Five decades of modeling the dynamics of personality

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Dynamic models of personality
Organized by Chris Jackson and Markus Quirin
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Outline

Preliminaries

Elaborating the analogy

Using theory to model individuals

Conclusions

Overview

1. That people vary in their moment to moment states of feeling (A), doing (B), thinking (C), and wanting (D) (the ABCDs) is obvious. The patterning in their variation is what I call their temporal signature. It is not the average that is important, it is the pattern over time. It is their song.
2. To summarize a dynamic process by its average or even its density distribution is to say the Mozart Requiem varies around D. Even to say the Requiem is in the key of D major is to equate it with the Beatles' "We can work it out".
3. As I hope everyone will recognize, a person, like a musical composition, is far more than a density distribution. To study personality is to study temporal signatures.

Overview part 2

1. Dynamic models of behavior using differential equations were suggested by Atkinson and Birch (1970) their Dynamics of Action.
2. A fundamental concept was that states have inertia and that differences in the rates of change in these states are characteristics of individuals.
3. Basic measurements need to assess latency. choice, and persistence of the ABCDs. I will review some recent developments and present simulations using R code incorporating these early dynamic models with theories of learning such as Reinforcement Sensitivity Theory (Corr et al., 1995; Gray and McNaughton, 2000). e.g., (Brown, 2017; Revelle and Brown, 2019; Brown and Revelle, 2021)

A prior talk

1. Last year, at ISSID, I reviewed the 100 year history of the study of dynamic model: The study of dynamics is very old and yet very new. Although tempting, I will not repeat that talk. (Very much.)
2. In that talk, I reviewed Lewin's field theory (Lewin, 1951) where he wrote that to study behavior was to study its dynamics, for behavior was a change of state over time.
3. People's states changed in response to the self perceived situation, not the situation as defined by an observer (Lewin et al., 1935)
4. I also discussed Jack Atkinson and David Birch's development of the *Dynamics of Action* (Atkinson and Birch, 1970) which influenced me while I was in graduate school. (54 years ago).
5. The basic idea of the DOA was that motivational states had inertia and that situations were forces acting upon these states.

Modeling dynamics: Cues-Tendencies-Actions (CTA)

1. Inspired by the DOA, but concerned that it was not easily modeled, I developed the CTA model as a reparameterisation of the DOA that was perhaps easier to understand (Revelle, 1986).
2. A subsequent elaboration with David Condon (Revelle and Condon, 2015) showed that a dynamic model can be applied within people, across people, and groups of people.
3. We subsequently discussed the power of such a model in analogy to understanding how weather, climate, and climate change can all be seen as instances of the same fundamental process (Revelle and Condon, 2017).
4. We suggested the analogy that personality states are to personality traits as climate is to weather.
   - Climate is what you expect, weather is what you get
   - Personality traits are what you expect, personality states are what you get

Cattell's Data Box

1. Most talks about dynamics using EMA to study motivation states refer to Cattell (1946, 1966) "Data Box".
2. The original "Data Box" was merely a visual organization to categorize six ways of slicing up three dimensions of data;
    - Subjects
    - Measures
    - Time
3. Until the development of portable data collection systems (e.g., the smart phone), the study of multiple observations over time was discussed more than done.
4. Even with smart phones, the number of observations is relatively limited.

Multiple ways of describing individual differences

1. The raw data – (completely idiographic)
2. Central Tendency (means or medians) – completelely nomothetic
3. Central tendency plus range (means $\pm$ standard deviation)
4. Density distributions (violin plots) (but ignores dynamics)
5. Over time (shows dynamics)
   - Pooled across individuals (hides the individual dynamics)
   - Within individuals – but how to account for differences in patterns
6. Theory comes from explaining/modeling the individual differences.

An example data set

1. An example data set to show dynamics and to discuss theory testing
2. Identified 87 major cites around the world and scraped a web based depository of weather data.
3. Why Weather?
   - Relatively known phenomena showing dynamic properties
   - Nice example of how simple idiographic or nomothetic approaches do not work
4. Downloaded to R for the following analysis
5. 63K + data points – how should we analyze them?

