

# Studying Propagation of Bad News

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## Abstract

For eons (slight exaggeration), humankind pondered and wondered on this question. How and why does bad news spread so fast? What possesses a person to spread this bad news? Is it an inherent wish for all to recognize it and take heed? Is it a perverse desire to see others when they first learn of the news? Could it be simply the wish to be the one to broadcast something new? I have programmed a simulation of this phenomenon, attempting to allow possibilities in reality to enter as simple variables. I have assumed every person in the world has a belief factor of this news, where full belief indicates a witness. I have studied this system and reached a simple conclusion. News is power. Bad news is power squared. Thus, people spread bad news to gain more power.

## Introduction

We live in what is known as the information age. Communication pathways have multiplied, especially over the last century or so. Before the telephone, it was considered impossible to communicate with someone farther than visual range. Now, we could easily communicate with people across the world. Speaking to someone in a different galaxy is no futile dream anymore. What's more, information can spread globally, possibly through wide-range single sources. Yet, what kind of news is spread? National disasters, crime, corruption, and the latest scandal top the list. The top reporters supposedly work diligently to find and broadcast these events as the "top story". Through TV and internet, this bad news spreads within days, possibly seconds, of the event. The people become "witnesses" as if they saw the event if they believe the news. What drives this bad news to spread? Do the reporters provide it? Do the people wish for it? Why would either happen? Even more possibilities arise comparing to reality. Doubt and distrust allow the possibility of misinformation or a negative belief transfer. What happens when people who distrust the information received? Furthermore, what happens when a person is reluctant to share the bad news? Do people want to share bad news? Unfortunately, this is too close to free will, which is very hard to simulate and unnecessary for a simple model. So the bad news is mostly a label. Why would someone want to share bad news and possibly witness another's grief? Following these thoughts, I thought up an interesting dynamical model for this system to be discussed in the next section.

Even if the model itself does not work, it can still represent other situations with the proper modifications. For example, it could model the spread of disease. Also, this model could be expanded in many different ways. It could be used to compare the spread of good and bad news. It could show the effects of just a rumor. It has numerous possibilities. I chose a specific label instead. Just studying bad news is enough for five weeks. To demonstrate one possibility, imagine this system. In this system, I assumed all people in it wished to spread the news. I also allowed the possibility of disbelievers. Disbelievers would have negative belief transfer, so they try to convince others the news is wrong. I also entered randomness in the system for aspects such as persuasion, phone call recipient, etc. This attempts to allow randomness in reality. Now, the initial witness sees some bad event. He or she wants to tell others. Immediately after viewing this event, he or she tells everyone within hearing range. These people believe some random amount. Then the people in the area move around a small amount. Now some random number of people will tell others using tools such as phones. Some may work for a broadcast station or enjoy posting such events on a website. Others will speak to the nearest people. Continuing this, the news spread further away from the original location of the event. Eventually, all people may have some level of belief. Then the people will cycle around this belief. When allowing only positive belief transfer, the system always ends with only full witnesses. As if everyone was there, all the people would say, "This happened". When allowing negative belief transfer, the conclusion is almost impossible to predict. In a short time, though, most people will not be full witnesses. So, everyone would say, "This might have happened". In either case, the bad news has reached the edges of the system in some form. How close is this to reality? I attempt to find out.

That being said, here is my project. I wrote a simulation of this system, hoping to show this behavior. Following the conditions I assumed above, I programmed each person to exist on a 2-dimensional area. It can be expanded for 3 dimensions, but the plotting is much more complex. 2-dimensional shows the main points I established above. Each person initially has a belief of 0, representing the news hasn't reached yet. I assume the event is at the origin. I set the first person at the origin to be the initial witness. Additionally, anyone starting at the origin becomes a full witness. Then, I run the program and let everyone move small random steps in any direction and see what happens. I allow a random chance of using some tool and which tool is used. When a person uses a tool, that person forfeits person to person contact for that time step. Each tool has a set belief transfer percentage, but person to person has a random transfer percentage. Also, only person to person may have negative transfer. Currently, only five total news channels are included. Each is exclusive. In other words, only one of them can be used per person each time step. These and their characteristics are as follows:

- Person – People: Each person may speak to all people within a small set radius. A random percent of inherent belief will transfer to those inside this radius. This may also be a negative percentage, allowing an unconvincing communication.
- Phone – Person: Each person may randomly call another person with no limits on distance. This can only contact one person. 75% is transferred.
- Radio – People: A person may broadcast through a “mobile” radio to anyone in a large set radius. Affects all people in range. 33% is transferred.
- TV – People: Same as radio, but the radius is even larger. 20% is transferred.
- Internet – People: Same as radio and TV, but much larger radius. However, only 10% is transferred.

