

Telling Stories with
Time Series Data

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Why does temporal analysis work?

1. Only time tells stories
2. Taken's theory: The dynamics of the parts embed the dynamics of the whole

*Dynamics of (e.g.) $g(w, x, y, z) =$
Dyn. of $h\{w(t), w(t-K), w(t-2K), w(t-3K)\}$*

*Dyn. of $g(\text{ROA}(t), \text{R\&D intensity}(t), \text{patents}(t)) =$
Dyn. of $h(\text{ROA}(t), \text{ROA}(t-1), \text{ROA}(t-2))$*

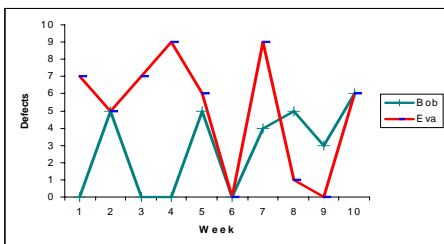


Think carefully about temporal variation

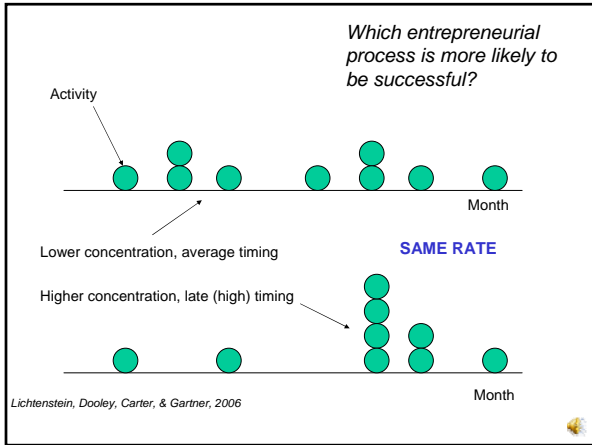
What to do?

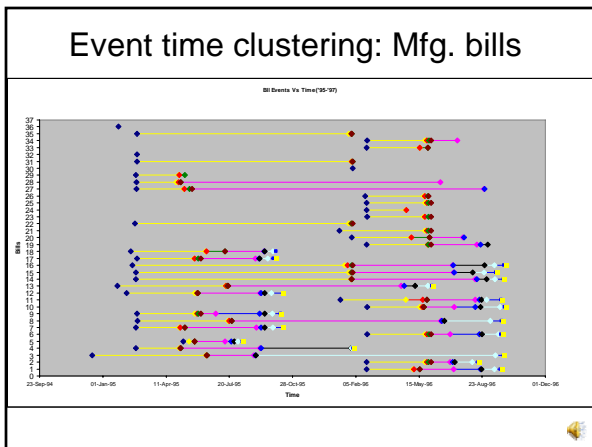
Employee	Week Number												TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	
Mary	7	0	0	2	9	1	1	5	7	4	8	4	48
Joe	6	2	1	3	6	1	7	9	5	3	5	1	49
Mike	1	2	2	4	3	7	9	9	8	8	2	6	61
Dick	4	0	7	2	5	5	5	3	4	5	7	8	55
Helen	7	5	5	3	4	3	8	2	0	8	2	0	47
Bob	0	1	0	5	0	0	5	0	4	5	3	6	29
Eva	9	3	7	5	7	9	6	0	9	1	0	6	62

- PLOT THE DATA
- ANALYZE THE DATA



Plot when events happen





Look for patterns of events over time, indicative of generative mechanisms

ebXML event sequences

Code
R—Requirements
S—Search
M—Model
D—Design
I—Internal review
E—External review

What story can you see?

