

LLM 4 ABM SIG Meeting



Exploring Conversational AI for Agent-Based Social Simulation Design

Paper available at <https://www.jasss.org/28/3/2.html>

Peer-Olaf Siebers

peer-olaf.siebers@nottingham.ac.uk

27/05/2025

Motivation



<https://deepai.org/machine-learning-model/cute-creature-generator>

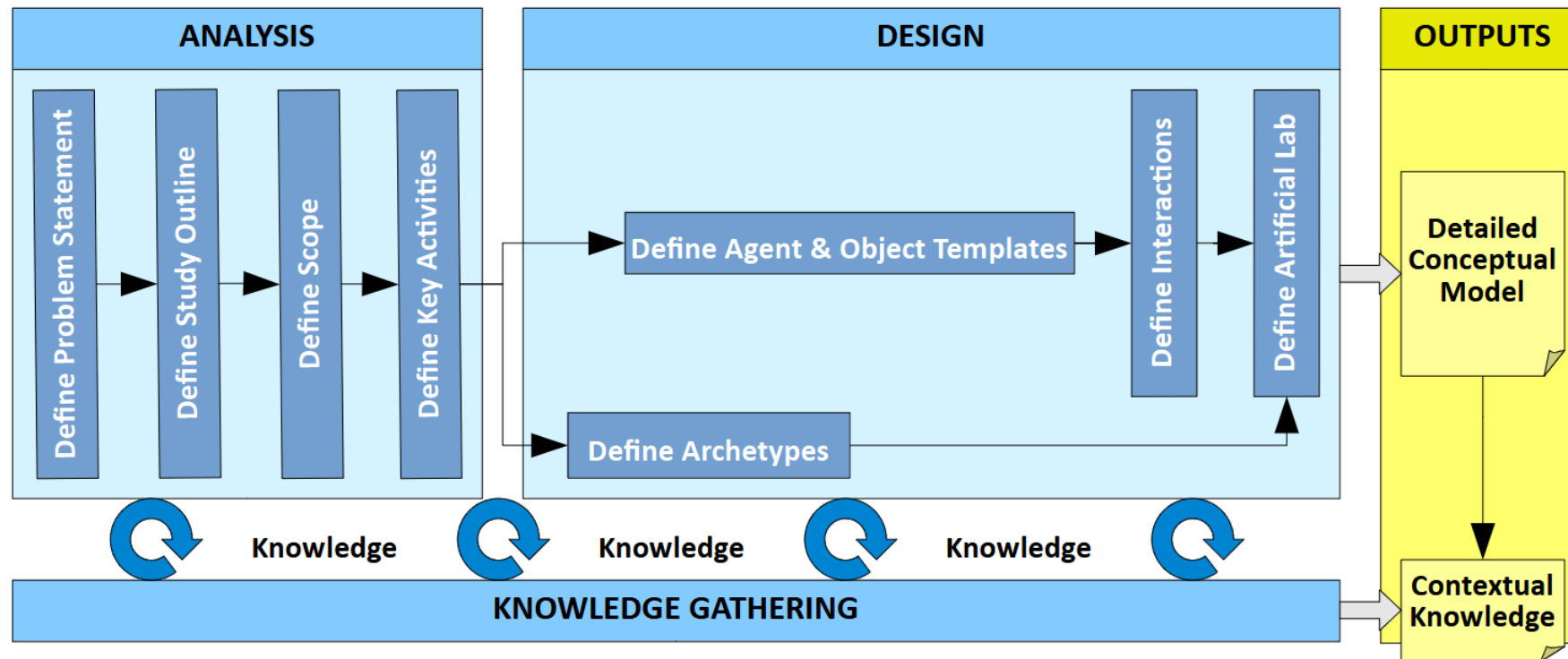
- Conversational AI Systems such as ChatGPT are good for conversations
- When tasked to produce an innovative ABM from scratch, we often struggle
- Conceptual modelling can be seen as having an internal dialog or a conversation with stakeholders about requirements and other relevant factors for ABM design
- Why not using ChatGPT as a buddy for innovative ABM design?

