Problem A: Group Affinity and Fashion Sense

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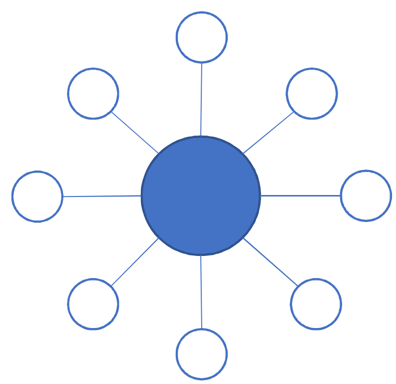
Problem Description

- In general, people tend to congregate into groups.
- People can create strong links in small cliques or identify loosely as part of a larger trend.
- When a larger trend begins to propagate through a group, how will the people in the group respond and change their appearance in response?
- Describe the exchange of information in the group, the interactions in the group, and describe the range of values for parameters and the meaning of higher and lower parameters.

Our General Approach

- For our approach, rather than looking at a person changing their physical appearance, we decide to look at their social media appearance. More specifically we focused on someone's appearance on Twitter.
- We defined a person's appearance on Twitter as how they portray the ideas they align with (i.e. their tweets, retweets, and likes).



Initial Model (SI)

- Inspired by the model for infectious disease spread.
- Assumes that the spread is not resisted and will eventually spread to the whole group.
- A major limitation is that it does not really show an accurate response to the problem, we simply used it as a starting point to build from.

$$\frac{dS}{dt} = -\frac{\beta SI}{N}$$

$$\frac{dI}{dt} = \frac{\beta SI}{N} = \beta I(1 - \frac{I}{N})$$

(Watts et al., 2012)

$$\tau(I) = I\phi$$

$$\frac{dI}{dt} = \frac{\tau S}{N}$$

$$\frac{dS}{dt} = -\frac{\tau S}{N}$$

Adding a "Resistant" Population

- For our approach, we did not account for a recovery, and instead used the idea that someone is "resistant" to the idea, meaning that they feel strongly enough about it to form an opinion and thus will not change their appearance.

$$\frac{dS}{dt} = -\frac{\beta SI}{N}$$

$$\frac{dI}{dt} = \frac{\beta SI}{N} - \gamma I$$

$$\frac{dR}{dt} = \gamma I$$

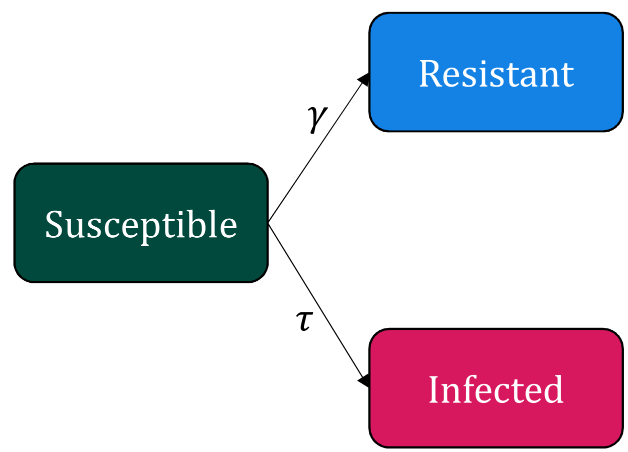
(Watts et al., 2012)

$$\frac{dS}{dt} = -\frac{\tau S}{N} - \gamma S$$

$$\frac{dI}{dt} = \frac{\tau S}{N}$$

$$\frac{dR}{dt} = \gamma S$$

$$\gamma = \frac{\phi S}{N}$$



Accounting for Active Interactions

- Our previous two modifications only consider passive interactions between the members in the group (viewing the content posted).
- To advance our model, we added in a factor to account for active interactions (direct messages, replies to tweets).
- ψ is our "passion" coefficient, accounting for a person's chance to actively interact with someone who has accepted the idea.
- ξ is our active interaction coefficient which accounts for the amount of active interactions that would occur.

