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YANFENG ZHENG

QUANTS IN UTOPIA? QUANTOPIAN AND ITS CROWD-WISDOM HEDGE-FUND MODEL

We're building a meritocracy here at Quantopian. Algorithm writing is no longer just for guys on Wall Street with exclusive access to the tools and data. With the Quantopian platform, anyone with a bit of coding skill and a mind for finance can start writing algorithms. The best ones win.[1]

- John 'Fawce' Fawcett, CEO of Quantopian

Ghost Trader in the Dorm

On a sunny day in May 2015 as the final bell rang, hundreds of students at Texas A&M University poured out of classrooms and turned their attention to celebrating the end of exams. Unlike his peers, Spencer Singleton, an undergraduate who was majoring in supply-chain management, made a beeline for his dorm. He turned on his laptop and logged on to a website called "Quantopian."

A few days before, Singleton had come up with a new idea for a long/short arbitrage trading strategy, after reading an algorithm shared by a member of Quantopian's online community. Scarcely able to contain his desire to test his idea, he carefully entered each line of code, clicked the "*Run Full Backtest"* button, and nervously waited for the results. When he saw the screen displaying a series of moving curved lines, he thought to himself, "The charts don't look bad!" and proceeded to fine-tune his algorithm.

[1] PR Newswire (5 March 2015) "Grant Kiehne, Finance Industry Outsider, Awarded US$100,000 to Manage by Quantopian," http://www.prnewswire.com/news-releases/grant-kiehne-finance-industry-outsider-awarded-100000-to-manage-by-quantopian-300045002.html (accessed 10 March 2017).

Professor Yanfeng Zheng prepared this case for class discussion. This case is not intended to show effective or ineffective handling of decision or business processes.

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After a few more days of modifications, debugging and backtesting, Singleton finally completed a satisfactory trading algorithm. He then submitted his work in a contest called the Quantopian Open, a paper-trading test to be held the following month. To his delight, he beat hundreds of participants and won the contest in July 2015.[2] His winning algorithm would be allocated US$100,000 in real money in the next six months, and he could keep all the profits generated from his trading strategy. For a college student with limited trading experience and programming skills, it was indeed a pleasant surprise and a very rewarding experience.

While Singleton and other winners celebrated their small successes, John Fawcett, the CEO of Quantopian, was pondering a significantly larger, perplexing challenge. After expending considerable effort over several years, his startup had amassed over 100,000 registered quantitative traders, or "quants," who developed, tested and shared their trading algorithms on the company's online platform.[3] The company had also accumulated more than US$48 million in financing, over several rounds, from leading venture capital (VC) firms such as Bessemer Venture Partners.[4] Fawcett knew that Quantopian had accomplished a great deal in terms of developing a vibrant community and strengthening its brand name among traders, but several burning questions remained: How could Quantopian's crowd-wisdom model be monetized in a scalable manner? How could Quantopian be transformed into a financially sustainable business? How could Quantopian differentiate its services from its competitors'?

Company Background

John Fawcett graduated from Harvard in 1999, majoring in mechanical engineering.[5] After working in systems development and investment research for two years, he founded his first company, Tamale Software LLC, in 2002. Tamale provided consolidated research systems for investment professionals to manage their investment ideas. At Tamale, Fawcett met Jean Bredeche, a software engineer who had graduated from Dartmouth College in 2003.[6] The two would eventually go on to co-found Quantopian. Tamale was acquired by Advent Software (NASDAQ: ADVS) for US$70 million in 2008.[7] Fawcett continued working at Advent until 2011.

Having spoken to many quantitative analysts on Wall Street, Fawcett and Bredeche realized there was an urgent and unaddressed need for an open-development environment with easy access to high-quality data in the quantitative-trading industry. They had observed that many

[2] Deychman, A. (7 August 2015) "Spencer Wins the July Edition of the Quantopian Open", https://www.quantopian.com/posts/spencer-wins-the-july-edition-of-the-quantopian-open (accessed 10 March 2017).

[3] Finextra (14 November 2016) "Andreessen Horowitz Invests in Crowdsourced Quant Investment Firm Quantopian", https://www.finextra.com/newsarticle/29760/andreessen-horowitz-invests-in-crowdsourced-quant-investment-firm-quantopian (accessed 10 March 2017).

