

Wavelet SiZer

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Network Modeling for the Internet

SiZer & Wavelets Working Group

Wavelet SiZer

- Discussion with Stilian Stoev
- Use all $d_{j,k}$
- Consider both scale (j) and location (k) simultaneously
- Wavelet coefficients have weak correlation each other
- Do original SiZer with wavelet coefficients at each scale j
- Statistical test of wavelet coefficients by SiZer

Wavelet SiZer (cont.)

Issues

- Initialization: little effects

- First order vs. Second order

2002 Sat 1300: [First](#) vs. [Second](#)

- Wavelet basis selection: depends on data sets

N=3, Second order, Initialization

Summary

FGN: No significant burstiness

Synthetic: Random + little spikes, trends
Significant feature at $j = 1 \sim 3$ (Bumps in WS)

2002: Spikes + Random + Trend
Spikes are ubiquitous

2003: Spikes + Trend + Random
Pattern of significant feature is not simple
Boundary (Fourth order)

Abilene: Spikes + Trend + random
Rich burstiness at small scales (Bumps in WS)

Meaning of Significant Burstiness

2003 Sat 1500 Wavelet SiZer

- Linear trend at $j = 1 \sim 4$
- Spikes at $j = 5 \sim 9$

2003 Sat 1500 original series

- Three spikes at the end

2003 Sat 1500: Second order vs. Fourth order

- Second order has more wiggles and burstiness
- Fourth order can catch fine scale behavior

Meaning of Significant Burstiness (cont.)

2003 Sat 1500 Truncated series 1

- Little effects

2003 Sat 1500 Truncated series 2

- Effect on spikes at $j = 5 \sim 8$

2003 Sat 1500 Truncated series 3

- Effect on spikes at $j = 6 \sim 9$

2003 Sat 1500 Truncated series 4

- Effect on spikes at $j = 5 \sim 9$
- Linear trend still remains

Meaning of Significant Burstiness (cont.)

2003 Sat 1500 N=5

- Linear trend still exists

TCP vs. UDP

2003 Sat 1500 TCP Wavelet SiZer

2003 Sat 1500 UDP Wavelet SiZer

- Linear trend: upwards vs. downwards

Conclusion and Future work

- Localized in both **time and scale** domain
- Find richer burstiness compared to WS and SiZer
- Useful for characterizing burstiness by combining SiZer
- Finding unusual behavior – structural breaks
- Defining alpha and beta traffic considering scale
- Finding changepoints
- Better interpretation of significant burstiness (e.g., trend)
- Define burstiness by wavelet coefficients