Project Documentation

CONTROLLING CHAOS

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Abstract:

The extreme sensitivity and complex behavior that characterizes chaotic mental states prohibit precise prediction of their behavior, yet allow one to estimate the relationship among several variables using the strength of data and regression analysis. Through a multiple regression techniques, one can build a simplified model of stimulus and response behavior, and give hope to control chaos through informed and targeted medical treatment.

1. INTRODUCTION OF THE PROBLEM

Scientists in many fields are recognizing that the systems that they study often exhibit a time evolution known as chaos. Its hallmark is wild, unpredictable behavior, a state often perplexing and unwelcoming to those who encounter it. Indeed, this highly structured and deterministic phenomenon was in the past frequently mistaken for noise and viewed as something to be avoided altogether. This is because small differences in initial conditions (such as those due to rounding errors in numerical computations) eventually yield wildly diverging outcomes, rending long-term prediction impossible in general – even though these systems are deterministic in nature, i.e. their future behavior is fully determined by their initial conditions.

However, although mathematics can't predict the future, not everything comes down to chance. We have no better way to understand the deterministic chaos than through math. The only way to make them visible and manageable is by using mathematical models and probabilistic methods. We can develop a probability model that works out certain behavioral dynamics. That alone, is useful information.

2. DATA COLLECTION AND METHODOLOGY

Through a personal relationship, I had the opportunity of collecting daily raw data over a period of approximately one year, on a close friend's mental state, which could best be described as wild, unruly swings and unexplained, hard-to-understand perception on the reality. My data collection focused on unbiased collection of several pieces of information, including hours of sleep, reading time, mental reorganization time, entertainment time, quality of food intake, social contact mass (with subject's support network), and finally, the degree of inner conflict of the subject has with the aggressor in the past (denoted "aggressor metric"). My goal was to attempt to discover the correlation between these factors and their impact, if any, on the subject's sense of well-being of that day. Ultimately, I attempted to develop a regression model that explains the seeming chaos, and hopefully with this knowledge, to assist the associated medical professionals in controlling the chaos.

After adjusting for incomplete data (due to subject's extreme un-wellness on those particular days), I used techniques of multiple regression to attempt to identify the most significant factors to the subject's mental well-being. Four factors (hours of sleep, quality of food intake, reading hours, and aggressor metric) were eventually selected. The selection was based on subject's own description of each mental health crisis, and on the strength of correlation based on the scatter plots of battle metric (defined as the subject's mental well-being) and the afore-mentioned factors. To facilitate mathematical analysis, several "quanta", (i.e. specified values at discrete jumps), were assigned to the qualitative categories of quality of food intake, battle matrix and aggressor metric. For example, there are 3 discrete quanta (i.e. numerical categories) for quality of food intake: 1, 2, and 3, corresponding to good, fair, and poor, respectively. Similarly, there are 6 quanta for battle metric (i.e. the subject's mental stress level), with 0 being the lowest, and 3 being the highest, which corresponds to a full-blown mental health crisis.

3. ANALYSIS

By methods of multivariable regressions and analysis of variances, I have conjectured that the fitted regression hyperplane has the following form:

$$\gamma = 0.3270469 - 0.03679 \cdot X_1 + 0.6810995 \cdot X_2 + 0.0296308 \cdot X_3 + 0.0029501 \cdot X_4,$$

where X_1 denotes hours of sleep

X_2 denotes aggressor metric

X_3 denotes quality of food

X_4 denotes social contact mass

On closer inspection, we observe that this regression surface can be collapsed to a one-dimensional regression line, given that R_2 of the full model (with variable X_1, X_2, X_3, X_4) of 0.6959, and that R_2 of the reduced model (with variable X_1) of 0.6840.

