Meme Adaptability and Popularity: Investigating the Evolutionary Dynamics of Internet Meme Templates

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Extended Abstract

Context and Research Questions As vehicles for humor, commentary, and critique, internet memes play an essential role in shaping online communication. While the term "meme" originates from Richard Dawkins' concept of cultural transmission through imitation (Dawkins, 1976/2006), its current meaning has changed significantly to encompass a dynamic, participatory way of social, cultural, and political expression (Shifman, 2014; Wiggins, 2019). Rather than static units of transmission, memes function as discursive acts–performative texts that construct and negotiate meaning through their circulation and adaptation.

Text-image memes, the focus of this study, which are typically composed of a recognizable template and overlaid text, balance continuity and flexibility. The template provides a shared reference point, while the text allows for reinterpretation and context-specific meaning, making this format highly adaptable and widely used across social media. Scholars have examined memes through different theoretical and empirical lenses. Some emphasize their discursive power as a genre of communication shaped by participatory remixing and social negotiation (Castaño Díaz, 2013; Coscia, 2013; Molina, 2020), while others analyze their spread via computational modeling (Bauckhage, Kersting, & Hadiji, 2013). This study builds on these perspectives by focusing on the adaptability of meme templates–how their structural flexibility enables reinterpretation while maintaining a recognizable core. A meme template's adaptability may influence both its longevity and its reach, shaping patterns of engagement across different communities.

Adaptability is not an inherent property of a meme template but is instead reflected in the content diversity of meme instances derived from it, which emerges through variations in overlaid text and the ways in which users repurpose the template to fit new discursive needs. Drawing on Giddens's structuration theory, meme templates can be seen as structural "rules" that guide both the creation and interpretation of new meme instances (Milosavljević, 2020). Through this lens, memes are evolving cultural forms where individual creativity interacts with shared conventions. This study investigates the role of adaptability in meme template popularity, asking:

1. How does the overall adaptability of meme templates influence the shape of their popularity trends?

2. How does adaptability within specific time intervals affect a template's relative popularity?

By examining these questions, this study aims to contribute to a deeper understanding of how meme templates evolve as communicative structures within digital culture. Using a computational approach informed by theoretical insights, it explores the mechanisms that shape meme adaptation and persistence in online spaces.

Data and Methods This study utilizes a dataset of approximately eight million user-generated memes from three major meme-related subreddits (*memes*, *dankmemes*, *meme*) spanning 2008–2023. To identify meme templates, all image instances were clustered based on visual similarity. HDBSCAN (Hierarchical Density-Based Spatial Clustering of Applications with Noise) was chosen for its ability to handle noise, detect clusters of varying sizes, and avoid the need to pre-define the number of clusters. Preliminary analyses focus on 67 major template clusters (≥ 300 images each) from the smallest of the three subreddits, *meme*. The cluster size distribution for this subreddit is presented in Fig.1. Meme template popularity trends were then represented using monthly frequency counts of template occurrences.

To quantify meme adaptability, textual content was extracted using OCR (Optical Character Recognition), combined with post titles. Since most extracted texts were short phrases or isolated words, they were transformed into sentence-level descriptions using the Llama 3.3 large language model. These descriptions were then embedded using a pre-trained sentence embedding model optimized for Reddit-style text interactions (Team, 2021). This model was selected to capture contextual meaning effectively, preserving semantic richness across meme instances. Meme adaptability was measured by calculating the pairwise cosine difference between embeddings of all instances derived from the same template. A higher average cosine difference indicates greater textual variation, signifying a higher adaptability of the template (can be applied to more topics).

To examine the relationship between meme adaptability and popularity trends, time-series modeling was applied. ARIMAX (AutoRegressive Integrated Moving Average with Exogenous Variables) was used to model popularity dynamics, incorporating adaptability as an explanatory variable while controlling for temporal dependencies. Additionally, Granger causality tests were conducted to assess whether adaptability predicts future popularity changes beyond what would be expected from historical trends. To mitigate potential confounders, template volume (to control for meme frequency effects) and overall temporal trends (using detrending techniques to eliminate seasonal or platform-wide fluctuations) were controlled. These methods ensure a more robust interpretation of the relationship between adaptability and meme diffusion patterns. The full analytical framework is shown in Fig.2.

