

# A Time-Series Analysis of my Girlfriends Mood Swings

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## Abstract

Despite recent advances in active listening, date night, and extended pillow talk; it is becoming increasingly more difficult to forecast Tiffany's mood. With more and more Playstation 5 exclusive games, it is becoming increasingly important to determine Tiffany's mood before purchasing a new game and playing online Co-op with the boys every evening for a week straight. This paper aims to determine the optimal forecast model of my girlfriend's drastically growing mood swings by comparing simple moving averages, to sextuple exponential smoothing and even an overly complicated Machine Learning model. Despite initial analysis showing non-stationarity and highly seasonal mood swings, the more simple models provided less riskier forecast predictions when planning a three day bender after Matt got divorced.

Keywords: Relationships, Time Series Analysis, Forecast Modeling, Playstation 5 Exclusives

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## 1. Introduction

Traditional methods of determining whether Tiffany is in a good mood has produced wildly subjective results causing dangerous outcomes such as her taking three hours to respond to a text, flaking on netflix and chill plans or even most disastrously having to return a speed boat even though it was a great deal and an even better investment.

Just asking her if she's okay is not enough anymore. The only reliable method is to develop, test, verify, and implement an extensive forecasting model by analyzing historical Tiffany mood swing data.

### 1.1 Background

Tiffany and I met at Cranberry-Lemon University as sophomores in our BS required Theoretical Physical Education class ten years ago. After being the last two in the quantum particle dodgeball match, we began an on again, off again relationship until our Junior fall semester when it became too cold to go outside. She and I are two young professionals living in our own home which we financed using a downpayment from not eating avocado toast for three years while I finished my doctorate program.

Tiffany is now a freemium gaming marketing consultant who hates it when I call it freemium gaming. She loves Disney, prefers beach vacations over mountains, and was obsessed with Game of Thrones until the end of the last season. When she's not binge watching the office, you can

find her endlessly scrolling through reddit for memes, facebook or instagram for jealousy, and twitter to keep up on all the public officials and celebrities she hates the most.

### 1.2 Purpose

Ever since her best friends started having kids and she got promoted to a stressful corporate position she was not trained for, it has become exponentially difficult to plan around Tiffany's emotional highs and lows. This is becoming not only problematic but is a problem that needs to be solved immediately. To dispel any misconceptions, it's not about avoiding her negative mood swings with asinine boyfriend behavior but also taking advantage of her positive mood swings for the least risky time to hang out with the boys or even more risky, refinance the house so I can get that boat back. Most importantly, there is one known application that has expedited the development of this forecast model. The Final Fantasy 7 remake will be released soon this June in under a month!

The amount of time it is expected to take to 100% complete the game, despite playing the original many times, must be carefully scheduled around a reliable Tiffany Mood Forecast Model (TMFM). Being able to plan around her mood will not only allow enough time to max out Cloud's stats but create more opportunities for other future video game releases while keeping Tiffany happy.

Initial analysis of historical screen time and purchase history data has shown that Tiffany's mood is not only

seasonal but auto correlated. This was confirmed in [1] by her Pearson Correlation Coefficient and a variety of metrics. Unfortunately, a study [1] determined that her mood is not stationary by using a Dickey-Fuller test which means that simple seasonally adjusted models will not be adequate.

## 2. Data Collection and Cleaning

Data collection of Tiffany's mood swings has been an ongoing effort ever since the infamous speed boat incident of 2018 deconstructed in [2]. As 1970s mood ring accuracy has been long debunked by popular science, a more active approach has been required [3]. Mood swing severity has been logged and time stamped with a subjective empathic pain scale, as well as time and monetary loss.

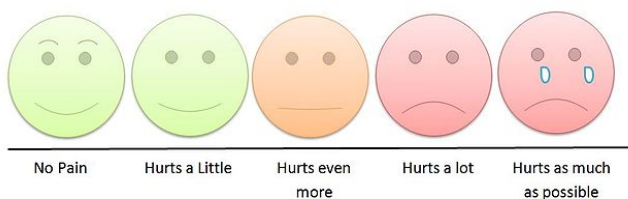


Figure 1: Empathetic mood pain scale [Robert Weis, CC BY-SA 4.0](#), via Wikimedia Commons

The analysis and modeling was only 15% of the work to develop the optimal TMFM. Before Tiffany's historical mood data was able to be analyzed in [1] and then forecasted in this paper, it had to be collected and cleaned. Of course her moods may be seasonal and represented in impromptu online purchases, non-mood related shopping appeared to be seasonal according to holidays and special occasions. Likewise, social media doom and hate scrolling might be highly correlated with mood, or just from breaking news stories which is not helpful in our TMFM.

