When to Stop Random Walks in Social Networks

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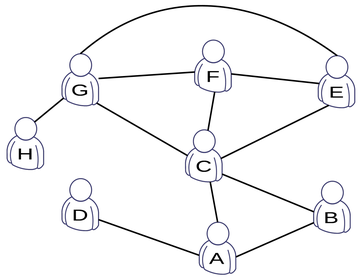
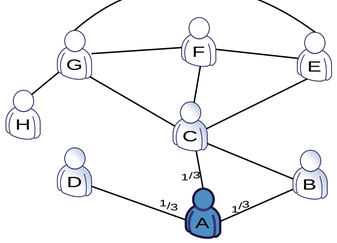
Walks in Online Social Networks

Given graph $G\langle V, E\rangle$, and a current node $u \in V$,k_v is degree of node v.



Online Social Network Graph

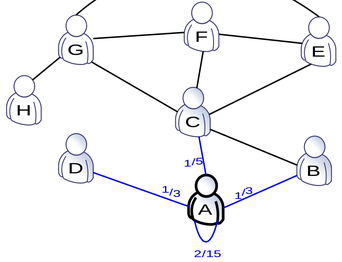
$$\pi_v = \frac{k_v}{2 \cdot |E|} \qquad \pi_v = \frac{1}{|V|}$$



Next candidate

Current node

Simple Random Walk



Next candidate

Current node

Metropolis-Hasting Random Walk

Random Walk Algorithms

Simple Random Walk (SRW)

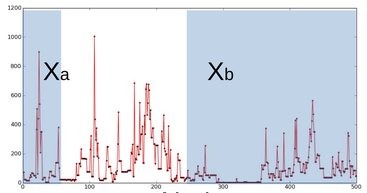
$$T(u,v) = \begin{cases} 1/|N(u)| & \text{if } v \in N(u) \\ 0 & \text{otherwise} \end{cases}$$

Metropolis-Hasting Random Walk (MHRW)

$$T(u,v) = \begin{cases} \frac{1}{N(u)} \cdot min\left\{1, \frac{N(u)}{N(v)}\right\} & \text{if } v \in N(u) \\ 1 - \sum_{w \in N(u)} T(u,w) & \text{if } u = v \\ 0 & \text{otherwise} \end{cases}$$

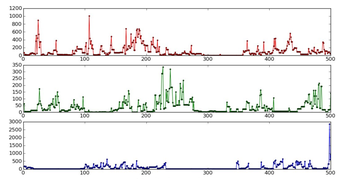
Online Convergence Diagnostics

Geweke Z-Score



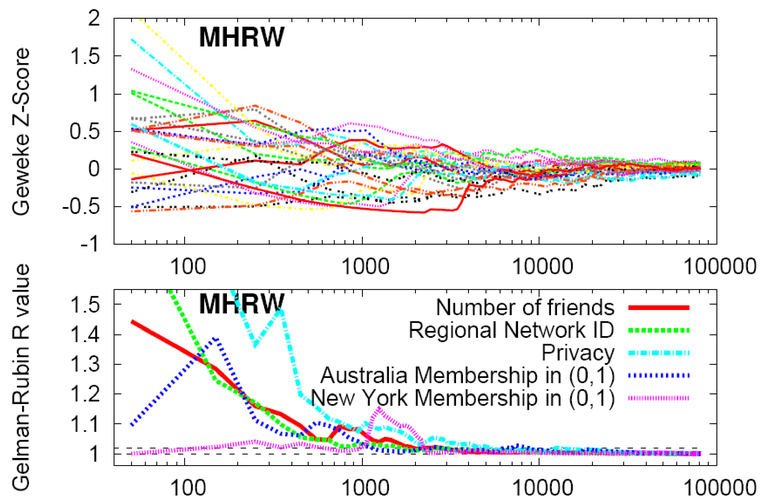
$$z = \frac{E(X_a) - E(X_b)}{\sqrt{Var(X_a) - Var(X_b)}}$$

Gelman-Rubin R value



$$\sqrt{R} = \sqrt{\frac{n-1}{n} + \frac{m+1}{mn}\frac{B}{W}}$$

Burn-in Period



MHRW Algorithm

Input: node u , starting node w , length of walk l
Output: set of nodes S_n

```
while l ≤ target do
    Randomly choose w from N(u)
    Generate α from U(0,1)
    if α ≤ N(u)/N(w) then
        goto w
    end if
end while
```

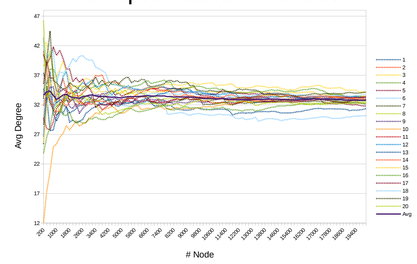
Experiments

Twitter Social Graph:
Twitter is an online social network which is popular among millions of users who generate huge numbers of tweets, posts, and reviews everyday.

We use the Twitter dataset from Stanford's SNAP dataset repository 5 which is crawled from public sources and has close to 80,000 nodes and more than 1.7 million edges.

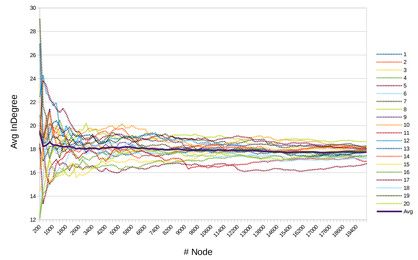
Average degree of Twitter Users

Simple Random Walk

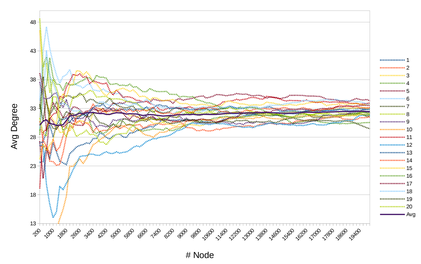


Average In-degree of Twitter Users

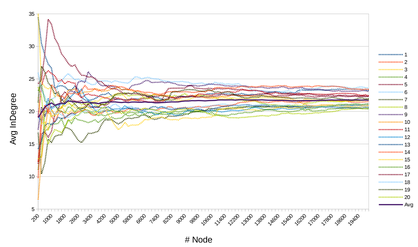
Simple Random Walk



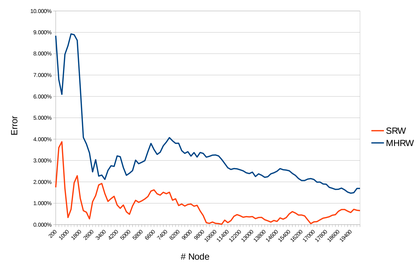
Metropolis-Hasting Random Walk



Metropolis-Hasting Random Walk



Compare Errors



Compare Errors