Preliminary Results The analysis reveals that the overall adaptability significantly influences the decreasing time of meme template popularity trends. Templates with higher adaptability experienced slower popularity decay, even after controlling for maximum popularity and meme count respectively, shown in Table 1. Time series modeling further explored the temporal dynamics of meme templates. ARIMAX results showed that among the 10 most frequently occurring meme templates, a template's adaptability in the current month is strongly correlated with its relative popularity. However, Granger causality tests revealed mixed patterns across templates–some exhibited a positive relationship between adaptability and future popularity, while others showed no connection or even an inverse trend, shown in Table 2. These variances suggest that additional factors, such as contextual relevance or templates' emotional tendency, may modulate the adaptability-popularity relationship, and further analysis is needed. Together, these results indicate that meme template evolution is influenced by both structural and contextual factors. By capturing how adaptability impacts on both the popularity trends and temporal dynamics of meme templates, this study provides a deeper understanding of their role in digital culture.

References

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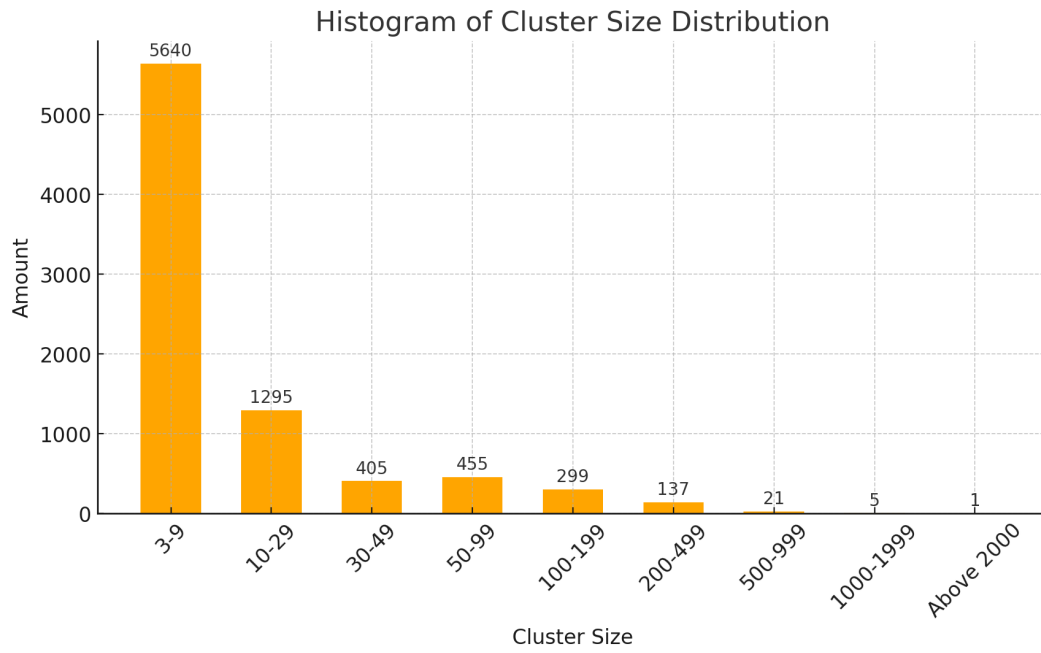
Figure 1: Cluster Size Distribution

