
... LET'S ASSUME THERE EXISTS SOME FUNCTION F(a,b,c...) WHICH PRODUCES THE CORRECT ANSWER—
HANG ON.
THIS IS GOING TO BE ONE OF THOSE WEIRD, DARK-MAGIC PROOFS, ISN'T IT? I CAN TELL.
WHAT? NO, NO, IT'S A PERFECTLY SENSIBLE CHAIN OF REASONING.
ALL RIGHT...
NOW, LET'S ASSUME THE CORRECT ANSWER WILL EVENTUALLY BE WRITTEN ON THIS BOARD AT THE COORDINATES (x, y). IF WE—
I KNEW IT!

August 23, 2016

Intro to math modeling

By the end of this class,

- *Understand what a mathematical model is and some of the components of one*
- *See how we take a problem of motion and turn it into a mathematical model*
- *See how we take a problem of importance and turn it into a mathematical model*
- *See how math modeling is used in industry*

Next class

Quiz 1 at start of class
Survey Due
Intro to Julia
G&C - Chapter 2 (and our notes)

Next next class

More Julia
G&C – Chapter 2

This semester: Numerical methods

Where are numerical methods used?

on mathematical models!

Mathematical Modeling

What is it?

The process of turning a verbal description into a set of equations or methods, usually for the computer

What are the components?

Assumptions, laws, simplifications, …

Is mathematical modeling used?

6 weeks to simulation 2/10s of airflow around an F1 car on a supercomputer

Mathematical modeling for Toyota

1. The equations were Navier-Stokes.
2. The approximations were well understood,
3. But far too slow.

4. The *new model of the model*
   approximate the solution of Navier-Stokes

Is this physics?

If you are trying to model something that really happens … the mathematical model usually involves physics.

Three examples in your textbook

Yoda's cape, radiation transport, soccer balls

(Springs law of motion, fluids)

But modeling is more general too!

Biology

Population models have assumptions about growth, death, and other factors.

Machine Learning and Information Retrieval

How alike are two images?

How similar are two documents? (Section 1.5)

Mathematical Modeling

Yesterday

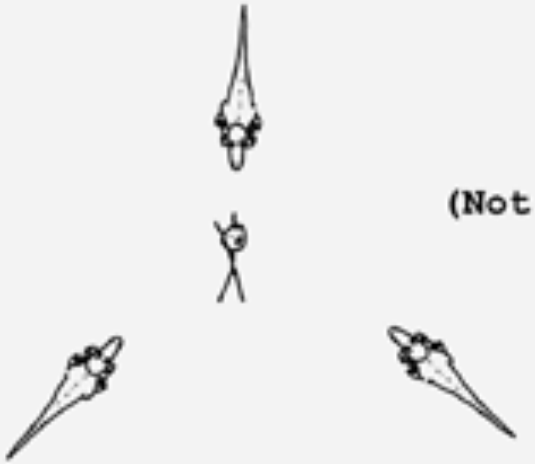
I visited Midcontential-ISO (in Carmel, IN) to learn about their mathematical model to determine the price of power for the next 24 hours, which is called the

Security Constrained Unit Commitment Problem

- We discussed DC approximations to AC power flows
- The way power-plants are modeled (startup cost, hourly operating cost, cost per MW, etc.)
- Creating the final mathematical model
  turns out this is regarded as GE Intellectual Property
  so they can give me the equations, but can't tell me what they mean.

A simple mathematical model

2. You are at the center of a 20m equilateral triangle with a raptor at each corner. The top raptor has a wounded leg and is limited to a top speed of 10 m/s.



(Not to scale)

The raptors will run toward you. At what angle should you run to maximize the time you stay alive?

How do you calculate how long you survive?
A mathematical model!

… work out on the pad …

The xkcd raptor model

Velocity human = 6.7 m/s

Velocity raptor = 17 m/s

Velocity wounded = 10 m/s

$$\mathbf{h}(t) = \begin{bmatrix} h_x(t) \\ h_y(t) \end{bmatrix}$$ Human x coordinate, Human y coordinate

$$\mathbf{r}_i(t) = \begin{bmatrix} r_{i_x}(t) \\ r_{i_y}(t) \end{bmatrix}$$ Raptor i x coordinate, Raptor i y coordinate

$$\frac{d\mathbf{h}(t)}{dt} = \begin{bmatrix} \cos\theta \\ \sin\theta \end{bmatrix} v_{\text{human}}$$

$$\frac{d\mathbf{r}_1(t)}{dt} = \frac{\mathbf{h}(t) - \mathbf{r}_1(t)}{\|\mathbf{h}(t) - \mathbf{r}_1(t)\|} v_{\text{wounded}}$$

$$\frac{d\mathbf{r}_2(t)}{dt} = \frac{\mathbf{h}(t) - \mathbf{r}_2(t)}{\|\mathbf{h}(t) - \mathbf{r}_2(t)\|} v_{\text{raptor}}$$

$$\frac{d\mathbf{r}_3(t)}{dt} = \frac{\mathbf{h}(t) - \mathbf{r}_3(t)}{\|\mathbf{h}(t) - \mathbf{r}_3(t)\|} v_{\text{raptor}}$$

When do you get eaten?
When the raptor gets close enough to jump

Code online

Lecture-2-Raptorchase.jl

But the end of the class, you should be able to understand everything this code is doing and even improve it.

