# Time Bandits: Fractal Query Times

## Preview Version

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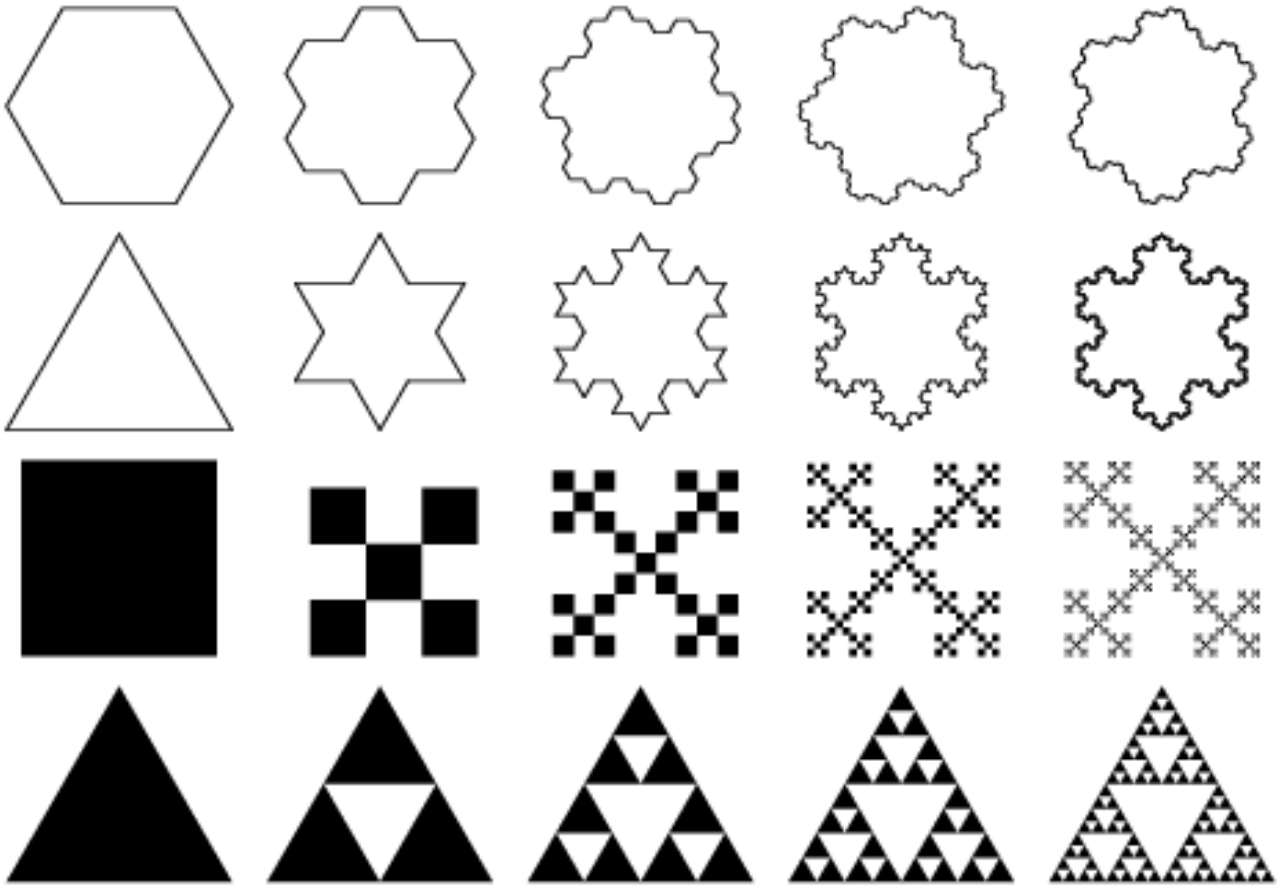
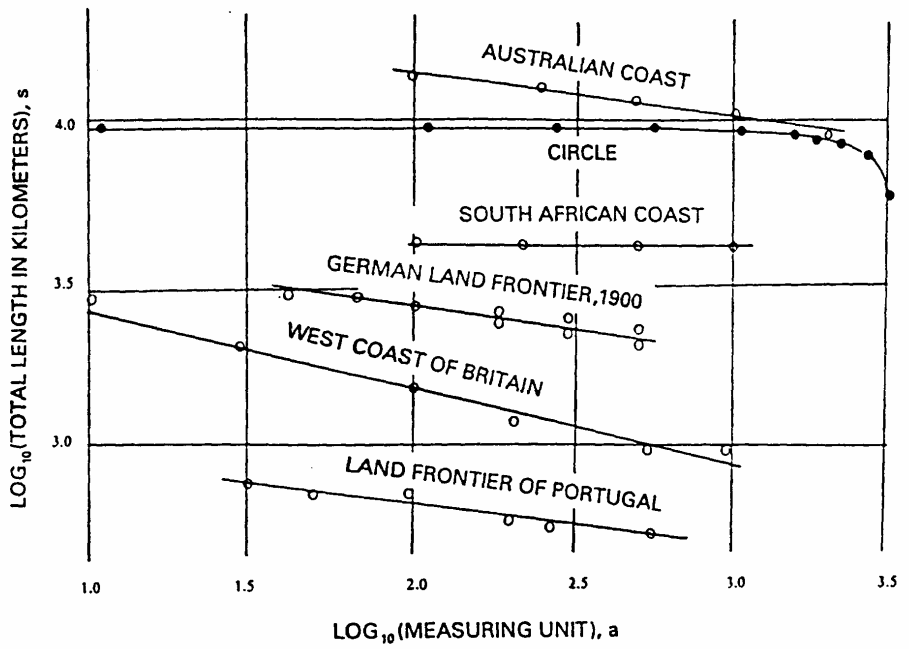
*Performance Dynamics*

