Movement Identification by Compression and Mantel Analysis

Presenter:

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What do these postures tell you?

And these postures?

Postures and gestures speak to us.

Can you hear them?

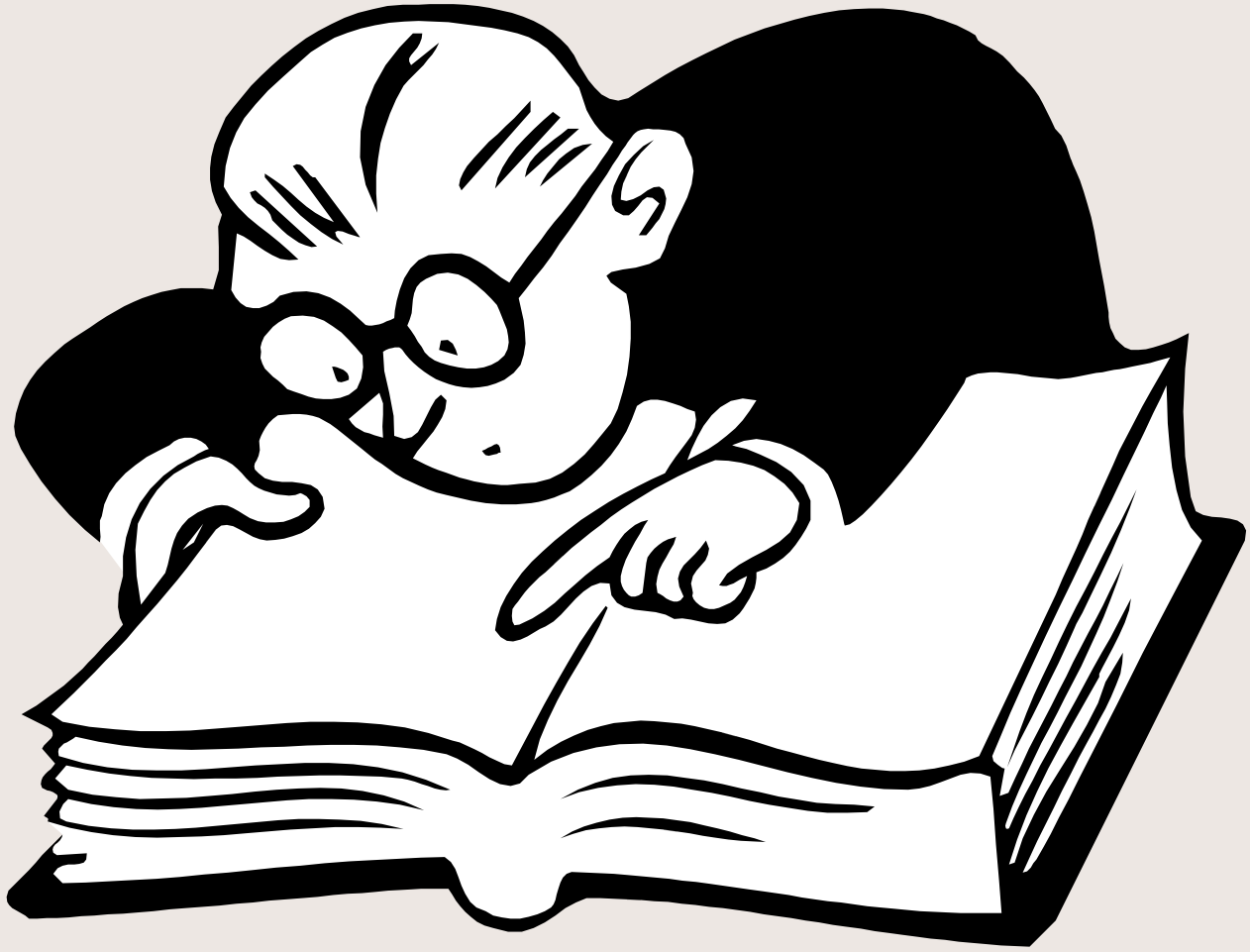
Sherlock Holmes could.

Her body oscillated backwards and forwards.

"Oscillation upon the pavement always means an *affaire du coeur*. When a woman has been seriously wronged by a man she no longer oscillates. Here we may take it that there is a love matter, but that the maiden is not so much angry as perplexed, or grieved."

