

Discussion of the 2014 Markov Lecture

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What's in a Traffic Model?



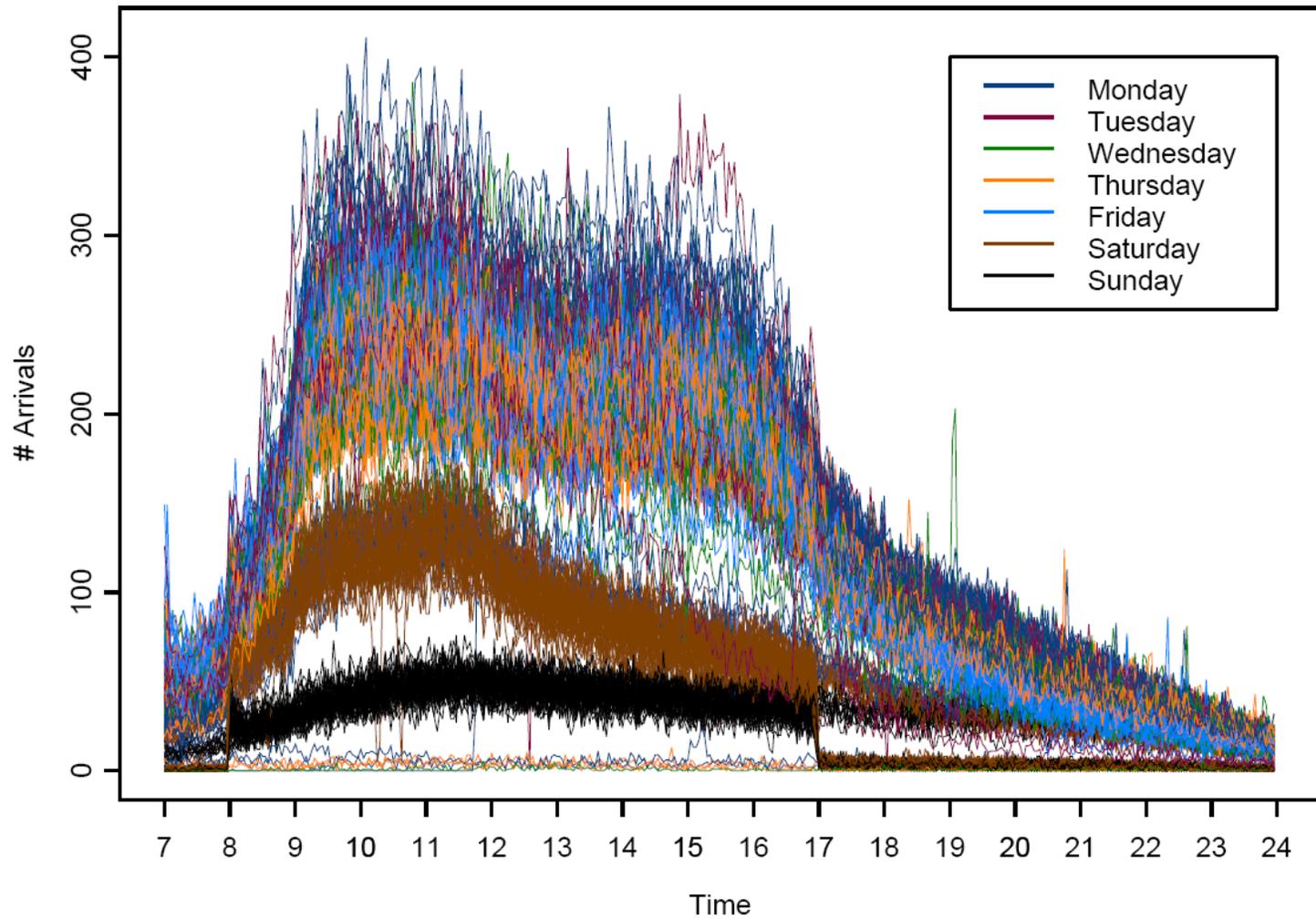
My First Traffic Model...

