*September 12, 2016*

# Monte Carlo Methods

*In this class:*

- *An introduction to Monte Carlo (MC) methods*
- *How to use MC methods to estimate the Monte Hall Problem probabilities*
- *How to evaluate the importance of a random web-surfer*

*Next class*

More Monte Carlo Methods
G&C – Chapter 3

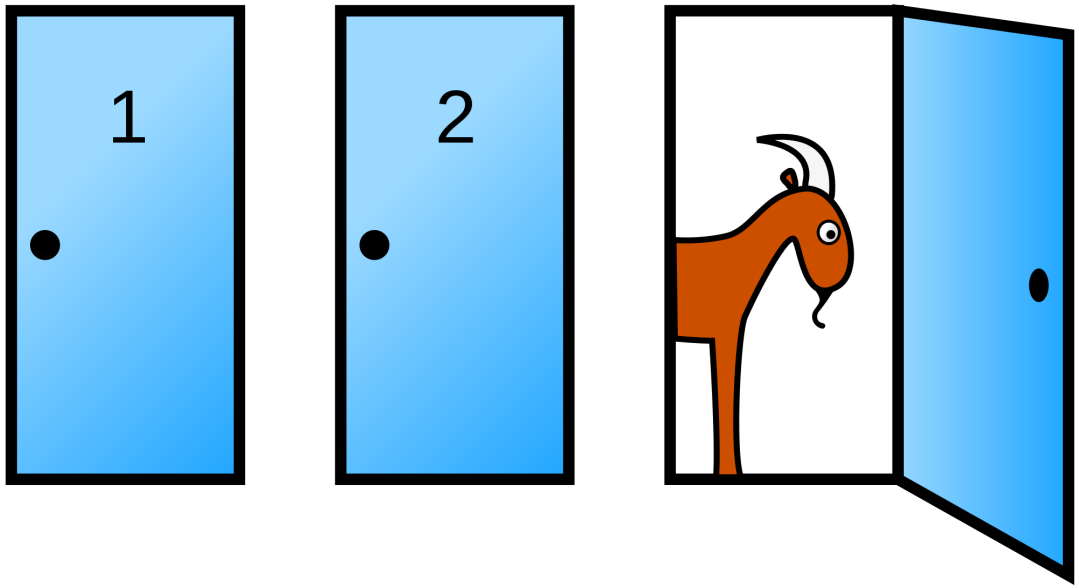
*Next next class*

HW Due, more MC!
G&C – Chapter 3

# Monte Carlo methods

- Use simple probability and statistics to estimate difficult to compute probabilities
- Are really only feasible on computers and involve 100,000 or 1,000,000s simulations

# The Monty Hall Problem




Behind one door is a car, behind the others are goats. After you pick a door, the host will show you one of the other two doors. You will then be able to switch to the remaining door.

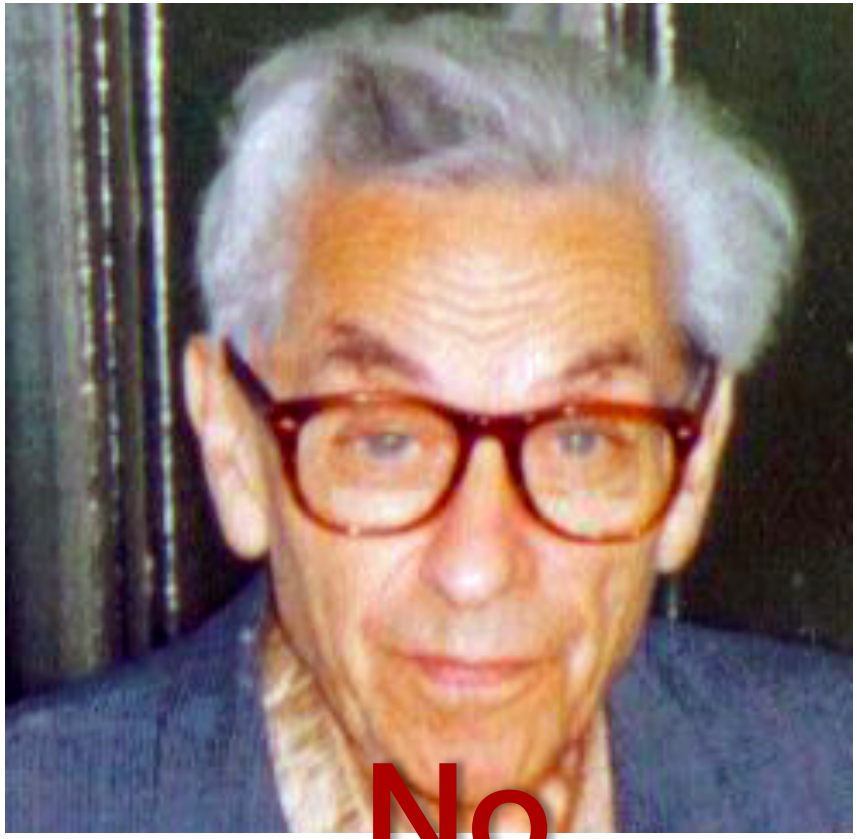
**Should you switch?**

# Who to believe?

Marilyn vos Savant

Yes

Paul Erdös



No

# The answer is Yes.

Erdös only became convinced after a Monte Carlo simulation said “Yes” too.