After running the simulation several times over a fixed time period, I found some odd conclusions. Like I stated earlier, with only positive transfer, each person became a full witness within the set period. However, this only happened consistently with the use of tools. Without, some trials showed some were not yet full witnesses. However, they had some nonzero belief factor, indicating they heard the bad news. Also, in some figures to be shown, the increase in full witnesses is small. When allowing negative transfer, the number of full witnesses never seems to stay over 10% the total number of people. It suggests having people who refute this news limits the number of full believers. So, it would be as if the event may or may not have happened. It sounds familiar to a realistic, possibly exaggerated, situation. In any case, the number of full witnesses depends heavily on the number of people with positive belief transfer. Also, allowing tool use dramatically changes the belief spread rate.

## Background

First, I need to define bad news. Bad news is information that people may or may not wish to spread. So, like I mentioned earlier, disasters, scandals, and the like would be bad news. Other possibilities might be harmful rumors, gossip, and misunderstandings. Bad news is also known to grow in the telling. Unfortunately, this model does not study that aspect too well.

News broadcast in such things as TV, internet, newspapers, etc. will show the different characteristics attached to each form. For example, TV news anchors tend to

start the perceived important news. This tends to be something that affects most viewers in some way. It might invoke an emotional response. It might lead to a logical or semilogical conclusion about the state of the home nation, world, etc. Usually, this news is bad. At least, I have yet to hear positive news first. Then considering how many viewers there might be, I set the probability and range of a TV broadcast. These numbers can be modified easily to reflect reality, so they are just trial numbers.

Next, what kind of behavior is expected for people? There are several possibilities here. Behaviors such as lying, exaggeration, etc. are very difficult to simulate. However, for this simple model, it is enough to assume every person has one behavior, honesty. So, they tell others as much as they know, represented by the belief idea. This allows me to simply consider belief to be additive.

Finally, recognizing what are the possible outcomes is necessary. Could a recipient believe this information? Here, the source is the main factor that determines this. Of course, everything is taken with some doubt. This is represented by the transfer percentages.

### Dynamical System

The model I decided for this system is as follows. This completely based on logic assuming the conditions mentioned above:

1. Take a set number of people. Randomly assign each a position and belief = 0.
2. Take the first person and/or people at the origin. Assign them as the initial witnesses with belief = 1.
3. Enter the time loop.
  - i. Randomly choose a number. Use the tool with probability nearest to randomly chosen number.
  - ii. If no tool used, use person to people contact.
  - iii. After running through all the people, randomly shift positions a small amount.
  - iv. Take new positions and belief and plot the people.
  - v. Restart time loop.
4. After all the time has passed, or have finished getting all witnesses, check how long it took.

This model allows the news to spread along different channels, and depends on the number of people in the system. For instance, take 100 people. When a person becomes a full witness, they do not necessarily stay a full witness. If someone came and refuted the event, the full witness might believe them and lose some belief. However, as the belief grows, the amount transferred grows too. So for a small amount of people, as the average belief increases, more people are more likely to transfer more belief. Assuming normal average, the average is inversely proportional to the number of people and directly proportional to the total belief. This shows the smaller the number of people, the higher the average gets. This system also depends on the population density. If the distance between people was large, such as if there were a sparse density, the chances of transfer are low. Essentially, phone would be the only allowed channel. So, supposedly, packed locations have higher chance of the bad news spreading.

Equations of motion for this system might be particularly complicated. There would be quite a few dependent variables after all. Also, randomness has been introduced in the system. Instead, it would be easier to study this system through the behavior. Visualizing and plotting what happens is easiest. However, we have discrete variables for number of witnesses. So the plots will act as combinations of step functions.

## Methods

To study this system, I built a simulation using this model. Using Python, I created a class to define a person. A person is defined to have a Cartesian coordinate position from the origin. Also, they have a variable for the belief number. The belief number domain is  $[0,1]$ . The position domain is all real numbers. However, due to computing limits, the limit can be chosen to be something small. I set the default at 200 each, so the total area is  $200^2$ . Using the built-in choice and randrange functions, I took a large range of numbers and chose one at random whenever I needed a random number, such as for transfer percent. Finally, I set it up to try and limit the people to this area only. Otherwise, it is not a closed system. If a person tried to leave, they reflect around to the other edge of the area.

After writing this program and strict debugging, I added other possibilities. Initially, it was set up to only study fixed belief transfer. As expected, having just people spread the bad news showed a relatively slow rate. However, adding tools, the system became filled with witnesses within a few loops. This indicates the advent of communication tools likely allowed reporters to broadcast news much quicker. Then, extending the random range to include negative transfer, just people showed periodic form. As mentioned earlier, it seems to hover around 10% of the population, no matter how many times I run it. However, again adding tools, the population becomes only full witnesses within a few time loops.