- AR(1) one of most widely used stochastic models

$$X_t = c + aX_{t-1} + Z_t$$

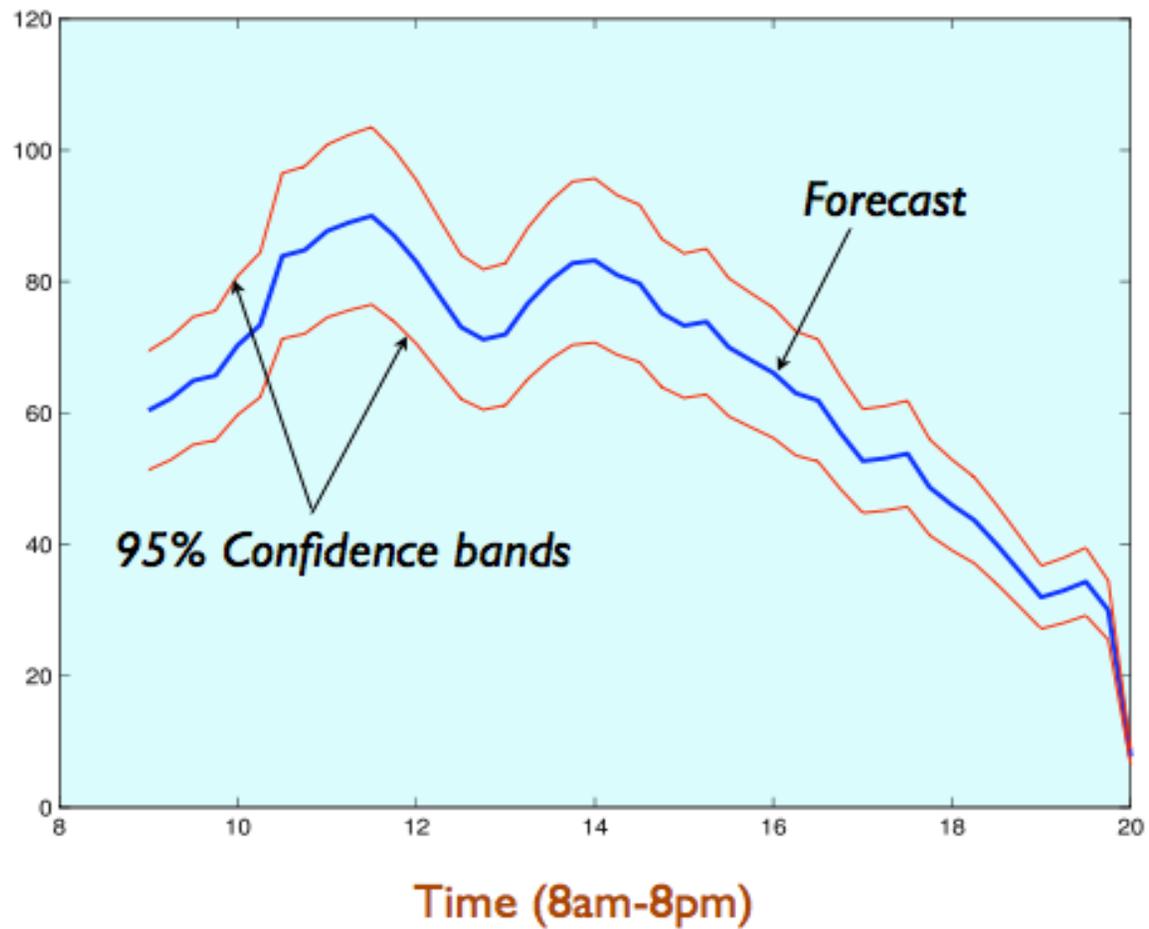
- If $|a| < 1$ is process always stable?

Modeling Traffic



A Closer Look

Arrival rate
calls/hr



Poisson?

Day	Mean no. of arriving calls	C.V. [empirical](%)	CV [Poisson] (%)
Mon	943	26.5	3.3
Tue	824	22.3	3.5
Wed	807	26.5	3.5
Thu	778	28.5	3.6
Fri	767	33.5	3.6
Sat	293	61.8	5.8
Sun	139	148.1	8.5



Variability versus Uncertainty

- Uncertainty dominates variability => coarse analysis ignoring CLT-type effects
- Variability dominates uncertainty => fine grain analysis w/ CLT-type corrections
- Relationship between coefficient of variation and function of offered load...



