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15-826: Multimedia Databases and Data Mining

Project lecture #2: Anomaly detection in large graphs

Christos Faloutsos

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Roadmap

- Introduction – Motivation
- Patterns in graphs
  - Static graphs
  - <etc>
- Tools:
  - OddBall
  - CatchSync
- Conclusions

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Problem

- Tools, for anomaly detection in graphs?

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Conclusions

- Tools, for anomaly detection in graphs?
- MANY – two of them:
  - OddBall (features of ego-nets)
  - CatchSync (in-degree vs 'authoritativeness', etc)

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OddBall: Spotting anoMalies in Weighted Graphs


Leman Akoglu, Mary McGlohon, Christos Faloutsos

Carnegie Mellon University

School of Computer Science

PAKDD 2010, Hyderabad, India

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Main idea

For each node,

- extract 'ego-net' (=1-step-away neighbors)
- Extract features (#edges, total weight, etc etc)
- Compare with the rest of the population

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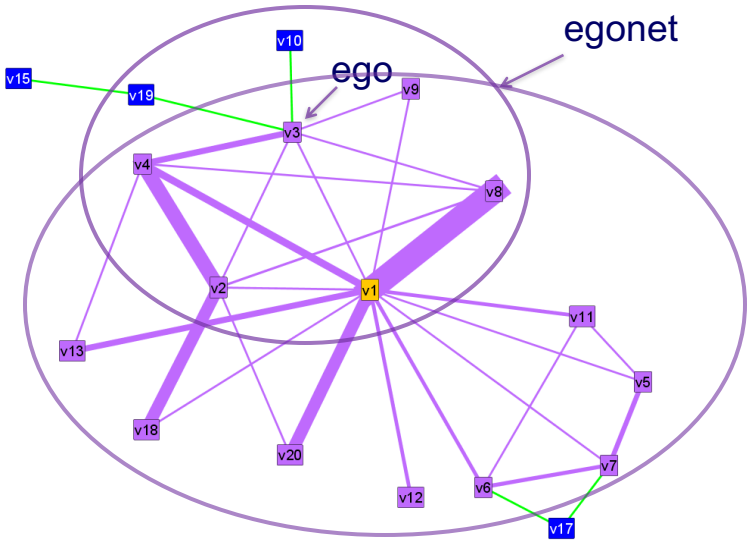
What is an egonet?



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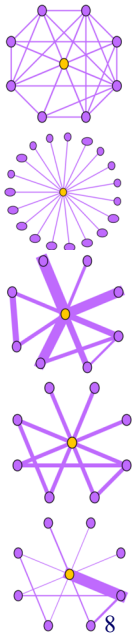
Selected Features

Q: which features?
Q': how many possible features exist?



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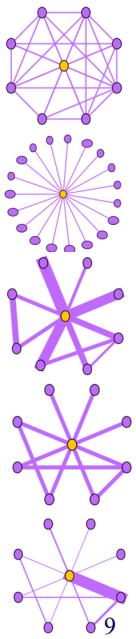
Selected Features

- N_i: number of neighbors (degree) of ego i
- E_i: number of edges in egonet i
- W_i: total weight of egonet i
- $\lambda_{w,i}$: principal eigenvalue of the weighted adjacency matrix of egonet I



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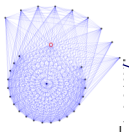
Near-Clique/Star



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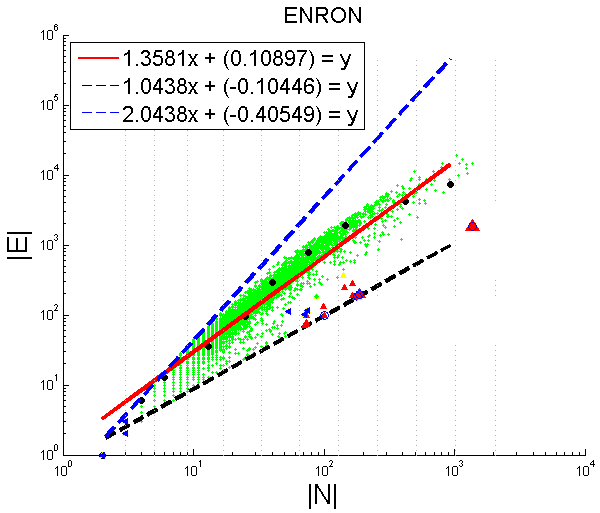
Near-Clique/Star



