CSS 610 Final Paper

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Social Dynamics of Religious Attendance with Agent-Based Modeling (ABM)

Abstract

This study presents an agent-based model (ABM) that simulates weekly religious attendance decisions in a small town with one or more places of worship. Building on the El Farol Bar Problem and inspired by Cragun et al.'s work on secularization and social networks, the model assigns heterogeneous decision strategies to agents embedded within structured social networks built around their religious communities. Agents choose whether or not to attend religious places of worship based on their unique decision rules and their position in the social network. This study explores how network topology, strategy distributions, social connections between religious groups, and initial religious conditions influence secularization. Results show that increasing religious diversity through inter-faith connections consistently promotes secularization, affirming theoretical predictions from the sociology of religion. The model demonstrates how pluralism lowers religious participation by diluting the social pressures to attend places of worship, highlighting the value of computational approaches in understanding complex social transformations.

1. Introduction

Understanding the social dynamics of religious affiliation is a longstanding concern in the sociology of religion, particularly in societies with religious pluralism. In the United States, the religious landscape has grown more diverse and less uniformly Christian in recent decades. Chaves (2011) documents a steep rise in the proportion of Americans identifying as religious "nones," from just 3% in 1957 to 21% in 2014, with much of this increase coming since the 1990s [1]. Immigration, changing social norms, and backlash against the religious right have contributed to the pluralization of belief and practice [2]. Furthermore, this pluralism has been linked to the decline in religiosity through the work of Peter Berger (1967, 1990), who posits that, as the proportion of individuals in one's social network who hold different worldviews increases, the presumed plausibility of any single worldview decreases [3][4].

Parallel trends to those observed in the United States have been also observed internationally. Burkimsher (2014) finds that in Europe, religious attendance has largely declined but appears to be stabilizing at low levels in some secular countries [5]. Similarly, Brenner (2016) highlights that while religious service attendance is declining across the United States, Canada, and much of Europe, rates of decline vary by region, and some societies display signs of long-term equilibrium rather than unidirectional secularization [6]. These findings underscore the fact that religious participation is a dynamic, context-sensitive phenomenon shaped by social structures and personal networks.

As noted by Cragun et al. (2021), statistical models attempting to predict religious disaffiliation have typically accounted for less than 15% of the variation in religious affiliation [7]. Given the challenges of

modeling religious affiliation with statistical models and the complexity of religious institutions within the broader social fabric, agent-based modeling (ABM) offers a powerful method to study religious attendance as an emergent property of individual decision-making embedded in social networks. Several studies illustrate the utility of ABMs in this domain. Wildman, Shults, and Diallo (2021) propose a computational demography of religion that integrates cognitive complexity and social network interactions, allowing for dynamic feedback between individual practices and broader social patterns [8]. Gore et al. (2018) similarly use an ABM to forecast religious change based on social influence and existential security, demonstrating how agent heterogeneity and network effects shape macro-level religiosity trends over time [9].

A key component of ABMs in the study of religious affiliation is the social network structure. Bagheri-Jebelli and Kennedy (2020) show that belief propagation among early human societies, modeled at Göbekli Tepe, was facilitated by small-world networks that enhanced resilience and cultural diffusion [10]. Building on and testing the theoretical work of Peter Berger, Cragun et al. (2021) demonstrate that in pluralistic societies, diverse social networks can dilute the strength of religious signals, increasing the likelihood of religious disaffiliation [11]. This finding aligns with broader theories of secularization that emphasize the weakening of religious authority in heterogeneous environments.

Other agent-based simulations explore religious regionalism and persistence. Iannaccone and Makowsky (2007) use a variant of Schelling's famous segregation ABM to explain how regional differences in religion within the United States persist despite high levels of geographic mobility, emphasizing the interplay between social influence and personal commitment [12]. Jo et al. (2021) incorporate external environmental factors and internal dynamics into a hybrid ABM-System Dynamics model of church sustainability, highlighting the importance of adaptive engagement with broader societal conditions [13].

Building on Brian Arthur's (1994) foundational work on bounded rationality and inductive reasoning in the *El Farol Bar* problem, this study adapts his approach to model religious affiliation and secularization dynamics [14]. In the original *El Farol* problem, agents independently decide whether to attend a bar based on predictions of crowd size, yielding complex group-level dynamics from simple, boundedly rational decision rules. Inspired by this framework, as well as the work of Cragun et al. (2021), this project develops a novel agent-based model in which individuals evaluate whether and where to attend religious services. Each agent is assigned a fixed decision strategy drawn from a diverse suite of rule types with varying parameters, based on social network dynamics. Agents choose among multiple religious institutions, or opt out and become/remain secular, based on local or global attendance patterns (where local refers to neighboring nodes and global refers to the full network). This heterogeneity of strategies allows an exploration into how pluralism shapes patterns of institutional affiliation, religious switching, and secularization. More specifically, this project develops an agent-based model (ABM) to explore the following questions:

1. How does the structure of social networks affect religious attendance over time?

2. What role does religious diversity and inter-group connectivity play in shaping attendance outcomes?
3. How do different initial population conditions influence long-term attendance dynamics?
4. How do individual decision-making strategies interact with social network dynamics to produce religious trends?

By systematically varying network properties, inter-group connection rates, and initial religious compositions, the model seeks to illuminate the social mechanisms that underlie observed patterns of religious persistence, transformation, and decline.

2. Methodology

2.1 Model Description

Purpose

This agent-based model (ABM) was built in Python to simulate the religious attendance decisions of agents in a small town with an adjustable number of religious institutions. It investigates how socially influenced rules for individual decision-making, institutional diversity, and social network structure shape patterns of religious participation over time. The model is designed to explore the conditions under which religious institutions grow, shrink, or disappear, and to assess the resilience of religious affiliation under varying levels of pluralism and secularization pressure. It is important to note that the model does not attempt to assess any differences in beliefs, doctrine, practices, or rituals of various religions. Rather, the social network, agent decision-making rules, and initial conditions are what determine simulated behavior.