Atomistic User Behavior

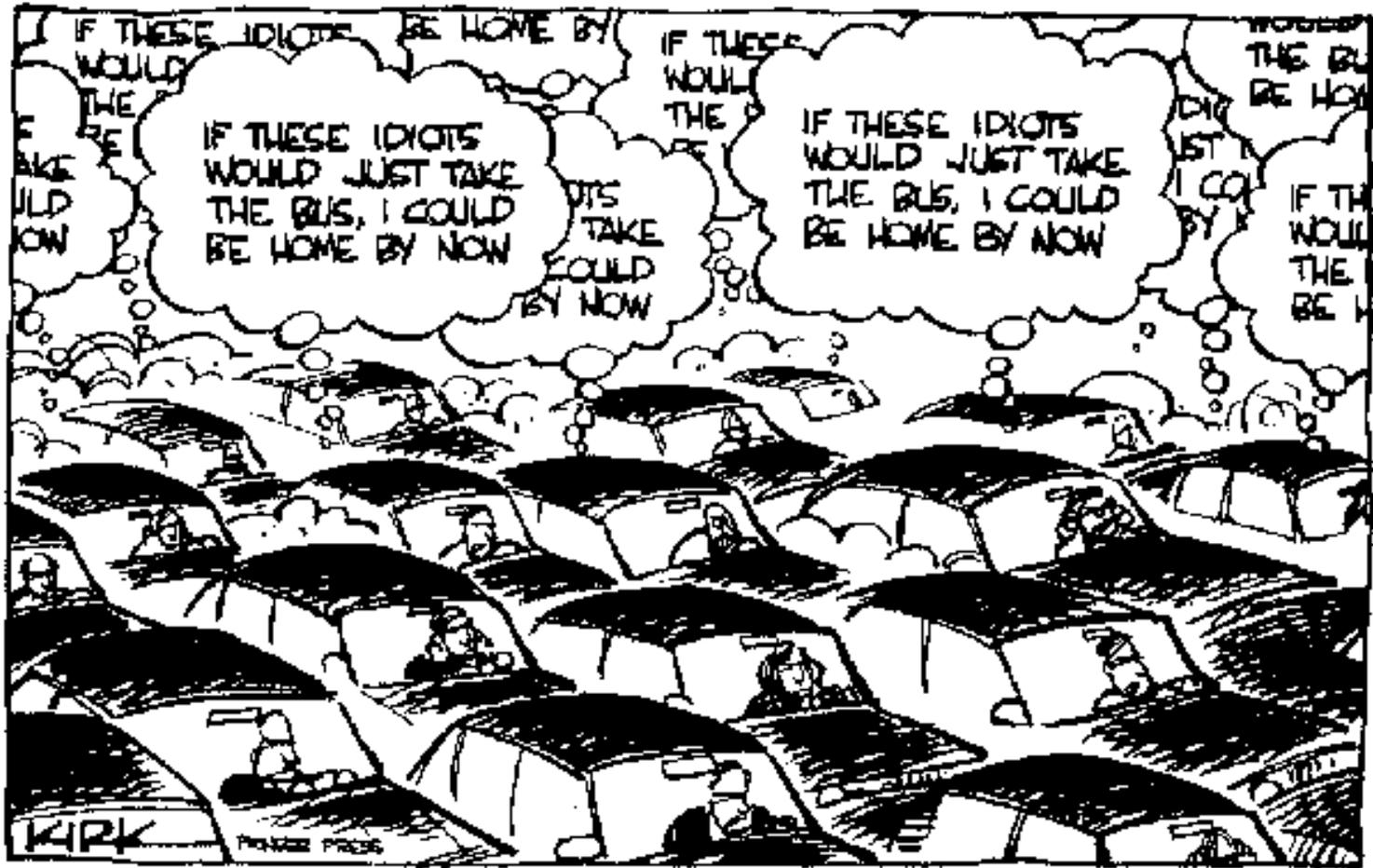
- Many instances of traffic involve atomistic users that seek to maximize their own utility...and make choices accordingly
- Gives rise to more complicated models that need to incorporate this behavior
- Original (and still classic) instances drawn from transportation networks



Important modeling primitives

- User choice (utility function)
- Feedback from system (congestion announcements, mobile GPS, feedback from other users etc)
- Pricing congestion externalities
- Traffic shaping...