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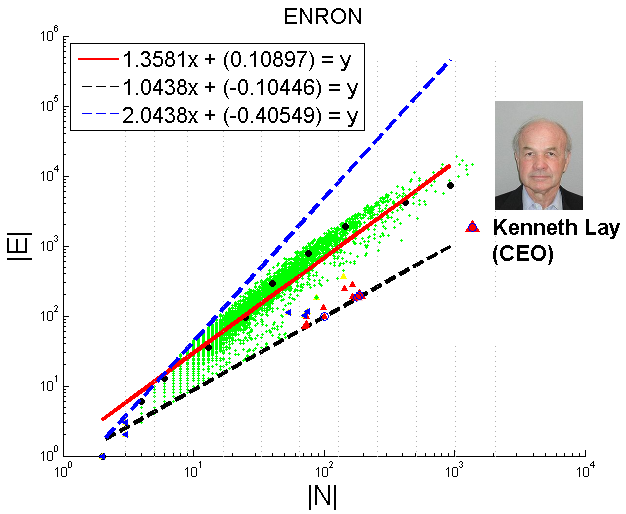
Near-Clique/Star



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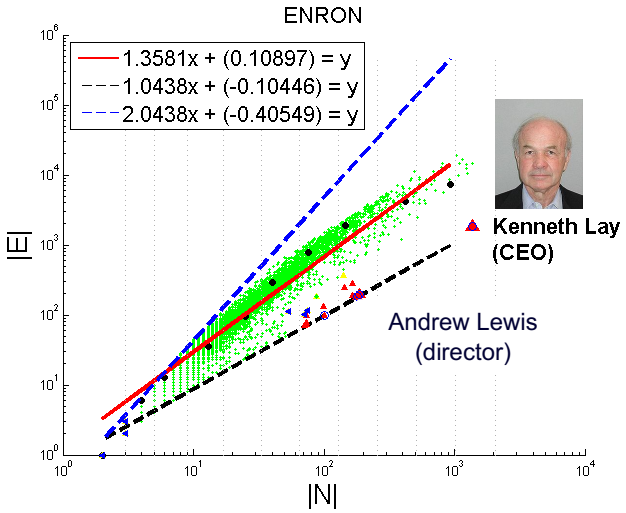
Near-Clique/Star



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Catchsync: catch synchronized behavior in large directed graphs

Meng Jiang, Peng Cui, Alex Beutel,
Christos Faloutsos and Shiqiang Yang
KDD, August 26, 2014 – NYC, USA

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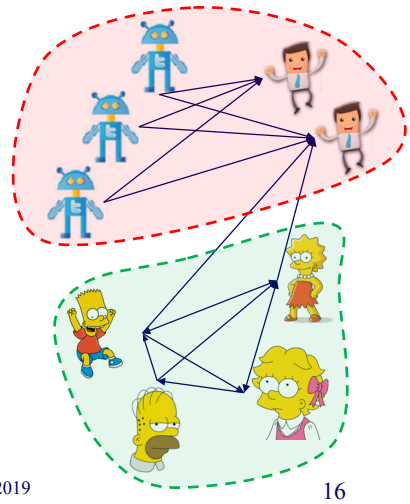
Fraud Detection: Graph Analysis Problem



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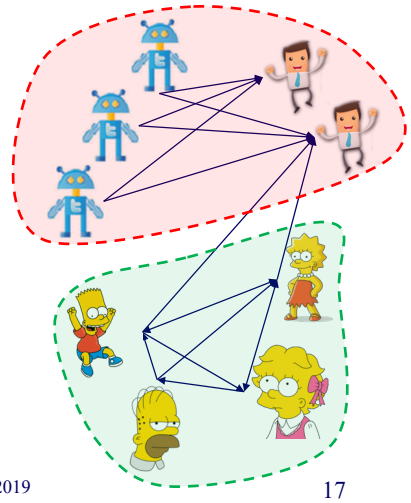
Fraud Detection: Graph Analysis Problem

[www.buyfollowz.org]

[buymorelikes.com]



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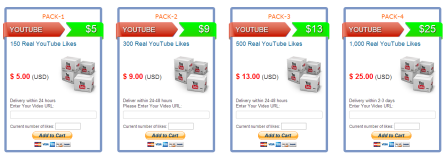
Fraud Detection: Graph Analysis Problem

[buycheaplikes.com]



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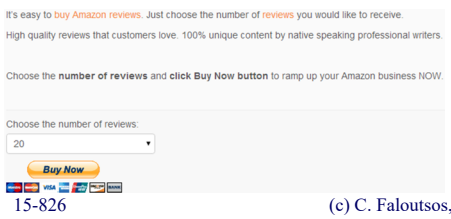