Key Assumptions

Some important assumptions of the model are as follows: first, religious attendance is based purely on social network dynamics and operate independently of religious beliefs, doctrine, practices, or institutional structures. This is obviously not the case, but for the purposes of this model only social network dynamics are considered. Second, agents make their decisions about religious attendance based on fixed decision criteria. Third, the structure of the social network does not change during the course of the simulation, meaning that no additional nodes or edges are added. This means that, for instance, if an agent joins a new religious institution, they do not automatically become more closely associated with the members of that social network. Fourth, agents initialized with a religious affiliation have historically attended their religious institution at each tick, while agents initialized as secular have never attended. Fifth, but closely related to four, agents attend at most one institution per tick. Finally, secular agents have a random network with a specifiable number of connections to other agents independent of religious affiliation. This differs from religious agents, who are initialized as part of their religious institution's local structure (small-world or scale-free).

2.2 Model Steps

There are a number of method calls made automatically when the model object is instantiated, prior to the simulation run. These method calls are listed below – for a more detailed description of each step, locate the method or function below its corresponding class in section 2.2.

1. Create agents
2. Create institutions
3. Assign agents
4. Build network

After the model is instantiated, the user must call the "run" method to begin the simulation. The run method begins by generating historical data for a warm-up period. To do this, the model iterates through each tick in the attendance memory and uses each agent's initial religious state to fill in the appropriate religious institution's history. Next, the run method iterates through each week and performs the following operations at each tick:

1. Agents choose whether to attend a religious institution, and if so, which one, using their strategy. Strategies are summarized in Table 1 below.
2. Agent attendance for that tick is logged with their respective religious institution.
3. The agent's previous religious state is compared to their newly selected institution. If the two are not equal, the agent updates their religious state.

Strategy	**Explanation of Score**	**Parameters**
Follow majority	If most neighbors attended last tick, returns number of neighbors who attended. Else, return 0.	-
Social majority recent	If majority of neighbors attended at least x of last y ticks, return number of neighbors who attended in last y ticks. Else, return 0.	x, y
Social trend following	If there's a positive trend in neighbor attendance over last x ticks, return trend. Else, return 0.	x
Peer pressure threshold	If enough total neighbor-attendances occurred across recent ticks, return that number. Else, return 0.	window, threshold
Contrarian follow minority	Opposite of follow majority. If minority of neighbors attended last tick, return large number minus neighbor attendance. Else, return 0.	-
Contrarian social minority recent	Opposite of social majority recent. If minority of neighbors attended in x of last y ticks, return large number minus neighbors attended. Else, return 0.	x, y
Contrarian trend	Opposite of social trend following. If neighbor attendance trend is flat or declining over last x ticks, return large number minus trend. Else, return 0.	x
Contrarian peer pressure	Opposite of peer pressure threshold. If neighbor-attendance is low enough across recent ticks, return the large number minus the number of neighbor attendances in so many ticks. Else, return 0.	window, threshold
Global sheep	If global attendance was above a certain threshold last tick, return global attendance. Else, return 0.	threshold
Global contrarian	Opposite of global sheep. If global attendance was below a certain threshold last tick, return large number minus global attendance.	threshold
Independent fixed	Keep initial religious state – no change.	-

Table 1: Strategy Types

2.3 Model Parameters

The following model parameters can be adjusted to explore the possibility space, perform experiments, and evaluate outcomes.

- **Number of agents:** total agents in the network.
- **Number of ticks:** the number of ticks to run the simulation, following the warm-up period.
- **Attendance memory:** how long to seed the model with historical attendance levels (used as the maximum agents are able to remember in their decision strategies).
- **Initial religious dictionary:** dictionary of nested dictionaries, where keys are unique IDs for each religious institution to instantiate in the model; nested dictionaries contain the number of agents who are initialized within the religious network, and the network type. It is important to note that, for ease of model development, "Secular" is treated as a religious institution, with important differences that will be elaborated below. One of these differences, however, is that "Initial Connections" is passed into the initial religious dictionary in lieu of network type for the nested secular dictionary. This number specifies the number of connections each secular agent will have to other members of the network.
- **Strategy distribution:** dictionary with strategy types to instantiate in the model as keys, with the proportion of agents who will adopt that strategy as values.
- **Inter-faith connections:** the number of edges added to the model bridging discrete religious networks.
- **Secular connections:** the number of social connections each agent initialized as secular will have.

2.4 Functions, Classes, Attributes, and Methods

The simulation runs at a non-defined time step, typically for 100 steps. There are four classes in the model, defined with state variables and methods as follows:

1. **Class: Strategy**
    - *Attributes:*
        - Strategy type: there are 11 unique strategy types, listed in table 1 below
        - Attendance memory
        - Dictionary containing key parameters specific to the strategy type, such as thresholds, window sizes, etc.
    - *Methods:*
        - Score institution: this method evaluates the fitness of a given institution, at a given week, for a given agent, based on their strategy type. It returns a score for the agent to compare against other institutions, using this same method.
2. **Function: Generate Strategies**: used to generate strategies for agents. Parameters specific to the strategy are generated using stochastic elements, such that a highly heterogeneous population of decision-makers is created.
3. **Class: Agent**

- *Attributes:*
    - Unique identifier.
    - Religious state: current institutional affiliation or secular status.
    - Strategy: fixed attendance decision rule with associated parameters.
    - Neighbors: list of connected agents in the social network.
- *Methods:*
    - Set neighbors: identify nodes sharing an edge with the agent.
    - Choose institution: evaluates the fitness of the agent's current religious institution, if any, using the "score institution" method of the strategy class. If the institution is deemed unfit, all other institutions are evaluated using the "score institution" method, with the highest score being selected. If no institutions have a score above 0, representing minimal fitness, the agent becomes secular.
    - Update religious state: update the religious state attribute when a change is made.

4. **Class: Religious Institution**

- *Attributes:*
    - Unique identifier in the form of the institution name ("Catholic", "Hindu", etc.). It is assumed that the small town this model is built to simulate has at most one brick-and-mortar location of worship.
    - Attendance history: dictionary with a list of agent IDs who attended at each tick (with tick numbers as the keys).
    - Network type: this can be small-world or scale-free.