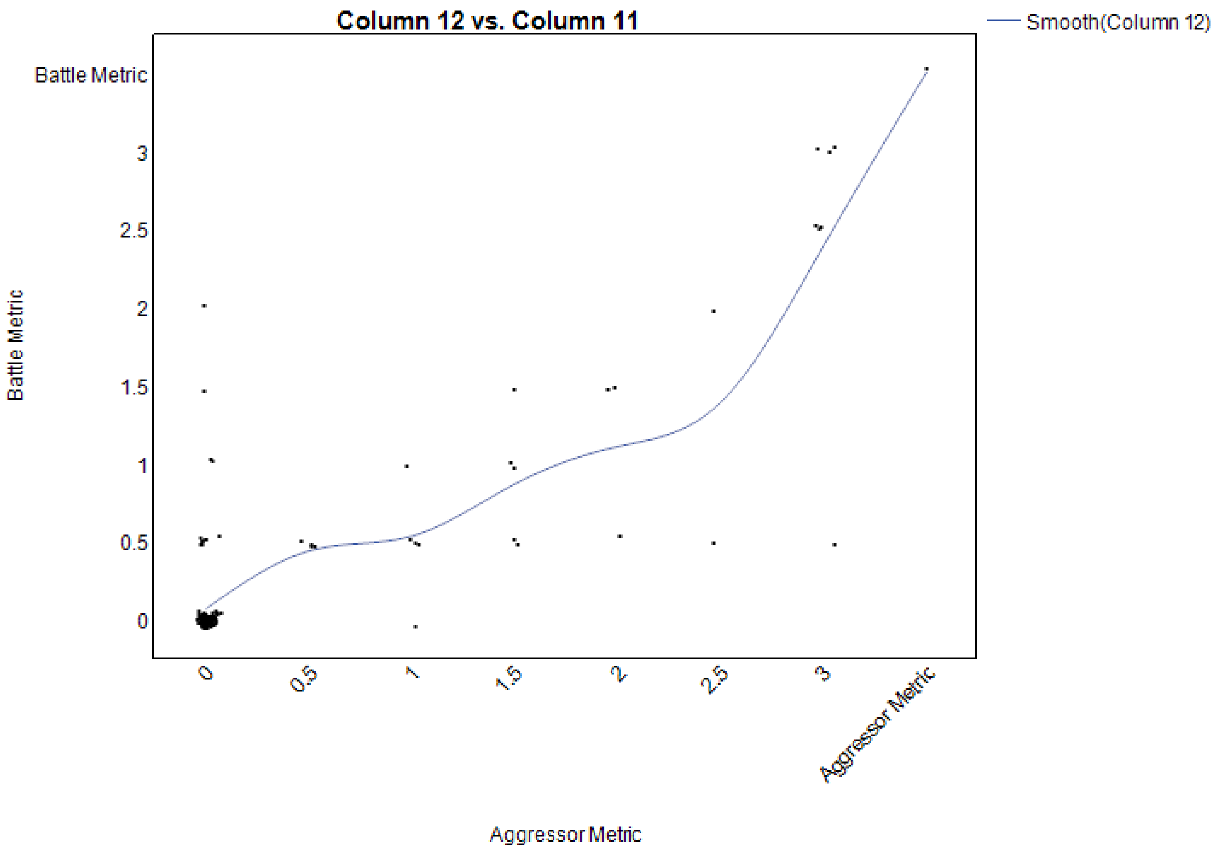
Using the techniques of multivariate regressions, my analysis indicated that the over-arching driver for the subject's well-being is the aggressor metric. Holding all other variable constant, one unit of increase in aggressor metric leads to an expected increase of nearly 0.70 quanta in the subject's mental stress level. This regression model explains 69.59% of the subject's wild variations in mental well-being.

This brings us back to our starting point: although mathematics can't predict the future, not everything comes down to chance. We have no better way to understand the deterministic chaos than through math. We have built a mathematical model based using the probabilistic approach and statistical analysis to make the mysterious forces visible and manageable. This simple mathematical model accounts for nearly 70% of the chaos. Furthermore, since we have identified the driving force of change, we have found our eigenvector for our dataset. This is quite a useful information. We are now in a position to take advantage of this insight and attempt to control the chaos.