Business process standard:

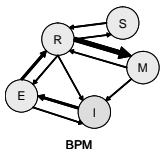
R—S—S—R—M—M—M—R—R—R—M—I—I—I—E—R—I—E—
R—E—E—E

Technical standard:

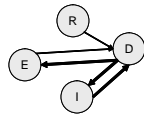
R—R—R—R—R—D—I—I—I—D—D—I—D—D—E—E—D—
D—E—E—E—E

Choi, Raghu, Vinze, & Dooley 2005

Process as generative



BPM



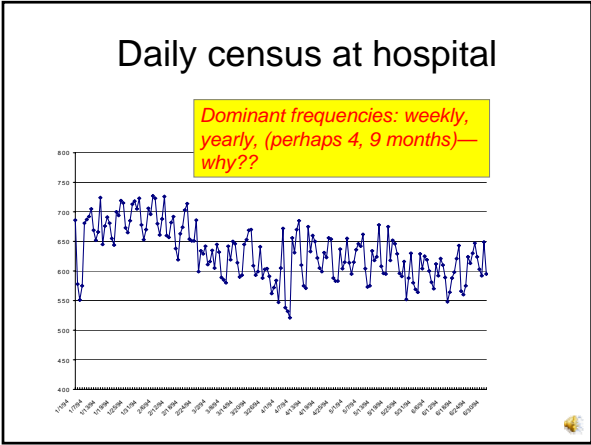
TRP

- Dominant closed path is "normative" (R-M-I-E).
- Requirements-centric
- Lots of transitivity
- No closed path
- Design-centric (hub)

AGILE

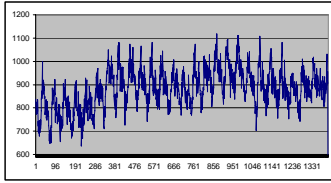
WATERFALL

Look for periodicities, a natural source of order



Look for colored noise, indicative of locally cascading processes

Periodicities & colored noise



Births to teenage mothers in Texas
Weekly totals, 1964-90

- periodicities: 7 days, 28 days, 1 year, 10 years
- after taking out periodicities, we find the "residuals" are "colored noise"

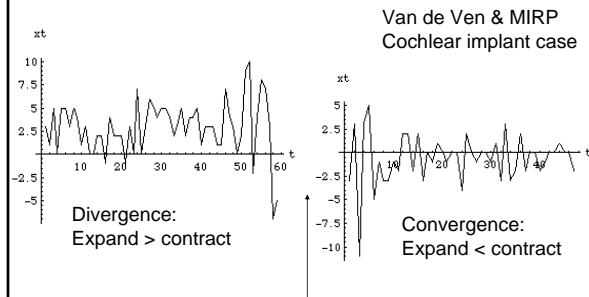
What's the story you would tell?