5. **Class: Model**

- *Attributes:*
    - Number of agents.
    - Number of initial seeding ticks before simulation begins.
    - Strategy distribution: dictionary of strategy types as keys, with the proportion of the population using that strategy as values.
    - Initial religious dictionary: configuration dictionary specifying institution populations and their network types at the beginning of the simulation. There are two recognized network types that can be passed in by the user, both of which are commonly observed in real social networks:
        - Small-world: built using the Watts-Strogatz method in NetworkX. These networks are densely connected with high clustering.

        - Scale-free: built using the Barbasi-Albert method in NetworkX. The distribution of node degree follows a power-law distribution. These networks are dominated by large hubs.
    - Inter-faith connections: the number of edges added to the graph bridging religious affiliation (independent of secular connections). This is used as a measure of how integrated the society is between religious groups.
    - Agents: a list agent objects.
    - Institutions: a dictionary of religious institution objects, keyed by their unique ID.
    - Graph: the full social network, built using the NetworkX library.
- *Methods:*
    - Create agents: instantiate the population of agents, using the strategy distribution and the generate strategies function.
    - Create institutions: instantiate religious institution objects, using the initial religious dictionary.
    - Assign agents: assign agent initial religious states, using the initial religious dictionary.
    - Build network: build a local social network for each religious institution, with structure taken from the initial religious dictionary. Then, add secular agents to the graph with some number of random connections to other agents, independent of religious affiliation (this number is passed in via the initial religious dictionary, as the value associated with the "Secular Connections" key). Finally, add edges randomly across religious groups based on the inter-faith connections variable.
    - Run: used to run the model for some defined number of ticks. Starts by simulating historical attendance, assuming every agent attended their respective religious institution (if they have one), at every tick during the warm-up period.
    - Plot attendance: used as a quick way to generate a plot of religious attendance for each institution, by tick, over the course of the simulation (warm-up period not included).
    - Get results: simple method that generates a dataframe with religious attendance at each tick, for each institution.
    - Plot network: used to generate a view of the social network, colored by either (1) religion or (2) strategy type. If religion is selected, the user can specify which tick to display, allowing them to visualize changes in the network across multiple ticks (or from start to finish).

- Animate attendance: creates an animation of the social network, where each node is colored according to their religious attendance, which changes for each tick in the simulation.

2.5 Experiment Design

To investigate how key model parameters influence patterns of religious affiliation and participation, I designed a series of simulation experiments using the agent-based model outlined above. Each experiment systematically varies a specific parameter or structural feature of the model while holding others constant, allowing for focused analysis of causal mechanisms. This is a highly flexible model, which means that the set of experiments performed was by no means exhaustive. To truly understand the effects of these parameters, I would have to run experiments where each variable is changed with every combination of other parameters also varied. Due to the complexity of the model, changing one parameter while holding others constant does not necessarily provide generalized insights about the effects of that parameter. It could very well be the case in certain situations that a different combination of tertiary parameters causes the parameter in question to have the opposite effect of what was found initially. However, this study focused primarily on single parameter variation rather than interaction effects between various parameters.

With that said, the experiments explore the effects of six key variables on mean attendance at each religious institution.

Strategy Distribution

I tested how different mixes of agent-level decision strategies influence long-term attendance dynamics. Strategies were assigned at initialization according to predefined probability distributions, ensuring population-level heterogeneity in behavioral heuristics. Five scenarios were tested, each with the same combination of other parameters: 100 runs, 100 ticks per run, 100 total agents, 10-tick memory window, 20 inter-faith connections, and a small-world network structure for each religious institution.

Initial conditions were as follows: 50 Protestant agents, 25 Catholic agents, 10 Hindu agents, 5 Buddhist agents, and 10 secular agents.

The strategies used within the model can be broken out into four categories, as shown in Table 2 below. This breakout of strategy types informed the five scenarios considered in this experiment.

Strategy Types	Local	Global
Majoritarian	follow majority, social majority recent, social trend following, peer pressure threshold	global sheep
Contrarian	contrarian follow minority, contrarian social minority recent, contrarian trend, contrarian peer pressure	global contrarian

Table 2: Strategy Categories

Scenario 1 – Uniform Distribution

In this scenario, the following strategy types were used, each employed by 10% of the population: follow majority, social majority recent, social trend following, peer pressure threshold, contrarian follow minority, contrarian social minority recent, contrarian trend, contrarian peer pressure, global sheep, and global contrarian.

Scenario 2 – Majoritarian Strategies

Only strategies in which agents seek to follow the majority of other agents (either locally or globally), were used. Each of the following strategies were employed by 20% of the population: follow majority, social majority recent, social trend following, peer pressure threshold, and global sheep.

Scenario 3 – Contrarian Strategies

Only strategies where agents seek to rebel against popular trends and institutions. Each of the following strategies were employed by 20% of the population: contrarian follow minority, contrarian social minority recent, contrarian trend, contrarian peer pressure, global contrarian.

Scenario 4 – Global Strategies

Only strategies that take the entire network into account were used, resulting in global sheep and global contrarian each forming 50% of agent strategies.

Scenario 5 – Local Strategies

Strategies where agents consider only their neighbors were used, resulting in 12.5% of the agent population employing each of the following strategies: follow majority, social majority recent, social trend following, peer pressure threshold, contrarian follow minority, contrarian social minority recent, contrarian trend, and contrarian peer pressure.

Number of Religious Institutions and Initial Percent Secular

Four simulations were conducted: ranging from one to four types of religious agents included (e.g., Protestant only; Protestant and Catholic; Protestant, Catholic, and Hindu; Protestant, Catholic, Hindu, and Buddhist). To reiterate an important point mentioned already, the names attached to various religious institution objects is totally arbitrary; the names of well-known religious identities were used for the purposes of familiarity and salience. Therefore, results are by no means indicative of true religious attendance trajectories.

In each configuration, the religious portion of the population was uniformly distributed across the active institutions. 100 runs were conducted for each, stepping the original percent of secular agents from 0 to 100 in steps of 10. Controlled parameters are as follows: 100 total agents, 100 ticks per run, attendance memory of 10 ticks, 20 inter-faith connections, small-world network, uniform strategy distribution, and 5 connections per secular agent.

