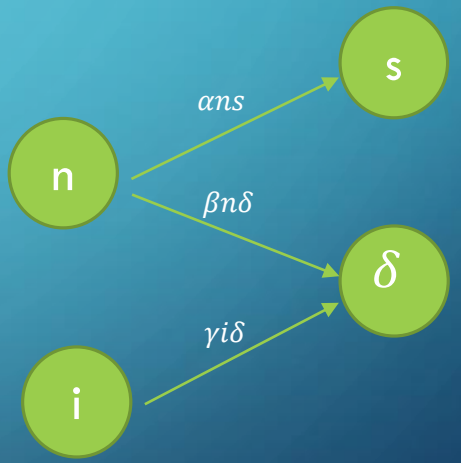
ON THE BASIS OF EPIDEMIOLOGICAL MODEL

SIS MODEL

$$\frac{dS}{dt} = \alpha I - \beta SI$$

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

OUR MODEL



where:

n: neutrals s:strongholds

i:impressionables δ : spreaders

DERIVED EQUATIONS

$$\frac{ds}{dt} = \alpha n s$$

$$\frac{dn}{dt} = -\alpha n s - \beta n \delta$$

$$\frac{d\delta}{dt} = \beta \delta n + \gamma \delta i$$

$$\frac{di}{dt} = -\gamma \delta i$$

$$\frac{ds}{dt} + \frac{dn}{dt} + \frac{di}{dt} + \frac{d\delta}{dt} = 0$$

EQUATION FOR δ (SPREADERS)

We expect the solution to be logistic in trend

$$\delta(t) = \frac{L}{1+e^{-k(t-t_0)}}$$

L : asymptotic limit for percentage of spreaders

Based on the previous experiments, L follows a bounded growth trend with respect to link density(ld).

$$L(ld) = M(1 - e^{-k(ld)+c})$$

M:maximum limit of percentage as $ld \rightarrow infinity$

EQUATIONS

$$L = \frac{n+i}{n+i+s}\left(1 - e^{-\frac{n+i}{n+i+s}(ld)+\frac{n+s}{n+i+s}}\right)$$

where:

$$L : spreader\ limit$$

$$n, i, s : initial\ neutral, impressionable, strongholds\ population$$

$$ld : link\ density$$

EXPERIMENTAL VALIDATIONS ON SPREADER LIMIT

strongholds-population	405	405	405	405	405	472	472	472	472	472
impressionable-population	786	786	786	786	786	808	808	808	808	808
neutral-population	794	794	794	794	794	211	211	211	211	211
trustfactor	0.86	0.86	0.86	0.86	0.86	0.12	0.12	0.12	0.12	0.12
link-density	6	6	6	6	6	5	5	5	5	5
[steps]	5	7	7	7	7	25	24	22	25	28
[initial & final values]	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders
	1541	1548	1549	1547	1556	951	966	949	931	961
observed	0.776322418	0.779849	0.780353	0.779345	0.783879	0.637827	0.647887	0.636486	0.624413	0.644534
predicted by equations	0.7837416	0.783742	0.783742	0.783742	0.783742	0.630532	0.630532	0.630532	0.630532	0.630532
errors	8.9612E-05	2.47E-05	1.87E-05	3.15E-05	3.08E-08	0.000134	0.000758	8.92E-05	9.42E-05	0.000493

EXPERIMENTAL VALIDATIONS ON SPREADER LIMIT

strongholds-population	116	116	116	116	116	198	198	198	198	198
impressionable-population	221	221	221	221	221	680	680	680	680	680
neutral-population	192	192	192	192	192	350	350	350	350	350
trustfactor	0.5	0.5	0.5	0.5	0.5	0.7	0.7	0.7	0.7	0.7
link-density	7	7	7	7	7	3	3	3	3	3
[steps]	9	9	9	7	9	11	10	11	12	11
[initial & final values]	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders
	412	409	407	406	408	935	924	900	905	893
observed	0.778828	0.773157	0.769376	0.767486	0.771267	0.761401	0.752443	0.732899	0.736971	0.727199
predicted by equations	0.77447	0.77447	0.77447	0.77447	0.77447	0.700296	0.700296	0.700296	0.700296	0.700296
errors	3.17E-05	2.88E-06	2.6E-05	4.88E-05	1.03E-05	0.003734	0.002719	0.001063	0.001345	0.000724