[4] For details, see Quantopian's CrunchBase: https://www.crunchbase.com/organization/quantopian (accessed 13 March 2017).

[5] For details, see John Fawcett's LinkedIn: https://www.linkedin.com/in/fawce/ (accessed 13 March 2017).

[6] For details, see Jean Bredeche's LinkedIn: https://www.linkedin.com/in/jeanbredeche/ (accessed 13 March 2017).

[7] Advent Software (1 October 2008) "Advent Completes Acquisition of Tamale Software", https://www.advent.com/about-us/newsroom/pressreleases/advent-completes-acquisition-of-tamale-software (accessed 10 March 2017).

professional "quants" (not to mention thousands of amateur data analysts), had dozens of potentially viable ideas for algorithms and trading strategies and spent 6 to 12 months developing algorithms for their employers. However, they all suffered from lack of access to a platform or tools that facilitated the execution of their own ideas. The duo decided to develop such a tool, provide free data and build a community for quants to write and test their algorithms.

In August 2011, Quantopian was born in Boston, Massachusetts. Fawcett claimed Quantopian was the first web-based platform that allowed professional and amateur quantitative traders to develop, test and execute their strategies.[8] Behind this simple plan of a back-testing platform was a big ambition: if barriers to algorithm trading were lowered and the development process standardized at Quantopian, thousands of talented quants would form a community around the platform. Talented minds could come together to create unlimited possibilities.

From Idea to Reality

Zipline: Quantopian's Cornerstone

Quantopian's first milestone was the 2012 release of its prototype backtester, Zipline. A good backtester engine was crucial for algorithm development and thus for attracting the best quants to a community. Fawcett and his founding team believed in crowd wisdom, as opposed to proprietary development. Hence Zipline was designed as an open-source Python package from the very beginning. Leveraging suggestions and contributions from hundreds of developers,[9] Zipline gradually stood out from multiple competing backtesters, such as PyAlgoTrade or pybacktest.

Stock-simulation and algorithm-backtesting services had existed for many years before Quantopian or Zipline. At the high end, professional firms such as Deltix provided comprehensive support for trading-strategy development, including backtesting and trading simulation.[10] However, the pricing of such services was often beyond individual traders' budgets. Many low-end trading-simulation websites provided simpler functions. Users could usually trade with a certain amount of virtual money in the U.S. equity market or test their strategies with historical data.[11] These simulators or backtesters, however, suffered from a fatal flaw - ignoring the realities of market transactions. In the real market, commission fees, limited liquidity, or even the speed of the algorithm could kill a trading strategy that looked promising on paper. Thus, these simulators and backtesters remained either a game or a marketing tool directing users to open brokerage accounts, but were far from what real traders desired.

[8] Quantopian (10 December 2014) "Exploration of Quantopian's Crowd-Sourced Hedge Fund", https://www.youtube.com/watch?v=D8ZWSTWFbO4 (accessed 13 March 2017).

[9] For detailed statistics, see Zipline's Github page: https://github.com/quantopian/zipline (accessed 13 March 2017).

[10] For details, see Deltix's website: http://www.deltixlab.com/ (accessed 13 March 2017).

[11] For some examples, see TopTenReviews' review: http://www.toptenreviews.com/money/investing/best-stock-trading-simulators/ (accessed 13 March 2017).

Fawcett and his team developed Zipline and Quantopian with a completely different mindset. Zipline's design was driven by the underlying intention of closely resembling and replicating reality. Even in paper trading and backtesting, each trade was hypothetically charged a brokerage fee or commission, based on numbers from Interactive Brokers, one of the largest brokerage firms hosting a large population of semi-professional traders. Bid-ask spreads were imposed on buy and sell orders. Furthermore, market depth and liquidity were carefully considered. The more capital one invested in a single stock, the less likely it was that the order would be fully executed, and the higher the execution price one would have to pay.

Road to Growth: Building the Brand and Exploring a Viable Business Model

With an ever-growing community as its foundation and backed by VC firms, Quantopian made its second critical move. In February 2015, it introduced a monthly contest, called Quantopian Open, to its registered members and the public.[12] The contest consisted of three stages. In the first stage, all registered members could submit their algorithms to the contest. The submitted "algos" would be backtested against two years of pre-contest historical data, and only the surviving candidates, measured across multiple dimensions, would enter the next stage. The second stage would be a month-long paper-trading competition. The algorithm with the highest score at the end of the month would be allocated US$100,000 in real money over the next six months as a reward, with all profits generated by the algorithm during the third stage going to the winner.