Network Structure

Two types of social networks were compared: small-world networks and scale-free networks. These represent distinct paradigms of community structure—tight-knit clustering versus hub-based connectivity—and enable analysis of how social topology conditions religious dynamics. 50 runs were performed for each network type, with the same configuration of parameters: 100 total agents, 100 ticks per run, 10-tick attendance memory, 20 inter-faith connections, and a uniform strategy

distribution. The model was initialized with 50 Protestant agents, 25 Catholics, 10 Hindus, 5 Buddhists, and 10 secular agents.

Inter-Faith Connectivity

The number of social connections bridging agents from different religious groups was varied to simulate differing levels of pluralism and inter-group interaction. For these experiments, I conducted 10 trials at each of 10 discrete levels of inter-faith connectivity (from 0 to 100 inter-faith ties). Parameter configuration was as follows: 100 total agents, 100 ticks per run, 10-tick attendance memory, small-world network, and a uniform strategy distribution. The model was initialized with 50 Protestant agents, 25 Catholics, 10 Hindus, 5 Buddhists, and 10 secular agents.

Secular Connectivity

Similarly, the number of connections assigned to initially secular agents was varied from full isolation to full integration. This parameter controls the degree of embeddedness secular individuals have in the broader social fabric. The parameters were identical to the previous experiment, except that the number of secular connections ranged from 0 to 10, and the number of inter-faith connections across the whole network was set at 20.

Each experimental condition was typically replicated across 100 simulation runs, each consisting of 100 time steps. A warm-up period preceded the main simulation in each run, seeding the necessary attendance history required for strategies with memory or trend-based logic to function correctly.

The primary outcome variable was mean weekly attendance, tracked either per tick or aggregated across the entire run, disaggregated by religious institution. This metric captures both the absolute levels and relative changes in institutional participation, enabling comparison across runs, network types, and experimental conditions.

3. Results

3.1 Experiment 1 Results: Strategy Distribution

Scenario 1 – Uniform Distribution

Running the model with a uniform strategy distribution quickly results in a balanced steady state with the Protestant religion prevailing as most prominent, commanding around 45% of the population (as shown in Figure 1 below). However, this is lower than the 50% that the simulation begins with. The secular population, which begins at only 10%, quickly rises to consistently command around 25% of the population. Buddhism does surprisingly well here, given that it begins with only 5% but rises to a steady state higher than both Catholicism and Hinduism at around 17%; Catholicism and Hinduism began the simulation with 25% and 10%, respectively, while both finish at close to 13%.

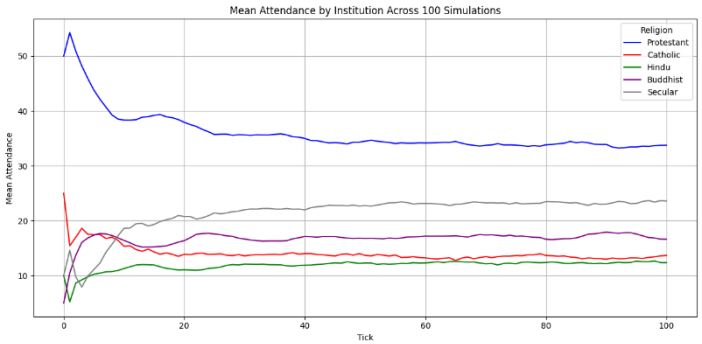

Figure 1: Mean Attendance by Religion with Uniform Strategy Distribution

Scenario 2 – Majoritarian Strategies

Predictably, when only majoritarian strategies are used, Protestantism increases its share of the population from 50% to around 75% before reaching a steady state as shown in Figure 2. Each of the minority religions decline in total percent of the population, with Hinduism and Buddhism disappearing entirely. Secularism, however, roughly doubles from 10% to 20% of the population.

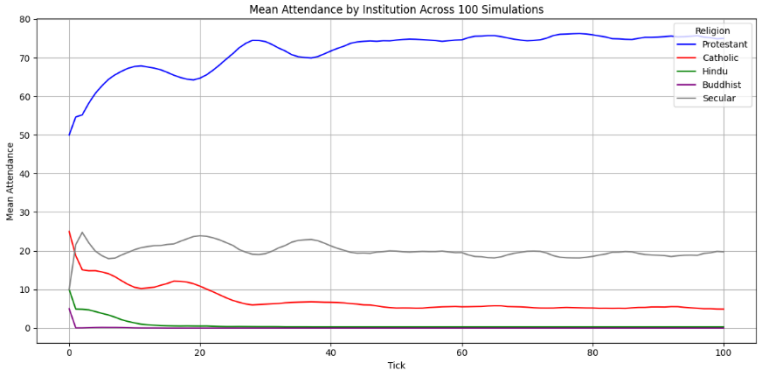

Figure 2: Mean Attendance by Religion with Majoritarian Strategies

Scenario 3 – Contrarian Strategies

Employing exclusively contrarian strategies largely levels the field (or closes the gap) between the religions, as shown in Figure 3. Those with a large starting percentage decline, while those with a low starting percentage rise. This is not surprising, as agents seek to attend places of worship that are least popular, locally or globally, according to various manners of calculation. What is surprising is that so few agents become secular in these conditions. This is, perhaps, a function of the thresholds at which various contrarian strategies must fall below in order to abandon a religion. Being a contrarian does not entail becoming secular per se; rather, like the majoritarian strategies, secularism is the result of all available religions failing to score high enough to meet the agent's threshold.

