The Tech Buzz Game

Bernard Mangold, Mike Dooley, Gary W. Flake, Havi Hoffman, Tejaswi Kasturi, and David M. Pennock, Yahoo! Research Labs
Rael Dornfest, O'Reilly Media

A Yahoo!/O'Reilly fantasy prediction market forecasts high-tech events and trends.

Prediction markets, also known as information or decision markets, are designed to forecast future events or trends. In such markets the payoff is tied to some outcome, such as an election result, and at any given time the trading price reflects traders' consensus on the outcome's likelihood.

Numerous prediction markets operate online. For example, Iowa Electronic Markets (www.biz.uiowa.edu/iem) are real-money political and economic futures markets, while TradeSports (www.TradeSports.com) is a sports-related real-money exchange. Popular play-money or fantasy markets include the Hollywood Stock Exchange (www.hsx.com) and the Foresight Exchange (www.ideosphere.com).

Internet-based prediction markets can easily aggregate the insights of an unlimited number of potentially knowledgeable people asynchronously. Researchers studying these markets in recent years have found them to be remarkably accurate.

THE TECH BUZZ GAME

The Tech Buzz Game (http://buzz.research.yahoo.com)—a joint venture between Yahoo! Research Labs and O'Reilly Media—is a fantasy prediction market launched in March 2005 at the O'Reilly Emerging Technology (ETech) Conference in San Diego, California.

The game consists of multiple submarkets that pit a handful of rival technologies, each represented by a stock, against one another. For example, the Browser Wars market contains seven stocks: Internet Explorer, Firefox, Opera, Mozilla, Camino, Konqueror, and Safari. Players have access to the current "buzz" around each technology, as measured by the number of Yahoo! Search users seeking information on it.

The game's object is to anticipate future search buzz and buy and sell stocks accordingly. Thus, a player who believes BitTorrent stock is undervalued might buy shares, while a player who thinks BitTorrent is overpriced might sell the stock or instead purchase shares in a competing peer-to-peer technology.

Research goals

The Tech Buzz Game serves two key research-oriented goals. One is to evaluate the power of prediction markets to forecast high-tech trends. O'Reilly Media (http://radar.oreilly.com) designed the game's ontology based on the landscape of technologies, products, and companies on its radar.

The other goal of the Tech Buzz Game is to field test the *dynamic pari-mutuel market*, a Yahoo! Research Labs trading mechanism designed to price and allocate shares. The "Dynamic Pari-Mutuel" sidebar describes this mechanism in more detail.

Buzz scores

Each stock in Tech Buzz Game is associated with a number of buzz words, or search phrases. For example, buzz words for Internet Explorer include "ie," "internet explorer," and "ie6 download." The game uses Yahoo! Search (http://search.yahoo.com) to generate a seed set of buzz words and then uses Yahoo! Search Web Services (http://developer.yahoo.net) to expand the set.

A stock's *buzz score* is the number of searches of buzz words over the past seven days, as a percentage of all searches in the same market. Thus, if searches for Internet Explorer make up 60 percent of all Yahoo! searches in the Browser Wars market, then IE's buzz score is 60. The buzz scores of all technologies within a market always add up to 100.

The buzz-scoring methodology was originally developed for the Yahoo! Buzz Index (http://buzz.yahoo.com), which tracks Web search spikes and trends.

Trading interface

Software developed by NewsFutures (http://NewsFutures.com) powers the game. Players enter the amount of

money they want to invest in a specific stock, and the system computes how many shares they're entitled to in return for their investment. Players don't need to deal with separate bid-and-ask queues or wait for a counterparty to execute a trade.

However, the total cost for all shares isn't equal to the current price multiplied by the number of shares because not all shares are purchased at the current price. Instead, as players purchase more shares, the price increases continuously. Each share purchased thus costs a little more than the previous one.