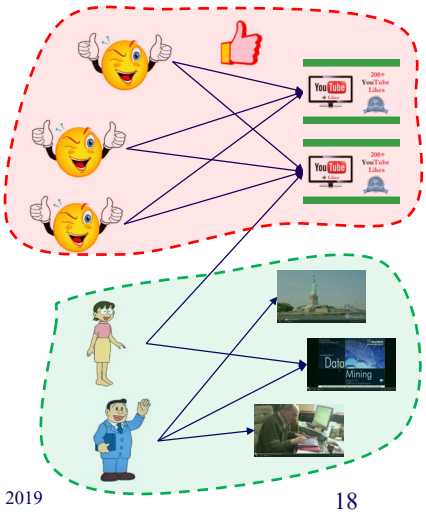

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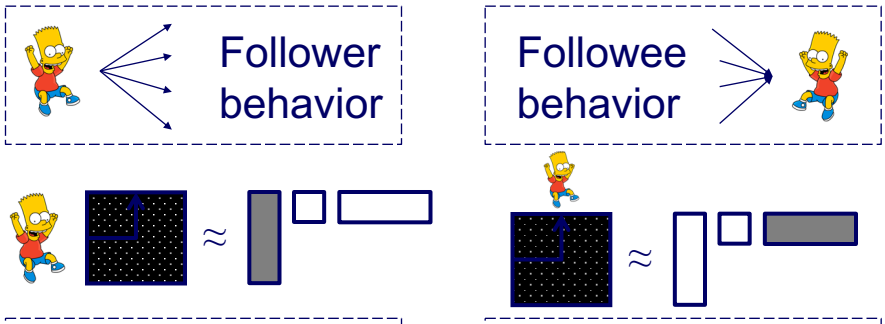
Behavior-based Features



Out-degree
1st left singular vector
(Hubness)
…

In-degree
1st right singular vector
(Authoritativeness)
…

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Hubs/Authorities

Jon M. Kleinberg: *Authoritative Sources in a Hyperlinked Environment*. SODA 1998: 668-677

(Later, in huge detail…)

```
import networkx as nx
G=nx.path_graph(4)
h,a=nx.hits(G)

print h
print a
```

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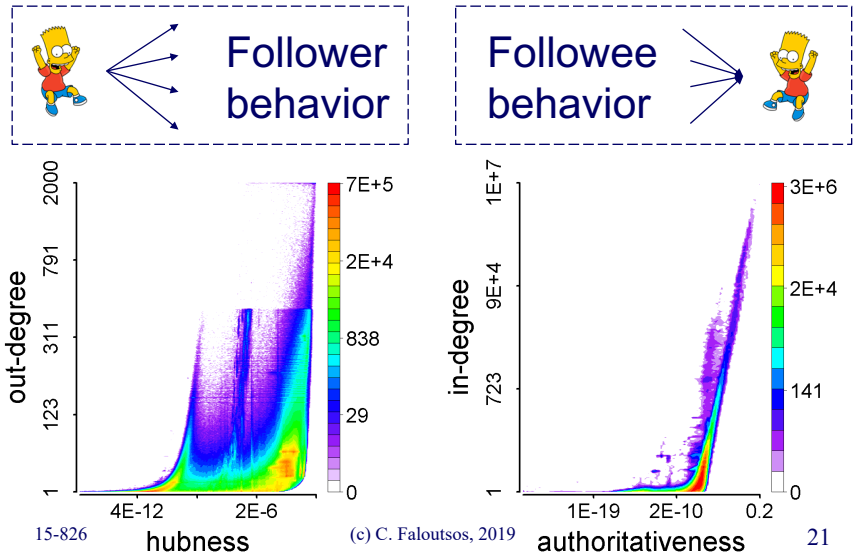
Behavior-based Feature Space



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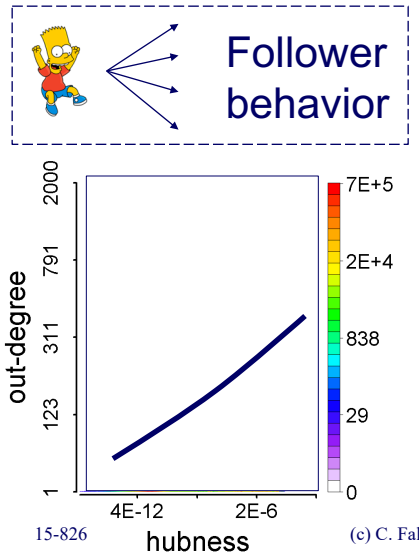

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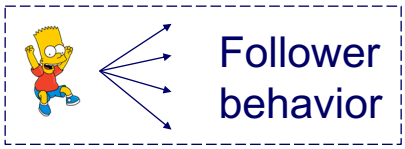

