ID2209 – Distributed Artificial Intelligence and Intelligent Agents

Final Project – Party Use Case

Group 13

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Overview: Enhanced Festival with Auctioneer Dynamics

The main goal is to show different behaviour and interactions between different types of agents in a party environment.
In this project, there are five different types of agents and two places where agents can meet.
Every agent has a parent species Person and inherits their skills (moving and fipa) and the type of control (simple_bdi) from it.

How to run

To run the simulation model developed in this assignment, please follow these steps:

- Open GAMA Platform version 1.7.
- Import the provided project files into GAMA by selecting File > Import, navigating to the 'General' folder, and choosing 'Existing Projects into Workspace'. Select the archive file and complete the import process.
- Locate the Model.gaml model within the imported project.
- Select the main experiment, which serves as the entry point for running the simulation.
- Press the 'Play' or 'Start' button to initiate the simulation run.

Species

Agent DieHardFan 🔴

The DieHardFan agent, distinguished by its red sphere representation, knows all the lyrics and dance moves and is fully immersed in the music.

Parameters Tweaking:
Adjusting these parameters will influence the agent's behaviour:

- enthusiasm: This trait measures their passion for the artist and their music. Higher enthusiasm means they will be more likely to express their excitement, dance energetically, and engage in enthusiastic chants.
- allegiance: This trait reflects their loyalty to the artist and their music. Higher allegiance means they will be more likely to sing along to every song.
- musicalRecognition: This trait reflects their ability to identify and appreciate different musical styles and genres. Higher musical recognition means they will more likely discuss the artist's musical background and influence.

If the enthusiasm of the agent is high, he will look for close people and start a conversation with them, asking if they are also enjoying the concert.

Agent Casual Observer 🟪🔺

The Casual Observer agent, distinguished by its pink pyramid representation, may not know every song, but appreciates the experience and is content to relax and take it all in.

Parameters Tweaking:
Adjusting these parameters will influence the agent's behaviour:

- passionForMusic: This trait measures their enthusiasm for the music genre being performed. Higher passion for music means they will be more likely to engage in discussions about the music.
- ingenuity: This trait reflects their creativity and ability to come up with fun initiatives.
- boredness: This trait determines their ability to empathize and connect with other fans.

If the agent is ingenue, he will start a conversation with the Critic species, to ask for info about the concert, through FIPA.
The other parameters influence the behaviour in the BDI control.

Agent Selfie Addict 🟡

The Selfie Addict agent, distinguished by its yellow sphere representation, spends significant time taking photos and recording snippets of songs. From the moment they arrive at the concert venue, the selfie addict is armed with their smartphone or camera, ready to capture every moment.

Parameters Tweaking:
Adjusting these parameters will influence the agent's behaviour:

- instaCredibility: This trait reflects their desire to capture memorable moments and share them on social media. Higher insta-credibility means they will be more likely to take selfies with the artist, capture crowd shots, and post live updates.
- attentionSeeking: This trait determines their craving for attention and validation through social media. Higher attention-seeking means they will be more likely to post selfies with creative captions.
- senseOfStyle: This trait reflects their interest in fashion and their desire to present themselves in a positive light. A higher sense of style means they will be more likely to take fashion-forward selfies and post stylish images of the concert experience.

If the agent is near a Bar, and its sense of style is high, he will ask someone to take a photo and then post it on social media.
The other parameters influence the behaviour in the BDI control.

Agent Critic 🟦

The Critic agent, distinguished by its blue box representation, analyses every aspect of the performance, from the artist’s stage presence to the sound quality.

Parameters Tweaking:
Adjusting these parameters will influence the agent's behaviour:

- musicalExpertise: This trait reflects their knowledge and appreciation of music. Higher musical expertise means they will be more likely to offer constructive criticism and engage in detailed discussions about the performance.
- verbalAssertiveness: This trait determines their confidence in expressing their opinions. Higher verbal assertiveness means they will be more assertive when giving feedback and engaging in debates about music preferences.
- OpenMindedness: This trait reflects their willingness to consider different perspectives on music. Higher open-mindedness means they will be more open to discussing varying opinions and appreciating different genres.

If the agent is open-minded, and he is near one of the concerts, he will look for someone to talk with and criticize the music. He will converse with the Casual Observers when they talk with him, only if his verbal assertiveness is high.
The other parameters influence the behaviour in the BDI control.

