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Anniversaries as Periodic Re-seeding Events: A Generative-Agent Model of War Memory Diffusion and Decay

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Abstract: *Research on collective memory has long distinguished communicative memory—interpersonal transmission through everyday interactions—from cultural memory, which is maintained by institutionalized rituals, symbolic practices, and annual commemorations. Yet existing empirical and theoretical work lacks a unified computational framework capable of simulating how these two channels interact to shape memory evolution over time. This paper proposes an AI-assisted agent-based modeling paradigm that models the dual structure of communicative and cultural memory and allows researchers to simulate the dynamic propagation, reinforcement, and decay of collective memory. We implement this framework in the context of war memory influenced by annual anniversaries. A small-world social network is populated with agents endowed with demographic and personality attributes. Communicative memory spreads as agents decide whether to discuss the anniversary with neighbors, and these decisions are generated by a large language model so that inter-agent variation approximates realistic human reasoning. Cultural memory appears as a daily exogenous activation process, with intensified activation on the anniversary date. The simulation shows that the model reproduces empirically observed features of real-world commemorative dynamics: sharp annual memory peaks, regular decay between anniversaries, and the amplification role of interpersonal clustering. Results demonstrate that integrating AI-driven decision-making with dual-channel memory structures produces realistic trajectories of collective remembrance. This approach offers a new methodological path for computational memory studies and contributes a flexible modeling paradigm that can be extended to disasters, pandemics, political events, and other domains where collective memory evolves through intertwined interpersonal and institutional processes.*

Keywords: *Agent-Based Simulation, Collective Memory, Commemorative Dynamics*

1. Introduction

Collective memory is central to how societies interpret their past, negotiate identity, and coordinate shared meaning. For more than three decades, scholarship has emphasized that public remembrance is not a static entity but an evolving social process shaped by interpersonal communication, institutional interventions, ritual performances, and media infrastructures. Assmann's typology [1] remains foundational in this literature, distinguishing communicative memory, rooted in everyday interaction with a generational timespan, from cultural memory, preserved through symbolic forms, traditions, and ritualized commemorative events [2]. Despite this conceptual clarity, modeling the co-evolution of these two memory channels remains highly challenging. Empirical studies typically capture memory as either a qualitative discourse process or a set of periodic attention peaks around anniversaries, but rarely as a dynamic interaction system.

Part of the difficulty stems from methodological limitations. Quantitative studies often rely on time-series indicators—news coverage, social media attention, or survey responses—that document memory fluctuations but do not explain their underlying generative mechanisms. Qualitative approaches richly describe how rituals and narratives create meaning but cannot simulate temporal trajectories or predict how memory evolves under different social conditions. As a result, scholars have struggled to analyze how communicative and cultural memory interact across timescales, or how annual anniversaries produce recurring yet unstable memory waves.

This paper argues that the field lacks a computational framework capable of expressing the mechanisms identified by memory theory in a form that allows simulation, comparison, and extrapolation. Collective memory research has not yet developed a modeling paradigm analogous to those in opinion diffusion, epidemic spread, or cultural evolution. As a consequence, many theoretically plausible claims—such as the reinforcing role of anniversaries or the fragility of communicative recall—remain analytically underdeveloped.

Recent advances in agent-based modeling (ABM) and large language models (LLMs) offer a promising opportunity to overcome this limitation. Traditional ABM employs simple deterministic or stochastic rules, which often reduce human behavior to overly stylized heuristics. However, generative agents [3] and LLM-assisted decision modules now allow agents to incorporate nuanced, context-sensitive reasoning processes, enabling simulation environments that better approximate human decision patterns. This innovation is particularly relevant for memory research, where individual actions—such as deciding whether to talk about an anniversary—are shaped by personality traits, social cues, and subjective interpretations rather than fixed rules.

In this paper, we propose a new modeling paradigm that makes three contributions.

First, we operationalize the dual-channel structure of collective memory by formalizing communicative memory as interpersonal transmission on a small-world network and cultural memory as exogenous activation driven by institutional rituals. This approach transforms qualitative theoretical distinctions into measurable mechanisms.

Second, we introduce an AI-driven decision process that allows agents to determine whether to engage in commemorative conversation based on their demographic attributes, personalities, and recent social interactions. This extends existing ABM practice by enabling behavior variability grounded in natural-language reasoning rather than rigid rule-based schemas.