EXPERIMENTAL VALIDATIONS ON SPREADER LIMIT

strongholds-population	198	600	600	600	600	40	40	40	40	40
impressionable-population	680	500	500	500	500	320	320	500	500	500
neutral-population	350	498	498	498	498	700	700	241	241	241
trustfactor	0.7	0.4	0.4	0.4	0.4	0.38	0.38	0.35	0.35	0.35
link-density	3	3	3	3	3	5	15	6	6	6
[steps]	11	23	21	17	24			50	50	50
[initial & final values]	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders			count spreaders	count spreaders	count spreaders
	893	652	627	613	568	1010	1040	739	737	739
observed	0.727199	0.40801	0.392365	0.383605	0.355444	0.95283	0.981132	0.946223	0.943662	0.946223
predicted by equations	0.700296	0.433627	0.433627	0.433627	0.433627	0.951267	0.962263	0.942399	0.942399	0.942399
errors	0.000724	0.000656	0.001703	0.002502	0.006113	2.44E-06	0.000356	1.65E-05	1.8E-06	1.65E-05

EXPERIMENTAL VALIDATIONS ON SPREADER LIMIT

strongholds-population	172	172	172	919	919	919	789	789	472	472
impressionable-population	622	622	622	980	980	980	409	409	808	808
neutral-population	619	619	619	495	495	495	237	237	211	211
trustfactor	0.44	0.44	0.44	0.038	0.038	0.038	0.78	0.78	0.12	0.12
link-density	8	8	8	9	9	9	4	4	5	5
[steps]	50	50	50	50	50	50	50	50	22	25
[initial & final values]	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders
	1238	1240	1238	1353	1339	1351	336	343	949	931
observed	0.87615	0.877565	0.87615	0.565163	0.559315	0.564327	0.234146	0.239024	0.636486	0.624413
predicted by equations	0.876905	0.876905	0.876905	0.610803	0.610803	0.610803	0.278812	0.278812	0.630532	0.630532
errors	7.41E-07	5.68E-07	7.41E-07	0.005583	0.007106	0.00579	0.025664	0.020364	3.54E-05	3.74E-05

EXPERIMENTAL VALIDATIONS ON SPREADER LIMIT

strongholds-population	472	116	116	116	116	116	198	198	198	198
impressionable-population	808	221	221	221	221	221	680	680	680	680
neutral-population	211	192	192	192	192	192	350	350	350	350
trustfactor	0.12	0.5	0.5	0.5	0.5	0.5	0.7	0.7	0.7	0.7
link-density	5	7	7	7	7	7	3	3	3	3
[steps]	28	9	9	9	7	9	11	10	11	12
[initial & final values]	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders
	961	412	409	407	406	408	935	924	900	905
observed	0.644534	0.778828	0.773157	0.769376	0.767486	0.771267	0.761401	0.752443	0.732899	0.736971
predicted by equations	0.630532	0.77447	0.77447	0.77447	0.77447	0.77447	0.700296	0.700296	0.700296	0.700296
errors	0.000196	1.9E-05	1.73E-06	2.6E-05	4.88E-05	1.03E-05	0.003734	0.002719	0.001063	0.001345

EXPERIMENTAL VALIDATIONS ON SPREADER LIMIT

strongholds-population	198	600	600	600	600	40	40
impressionable-population	680	500	500	500	500	320	320
neutral-population	350	498	498	498	498	700	700
trustfactor	0.7	0.4	0.4	0.4	0.4	0.38	0.38
link-density	3	3	3	3	3	5	15
[steps]	11	23	21	17	24		
[initial & final values]	count spreaders	count spreaders	count spreaders	count spreaders	count spreaders		
	893	652	627	613	568	1010	1040
observed	0.727199	0.40801	0.392365	0.383605	0.355444	0.95283	0.981132
predicted by equations	0.700296	0.433627	0.433627	0.433627	0.433627	0.951267	0.962263
errors	0.000724	0.000656	0.001703	0.002502	0.006113	2.44E-06	0.000356

EXPERIMENTAL VALIDATIONS ON SPREADER LIMIT

With 56 random experiments to verify the equation for L. Which is the percentage of spreaders at the end of a simulation given the link density, and the initial populations for each class of agents. It is found at that it produces a

0.056242133 RMSE (root mean square error)

EXPERIMENTAL VALIDATIONS ON SPREADER FUNCTION

We come up with the following function to approximate σ (the number of spreaders over time given initial populations for each class of agents, trust factor and link density.

0

$$\sigma(n,i,s,f,ld,t) = \frac{L}{1+(\frac{2L}{L-1})e^{(-\frac{n+i}{n+i+s}(ld)+\frac{n+s}{n+s+i})(f)(t-t_0)}}$$