Aim and Objectives

- Aim
 - Demonstrate how ChatGPT can facilitate the development of innovative conceptual ABM in a concise timeframe and with minimal required upfront case-based knowledge
- Objectives
 - Explore the use of ChatGPT for conceptualising ABMs
 - Explore the use of ChatGPT for running focus groups with virtual stakeholders
 - Develop a structured methodology for collaborating with ChatGPT
 - Evaluate the effectiveness of ChatGPT in generating innovative ideas
 - Demonstrate time efficiency and cognitive support provided by ChatGPT

Conceptualising Agent-Based Models

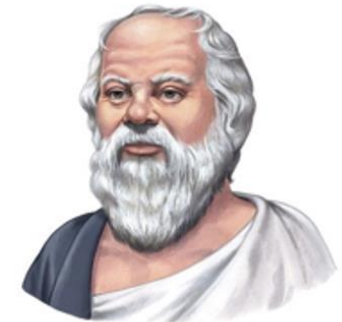
- The Engineering Agent-Based Social Simulation (EABSS) Framework



Adapted from Siebers & Klügl (2017)

The EABSS Framework

- Two different use cases
 - Using it for co-creation (original intent)
 - Mini focus group of **4-5 participants** (including moderator) work best
 - Confucius vs Socrates
 - Collaborative brainstorming: mainly discussions (information gathering); debates only when needed
 - Moderator (usually the modeller)
 - Will often also act as a stakeholder
 - Will guide the discussions
 - Using it as an individual for model design
 - Going through the process step-by-step
- Iterative process
 - Reuse of information from previous steps
 - Important to go forward and backwards



Engineering Agent-Based Social Simulations

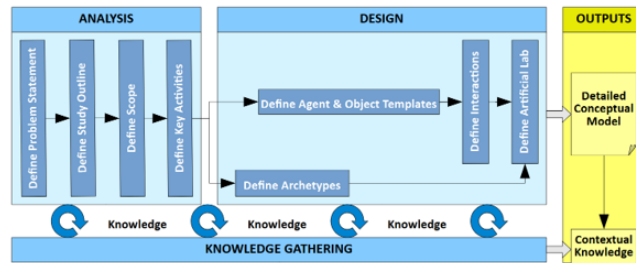
Peer-Olaf Siebers

School of Computer Science, University of Nottingham, UK

Email: peer-olaf.siebers@nottingham.ac.uk

Brief Summary with Example Snippets

High level overview of the EABSS-2



Small print **orange remarks** are meant to guide the focus group moderator regarding the re-use of information; **purple remarks** list the tools to be used in that particular step.

Define Problem Statement (also clarify terminology and come up with a common pool of term definitions)

- Clarify the "Purpose" of the model, if not provided by the client:
 - Study title
 - Broad theme(s) (Blue Sky; Toy; Organisation Studies; Social Studies; Operations Research; Operations Management; Economics; Ecology; ...)
 - Sub-theme(s) (Service Systems; Emergency Modelling; Organisational Cognition; Human/Natural Systems; Occupant behaviour; ...)
 - Study approach (level of abstraction [strategic ...]; purpose [exploratory ...]; driver [theory ...])
 - Study context (background information that provides a framework for understanding the research problem and its significance)
 - Study aim (a broad statement indicating the general purpose of your simulation study; consider title + themes + context)

Define Study Outline (also clarify terminology and come up with a common pool of term definitions)

- Define a list of "Objectives" (and constraints) to be fulfilled and/or "Hypotheses" to be tested (objectives: how you plan to achieve your aim; hypotheses: an attempt at explaining a phenomenon or the relationships between phenomena/variables in the real world)
- Define a list of "Experimental Factors" (parameters) to allow creating scenarios relevant to testing objectives and/or hypotheses (look at objectives/hypotheses to work these out)
- Define a list of "Responses" (outputs/statistics) for measuring if objectives have been achieved and to test if hypotheses should be accept/reject (look at objectives/hypotheses to work these out)

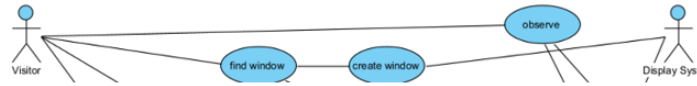
Define Scope (what do we need to represent to fulfil the aim; use "Context" words captured and "nouns" from the previous answers)

- List entities (key actors - represented by the role they play, and key objects) and concepts (key actors can also represent social/economic units, as for example families or firms)
- Indicate if these should be included/excluded in the model and justify your decision
- Use pre-defined table (COLUMNS: Category; Sub-Category; Element; Decision; Justification; CATEGORIES: Actor; Physical Environment; Social and Psychological Aspects; Misc)