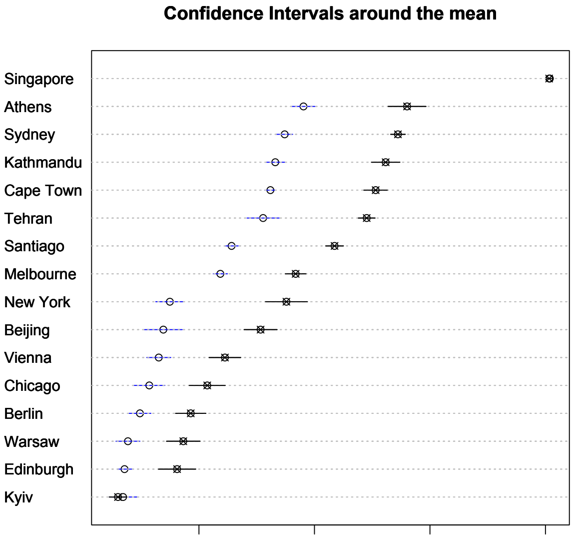
Basic statistics, not very informative

	vars	n	mean	sd	median	trimmed	mad	min	max
temp_max	1	63597	22.77	9.98	24.30	23.43	9.93	-27.40	50.50
temp_min	2	63597	13.89	9.41	14.40	14.48	10.67	-41.30	34.60
temp_mean	3	63597	18.07	9.46	19.00	18.70	10.38	-32.60	43.30
wind	4	63597	18.38	7.39	17.30	17.72	6.82	1.80	76.00
precip	5	63597	2.96	7.16	0.10	1.26	0.15	0.00	176.80
prcip_hours	6	63597	3.94	5.46	1.00	2.84	1.48	0.00	24.00
daylight	7	63597	43858.80	7110.49	43693.71	43802.27	6087.57	20880.55	68213.48
sunshine	8	63597	33163.90	13651.13	36949.89	34794.96	9266.41	0.00	64847.53

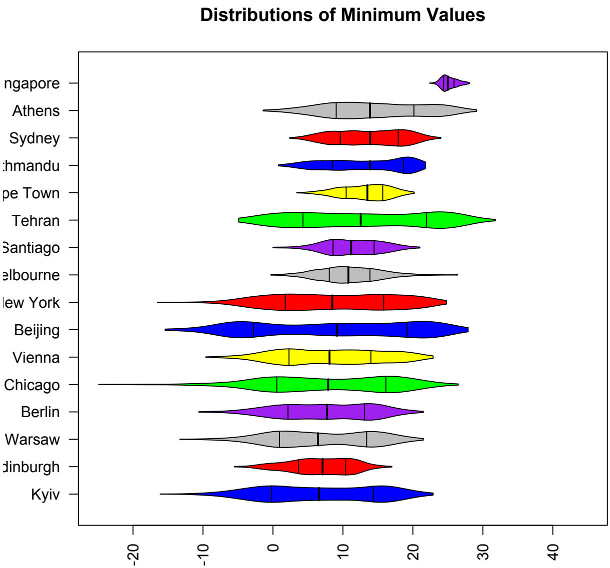
Scatter plot of five variables- also not very informative

Graphic not included for speed

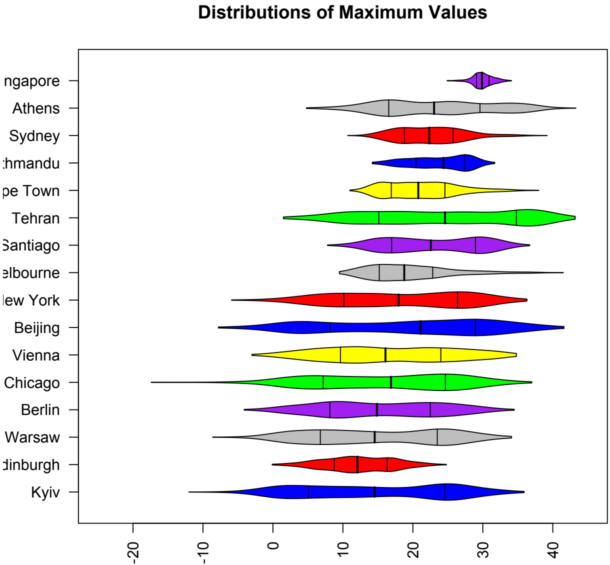
Mean high/low temperatures for 16 cities N=731 with standard errors



