Evaluation of Graph Sampling: A Visualization Perspective

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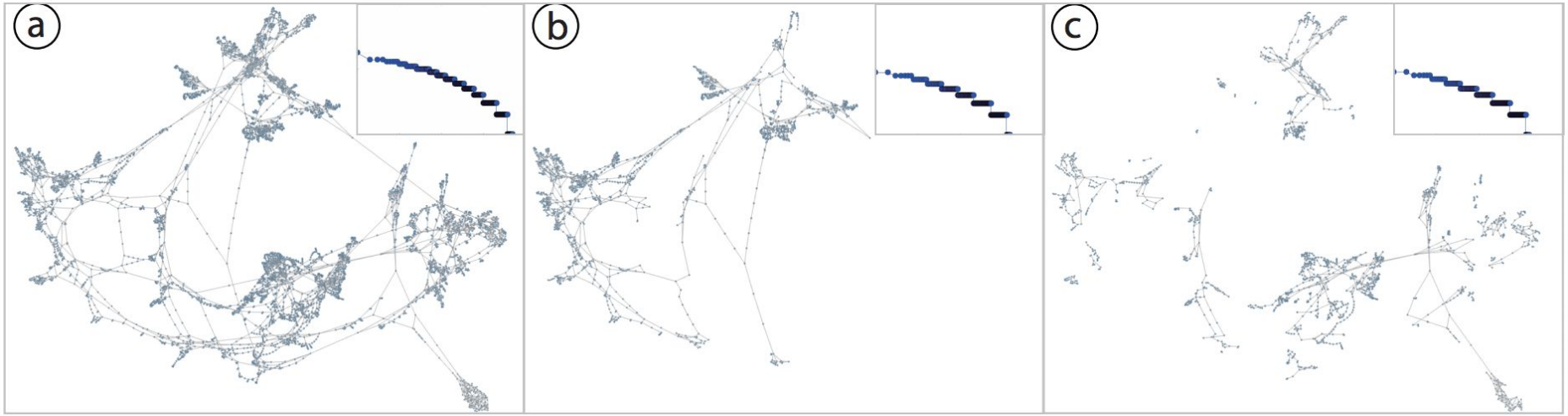
What’s better, B or C?



A little different, right?

- Similar quantitative statistics
- Very different perceptually

Problem: Analyzing large graphs

- Large graphs are difficult to analyze even with state of the art techniques on high-end clusters
- Can reach hundreds of millions, or even billions of nodes

One Solution: Graph sampling

- Sampled graph often more desirable than small chunk of original graph
- Makes analysis on large graphs tractable
- Can be used for preliminary evaluation

One more problem: How to sample?

What is the best way to sample?

- Should we pick nodes at random?
- Traverse the graph?

Lots of solutions!

This paper focusses on five of the most widely used:

- Random Node (RN)
- Random Edge Node (REN)
- Random Walk (RW)
- Random Jump (RJ)
- Forest Fire (FF)

What? Why? How?

What:

- Node-link unweighted networks (N: ~1000-20000)

Why:

- Summarize topology

How:

- RN, REN, RW, RJ, FF

Key Question: Perceptual Quality

What are the main factors that affect perceptual quality in a sampled graph?

How are those factors affected by the five sampling strategies?

Important Perceptual Qualities

Three identified:

-

Important Perceptual Qualities

Three identified:

- Coverage Area
-

Important Perceptual Qualities

Three identified:

- Coverage Area
- Cluster Quality
-

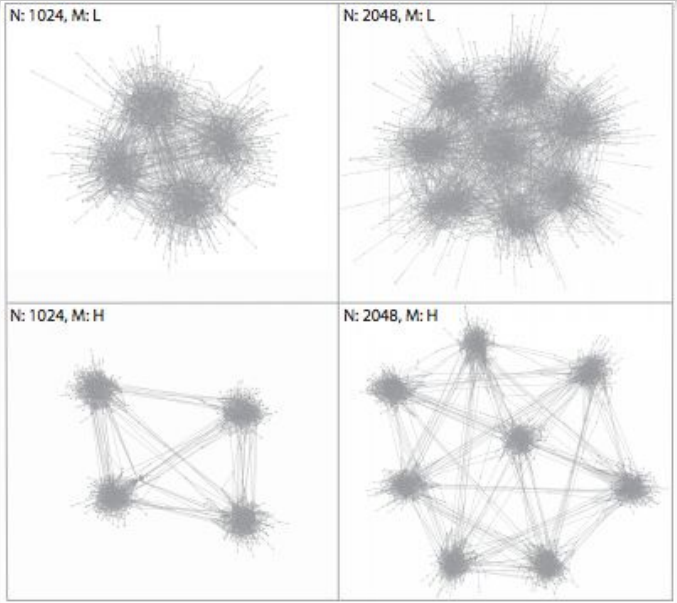
Important Perceptual Qualities

Three identified:

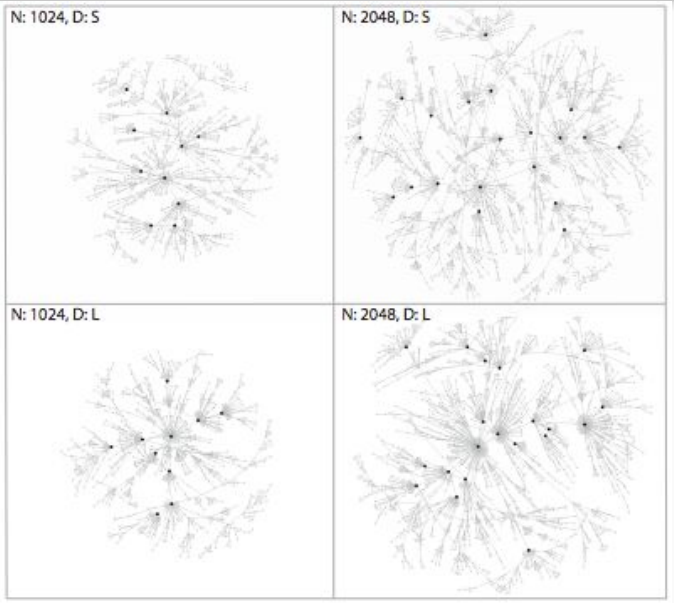
- Coverage Area
- Cluster Quality
- High Degree Nodes, and their preservation

In addition, 20% sampling rate was selected as a fair comparison rate

Graphs used: BA and Sah



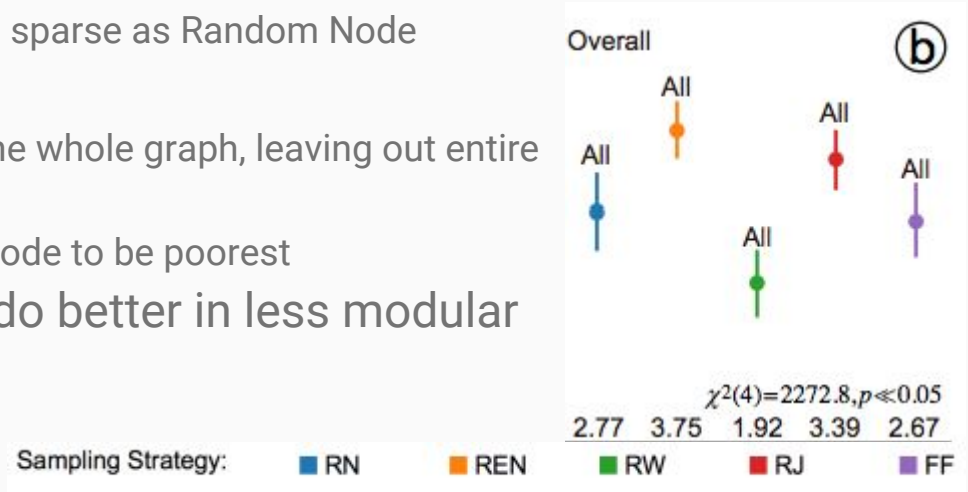
Guaranteed cluster networks generated by Sah et al.'s model