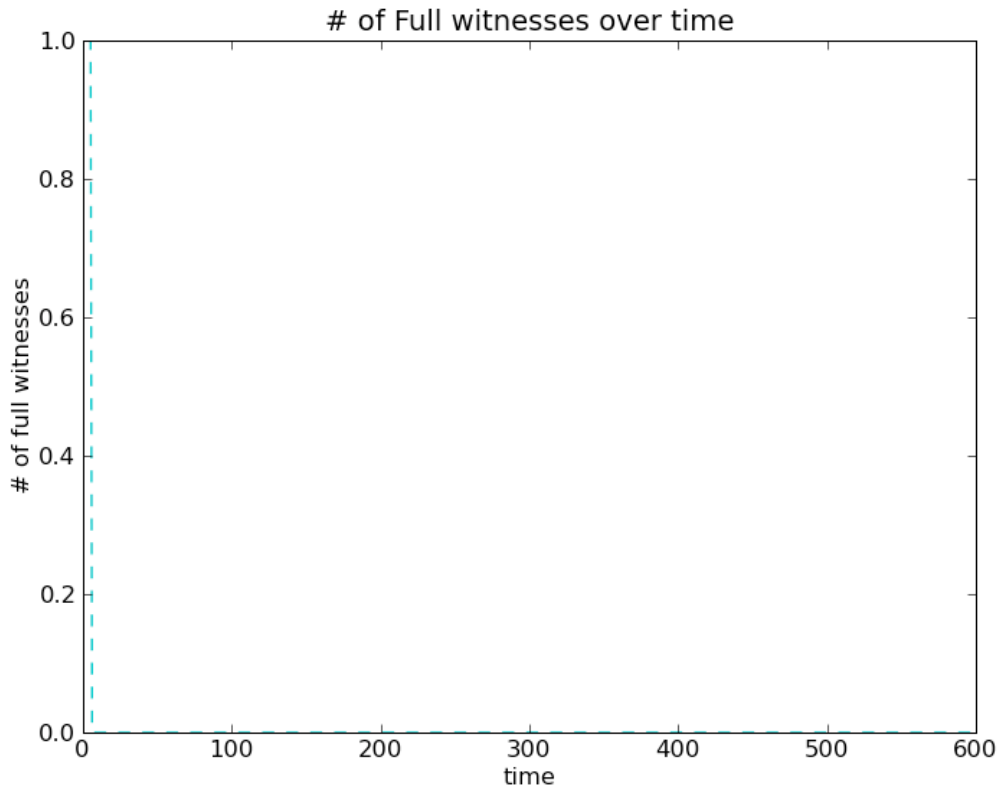
After allowing negative belief transfer, I decided the simulation is too slow and crude. The system it studies only has negative belief transfer out of all the possibilities mentioned. However, just that aspect allows for interesting behavior. Judging from the data, the form stays almost the same. So, this simulation will be enough to study an aspect of bad news.

## Results

I found this system with only negative belief transfer and some imposed randomness shows odd behavior comparing between person-people only and tools. For a small community, like a small neighborhood, just person-people might fit best. Without negative behavior transfer, I found the system reaches saturation usually within the set time period. However, when negative transfer is introduced, what happens instead is a periodic form. Instead, when people transfer belief, some gain belief and some lose belief. Then this happens over and over again. Unfortunately it seems a rare occurrence, so it will be left for another time.

In the small community, this is equivalent to half the people distrusting the other half and that half trusting the other half. The random generator on average picks equally between negative and positive due to following a Gaussian distribution. Then, it is not