This does not mean that these special seasonal effects and 24 hour news cycles are not influential towards Tiffany's mood swings. Due to the problem of season-holiday-mood causality, a Mood Metric Equivalent Measurement (MMEM) was established in [4] in order to in take seasonal data to accurately assess Tiffany Mood Variability (TMV) in the equations below where SACM is the Seasonal Auto Correlated Matrix calculated by average purchases and social media trending analytics normalized by her work week burden. The SACM is then transformed into the TMV by ensuring matrix symmetry.

- (1)  $SACM = (eig(Purchases) + eig(dSocial MediaScrolling/dt)) * inv(Work Week Burden)$
- (2)  $TMV = 0.5 * (SACM + SACM.transpose)$

## 3. Methodologies

Due to the meticulously cleaned data, black box Time Analysis tools were easily applied and evaluated against Tiffany's historical data. With more than two years of data, these forecasting models could be cross validated for a historical first in our ten year relationship, far beating the over fit multivariate approach which caused the end of my relationship with my highschool sweetheart a year into college [5]. Tiffany's data was modeled in this paper using a seven day moving average, Sextuple Exponential Smoothing, Autoregressive-moving average (ARMA) and one overly complicated Machine learning black boxes.

### 3.1 Moving Average

The most simple model applied to Tiffany's mood swing data was a seven day moving average. While this extremely rudimentary approach may have not been the best for implementing higher dimensionality predictors, it created less noisy forecasts compared to the more complex alternatives. While her data appeared to be autocorrelated over a 24 hour cycle, the most effective averaging window for non intuitive forecasts optimized at a 7 day moving average in case she was just feeling a bad case of the Mondays. This is not true in extremely variable days such as below in Figure 2 implemented with an hour by hour moving average model of Tiffany's mood during the 2018 Speedboat and Pregnancy Score Incident [2].



Figure 2: Tiffany's Mood during the 2018 Pregnancy Score

Tiffany by no means could be modeled with a simple moving average with sufficient hour by hour or even day by day resolution. This was established in the widespread panic conjecture [6] after I saw her at a jam band concert for the first time. Regardless, seven day average forecasting does find use in this simple model beyond traditional intuition.

### 3.2 Sextuple Exponential Smoothing

In order to make exponential smoothing achievable for an optimal TMFM, six smoothing functions were needed. Traditionally, a single exponential smoothing model can be used on more stationary data. A double exponential

smoothing function is then used when there is a trend in the time series. Adding yet another exponential smoothing function then can handle seasonal variation.

For Tiffany's model, a fourth, fifth and sixth exponential smoothing layer was needed to account for weekly boys nights keeping me at the bar until last call, the effects from her mother's periodic cryptic telephone conversations as well as the occasional friends weddings and child births while I wait for the perfect time to pop the question, even though she understands that it just hasn't been the right time for the past three years and we do not need a societal construct to show how much we love each other. Choosing the smoothing alpha values has proven to be almost as challenging as cleaning the data but still not impossible.

### 3.3 Autoregressive-moving-average model

While Tiffany is very self conscious about this and I've always been into it, she has always required a extensive linear combination of polynomials to be effectively modeled [7] both in personality and physical appearance. As far as this paper is concerned, an Autoregressive-moving-average (ARMA) model was the only way to capture her unique combination of seasonality and personality describing polynomials.

Among the traditional Time-Series forecast modeling techniques, ARMA is the most likely to get the lower level resolution forecast predictions for riskier behavior such as reopening the boat discussion while potentially defending seemingly low risk behavior against classic Tiffany relationship conversations that begin with "I'm fine...it's just that..."

The ARMA is expected to be the most high risk high reward mood swing modeling technique. Discovering the positive and negative mood swings will be high risk high reward depending on if the forecast model can find the right time delay parameter when fitting the weekly/daily/seasonal driven polynomials.

### 3.4 Overly Complicated ML Approach

There's nothing better at modeling a black box like Tiffany's mood swings like an unexplainable Machine Learning black box. Using a python Long Short Term Memory (LSTM) structure I created for my buddy so that he would stop bothering me about making billions predicting the stock market with my programming knowledge and his financial acumen, Tiffany's mood could also be forecasted.

Even after ten years of a steady relationship and many ups and downs, there is still a lot which baffles me about that wonderful woman. As much as I think I know about her, a black box canned Machine Learning algorithm approach may be the best method to have my cake and eating it when FF7 comes out in less than three weeks.