Rather than a marketing campaign or gimmick, Quantopian Open was designed as a very serious and professional contest, with strict entrance criteria, in order to monitor and select the best "hedge fund" algorithms from its community. To enter the contest, one's algorithm must have had low correlation (beta between 0.3 and -0.3) with general market performance, been hedged with both long and short positions, have had positive returns in the backtesting stage, and been subject to slippage and commission models with simulated execution costs. The judging criteria were also set at the "industrial standard" of the hedge-fund industry. The seven metrics serving as such criteria were Beta-to-SPY, Sharpe Ratio, annualized volatility, annualized return, max drawdown, stability of return and Sortino Return [see **Exhibit 5**].

Many algorithms on Quantopian were developed by semi-professionals or amateurs like Spencer Singleton, the Texas A&M student. Nevertheless, top-ranking algorithms on the platform and winning algorithms in the Quantopian Open contests exhibited industry-level quality. With its community and contest, Quantopian had access to hundreds of thousands of quants developing and sharing their algorithms on an unprecedented scale. The community, contrary to the investment industry's traditional wisdom of keeping secrecy, was well-known for its openness. [See **Exhibit 3** for an example of sharing source codes.] Some winners of the Quantopian Open even shared their winning codes with the community.[13]

[12] PR Newswire (5 March 2015) "Grant Kiehne, Finance Industry Outsider, Awarded US$100,000 to Manage by Quantopian", http://www.prnewswire.com/news-releases/grant-kiehne-finance-industry-outsider-awarded-100000-to-manage-by-quantopian-300045002.html (accessed 10 March 2017).

[13] Kiehne, G. (25 January 2017) "Contest Algo", https://www.quantopian.com/posts/contest-algo (accessed 13 March 2017).

In addition to creating a powerful yet easy-to-use backtesting and algorithm development platform [see **Exhibits 1 and 2**], Quantopian also developed its community and brand awareness through offline events, such as organizing in-person meetups in numerous cities, presenting at leading universities such as at the MIT Enterprise Forum,[14] and even running a globally recognized annual conference, QuantCon. The combined efforts of these online and offline initiatives paid off: The number of registered members in Quantopian's community surged from 35,000 in 2014 to 60,000 in 2015, then to 80,000 in 2016 and stood at more than 100,000 as of January 2017. In November 2016, Quantopian completed its Series C funding of US$25 million, led by Andreessen Horowitz, a leading VC firm that had in the past also invested in Airbnb, Facebook, GitHub, and Groupon.[15] This brought the total funding raised to US$48.8 million [see **Exhibit 4**].

Quantopian followed a classic freemium model. It offered most services such as backtesting and access to many databases for free. It only charged subscription fees for premium databases, such as CEO Changes (US$50/month) and Zacks Earning Surprise (US$25/month). As more advanced algorithms required broader data-feeds, there was a demand for such premium data. The company was experimenting with its own hedge fund, built on talent discovered in its community, the Quantopian Managers Program.[16] When working properly, Quantopian could effectively exploit the talent pool of its growing community for still greater financial gains. The fee structure would be similar to that of other hedge funds, e.g., an annual fee of 1% of assets under management (AUM), plus a performance-based fee, or it could be placed at an even more attractive level, given its unique talent-discovery approach.

The Competitive Landscape

Quantopian was by no means the first or only player that provided an algorithm-development platform in the investment field. Its closest competitor, QuantConnect, was founded in 2011, the same year that Quantopian was born.[17] The founders of QuantConnect first located their startup in Chile due to a government grant, but later moved to New York City.[18] On the surface, QuantConnect's services were almost identical to those Quantopian provided [see **Exhibit 8**]. In fact, QuantConnect provided even faster backtesting with its C# infrastructure, more financial instruments (e.g., options and futures), more order types (e.g., Market-on-Open), and more fine-grained data (i.e., tick-by-tick instead of minute-level trading data). Nonetheless, QuantConnect raised only approximately US$1 million in 2016[19] and grew its membership

[14] MIT FinTech (31 May 2015) "MIT FinTech Conference 2015: John Fawcett - CEO and Founder of Quantopian", https://www.youtube.com/watch?v=4LcKTIH6W7k (accessed 13 March 2017).