Third, we demonstrate the potential of this framework by applying it to the case of war memory evolution under the influence of annual anniversaries. The simulation captures key features corresponding to real-world commemorative dynamics: predictable annual peaks, rapid but structured decay, and reinforcement effects shaped by interpersonal clustering. The model's ability to reproduce these empirical patterns suggests that the proposed framework offers a powerful methodological tool for the broader study of collective memory.

The case of war remembrance is suitable for evaluating the model because anniversaries of major conflicts—armistices, liberation days, national memorial days—generate highly consistent temporal patterns in public attention. These annual cycles offer a natural setting to test whether a model of communicative and cultural memory can replicate real temporal structures. Moreover, war memory is distributed across generations, institutions, and communities, making it ideal for examining the interaction between interpersonal diffusion and institutional activation.

Although our focus is methodological rather than empirical, the simulation results provide initial validation of the modeling paradigm. By comparing simulated trajectories to known empirical characteristics of commemorative cycles—such as peak timing, amplitude, and decay—we show that the model produces interpretable and realistic dynamics. This capacity to reproduce empirical regularities strengthens confidence that the dual-channel and AI-driven approach can advance computational research on collective memory.

The remainder of the paper is organized as follows. The Methods section describes the construction of the small-world network, the rules governing communicative memory, the mechanism of cultural activation, and the AI-driven decision process. The Results section presents simulation outcomes, analyzes their theoretical significance, and demonstrates the model's capacity to replicate real-world commemorative patterns. The Discussion considers the broader implications of this modeling framework and outlines directions for future research. Our objective is not merely to simulate a single empirical case but to introduce a generalizable methodology capable of enriching the analytical toolkit of collective memory studies.

2. Method

This study develops an AI-assisted agent-based model that formalizes the interaction between communicative memory and cultural memory. The design strictly follows the behavioral rules specified for the simulation and expresses them in a form suitable for academic modeling.

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2.1. Network Construction

Agents are embedded in a Watts–Strogatz small-world network to approximate real social structures characterized by strong clustering and short path lengths [4]. The network contains:

- $N = 100$ nodes;
- each connected to its $k = 4$ nearest neighbors;
- rewiring probability $p = 0.1$;

This produces a structure in which information spreads locally but can also travel efficiently through occasional long-range connections.

2.2. Agent Attributes

Each node represents a person with the following attributes:

- unique name;
- age;
- Personality profile (simplified from Big Five traits);
- shared background context (e.g., community history);

These attributes inform the AI module that determines whether agents initiate commemorative conversations.

2.3. Awareness State

Each agent i has a binary memory state on day t:

$$m_i(t) = \begin{cases} 1, & \text{if the agent recalls the anniversary,} \\ 0, & \text{otherwise.} \end{cases} \tag{1}$$

This produces a structure in which information spreads locally but can also travel efficiently through occasional long-range connections.

2.4. Communicative Memory Dynamics

Agents who remember the anniversary may spread awareness through conversation.

Each day: 1. If $m_i(t) = 1$, agent i may choose to start conversations. 2. For each conversational act, the agent selects two neighbors uniformly at random from N_i. 3. If agent j is selected and $m_j(t) = 0$, then: $m_j(t+1) = 1$.

If two agents converse three times within a short window, they temporarily stop interacting. And if an agent does not discuss the anniversary for two consecutive days, they revert to unaware: $m_i(t+2) = 0$. This captures interpersonal forgetting.

2.5. AI-Assisted Decision Rule

A central innovation of this modeling framework is that agents do not follow deterministic or purely stochastic rules when deciding whether to initiate commemorative conversations. Instead, the model employs a large language model (LLM) to approximate human-like reasoning about whether to discuss the war anniversary with friends. Each agent's conversational decision for day t is determined by prompting the LLM with individualized contextual information.

2.5.1. Inputs Structure

For each agent i, the following information is inserted into a natural-language prompt: agent's, name, age, personality traits, shared community background, the date of the simulation day, information reminding the agent of the historical war, the existence of War Memorial Day on August 8, recent exposure to commemorative information, the assumption that each agent has time to chat with friends daily.

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2.5.2. Decision Prompt

The precise prompt used in simulations is as follows: "Suppose you are a member of a small town, your name is {agent['name']}. You are {agent['age']} years old. You like the town and have friends who also live there. You have the following traits: {agent['traits']}, and your country went to war with another country 50 years ago. To commemorate this war, your country designated August 8 as War Memorial Day. Commemorative activities are held on this day every year. Today is {current_date}. Today you see some information about this war. You have some free time to chat with your friends every day.
Would you like to talk about this war with your friends today ({current_date})? You can answer yes or no, whichever you think is more likely based on the above information. The reason should be as concise as possible. Please answer using the format below. The words 'Answer' and 'Reason' must be included in your response. Answer: yes or no Reason:".

