Chapter 5

Results and Discussion

In this chapter, I present the results of the trend detection experiment described in chapter 4. I show the quality of the trend detection algorithm using ROC curves and distributions of detection time relative to the true trend onset. I analyze the effect of the algorithm parameters on the tradeoff between false positive rate, true positive rate, and relative detection time. Finally, I propose parameter regimes appropriate for three situations: 1) the cost of a false positive outweighs the cost of a false negative, 2) the cost of a false negative outweighs the cost of a false positive, and 3) the costs of a false positive and a false negative are comparable.

5.1 ROC Curve Envelopes

Figures **??** and **??** shows the false positive rates (FPR) and true positive rates (TPR) that result from varying each detection parameter, aggregated over all combinations of the remaining parameters. The left side of each plot shows a scatter plot of false positive and true positive rates, while the right side shows the upper-left-most envelope of the set of all ROC curves.

5.2 Examples

True positives. Slow rising vs fast rising.

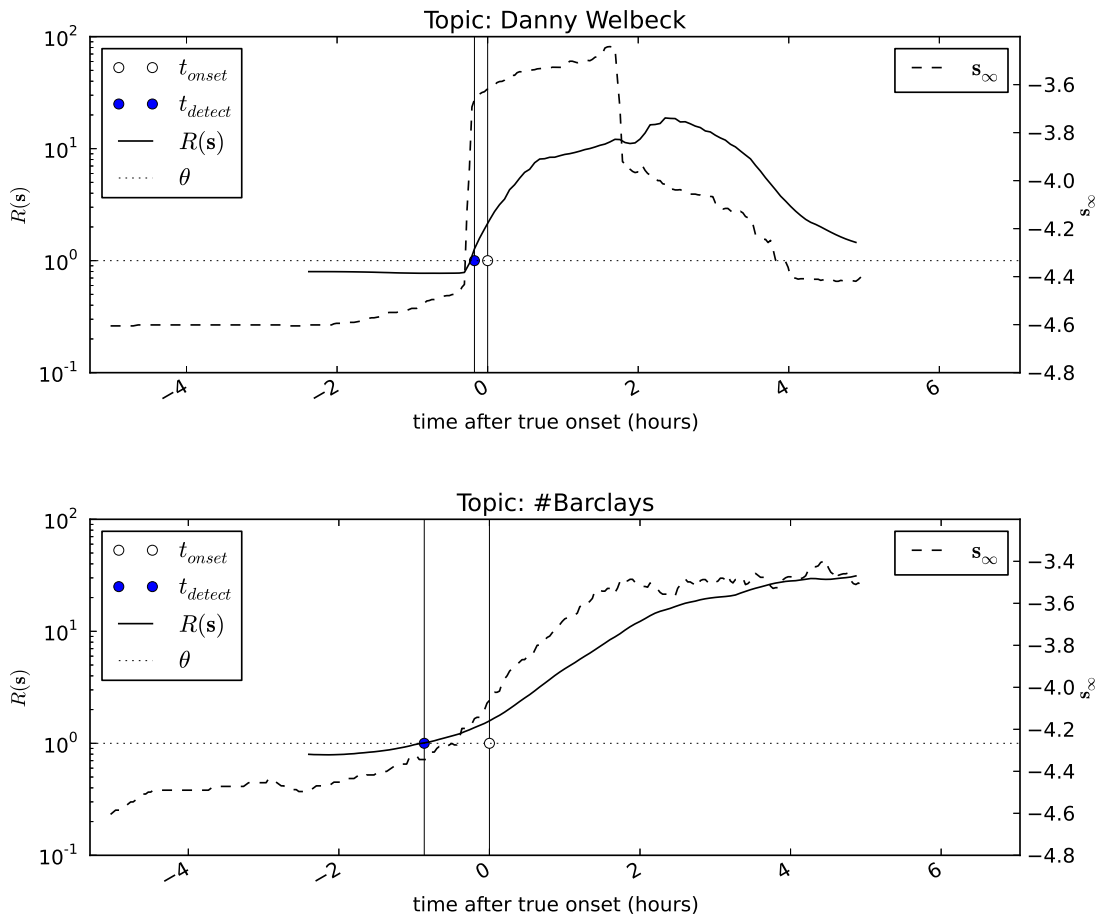

Figure 5-1: Fast-spreading vs. slow-spreading topics. **Top**: English football player Danny Welbeck scores late in the second half of the June 15th match between England and Sweden in the Euro 2012, securing a 3-2 victory for England. The reaction on Twitter is immediate. **Bottom:** Ed Miliband, leader of the UK's Labour Party, calls for a criminal investigation of Barclays, the global financial services provider, over involvement in the Libor fraud scandal. The story stimulates steadily growing discussion over the course of the day.

True negatives.

False positives. Stuff with significant volume or spikes.

