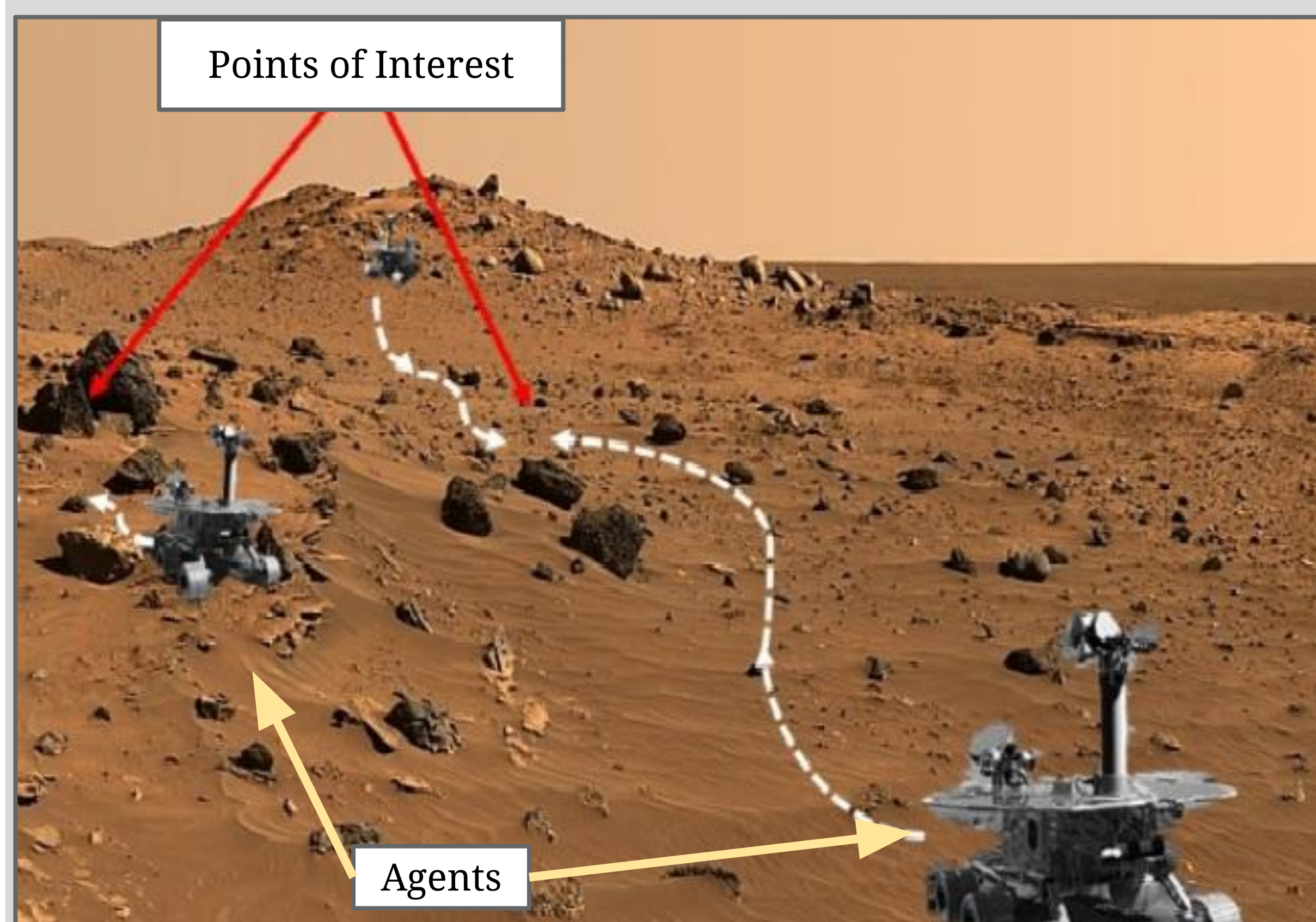
Agents are not always given explicit instructions on how to complete tasks. Instead, agents learn through exploration. In a tightly coupled multiagent domain, coordination between agents is necessary to complete tasks.