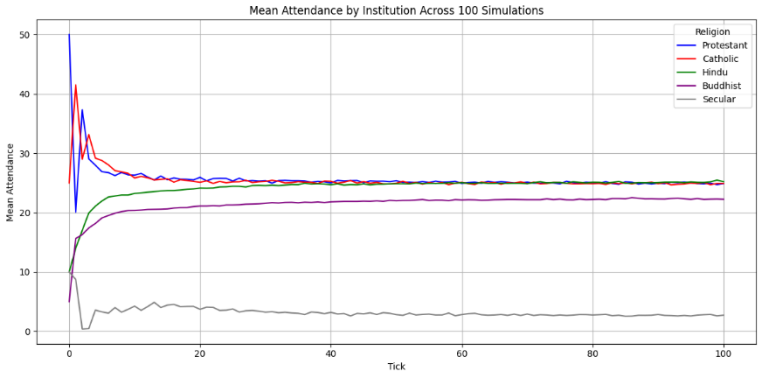

Figure 3: Mean Attendance by Religion with Contrarian Strategies

Scenario 4 – Global Strategies

In this scenario, 50% of agents are looking for a religious institution with high attendance last week and 50% are looking for low attendance last week. Surprisingly, Protestantism falls to 0% before recovering slightly and reaching a steady state around 3% (see Figure 4). Conversely, secularism climbs to 50% before reaching a steady state around 45%. My hypothesis was that this scenario would produce drastic swings in religious attendance, since each agent is only concerned with what other agents did last week, but half want to follow the minority and half the majority. However, this scenario produced the most stable outcomes of all five strategy distributions.

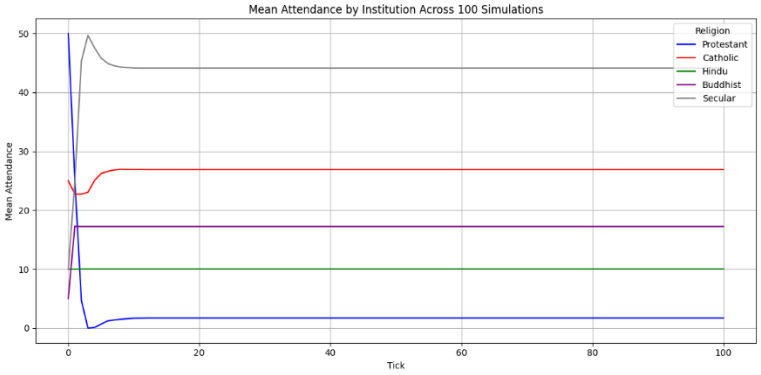

Figure 4: Mean Attendance by Religion with Global Strategies

Scenario 5 – Local Strategies

Employing exclusively local strategies results in the smallest deviation from initial conditions of the five scenarios (see Figure 5). Global strategies allow information to travel more quickly through the network, whereas local strategies rely on a slow diffusion that is balanced in this scenario, with an even percentage of contrarians and majoritarians stabilizing local religious populations. Also, in each of these scenarios, religious groups are very insular, with one in five religious agents, on average, having a connection with an agent of a different religion at the start of the model. This makes it difficult for information to diffuse across the boundaries of religious groups.

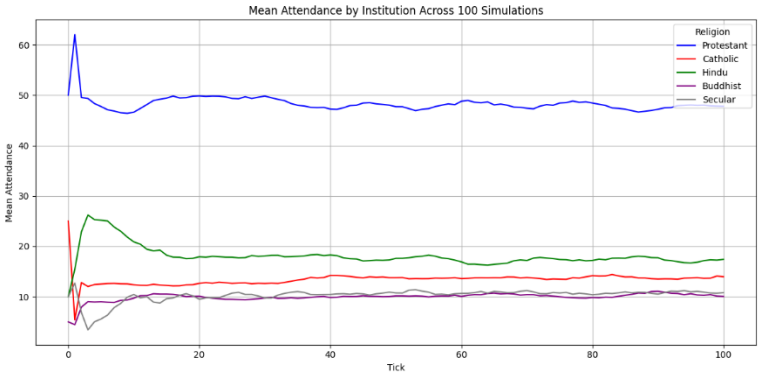

Figure 5: Mean Attendance by Religion with Local Strategies

3.2 Experiment 2 Results: Number of Religious Institutions and Initial Percent Secular

Experiment 2 found the persistent outcome that, as the initial percent of the secular population increases, the mean secular population increases throughout the simulation (see Figure 6 below). This general outcome, while not at all surprising, was insensitive to the number of competing religions. However, this effect appears to dampen with multiple religions. The secular attendance line is approximately linear when only one religion exists, reaching a maximum greater than 50% of the population, but levels out between 35% and 40% of the population when multiple religions are present.

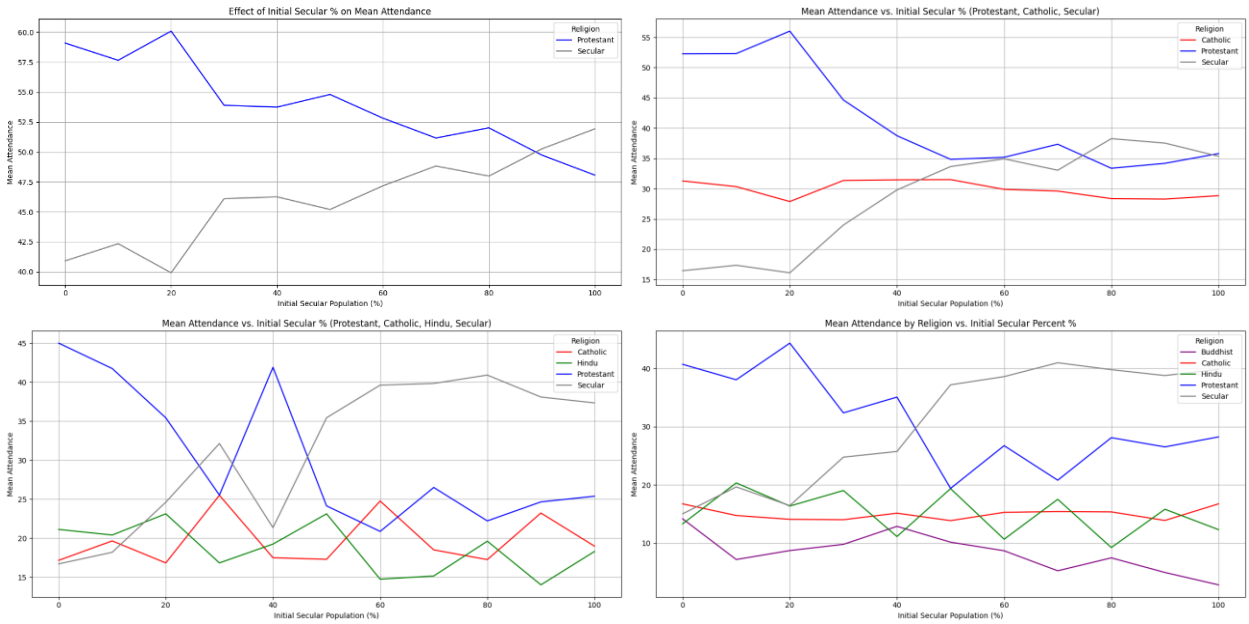

Figure 6: Effect of Religious Pluralism and Initial Percent Secular on Mean Attendance