Violins show distributions



Violins show distributions

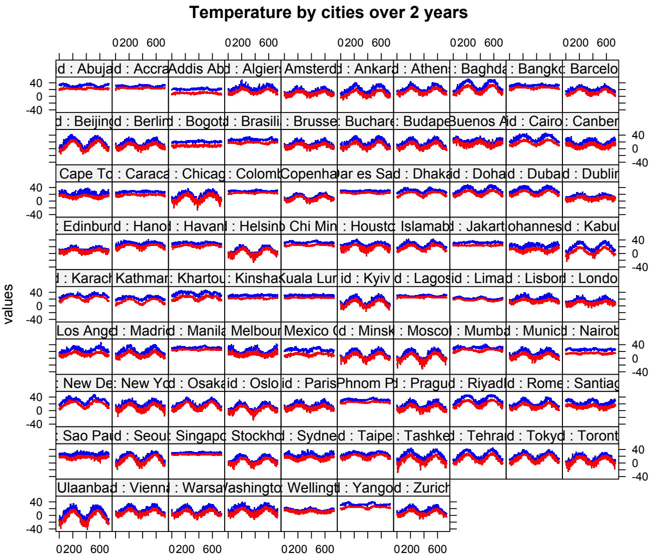


To understand the data, we need to consider dynamic patterning.

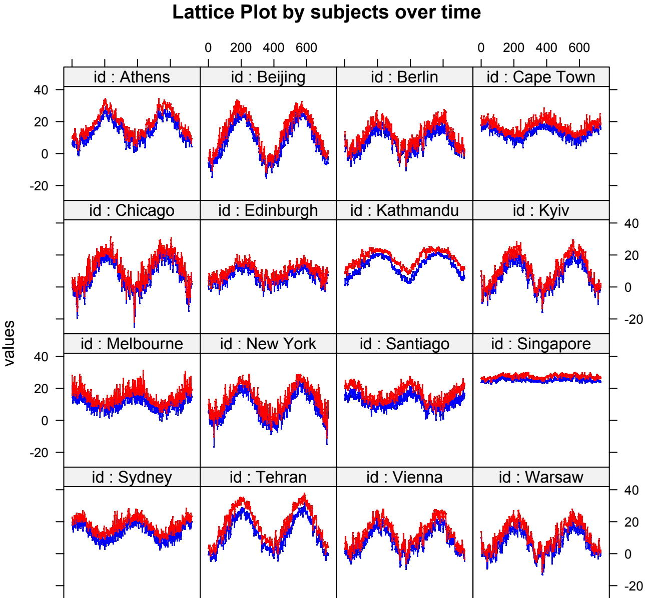
1. Density distributions are hiding some very important information
2. Plotting the data over time is necessary to consider the dynamics.
3. How do we explain differences between patterns?

