

Friday, April 16

Lecture #34/42

## Neighborhoods in Continuous Space

Picking points randomly in a  $d$ -sphere

Bad: picking  $x$  first, then  $y$

Bad: pick  $\theta$ , then  $r$

Muller method (good)

To pick points randomly (uniformly) in a  $d$ -dimensional sphere:

- picking  $(u_1, u_2, \dots, u_d)$  each from a Gaussian (normal) distribution with mean 0 and std. dev. 1.

- set  $\text{norm} = \sqrt{u_1^2 + u_2^2 + \dots + u_d^2}$

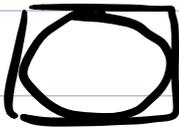
- set  $r = (\text{random \# in } [0, 1])^{1/d}$   
(`random.random()`)

- your random point is:

$$x = \frac{r \cdot \vec{u}}{\text{norm}}$$

The d-sphere and d-cube are very different

d	volume of d-sphere	vol. of d-cube
1	2	2
2	3.14	4
3	4.19	8
4	4.43	16
5	5.26	32
6	5.168	64
10	2.55	1,024
20	0.03	1,048,576



Very different neighborhoods.

Other ways to move around space:

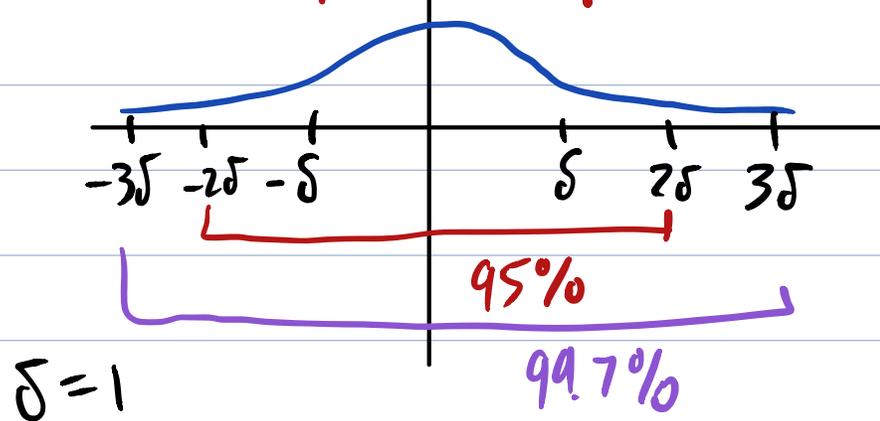
1) Gaussian Random Walk (Brownian Motion)

For each component, add a shift drawn from a normal distr.

$N(0, \delta)$



Median shift in each component is  $< \delta$

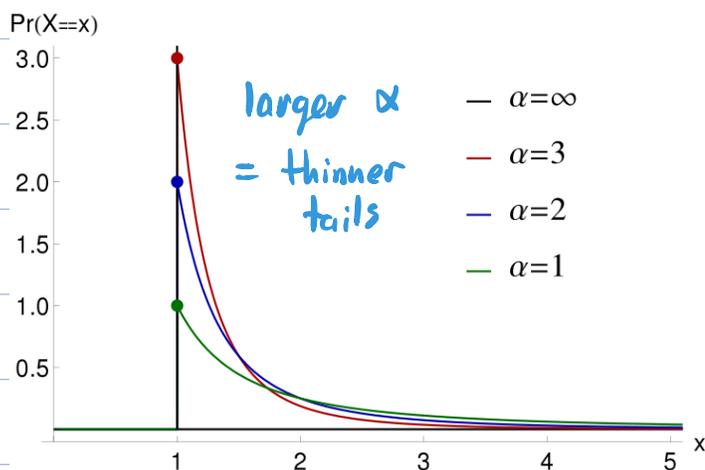


## Thin tails

### 2) Lévy flight

Uses a different distribution with much thicker tails  $\Rightarrow$  larger probabilities of really big jumps.

### Pareto distribution (power law)



pick from this distribution, subtract 1 multiply by  $\pm 1$  randomly

To pick a random # from this distr.  
 $s = r^{1/\alpha}$ , and  $r$  is uniformly drawn from  $(0, 1]$ .

## Topic 17 - Firefly Search and Cuckoo Search

Two MHs inspired by biological processes.

Trick: separate the clever ones from gimmicks

### Firefly Search

Fireflies use their lights to attract each other, and the level of attraction depends on the intensity of the light and the distance between them.

F.S. is a population MH.  
Kind of like PSO but with different movement rules.

Each firefly represents a solution. The better the solution, the brighter the firefly.

A firefly's movement in each step is toward each other brighter firefly, plus a random component (Gaussian or Lévy movement).

PSO - we never compare qualities