3.3 Experiment 3 Results: Network Structure

Small-World Networks

As you can see from the structure of the starting network in Figure 7 below, small-world networks are tightly clustered within religious groups, with secular agents often acting as bridges between groups. The model builds the network of each religious group independently, then combines them by adding secular agents with random connections, along with some user-defined number of inter-faith connections. The results of this can be seen at tick 1 of the plot below, where Buddhists have only one edge between their small network cluster and the rest of the graph. However, by tick 100 this community still exists, but none of its agents are Buddhist. Interestingly, this does not mean that Buddhism disappears from the network; instead, it has diffused to a few nodes within what were initially Protestant, Hindu, and secular parts of the network. These nodes likely represent agents that have contrarian strategies.

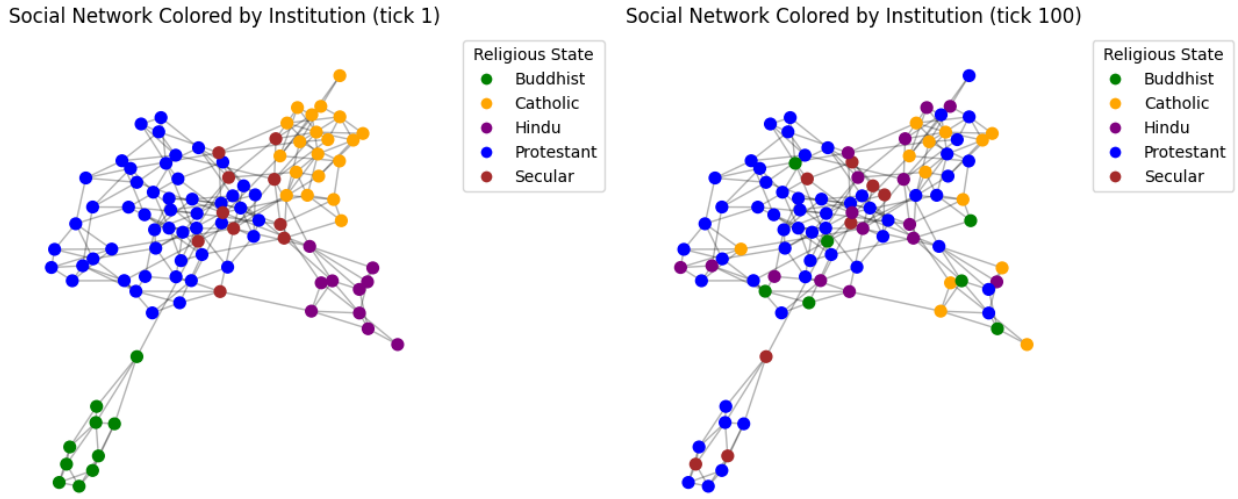

Figure 7: Small-World Network at Ticks 1 and 100

Scale-Free Networks

Unlike small-world networks, scale-free networks are dominated by central hubs and sparsely connected nodes on the periphery (as shown in Figure 8 below).

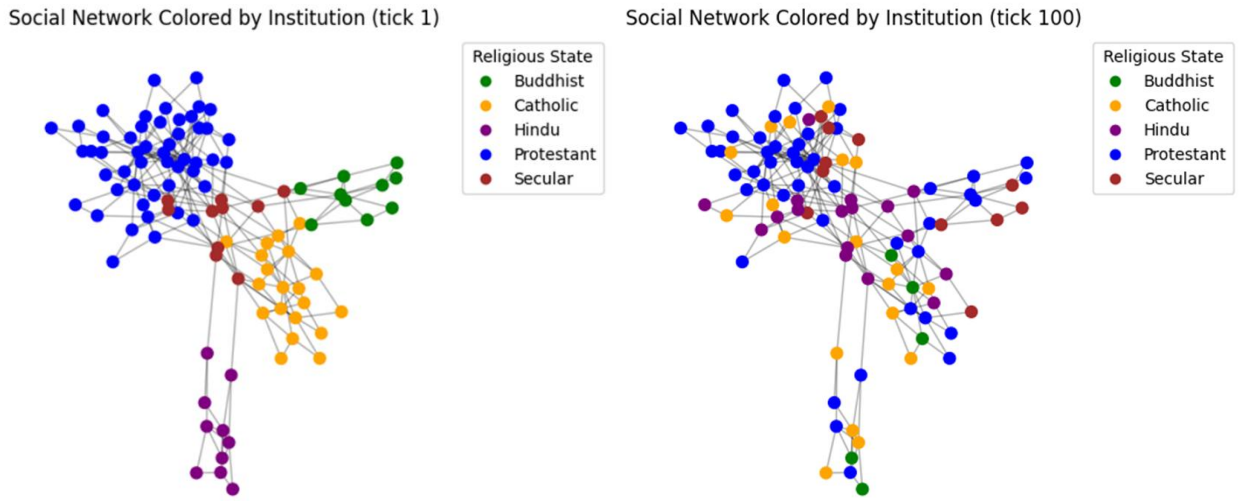

Figure 8: Scale-Free Network at Ticks 1 and 100

Despite differences between these two network structures, their effects on mean attendance across religious groups were not meaningfully different, as shown in Figure 9 below.

