**Angle Between Noodles**



**Noodles are born Lines.**

Being born into the world of lines, the mathematical Noodle Laws of course are also linear. The beauty of such rules is that (almost) no matter where in noodle life you may start, given enough time, they all reach the same conclusion. For noodles, that means a tragic death by an underfed, underpaid, graduate student. Surely you have witnessed this atrocity in your college days.



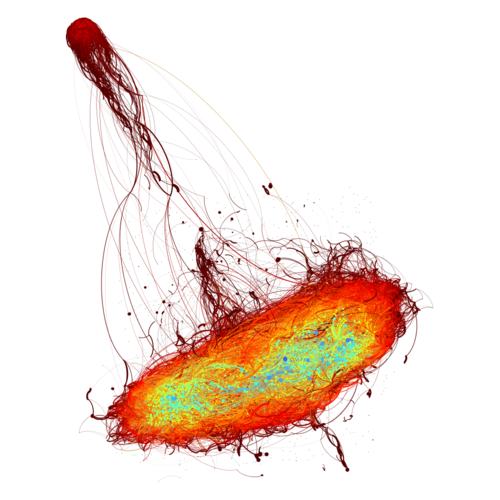
**Eventually all noodles will get eaten. But how long is eventually?**

Even though all things governed by linear rules will eventually reach the same conclusion, the timing is vague. So I've set out on a journey to peer into the very nature of mathematical rules and logic to find out exactly how long it takes to reach this inevitable end. How long exactly will it take for rules to play out given any starting point and set of rules? Is there an answer that isn't restricted to domain-specific knowledge? If so, is it easy to compute?

**The Journey**

This epic begins with me. A young man with nothing to lose and everything to gain - thrusting himself against the odds. With his right hand, he furiously mashes numbers into a computer and draws symbols onto a whiteboard. *The Hand Of Gauss*. With his left hand, he ignores the boiling broth on his skin and sips from his ramen cup with unbreakable concentration. *The Hand Of Gauze*.

I had the idea to attack this problem when I was making a game engine. The game engine involved a lot of economics and population dynamics that I was modeling with differential equations. Analysis was rough, things would break in unexpected ways, and, most of all, my computer was just too slow. I wondered if there was a way to figure out a few main points about any modification I'd make without having to run it through the simulation or to try and solve it by hand. Development time is always expensive no matter what the setting and I couldn't afford to waste it waiting for my computer to run hours of simulations.



Equip with the power of great determination, skill, and about 875mg of sodium, I quickly discovered a way to find the end result for all linear rules and the one exception to every rule. In math speak, the inevitable end result of linear rules is called the "primary eigenvector" and the exception to the rule is the "secondary eigenvector." I'll be calling them the convergence line and exception line respectively.

With my work cut out for me, I began thinking of starting points as starting lines, and then determined the angles between the starting line, convergence line, and exception line. The convergence line and the exception line are like magnets fighting to rotate the starting line towards themselves. Since I was thinking of them as magnets they of course also had a corresponding strength. Once I started to think of the problem in this way, I was able to create a statistical model for how much time it would take to reach the inevitable conclusion (convergence line) when the starting position is known.

**Can you use this for anything besides ramen?**

Because of some overly-mathy reasons, it turns out that there's an aspect about everything that obeys linear rules. Many rules are even either totally linear or well approximated by linear rules.

A pretty easy example of this would be population growth, preferably rabbits since they're adorable. Normally you would have to solve a differential equation to model population growth in rabbits and predict what the final population will be. Aside from being computationally expensive and well, a lot of work, you probably won't ever need to worry about any of the in-between sizes of the population.

My model skips right to the end with a computational time that is scarily small.

**Why Didn't I Create an Analytic Equation?**

Simply put, writing analytic proofs to mathematical models is not an easy task. Although this is definitely something that I will pursue in the near future, sadly, finals sometimes must take precedence over research. Additionally, I am exploring what happens in the stages between the beginning and the inevitable end and finding many very interesting situations that my model points out which are far from obvious in a differential equations model. I would like to explore these more so I can create a more encompassing model when I finally make actual equations. Plus, for all practical purposes, the statistical model is certainly well within any reasonable error tolerance.

**Where's the Noodles?**

That was a lot to chew on, you may be thinking, "Hey Dawer,"

[Do you know of any good resources to visualize all of this math theory?](http://setosa.io/ev/eigenvectors-and-eigenvalues/)

[Where can I learn more about Eigenvalues and Eigenvectors?](http://college.cengage.com/mathematics/larson/elementary_linear/5e/students/ch08-10/chap_10_3.pdf)

[Has anyone else done this kind of research before?](http://www.cs.cornell.edu/~bindel/class/cs6210-f09/lec26.pdf)

Can I see your recipe? (coming soon)

- Dawer