Need for coordination complicates the way agents learn since agents must account for the actions of other learning agents as they explore.

Counterfactuals can help agents learn the correct joint actions and enhance the team's overall performance.

The Rover Domain

Agents are tasked with observing points of interest (POIs).



Edited: D++: Structural Credit Assignment in Tightly Coupled Multiagent Domains - Fig. 1

Project Goal

Investigate and test the effectiveness of counterfactuals within the rover domain.

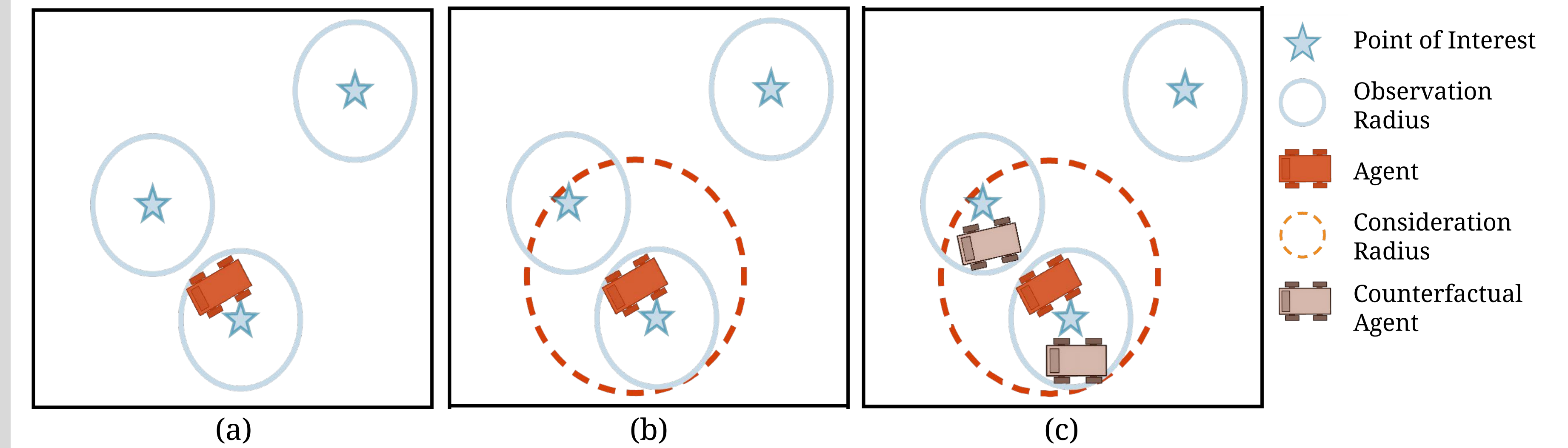
Counterfactuals

Previously Tested

- **Difference Reward:** remove an agent
 - Determines a single agent's contribution to the global reward.
- **D++:** add agents
 - Evaluates the effect additional agents have on the global reward.
 - Place counterfactual agents at the same POI

New

- Extension of D++.
- Place counterfactual agents at **different POIs**.
- Distribute team to POIs within range of an agent.



New counterfactual, how it works

- (a) An agent within the observation radius of a POI.
- (b) The agent determines which POIs are within its consideration radius.
- (c) Counterfactual agents are placed at each POI and the agent evaluates their effect on the global reward.