Table 1: Results of Overall Adaptability on Popularity Decay Time

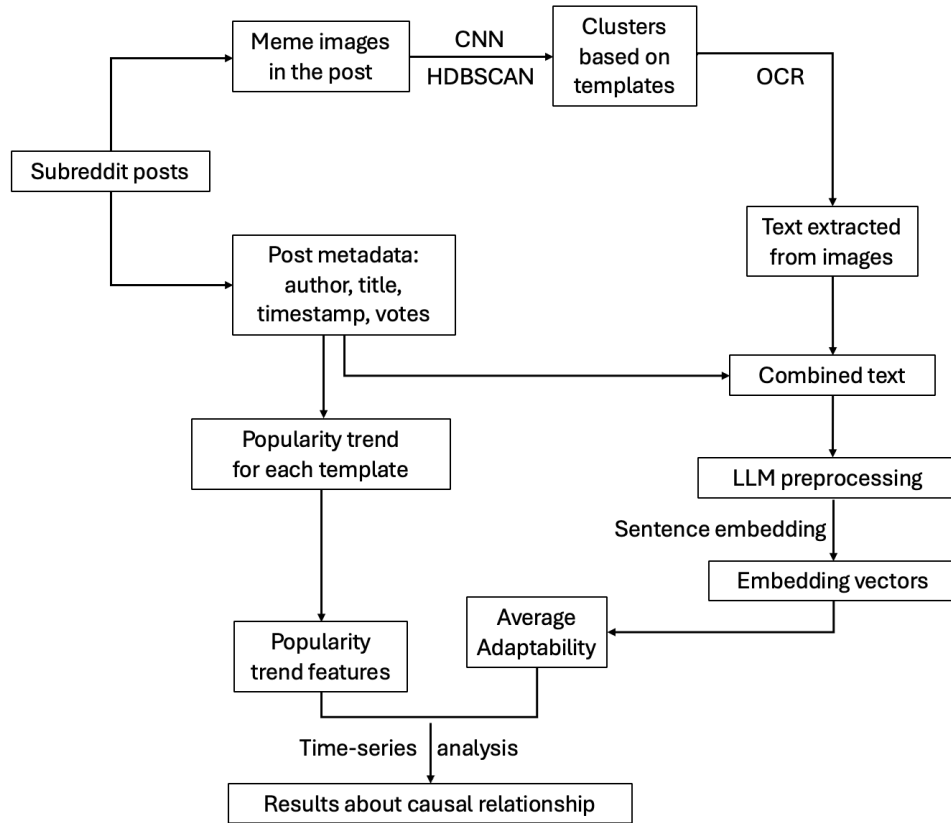|	Model 1: Only Adaptability	Model 2: Adaptability and Maximum Popularity	Model 3: Adaptability and Meme Counts
Constants	-0.4453	-0.2008	-1.3864
Adaptability	4.7638^*	4.6694^*	$3.6261*$
Maximum Popularity	–	-0.0033	–
Meme Counts	–	–	0.0032^*
R^2	0.080	0.082	0.303

*Significant at $p < 0.05$.

Figure 2: Framework of Data Processing and Analysis

Meme template	Time Range	Overall Adaptability	ARIMAX	Impact of Adaptability on Relative Popularity				Impact of Relative Popularity on Adaptability			
				Lag1	Lag2	Lag3	Lag4	Lag1	Lag2	Lag3	Lag4
template_1	2018.12 - 2023.10	0.85	0.0023***								
template_2	2019.04 - 2023.12	0.846	0.0013***								
template_3	2018.12 - 2023.12	0.767	0.0016***	✓							
template_4	2019.01 - 2023.06	0.813	0.0012***								
template_5	2019.06 - 2023.03	0.830	0.0012***	✓	✓						
template_6	2019.02 − 2023.12	0.746	0.0013***								
template_7	2019.01 − 2022.02	0.828	0.0010***						✓	✓	
template_8	2019.04 - 2022.07	0.804	0.0012*							✓	
template_9	2019.07 − 2022.07	0.653	0.0013*	✓	✓	✓	✓				
template_10	2019.02 − 2023.12	0.868	0.0008***							✓	

Table 2: Results of ARIMAX and Granger Causality Test

*ARIMAX coefficients show the effect of content diversity on relative popularity. Significant values are marked as follows: ***p<0.001, **p<0.01, *p<0.05. The last 8 columns on the right shows the impacts at different time lags (Lag1 refers to one month, and Lag4 refers to four months). A checkmark denotes a significant effect.