Category	Sub-Category	ID	Element	Decision	Justification
Actor	Human	A01	Visitor	Include	Main research subject
		A02	Group	Include	Important for capturing group behaviour
		A03	Staff	Exclude	Have no impact on the dynamics
	Intelligent	A04	Content window	Include	Intelligent artefact that can make proactive decisions

Define Key Activities (actors come from scope table; key activities come from objectives/hypotheses and by creating user stories)

- Formulate user stories: As <actor>, I want to <what?> (so that <why?>)
- Assign key actors to relevant key activities (use cases)
- Use UML use case diagram



Define Archetypes (these allow to define behaviour of actors; units and values are not really required at this stage, but should be captured if they emerge from the discussion)

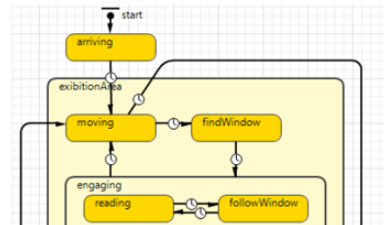
- Come up with categorisation schemata for relevant key actors (agents) that will allow to separate a simulated population into behaviourally different groups
- Use habit template(s) and/or demographics and/or utility function(s)

Visitor: Interest-related behaviour	
Archetype	Reading time [seconds]
Disinterested visitor	3-10
Average visitor	10-40
Researcher	40-90

Define Agent & Object Templates (AGENT LEVEL) (state charts: states can often be derived from use cases; state variables are often a level of something, e.g. tiredness level; state transitions: transition start/end can be derived from state chart; agent & object classes: attributes can be derived from archetype criteria and by looking at the scope table; operations can be derived from the states in the related state charts)

- The following is done in parallel
 - Create state chart templates by defining key states an entity can be in and how these are linked
 - List State variables (dynamic variables representing entity states)
 - Create a table that defines triggers for transitions
 - Create classes (3 sections) providing a name, listing attributes, and listing activities and conditional checks
 - Use UML state machine diagram(s); transition table(s); class definition(s)/diagram(s)

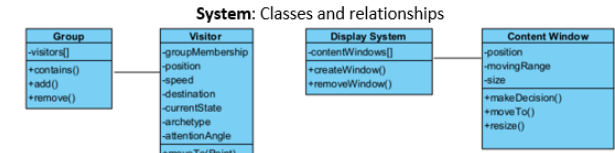
Visitor: State chart



Visitor: State transitions

From State	To State	Trigger Type	Notes
arriving	moving	Timeout	Pseudo state; takes no time; adds transparency
moving	findWindow	Condition	Choose window
findWindow	engaging	Timeout	Pseudo state; takes no time; adds transparency
engaging/reading	engaging/followWindow	Timeout and Condition	Linked to archetype

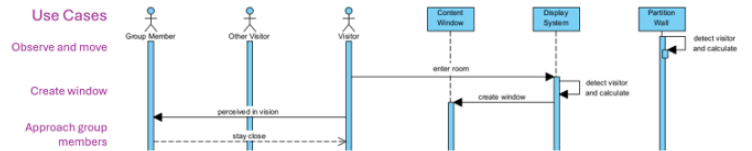
Visitor: State variables: Location; mood; interest/fatigue/satisfaction level



[] indicates a collection of elements
() indicates that we are dealing with an operation

Define Interactions (SYSTEM LEVEL) (all elements defined in the Agent and Object Templates step need to be listed on the horizontal axis; use cases could be listed on the vertical axis; alternatively, a separate diagram could be created for each individual use case)

- Define sequences of interactions that can take place between agents and between agents and objects in specific use case realisations
- Use UML sequence diagram(s)



Define Artificial Lab (attributes provide storage for all agents and objects and initialisation parameters required for experimental factors; operations are related to responses; averages of agent and object dynamic variables could also be calculated)

- List entities that need to be created; listing variables that ought to be tracked at the macro level to gain insight about the issues identified during the problem analysis
- Define order of execution (if relevant)
- Use UML class definition for capturing class content and sequence diagram(s) for capturing execution order

Museum	
-individualVisitors[]	
-groups[]	
-structures[]	
-displaySystem	
-partitionWall	
-movementModelParameters[]	
+initialise()	
+calculateVisitorClusters()	
+calculateAverageVisitTime()	