“Price of Anarchy”



Queueing Questions

- Does ample capacity always lead to short delays?
- Delays can help force user “self selection”...
- What happens when users act strategically?
- Observational learning phenomena...

Queueing Questions (cont'd)

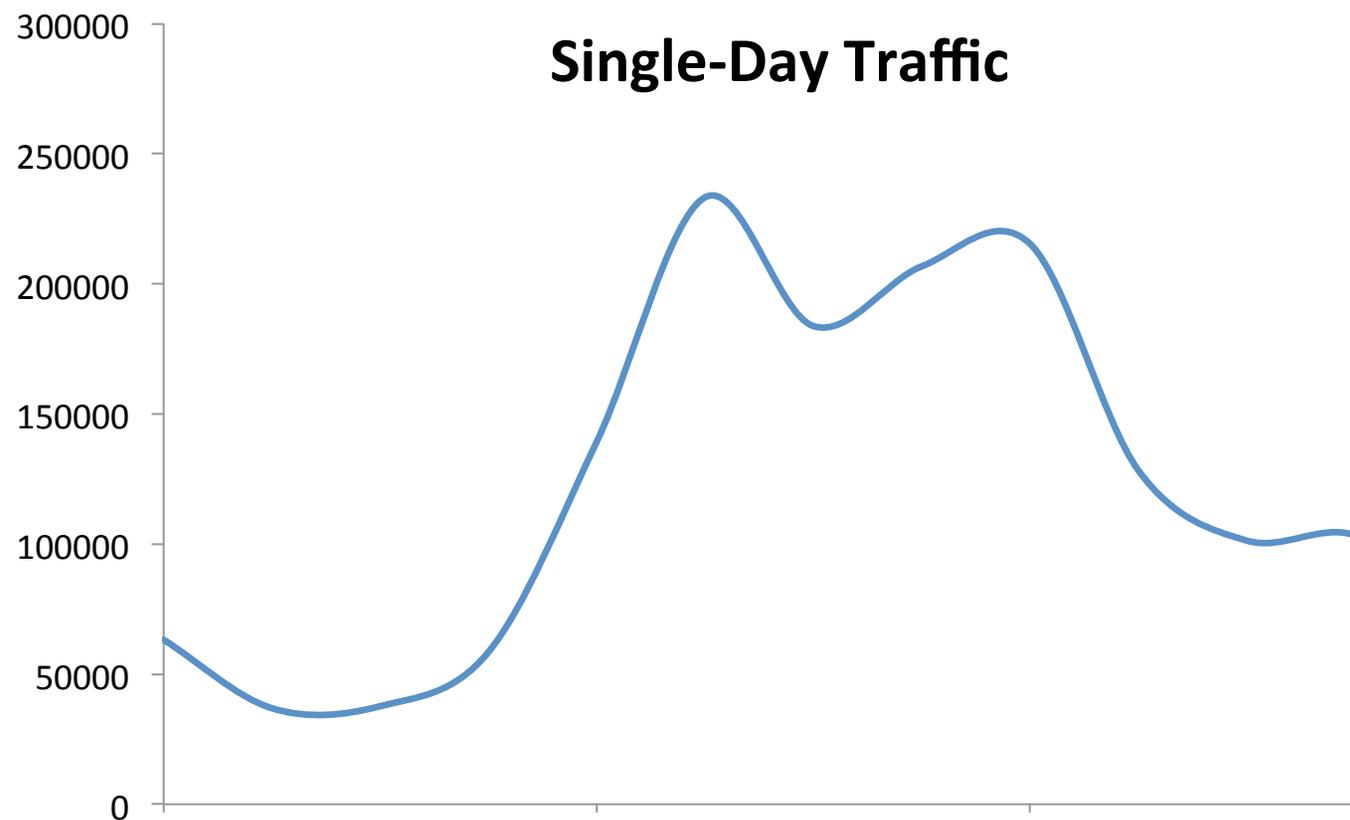
- What/how should congestion information be shared with users?
- Does truthful information sharing improve system-wide performance?
- Is a precise delay estimate announcement better (or worse) relative to “vaguer” information?
- **How do the above affect resulting traffic patterns?**



