

# **ARGUS - A BDI MULTI-AGENT MINECRAFT ENVIRONMENT**

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COMP 5900





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# INTRODUCTION



# MOTIVATION

- Lack of complex multi-agent applications for the BDI design paradigm
- What would BDI-MAS strategies look like?
- What are some successful strategies?



# PROBLEM DESCRIPTION

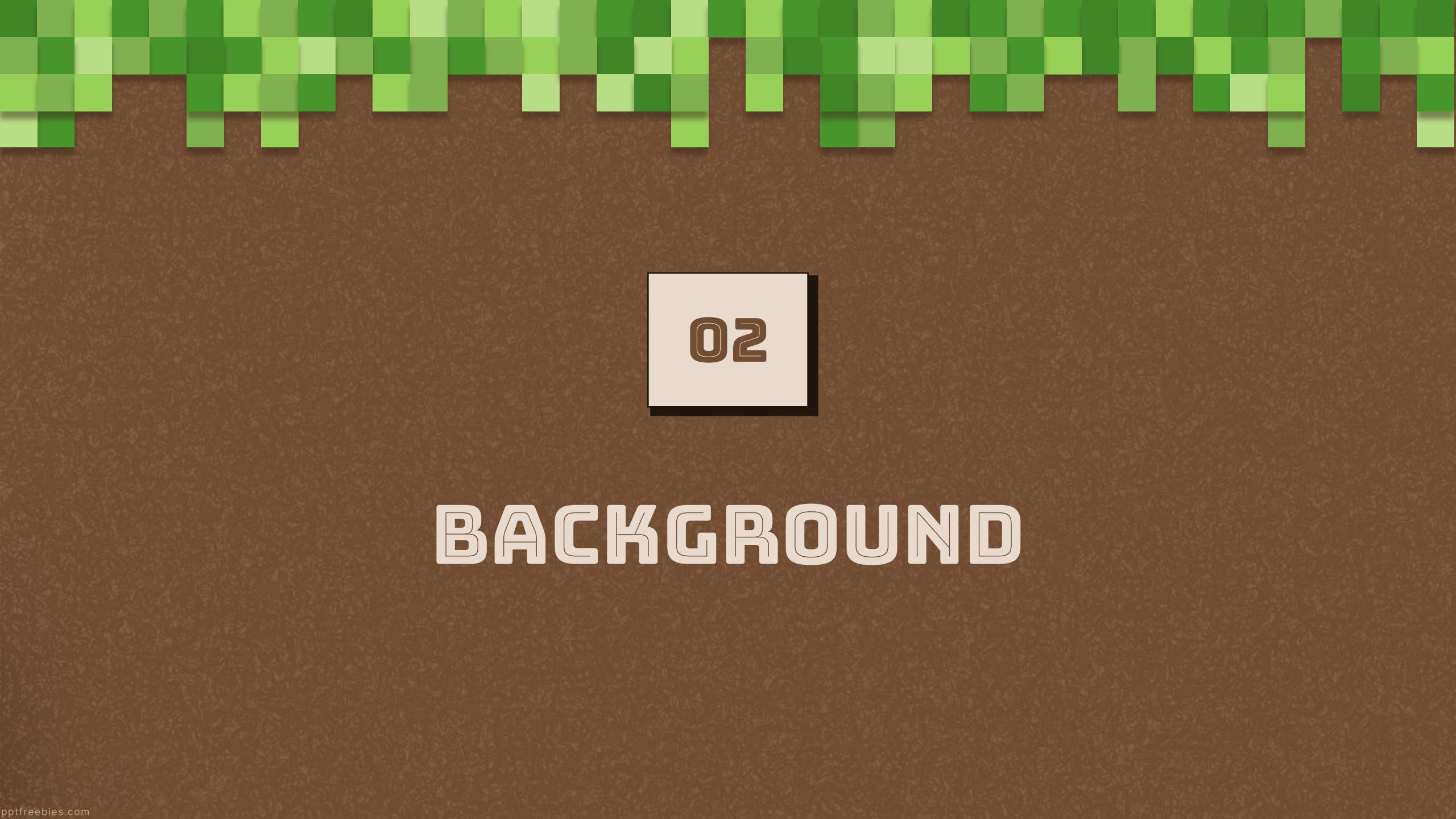
## Objectives:

- Autonomous NPCs vs zombies
- Survive the game and collects points

## Rules:

- can attack the zombies and other NPCs
- games run for 1.5 minutes
- can chop trees and collect wood
- can build houses to hide and recover (can fit 2 players at a time)
- can form alliances
  - > share houses, donate wood, protect each other



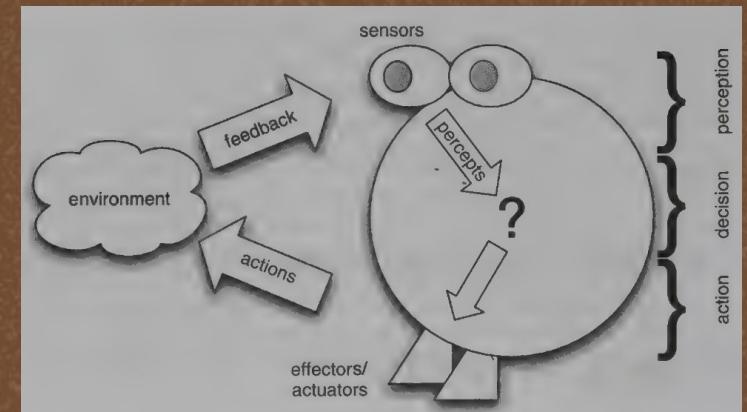


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# BACKGROUND

# WHAT ARE BDI AGENTS?

- “An agent is a **computer system**, situated in some **environment**, that is capable of **flexible autonomous action** in order to meet its **design objectives**”
  - Jennings et al
- Autonomous robots are a great example!
- Popular ways to design robots: imperative programming, state machines, subsumption architecture, etc.
- Proposing **BDI**:
  - **BELIEFS**: agent’s knowledge about the world
  - **DESIREs**: the goals for the agent
  - **INTENTIONS**: agent’s plans to for achieving its goals



# HOW TO WRITE BDI AGENTS?

- **AgentSpeak**: a theoretical formal language for BDI
  - Formal notation for agent's beliefs, goals, and plans
- **Jason**: one of its most popular implementations!
  - The agent repeatedly perceives, reasons, and acts!





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# THE MODEL

# AGENT BELIEFS

## Internal Beliefs

Belief	Meaning
lowHealthThreshold(_)	the agent considers this a low health
searchTimeout(_)	how long the agent should conduct a search for
buildRequirement(donation, _)	the agent's donation limit
ally(_)	the agent is an ally with the agent

## External Beliefs (Perceptions)

Perception	Meaning
type(_)	the agent type
woodsChopped(_)	the number of woods chopped by the agent
buildRequirement(house, _)	the number of woods needed to build a house
buildRequirement(sword, _)	the number of woods needed to build a sword
buildRequirement(axe, _)	the number of woods needed to build an axe
buildRequirement(trident, _)	the number of woods needed to build a trident
zombieDefenceLimit(_)	the number of zombies the agent can take on at once
allPlayers([_, ..., _])	the list of current players in the game
near(tree)	the agent is near a tree
near(zombie, _)	the agent is near zombies (second parameter indicates the count)
near(player, [_, ..., _])	the agent is near player (second parameter indicates the list of players)
houseCount(_)	the number of houses available to the player
hiding	the agent is hiding in a house
health(_)	the agent's current health (between 0 and 1)
hasWeapon(_)	the agent has a weapon. Parameter indicates the weapon type
damagedBy(_)	the agent took damage from the given entity

# AGENT ABILITIES

## Desires

Desire	Meaning
!broadcast(__, __)	send a message of given type and content to all players
!sendToGroup(__, __, __)	send a message to a given group of people with a given type and content
!loop	the agent's main logic loop

## Messages

Message	Type	Meaning
wantAlliance(__)	askIf	the asking agent wants an alliance
allianceConfirmation(__)	tell	the agent formed an alliance
endAlliance(__)	tell	the agent ends an alliance
hasHouse(__)	tell	the agent announces they have a house
need(__)	askIf	the asking agent needs something
donated(__, __)	tell	the agent donated a number of woods to the agent

## Actions

Action	Meaning
say(__)	the agent sends a message to the logs
find(__)	find and navigate to a specific parameter (tree, zombie, [player])
chop_wood	the agent chops a tree
escape	the agent jumps to a random location
attack(__)	the agent attacks a random entity (zombie, [player]) if nearby
build(__)	the agent builds an object (house, sword, axe, and trident)
enter_house	the agent goes to the house
leave_house	the agent leaves the house
donate_wood(__)	the agent donates a certain amount of wood
receive(__, __)	the agent either receives (wood, count) or (house, from)