$$\psi(I) = \xi I$$

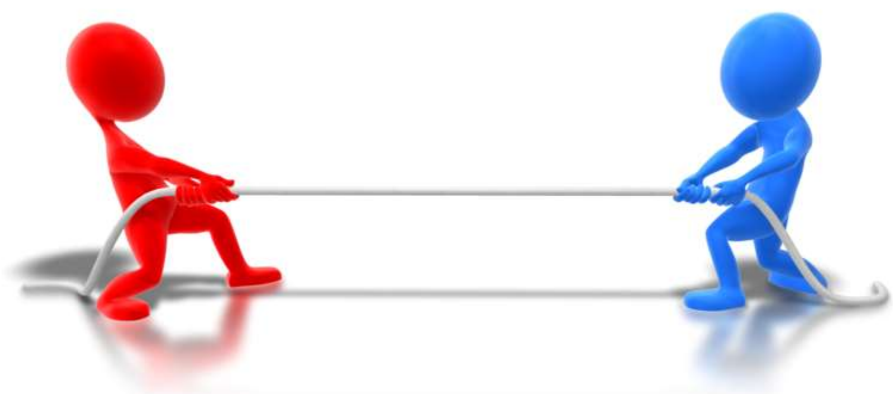
$$\frac{dS}{dt} = -\frac{\tau S}{N} - \gamma S - \frac{S\psi}{N}$$

$$\frac{dI}{dt} = \frac{\tau S}{N} + \frac{S\psi}{N}$$

$$\frac{dR}{dt} = \gamma S$$

Adding an “Anti” Population

- We believe that the anti group is similar to a hipster group, in that it spawns out of the desire to oppose another group. It grows similarly to that of the infected group.
- This group spawned from a “bad” interaction with the infected group, and then proceeded to have its own passive growth, once a population was established.



Modeling the "Anti" Population

The "1-a" represents the bad active interactions, while the κ represents the production coefficient of the anti group.

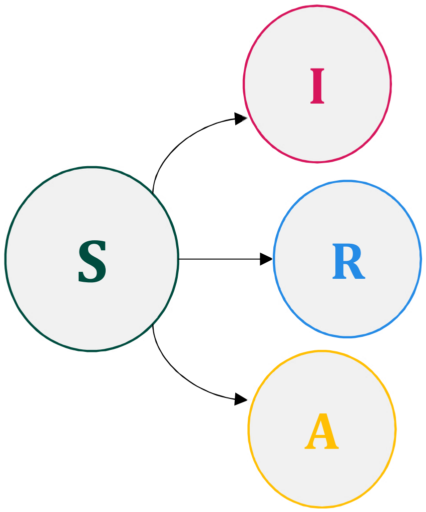
$$\frac{dI}{dt} = \frac{\tau S}{N} + a(\frac{S\psi}{N})$$