False negatives. Stuff with too little volume or not enough spikes.

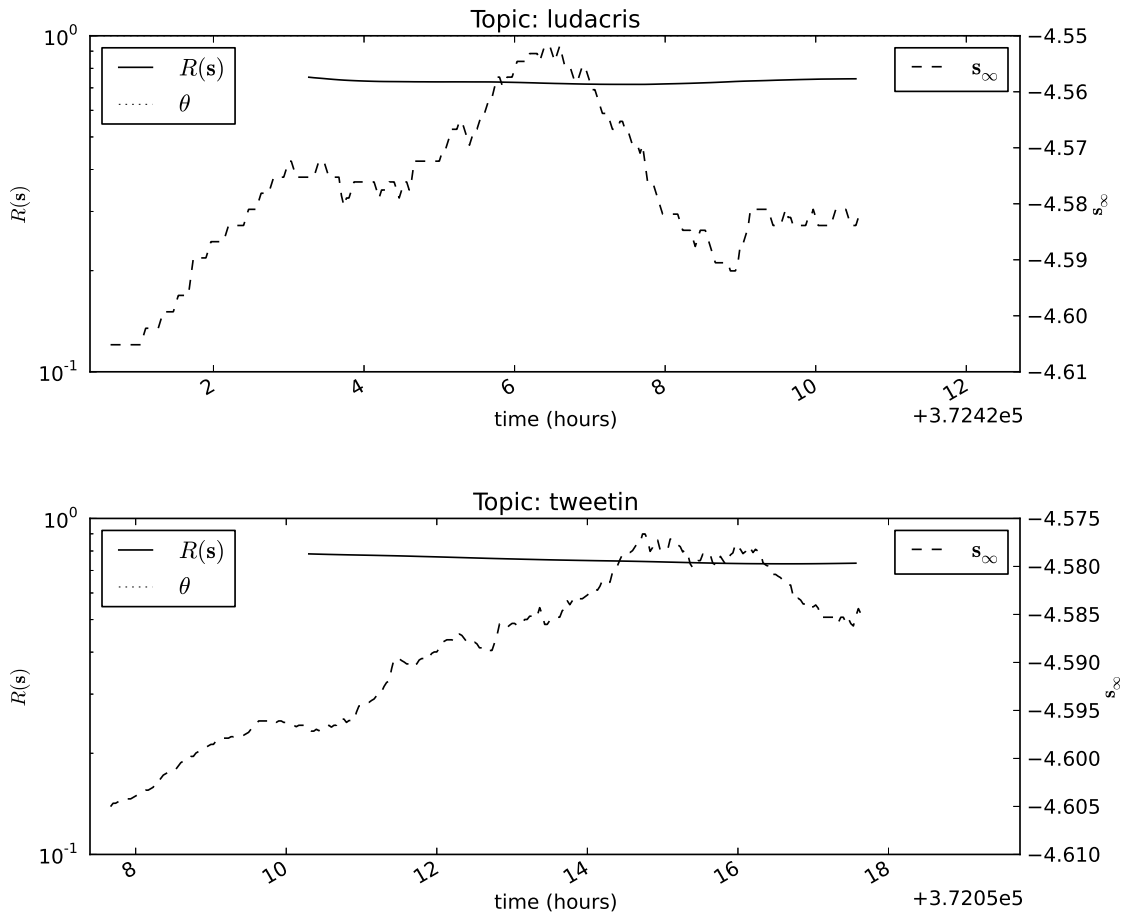

Figure 5-2: Examples of true negatives — topics that did not trend and were not detected as trending. **Top**: Although Ludacris, a well-known celebrity, receives constant attention on Twitter, there is no anomolous event involving Ludacris that would cause the topic to trend. **Bottom**: The word "tweetin" is being used as a part of regular speech to refer to the act of posting a message on Twitter, and does not constitute a trending topic.