# WEAPONS AND SCORES

WEAPONS	COST (IN WOODS)	# ENTITIES TO ATTACK	ESCAPE RANGE (IN BLOCKS)
NOTHING	0	1	10
SWORD	10	2	8
AXE	15	3	6
TRIDENT	20	4	4

ACTIVITY	COST (IN WOODS)	Reward (in Woods)
BUILD HOUSE	12	500
ATTACK ZOMBIE (PER ATTACK)	0	25
DONATE	2 (DEFAULT)	50
SURVIVE	0	10000/[# PLAYERS]

# PROPOSED STRATEGIES

## - Capitalist

- try to build as many houses as possible
- only buy swords for weapons after having at least one house
- Shares the houses with the allies and donate wood to them
- Attack zombies
- Find and attack non allies only if has sword

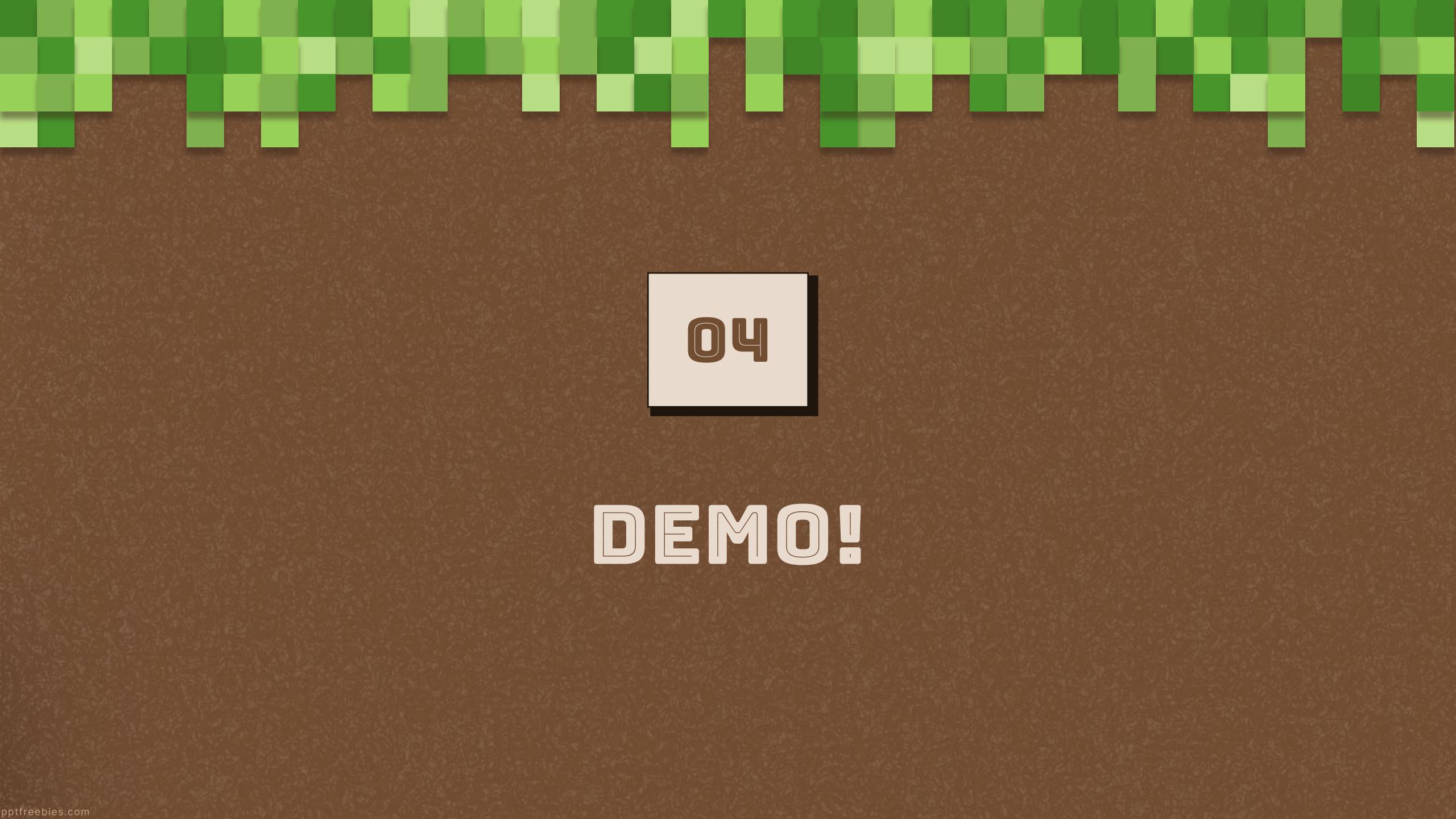
## - Attacker

- try to buy a sword first
- try to build a house after
- upgrade weapon to axe and trident only after having at least a house
- Shares the houses with the allies and donate wood to them
- Attack zombies and non ally players only if has a weapon



