

# A population dynamics model for the spread of two competing pieces of information

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In this work, we employ the use of a system of ordinary differential equations to see how two competing pieces of information behave at a given time,  $t$ , in a population divided into those who have not been exposed to any of the two pieces of information,  $U(t)$ ; those who know and transmit only the first piece of information,  $P_1(t)$ ; those who know and transmit only the second piece of information,  $P_2(t)$ ; those who know both but transmit only the first piece of information,  $V_1(t)$ ; those who know both but transmit only the second piece of information,  $V_2(t)$ . Based on these five groups, we have the following general formulas for our model:

$$\begin{aligned}\frac{dU}{dt} &= -\Lambda_1 U - \Lambda_2 U - \Lambda_3 U - \Lambda_4 U - \Lambda_5 U; \\ \frac{dP_1}{dt} &= \Lambda_1 U - \Gamma_1 P_1 - \Gamma_2 P_1 - \Gamma_3 P_1; \\ \frac{dP_2}{dt} &= \Lambda_2 U - \Xi_1 P_2 - \Xi_2 P_2 - \Xi_3 P_2; \\ \frac{dV_1}{dt} &= \Lambda_3 U + \Gamma_1 P_1 + \Xi_1 P_2 - \Psi_1 V_1 + \Psi_2 V_2 - \Phi_1 V_1; \\ \frac{dV_2}{dt} &= \Lambda_4 U + \Gamma_2 P_1 + \Xi_2 P_2 + \Psi_1 V_1 - \Psi_2 V_2 - \Phi_2 V_2.\end{aligned}$$

Furthermore, we have those who transfer directly from the state  $U$  to a state in which they know and transmit both pieces of information,  $W_{02}(t)$ ; those who transfer from the states  $P_1$  and  $P_2$  to a state where they know and transmit both pieces of information,  $W_{12}(t)$ ; those who transfer from the states  $V_1$  and  $V_2$  to a state where they transmit both pieces of information,  $W_{22}(t)$  such that we have

$$\begin{aligned}\frac{dW_{02}}{dt} &= \Lambda_5 U; \\ \frac{dW_{12}}{dt} &= \Gamma_3 P_1 + \Xi_3 P_2; \\ \frac{dW_{22}}{dt} &= \Phi_1 V_1 + \Phi_2 V_2.\end{aligned}$$

The coefficients  $\Lambda_i$ ,  $\Gamma_i$ ,  $\Xi_i$ ,  $\Psi_i$  and  $\Phi_i$  are related to transition of states and they are generally functions of relevant subpopulations.

We consider this eight dimensional system in order to understand the dynamics of various population segments with respect to the spread of two items of information with unique attributes. As an example of what we hope to achieve, the findings could help us to appreciate the impact of misinformation on the society and promote information literacy which has become a very crucial need in this Internet enabled information age.