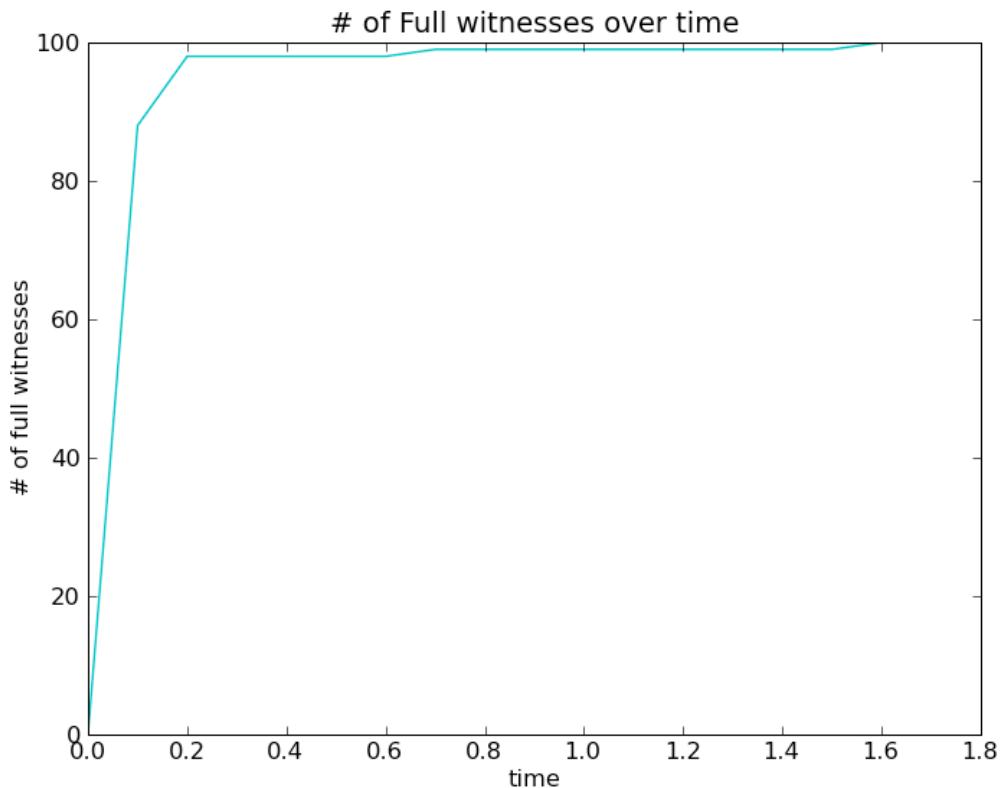
unimaginable to have this periodic structure. Using the terms we have studied, it looks like a stable limit cycle. Some people believe, some do not, and they balance each other out. This indicates the system depends on belief transfer as a parameter. If varied, it might lead to a bifurcation somewhere. Perhaps this can be done another time. Another possibility from this is the initial witness(es) lose all their belief before transferring it, shown in Fig. 1.



**Figure 1: This is a bit hard to see, but the dashed line indicates the trend for the number of witnesses. This is with negative belief transfer. A refuter got to the initial witness before spreading the news, eliminating a source. So no one basically knows the bad news.**

Then the system has no witnesses because the initial witness(es) do not believe what they say themselves. This is equivalent to refuting an event convincingly as early as possible. If done before the news spreads, the bad news dies out before starting. So, you could say if you cut off at the roots, the body cannot grow.

When adding tools, the number of witnesses increases tremendously fast, shown in Fig. 2.



**Figure 2: Number of full witnesses over time with tools.**

In other words, the tools dominate the spread of bad news. The tools are not affected by negative belief transfer. So when people can communicate through tools, everyone knows the bad news. This could be the reason for the incredibly fast spread of bad news. Applying to a realistic situation, it would be equivalent to everyone knowing the same thing due to one person broadcasting it. So, if you have something everyone should know, broadcast it as soon as possible.

The plots I obtained are with pseudorandom initial positions. They have the same form and behavior. This indicates where the people initially are has no effect on the system. On the other hand, it looks like varying initial belief may have an effect. It may increase or decrease the chances of the bad news being spread. The initial belief could also indicate the magnitude of the event. A big event might be easier to believe than an unimportant one. Of course, this depends on the individual. This is another possible question for later.

### Conclusion

Using my simple system, I found negative belief transfer could be a bifurcation parameter. When it is just people, this allowed a stable limit cycle in the number of full witnesses. This indicates the witnesses are both gaining and losing confidence in what they saw. However, neither refuters nor witnesses seem to dominate the system. If the belief transfer parameter were varied, it might show this behavior. However, there was not enough time for that, so it will be left for another time.

Additionally, tools dominate the system. Which tool is a question for another time. If tools were allowed negative belief transfer, so refuters could broadcast as well, it might lead to chaotic behavior. Perhaps refuters or witnesses will suddenly dominate the system. It reminds me of the chaotic pendulum in the magnetic fields. Within the average of the magnetic fields, the pendulum achieves an unstable balance. With a slight, seemingly random shift, the pendulum suddenly gets caught in another field and becomes “confused”. So it is with this system. A delicate balance is achieved. The magnitude of the oscillations likely depends on whether people or tools dominate.

The simulation I wrote was very crude. Allowing randomness in the system seems to be a main reason for this behavior. When testing the code without randomness, I found the outcome was always the same since regardless where everyone was, the news spread outwards. Also, it only works for a small number of people. Too many people crashes the simulation. A lot of plots were left out due to unrepeatability. If the code were improved a lot, this system could be studied for a global population. Then it might be able to incorporate aspects such as world news. There are many more possibilities than I expected in this system. Just this much was enough to think about for half the quarter.



## Bibliography

Note: Wasn't able to find anything scholarly on this topic. These are some comments from the web that indicate similar topics.

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