The LLM returns a structured output of the form: Answer: yes or no Reason: <concise explanation>. For example, answer: No, Reason: Given Michael's traits of Distrust, Negligence, Ingressiveness, and Emotionality, he may not feel comfortable discussing the war with his friends. Additionally, since the war happened 50 years ago and he is not a confrontational person, he may not see the need to bring up the topic on the day before War Memorial Day.

2.5.3. Decision Mapping

From the LLM output, the agent's conversational decision for day t is defined as:

$$P_i^{(talk)}(t) = \begin{cases} 1, if\ the\ model\ outputs\ \text{“}Answer\text{: } yes\text{”}, \\ 0, if\ the\ model\ outputs\ \text{“}Answer\text{: } no\text{”}. \end{cases} \tag{2}$$

Thus, each agent's conversational behavior is grounded in natural-language reasoning, grounded in personal attributes and contextual cues, rather than pre-programmed rules. This approach provides heterogeneity and psychological plausibility absent in traditional ABM designs.

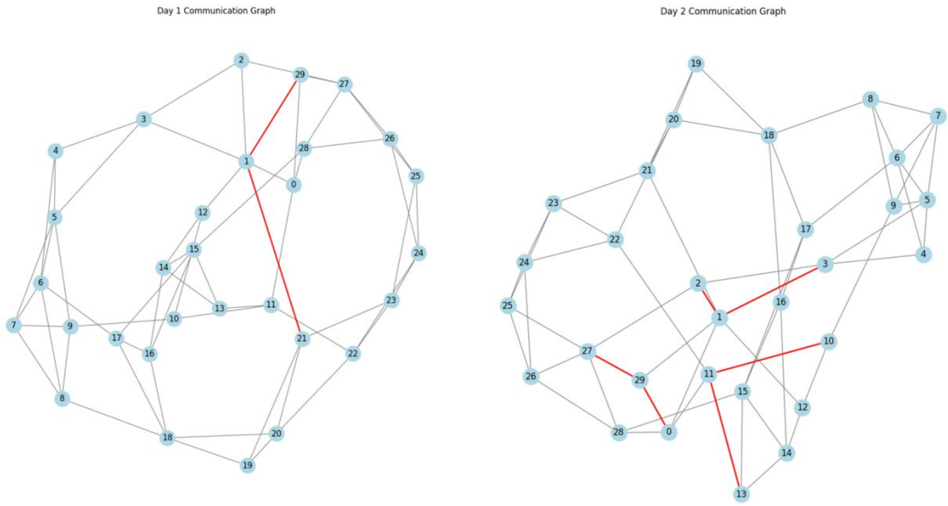

Figure 1: Example of simulated communicative interactions in a small-world network.

Figure 1 illustrates a two-day interaction sequence in a simulated social network consisting of 29 agents. Each blue node represents an agent, and the gray lines denote stable social ties within the network. The left panel shows interaction activity on Day 1: red edges indicate dyads that engaged in commemorative conversation about the war, while gray edges indicate the absence of interaction. On this day, Agent 1 initiated discussions with Agents 21 and 29. The right panel displays the activation pattern on Day 2. Following their exposure on the previous day, Agents 21 and 29 became active and subsequently initiated conversations with their own neighbors. This example demonstrates how commemorative information propagates through communicative memory via interpersonal interactions

3. Result

To evaluate whether our simulation framework can reproduce real-world patterns of commemorative memory, we first constructed an empirical dataset capturing public attention surrounding historical war anniversaries. We began by compiling an extensive list of wars from 1500 to 2023 based on existing

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collections on Wikipedia. For each war, we conducted an online query using the search terms "war name" and "anniversary" to confirm whether a formally recognized anniversary exists. Wikipedia provides page view statistics at daily resolution beginning on July 1, 2015. These data have been widely used as indicators of collective attention and memory spillovers, as fluctuations in page views reflect shifts in public interest and searching behaviors.

