

## Social Complexity

Underlying mechanisms? (Ex C2)

- Patriarchal structure [Navajo]
- Child-caregiver relation [Apache]
- Economy (+ love, respect) [Zuni]
- Biology (+ mind) [Yavapai]
- Networking [Hopi]

How about: internet use, city populations, ...

## Unit C5 Goals

- Digression: Comparing your papers and masterpieces
- Explore the mechanism underlying various complex phenomena
- Preview Module C Evaluation Workshop

Permission to use the posted draft in future classes?

## Is your paper a masterpiece?

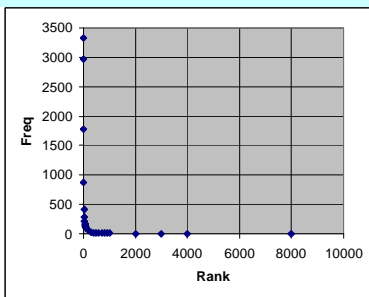
- What do your paper and *Tom Sawyer* have in common?

## Word Frequency in *Tom Sawyer*

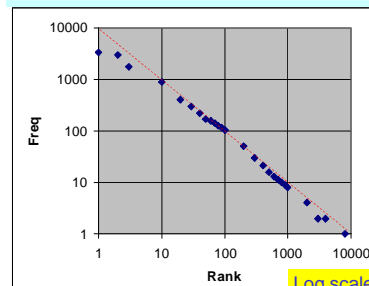
Word	Freq	Rank	F x R
the	3332	1	3332
and	2972	2	5944
and	1775	3	5325
he	877	10	8770
but	410	20	8200
be	294	30	8820
there	222	40	8880
one	172	50	8600
about	158	60	9480
more	138	70	9660
never	124	80	9920
Oh	116	90	10440
two	104	100	10400

Word	Freq	Rank	F x R
turned	51	200	10200
you'll	30	300	9000
name	21	400	8400
comes	16	500	8000
group	13	600	7800
lead	11	700	7700
friends	10	800	8000
begin	9	900	8100
family	8	1000	8000
brushed	4	2000	8000
sim	2	3000	6000
Could	2	4000	8000
Applusive	1	8000	8000

## Graphical Representation (1)



## Graphical Representation (2)



Log scale  
(large numbers are compressed)

## Zipf's Law

- Also known as
  - Zipf-Mandelbrot Law
  - Power Law
- (roughly) The rank-frequency relation for *any* text appears as a straight line with the slope  $-1$  on a log-scale graph.
- (formally)  $Freq \propto Rank^{-1}$

Observed in other contexts as well

FSP111 C5

7

## Group Exercise 1

- Speculate whether any of the following would follow Zipf's Law
  1. City population vs. rank
  2. Intensity of war vs. frequency
  3. Number of links vs. number web pages
  4. Area of fire vs. forest fires per unit time
  5. Earthquake magnitude vs. Earthquakes per year

Hint: Draw rough graphs

FSP111 C5

8

## Web Site Visits

FSP111 C5

9

## Mail List Activities

FSP111 C5

10

Implication to group size?

## Material Fracture Pattern

FSP111 C5

11

## Shore Erosion

FSP111 C5

12

## Interim Summary

- Zipf's law is observed in a wide range of both **artificial** and **natural** phenomena.
- Why?
- Is there any deep underlying principle governing all of these phenomena?

A lot of work in various disciplines

## See Zipf's Law?



Pink noise  
(cf. white noise)

Connection to music?

## Pink Noise Distribution

- More lower frequencies than higher frequencies
  - Continuous, cf. discrete examples earlier
- Observed in “pleasant” music (all genres)
- Also observed in
  - Electric signals detected at the surface of a brain
  - Ecgardiogram of the human heart
  - Postural sway of the body on a platform

## Group Exercise 2

- Why is Zipf's Law observed in so many different phenomena?
  - Artificial and natural
  - Discrete (e.g., texts) and continuous (e.g., noise)
- Is there any underlying principle?
- What kind of phenomena would not follow Zipf's Law?

## Complex Systems

- Characterized by the **interaction** of simpler components (**agents**).
  - Each agent may have “**bounded rationality**” [Herbert Simon]
- Often, **unpredictable** behaviors **emerge**
  - Possibility of ending up with chaos
- But may also **self-organize** to show certain remarkable phenomena
  - Cannot be explained by any “design”

## Possible Mechanism

- There may well be some mechanism more primitive than competition or cooperation.
- “**Self-Organized Criticality**” (SOC) [Bak, 1987]
  - Data analysis, experiment with sandpile

## Examples

- Social phenomena
  - City population, wars, fires, earthquakes
- Cognitive phenomena
  - Word occurrences in any text
  - Brain signals, heart beats, body movements
  - Mind (out of brain activity)
- Biological phenomena
  - Swarm intelligence (e.g., ants)
  - Evolution (interaction of species, individuals)

FSP111 C5

19

## How to do this with no (little) brain?

FSP111 C5

20

## Family Values

- Complex systems within a family
- Family as a component of a complex system
- Principles that would work for both of the above perspectives

FSP111 C5

21

Preview

## Module C Evaluation Workshop

- Required materials (**hardcopy**) **print in advance**
  - Module C evaluation form
  - Supporting notes
  - Exercises, project paper (second draft), etc.
- **Important: Do not include your critical reviews**
- Activities
  - Module review exercise (new activity)
  - Peer discussion
  - Reflection and self-evaluation

FSP111 C5

22

## Unit Summary

- Digression: Comparing your papers and masterpieces
  - Zipf's law
- Explore the mechanism underlying various complex phenomena
  - Interaction of components
- Preview Module C Evaluation Workshop

FSP111 C5

23