# WHICH STRATEGY IS BETTER? HOW MANY ALLIES ARE SUITABLE?

- Have 4 attackers, 4 capitalists, and 8 zombies
- Three experiments each run 30 rounds:
  - Have agents form no alliances
  - Have attackers and capitalists pair up to alliances of size 2
  - Have attackers and capitalists team up to two teams of size 4



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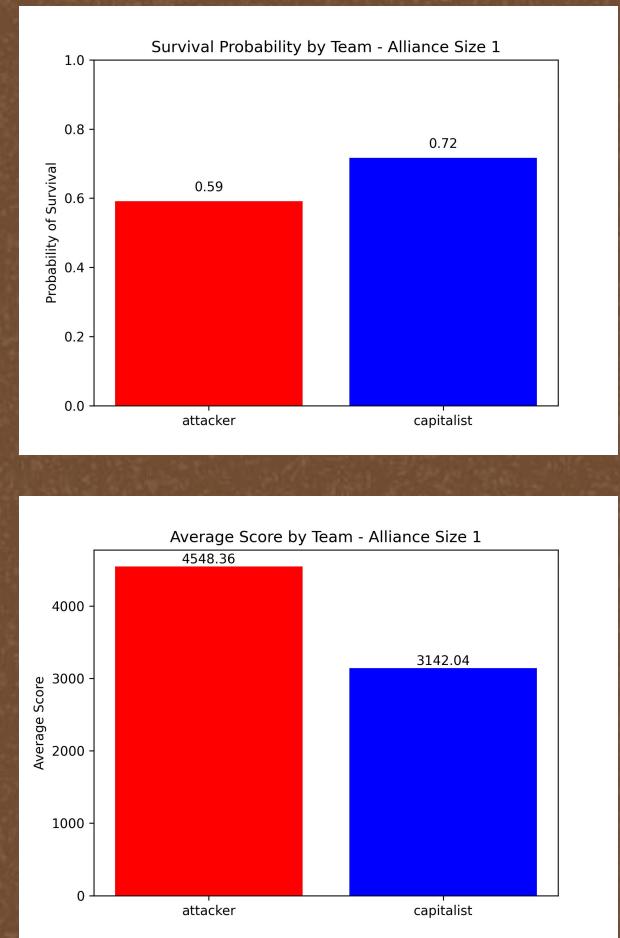
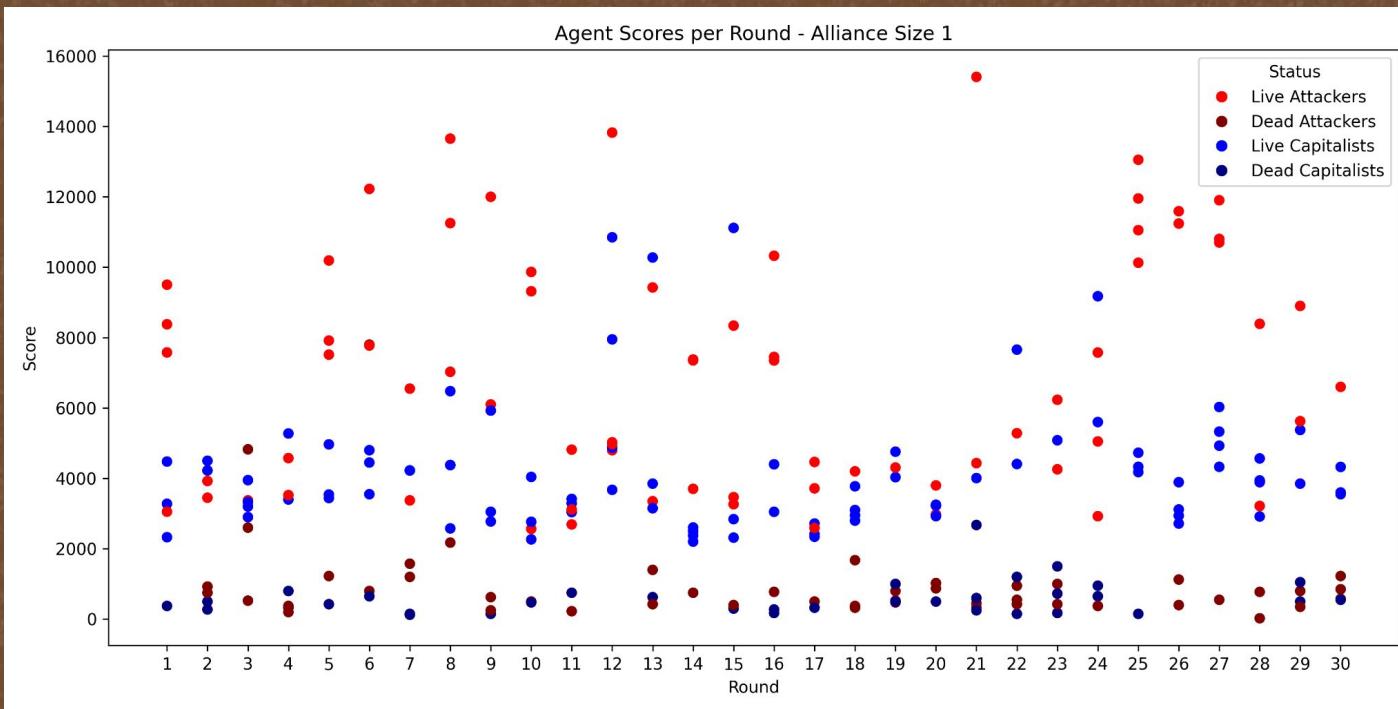
DEMO!