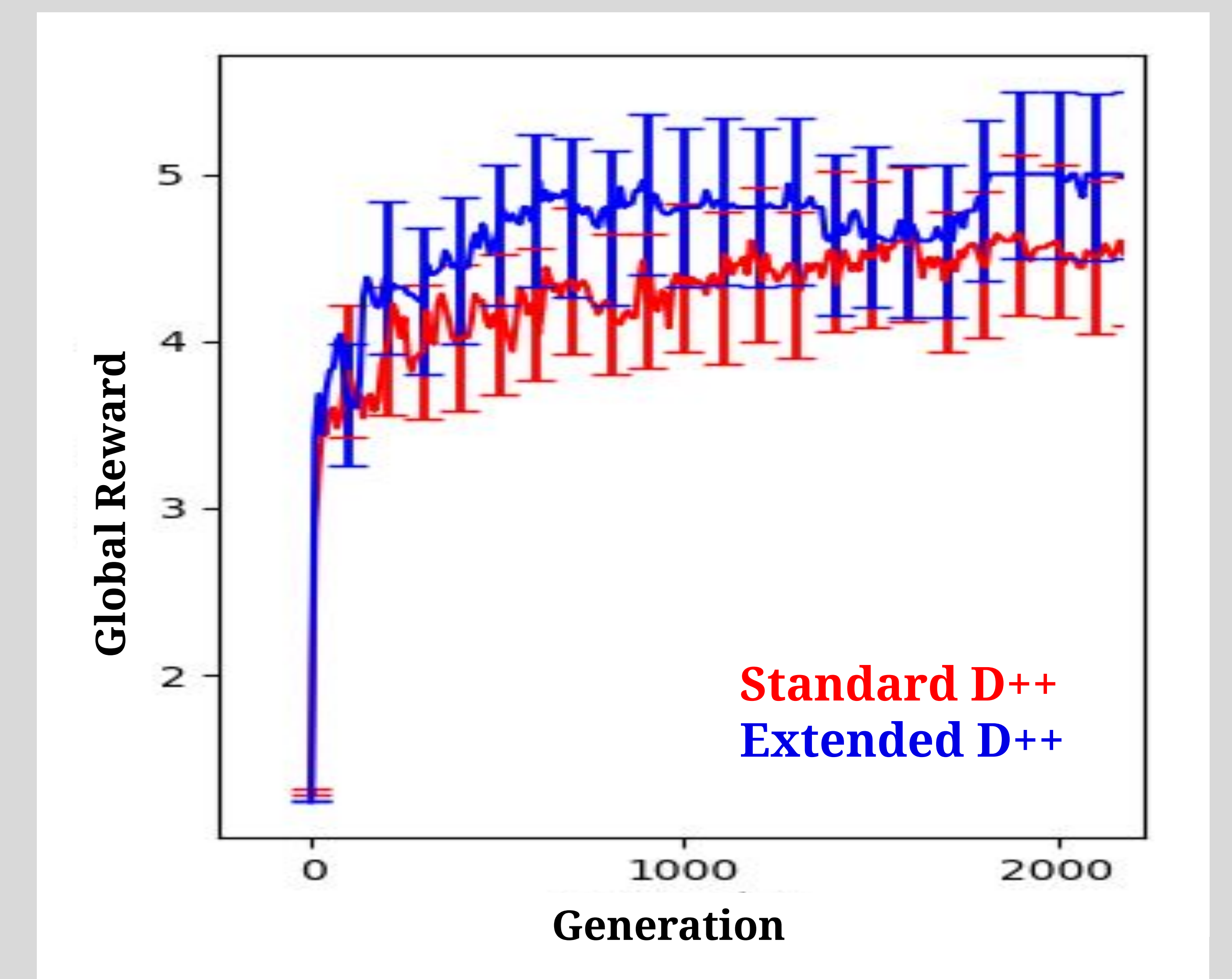
Results

The new counterfactual of adding agents to different points of interest had been implemented within a **custom Python simulator** of the rover domain.

Simulation setup:

- 20 agents
- 50x50 domain size
- 10 POIs
- Coupling of 5

The extended D++ counterfactual within the rover domain resulted in some improvement in performance over the standard D++ counterfactual.



Conclusions and Future Work

Further testing of counterfactuals within the rover domain will be necessary to verify initial results. Future tests would involve increasing the number of agents, the size of the domain, and the degree of coupling.

Modifications to the counterfactuals implemented may be necessary to continue improving the performance of agents within the rover domain.

