

# Measuring Collaboration in **HIHECRAFT**

**Black Team**

**Group 21:** Chloë Geller, Connor Austin, Andrew Amado, and Anthony Yu

**Faculty Sponsor:** Dr. Gita Sukthankar

# Project Goals & Broader Impacts

Main objective is to provide tools that will allow analysts to draw conclusions about a Minecraft player's behavior.

## Specifically

- Theory of Mind (ToM).
  - Our ability to attribute mental states to ourselves and others, making it one of the foundational elements for social interaction.

## Plan

- Data Collection.
- Data Visualization.

We also hope that our work will help researchers answer the following questions:

- Do psychological theories of human team cognition apply to human-agent teams?
- Can we create socially intelligent agents capable of exhibiting theory of mind?

# Workload distribution

- **Andrew**
  - Primary: Minecraft Plugin.
  - Secondary: Web Development & Back End.
- **Anthony**
  - Primary: Minecraft Plugin.
  - Secondary: Web Development.
- **Chloe**
  - Primary: Front End / Data Processing and Visualizations.
  - Secondary: Administrative and Point of Contact.
- **Connor**
  - Primary: Front End / Data Processing and Analysis.
  - Secondary: Minecraft Plugin

# Minecraft

- Sandbox Video Game that was created in Java.
  - Limit is based on the player's imagination.
- Released to the public in 2011.
- Uses procedurally generated Voxel worlds to provide unique experiences.

# Project Overview

## Data Collection Plugin

- Tracks, Organizes, and sends data to DB.
- Records Minecraft game chat.
- Activity data feature.

## Interactive Heat Map

- Main visualization tool.

# HeapCraft

HeapCraft is the first iteration of our project.

## Epilog Plugin

- HeapCraft's Data Collection Plugin.

## Classify Plugin

- Shows if a player is building, mining, exploring, fighting or idle.

# Our Data Collection Plugin

## Addresses a few issues with Epilog

- Inefficient.
- Outdated (1.12.1).
- Collects Unnecessary Data.

## Collecting 22 player triggered events and player chat

### Activity

- Ability to measure activity and nearby players.

### Modular

- Add new events with ease.