-- "A Case of Identity"

But . . . mind capacity limits most humans.



WHAT IF . . .

we could teach a MACHINE to recognize posture and gesture?

I believe we can, & that's my experiment.

Here's how.

1. Describe movements graphically.
2. Convert the graphics to computer files.
3. "Zip" all pairs of files.
4. Determine compression efficiencies.
5. Relate movements by the efficiencies.
6. Compare the machine results with human-derived results.

Why should it work?

- Benedetto et al. did it with languages.
- Benedetto et al. also did it with authors.
- Bennett et al. did it with chain letters.
- Grumbach & Tahi did it with phylogenics.
- Li et al. did it with phylogenics and phylogenetics.
- Cilibrasi et al. did it with music.

SO WHAT?

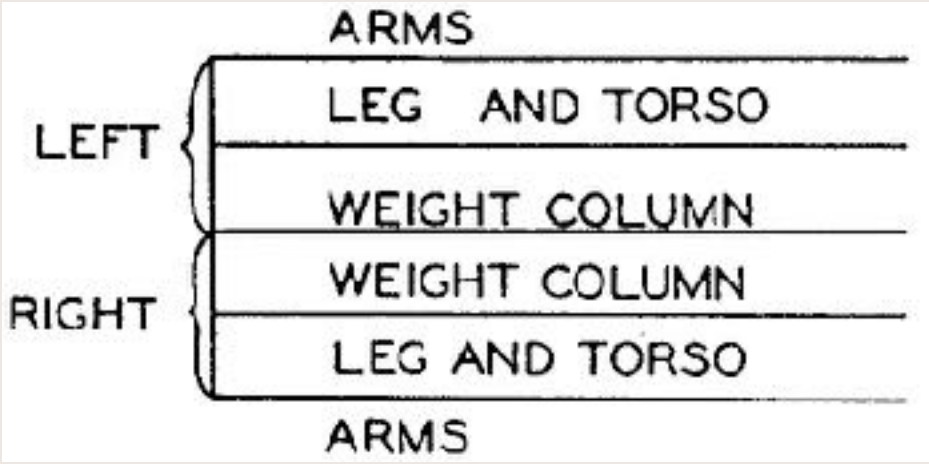
- Diagnosis of autism, frailty, stroke, . . .
- Industrial time-motion studies, RMS, . . .
- Analysis of athletic performance.
- Detection of emotions (Holmes).
- Prediction of behavior, e.g., criminal.
- Tracing population movements, as with language.

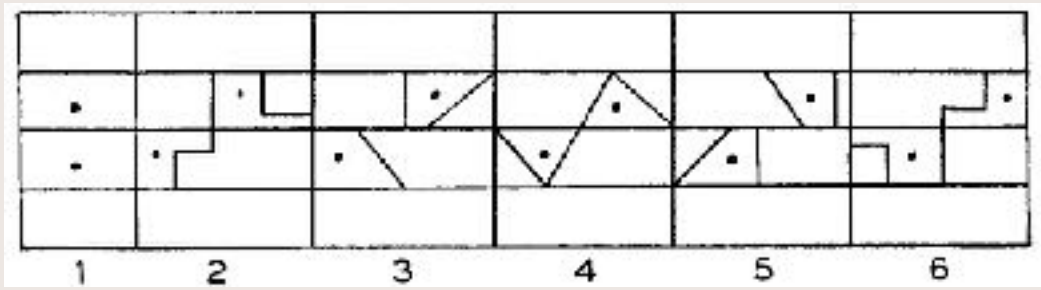
Here are those six steps, again.