$$\frac{dA}{dt} = (1 - a)\left(\frac{S\psi}{N}\right) + \frac{\beta S}{N}$$

$$\beta(A) = A\kappa$$

$$\psi(I, A) = \xi(I + A)$$

Final Model



$$\tau(I) = I\phi$$

$$\beta(A) = A\kappa$$

$$\psi(I, A) = \xi(I + A)$$

$$\gamma = \frac{(\phi + \kappa)S}{N}$$

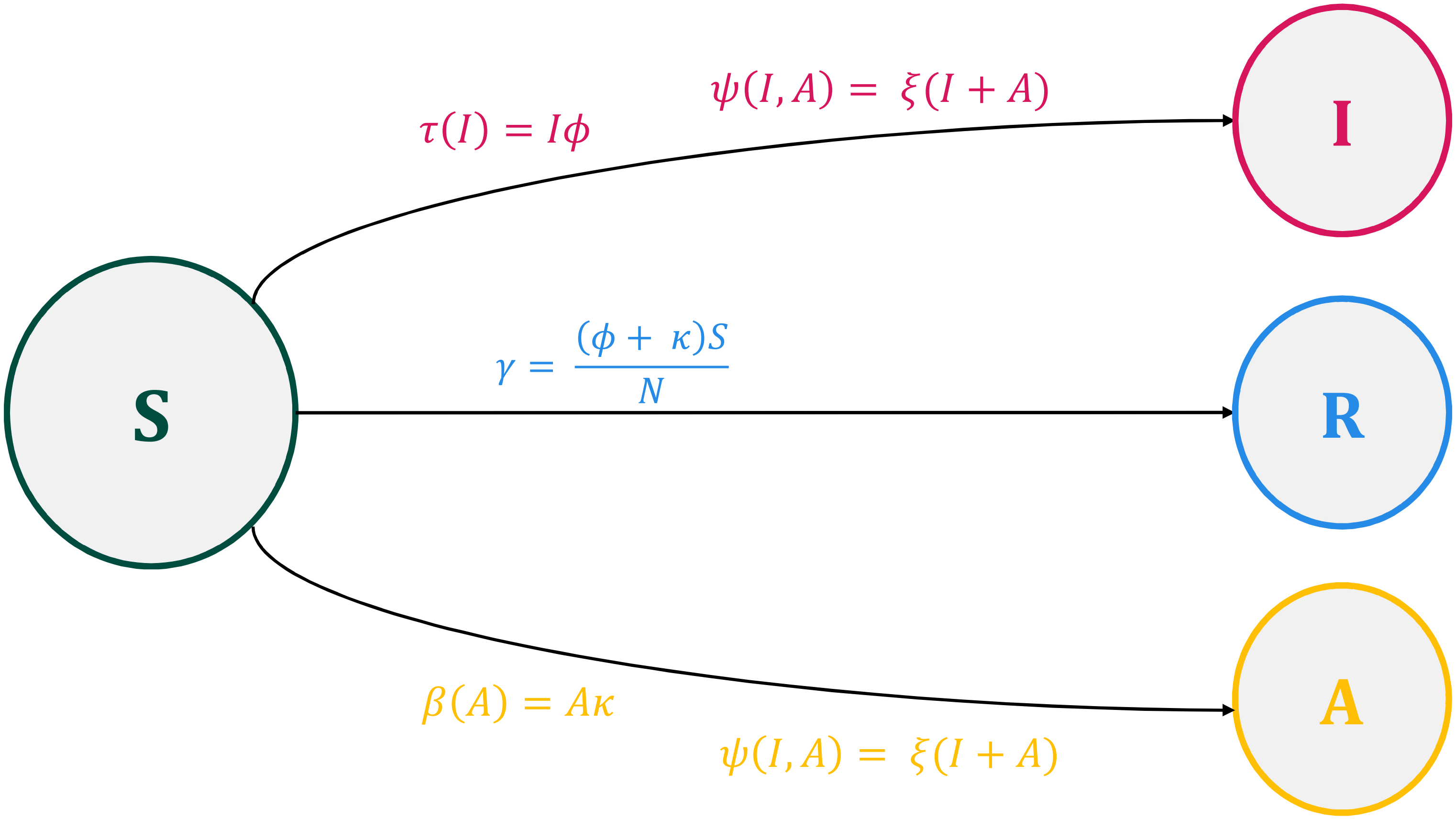
$$\frac{dS}{dt} = -\frac{\tau S}{N} - \frac{\beta A}{N} - \gamma S - \frac{S\psi}{N}$$

