Simulating Hot Topic Popularity with a Modified SIR Model

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Introduction

Ideas randomly spread out over the Internet similar to a contagious disease.

Figure 1: The random spread of ideas over the Internet (T3Leads).

Google Trends index: a normalized value between 0 and 100 representing the relative number of searches for a topic at a specific time compared to the rest of a time range.

Model

Consider the population of all users who will ever search Google for a particular hot topic. Divide this into three groups S, I, and R:

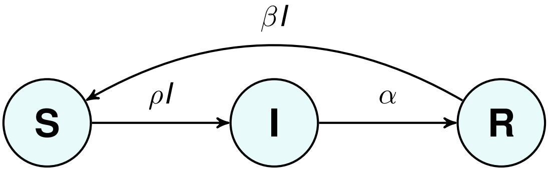

Figure 2: A flowchart for the dynamics of the susceptible (S), *interested* (I), and recovered (R) groups.

$S + I + R = 100$ in this closed population after rescaling to fit the range of the Google Trends index.

Model (cont.)

At time t for a specific hot topic,

$$\frac{dS}{dt} = -\rho SI + \beta IR \tag{1}$$

$$\frac{dI}{dt} = \rho SI - \alpha I \tag{2}$$

$$\frac{dR}{dt} = \alpha I - \beta IR \tag{3}$$

where

- $S(t) \propto$ users *still unaware of* the topic or *thinking about* the topic,
- $I(t) \propto$ users *searching for* the topic (i.e., interested in it), and
- $R(t) \propto$ users *no longer thinking about* the topic.

Model (cont.)

At time t for a specific hot topic,

$$\frac{dS}{dt} = -\rho SI + \beta IR \tag{1}$$

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$$\frac{dR}{dt} = \alpha I - \beta IR \tag{3}$$

This model can cover past and present topics, including things like

- historical events,
- Internet memes, and
- popular songs.

Past Example: Flint Water Crisis

Figure 3: Flint Water Plant water tower (Osorio).

Past Example: Flint Water Crisis

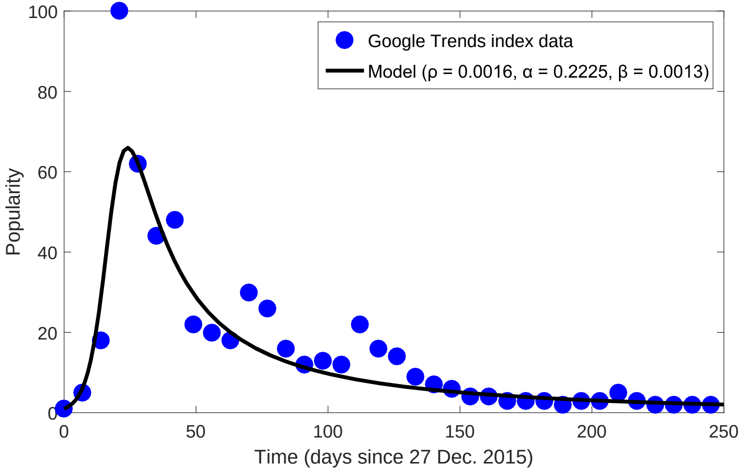

Figure 4: According to Google Trends, public interest in the topic has died down.

Recent Example: ”Catch Me Outside”

Figure 5: Danielle Bregoli (Collins).

Recent Example: ”Catch Me Outside”