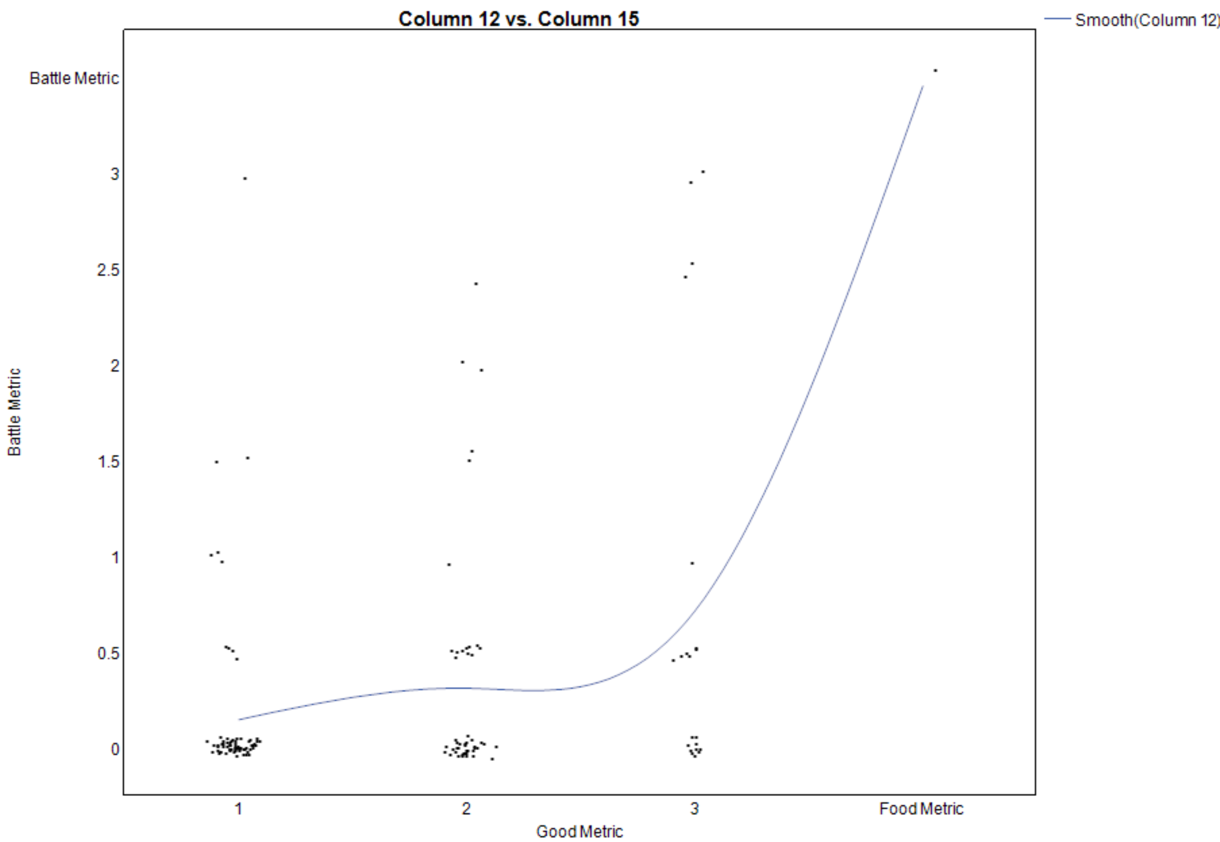
4. CONCLUSION OF PROJECT

In a subsequent mental health crisis, the subject was diagnosed with schizophrenic affective disorder, and the medical professional has indeed identified the "aggressor metric" as the voices subject hears. The subject is now on medication which has been successful in managing the chaos by managing the voices, and therefore improves her quality of life.

