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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

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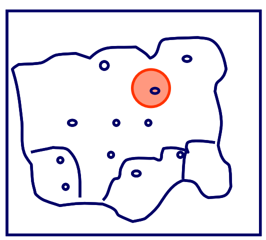
Indexing - similarity search



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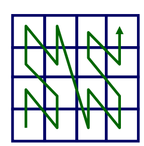
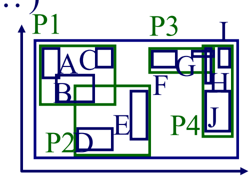
Indexing - similarity search

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





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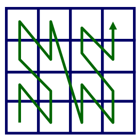
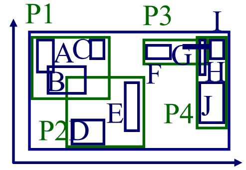
Indexing - similarity search

- 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 – Bloom filters
- Vector space model
  - Ranked output
  - Relevance feedback
- String editing distance (-> dynamic prog.)

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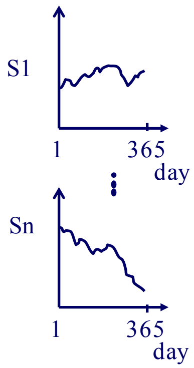
Multimedia indexing



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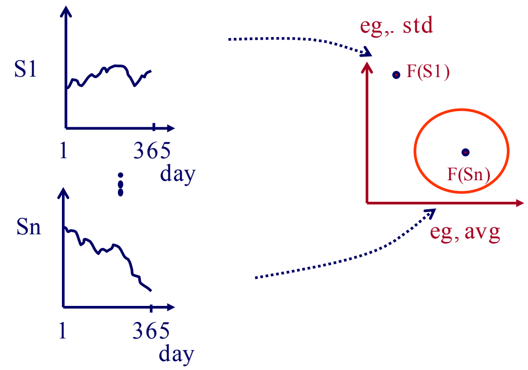
'GEMINI' - Pictorially



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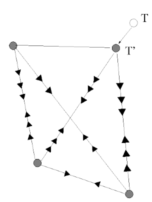
Multimedia indexing

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



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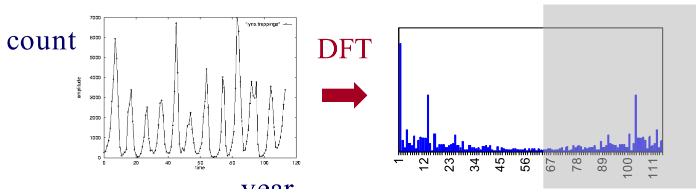
Time series & forecasting

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

Find: patterns and/or compress



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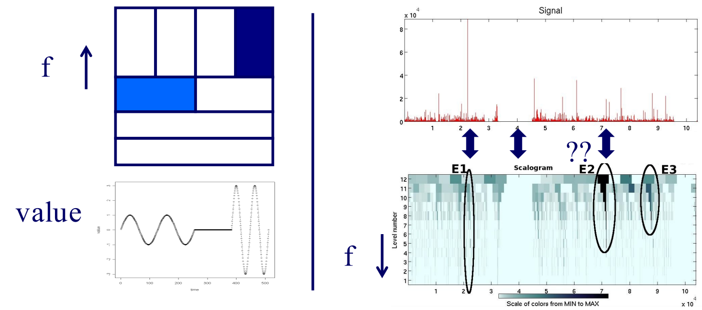
Wavelets

- Q: baritone/silence/soprano - DWT?



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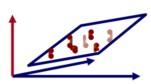
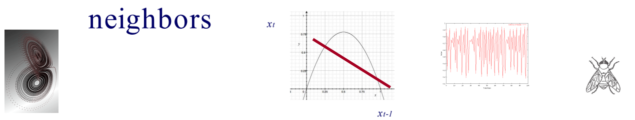
Time series + forecasting



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



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Outline

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Graphs

- Real graphs: surprising patterns
  - ??

