Complex Network Analysis Reveals Kernel-Periphery Structure in Web Search Queries

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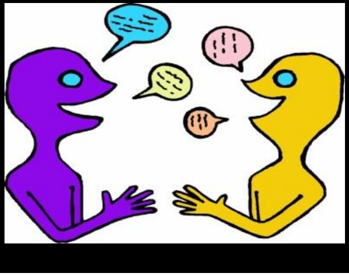


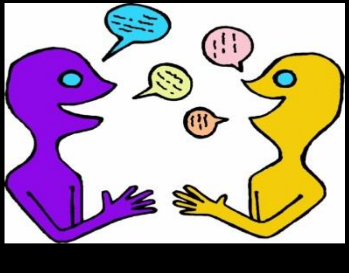
Language of Queries

- Interaction between user and search engines over the years has resulted in the evolution of a distinct language for Web search queries

✓ *gprs config samsung focus at&t*

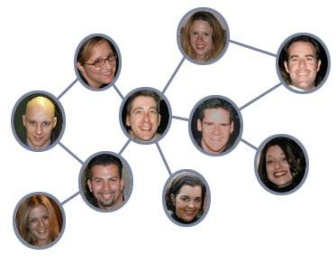
✓ *samsung focus at&t gprs config*

✗ *focus config at&t gprs samsung*



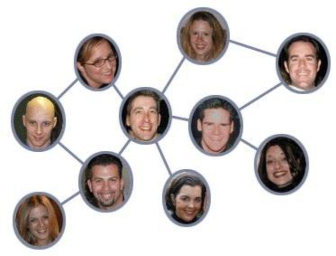
Language of Queries

How can we begin to analyze this new language?



Complex Networks

- Real life networks not easily explained by standard topologies
- Applications to linguistics – word co-occurrences, consonant inventories, syntactic and semantic features, language dynamics



Complex Networks

Word co-occurrence networks: Interesting tool to discover fundamental properties of a language