Agent SocialButterfly🟧

Behaviour: The SocialButterfly agents are created to mimic extroverted, curious, and communicative personalities. These agents actively seek social interactions and are highly engaged with other agents within the festival environment.

Parameters Tweaking:

- Introversion: Influences the likelihood of seeking social interactions. Lower introversion increases social engagement.
- Curiosity: Drives the agent to explore and interact within the festival, leading to new encounters.
- Talkativeness: Impacts the frequency and extent of the agent's conversations with others.

BDI Implementation:

- Beliefs: Recognizing potential social interaction opportunities, such as identifying crowded concert areas.
- Desires: Aimed at seeking interactions and socializing with other festival participants.
- Intentions: Executing specific plans for interaction, like moving towards a busy concert area or initiating conversations.

Interaction with the Environment: SocialButterfly agents utilize their curiosity to roam the festival, gravitating towards crowded areas, particularly concerts, to fulfil their socialization objectives. They initiate and engage in conversations, enhancing the dynamic and vibrant atmosphere of the festival.

Expected Outcomes: An increase in social interactions, especially in densely populated areas.
An enriched dynamic behaviour among agents, reflects a more lifelike social setting.

Implementation

In our simulation, we created an enhanced festival environment featuring a variety of agents and dynamic auctioneer interactions. Each agent type, inheriting from the base species Person, possesses unique traits influencing their behaviours, which are enriched by the moving and fipa skills, and controlled by the simple_bdi architecture.

Species Implementation Details

1. DieHardFan: Modeled to actively seek out musical stages and initiate conversations with nearby attendees, their level of enthusiasm, allegiance, and musical recognition governs their likelihood to engage with the environment and other agents.
2. Casual Observer: Designed to enjoy the festival atmosphere, their parameters such as passion for music, ingenuity, and boredom affect their choices, including engaging with Critics for insights into the event.
3. Selfie Addict: Focused on documenting the festival experience, their behaviour is dictated by instaCredibility, attentionSeeking, and senseOfStyle. They look for photo opportunities, especially near bars, and share their moments on social media.
4. Critic: With a keen eye for performance details, their musical expertise, verbal assertiveness, and open-mindedness shape their interactions. They provide critiques of the concerts and engage with Casual Observers for discussions.
5. SocialButterfly: Characterized by their extroverted and friendly nature, these agents embody the social spirit of the festival. Their introversion, curiosity, and talkativeness dictate their eagerness to engage in social interactions. They actively seek crowded areas and initiate conversations, enriching the festival's social dynamic.

Places where agents can meet

These locations serve as social hubs where agents can interact and have drinks, contributing to the overall vibrancy of the festival atmosphere.

1. Bar: In the party area there are several Bars, represented by red boxes. They have one parameter tweaking, the hasDrink.
2. Concerts: In the party area, there are several concerts with different artists, represented by green cylinders. They have two parameters tweaking, the hasMusic and isCrowded

Results

Total Interactions

We plotted "Total Interactions" over "Time", and observed the following:

- Linear Increase in Interactions: The number of total interactions seems to increase linearly over time. This suggests that the interaction rate (interactions per time unit) is constant. In other words, the agents in your simulation are interacting at a steady rate as time progresses.
- No Saturation Point Observed: Since the interactions continue to increase and there is no plateau in the chart, it appears that the simulation does not reach a saturation point within the observed timeframe. A saturation point would be indicated by a levelling off of the line, meaning the interactions per time unit would decrease, which could happen if

agents have a maximum interaction limit or if they change behaviour after a certain number of interactions.

- Consistent Agent behaviour: The consistency in the slope of the line suggests that agent behaviour does not significantly change over time, or that any changes in individual agent behaviour balance out when considering the total number of interactions.