$$\frac{dI}{dt} = \frac{\tau S}{N} + a(\frac{S\psi}{N})$$

$$\frac{dR}{dt} = \gamma S$$

$$\frac{dA}{dt} = (1 - a)\left(\frac{S\psi}{N}\right) + \frac{\beta S}{N}$$

Final Model



$$\frac{dI}{dt} = \frac{\tau S}{N} + a(\frac{S\psi}{N})$$

$$\frac{dR}{dt} = \gamma S$$

$$\frac{dA}{dt} = (1 - a)\left(\frac{S\psi}{N}\right) + \frac{\beta S}{N}$$

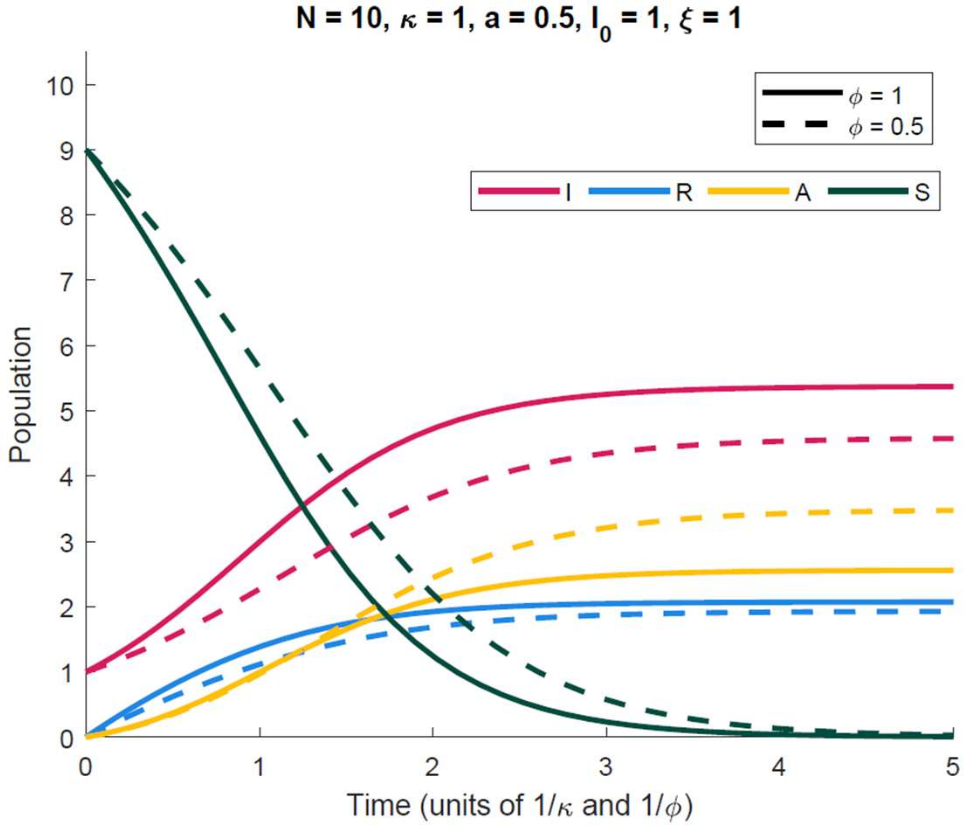
Changing Φ – Infected group is not as productive

$$\frac{dS}{dt} = -\frac{\tau S}{N} - \frac{\beta A}{N} - \gamma S - \frac{S\psi}{N}$$

$$\frac{dI}{dt} = \frac{\tau S}{N} + a(\frac{S\psi}{N})$$

$$\frac{dR}{dt} = \gamma S$$

$$\frac{dA}{dt} = (1-a)\left(\frac{S\psi}{N}\right) + \frac{\beta S}{N}$$



The dotted line represents a less productive infected group, that produces less passive content.