**Hotsos Symposium**
Tuesday, March 6 @ 2:15 pm

# Fractals in Space



# Borders and War

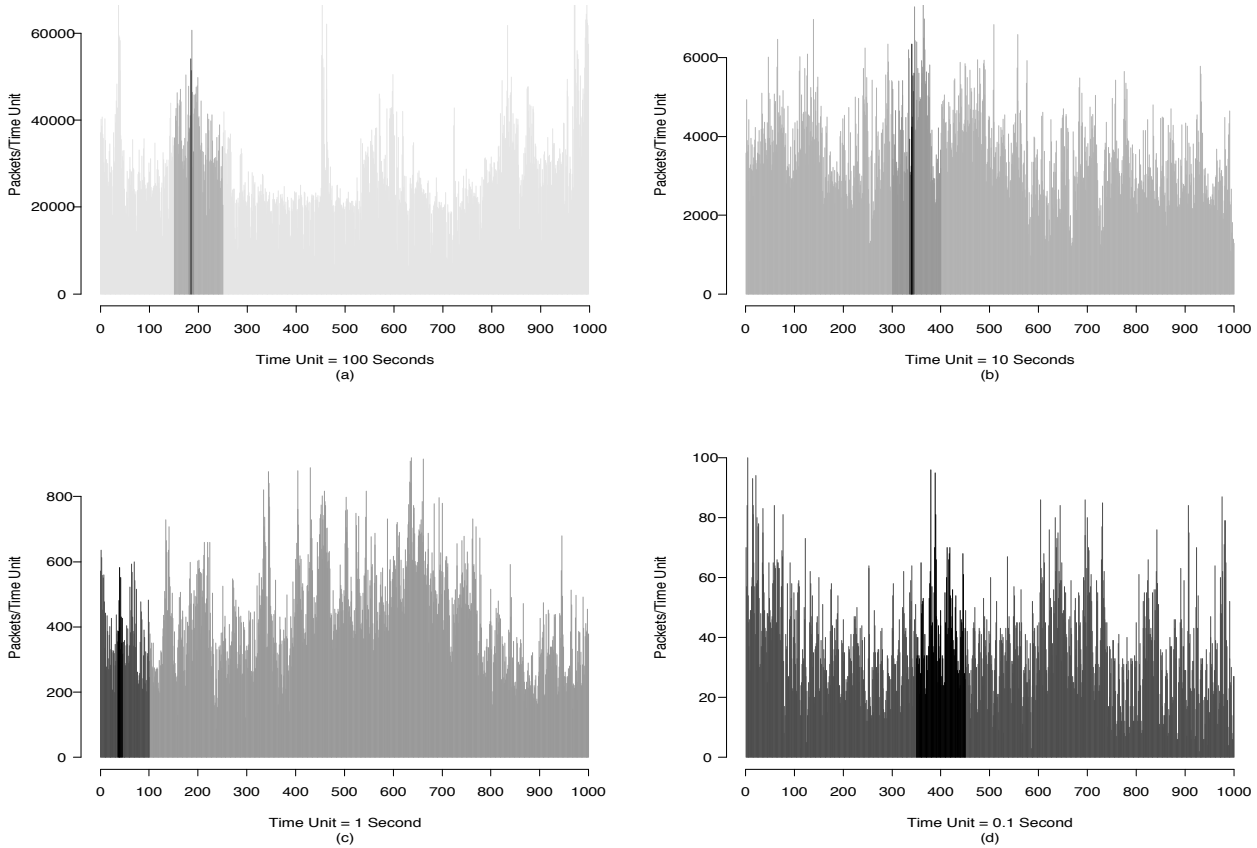



- The borders of countries are highly irregular shapes with very different lengths.
- Can't express these shapes using regular Euclidean geometry.
- Why do border lengths fall on **straight lines** in log-log plot?[1]
- Any crazy country shape is then characterized by one number: its slope!