Selling is likewise mechanically simple: Players enter the number of shares they wish to sell, and the system computes their proceeds. Again, as each additional share is sold, the price decreases continuously. Thus, each incremental share sold returns a little less money than the previous share, and the total proceeds are less than the current price multiplied by the number of shares.

Interest in a technology ultimately determines its stock value. For example, Figure 1 graphs the prices, trading volume, and buzz scores for Wi-Fi and WiMax, the two competing stocks in the Wireless Internet market. In mid-April 2005, WiMax's buzz began to grow relative to Wi-Fi, following announcements of new WiMax chips from Intel and Fujitsu as well as a WiMax deployment partnership between Intel and Sprint.

Price changes appear to parallel changes in buzz scores, but graphical analysis alone is insufficient to judge which is leading the other. We plan to conduct statistical analyses across all Tech Buzz Game markets to examine the hypothesis that prices anticipate buzz trends.

Dividends and cash-out events

Paid dividends and the final cash settlement are in proportion to actual search buzz. Thus, savvy traders don't engage in a "beauty contest" of picking their favorite technologies but consider both prices and buzz scores, buying stocks where prices appear low compared to expected future buzz scores.

On every Friday at 6:00 pm Eastern time, each stock receives a total dividend equal to 100 times the stock's buzz score. For example, if IE's buzz score is 60, then the total dividend for IE is $6,000. The total dividend is then

Dynamic Pari-Mutuel

The dynamic pari-mutuel determines the way share prices in the Tech Buzz Game change by using a continuous function solution to a set of differential equations. The game attempts to combine the advantages of two common market mechanisms: the continuous double auction (CDA), which is used in stock exchanges such as Wall Street, and the pari-mutuel, which is used for betting on horse races and other sporting events.

Because a CDA lets you buy shares in a stock only if someone else is willing to sell them at a price less than or equal to what you're willing to pay, the stock's market price reflects current demand. Thus, if you correctly anticipate that demand will increase, you can realize a profit by buying the stock and then selling it after increased demand has raised its price. When there are few traders, however, the best buy and sell prices can be far apart—a situation known as the *thin market problem*.

The pari-mutuel avoids this problem but doesn't allow you to profit by predicting future demand. For example, after a horse race, the money the ticket holders spent on all the tickets they bought is divided in proportion to the number of winning tickets they own. The problem with this mechanism is that there's no incentive to buy early; in fact, the best strategy is to wait until the last possible moment to buy.

The dynamic pari-mutuel avoids the thin market problem while ensuring that stock prices reflect demand. It functions like a classic pari-mutuel in that you can always make purchases for each outcome, but it resembles a CDA in that prices increase with demand.

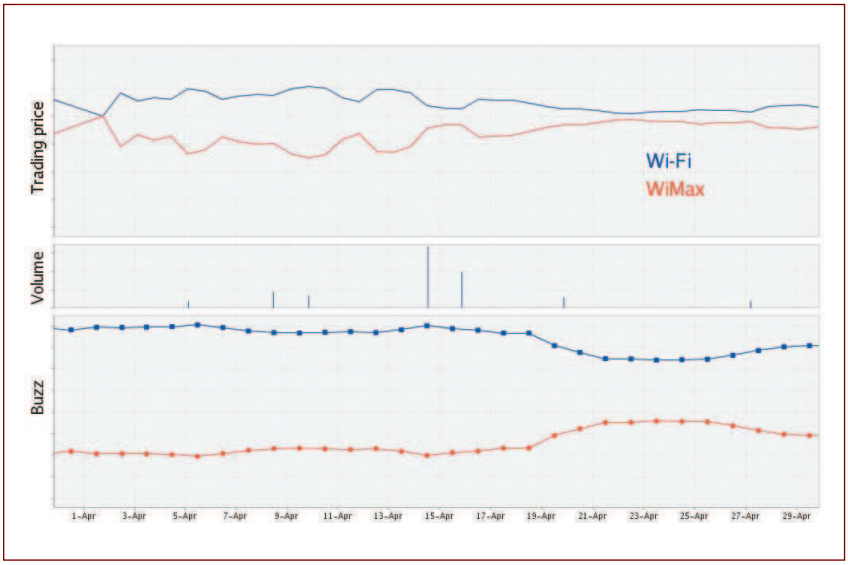

Figure 1. Stock value. In the Wireless Internet market, Wi-Fi and WiMax price changes appear to parallel changes in buzz scores.