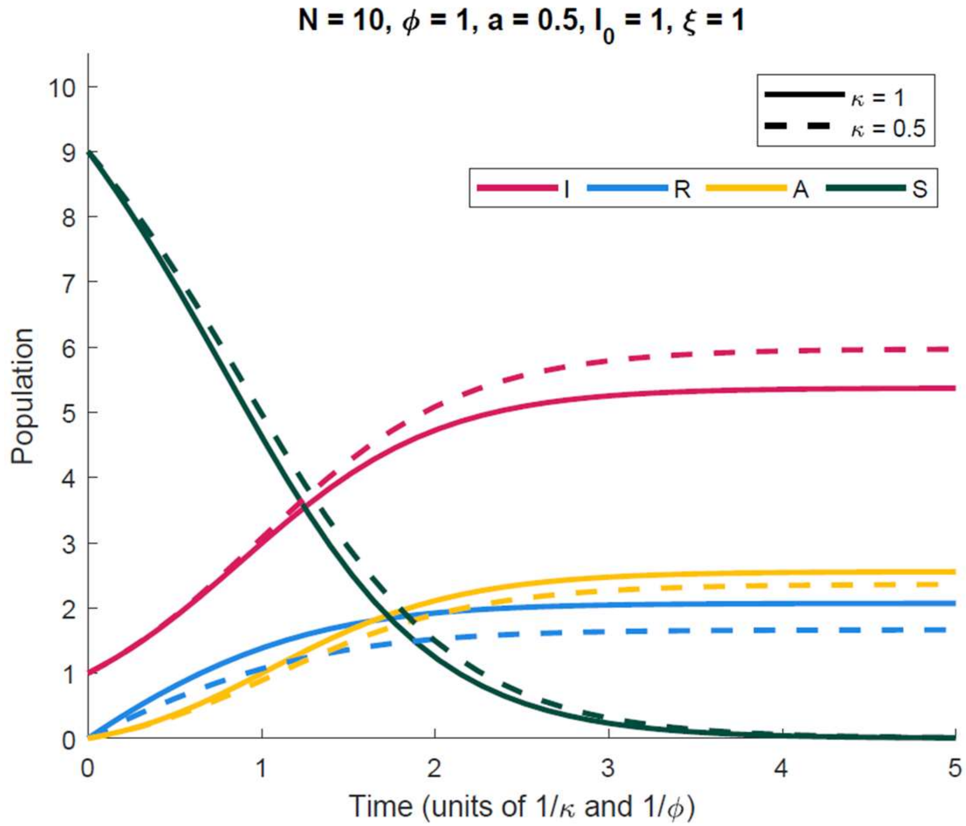
Changing κ – Anti group is not as productive

$$\frac{dS}{dt} = -\frac{\tau S}{N} - \frac{\beta A}{N} - \gamma S - \frac{S\psi}{N}$$

$$\frac{dI}{dt} = \frac{\tau S}{N} + a(\frac{S\psi}{N})$$

$$\frac{dR}{dt} = \gamma S$$

$$\frac{dA}{dt} = (1-a)\left(\frac{S\psi}{N}\right) + \frac{\beta S}{N}$$



The dotted line represents a situation where the anti group is not producing as much content.