Look for change points and stages



Two stage innovation



Van de Ven & MIRP
Cochlear implant case

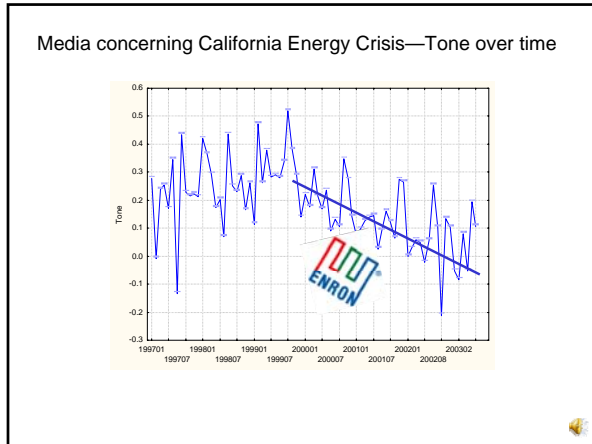
Divergence:
Expand > contract

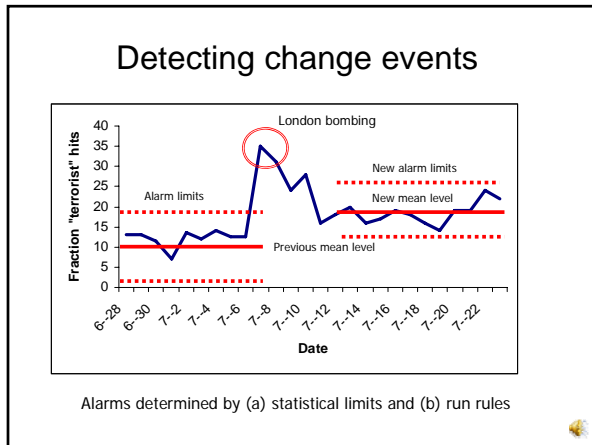
Convergence:
Expand < contract

Commercialization decision

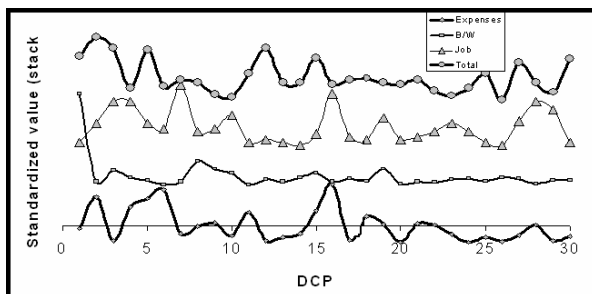


Chaos and Complexity





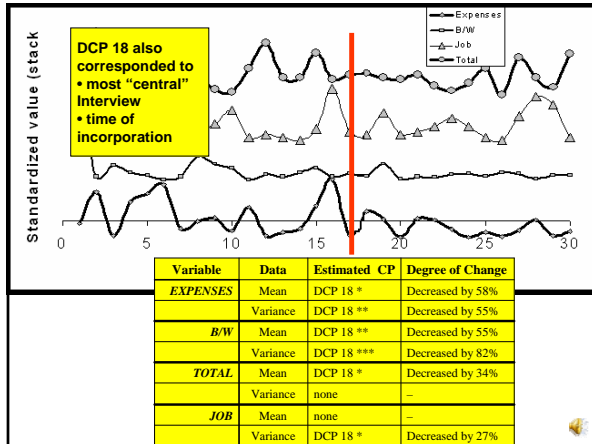
Alarms determined by (a) statistical limits and (b) run rules

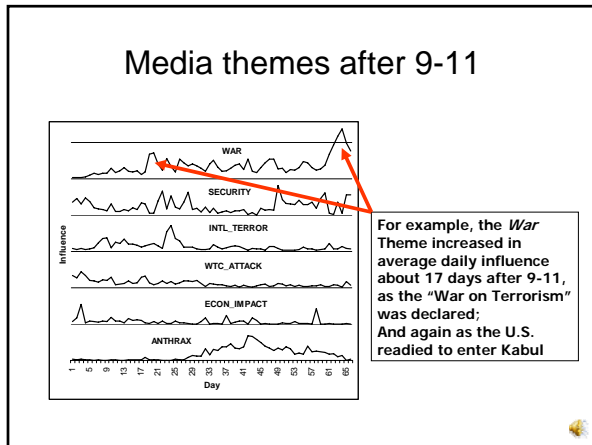


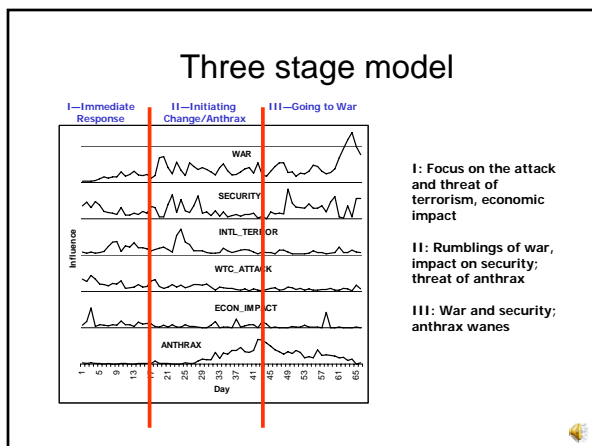
Where is/are the change point(s) in each series?
What story is told?

