



Co-funded by
the European Union



MINISTRY OF EDUCATION,
YOUTH AND SPORTS

Information Spread Modelling Using Generative Agents

Petra Vidnerová, Gábi Kadlecová, Roman Neruda, Josef Šlerka

June 26, 2024

CoRE Project

Acknowledgement

This work was supported by the European Regional Development Fund project “Beyond Security: Role of Conflict in Resilience-Building”

(reg. no.: CZ.02.01.01/00/22_008/0004595).



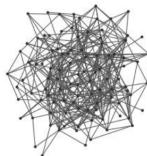
**Co-funded by
the European Union**



- Multi-agent network models
- Generative Agents
- Generating conversations in small agent communities
- Experimental results

Multi-agent network models

- Used both for infection and information spread modelling
- Agent models work with a **population** of individuals
- Each individual is in exactly one of the possible **states**
- Agents are connected in a **network**, i.e. a contact graph, each node represents one individual
- Spread of infection/information **depends** on the **graph**
- Nodes can have **attributes**



- Agents provide simulation tools for modelling of **individual human behaviour**

SIR

- An agent gets infected with probability β if it has a positive contact
- Agents evaluated each time step

Tipping Model

- Deterministic model
- Each time step agents become positive if the percentage of positive neighbours is higher than a given threshold

What agents offer and simple models do not

- Detailed simulations
- Each individual can have its own attributes and behaviours
- Infection mechanism can be more complex, such as combining simple SIR and Tipping models
- We can modify the network during the simulation run
- The model can be very complex, but simple is often better

Agent Models with Generative Conversations

- Attempt for natural conversations between agents
- Inspired by Generative Agents (see the next slide)

Generative Agents

Generative Agents: Interactive Simulacra of Human Behavior

Joon Sung Park
Stanford University
Stanford, USA
joonspk@stanford.edu

Joseph C. O'Brien
Stanford University
Stanford, USA
jobrien3@stanford.edu

Carrie J. Cai
Google Research
Mountain View, CA, USA
cjc@ai.google.com

Meredith Ringel Morris
Google DeepMind
Seattle, WA, USA
merrie@google.com

Percy Liang
Stanford University
Stanford, USA
pliang@cs.stanford.edu

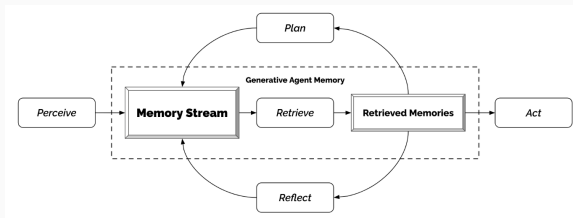
Michael S. Bernstein
Stanford University
Stanford, USA
msb@cs.stanford.edu



<https://doi.org/10.48550/arXiv.2304.03442>

Generative Agents

- LLMs encode a wide range of **human behaviour**
- Use LLMs to **generate believable behaviour**
- Memories saved in **comprehensive language**
- **Gpt3.5-turbo** version of ChatGPT



Agent Model with Generative Conversations

- Agents connected in a graph
- Edges represent the possibility of a contact between two agents, a contact means the two agents have a chat
- A chat is a sequence of natural language statements (sentence, group of sentences)
- Statements generated via LLMs
- [Mixtral-8x7B-Instruct-v0.1](#), run locally on three NVIDIA A40
- [Cohere Coral](#) so far not better, free plan is not enough for experiments
- Does not scale to large agent communities

Agent Memory and Conversation Mechanisms

Memory

- Each agent has a memory - a list of natural language statements
- General memory, memory for each colleague
- After each communication step an LLM is asked to summarize it into a fact (saved into memory)

Conversation

- A meets B, we randomly select who starts a conversation
- A starts, generates a statement based on its description, its general memory and its memory corresponding to B
- B replies based on its description, its memories and the conversation so far
- A replies until one of them says goodbye or max. reach

Quantifying Information Spread

- Need for quantifying the information spread
- Each step (after each single chat, i.e. meeting of two agents) each agent is asked a YES/NO question
- For example:
"Isabella is
Here is a list of her memories:
Does she know?"
- Mixtral does not tend to reply in one word (yes/no)
- Forcing it with example output format: *YES*, *NO*
- Still we get outputs like *POSSIBLE*

Preliminary Experiments

- Does information spread between agents?
- Can we quantify it?