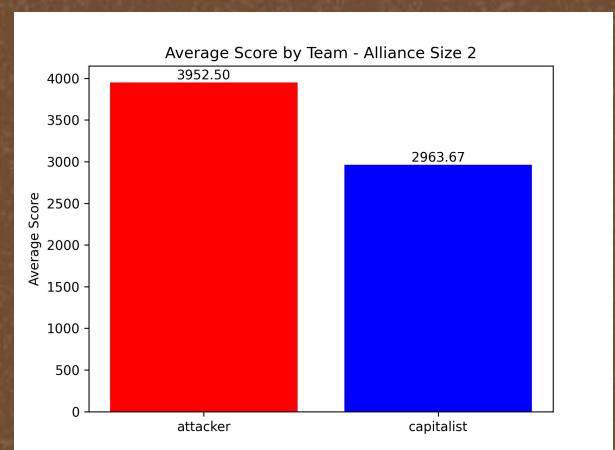
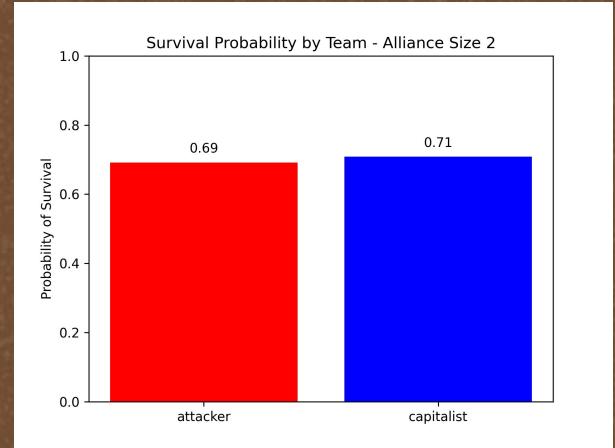
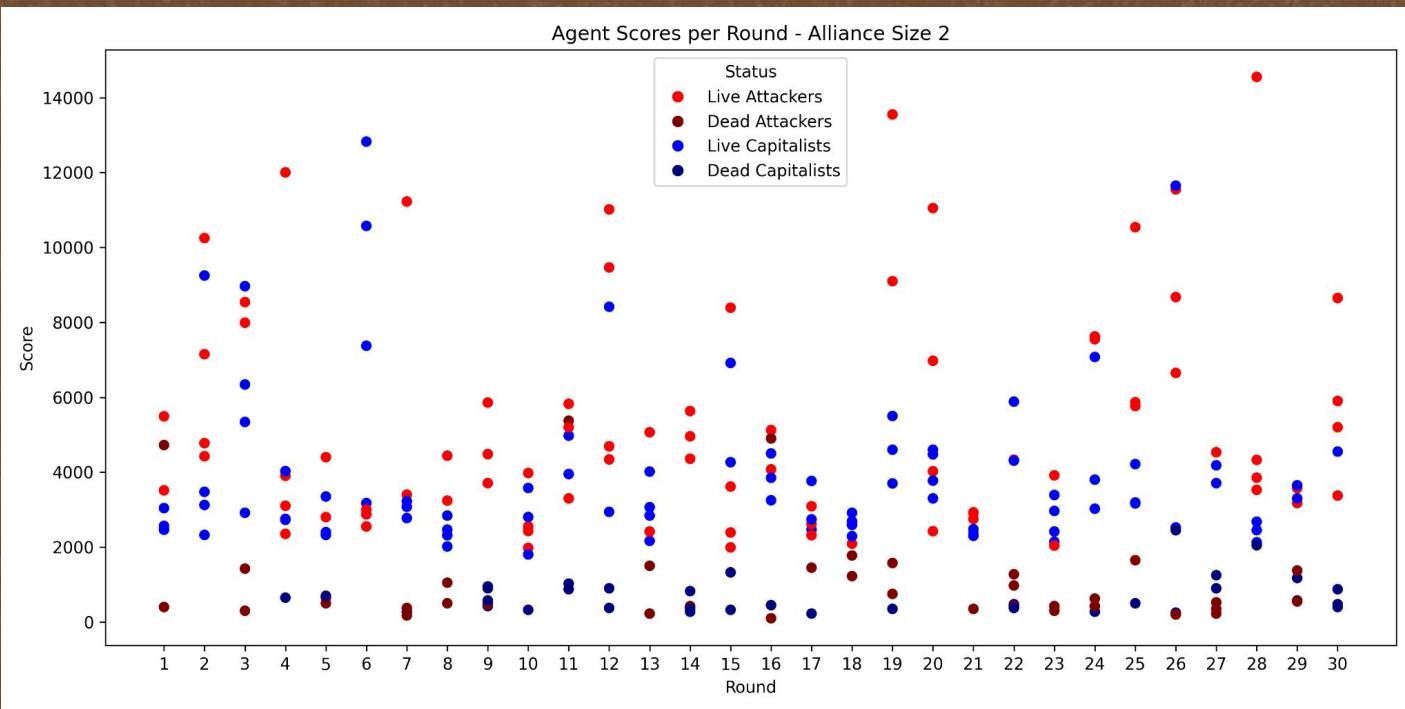
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# RESULTS

