1 Overview

1.1 Purpose:

This model is a basic implementation of an agent interaction framework that uses Bayesian inference to update opinion. The goal of this basic implementation was to test the framework's capabilities to create polarisation in a population of agents and to compare to another, older Bayesian framework.

1.2 State variables and scales:

In the model, there are (n) agents representing individuals in a social network. These agents have an opinion (x) and an uncertainty (σ). Every agent knows the global truth rate (p), where p is the proportion of accurate information rate in the simulation. The social network is fully connected, meaning that agents have no spatial restrictions when they interact, i.e. any agent has an equal likelihood of interacting with any other agent. At all time steps, the simulation chooses two agents at random to interact. This choice of time scale is due to the apparent president set by the previous Bayesian framework.

1.3 Process overview and scheduling:

There are three main functions used in the model.

First is AgentModeler, which is the interface function of the model. This function takes all the initial parameters of a simulation. These parameters are the initial x and σ of all agents and the timeframe of the simulation. After initialising the model, AgentModeler will call the other two functions to run the simulation. Once the simulation is complete, AgentModeler will output a vector of recorded timesteps and a matrix containing both the x and σ of every agent at every timestep. The rows of the output matrix refer individual agents, and the columns refer to the timestep.

The second function is FullyConNetModel1by1, which handles the network side of simulations. This function controls the fully connected social network of the model where every agent can interact with any other agent and is the function that chooses two agents at random.

Third is BayesInteractionFixedP which handles agent interaction in the model. When two agents interact at time t in the simulation they update their opinion according to

$$x_i(t+1) = p^* \frac{(x_i/\sigma_i^2) + (x_j/\sigma_j^2)}{(1/\sigma_i^2) + (1/\sigma_j^2)} + (1-p^*)x_i(t)$$

and their uncertainty according to

$$\sigma_i^2(t+1) = \sigma_i^2(t)\left(1 - p^* \frac{\sigma_i^2(t)}{\sigma_i^2(t) + \sigma_j^2(t)}\right) + p^*(1-p^*)\left(\frac{x_i(t) - x_j(t)}{1 + (\sigma_j(t)/\sigma_i(t))^2}\right)^2,$$

where

$$p^* = \frac{p\phi\left(x_i(t) - x_j(t), \sqrt{\sigma_i^2 + \sigma_j^2}\right)}{p\phi\left(x_i(t) - x_j(t), \sqrt{\sigma_i^2 + \sigma_j^2}\right) + (1-p)},$$

and

$$\phi\left(x_i(t) - x_j(t), \sqrt{\sigma_i^2 + \sigma_j^2}\right) = \left(1/\left(\sqrt{2\pi(\sigma_i^2 + \sigma_j^2)}\right)\right) e^{-(x_i(t)-x_j(t))^2/2(\sigma_i^2+\sigma_j^2)},$$

and x_i, σ_i are the opinion and uncertainty of the agent who is updating their opinion, and x_j, σ_j are the opinion and uncertainty of the other agent in the interaction. Both agents in the interaction update their opinion and uncertainty, and both according to the same equation.

2 Design concepts:

Emergence: The model imposes a fully connected social network on the simulations. Otherwise, the tendency for the simulations to polarise is an emergent behaviour, based on p, σ, and the maximum and minimum x.

Sensing: All agents in the simulation know the truth rate, p.

Interaction: The assumption is that agents truthfully share both their uncertainty σ and opinion x.

Stochasticity: Agents are chosen at random to interact because in a fully connected social network individuals will have social ties to all other individuals.

3 Details

3.1 Initialization:

The model was initialised by to have every agent start with an opinion x between 0 and 1. Every agent started with the same initial uncertainty, varying between 0.02 to 0.16. There were 10 000 agents in the simulation, and we chose the global truth rate p to be 0.7 to match simulations of the older model.