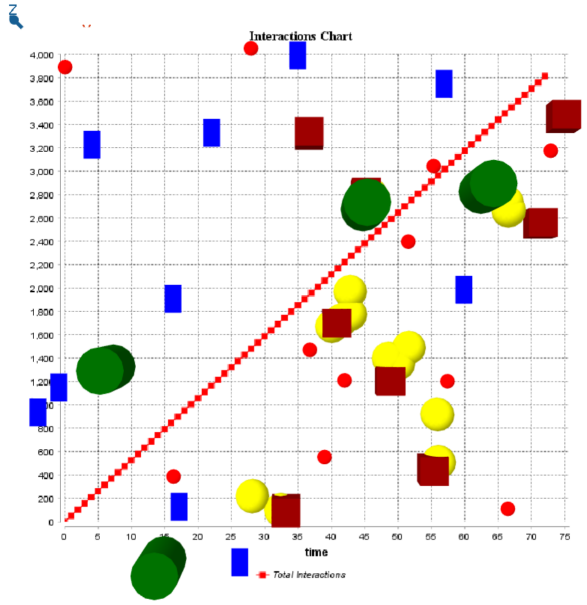

Figure: Total Interactions Chart

Happiness Metric

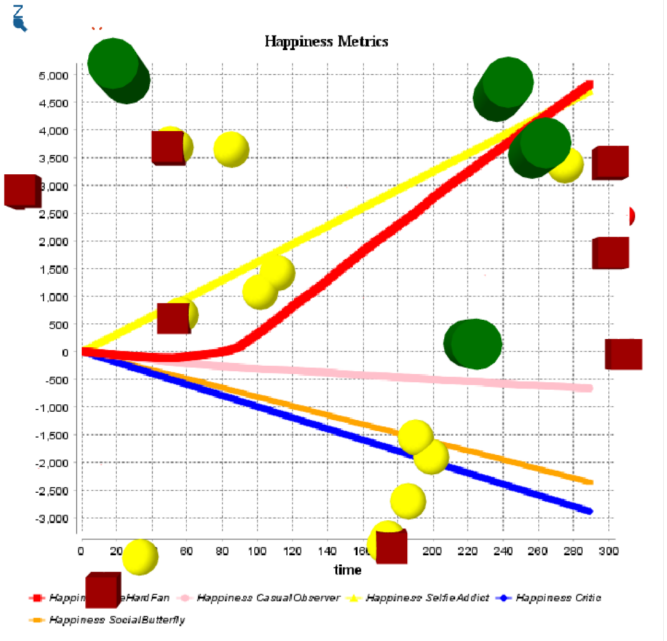

Figure: Happiness Metric for each agent type

The graph in this section titled "Happiness Metrics" represents the happiness levels of five different agent types over time in a simulated party environment. Each agent type's happiness is depicted by a distinct colour line, indicating how their happiness changes as the simulation progresses.

- The DieHardFan agents, represented by the red line, show a positive trend in happiness. This suggests that their interactions at the concert venues are fulfilling their desires, such as enjoying the music or engaging with other fans, which boosts their happiness.
- The CasualObserver agents, shown with a pink line, have a fluctuating happiness level that trends upward. Their happiness may be dependent on finding bars or interacting with critics, indicating varied experiences throughout the simulation.
- The SelfieAddict agents, with a yellow line, also display a positive trend. Their happiness increases when they are able to take selfies and interact with others at bars, reflecting their attention-seeking and style-conscious behaviours.
- The Critic agents, marked by a blue line, demonstrate a notable increase in happiness when they engage in music criticism at concerts, aligning with their expertise and assertiveness traits.
- The SocialButterfly agents, represented by an orange line, show a significant rise in happiness. This is likely due to their successful social interactions at crowded concerts, fulfilling their talkative and curious nature.

Overall, the graph indicates that all agent types have opportunities to increase their happiness through interactions and activities aligned with their traits and preferences. However, some agents experience more significant gains than others, suggesting differences in how each agent type's desires are met within the simulation environment.

The steady increase in happiness across most agent types suggests that the simulation provides ample opportunities for fulfilling interactions, contributing to an overall positive experience for the simulated agents.

Challenge 1

In the first challenge, our task involved incorporating a BDI (Belief Desire Intention) control within our agents. BDI is a model of human practical reasoning that has been adapted for use by autonomous agents in multi-agent systems. The BDI architecture involves agents that possess beliefs about the world, desires representing objectives they want to achieve, and intentions signifying the commitments they make to achieve these desires. This architecture serves as a framework to separate the process of choosing a plan from actually executing the plans that are currently active. This separation enables BDI agents to effectively manage their time between deliberating on what to do (selecting a plan) and carrying out those chosen plans (taking action).