- Reason remained obscure until Mandelbrot resurrected it as geometry of fractals[2]

[1] Lewis F. Richardson (1961) "The problem of contiguity: An appendix to Statistic of Deadly Quarrels."

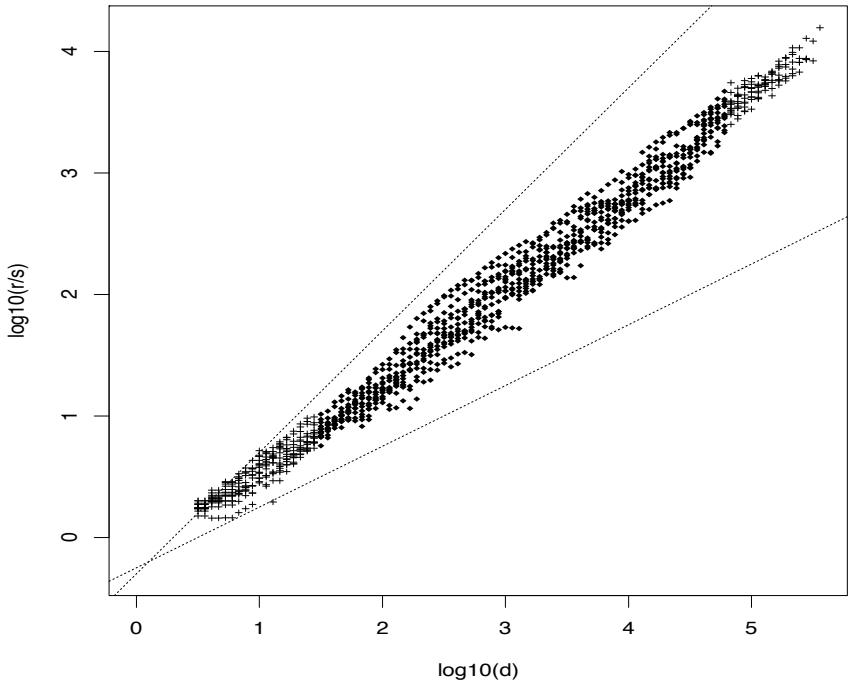
[2] B. Mandelbrot, The Fractal Geometry of Nature, W. H. Freeman, New York (1983)

# Fractals in Time




Internet packet traces in time.