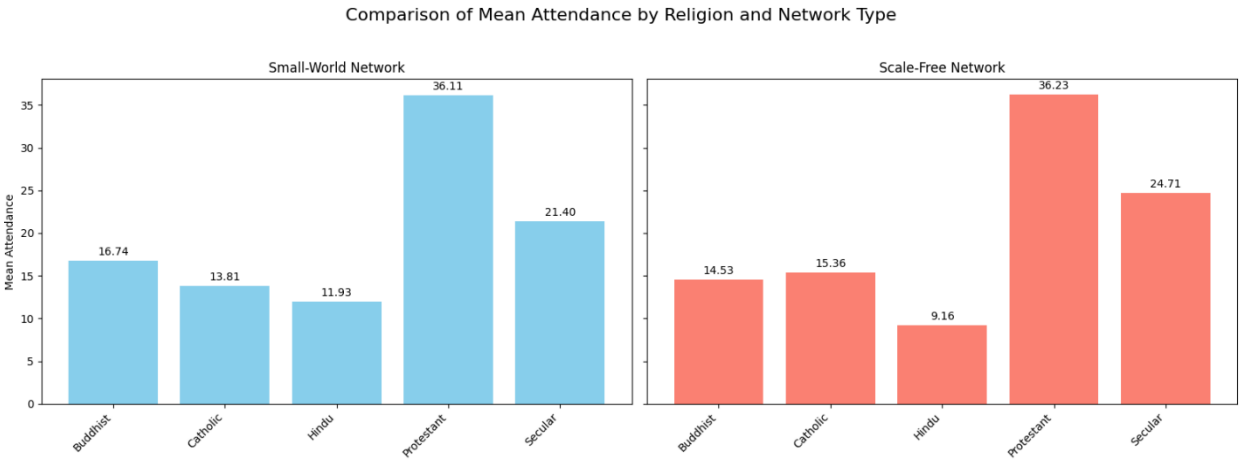

Figure 9: Comparison of Small-World and Scale-Free Network Structures on Mean Attendance of Religious Groups

3.4 Experiment 4 Results: Inter-Faith Connections

Increasing the quantity of inter-faith connections was shown to reliably increase the secular percentage of the population, as shown in Figure 10. Inter-faith connections had little impact on the minority religions, but stark implications for the majority religion (Protestantism) and secularism. Inter-faith connections means a more integrated polity across the lines of religious groups, which presents opportunities for religious conversion by agents employing local strategies, and the increased likelihood that no religion will reach the threshold required for attendance amongst agents with majoritarian strategies.

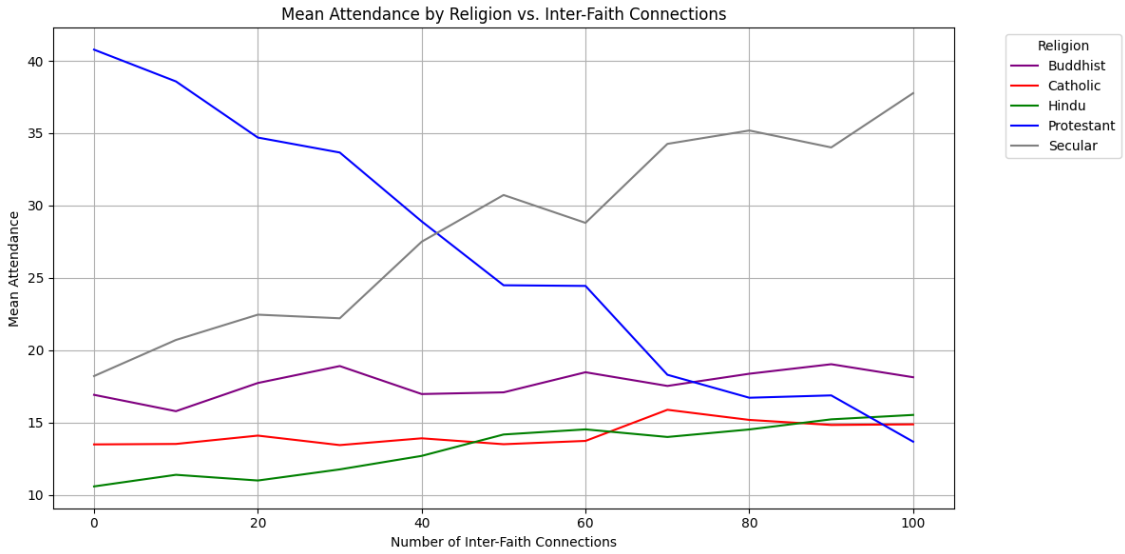

Figure 10: Effects of Inter-Faith Connections on Secularization

3.5 Experiment 5 Results: Secular Connections

In experiment five, we see a decline in the majority religion (Protestantism) and a rise in secularism as the number of secular connections increases (shown in Figure 11 below). The results of experiment five corroborate those of experiment four, since both cases vary the amount of connections between agents outside of one's religious group. However, the effects are not as pronounced, since the connections outside an agent's religious group are limited to secular agents, rather than being dispersed randomly amongst all agents, as in experiment four.