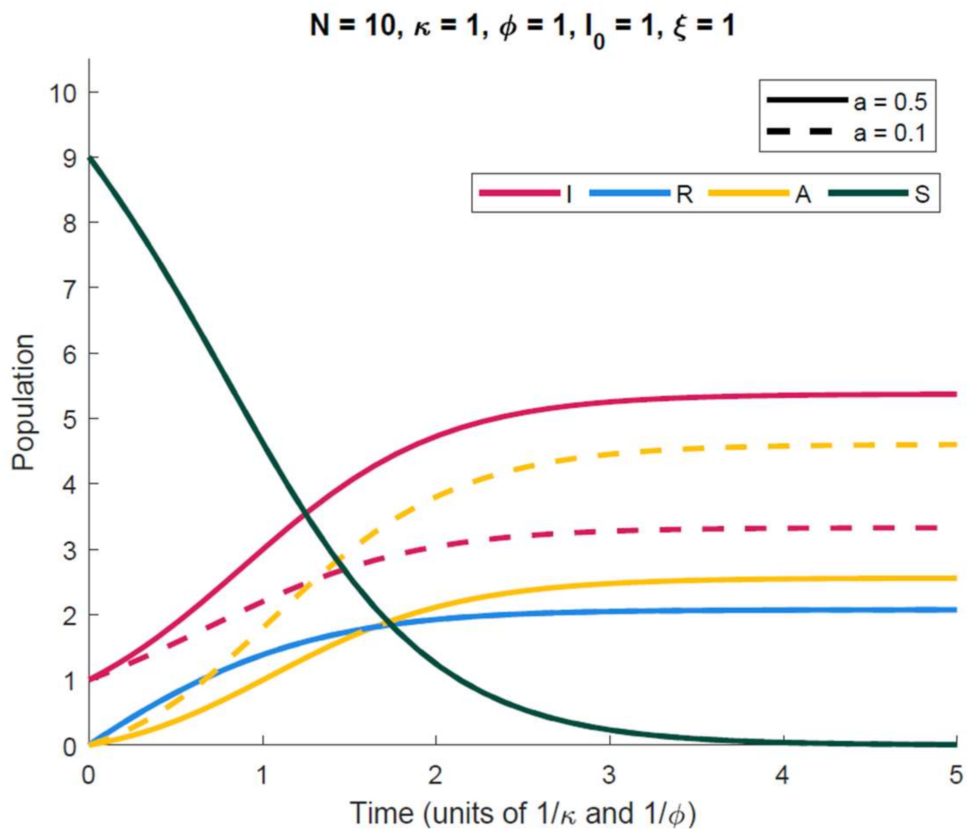
Varying a – more negative interactions

$$\frac{dS}{dt} = -\frac{\tau S}{N} - \frac{\beta A}{N} - \gamma S - \frac{S\psi}{N}$$

$$\frac{dI}{dt} = \frac{\tau S}{N} + a(\frac{S\psi}{N})$$

$$\frac{dR}{dt} = \gamma S$$

$$\frac{dA}{dt} = (1-a)\left(\frac{S\psi}{N}\right) + \frac{\beta S}{N}$$



This causes a larger portion of the active interactions to lead towards the anti group as opposed to the infected group.

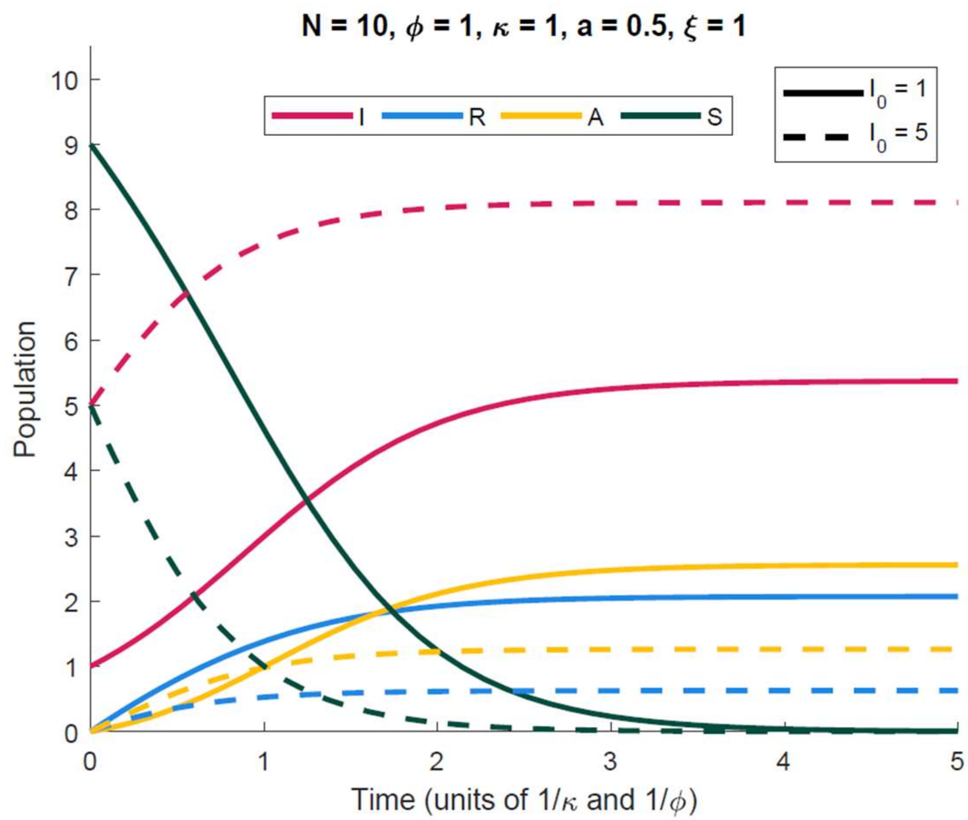
Varying I_0 – starting off with bigger I group

$$\frac{dS}{dt} = -\frac{\tau S}{N} - \frac{\beta A}{N} - \gamma S - \frac{S\psi}{N}$$

$$\frac{dI}{dt} = \frac{\tau S}{N} + a(\frac{S\psi}{N})$$

$$\frac{dR}{dt} = \gamma S$$

$$\frac{dA}{dt} = (1-a)\left(\frac{S\psi}{N}\right) + \frac{\beta S}{N}$$



Difference is a larger population of the infected group initially.