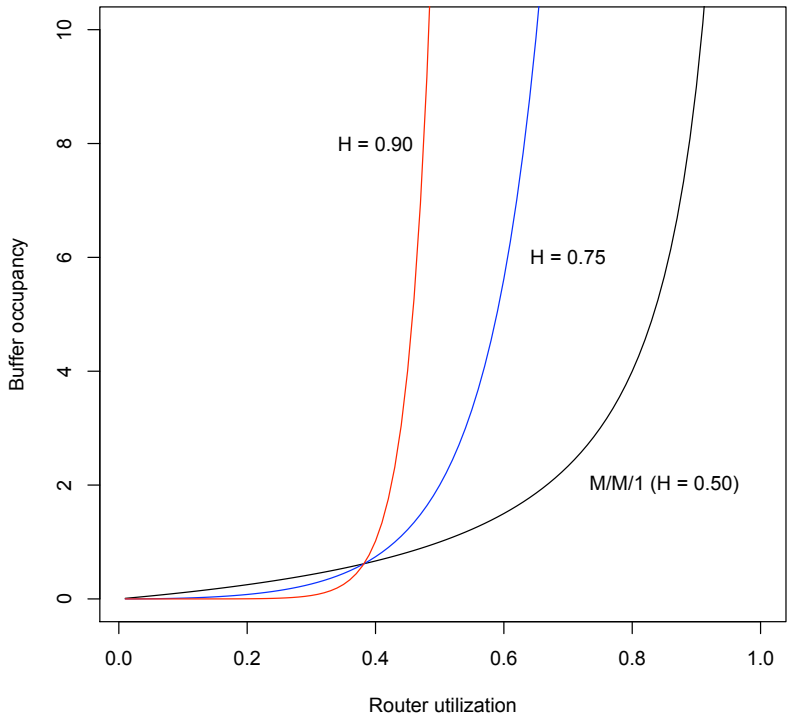
# Packet Data on Log-Log Axes




$Y = (max - min)/\text{std dev}$ (“rescaled range”)

$X =$ sample size (in trace file

# Buffer Overflow




- $Q$: queue length or buffer occupancy
- $\rho = \lambda S$: router utilization
- $H$: power law exponent (Hurst parameter)

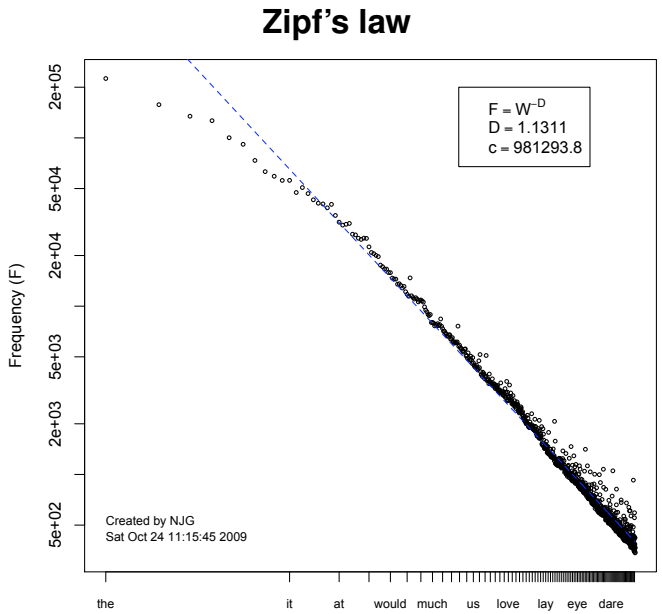
$$Q = \frac{\rho^{\frac{1}{2(1-H)}}}{(1-\rho)^{\frac{1}{1-H}}}$$