Experiment I - Isabella's Party



Isabella - 34 yo, owner of Hobbs Cafe, planning Valentine's Day party

Maria - 21 yo, physics student, game streamer

Klaus - 20 yo, sociology student, writing a research paper on gentrification

(all three persons taken from Generative Agents example project)

Experiment I - Isabella's Party

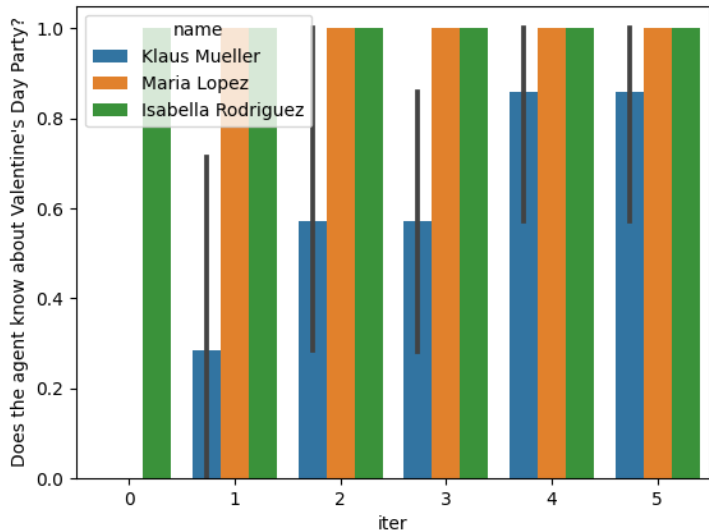
Question: Does information about Valentine's Day party reach Klaus?

Setup

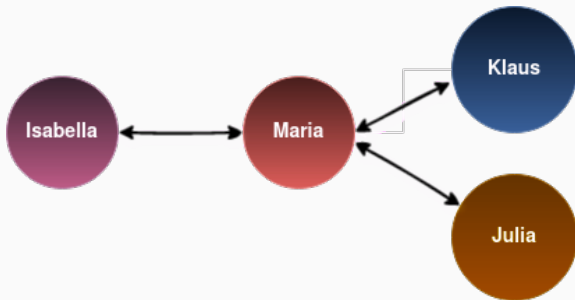
- One iteration - Isabella and Maria meet, Maria and Klaus meet
- Maximum of 6 replies



Experiment I - Isabella's Party



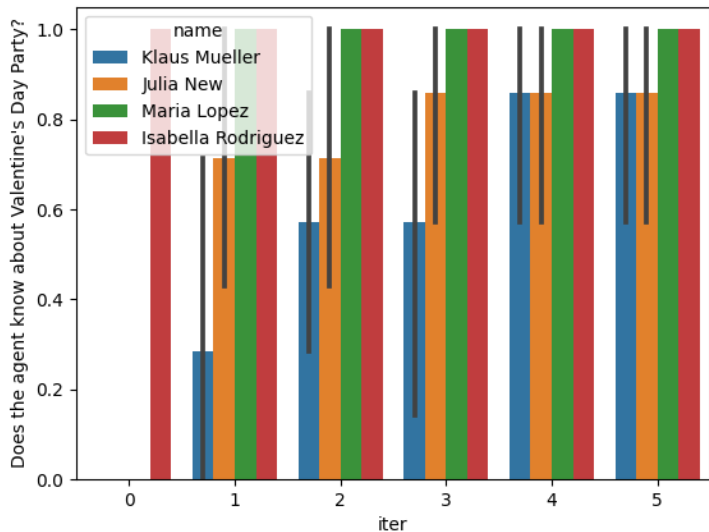
Experiment II - Isabella's Party



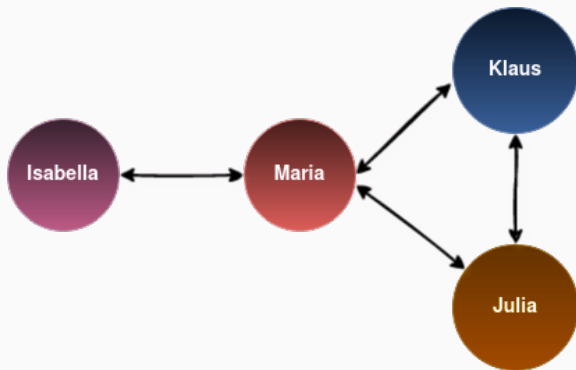
Julia - 22yo, florist, sociable, loves partying