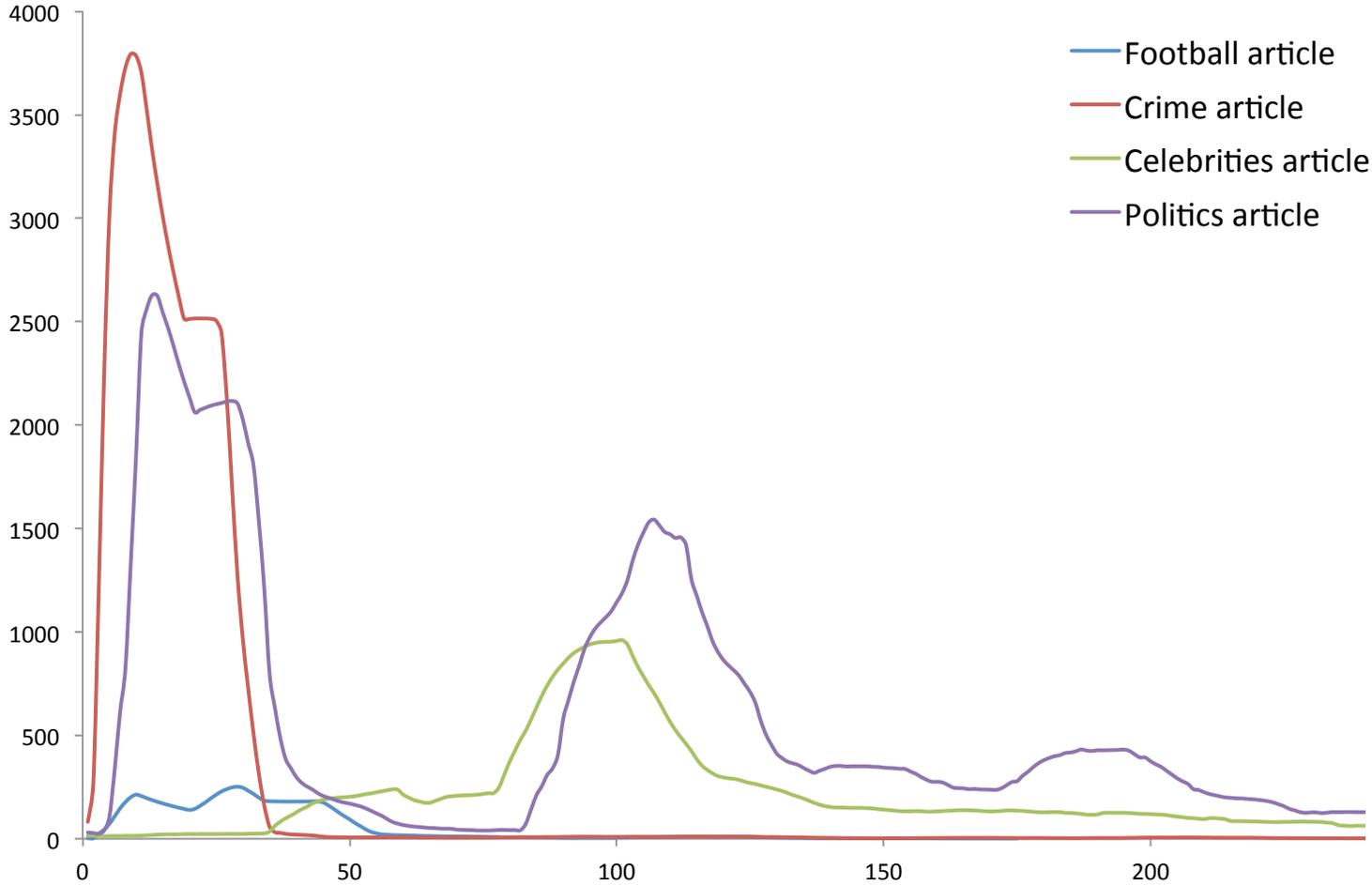
Content on the Internet

- Close to million new content pages a day
- How does this content behave in terms of user interest?