Using weather data to understand theory testing

1. Consider the weather data from 87 cities across 2 years



16 cities show different seasonal/yearly patterns



A theory of dynamic processes

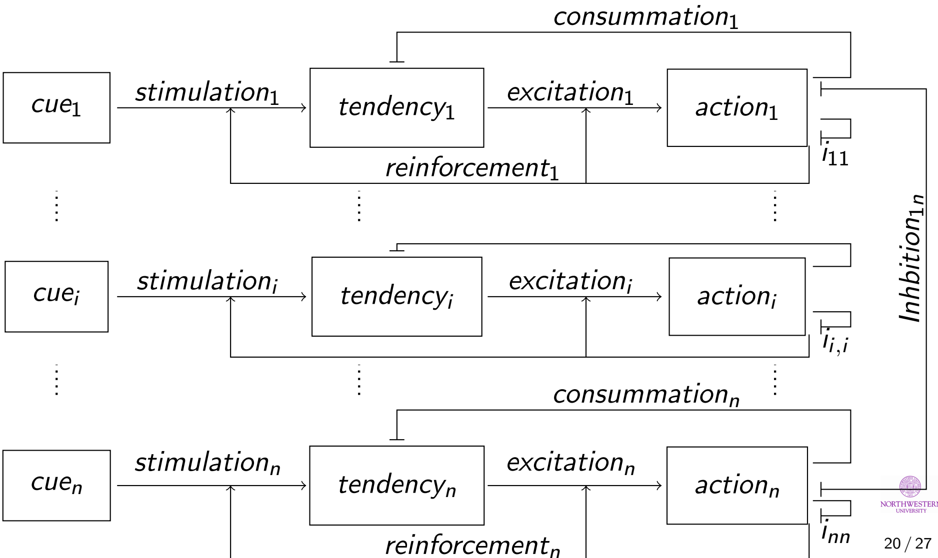
1. Each individual city shows a unique pattern of dynamics.
2. If we were to try to model just one city, we would not understand basic between city processes.
3. We would also not understand the importance of some of the parameters of the dynamics.
4. Can we think about individuals in motivational systems as another example of dynamics
5. Let try the Cues-Tendency-Action (CTA) model (Revelle and Condon, 2015) as an exanple.

CTA as a simple but general model

1. The basic model: dt = Sc - Ca dA = Et -Ia
2. For People:
   - Three vectors: the situational cues, the tendencies, the actions
   - Four matrices of interconnections: stimulation, excitation, consummation, reinforcement
3. for Climate
   - Energy inputs (solar radiation) (varies by latitude and season)
   - Transient states (weather)
   - Energy loss (re-radiation) varies by transparency of atmosphere to infra-red
4. The model is dynamic but does not require a set point

CTA as a simple but general model

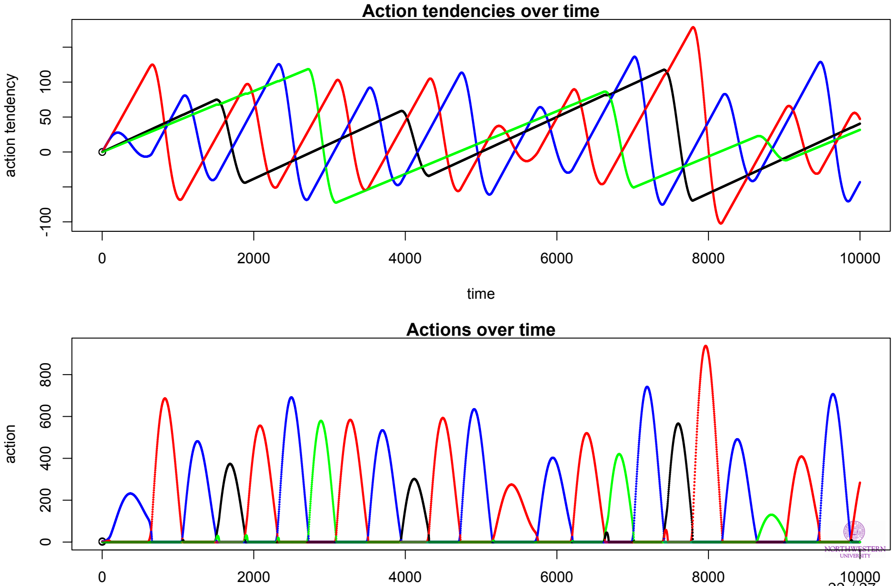
$dt = Sc - Ca$ $dA = Et - Ia$



Consider four people in a conversation

1. 2 introverted people who find the stimulus value of talking to be low
2. 2 extraverted people who find the stimulus value of talking to be high
3. CTA model suggests that people are polite and take turns