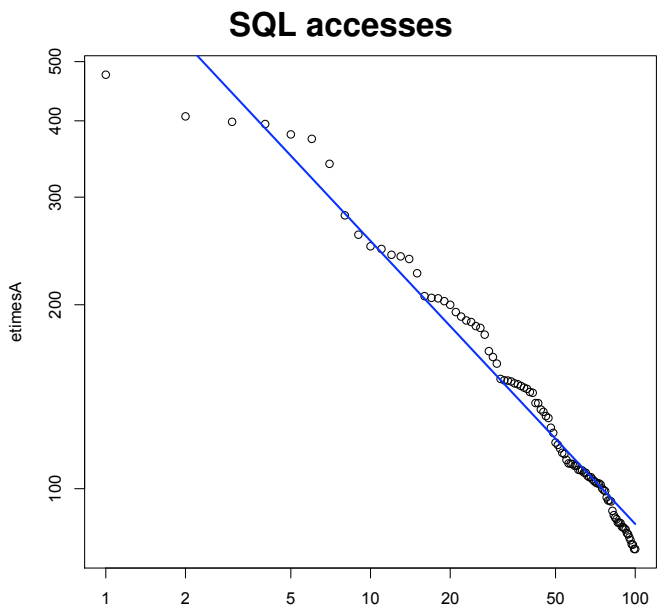
- $H = 0.5$ is identical to **M/M/1 queue**
- $H = 0.9$ Internet empirical Hurst exponent
- Buffer overflow can occur at lower loads

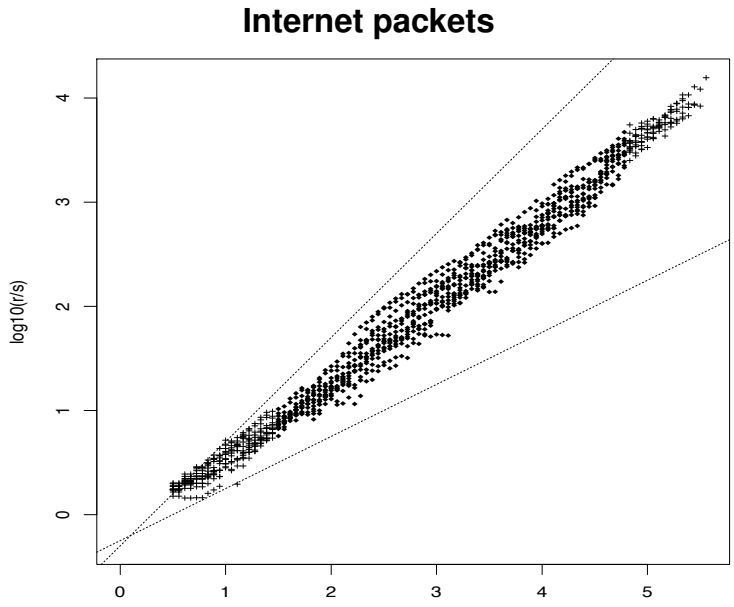
## Router model

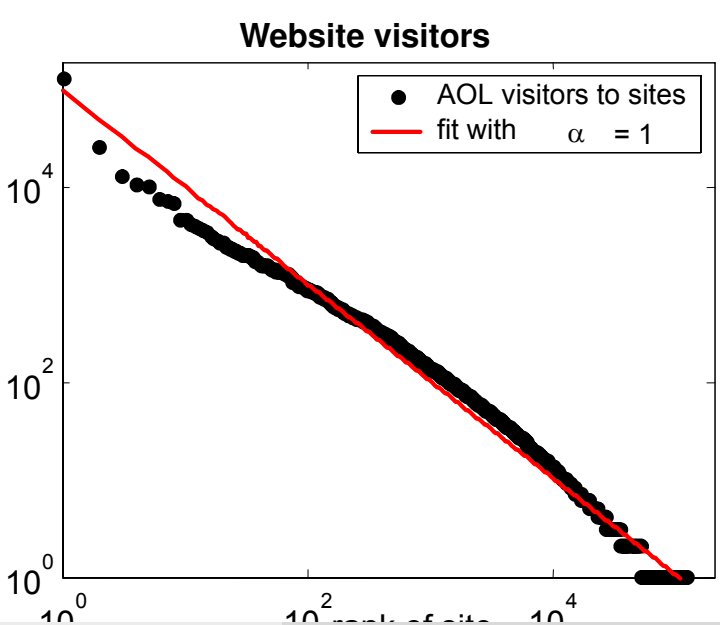
```
x<-c(1:100)
rho<-x/100
qlen<-function(r,H){r^(1/(2*(1-H))) / ((1-r)^(H/(1-H)))}
plot(rho,qlen(rho,0.5),type="l",xlab="Router utilization",ylab="Buffer occupancy",ylim=c(0,10))
lines(rho,qlen(rho,0.75),col="blue")
lines(rho,qlen(rho,0.90),col="red")
```