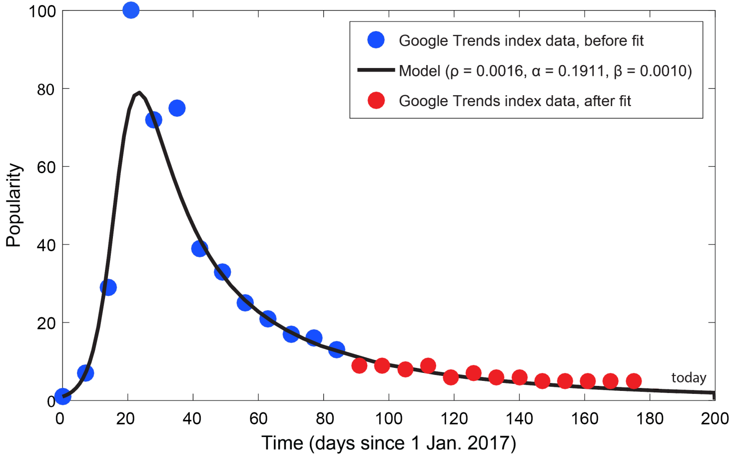

Figure 6: Calculated parameter values show that interest in Danielle Bregoli grew at the same rate as the Flint water crisis.

Current Example: ”Bad Things”

Figure 7: ”Bad Things” cover artwork (Redfearn).

Current Example: "Bad Things"

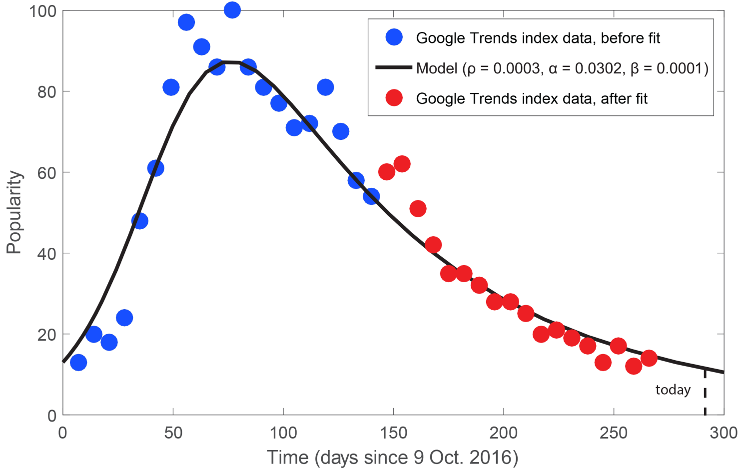

Figure 8: Additional data gathered in July 2017 supports the predicted decline of the song's popularity over the summer of 2017.

Further Improvements: Stochastic Model

The fitted curves do not represent erratic regions of the data as well, as seen in the Flint water crisis example.

One way this can be mitigated is by adding a stochastic process to the losing-interest rate α:

$$\frac{dS}{dt} = -\rho SI + \beta IR \tag{1}$$

$$\frac{dI}{dt} = \rho SI - (\alpha + \sigma\xi)I \tag{2}$$

$$R = 100 - S - I \tag{3}$$

Where

- ξ = low-pass filtered white noise with mean = 0 and std = 1, and
- σ = noise intensity.

All other parameters are the same as in the deterministic model.

Stochastic Simulation: Flint Water Crisis

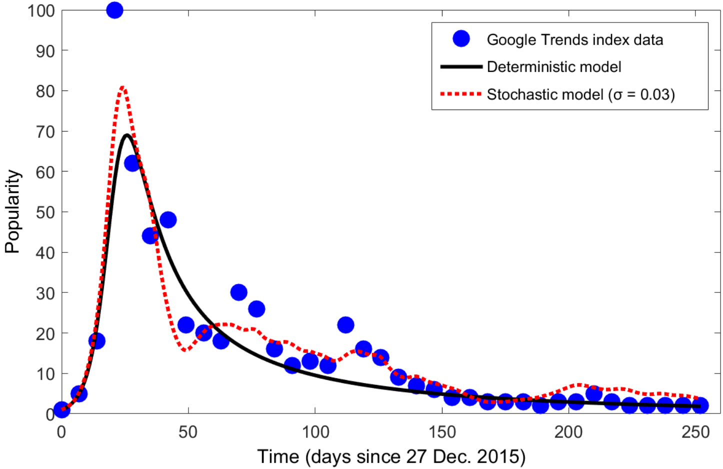

Figure 9: The stochastic model better simulates the fluctuation of the data.

References

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