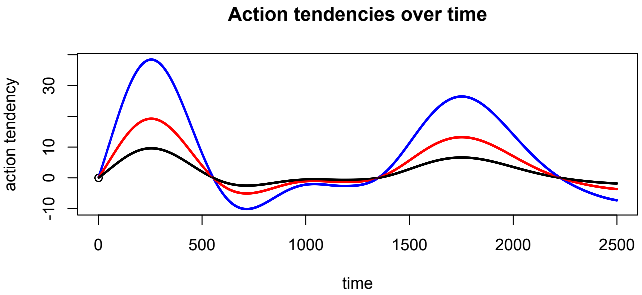
Simulation of four individuals in a conversation

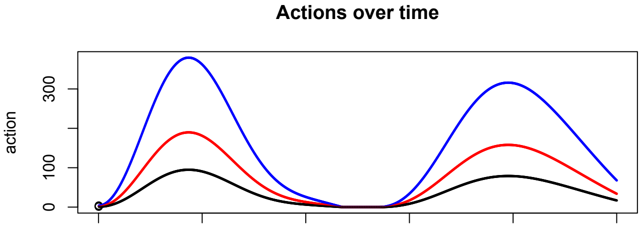


Consider the dynamics of weather

1. A dynamic system reflect the balance between various drivers, and does not need a set point.
2. Although part of the dynamics can be modeled at the idiographic level, some of the parameters are detectable only nomothetically.
3.
    - Stimulus input is amount of daily sunshine (varies as cosine curve over year)
    - Varies as function of abs(latitude) as well as the albedo due to ice and clouds.
4. Consummation is amount of daily heat loss (infra-red radiation) (varies as amount of CO_2 in atmosphere).
5. Inertia reflects proximity to large bodies of water.

Three simulated cites as examples of different amount of inertia





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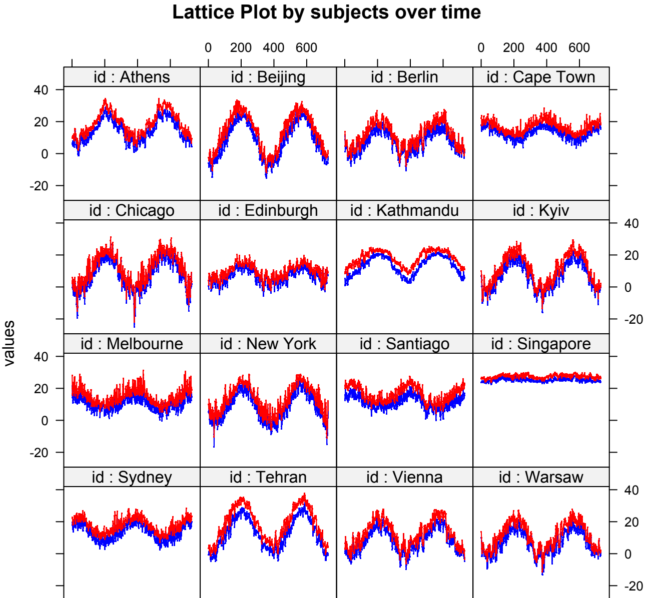

Summary and Conclusions

1. We already know examples of dynamics and deal with them every day.
2. Trait differences between people are like climate differences between cities.
3. State differences within people or across people are like daily differences in weather
4. Predicting human behavior is more complicated than predicting the weather, but the math is analogous.
5. As we suggested (Revelle and Condon, 2017), we can generalize this model to personality development, for just as climate change varies by increases in CO_2, so do people change their dynamic parameters with age.
6. We need to study the basic models of dynamics to understand personality.

Thank you– questions?

1. Questions
2. Comments
3. Slides for this talk and the ISSID talk last year are available at
4. https://personality-project.org/revelle/presentations/issid.dynamics.25.pdf
5. https://personality-project.org/revelle/presentations/ecp.26.pdf

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