## Lessons

- The power of Monte Carlo simulations!
- The failure of even experts grasp on probability.

# How to convince the most famous combinatorist ever that he's wrong.

… Julia demo …

Lecture-9-Monty-hall.jl

# Pop Quiz

… the following question is something I'd consider for the midterm …

**What is the probability that two points on the unit circle are greater than distance one apart?**

**(Compute it, or write a program to estimate it.)**

… solution in
Lecture-9-Circle-points.ipynb file …

Monte Carlo experiments and simulations are now used to resolve some of the most vexing questions in science and engineering.

- What's the probability that my device will fail given natural variability in the material construction (e.g. steel)?
- How do neutrons behave in a nuclear reactor?

# And beyond

Twitter uses a Monte Carlo algorithm reminiscent of what we'll see next to recommend who you should follow on Twitter

# 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

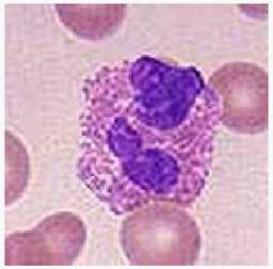
From Wikipedia, the free encyclopedia

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*



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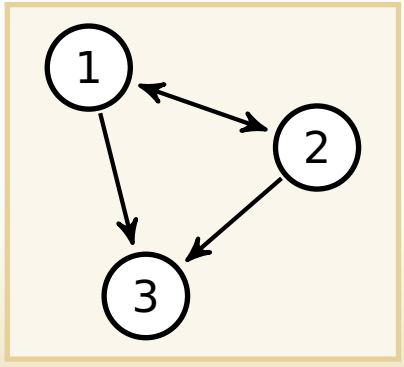
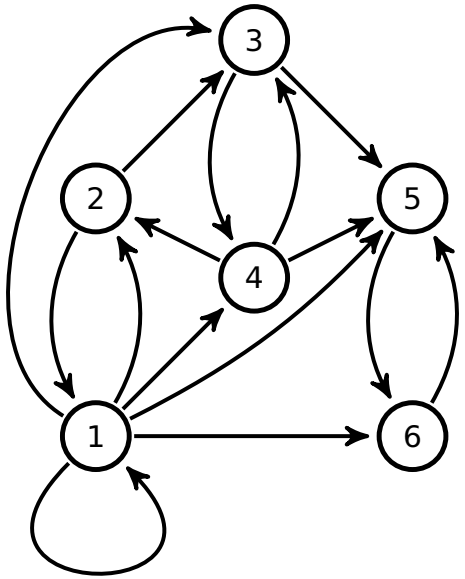


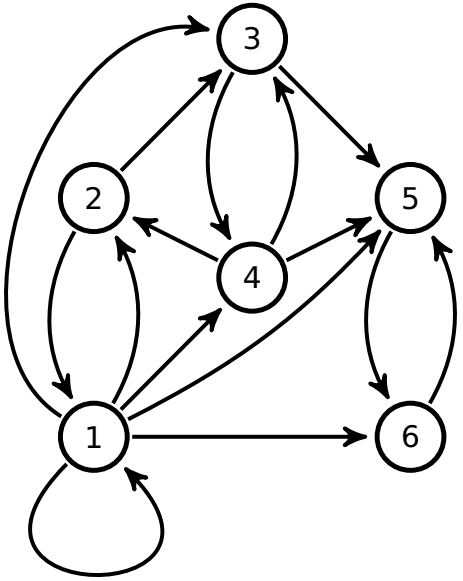
# What is PageRank?




**The Model**

1. follow edges uniformly with probability $\alpha$, 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 $\alpha$, 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.

Lecture-9-PageRank-random-surfer.ipynb

# Challenges in Monte Carlo methods

1. How to turn your problem into a probability
    - How to evaluate pi via Monte Carlo
    - How to turn an integral into a Monte Carlo trial

2. How to improve accuracy.
    - Why the central limit theorem impedes high accuracy.

3. Monte Carlo methods and floating point.

# Your homework questions

1. Evaluate an integral with a Monte Carlo method
2. Resolve the birthday paradox in light of real data on when people are born.
3. Determine the number of nodes in a graph by estimating the collision probability