1 Describe movement graphically

Benesh Notation

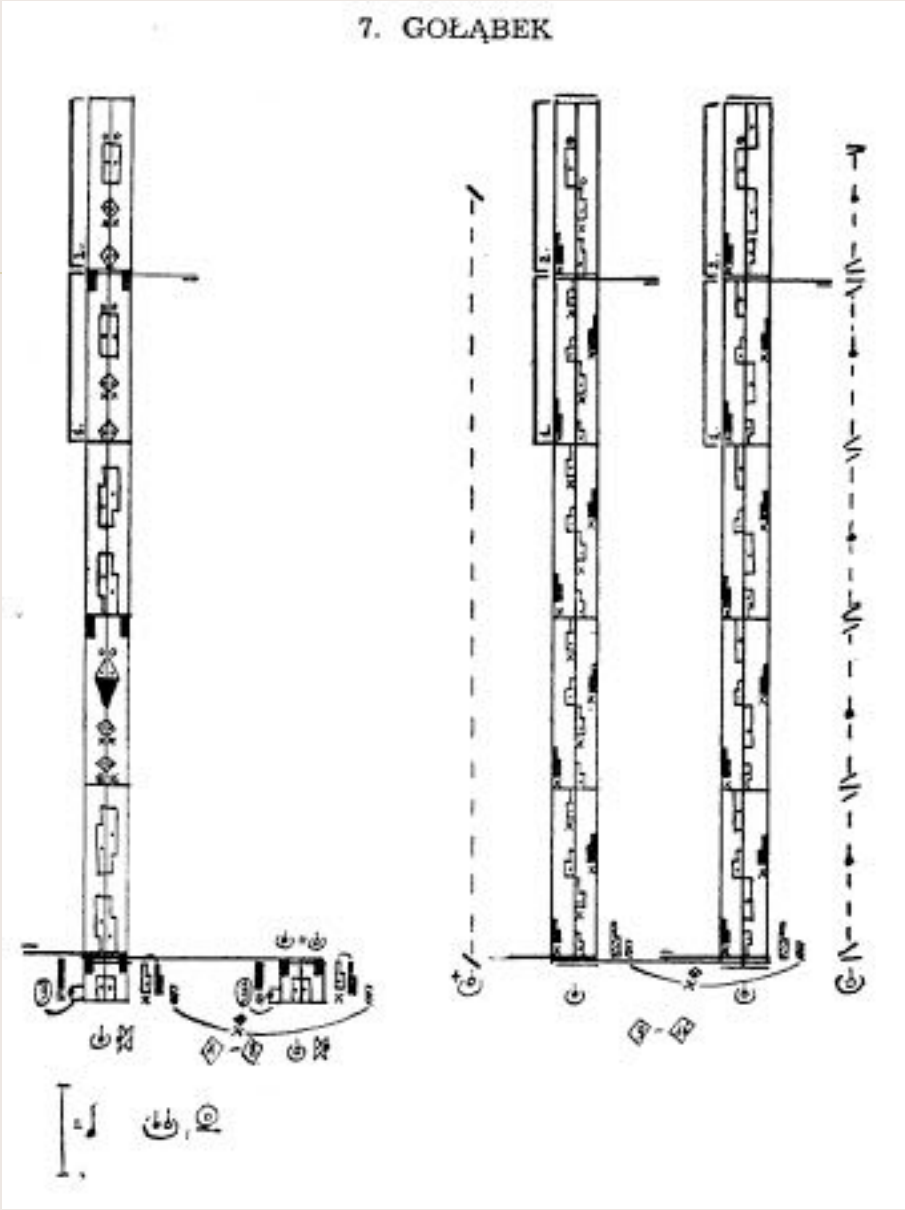
1 Describe movement graphically





Labanotation

1 Describe movement graphically



Labanotation

2 Computerize the graphics

- LabanWriter, developed at OSU:

A program to copy, edit, and store dance on a computer, through its more than 700 symbols that indicate parts of the body, direction, levels, and types of movement and the durations of each action.

3 “Zip” all pairs of files (a)