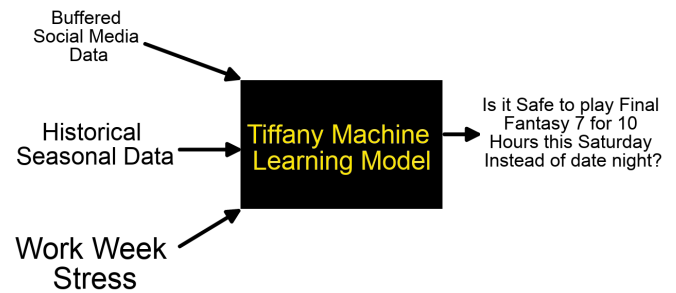


Figure 3: ML implementation of a TMFM

However, as the ARMA approach was high risk/high reward, there's no telling how high risk/high reward using an overkill trendy machine learning algorithm will be in practice. It may pick up on things about her I won't know for another ten or even twenty years, likewise it could ignore obvious trends and characteristics I could code into a moving average or exponential smoothing function.

As exciting as it is, playing the Final Fantasy 7 remake is not important enough and there is not enough training data to create an extensive staged supervised deep learning training scheme that could take advantage of my knowledge of a properly structured TMFM. It's coming out in under a month, there's no time! Canned ML algorithms it is!

## 4. Results

With under a month away to the release date, the forecasting was hastily tested and documented so that in the eventuality the models do not work, I can't be labeled "Insensitive to her feelings again," like when CyberPunk 2077 came out right when she couldn't tell if her entire marketing team was completely working against her after her promotion to team lead. It turned out they weren't but that's not what was important.

When my college roommate Matt got divorced, we last minute drove to New York for a three day bender and monitored Tiffany's passive aggressive text messages and concern for how much money I was spending to evaluate each model against MMEM truth data. Each model performed generally as predicted and their results can be seen in Figure 4. As speculated, the lower fidelity models were lower risk while the higher fidelity models were locally more accurate with occasional inaccurate predictions and time delay problems.

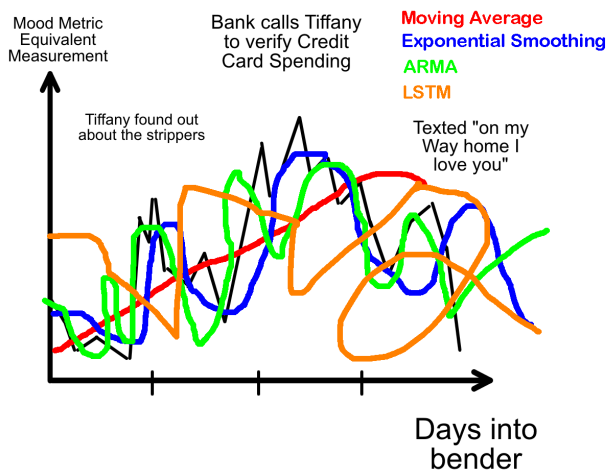


Figure 4: Forecast Performance During 3+ Day Bender

The seven day moving average was able to best predict overall trends in Tiffany's mood but missed the lower fidelity changes the other models predicted. The Sextuple Exponential Smoothing function was able to achieve higher fidelity forecasting but missed many of the local trends. While the ARMA was able to pick up on the greater trends and more of the local trends, it produced dangerously inaccurate forecasts which, if acted upon, would have started at least one, maybe two evening long discussions on "Where is this relationship even going."

The ML approach was unfortunately bad at nearly everything and the effort should be completely scrapped until there is enough historical Tiffany data to adequately train the LSTM or a more developed supervised deep learning method. Just because the algorithm is trendy doesn't mean it's a good idea for such fast turn around analysis and forecasting like a TMFM.

## 5. Conclusion

With 18 days to go until the Final Fantasy 7 remake downloads on my PS5, these algorithms are all actively monitoring Tiffany's purchasing behavior, doom scrolling, and work conversations about her subordinates not knowing what they're doing. Once all forecasting models agree, except the LSTM, I am confident that I can schedule enough evening video game time in between June 10th and the July 4th vacation to her parents house in Louisville KY to beat the game so that my friends won't call me whipped.

As typical of almost any modeling project, this forecasting model highlighted the risk of balancing the inaccuracies of the higher and lower fidelity models. Tiffany will never make me go to another one of her friends' plays if I stick with a 7 day average forecasting model, but, I won't ever be able to max my FF7 characters before christmas unless I at least use a seasonally adjusted Three Exponential Smoothing Model. These low maturity methods are rudimentary but they do

show significant utility. Eventually, one of the forecast models or combination of models will give me the confidence to buy back that speedboat.

## 6. Future Work

The great speedboat fiasco of 2018 was not a permanent defeat. With the right modeling and some common sense risk management, these techniques could be used to determine the best time to purchase back that speedboat from Jeffrey. I know there are not many good locations for a speedboat near Pittsburg, but it's more of an investment in memories and with an accurate enough forecasting model, it could non-confrontationally be readdressed with Tiffany.

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