# Heapcraft Move Event



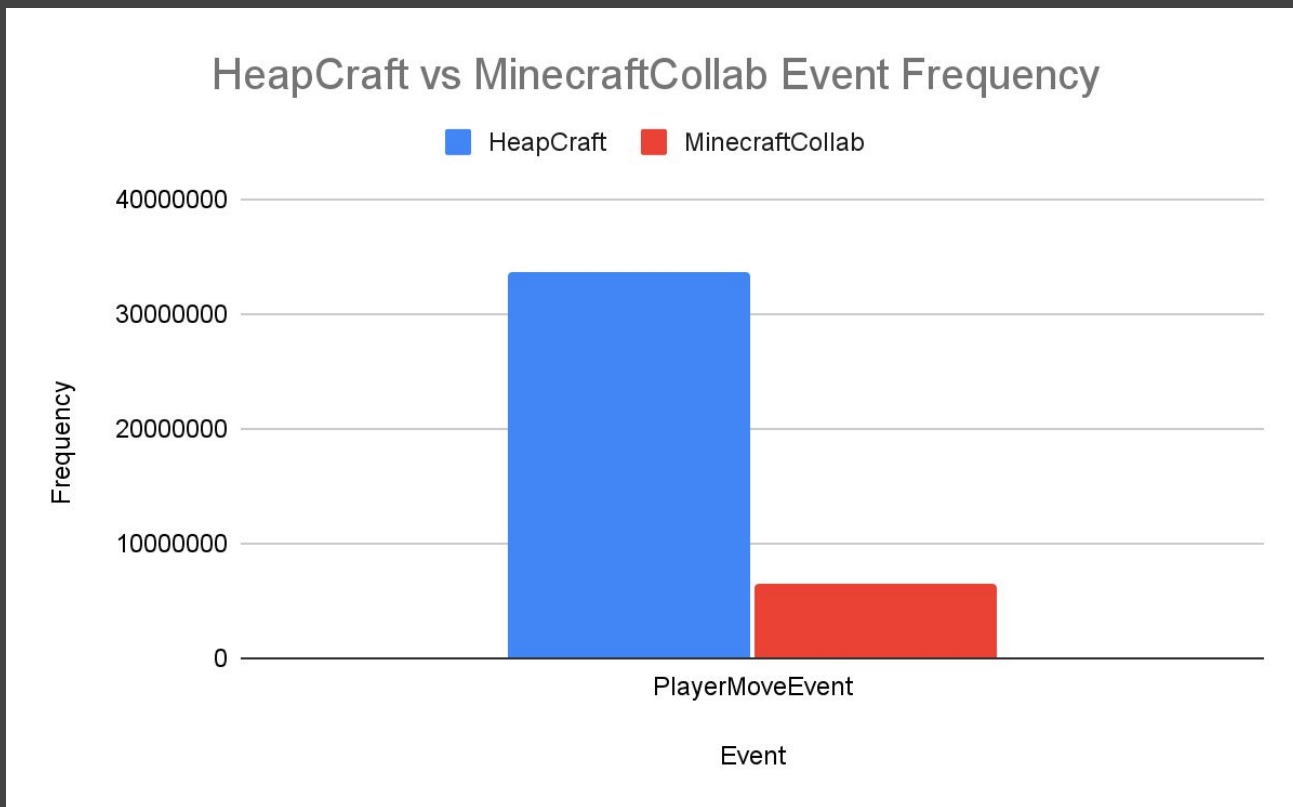


# Our Move Event

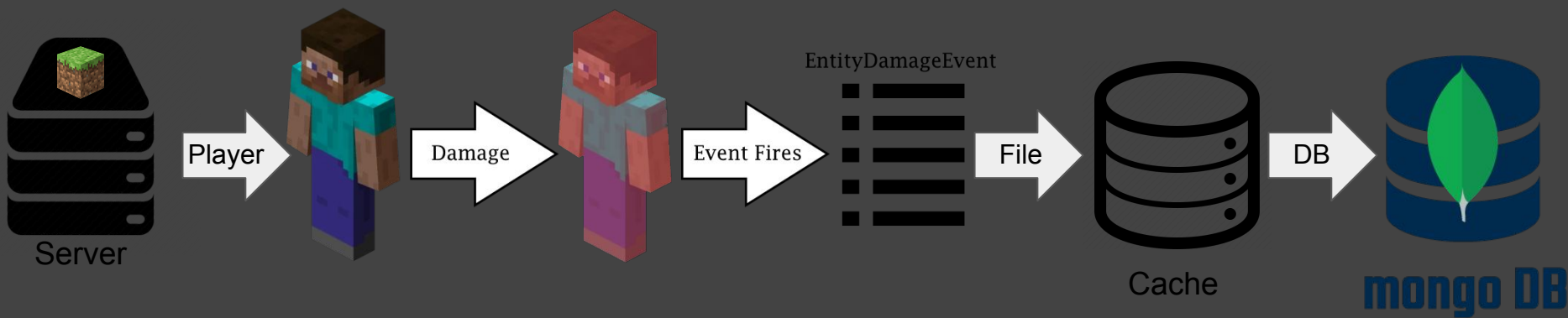
```
> reload confirm  
[22:21:09 INFO]: CONSOLE: Please note that this command is not s  
[22:21:09 INFO]: CONSOLE: If you encounter any issues please use  
[22:21:09 INFO]: Debug logging is disabled  
[22:21:09 INFO]: Server Ping Player Sample Count: 12  
[22:21:09 INFO]: Using 4 threads for Netty based IO  
[22:21:09 INFO]: [DataCollection] Disabling DataCollection v0.1  
[22:21:09 INFO]: [DataCollection] [DC] DataCollection been disab  
[22:21:09 INFO]: Reloading ResourceManager: Default, bukkit  
[22:21:09 INFO]: Loaded 7 recipes  
[22:21:09 WARN]: Legacy plugin DataCollection v0.1 does not spec  
[22:21:09 INFO]: [DataCollection] Loading DataCollection v0.1  
[22:21:09 INFO]: Server permissions file permissions.yml is empt  
[22:21:09 INFO]: [DataCollection] enabling DataCollection v0.1*  
[22:21:09 INFO]: [DataCollection] [DC] DataCollection been enabled.  
[22:21:09 INFO]: CONSOLE: Reload complete.  
[22:21:09 INFO]: Timings Reset
```



# HeapCraft vs MinecraftCollab Event Frequency



# Data Collection Overview



```
[DataCollection] [DC] Sent 274 PLAYER data documents this time around.  
[DataCollection] [DC] Sent 2 CHAT data documents this time around.  
[DataCollection] [DC] Sent 1 ACTIVITY data documents this time around.
```

# Activity Feature

Grants the ability to collect the activities a player may be participating in.