bing™

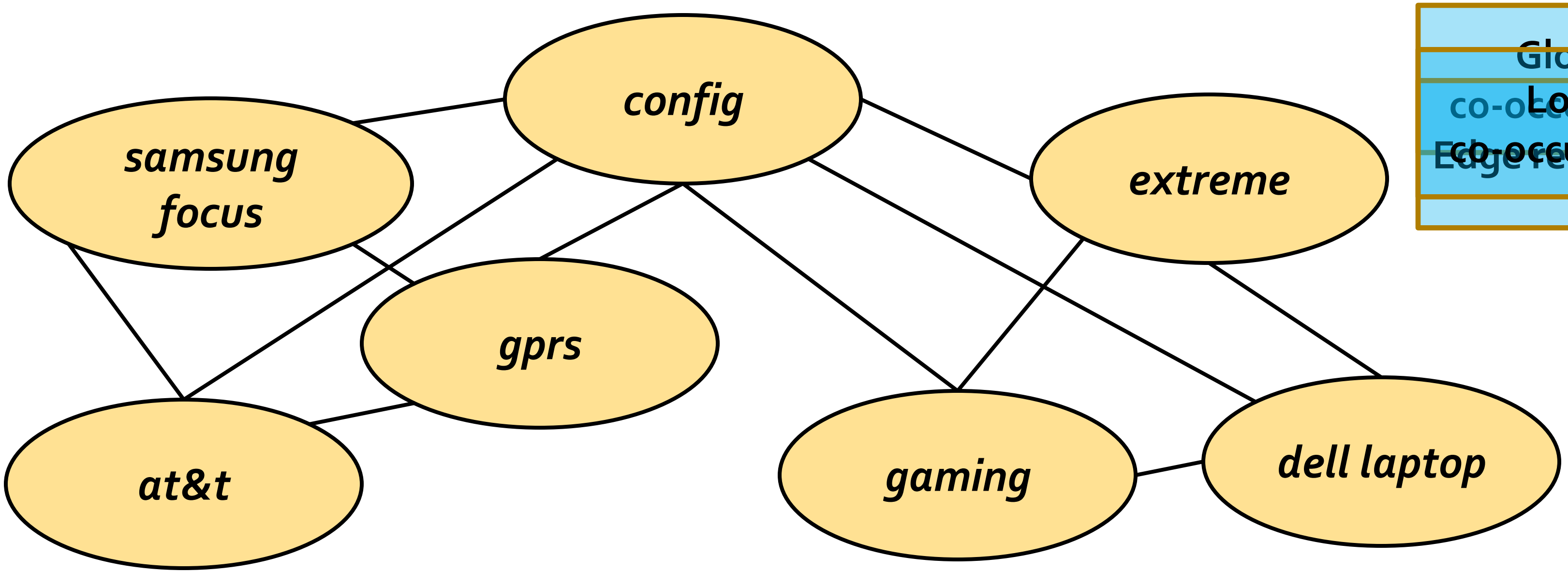
Data

16.7 million entries sampled from Bing Query Logs from Australia (February – May 2009)

Courtesy: Microsoft India Development Center

Network Models for Queries

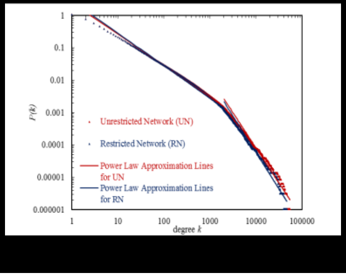
- *"gprs" "config" "samsung focus" "at&t"*
- *"dell laptop" "extreme" "gaming" "config"*