Opportunities for using ChatGPT in Collaboration with EABSS

1. ChatGPT as an idea generator for developing novel and innovative project ideas
2. ChatGPT as an impersonator for representing absent focus group participants, providing their perspectives during discussions and debates
3. ChatGPT as a trainer for EABSS moderators
4. ChatGPT as a mentor, helping when ideas are scarce, before, during, or after each EABSS step within a focus group session
5. ChatGPT as an expert for filling gaps in a focus group report after the focus group session is completed

In the paper I focus on the first two

Methodological Considerations (1/2)

- Prompt engineering Busch et al (2023)
 - Context or background information; clear instructions; example(s); constraints or guidelines; acknowledgement of ambiguity; and feedback loop to critically assess answers
- Scripting principles
 - Easy to maintain and extend; accessible for everyone
- Embedding the concept of co-creation

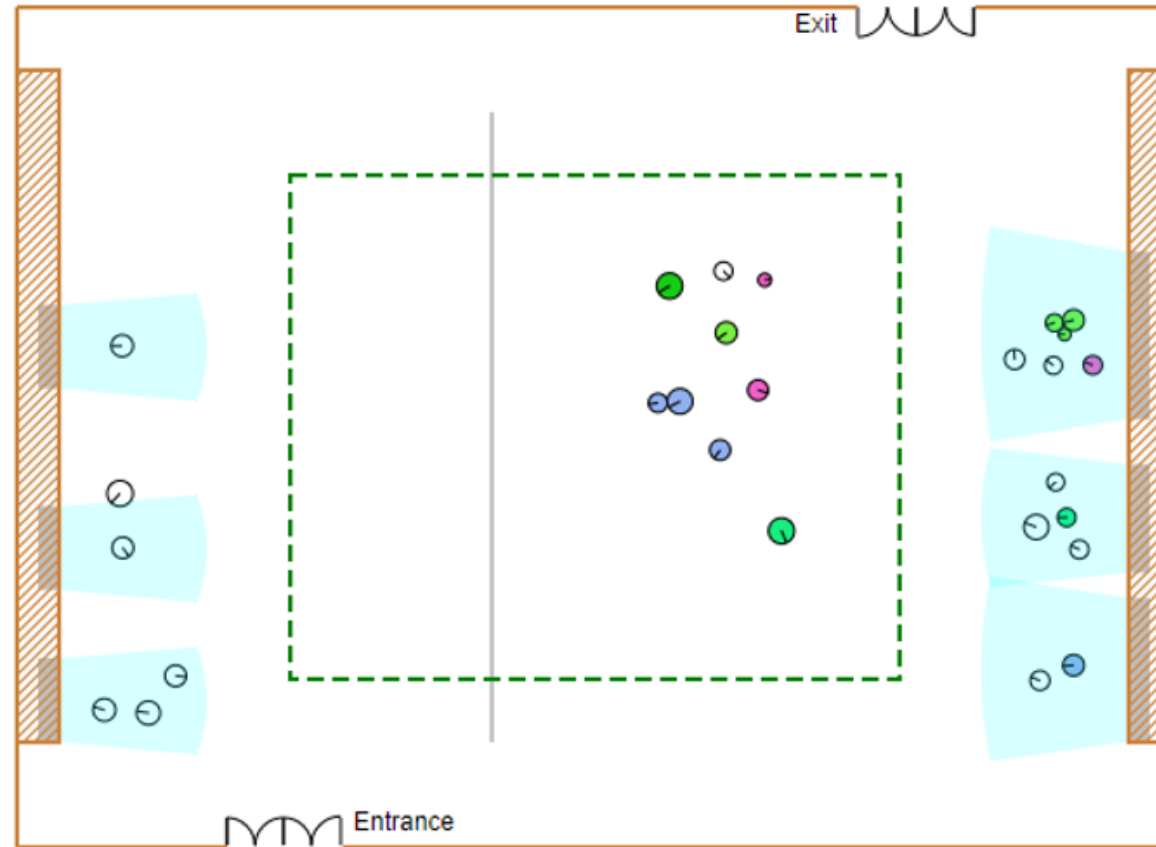
Methodological Considerations (2/2)

- Controlling conversation flow through human intervention
- Controlling the level of stochasticity for LLM responses (temp + top_p)
- LLM fine-tuning
- Concept validation
 - Criteria: Usability; Generality; Pertinency; Readability; Conformity; Believability; Originality