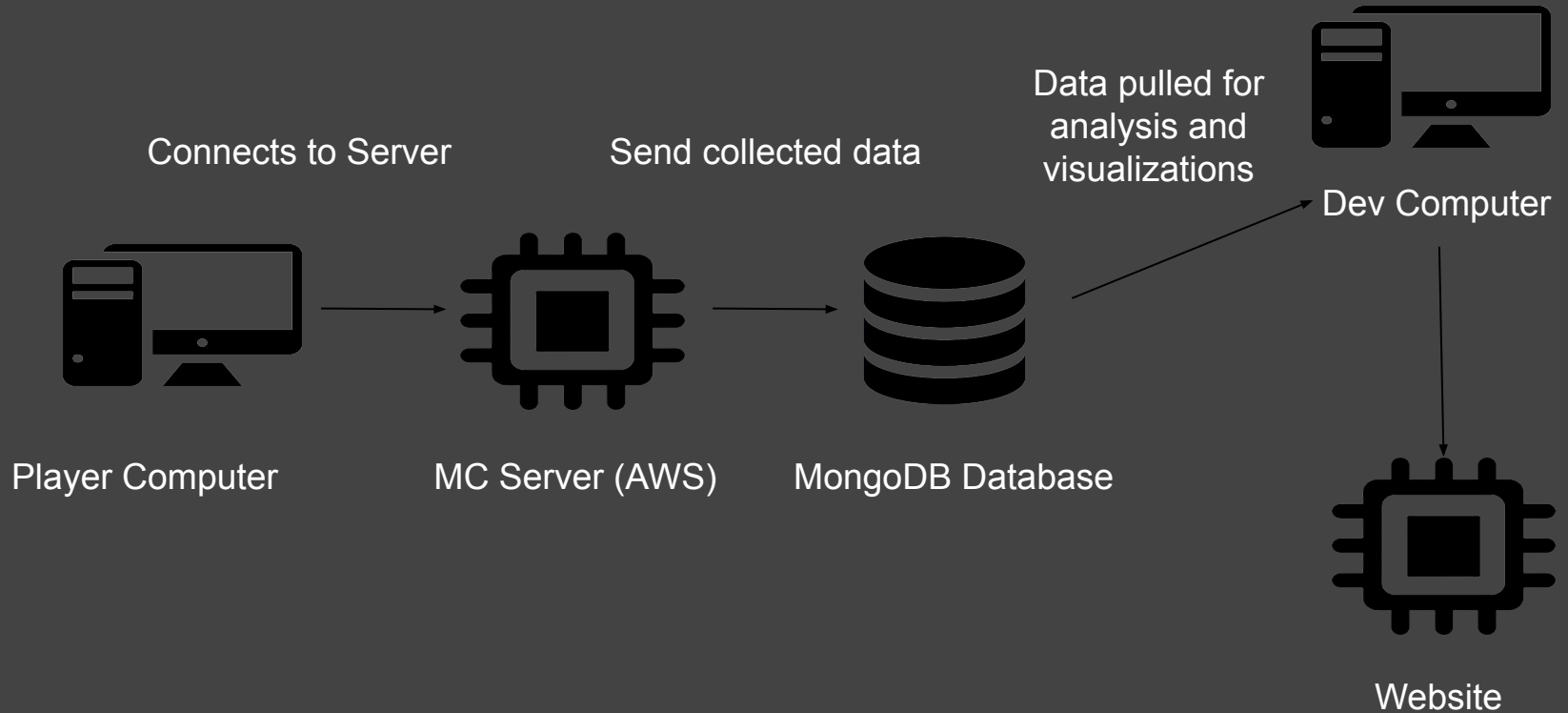
## Mining



**dinosaur10**

Distance: 4.613433622276968m

# System Design Diagram



## Example of player data

```
_id: ObjectId("6166f64890040f372e2e61a5")
✓ location: Object
  x: -80
  y: 67
  z: 2
player: "7ae1ce09e166b11edb08be2c58017837"
worldName: "world"
worldTime: 196990
event: "PlayerJoinEvent"
```