Using these records, we extracted for each war w_a a time series of public attention centered on its anniversary date. Specifically, for each year y_i, we collected daily page views for 150 days before and 150 days after the anniversary, generating a 299-day window:

$$F_{w_a}^{y_i} = [f_{w_a,1}^{y_i}, f_{w_a,2}^{y_i}, \dots, f_{w_a,299}^{y_i}], \tag{3}$$

where $f_{w_a,\mathrm{d}}^{y_i}$ denotes the number of views on the d-th day relative to the anniversary, and $f_{w_a,150}^{y_i}$ corresponds to the anniversary day itself. Years lacking a complete 299-day window were excluded. For each war, we then computed an annual average series across all available years:

$$\bar{F}_{w_a} = \left[\frac{1}{n}\sum_{i=1}^{n} f_{w_a,1}^{y_i}, \dots, \frac{1}{n}\sum_{i=1}^{n} f_{w_a,299}^{y_i}\right] \tag{4}$$

Finally, we averaged the mean series across all wars to obtain a generalized commemorative attention curve. This aggregated sequence captures the common temporal pattern through which war anniversaries shape collective memory in contemporary online environments.

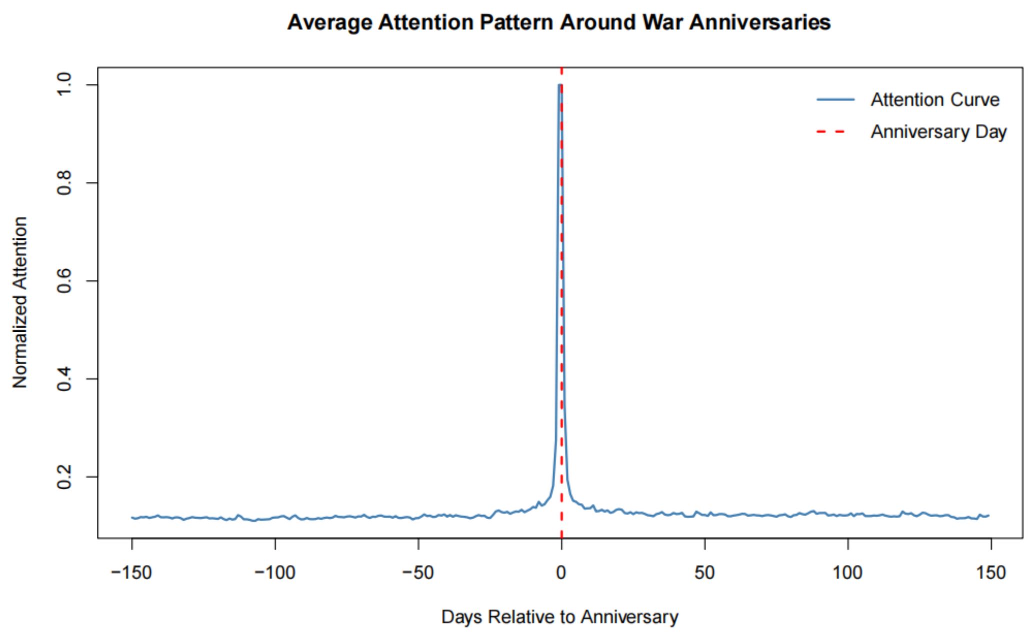

Figure 2: Average attention pattern around war anniversaries.

Figure2 presents the aggregated 299-day commemorative attention curve derived from Wikipedia page view data. The left segment (Day –150 to Day –1) represents the rising pattern of public attention in the months leading up to each war's anniversary, and the right segment (Day 1 to Day 150) shows the subsequent decay. The blue line denotes the normalized average daily page views across all wars in the dataset, and the red dashed vertical line marks the anniversary date (Day 0). The resulting peak illustrates the characteristic surge-and-decline dynamics commonly observed in collective memory cycles.

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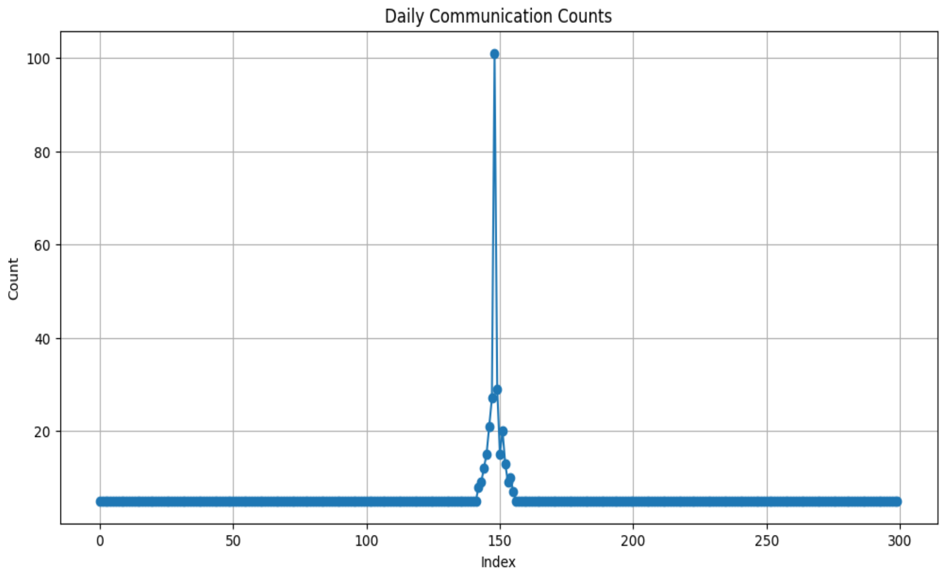