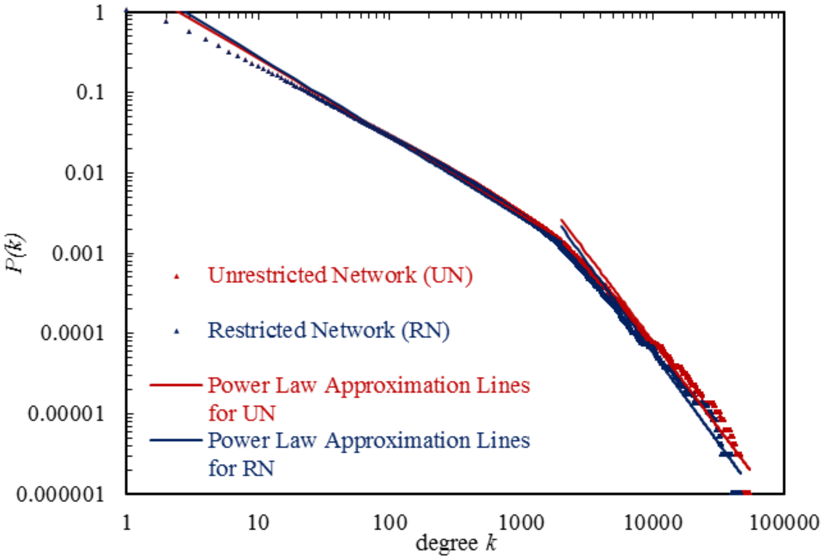
Global co-occurrence

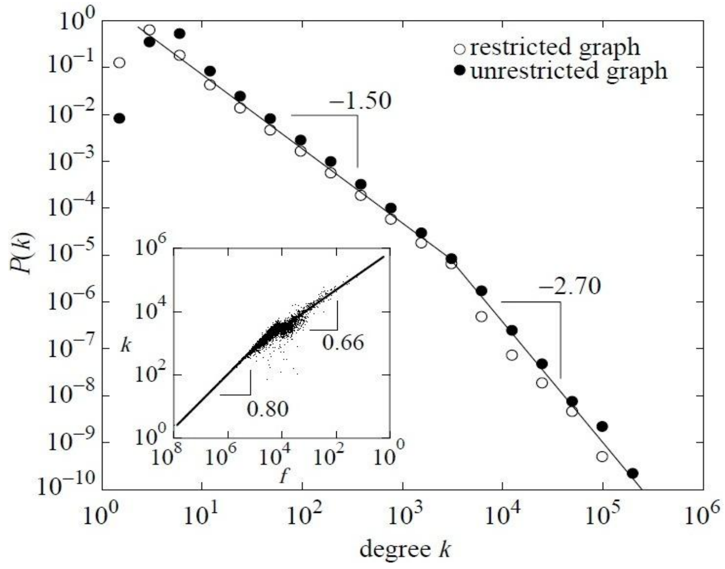
Local co-occurrence

Edge restriction

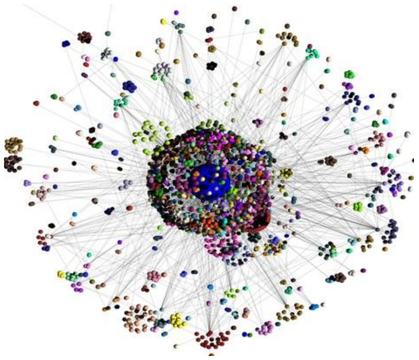


Two-regime Power Law





- Two-regime power law in degree distribution
- Similar coefficients for queries and English
- Kernel (K-Lex) and peripheral (P-Lex) lexicon distinction

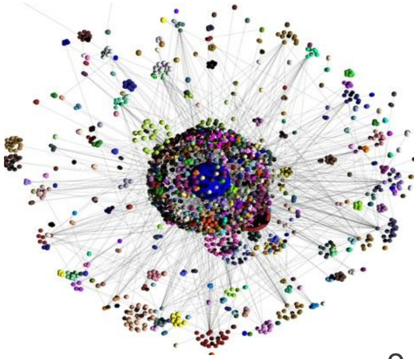


Insights (1)

- ✓ K-Lex and P-Lex
- ✓ Higher mean shortest paths
- ✓ Less tight kernel
- ✓ More k-p edges
- ✓ Socio-cultural effects

- Differences in compositions of K-Lex and P-Lex
- Heads and modifiers

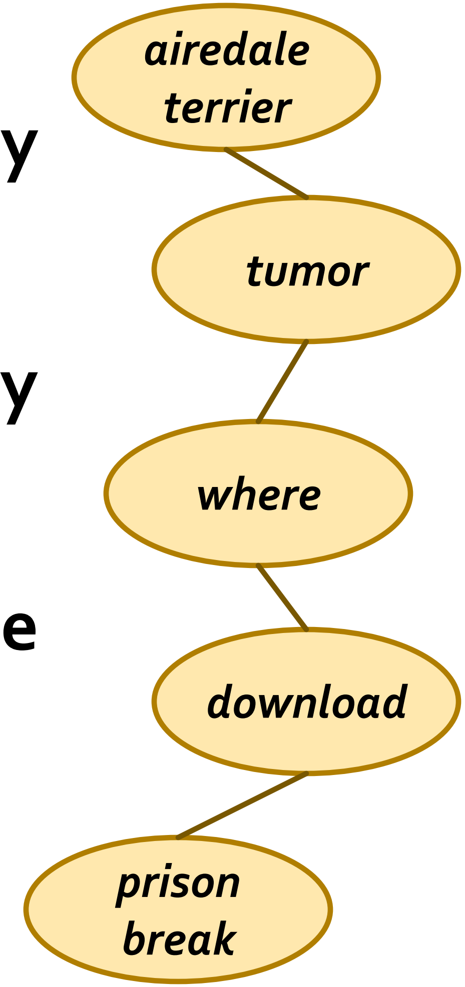
K-Lex (popular segments)	P-Lex (rarer segments)
how to	*matthew brodrick*
wiki	*accessories*
free	*police officer*
and	*who is*
in australia	*epson tx800*
videos	*star trek next gen*
real estate	*adams apple*
difference between	*harvard university*
windows xp	*leukemia*



Insights (2)

- ✓ K-Lex and P-Lex
- ✓ Higher mean shortest paths
- ✓ Less tight kernel
- ✓ More k-p edges
- ✓ Socio-cultural effects

- Higher mean shortest path in query networks
- Peripheral units can independently form queries
- More difficult to understand the context of a previously unseen unit
- High surprise factor



Insights (3)

- ✓ K-Lex and P-Lex
- ✓ Higher mean shortest paths
- ✓ Less tight kernel
- ✓ More k-p edges
- ✓ Socio-cultural effects

- **Kernel is less tightly coupled**
- **98% edges run between kernel and periphery, while intra-kernel edges dominate in English**
- **Socio-cultural factors govern kernel-periphery distinction (*lyrics*, *movies*, *adelaide* in K-Lex; *code*, *accessories*, *delhi* in P-Lex)**

Thank You!