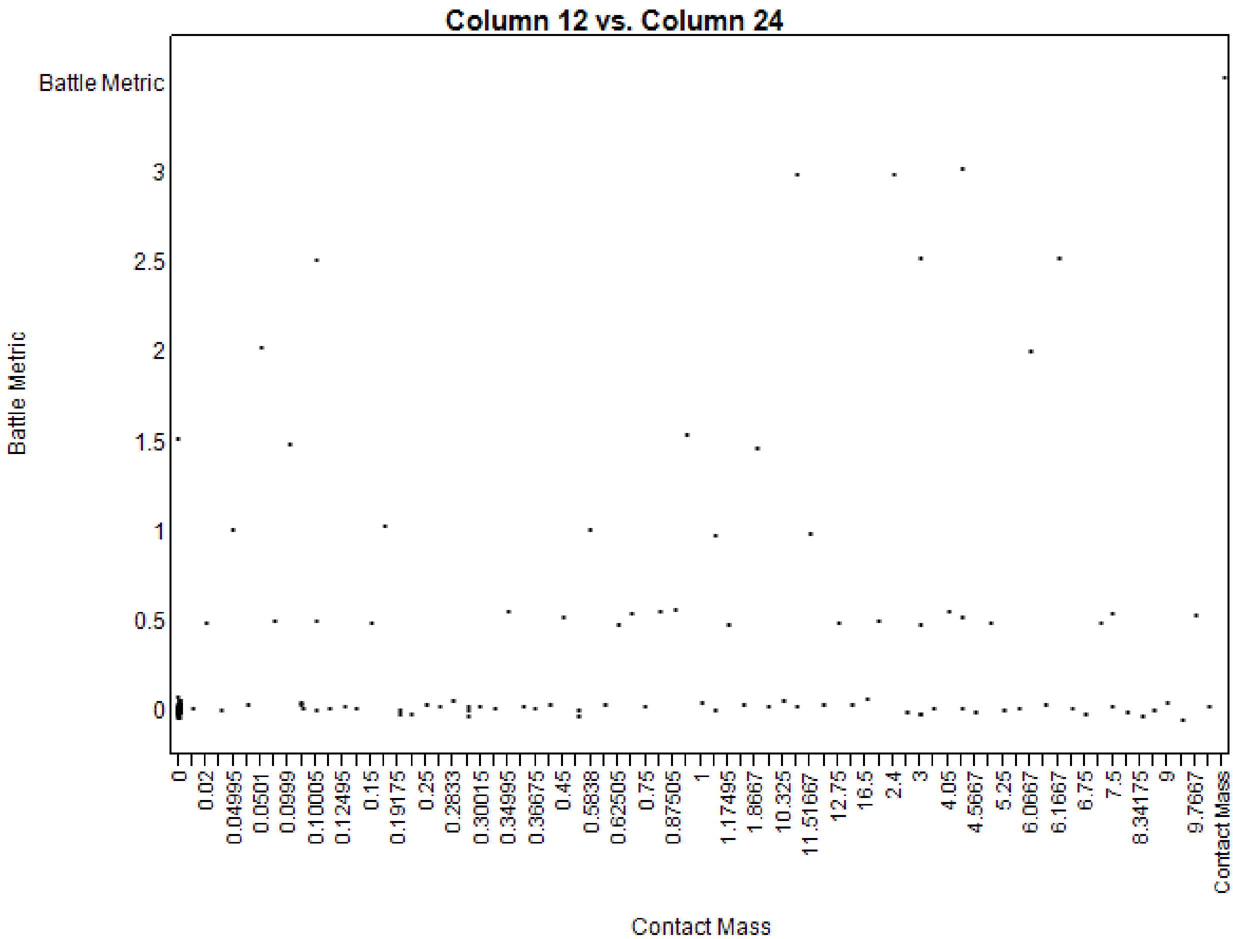
Scatter Plot: Battle Metric on Aggressor Metric