# Example of Activity data

```
_id: ObjectId("61a44d2135d4f33a2fd343ba")
> location: Object
  player: "cd1d675519ad2c32d140974f1a6f21a1"
  worldName: "world"
  worldTime: 81124670
  activity: "Exploring"
  ~ nearbyPlayers: Object
    ~ 0: Object
      player: "4ec2a2c48b7707339c2e090ed592f58c"
      distance: 2.14
```



# Example of Chat Data

```
_id: ObjectId("616760a7ee826c1e7ef70b3a")  
player: "7ae1ce09e166b11edb08be2c58017837"  
time: 643809  
message: "Are you guys teaming up"
```

# Significant Design Decisions

- Minecraft, why?
  - Popular game that mimics social situations.
  - The Defense Advanced Research Projects Agency (DARPA).
  - The Artificial Social Intelligence for Successful Teams (ASIST).
- Plugin vs Mod
  - Server-sided vs. Client-Sided.
- API for Development
  - Bukkit vs. Spigot vs. Paper.
- Data Storage
  - Cloud vs. Locally.

# Technologies Used

- Server Hosting: Amazon Web Services.
- Database: MongoDB Atlas.
- PaperMC.
  - Server framework.
  - Plugin library.
- Plotly.js: Web visualizations.
- HTML / CSS.
- Python: Post-Experiment Data Analysis.

# Recruiting Participants

- Flyers were posted on campus, Discord, Reddit, and advertised through student organizations with a survey link attached.
- Potential participants filled out the pre-survey which includes giving consent to gather data.
- Instructions to join the Minecraft server will be given once the survey is completed.

# Server Rules

- We will have very few restrictions on in-game actions.
- Only the spawn area will be protected.
- General rules of respect.
  - No profanity, racism, hate speech.
  - Be a decent human.
- Play as you would normally play.
- We also have a discord server for all players to collaborate, team up, etc.

# Institutional Review Boards (IRB)

Committee established to review and approve research involving human subjects.

## Requirements:

- Complete Collaborative Institutional Training Initiative (CITI) Program.
- Submit documentation to IRB and obtain approval.
- IRB approval needed to start collecting data.

# Challenges

- **Minecraft Server**

- Player Moderation.
- Player Count.
- Server Troubleshooting.
  - UCF Connectivity Issue.

- **Heat Map**

- Development.
- Stress Testing.

- **Administrative**

- Recruiting participants.
- IRB.
- Ambiguity.

# Successes

- Plugin/Backend.
  - New plugin worked with current Minecraft version, and increased efficiency.
- Team cohesion.
- Weekly meetings.
- Budget.
- Maintaining Minecraft server.
- Finish everything on time.



# Budget

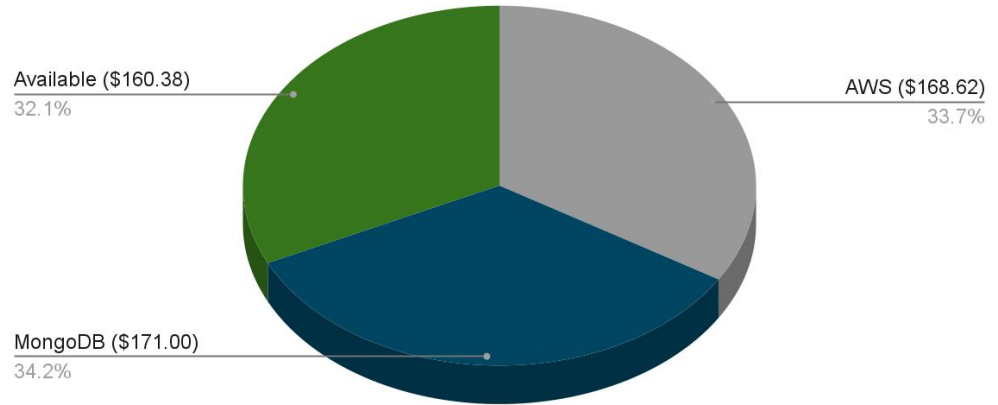
Available Funds- \$500

Estimated usage:

- AWS Server: \$ 84.31 x 2 mo
  - = \$168.62
- MongoDB Atlas: \$99.49  
(as of 12/01)

Available - \$231.89

Estimated Budget



# Aug. / Sept. - Schedule

Aug. Week 4 8	Sept. Week 1 8	Sept. Week 2 7	Sept. Week 3 6	Sept. Week 4 5
<b>Install VSCode extensions for Java Project environment</b> A Andrew Amado A Anthony Yu Completed	<b>Begin Plugin Creation</b> A Andrew Amado Completed	<b>Hook plugin to database</b> A Andrew Amado Completed	<b>Add/Change Survey questions?</b> Chloë Geller Completed	<b>[Chloë : Connor] Meeting</b> Chloë Geller C Connor Austin Completed
<b>Frontend creation process</b> Completed	<b>Set up Mongo server</b> A Andrew Amado C Connor Austin Completed	<b>Format Data Output</b> A Andrew Amado Completed	<b>Looking at Epilog to see all events used</b> Completed	<b>Have Heatmap working with sample local data file</b> C Connor Austin Completed
<b>IRB Paperwork</b> Chloë Geller Completed	<b>Touch up data processing script</b> C Connor Austin Chloë Geller Completed	<b>Refactor Code</b> A Andrew Amado Completed	<b>[Chloë : Connor] Meeting</b> Chloë Geller C Connor Austin Completed	<b>[Andrew : Anthony] Meeting</b> A Anthony Yu A Andrew Amado Completed
<b>Get CITI training done or check if it is</b> C Connor Austin Completed	<b>[Andrew : Anthony] Meeting</b> Completed	<b>[Chloë : Connor] Meeting</b> Completed	<b>[Andrew : Anthony] Meeting</b> A Anthony Yu A Andrew Amado Completed	<b>Sponsor Meeting</b> Completed
<b>Team Meeting</b> Completed	<b>[Chloë : Connor] Meeting</b> Completed	<b>[Andrew : Anthony] Meeting</b> Completed	<b>Sponsor Meeting</b> Completed	<b>Decide which events are being recorded in the plugin</b> A Andrew Amado A Anthony Yu Completed
<b>[Andrew : Anthony] Meeting</b> Completed	<b>Look at Minecraft Plugin Tutorials on YouTube</b> A Anthony Yu Completed	<b>Sponsor Meeting</b> Completed	<b>Get Quote for AWS Server</b> A Andrew Amado C Connor Austin A Anthony Yu Chloë Geller Completed	+ New
<b>[Chloë : Connor] Meeting</b> Completed	<b>Create new and use new branch for plugin on GitHub repository</b> A Andrew Amado Completed	<b>UI For website</b> C Connor Austin Chloë Geller Completed	+ New	
<b>Sponsor Meeting</b> Completed	<b>Copy of Sponsor Meeting</b> Completed	+ New		
+ New	+ New			



# Oct. / Nov. Schedule

Oct. Week 1 7

[Chloë : Connor] Meeting

 Chloë Geller  Connor Austin  
Completed

[Andrew : Anthony] Meeting

 Anthony Yu  Andrew Amado  
Completed

Hashing Usernames

Completed



Sponsor Meeting

Completed

Schedule meeting for setting up AWS server

 Chloë Geller  Anthony Yu  
 Connor Austin  Andrew Amado  
Completed

Complete Data Collection Plugin

 Anthony Yu  Andrew Amado  
Completed

Access database through website

 Connor Austin  Chloë Geller  
Completed



+ New

Oct. Week 2 8

[Chloë : Connor] Meeting

 Chloë Geller  Connor Austin  
Completed

[Andrew : Anthony] Meeting

 Anthony Yu  Andrew Amado  
Completed

Filter heatmap by time (slider)