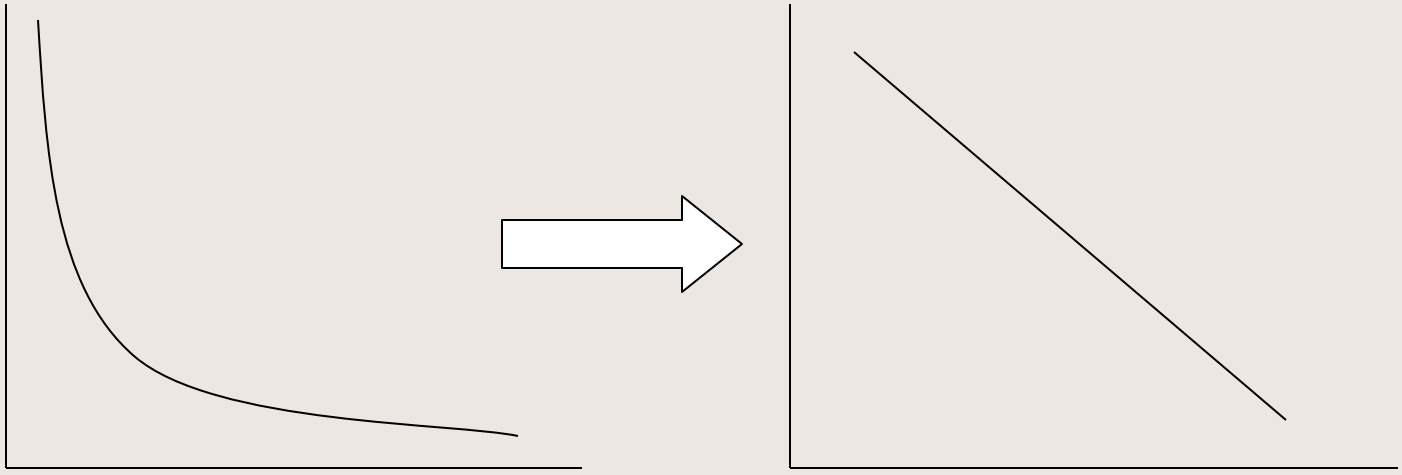
- Vilfredo Pareto [1848-1923]: 20% of the people control 80% of the wealth
- Benford – leading digit distribution
- Bradford – scientific journal importance
- Lotka – authorship of journal articles
- Trueswell – library circulation
- Zipf – word use frequency

How Zipping Works

- The “80-20” curve, a “rank-frequency” distribution:

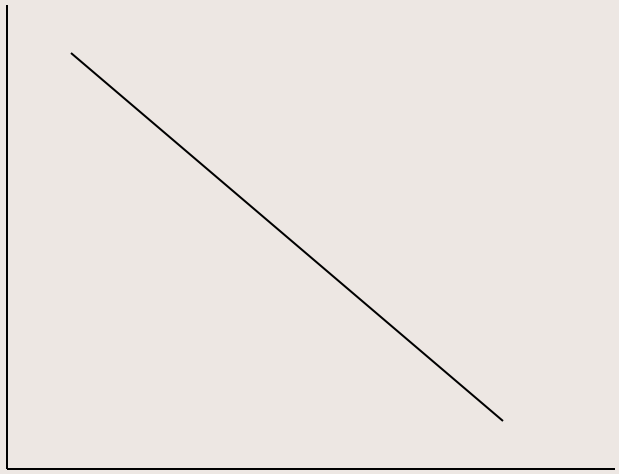
linear graph

log-log graph



Lempel & Ziv (1977) created a "dictionary" approach:

- Assign strings an address in a table
- Frequent strings get a short address
- Rare strings get a long address.



4 Determine compression ratios

- Pair all files

  AA, AB, AC . . .

  BA, BB, BC . . .

  Etc.

- Compress pairs

- Divide compressed AAc / full AAf = AAr, for all file pairs, to derive compression efficiencies.

Meanwhile:

- Human subject-experts recruited.
- Sent list of several hundred dances to determine which are known to all.
- Sent list of known dances for similarity rating.
- Results averaged to derive “human” matrix.

6 Comparison of "human" and computer matrices

- Compute Mantel statistic, a correlation.
- Compute "Monte Carlo" comparisons: the Mantel statistic of the "human" matrix with a distribution of a large number of random permutations of the computer matrix.
- Null hypothesis: the Mantel statistic lies within 1.28 z's of the mean of the random correlation (testing at p=.10).