Setup One iteration: first Maria meets Isabella, then meets Klaus and Julia in random order

Experiment II - Isabella's Party

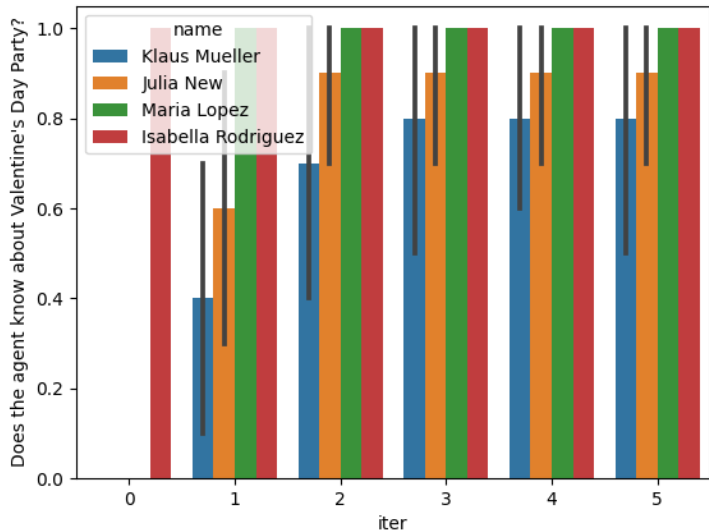


Experiment III - Isabella's Party



Setup One iteration: first Maria meets Isabella, then in random order, the three remaining edges are activated

Experiment III - Isabella's Party



Examples of dialogues

2024-06-19 23:12:12,376 - INFO - Isabella Rodriguez meets Maria Lopez
2024-06-19 23:12:12,376 - INFO - ISABELLA RODRIGUEZ: Hello there, I'm Isabella Rodriguez, the owner of Hobbs Cafe. I noticed you here in our cafe, and I just wanted to say hello and welcome you. By the way, I'm planning a Valentine's Day party here at the cafe on February 14th, 2023, from 5 to 7 pm. I'd love it if you could join us! I'm gathering party materials and making sure everything is perfect for our customers to have a great time. I hope to see you there!
2024-06-19 23:12:33,666 - INFO - MARIA LOPEZ: Hello Isabella, I'm Maria Lopez, a student at Oak Hill College. I come here to Hobbs Cafe every day to study and eat, and I love the atmosphere you've created here. Thank you for inviting me to the Valentine's Day party! I would be delighted to attend and I'm looking forward to it. I'm sure it will be a lot of fun.

2024-06-19 23:14:01,404 - INFO - Klaus Mueller meets Maria Lopez
2024-06-19 23:14:01,404 - INFO - KLAUS MUELLER: Hello, I couldn't help but notice you over here. I'm Klaus Mueller, a sociology student at Oak Hill College. I'm currently working on a research paper about the effects of gentrification in low-income communities. I was wondering if you might be interested in sharing your thoughts or perspectives on the topic, as I'm eager to learn from different viewpoints.
2024-06-19 23:14:27,904 - INFO - MARIA LOPEZ: Hi Klaus, I'm Maria Lopez, a physics student at Oak Hill College and a part-time Twitch game streamer. I'd be happy to share my thoughts on gentrification with you. It's an important issue that affects many communities, including the one where Hobbs Cafe is located. I often visit the cafe, and the owner, Isabella Rodriguez, has shared her concerns about the impact of gentrification on her business and customers. I'm looking forward to the Valentine's Day party she's hosting, but I also worry about the long-term effects of gentrification on the community's diversity and affordability.
2024-06-19 23:14:52,020 - INFO - KLAUS MUELLER: Thank you for sharing your thoughts, Maria. I'd love to be

2024-06-20 10:55:28,068 - INFO - Julia New meets Klaus Mueller
2024-06-20 10:55:28,068 - INFO - JULIA NEW: Hi Klaus! It's great to see you again. I heard from Maria that you're working on a research paper about the effects of gentrification in low-income communities. I'm really interested in that topic, especially since I've noticed some changes in my neighborhood that could be related to gentrification.

Advantages and Disadvantages

Pros

- Conversation in natural language
- Enables to study framing and other aspects

Cons

- Computationally intensive
- Noise in replies
- At the moment the lack of a benchmark or ground truth

Future Work

- Tune the YES/NO questions
- Let the agent have a plan or BDI
- Try to replicate a real-world experiment

That's all.

Thank you!

Questions?