 Connor Austin  
Completed

Be able to filter heatmap by event type

 Connor Austin  
Completed

Sponsor Meeting

Completed

CDR Presentation

 Chloë Geller  Connor Austin  
 Andrew Amado  Anthony Yu  
Completed

Integrate Data Processing Script with JS

 Chloë Geller  
Completed

Host Minecraft server on AWS server

 Andrew Amado  Anthony Yu  
Completed

+ New

Oct. Week 3 6



Finish Web Interface

 Chloë Geller  Connor Austin  
Completed

[Chloë : Connor] Meeting

 Chloë Geller  Connor Austin  
Completed

[Andrew : Anthony] Meeting

 Anthony Yu  Andrew Amado  
Completed

Sponsor Meeting

Completed

Advertise server to get players

 Andrew Amado  Chloë Geller  
 Anthony Yu  
Completed

Maintain Server

Completed



+ New

Oct. Week 4 4

[Chloë : Connor] Meeting

 Chloë Geller  Connor Austin  
Completed

[Andrew : Anthony] Meeting

 Anthony Yu  Andrew Amado  
Completed

Sponsor Meeting

Completed

Continue Working on Visual Tools

 Andrew Amado  Anthony Yu  
 Connor Austin  Chloë Geller  
Completed



+ New

Nov. 7

[Chloë : Connor] Meeting

 Chloë Geller  Connor Austin  
Completed

[Andrew : Anthony] Meeting

 Anthony Yu  Andrew Amado  
Completed

Sponsor Meeting

Completed

Finish the Visualization Tools

Completed

Update final design document

Completed

Close the Server

Completed

Finalize Final Presentation

Completed

+ New

# Finalizing the Project

- Closing the Minecraft Server.
  - Dec. 1st
- Remove any identifying information in the chat logs.
- Send all requested files and information to our sponsor.
  - The data our plugin collected, world files, and survey information.
- Providing world files to participants.

# Lessons and what we would do differently

- Establishing clearer rules on the Minecraft Server.
- Not use AWS.
- Including more events.
  - VehicleMoveEvent.
- Obtain a map of the Minecraft Server to overlay onto the Heatmap.

# Important Information for Demo

- Minecraft runs on a tick system.
  - A single day in Minecraft = 24,000 ticks = 20 minutes in real life.
  - 1,728,000 ticks = 24 Hours in real life.
- Minecraft has 3 unique dimensions.
  - The Overworld, The Nether, and the End.
  - OverWorld and Nether have a 1:8 ratio coordinate correlation.
- Our (x,y,z) is translate to (x,z,y) in Minecraft.
  - Z value is the Height in the Heatmap
  - Y value is the height in Minecraft.

# Interactive Heat Map

Main Visualization tool.

## Features

- 2D and 3D.
- Color Coded Dot-Density maps.
- Able to select specific details (e.g. player events).
- Can see when events occurred.
- Informational Tooltips.