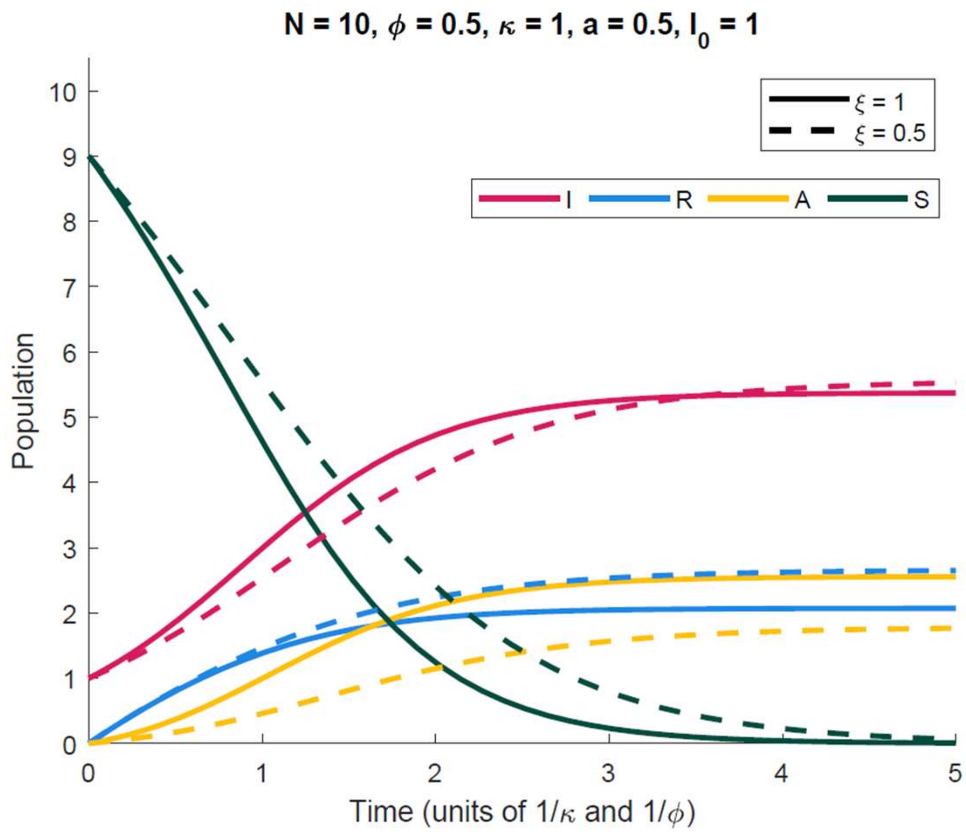
Varying ξ – less active interactions occur

$$\frac{dS}{dt} = -\frac{\tau S}{N} - \frac{\beta A}{N} - \gamma S - \frac{S\psi}{N}$$

$$\frac{dI}{dt} = \frac{\tau S}{N} + a\left(\frac{S\psi}{N}\right)$$

$$\frac{dR}{dt} = \gamma S$$

$$\frac{dA}{dt} = (1-a)\left(\frac{S\psi}{N}\right) + \frac{\beta S}{N}$$



The overall effect of the active interaction is lessened (for dashed lines).

Change in Appearance

- In our model, we assume that a person will begin changing their appearance on social media (via retweets, likes, original content) once they become infected (or join the anti group).

- Intuitively, the longer a person is a member of the group, the more they will change their appearance on social media.