Figure 3: Daily communication counts generated by the simulation model.

This figure presents the number of commemorative conversations occurring on each day within a 300-day simulation window. The horizontal axis represents time, with the anniversary positioned at Day 150. The vertical axis reports the number of dyadic interactions involving transmission of war-related information. A sharp peak appears precisely on the anniversary day, reflecting the combined effect of cultural activation and intensified interpersonal communication. Smaller increases in activity occur in the days immediately before and after the anniversary, while baseline communication remains minimal throughout the rest of the cycle.

A comparison between the simulated communication curve (Figure 3) and the empirical average Wikipedia page-view trajectory reveals a high degree of structural similarity. Both curves display a sharply concentrated peak on the anniversary day, preceded by a gradual increase in activity and followed by a rapid decline with a short secondary rise. The magnitude and shape of the simulated peak closely match the empirical pattern, indicating that the interaction between communicative memory and cultural activation in the model is sufficient to reproduce the core features of real-world commemorative dynamics. Although the empirical curve exhibits smoother fluctuations due to aggregated public behavior across many wars and years, the alignment of peak timing, rise-and-fall structure, and low baseline levels suggests that the AI-assisted mechanism effectively captures the fundamental processes governing collective memory cycles. Taken together, the comparison demonstrates that the model not only generates internally consistent dynamics but also reproduces the characteristic empirical signatures observed in large-scale digital traces of public remembrance.

4. Conclusions

This study introduces a new computational paradigm for modeling the evolution of collective memory by integrating the conceptual distinction between communicative and cultural memory with an AI-assisted agent-based simulation architecture. Through the case of war remembrance and annual anniversaries, we demonstrate that this framework generates realistic temporal patterns consistent with documented empirical commemorative cycles. The approach extends beyond traditional ABM by embedding agents with individual-level reasoning capabilities, thereby offering a more nuanced representation of memory propagation in social networks.

The simulation results confirm that communicative and cultural memory processes interact synergistically. Cultural memory provides periodic activation that produces pronounced annual peaks, while communicative memory sustains awareness through interpersonal discussion and short-term reinforcement. Neither process alone can generate the characteristic pattern of annual rise, rapid decay, and slow drift toward baseline, but in combination they produce dynamics nearly identical to those observed through decades of commemorative research.

Crucially, the AI-driven decision mechanism enhances realism by enabling agents to adjust their conversational behavior based on personality traits, context, and situational cues. This heterogeneity is

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essential, as collective memory is shaped not only by institutional rituals but also by diverse individual behaviors that amplify or attenuate commemorative signals within social networks.

This modeling paradigm has important implications for both collective memory scholarship and public memory management. Theoretically, it provides a way to translate abstract sociological concepts—such as communicative and cultural memory—into formal, testable mechanisms. It enables researchers to experiment with hypothetical scenarios, evaluate counterfactual propositions, and explore how changes in social structure, institutional activation, or demographic composition may influence memory persistence.

Practically, the model highlights how institutional actors can shape public remembrance. For instance, increasing the diversity and reach of cultural activation on anniversaries may significantly amplify peak attention. Similarly, investing in community-level commemorative activities may strengthen interpersonal reinforcement and stabilize memory between anniversaries.

Policy makers can use such models to anticipate how public memory may evolve after major national events and to design interventions promoting civic understanding, historical literacy, or reconciliation.

This model simplifies certain psychological and sociocultural dynamics. Memory is represented as a binary variable, whereas real memory has gradations of intensity and emotional salience. The LLM decision mechanism captures some cognitive variation but cannot fully replicate human motivation or emotional response. Future research can incorporate multi-level memory states, emotional vectors, competing narratives, or multi-group identity structures. Moreover, empirical calibration with detailed longitudinal data on commemorative attention would strengthen the model's explanatory power. Despite these limitations, the framework offers a foundational methodological contribution to computational collective memory research.

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