EABSS Script Details

- Script segmentation
 - Preparation; Problem Analysis; Model Design; Conclusion
- Prompt design strategies (for making ChatGPT do what "you" want ;-)
 - Chat preparation; avoiding response display; roles and tones; reuse of information; prompt clarity and structure; script-based visualisation; refining responses
- Prompt design patterns (reusable complex prompt templates)
 - General pattern; co-creation pattern; table pattern; diagram pattern

Validation Experiment



- Display MD "Problem Statement". Render as 'Heading Level 3'. Only show rendered result| Take on the "role" of a "Sociologist" with experience in "Agent-Based Social Simulation". Memorise this role as {**key-role1**}. List memorised key-role1| Define the "topic" of the memorised key-studyType as "The goal of this study is to generate IDEAS for using ADAPTIVE ARCHITECTURE in futuristic MUSEUMS within an exhibition room that is visited by ADULTS and CHILDREN. The adaptive architecture consists of 2 kinds of artefacts: (1) 2 large wall-mounted SCREENS on which SMART CONTENT WINDOWS move with the visitors and (2) a SMART PARTITION WALL that creates a dynamic and flexible exhibition environment by continuously analysing visitor movement, making real-time decisions, and physically reconfiguring the space to optimise the experience for everyone. The adaptive architecture artefacts represent AI-DRIVEN INTELLIGENT OBJECTS.". Memorise this topic as {**key-topic**}. List memorised key-topic| Memorise "Exploratory" as {**key-researchDesign**}. List memorised key-researchDesign| Memorise "Social Studies" as {**key-domain**}. List memorised key-domain| Memorise "Human Behaviour" as {**key-specialisation**}. List memorised key-specialisation| Use an "inspirational tone". Define a novel and creative "context" for the memorised key-topic in 200 WORDS (if possible)| Use a "scientific tone". Memorise this context as {**key-context**}. List memorised key-context| Define 5 "stakeholders" for the memorised key-topic, to participate in a co-creation role-play game. Memorise these 5 stakeholders together with their personas (without names) as {**key-stakeholders**}. List memorised key-stakeholders.
- Define 5 "keywords" for the memorised key-studyType in the context of the memorised key-topic in the form of a comma-separated list. Memorise these 5 keywords as {**key-keywords**}. List memorised key-keywords| Use an "inspirational tone". Define the "title" for the memorised key-studyType in the context of the memorised key-topic in 12 WORDS (if possible). Memorise this title as {**key-title**}. List memorised key-title| Define the "aim" for the memorised key-studyType in the context of the memorised key-topic in 40 WORDS (if possible). CONSIDER the memorised key-potentialAims in your definition| Use a "scientific tone". Memorise this aim as {**key-aim**}. List the memorised key-aim.

Memorised Stakeholders {**key-stakeholders**}: Museum Curator: Responsible for overall museum design and visitor experience. Persona: Enthusiastic about innovative approaches but cautious about disruptions to traditional museum layouts. Architect: Designs the physical layout and structure of the museum. Persona: Focused on aesthetics and functionality, interested in integrating technology seamlessly. Educator: Develops educational programs and activities for museum visitors. Persona: Seeks to enhance learning outcomes through interactive experiences. Technologist: Provides technical support for implementing adaptive architecture. Persona: Driven by innovation, eager to explore cutting-edge technologies. Visitor: Represents the end-user experience. Persona: Seeks engaging and memorable experiences during museum visits. Memorised Keywords {**key-keywords**}: Adaptive architecture, Futuristic museums, Smart content windows, AI-driven objects, Visitor experience. Memorised Title {**key-title**}: "Adaptive Architecture: Transforming Future Museums with Intelligent Environments". Memorised Aim {**key-aim**}: The aim of this study is to explore the integration of adaptive architecture into futuristic museums to enhance visitor experience and educational value. By investigating the potential of smart content windows and AI-driven objects, the study seeks to create dynamic and engaging environments that cater to diverse audiences.