To implement this architecture across all agents, we followed a systematic approach. Initially, we established a desire using specific predicates and integrated it into the agent using the 'add_desire' function. Subsequently, we formulated a plan to fulfil this intention. Then, we defined a belief rule indicating that once the agent fulfils its initial desire, it should introduce a new desire with a certain level of importance or strength to complete an action comprehensively. This cycle of desires, beliefs, and plans continued iteratively until we achieved the desired outcome. Finally, to signal to the agent that a particular desire no longer needed fulfilment, we utilized the 'remove_belief' function to eliminate the associated beliefs. This systematic process allowed us to effectively manage the decision-making and action-taking aspects of our agents using the BDI architecture, ensuring a balance between contemplating plans and executing them.

Here's how we implemented BDI for each agent species:

- DieHardFan agents possess beliefs about the location of stages with music, a desire to find and move to the stage, and intentions to enjoy the music once they reach the stage. Their happiness increases when they engage with music, indicating a fulfilled desire.
- CasualObserver agents have beliefs about the locations of bars when they are bored, a desire to find a bar, and intentions to take a drink there. Their happiness fluctuates but generally increases when they find a bar and can relax, showing their desires being met.
- SelfieAddict agents hold beliefs about good spots for selfies, desire to capture these moments, and intend to share them on social media. Their happiness trends upwards when they successfully take and post selfies, fulfilling their attention-seeking desires.
- Critic agents have beliefs about concerts' quality, a desire to engage in musical critique, and intentions to discuss their views with others. Their happiness spikes when they can express their opinions, reflecting their fulfilled desires for intellectual engagement.
- SocialButterfly agents believe in finding social interactions, desire to engage with others, and intend to socialize at crowded concerts. Their sharp rise in happiness when socializing indicates their extroverted desires are being satisfied.

For each agent, the fulfillment of desires is directly linked to an increase in their happiness metric, which we successfully monitored and plotted over time. This approach clearly demonstrates the BDI architecture's impact on agent behaviour within our simulation, as reflected in the happiness metrics chart.

In summary, we implemented BDI behaviour across different agent species by defining their beliefs, desires, and intentions in line with their unique traits and the simulated environment's opportunities. The increase in happiness metrics for each agent type over time in the simulation provided clear evidence of BDI behaviour, successfully fulfilling the requirements of Challenge 1.

Challenge 2

For Challenge 2, our objective was to introduce reinforcement learning (RL) into our agents' behaviour to enable them to learn and improve over time based on their experiences. This challenge was particularly complex as it required a departure from pre-defined behavioural scripts to dynamic decision-making processes that evolve as the simulation progresses.

DieHardFan RL Implementation:

- States and Actions: We defined a set of states representing whether the DieHardFan is wandering, searching for a stage, or at a stage. The actions included moving to the stage, listening to music, and leaving the concert.
- Q-Table: A Q-table was initialized with default values for state-action pairs, serving as the learning mechanism for the agent to evaluate the expected utility of actions in each state.
- Reflexes: Reflexes were created to transition between states and to make decisions based on Q-values. For example, when music is recognized, the DieHardFan enters a state of searching for the stage.
- Reward System: A reward system provided positive feedback for finding and enjoying

music at a stage, which updated the Q-values and reinforced the desired behaviour.

- Metrics: To evaluate learning, we tracked the average time the DieHardFan took to find a stage, the total rewards accumulated, and the number of successful stage findings.

CasualObserver RL Implementation:

- States and Actions: The states for the CasualObserver included wandering, searching for a bar, and being at a bar. Actions involved moving towards a bar, ordering a drink, engaging in conversation, or leaving the bar.
- Q-Table: A similar Q-table to the DieHardFan was set up for the CasualObserver, dictating the learning process for bar-related activities.
- Dynamic behaviour: The CasualObserver's behaviour dynamically changed based on the accumulated experience, choosing actions that led to increased happiness.
- Rewards: Rewards were given for successful social interactions at bars and penalties for aimless behaviour, with the Q-table reflecting these experiences to guide future actions.

The integration of RL into these agents resulted in adaptive behaviours where the DieHardFan became more efficient at finding stages to enjoy their favourite music, and the CasualObserver improved their ability to find satisfying social interactions at bars. The RL framework allowed these agents to make decisions based on past experiences, which were visualized in the simulation through updated happiness metrics.

In conclusion, Challenge 2 was successfully met by implementing reinforcement learning within the DieHardFan agents, enabling them to learn from their experiences and improve their decision-making processes over time, which was demonstrated in both our presentation and report.