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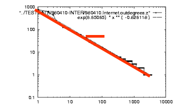
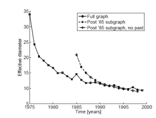
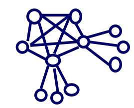
Graphs

- 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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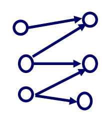
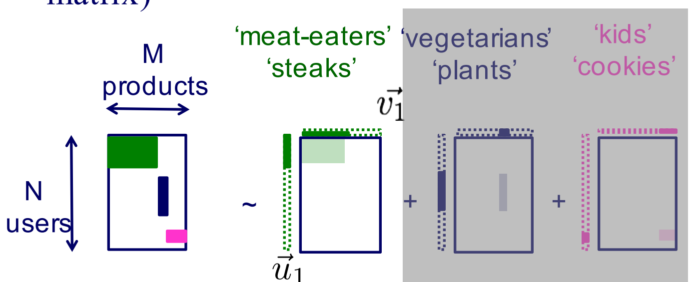
Graphs - SVD

- Hubs/Authorities (SVD on adjacency matrix)

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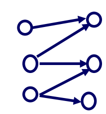
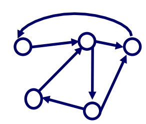
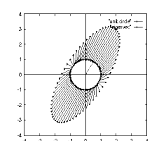
Graphs - PageRank

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

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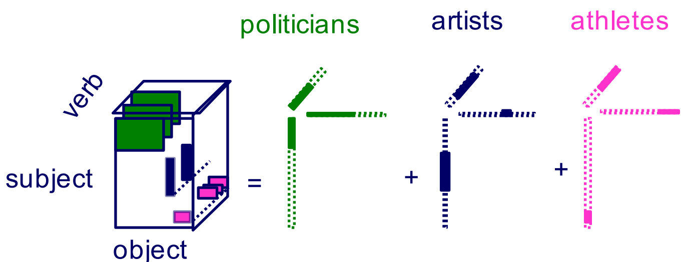
Tensors

- Eg., time evolving graphs; Subject-verb-object triplets; etc



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Taking a step back:

We saw some fundamental, recurring concepts and tools:

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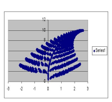
T1: Powerful, recurring tools

- Fractals/ self similarity



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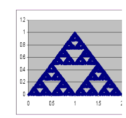
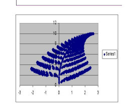
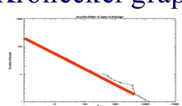
T1: Powerful, recurring tools

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







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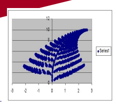
T1: Powerful, recurring tools

- Fractals/ self similarity
  - Zipf, K...
  - ...ession
  - ...er graphs)

- 'Take logarithms'
- mean-> meaningless
- Gaussian trap



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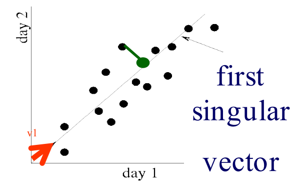
T2: Powerful, recurring tools

- SVD (optimal L2 approx)



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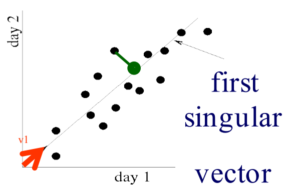
T2: Powerful, recurring tools

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



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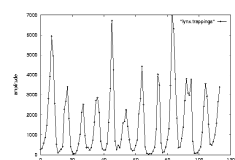
T3: Powerful, recurring tools

- Discrete Fourier Transform
- Wavelets



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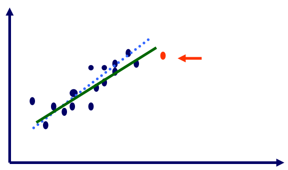
T4: Powerful, recurring tools

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



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Summary

- **T1: fractals / power laws** lead to startling discoveries
  - 'the mean may be meaningless'
  - Don't assume Gaussian (average, k-means, etc)
- **T2: SVD**: behind PageRank/HITS/tensors/…
- **T3: Wavelets**: Nature seems to prefer them
- **T4: RLS**: matrix inversion, without inverting

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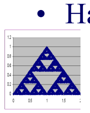
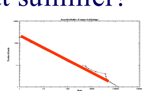
Thank you!

- Feel free to contact me:
  - Cell#; christos@cs; GHC 8019
- Reminder: faculty course eval's:
  - www.cmu.edu/hub/fce/
- Final: as announced in Hub
  - Mo 5/8/2017, 8:30-11:30am, DH 2315
  - (**double-check** with www.cmu.edu/hub/docs/final-exams.pdf)
- Have a great summer!





- 'Take logarithms'
- mean -> meaningless
- Gaussian trap

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