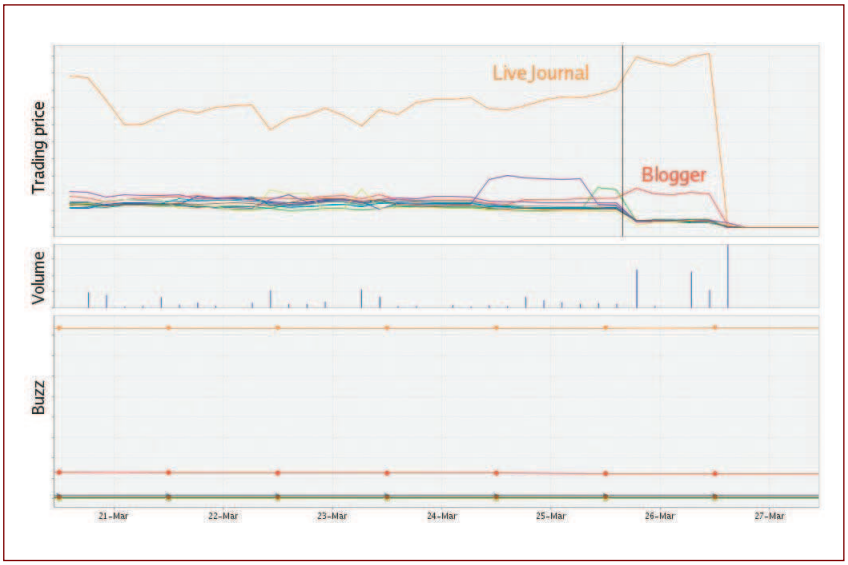

Figure 2. Example of market collapse. A flaw in the dynamic pari-mutuel's money-ratio price function encouraged arbitrage, causing stock prices to fall precipitously.

distributed to shareholders, with each share receiving an equal portion.

Shares are liquidated for cash at long-term intervals. During a cash-out event, all money in every market is distributed to shareholders. Within each market, all money is first allocated among stocks according to buzz scores. For example, if the buzz scores for IE and Firefox are 60 and 20, respectively, and the total Browser Wars market capitalization is $100,000, then $60,000 will be allocated to IE and $20,000 to Firefox. The money allocated to each stock is then distributed to shareholders, with each share receiving an equal portion.

OUT OF THE GATES

The Tech Buzz Game got off to a fast and furious start. The ETech crowd is decidedly alpha geek, with a huge density of wirelessly connected gadget-wielding bloggers. Many conference attendees signed on to play the game as soon as it was announced and immediately began plotting strategies to help them win.

In the first week, the game site received 2.7 million hits. Participants activated 13,310 accounts, placed 117,530 orders, invested $88,480,577 fantasy dollars, and purchased 46,379,241 shares.

A core group of dedicated players demonstrated impressive creativity in building supporting tools and bots, deriving equations, and debating strategies. One player started an independently moderated Yahoo! group for players to discuss the game outside the official message boards.

These forums often resemble typical stock market message boards—full of "pump and dump" exhortations, junk advice, flame wars, and rants. Those who read the message boards with care, separating rare good advice from the noise, fare well. Many players, especially novices, simply buy the technologies they like regardless of price. These players tend to lose money, then either learn to invest more wisely or give up.

Many players expend equal energy subverting the rules. From the beginning, the game was inundated with cheaters who opened up hundreds of accounts, orchestrating them to artificially inflate the stocks in their main portfolio. Consequently, we now employ e-mail verification and CAPTCHA (www.captcha.net) controls, log IP addresses, and search the database for signs of suspect coordination of transactions.