- It's using Forward Euler to "solve" the ODE

An example of math modeling

Google’s PageRank

A cartoon websearch primer

1. Crawl webpages
2. Analyze webpage text (information retrieval)
3. **Analyze webpage links**
4. Fit measures to human evaluations
5. Produce rankings
6. Continuously update

SportsIllustrated.com

Bob**sPortsIllustrated**.com

Gleich's syndrome

From Wikipedia, the free encyclopedia

Gleich's syndrome or **episodic angioedema with eosinophilia** is a rare disease in which the body swells up episodically (angioedema), associated with raised antibodies of the IgM type and increased numbers of eosinophil granulocytes, a type of white blood cells, in the blood (eosinophilia). It was first described in 1984.[1]

Its cause is unknown, but it is unrelated to capillary leak syndrome (which may cause similar swelling episodes) and eosinophilia-myalgia syndrome (which features eosinophilia but alternative symptoms). Moreover, it is not a form of hypereosinophilic syndrome as there is no evidence that it leads to organ damage. Some studies have shown that edema attacks are associated with degranulation (release of enzymes and mediators from eosinophils), and others have demonstrated antibodies against endothelium (cells lining blood vessels) in the condition.[2]

Gleich syndrome has a good prognosis. Attack severity may improve with steroid treatment.[1][2]

Eosinophilia

From Wikipedia, the free encyclopedia

Eosinophilia is the state of having a high concentration of **eosinophils** (eosinophil granulocytes) in the blood. The normal concentration is between 0 and 0.5 x 10^9 eosinophils per litre of blood. Eosinophilia can be *reactive* (in response to other stimuli such as allergy or infection) or *non reactive*.

The release of interleukin 5 by T cells, mast cells and macrophages stimulates the production of eosinophils.

Eosinophilia	
Classification and external resources	
ICD-10	D72.1
ICD-9	288.3
DiseasesDB	4328
eMedicine	med/685
MeSH	D004802

Causes [edit]

Diseases that feature eosinophilia:

Hypereosinophilic syndrome

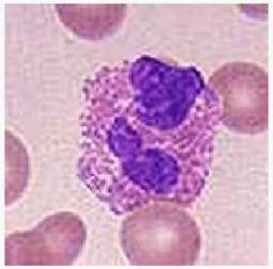
From Wikipedia, the free encyclopedia

The **hypereosinophilic syndrome** (HS) is a disease characterized by a persistently elevated eosinophil count (≥ 1500 eosinophils/mm³) in the blood for at least six months without any recognizable cause, with involvement of either the heart, nervous system, or bone marrow.[1]

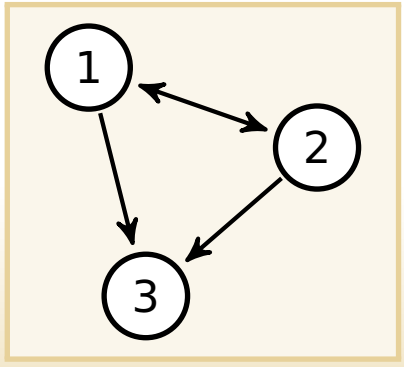
HS is a diagnosis of exclusion, after clonal eosinophilia (such as leukemia) and reactive eosionophilia (in response to infection, autoimmune disease, atopy, hypoadrenalism or cancer) have been ruled out. [2]

There are some associations with chronic

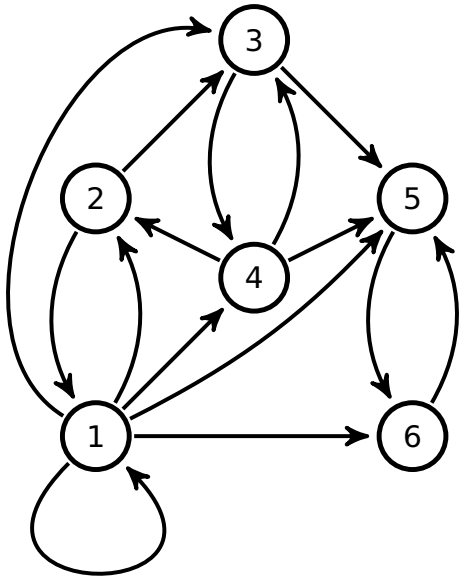
Hypereosinophilic syndrome
Classification and external resources



to



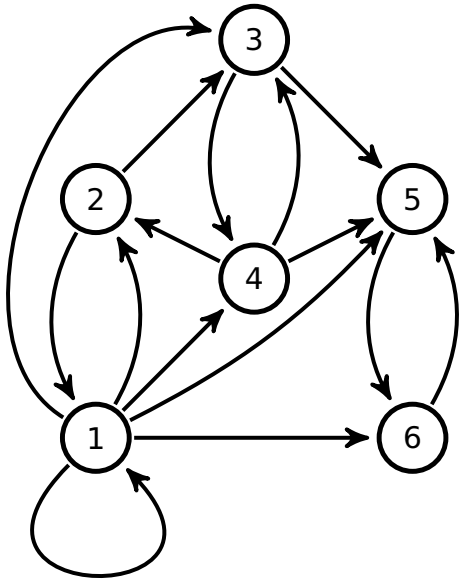
What is PageRank?



The Model

1. follow edges uniformly with probability α, and
2. randomly jump with probability $1-\alpha$, we'll assume everywhere is equally likely

How do we solve PageRank?



The Model

1. follow edges uniformly with probability α, and
2. randomly jump with probability $1 - \alpha$, we'll assume everywhere is equally likely

Just simulate it!

See Figure 3.13 in your textbook for code to do this.

Math. Modeling in this class

You won't have to do too much mathematical modeling. Usually, I'll give you the model; or at least a good hint.

Important questions about models

1. What are the assumptions?
2. What are the physics?
3. How accurate do the results need to be?
4. Is there data available?
5. Do you have anything to compare against?
6. How quickly do you need results?

What's on the Quiz

1. Chapter 1 in G&C
2. This lecture (Lecture 2)
3. The material in Appendix A of G&C

My philosophy

- no memorization (but you should know basics!)
- no intentionally tricky questions