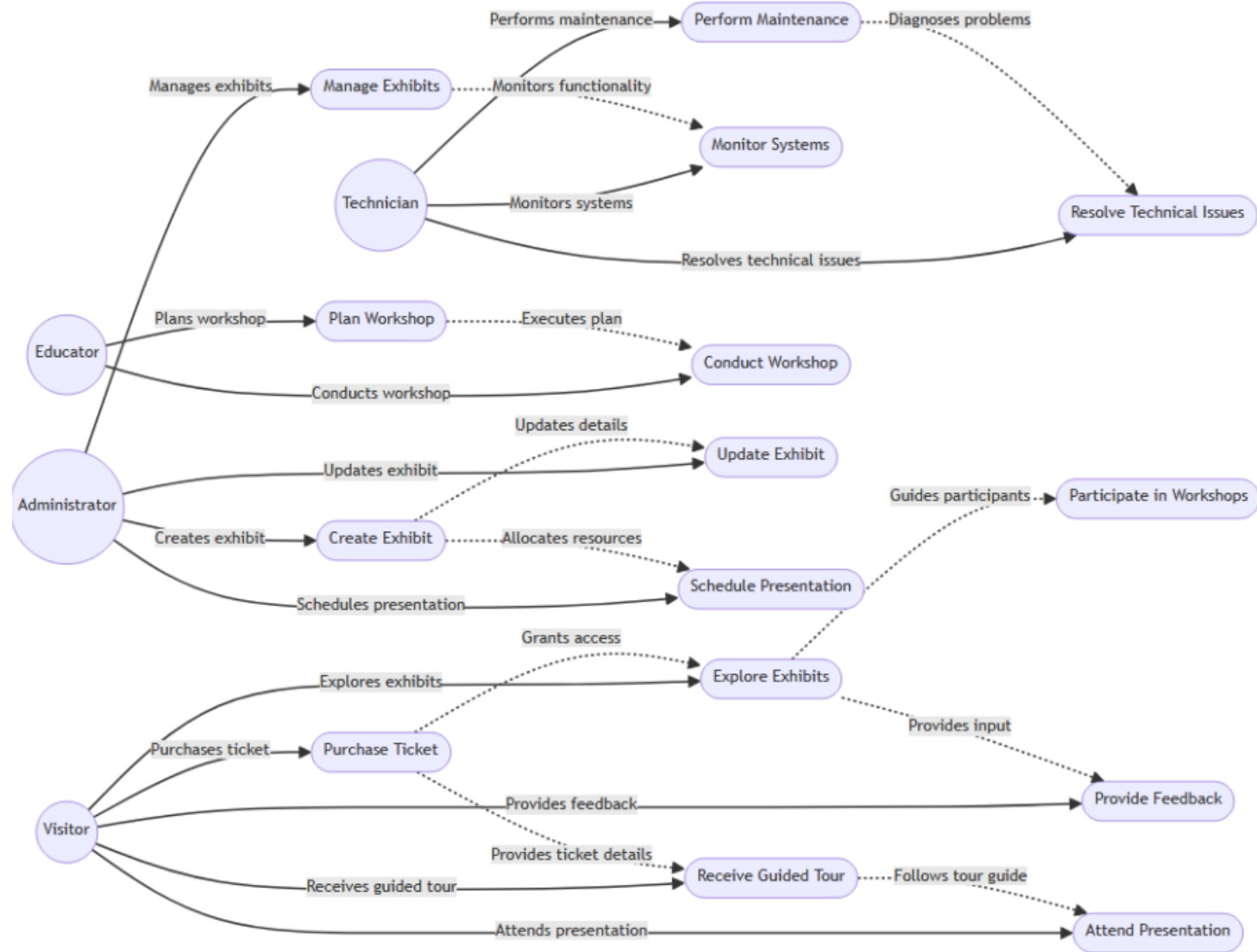
- Play a co-creation role-play game in which all the memorised key-stakeholders discuss with each other potential ABSS UML actors for the study considering the pros and cons. Use a "debating tone". The moderator focuses on 1 novel RANDOM question. Provide the question and the details of the controversial discussion| Agree on 8 potential ABSS UML actors that satisfy the view of all participating memorised key-stakeholders| Memorise these potential ABSS UML actors as {**key-potentialUMLActors**}| Propose 3 criteria for ranking the 8 potential ABSS UML actors to support the decision which ABSS UML actors to carry forward| Use a "scientific tone".