In addition to being a useful research tool, the game is a fascinating social experiment, complete with archetypes like the Leader, the Lurker, the Cheater, the Braggart, and the Novice. Some successful players openly share their strategies, data, tools, and analyses, while others try to cheat their way to the top. One player openly boasted of illicitly amassing a fortune and announced when and where he was going to invest his ill-gotten gains.

DOWN THE STRETCH

During the Tech Buzz Game's second week, stock prices in many markets began falling precipitously, often below their initial starting value, with no signs of stopping. This initially baffled us given that each market was designed to be a zero-sum game in which one stock's price fall would cause other stocks' prices to rise.

The behavior resulted from a flaw in the dynamic pari-mutuel's *money-ratio* price function, which defines the ratio of any two stock prices in the same market as always equal to the ratio of money invested in the stocks. This function enabled traders to perform arbitrage via a four-step process: buy a cheap stock, buy an expensive stock, sell the cheap stock, and sell the expensive stock. If conditions are right, the sequence produces a net positive gain.

Through a combination of mathematical study and trial and error, two 17-year-old students uncovered the flaw. Other traders caught on and exploited it rapidly, causing all stocks in some markets to drop toward zero. Figure 2 shows an example of one such collapse in the Weblog Applications and Services market.

Our initial response was to disallow the purchase of multiple stocks in the same market, which makes arbitrage by any single player impossible. However, this Band-Aid fix stemmed the tide for less than a day. Soon pairs of players colluded to carry out arbitrage in tandem, sharing the spoils. Several even

actively sought out partners in crime in the Yahoo! group chat room.

We employed a more permanent fix by replacing the money-ratio price function with a *share-ratio* price function that defines the ratio of any two prices in a market as always equal to the ratio of outstanding shares for those two stocks. For example, if the number of outstanding shares of IE is twice that of Firefox, then IE's price is twice that of Firefox; if the number of shares is equal, the prices are equal.

The share-ratio price function does not admit arbitrage. The dynamic pari-mutuel mechanism has been running fairly smoothly since the change.

Given the interest among programmers in the Tech Buzz Game, we recently implemented a Representational State Transfer application programming interface to open up access to third-party programs. REST accepts queries as URLs and returns results in easily parseable XML.

Currently, the service is read-only: Users can retrieve stock prices, buzz scores, number of shares outstanding, and market cap information. This makes it possible to create simple support applications such as stock tickers, RSS feeds, or "triggers" that inform users about events such as a major price or buzz score change.

In the future, players will be able to use REST to access their account information and make trades. They will be able to write an application that fully replaces the existing Web-based interface, so that they won't even need to visit the site to play the game. We also plan to expand the Tech Buzz Game to include more markets and areas as well as support tools for use in defining markets and stocks. ■

Bernard Mangold *is the senior director of Yahoo! Research Labs. Contact him at mangoldb@yahoo-inc.com.*

Mike Dooley *is a senior developer at Yahoo! Research Labs. Contact him at dooleym@yahoo-inc.com.*

Gary W. Flake*, a distinguished engineer at Microsoft Corp., contributed to this work as head of Yahoo! Research Labs. Contact him at gary.flake@usa.net.*

Havi Hoffman *is a writer and editor at Yahoo!. Contact her at havi@yahoo-inc.com.*

Teijaswi Kasturi *is a developer at Yahoo! Research Labs. Contact him at kasturit@yahoo-inc.com.*

David M. Pennock *is a senior research scientist at Yahoo! Research Labs. Contact him at pennockd@yahoo-inc.com.*

Rael Dornfest *is chief technology officer at O'Reilly Media. Contact him at rael@oreilly.com.*

Editor: Richard G. Mathieu, Dept. of Decision Sciences and MIS, St. Louis Univ., St. Louis, MO; mathieur@slu.edu