[15] Business Wire (14 November 2016) "Quantopian Raises US$25 Million in Series C Funding Round Led by Andreessen Horowitz", http://www.businesswire.com/news/home/20161114005847/en/Quantopian-Raises-25-Million-Series-Funding-Led (accessed 13 March 2017).

[16] For details, see Quantopian's website: https://www.quantopian.com/allocation (accessed 13 March 2017).

[17] For details, see QuantConnect's website: https://www.quantconnect.com/ (accessed 13 March 2017).

[18] Janowski, D. (2 July 2013) "QuantConnect Adds Data to Trading Platform, Builds Global Network", *InvestmentNews*, http://www.investmentnews.com/article/20130702/BLOG02/130709980/quantconnect-adds-data-to-trading-platform-builds-global-network (accessed 13 March 2017).

[19] For details, see QuantConnect's CrunchBase: https://www.crunchbase.com/organization/quantconnect#/entity (accessed 13 March 2017).

base to only about a quarter of Quantopian's as of January 2017. In terms of its revenue model, QuantConnect provided free basic backtesting services and charged a monthly subscription fee of US$20 for executing trading algorithms via a virtual private-server service.

Quantopian and QuantConnect also inspired global emulation. UQer (优矿) was founded in 2013 in Shanghai and adopted a freemium model - basic functions were free and advanced analytic tools or data packages could be had at a premium price - similar to Quantopian's business model.[20] Other platforms, such as EquitySim in Hong Kong, where traders built their paper-trading records on a stock simulator for job-seeking purposes, were also potential competitors. Nonetheless, Quantopian, QuantConnect and their imitators together presented a serious alternative and possible threat to a trillion-dollar industry: hedge funds.

The Hedge-Fund Industry and Quantopian's Impact

The Existing Model

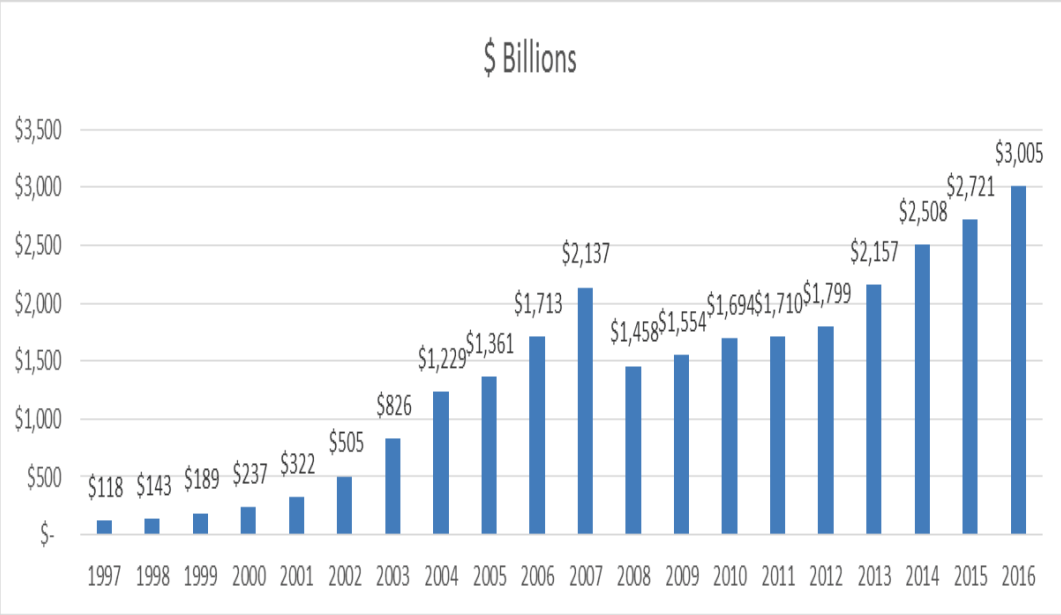
Hedge funds are alternative investments, using pooled funds that employ numerous different strategies to earn active return, or alpha, for their investors.[21] Hedge funds are different from other asset classes, such as mutual funds, because hedge funds have higher levels of discretion and flexibility over investments, but lower levels of disclosure or liquidity pressure. The hedge-fund industry, which burgeoned in the 1990s, grew extremely fast. According to Barclay Hedge, a consulting firm that tracks alternative investment classes worldwide, and illustrated in Figure 1 below, the industry reached US$3 trillion assets under management by the end of 2016. Common investment strategies adopted by hedge funds included equity hedge, event-driven, macro, relative value and fund of funds [see **Exhibit 6a**]. Legendary success stories such as George Soros (Quantum Fund) shorting the British pound in 1992, and John Paulson (Paulson & Co) betting against the U.S. subprime-mortgage loan market in 2007, painted an image of hedge funds as cruel, fearless and sharp financial animals. Nevertheless, hedge funds barely beat equity indices such as the S&P 500 Index overall over a long period. Figure 2 below shows annual returns of the SPY (S&P 500 Index ETF), hedge fund total index, and quantitative directional equity hedge fund index for the past two decades. In the most recent decade, SPY had a significantly greater 10-year buy-and-hold return (79.51%) than that of either the hedge fund total index (10.85%) or hedge fund equity hedge quantitative directional index (52.53%). Even legendary hedge funds, such as the Quantum Fund and Paulson & Co, that once upon a time made billion-dollar profits, suffered a billion-dollar loss in 2016.[22]