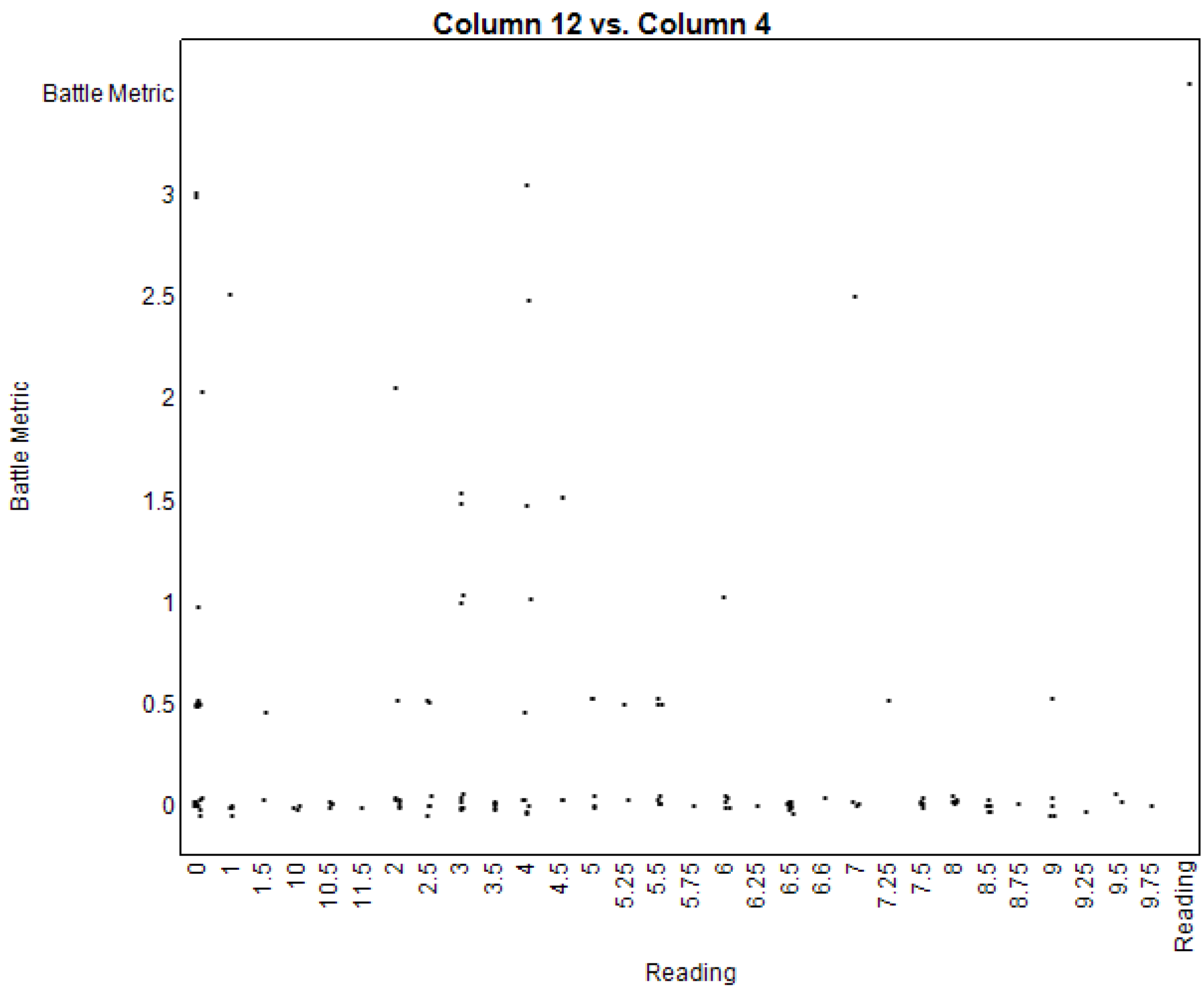
Scatter Plot: Battle Metric on Food Metric



Scatter Plot: Battle Metric on Contact Mass



Scatter Plot: Battle Metric on Reading



Summary of Fit

RSquare	0.695854
RSquare Adj	0.687038
Root Mean Square Error	0.365779
Mean of Response	0.29021
Observations (or Sum Wgts)	143

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	4	42.242713	10.5607	78.9323
Error	138	18.463580	0.1338	**Prob > F**
C. Total	142	60.706294		<.0001*

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	110	18.463580	0.167851	.
Pure Error	28	0.000000	0.000000	**Prob > F**
Total Error	138	18.463580		.
				Max RSq

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	0.3270469	0.164555	1.99	0.0489*
Column 3 (Sleep)	-0.036794	0.016978	-2.17	0.0319*
Column 11 (Aggressor Metric)	0.6810995	0.041182	16.54	<.0001*
Column 15 (Food Quality)	0.0296308	0.044459	0.67	0.5062
Column 24 (Contact with Support Network)	0.0029501	0.008827	0.33	0.7387