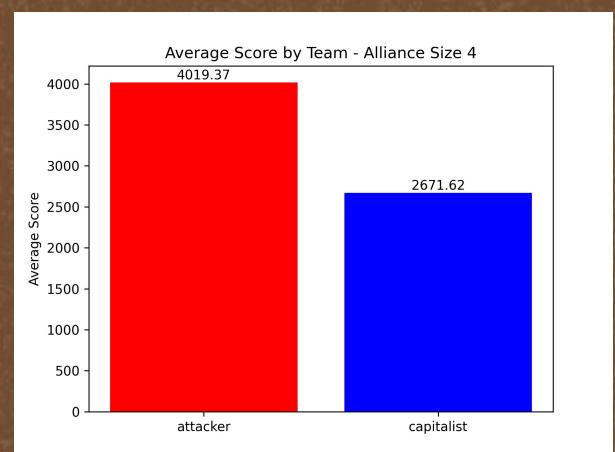
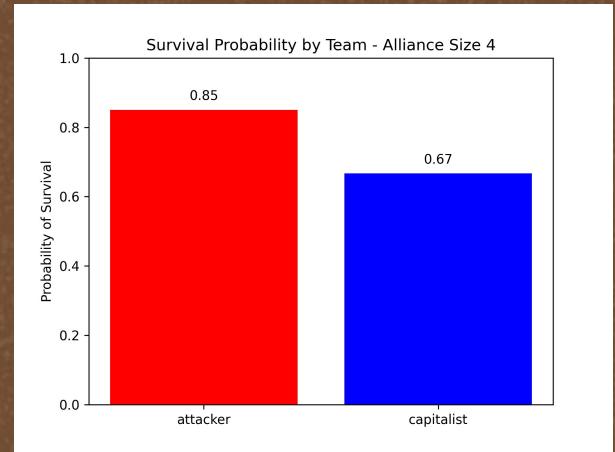
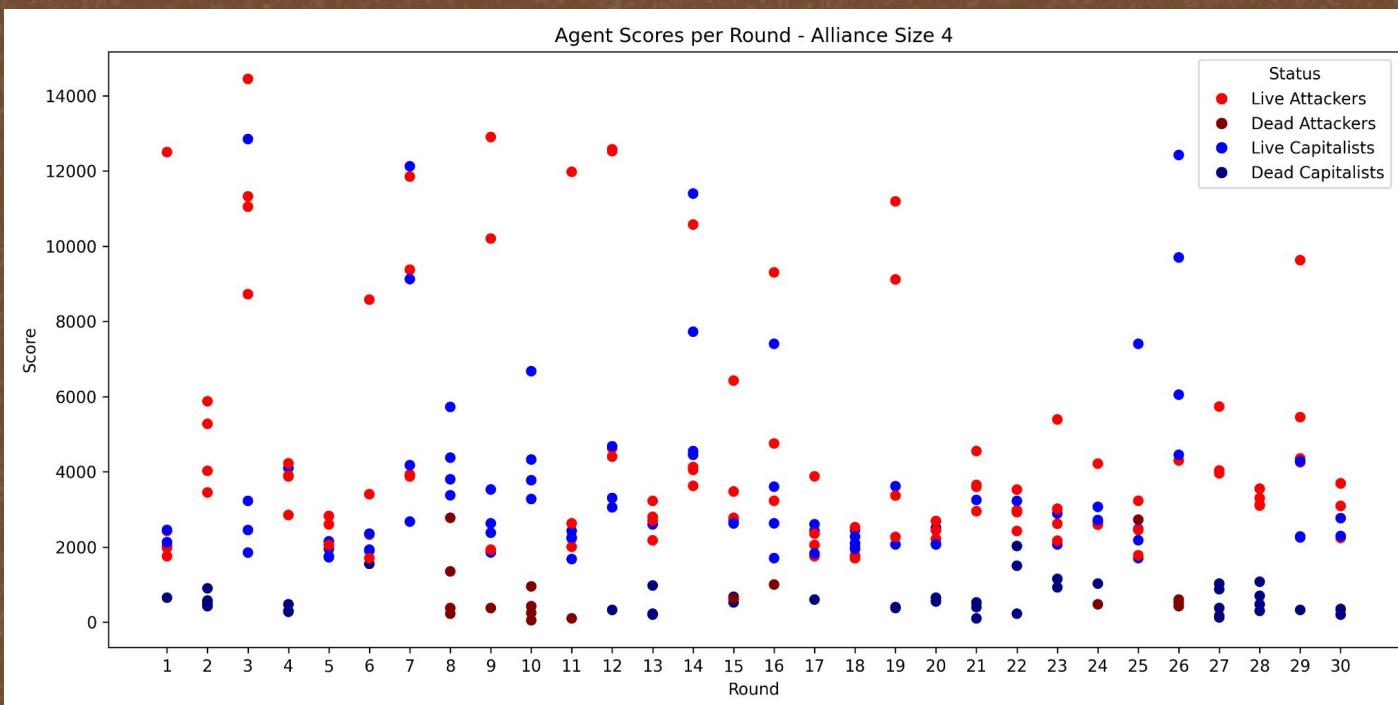
# ALLIANCE SIZE 1



# ALLIANCE SIZE 2



# ALLIANCE SIZE 4





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# CONCLUSION



# PROBLEM DESCRIPTION



## Overall Findings:

- Jason is able to keep up with the fast paced (20 ticks/second) environment
- AgentSpeak makes agent's implementation clear and transparent
- BDI leads to easy belief maintenance and plan selection for strategies
- BDI/Jason should only be used for high level strategies
- Notion of BDI matches closely with our understanding of mechanisms!

## Strategy Findings:

- Attackers are generally more successful -> invest in a lot of weapons
- Being an attacker requires more allies though!
- For small alliances, agents need to invest in houses but also attack a lot!

# FUTURE WORK



MORE COMPLEX STRATEGIES



MORE EXPERIMENTS/DATA  
COLLECTION



MORE COMPLEX FEATURES



COMPARE OTHER  
PARADIGMS



THANK YOU