Appearance Equations

This change in appearance (V) would manifest itself in changes in likes (ρ), retweets (σ), and original content (χ). Further improvements of this model would account for these changes in available content (C).

$$\frac{dV}{dt} = \frac{d\rho}{dt} + \frac{d\sigma}{dt} + \frac{d\chi}{dt}$$

$$\frac{dC}{dt} = \sum_{n=1}^{n=N} \frac{d\rho_n}{dt} + \frac{d\sigma_n}{dt} + \frac{d\chi_n}{dt}$$

Additional Issues – “Influencers”

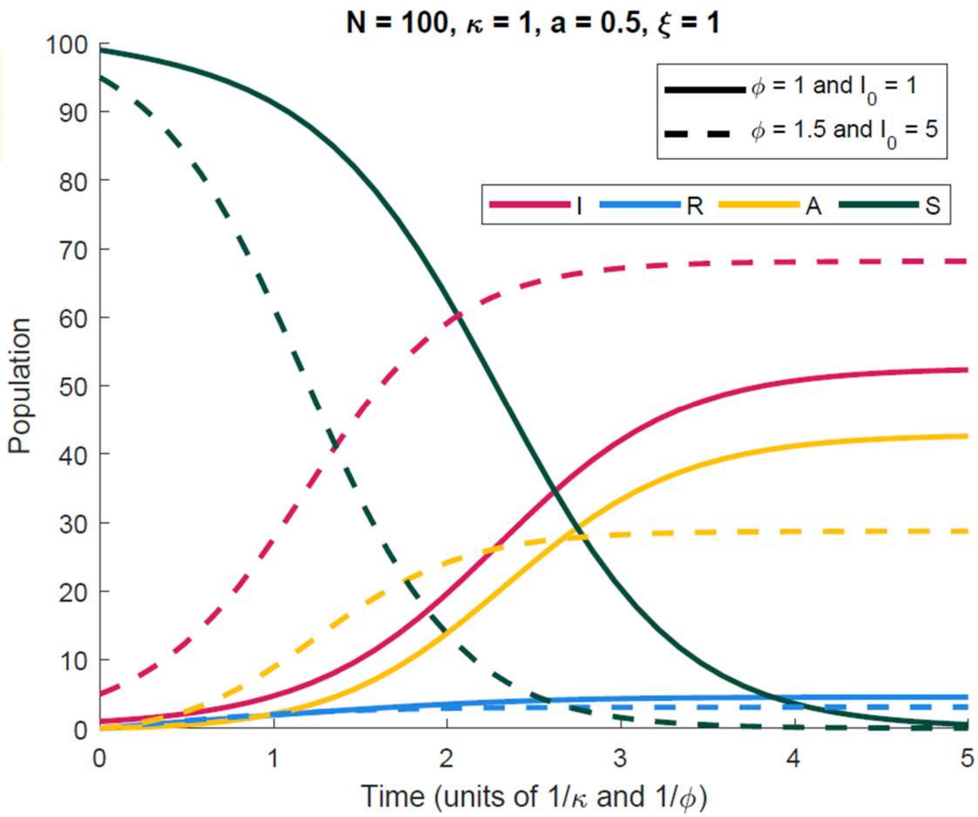
Now a company hopes to use our model to sell a product. To do this, we suggest that they “plant” a few members of the infected group and pay them to produce content, thus increasing I_0 and Φ.

$$\frac{dS}{dt} = -\frac{\tau S}{N} - \frac{\beta A}{N} - \gamma S - \frac{S\psi}{N}$$

$$\frac{dI}{dt} = \frac{\tau S}{N} + a\left(\frac{S\psi}{N}\right)$$

$$\frac{dR}{dt} = \gamma S$$

$$\frac{dA}{dt} = (1-a)\left(\frac{S\psi}{N}\right) + \frac{\beta S}{N}$$



Increased N to show effects more clearly. Company paid to increase I_0 and Φ, thus causing more rapid growth in the infected group (and likely causing people to buy more products).

Future Steps

- Varying the Population (N) group size.
- Allowing for oscillations between I, A, and R groups.
- Account for varying quality of content.
- Consider that individual time on Twitter may be different.