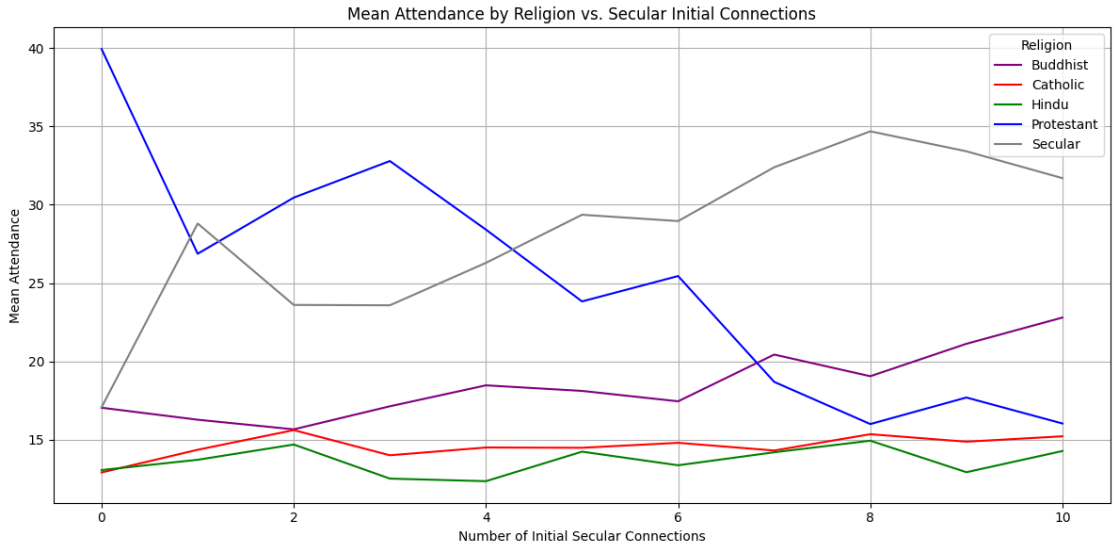

Figure 11: Effects of Secular Connections on Secularization

4. Analysis & Discussion

4.1 Secularization

The results of this agent-based model affirm key aspects of Peter Berger's theory of religious pluralism and its potential to drive secularization, while extending this theoretical tradition using a novel computational approach. In particular, the findings closely parallel those of Cragun et al. (2021), who argue that increasing worldview diversity within social networks leads to religious disaffiliation not simply due to rational theological deliberation, but as a byproduct of social plausibility structures breaking down in heterogeneous environments. By using an agent-based simulation in which religious attendance is driven by decision heuristics informed by social network structure, this study contributes to the growing body of computational sociology literature demonstrating the role of network-level pluralism in shaping religious dynamics. However, this model not only comes at the question of pluralism and secularization from a unique angle, but builds upon the work of Cragun et al., by allowing for multiple religions to exist simultaneously. In contrast, the model in Cragun et al. only allows for one religious option.

Across experiments, the model developed in this study consistently showed that increasing pluralism—operationalized as higher numbers of religious institutions and inter-faith connections—correlates with declining participation in religious institutions and increasing secularization. These patterns mirror those observed by Cragun et al., who similarly found that worldview diversity weakens religious signals and makes disaffiliation more likely, particularly once a threshold of diversity is crossed. In Cragun et al., a two-stage process of secularization takes place; in the first, the early adopters leave the religious groups, creating momentum that allows others to leave as well. A similar logic can operate in this model, where contrarians leave their religion first, followed by the majoritarians. However, the presence of the contrarian agents can cause oscillation, given that if the religious exodus becomes large enough the contrarian agents may return to it. Another vector for the initial stage of secularization are the majoritarian agents with a high threshold that must be reached for attendance. In this model, two agents with the same strategy will not necessarily make the same decisions, since parameters like attendance memory and attendance threshold are chosen stochastically.

Despite similarities between this model and that of Cragun et al., the methodological approach differs substantially. Cragun et al.'s model focused on simulated transitions in worldview orientation over time, while this model focuses instead on weekly attendance decisions, tracking behavior rather than belief. Cragun et al. leveraged CREDs (credibility-enhancing displays) and continuous worldview scores in a cognitively enriched artificial society. By contrast, this model draws from Brian Arthur's El Farol bar problem in the sense that a plethora of rule-based heuristics are employed by agents to shape attendance decisions. In this model, agents adopt diverse yet fixed strategies for decision-making, ranging from majority-following to contrarian to trend-based, with both global and local variants. This allows for a population-level exploration of how strategy heterogeneity interacts with social context to produce emergent patterns of persistence, decline, or transformation within religious groups.

Overall, this study reinforces the argument that secularization is not merely a product of abstract cultural change or theological skepticism, but a dynamic, emergent outcome of social network interactions in an increasingly pluralist religious landscape.

4.2 Future Work

This model provides a flexible framework for simulating the social dynamics of religious attendance, but it remains in the exploration phase. Future work can focus on calibrating model parameters through iterative testing and comparison with empirical data. In addition to the adjustable parameters, there are also non-adjustable parameters within the model that should be calibrated. For instance, strategies have

parameters like attendance memory and attendance thresholds that are chosen stochastically; however, the distribution and bounds on these random selections could be tuned based on known demographic trends. Given that the model's primary aim is to study the impact of pluralism on secularization, subsequent studies could more precisely examine how inter-faith connections influence disaffiliation under different strategic and structural conditions.

Several promising extensions are also envisioned. One is to implement strategies with weighted social influence, where agents place greater importance on central or highly connected peers, using network metrics like degree or eigenvector centrality. Along similar lines, more global strategies could be introduced, since there are currently far more local strategies than global (eight compared to two, respectively). Another direction is to introduce dynamic social networks, allowing agents' ties to evolve based on shared attendance patterns or institutional loyalty, better capturing the co-evolution of community structure and religious behavior over time.

5. Summary

This study developed and explored an ABM to simulate the weekly religious attendance decisions of individuals embedded in social networks, focusing on the effects of religious pluralism, network structure, and heterogeneity of socially determined decision-making heuristics. Inspired by Brian Arthur's famous 1997 El Farol Bar Problem and building on Cragun et al.'s (2021) secularization ABM, the model represents a novel approach to understanding how diverse social interactions and decision-making heuristics shape patterns of institutional persistence and disaffiliation.

Across a range of experiments, the model demonstrated that increased pluralism—modeled through inter-faith and secular connections—predictably promotes secularization. Network structure had more modest effects, with small-world and scale-free topologies yielding similar outcomes at the small scale used in this study. Strategic heterogeneity introduced important variation, with majoritarian strategies reinforcing dominant institutions and contrarian strategies driving fragmentation and institutional churn. These findings affirm theoretical expectations that religious participation is not only shaped by personal belief but also by dynamic social environments.

Overall, the model offers a flexible and extensible framework for studying religious affiliation as an emergent property of individual behavior in pluralistic societies. Future research can refine parameters, introduce adaptive social ties, and validate outcomes against empirical data to further illuminate the networked nature of religious attendance.

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