- Moderator: Let's discuss the potential ABSS UML actors for our study on adaptive architecture in museums. Before we begin, here's a question: Should we include a separate actor for children, or should they be considered within the general visitor category? Museum Curator: Children have unique needs and behaviors compared to adults. It makes sense to have a separate actor for them. Educator: I agree. Children's engagement and learning experiences are often different from adults. We need to tailor our approach accordingly. Visitor: But wouldn't separating them make the model too complex? We should keep it simple and just consider them as visitors. Architect: Complexity isn't necessarily a bad thing if it allows us to capture the nuances of visitor behavior accurately. Let's hear from the technologist on this. Technologist: From a technical standpoint, it's feasible to include separate actors for children. With proper design, we can maintain clarity while accommodating their specific interactions. Visitor: But what about the risk of overlooking other important actors? We shouldn't focus too much on children at the expense of other visitor groups. Museum Curator: That's a fair point. We should consider other important actors like museum staff and maintenance personnel. Architect: Agreed. We need to ensure that our model covers all relevant actors involved in the museum's operation and interaction with the adaptive architecture. Moderator: It seems like there's a balance to be struck between including specific actors like children and ensuring we cover all necessary roles. Let's aim for a comprehensive yet manageable set of ABSS UML actors. Potential ABSS UML Actors: 1. Adult Visitor. 2. Child Visitor. 3. Museum Staff. 4. Maintenance Personnel. 5. Architectural Designer. 6. Technologist. 7. Curator. 8. Educator. Criteria for Ranking Potential ABSS UML Actors: 1. Relevance to the study's objectives. 2. Influence on the adaptive architecture system. 3. Availability of data for accurate modeling.

- Use TABLE format WITH "plaintext" and WITHOUT any code formatting. DO NOT use "
". IGNORE ALL space limitations| Define 15 "real-world elements" with relevance to the memorised key-topic. You ALWAYS must satisfy the following 7 requirements for defining real-world elements: 1) Consider what 'real-world elements' are needed to represent in the model scope and to satisfy the memorised key-aim. 2) ALL 4 memorised key-umlActors MUST BE REPRESENTED. 3) At least 2 Physical Environment elements MUST be present. At least 2 Social Aspect elements MUST be present. At least 2 Psychological Aspect elements MUST be present. At least 2 Misc elements MUST be present. 4) Consider the memorised key-context. 5) Consider all nouns in the conversation history. 6) Each element can only be in 1 category. 7) Social Aspect elements MUST describe theories of social behaviour. 8) Psychological Aspect elements MUST describe theories of psychological behaviour. Feel free to be creative and add your ideas. Categorise the 'real world elements' into Actors, Physical Environment, Social Aspects, Psychological Aspects, and Misc. TABLE MUST include 15 rows. Organise all 15 elements into categories and provide a brief explanation. Memorise these 15 elements and explanations as {**key-explanations**}| List the memorised key-topic relevant real-world elements in the form of table rows. Provide a column for Category. Provide a column for Sub-Category. Provide a column with the memorised key-explanations. Provide a column with concise justifications in ABOUT 25 WORDS. Memorise this table as {**key-modelScope**}.

Category	Sub-Category	Explanation	Justification
Actors	Visitor	Represents individuals visiting the museum, including adults and children	Visitors are essential for simulating interactions with the museum environment and adaptive architecture
	Educator	Represents educators responsible for developing educational programs and activities for museum visitors	Educators play a key role in designing educational experiences and guiding visitor interactions
	Technician	Represents technicians providing technical support for implementing adaptive architecture in the museum	Technicians ensure the feasibility and effectiveness of integrating technology into museum exhibits and spaces
	Administrator	Represents management personnel overseeing the overall operation and strategic direction of the museum	Administrators ensure smooth operations and effective resource coordination
Physical Environment	Exhibition Spaces	Represents the physical areas within the museum where exhibits are displayed	Understanding the layout and dynamics of exhibition spaces is crucial for designing adaptive architecture
	Interactive Installations	Represents interactive installations and exhibits within the museum	Interactive installations are key components of the museum experience and need to be considered in adaptive design
Social Aspects	Visitor Interactions	Represents social interactions among visitors, such as group visits, conversations, and collaborative activities	Social interactions contribute to the overall museum experience and influence visitor engagement
	Learning Communities	Represents communities of learners engaging in educational activities and programs within the museum	Learning communities foster engagement and knowledge sharing among visitors, enhancing learning outcomes
Psychological Aspects	Engagement Levels	Represents the varying levels of engagement exhibited by visitors, ranging from passive observation to active exploration	Understanding engagement levels helps tailor experiences to visitor preferences and interests
	Emotional Responses	Represents the emotional responses of visitors to exhibits and interactive elements within the museum	Emotional responses influence visitor satisfaction and memory retention, impacting the effectiveness of museum experiences
Misc	Time	Represents the time spent by visitors in different areas of the museum	Time is a crucial factor in understanding visitor behavior and optimizing museum layouts and experiences
	Spatial Layout	Represents the physical arrangement and layout of exhibits, interactive elements, and pathways within the museum	Spatial layout affects visitor navigation, engagement, and overall museum experience
	Safety	Represents emergency protocols and procedures for ensuring visitor and staff safety in case of emergencies	Safety is important in cases of emergency such as evacuations or medical incidents
	Feedback Mechanism	Represents the use of visitor feedback collection systems	Feedback mechanisms gather insights to improve exhibits, enhancing visitor satisfaction and engagement with tailored experiences
	Staff Training	Represents training programs for educators to enhance their skills and knowledge	Staff training ensures that educators have the necessary skills and knowledge to facilitate visitor learning experiences effectively