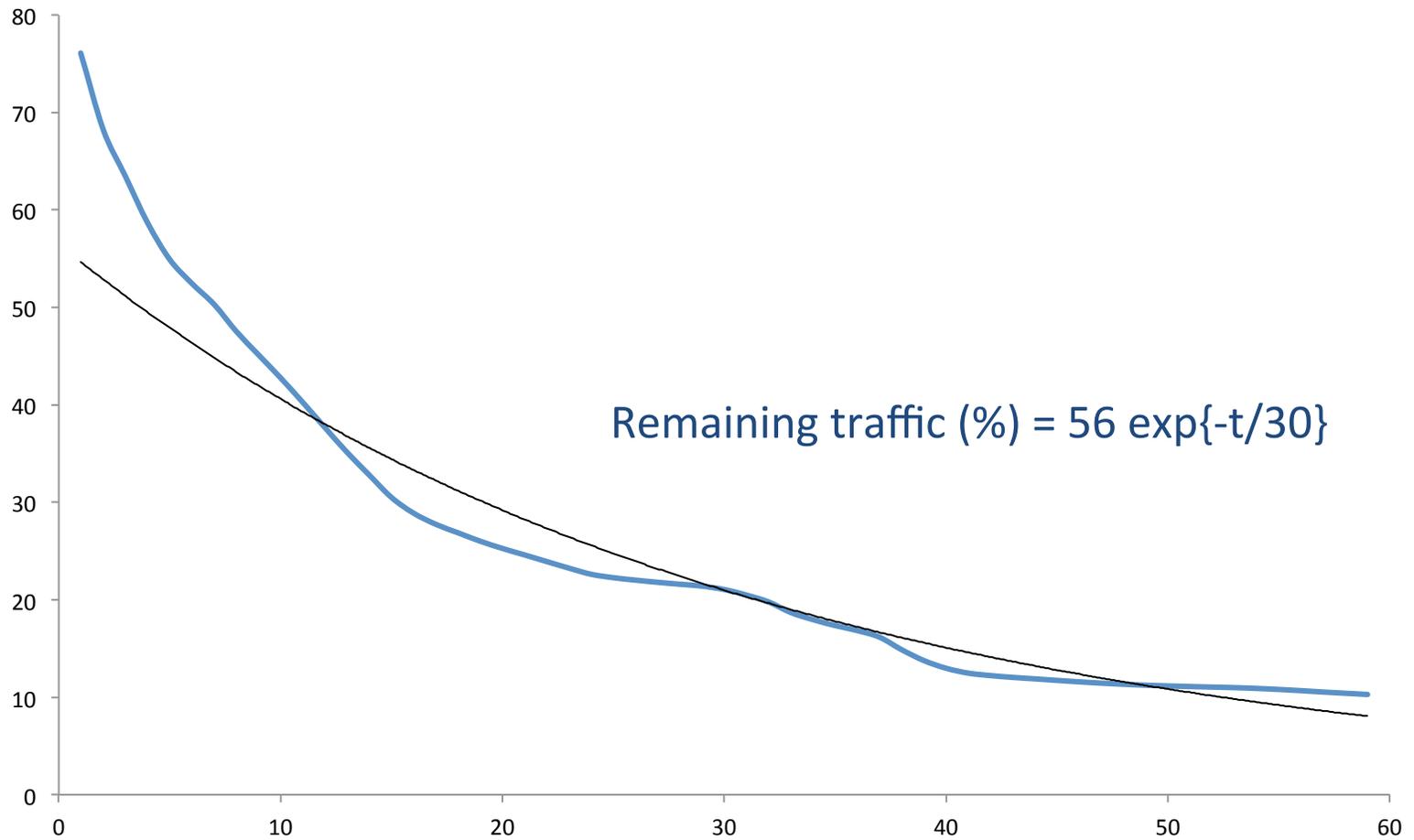
Aggregate Traffic Patterns



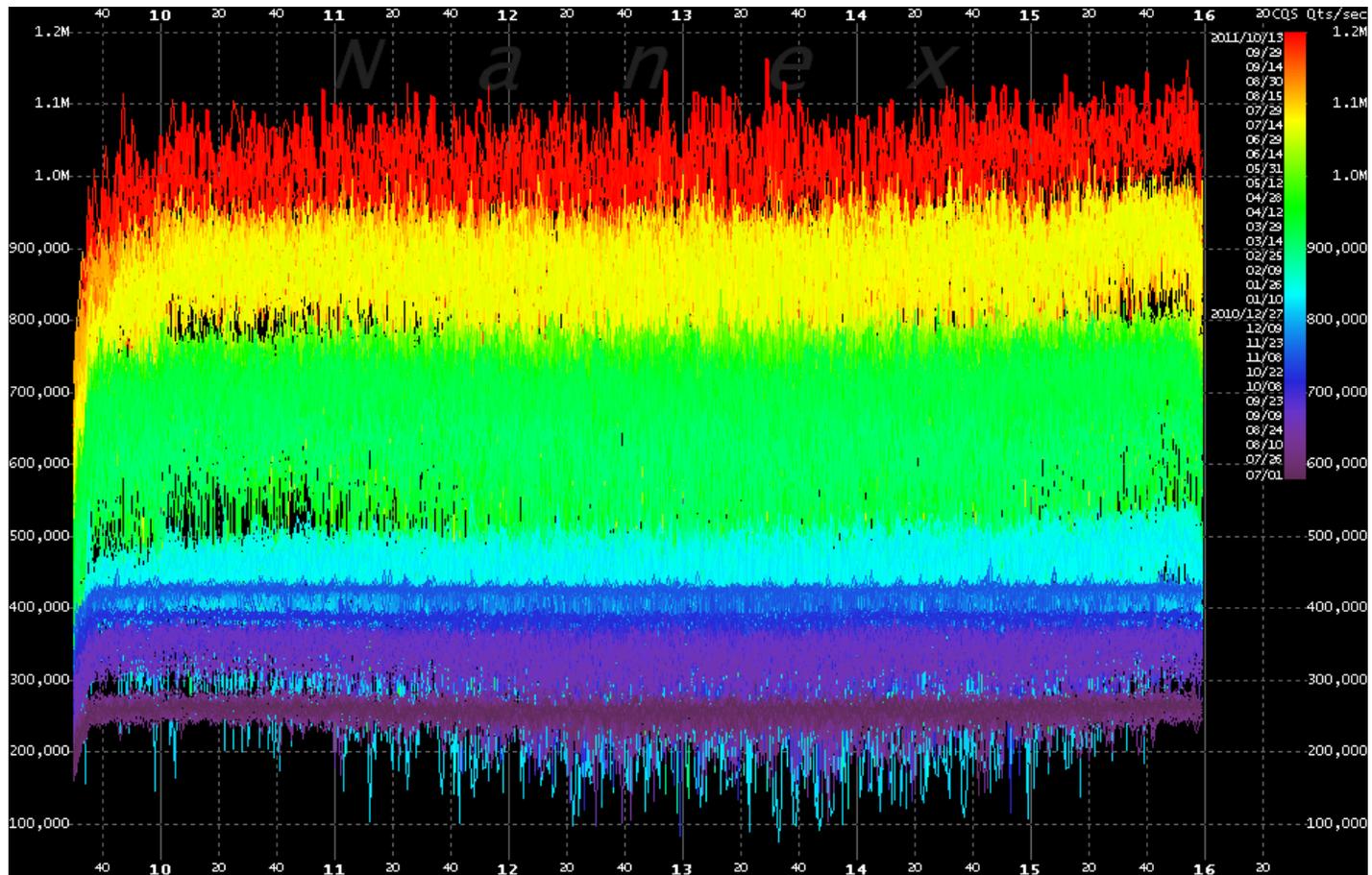
Temporal Interest Patterns



Aging Patterns



High Frequency Trading