# Hidden Fractals



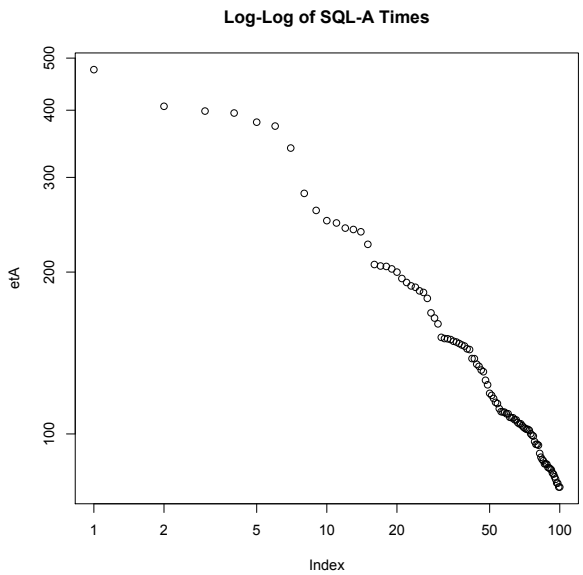



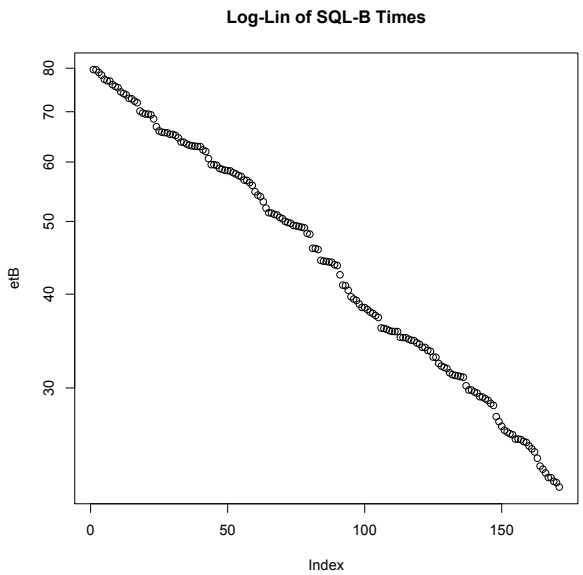
# Windowed SQL Query Regions

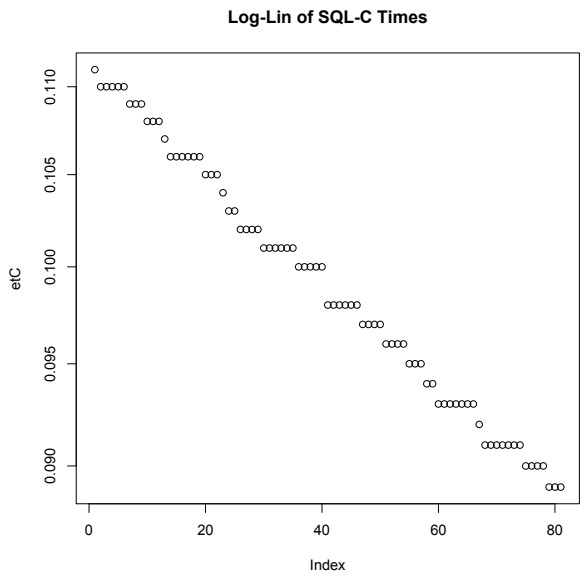
This suggests breaking data across 3 regions as follows:

## Windowed plots

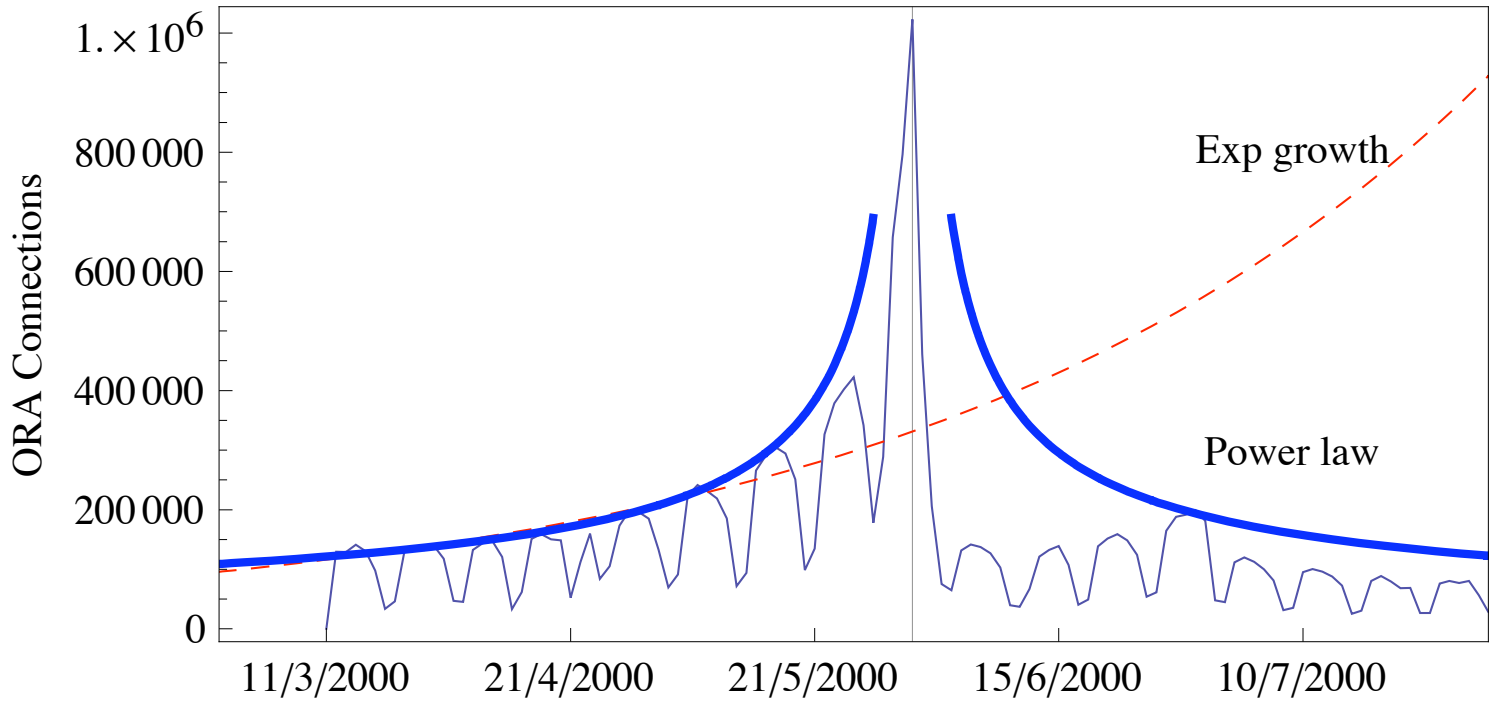
```
# Define data windows of ranked data
etA<-otr[1:100]
etB<-otr[100:270]
# gap...
etC<-otr[420:500]
plot(etA,type="p",log="xy",main="Log-Log of SQL-A Times")
plot(etB,type="p",log="y", main="Log-Lin of SQL-B Times")
plot(etC,type="p",log="y", main="Log-Lin of SQL-C Times")
```



# Oracle Data Models




- Exponential trend is consistent with data through April 2000
- Completely underestimates onset of the “11th hour” spike
- Completely overestimates decay of traffic load beyond spike
- Data is already exceeding Exp model during April-May period
- Fractal model predicts all these effects quite well
- Critical observation is inclusion of critical point $t_c = 31/5/2000$
- Use Exp model to baseline a fractal model
- “11th hour” spike explained by **social networking** correlations

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