- Generate a script for a 'comprehensive use case diagram' in "Mermaid.js". Use the memorised key-umlActors as UML actors. Remove all brackets from the actor names. Use the memorised key-umlUseCases as UML use cases. You ALWAYS must satisfy the following 4 requirements for defining the use case diagram: 1) Each UML actor MUST be linked to at least 1 UML use case. 2) Each UML use case MUST be linked to at least 1 UML actor OR MUST be pointing to at least 1 other UML use case. 3) There is no UML actor to UML actor interaction. 4) A UML use case CAN be linked to multiple UML actors| Add relationships with 'detailed descriptors'. Start the script with "graph LR". DO NOT Add subgraphs. Use the following format (Example for actor A((actor))) AND (Example for use case A([activity])) AND (Example for relationship: A -->|activity| A1). Feel free to be creative and add your ideas. Memorise this mermaid.js script as **{key-mermaidKeyActivitiesScriptDraft}**.
- INCREASE COMPLEXITY. Add ADDITIONAL use cases directly linked to the UML actors and ADDITIONAL use cases LINKED to other USE CASES| Link use cases for different actors. IMPROVE clarity of descriptors| Critically REFLECT and IMPROVE the script based on your reflection. Find and remove any mermaid.js script errors. Memorise this mermaid.js script as **{key-mermaidKeyActivitiesScript}**.



Validation Metrics

- Evaluation Criteria

- | | |
|---|----|
| • Usability: Ease of script application | ok |
| • Pertinency: Relevance to the topic | ok |
| • Readability: Clarity of outputs | ok |
| • Believability: Human-like responses | ok |
| • Originality: Novelty of ideas | ok |

Pros and Cons of using ChatGPT for ABM Design

- Pros
 - Efficiency
 - Streamlines the design process from hours to minutes
 - Provides extensive supplementary information
 - Explanations and justifications of choices; contextual knowledge
- Cons
 - Lack of causality comprehension
 - LLMs underlying ChatGPT learn from observational data and lack a deep understanding of why certain events or variables influence others
 - Bias in training data can lead to biased outcomes
 - Multiple runs of the same scenario tend to produce similar outcomes

Conclusion

- Is the work already outdated due to the rapid evolution of LLMs?
 - Design strategies and patterns are developed for long term use
 - EABSS script still works, but could be streamlined
- What did I learn from this research?
 - Using a structured approach helps a lot to generate feasible story lines
 - With human guidance of conversation flow it might even be able to develop the desired model
 - You need to understand that the ChatGPT is an innovator that still needs human guidance
 - There is no guarantee for the correctness of anything generated

Future Work

- Streamline and fine-tune EABSS script
- Improve control of conversation flow through human intervention
- Develop a GUI to automate the interaction with the ChatGPT
- Test the EABSS script with the latest ChatGPT features (e.g. reasoning support)
- Check if adaptations are required for different ChatGPT
- From EABSS conversation to implemented simulation model
- Explore the remaining three opportunities mentioned on p7

Resources

- References

- BUSCH, K., ROCHLITZER, A., SOLA, D. AND LEOPOLD, H. (2023, May). Just tell me: prompt engineering in business process management. In International Conference on Business Process Modeling, Development and Support (pp. 3-11). Cham: Springer Nature Switzerland.
- SIEBERS, P.O. AND KLÜGL, F. (2017). What software engineering has to offer to agent-based social simulation. In Edmonds, B. and Meyer, R. (Eds). Simulating Social Complexity: A Handbook - 2e. Springer.

- Resources

- Paper: <https://www.jasss.org/28/3/2.html>
- Slides: https://people.cs.nott.ac.uk/pszps/resources/llm4abm-presentation-jasss_v01.pdf
- GitHub Repository: <https://github.com/PeerOlafSiebers/abss-with-chatgpt>