**TimeFork: How to Predict the Future**  
*(With a Little Help from Your Machine Friends)*

Sriram Karthik Badam         Daniel Apon         Alejandro Flores Velazco         Zhenpeng Zhao  
University of Maryland

Introducing *TimeFork: The Future-Trend Prediction Engine*

Predicting future trends is an essential task in modern domains from areas as diverse as finance, science, and medicine. Analysts working in these areas often deal complex, multi-faceted data, representing an interdependent system evolving over time. Making accurate and timely predictions about the near-future behavior of rapidly changing data has crucial consequences. For instance, accurately predicting the stock prices in financial markets can help stock traders better manage their portfolios and gain from their investments. See a typical example in Figure 1 below.

In this report, we discuss the challenges of predicting trends in complex time-evolving data, and present a solution: the *TimeFork* project\(^1\), recently developed by a Maryland-Purdue group.

![Figure 1: Stock market data (in TimeFork) with two possible future trends: light blue vs orange.](image)

**Predicting the Future Ain’t Easy! (Challenges for Trend Prediction)**

Current approaches for computer-aided trend prediction strongly rely on technical procedures, designed to learn and adapt from emerging historical trends, to provide forecasts for the future\(^2\). However, purely-automated prediction procedures may not fully account for every specialized, contextual factor that may influence future trends. Consider that legislation on fracking affects oil stock prices (independent of market-specific data). This kind of contextual information is often processed by human analysts.

In this direction, the *TimeFork* technique of Badam et al. offers an interactive approach for trend prediction, in which analysts have a “feedback-heavy conversation” with a computerized model. The goal is to utilize this synergy to achieve more accurate, faster-paced trend prediction than either computer-only or human-only trend prediction currently allows.

**TimeFork: Machine-Human Interactive Prediction**

*TimeFork* is a visual analytics approach towards prediction. The field of visual analytics\(^3\) focuses on analytical reasoning of complex datasets by converting them into graphical (visual) forms that can be easily understood by humans interacting with a computer. This philosophy

---

implies closely coupling computational models with visual exploration (interaction with the graphics). The TimeFork technique does exactly this to overcome the aforementioned challenges of prediction. This technique allows the analysts to have a back-and-forth dialogue (Figure 2) with the computer, in which (1) the computer first visualizes multiple predictions for each time-series variable using a prediction model (e.g., for each stock in stock market), (2) the analyst can then provide their own opinion about a variable (e.g., Apple’s stock might increase) based on their own knowledge from news articles, social media, and other public information, and finally (3) the computer takes the analyst’s assessment of the future into account and updates predictions for other time-series variables (essentially, “forking time”) by assuming that the analyst is correct. By following such a workflow, analysts can now understand the effects of their guesses and come up with predictions that balance both human and machine “intelligence”.

![Figure 2](image)

Figure 2: How TimeFork works. Far Left: Predictions are visualized (light blue). Left: User interacts. Right: Predictions globally revised on-the-fly (orange). Far Right: The user continues the interaction to cultivate the best overall predictions.

The researchers explored the potential of the TimeFork technique in stock markets. They developed a web application that visualized the stock prices and trade volume information for stocks of interest, as well as the statistical correlations between stocks and their Twitter feed. The source code of this application was made available on Github⁴, along with a video demo⁵ showcasing the usage scenario of TimeFork.

How well does TimeFork perform in practice?

The TimeFork technique was evaluated on real stock market data from 2014 and 2015 using volunteers from a general university population. Participants made investments in a simulation of the market using virtual money of $100,000. In these experiments, 3 preliminary trends emerged:

1. Using TimeFork nearly doubled monetary gains for “long-term” investments (as compared to either manual human prediction, or purely computer-generated prediction).
2. Participants (using TimeFork) who interacted more with the program made more money.
3. Participants interacting with an intelligent computational model made larger profits than those interacting with alternative methods.

The Future of Predicting the Future

TimeFork has strong implications in time-series prediction and also visual analytics in general. TimeFork’s unique workflow can help the analysts better collaborate with computational models that are typically based on machine learning and artificial intelligence. The interesting “next question,” of course, is how to further improve computer-aided trend prediction. Toward this end, TimeFork gives evidence that the “best-of-all-possible-worlds” is realized by interactively merging computer-generated predictions with human intuition, suggesting that future research and development should aim to refine the synergy of human and machine.

---

⁴ Source Code: [https://github.com/karthikbadam/TimeFork](https://github.com/karthikbadam/TimeFork)
⁵ Video Demo: [https://www.youtube.com/watch?v=nUfSqqbaDSk](https://www.youtube.com/watch?v=nUfSqqbaDSk)
This research report was written by Sriram Karthik Badam (sbadam@umd.edu), Daniel Apon (dapon@cs.umd.edu), Alejandro Flores Velazco (afloresv@cs.umd.edu), and Zhenpeng Zhao (zhaoz@umd.edu) on February 22, 2016 for the CMSC798F "How to conduct great research" seminar. [Revised: February 29, 2016]