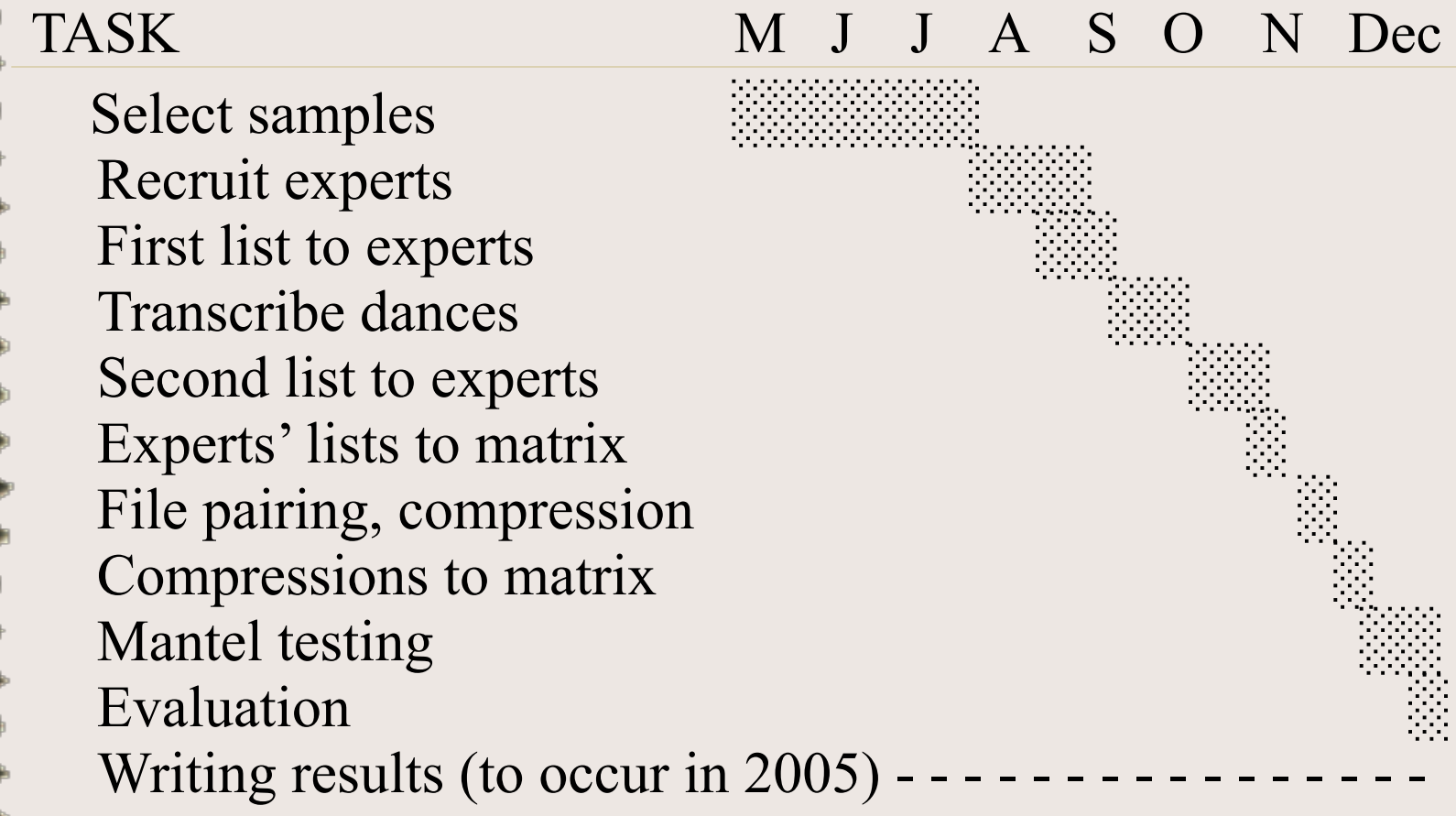
What This Means

- If we accept the Ho at p=.10, the study does not show that machines can recognize patterns. In other words, you should vary the methodology before trying it again.
- If we reject the Ho at p=.10, the experiment indicates that use of a computer can assist a human to recognize movement patterns.

If a computer can assist a human to recognize movement:

- Movement notators could computerize movements.
- Studies like mine could analyze the movement representations.
- Programs exist to animate Labanotation.
- We would have the complete human-computer interface: movement, representation, analysis, and back to movement representation.

Time frame


TASK
M J J A S O N Dec
Select samples
Recruit experts
First list to experts
Transcribe dances
Second list to experts
Experts' lists to matrix
File pairing, compression
Compressions to matrix
Mantel testing
Evaluation
Writing results (to occur in 2005)

Questions?