Lichtenstein, Dooley, & Lumpkin JBV 2006

Chaos and Complexity

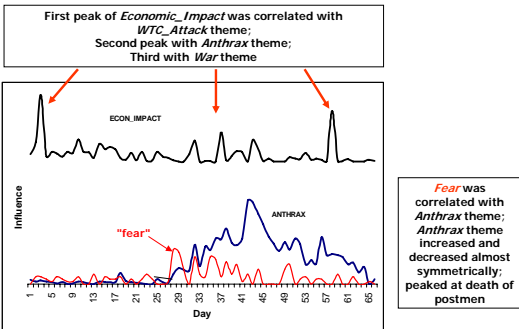






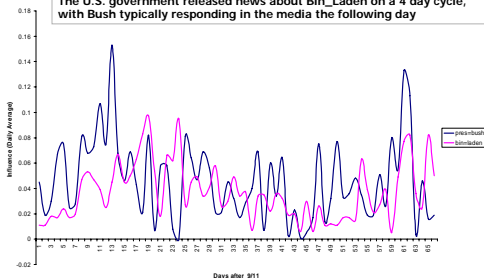
Correlate time series to find co-incidence and causation

Media themes after 9-11



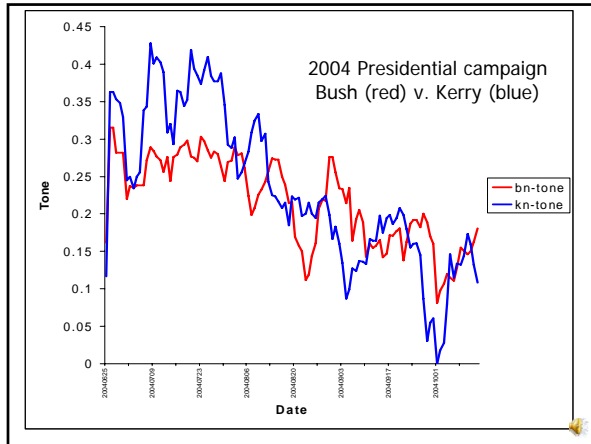
Lagged correlation indicates sequence and cause

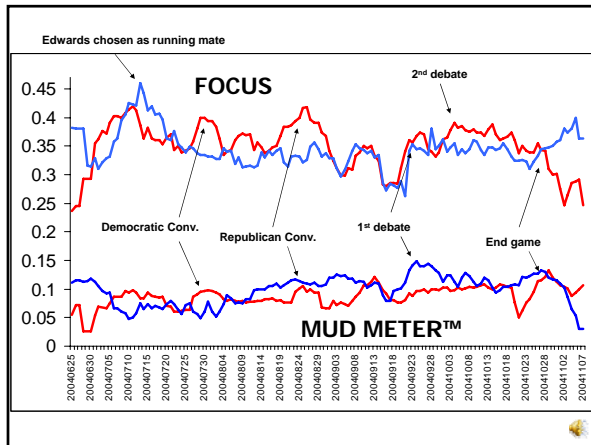
Facts:
(a) The Bin_Laden time series is cyclical with a periodicity of 4 days
(b) The Pres_Bush time series is correlated to the Bin_Laden series but at a one day lag
Possible conclusion:
The U.S. government released news about Bin_Laden on a 4 day cycle, with Bush typically responding in the media the following day

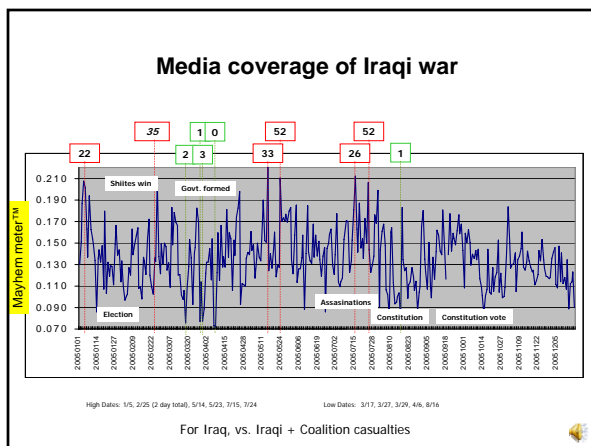


Source: Reuters newswire articles

Chaos and Complexity







Summary

- Think carefully about temporal variation
- Plot when events happen
- Look for patterns of events over time, indicative of generative mechanisms
- Look for periodicities, a natural source of order
- Look for change points and stages
- Correlate time series to look for co-incidence and causation