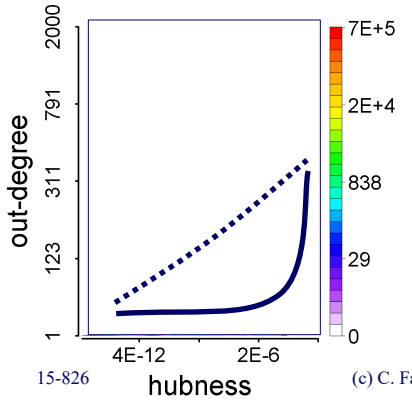

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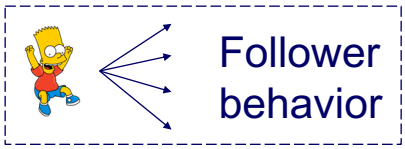
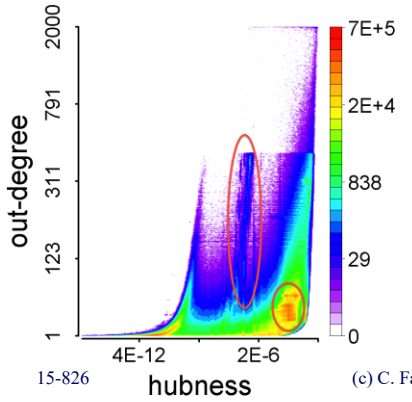
Before CatchSync





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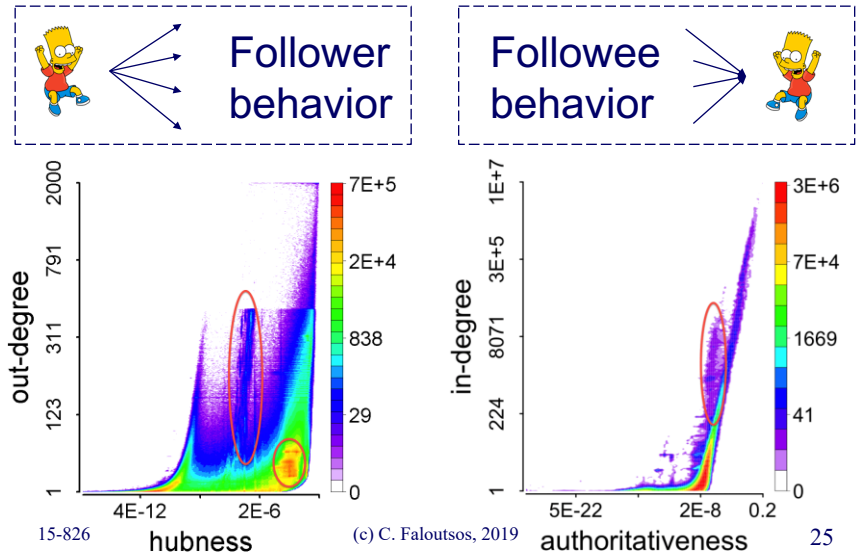
Before CatchSync



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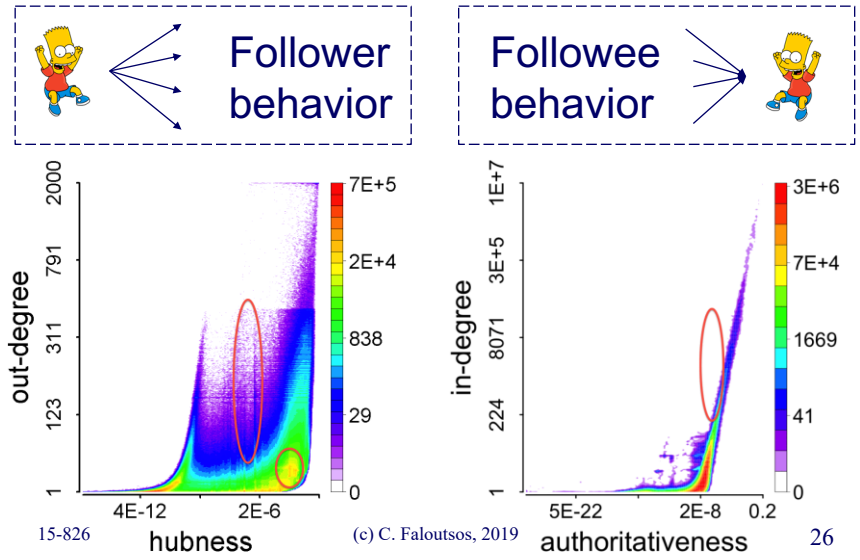
After CatchSync



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