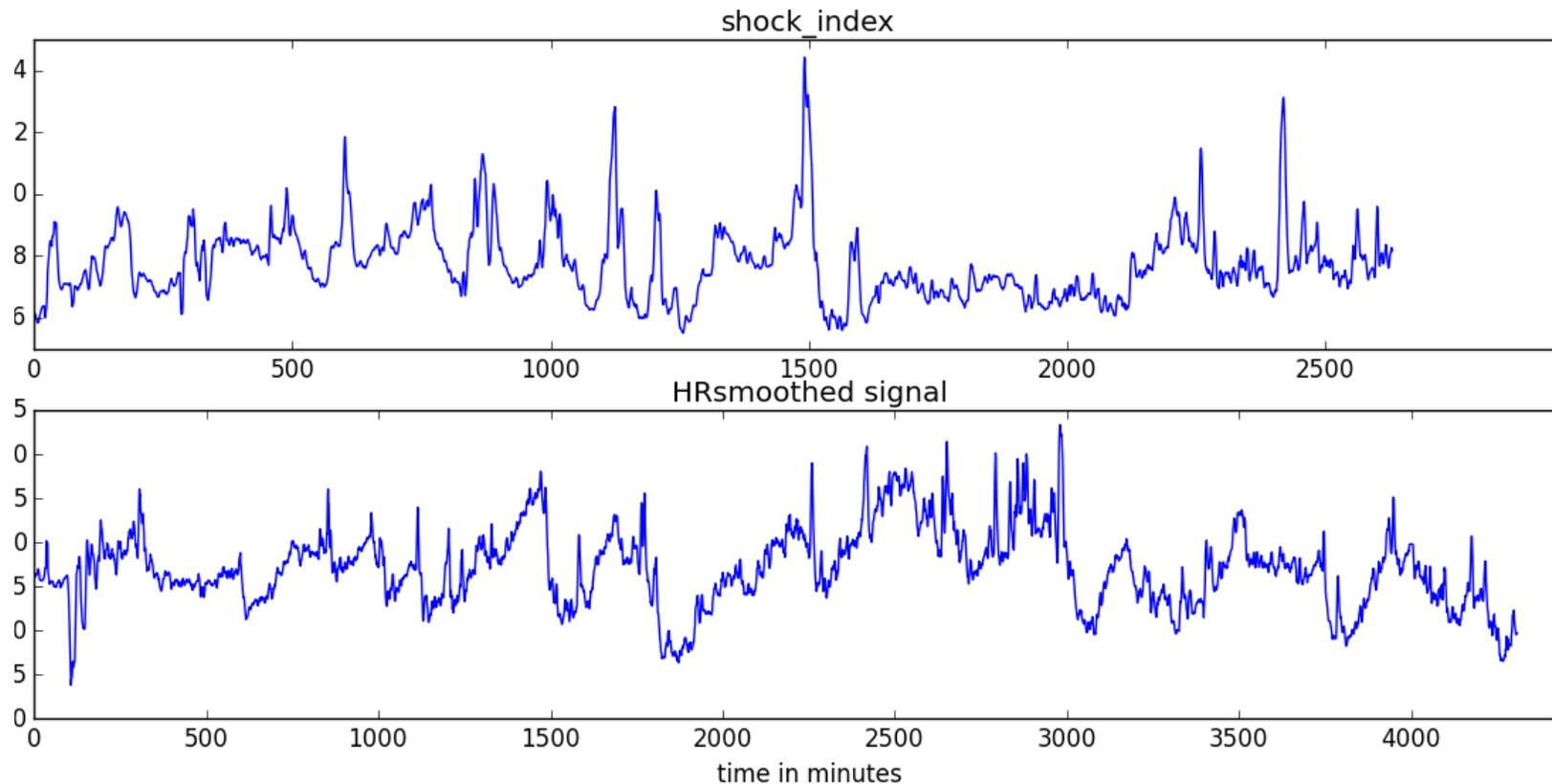




HFT (cont'd)

- How do capacity constraints affect trade dynamics?
- How does user strategic behavior impact traffic “peak” formations?
- Recent queueing theoretic models of limit order book dynamics and strategic execution patterns...

Modeling Patient Sensor Data





THANK YOU!

Boston Area Traffic Density