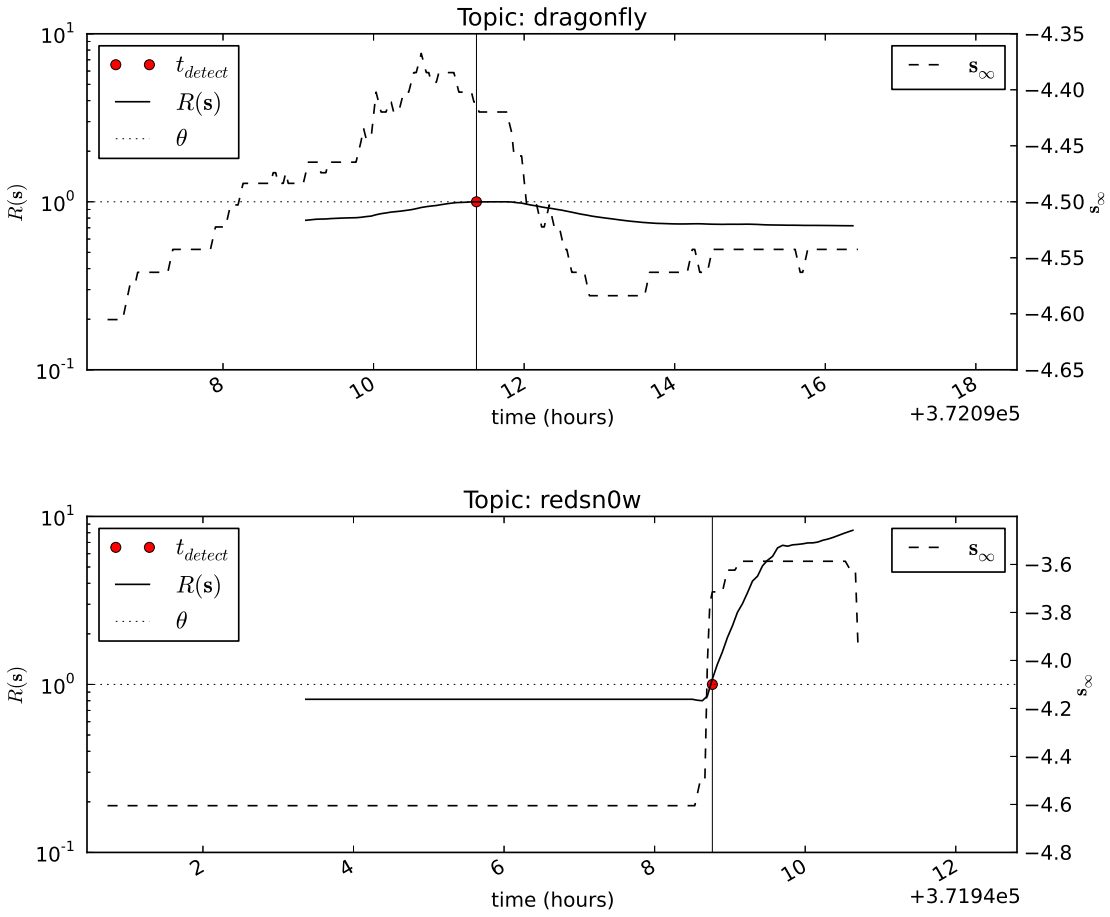

Figure 5-3: Examples of false positives — topics that did not trend but were detected as trending. **Top**: If the activity of a topic trends upward for a sufficiently long time, it may sufficiently resemble the activity of topics that trendedand lead to a false detection. **Bottom**: Some false positives refer to actual breaking events that happened to not make the Trending Topics list on Twitter. The topic "redsn0w," for example, coincides with a new release of popular jailbreaking tool for iOS

5.3 Effect of Parameters

For each ROC curve, we have a parameter that varies to produce the ROC curve, which we will call the variable paramter, and a fixed combination of the remaining paramters, which we will call the constant parameters.

Do we move up or down the curve?

We show how varying a given parameter p trades off FPR for TPR by computing the discrete derivative of FPR and TPR with respect to p. For each ROC curve, corresponding to the variable parameter p and some fixed combination of remaining parameters, we compute

$$\Delta_{p,i}^{FPR} = \frac{FPR(p_i) - FPR(p_{i-1})}{p_i - p_{i-1}} \tag{5.1}$$

$$\Delta_{p,i}^{TPR} = \frac{TPR(p_i) - TPR(p_{i-1})}{p_i - p_{i-1}} \tag{5.2}$$

for each ROC curve associated with p and for i ranging from the second to the last value of p in increasing order. If each point on the ROC curve is produced by multiple trials, we compute the above for all possible combinations of ROC curves. Finally, we compute the above across all combinations of fixed parameters.

The result is a distribution of discrete derivatives of FPR and TPR with respect to a variable parameter of interest p which highlights the effect of p on tradeoffs between FPR and TPR. We can refer this effect as moving "up" the ROC curve, or "down" the ROC curve. If most of the mass of Δ_p^{FPR} and Δ_p^{TPR} is at values greater than 0, then an increase in p causes a decrease in FPR at the expense of lower TPR, moving down the curve. If, on the other hand, most of the mass is at values less than zero, an increase in p causes an increase in TPR at the expensive of higher FPR, moving up the curve.

Sometimes, the curve moves neither toward $(0, 0)$ ("down the curve") nor toward $(1, 1)$ ("up the curve") but toward $(0, 1)$ or $(1, 0)$. The former represents an increase in TPR in addition to a decrease in FPR — a win-win situation. The latter represents the exact opposite of that — an increase in FPR and a decrease in TPR.

Note that we did not count Δ_p for consecutive points at $(0, 0)$ or $(1, 1)$ since the TPR and FPR are not free to move any further despite changes to the variable parameter.

5.4 Recommendations