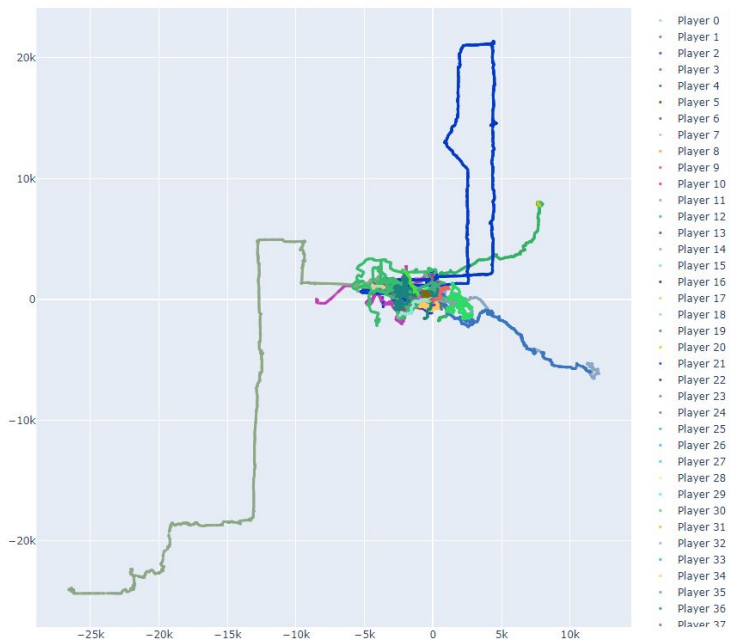
# 2D Map

## 2D Map

Overworld ▾ Movement ▾

The Overworld

PlayerMoveEvent





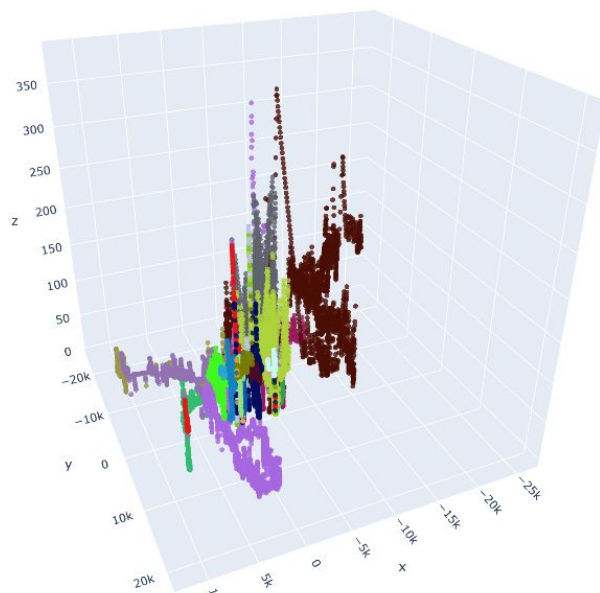
# 3D Map

Overworld ▾

Movement ▾

## The Overworld

PlayerMoveEvent



- Player 0
- Player 1
- Player 2
- Player 3
- Player 4
- Player 5
- Player 6
- Player 7
- Player 8
- Player 9
- Player 10
- Player 11
- Player 12
- Player 13
- Player 14
- Player 15
- Player 16
- Player 17
- Player 18
- Player 19
- Player 20
- Player 21
- Player 22
- Player 23
- Player 24
- Player 25
- Player 26
- Player 27
- Player 28
- Player 29
- Player 30
- Player 31
- Player 32
- Player 33
- Player 34
- Player 35
- Player 36
- Player 37

# Plugin Demo

# Website



## Group 21

### Measuring Collaboration in Minecraft: Interactive Heatmaps

#### Project Description

Our project aims to analyze Minecraft player behavior, such as movement, actions, chat interactions, and much more. We'll be using this data to build tools to analyze and visualize certain aspects where we hope to see complex emergent behavior, which can then be studied and applied to real world situations.

This project belongs to a Cognitive Science field called Theory of Mind (aka ToM). ToM is our ability to attribute mental states to ourselves and others, making it one of the foundational elements for social interaction. ToM is important since it provides us with the ability to predict and interpret the behavior of others.

Through Minecraft, we will be taking advantage of the fact that our subjects are human, and that their in-game behavior can be translated to real life behavior in many cases.

#### Document Links

CDR: [Here](#)

Demo: [Here](#)

Design Document: [Here](#)

#### Team Members



##### Chloë Geller

Chloë Geller is an undergraduate Computer Science student at the University of Central Florida. In the summer of 2021, she was in the MIT Summer Research Program - Center for Brains, Minds, and Machines. Chloë is currently a Research Assistant (RA) in the Computation, Cognition, and Development (CoCoDev) Lab at Harvard University. After UCF, Chloë will pursue a Ph.D. in Computational Cognitive Science, and continue as an RA in the CoCoDev Lab.



##### Connor Austin

Connor Austin is an undergraduate Computer Science student at the University of Central Florida. He will be graduating in the Fall semester of 2021 and currently works for Lockheed Martin as a machine learning engineer. In the future, Connor plans on working in the AI industry and getting his Ph.D. in Computer Science.

December 2021



##### Andrew Amado

Andrew Amado is an undergraduate Computer Science student at the University of Central Florida. He is currently employed by Orange County Public Schools as an instructional intern. After graduating, he will be relocating to Pennsylvania to pursue further career choices.

December 2021



##### Anthony Yu

Anthony Yu is an undergraduate Computer Science student at the University of Central Florida. He is currently a full time student and after graduating plans on staying in Orlando to pursue a career in the field of computer science.

December 2021

**Questions?**