Power law networks generated by a Barabasi-Albert model

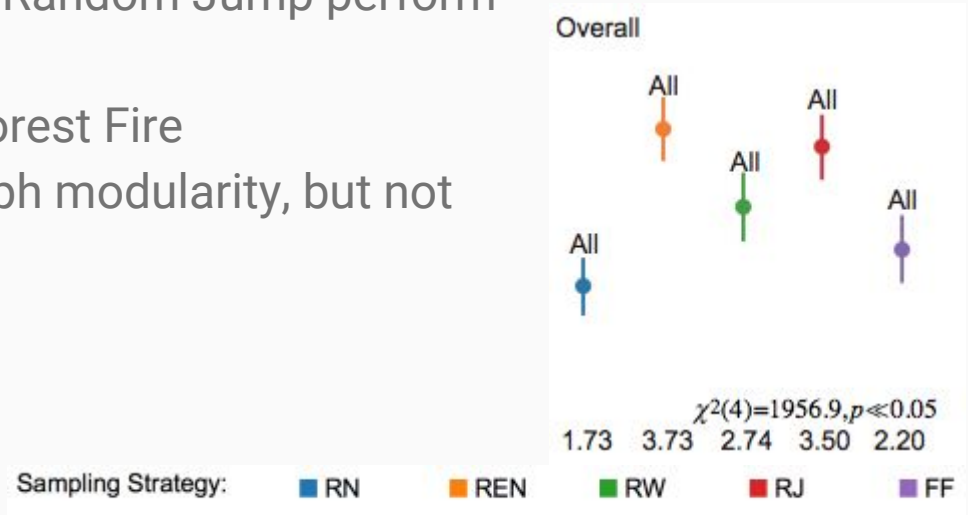
How did they fare: Coverage Area

- **Best:** Random Edge Node and Random Jump
  - Do not get trapped, but are not as sparse as Random Node
- Random Walk is poorest
  - May not explore anywhere near the whole graph, leaving out entire sections
  - Researchers expected Random Node to be poorest
- Forest Fire and Random Walk do better in less modular graphs



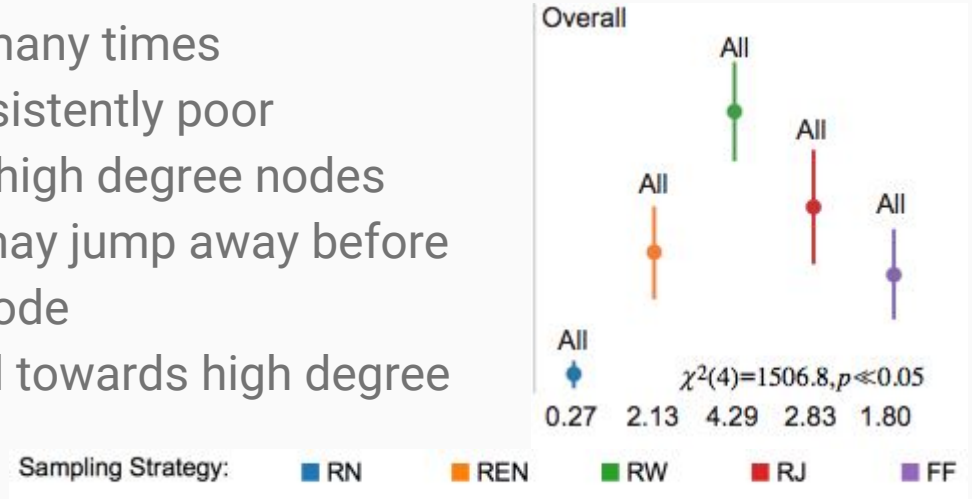
How did they fare: Cluster Quality

- **Best:** Random Edge Node and Random Jump perform best
- **Poorest:** Random Node and Forest Fire
- Random Walk depends on graph modularity, but not graph size



How did they fare: High Degree Nodes

- **Best:** Random Walk
  - Can visit the same node many times
- **Poorest:** Random node is consistently poor
  - Not at all biased towards high degree nodes
- Random jump does well, but may jump away before fully exploring a high degree node
- Random Edge Nodes is biased towards high degree nodes, so does better



So, which is best?

- Random Walk to preserve high-degree nodes
- Random Jump or Random Edge Node to preserve global structure and cluster quality
- Almost never use Random Node

Strengths

- Substantial thought given to experiment design and neutralizing potential confounds
- Depth of work: Pilot study, three formal studies
- Useful, well explained, and nuanced recommendations

Weaknesses and limitations

- Does not explore the laying out of graphs post-sampling.
- Only used computer science students/graduates in their studies
- Single sampling rate was tested

Potential future work

- Improve metrics based on human feedback
- Perceptual quality of graph abstraction, as opposed to sampling
- Investigate time to complete tasks on sampled graphs, as well as accuracy
- Investigate false positives, such as a sampled low degree perceived as high degree