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15-826: Multimedia Databases and Data Mining

Lecture #30: Conclusions

C. Faloutsos

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Outline

Goal: 'Find similar / interesting things'

- Intro to DB
- Indexing - similarity search
  - Points
  - Text
  - Time sequences; images etc
  - Graphs
- Data Mining

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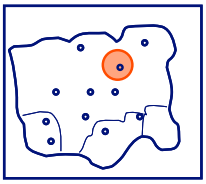
Indexing - similarity search



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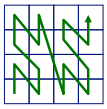
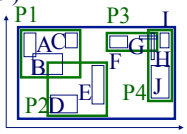
Indexing - similarity search

- R-trees
- z-ordering / hilbert curves
- M-trees
- (DON'T FORGET …)





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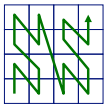
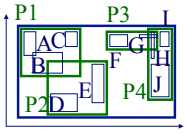
Indexing - similarity search

- R-trees
- z-ordering / hilbert curves
- M-trees
- **beware of high intrinsic dimensionality**





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Text searching

- 'find all documents with word *bla*'

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Text searching

- Full text scanning ('grep')
- Inversion (B-tree or hash index)
- (signature files)
- Vector space model
  - Ranked output
  - Relevance feedback
- String editing distance (-> dynamic prog.)

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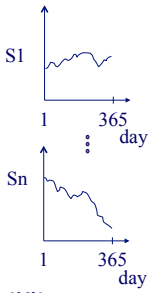
Multimedia indexing



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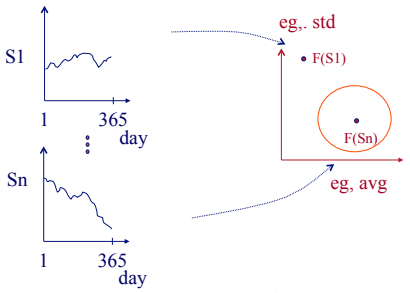
'GEMINI' - Pictorially



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Multimedia indexing

- Feature extraction for indexing (GEMINI)
  - Lower-bounding lemma, to guarantee no false alarms
- MDS/FastMap

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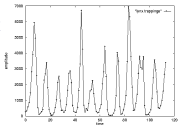
Time series & forecasting

Goal: given a signal (eg., sales over time and/ or space)

Find: patterns and/or compress

count  lynx caught per year

year

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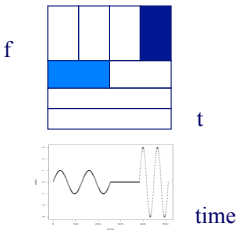
Wavelets

- Q: baritone/silence/soprano - DWT?



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Time series + forecasting

- Fourier; Wavelets
- Box/Jenkins and AutoRegression
- non-linear/chaotic forecasting (fractals again)
  - 'Delayed Coordinate Embedding' ~ nearest neighbors

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Graphs

- Real graphs: surprising patterns
  - ??

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Graphs

- Real graphs: surprising patterns
  - '**six degrees**'
  - **Skewed** degree distribution ('rich get richer')
  - Super-linearities (2x nodes -> 3x edges)
  - Diameter: **shrinks** (!)
  - Might have **no** good cuts

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Graphs - SVD

- Hubs/Authorities (SVD on adjacency matrix)
- PageRank (fixed point -> eigenvector)

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Data Mining - DB

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Data Mining - DB

- Association Rules ('diapers' -> 'beer')
- [~~OLAP – (DataCubes, roll-up, drill-down)~~]
- [~~Classifiers~~]

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Taking a step back:

We saw some fundamental, recurring concepts and tools:

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Powerful, recurring tools

- Fractals/ self similarity
  - Zipf, Korcak, Pareto's laws
  - intrinsic dimension (Sierpinski triangle)
  - correlation integral
  - Barnsley's IFS compression
  - (Kronecker graphs)

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Powerful, recurring tools

- Fractals/ self similarity
  - Zipf, Korcak, ...
  - ...
  - ...pression
  - (...necker graphs)

•'Take logarithms'
•AVOID 'avg'

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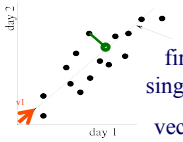
Powerful, recurring tools

- SVD (optimal L2 approx)
  - LSI, KL, PCA, 'eigenSpokes', (& in ICA)
  - HITS (PageRank)



first singular vector

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Powerful, recurring tools

- Discrete Fourier Transform
- Wavelets

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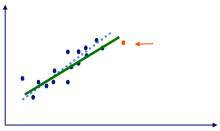
Powerful, recurring tools

- Matrix inversion lemma
  - Recursive Least Squares
  - Sherman-Morrison(-Woodbury)



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Summary

- **fractals / power laws** probably lead to the most startling discoveries ('the mean may be meaningless')
- **SVD**: behind PageRank/HITS/tensors/…
- **Wavelets**: Nature seems to prefer them
- **RLS**: matrix inversion, without inverting
- approximate counting (do the impossible!)

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Thank you!

- Feel free to contact me:
  - christos@cs GHC 8019
- Reminder: faculty course eval's:
  - www.cmu.edu/hub/fce/
- Final: Tue, Dec. 10, 1:00-4:00p.m. WEH7500 (double-check with
  - www.cmu.edu/hub/docs/final-exams.pdf
- Have a great break!