[20] For details, see UQer's website: https://uqer.io/home/ (accessed 13 March 2017).

[21] Investopedia (2017) "Hedge Fund", http://www.investopedia.com/terms/h/hedgefund.asp (accessed 10 March 2017).

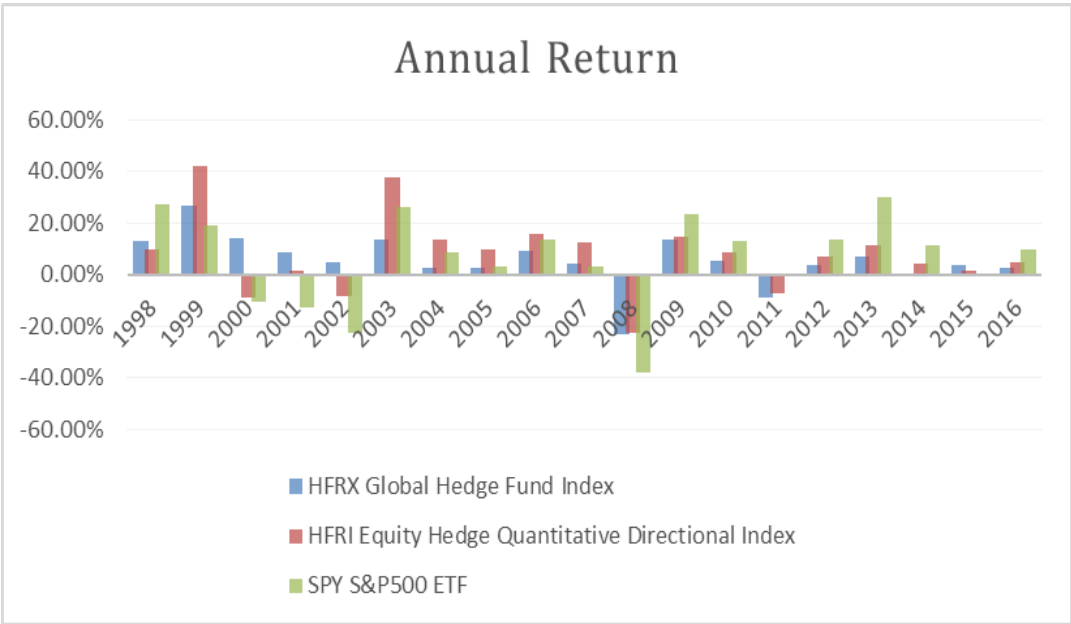
[22] Kumar, N. (1 February 2017) "Ray Dalio Makes Clients US$4.9 Billion in 2016 as Paulson, Soros Falter", *Bloomberg*, https://www.bloomberg.com/news/articles/2017-02-01/dalio-makes-clients-4-9-billion-in-16-as-paulson-soros-falter (accessed 13 March 2017).

Figure 1: Assets under Management (AUM) of the Hedge-Fund Industry



Data source: Barclay Hedge

Figure 2: Annual Returns of Hedge-Fund Indices and SPY



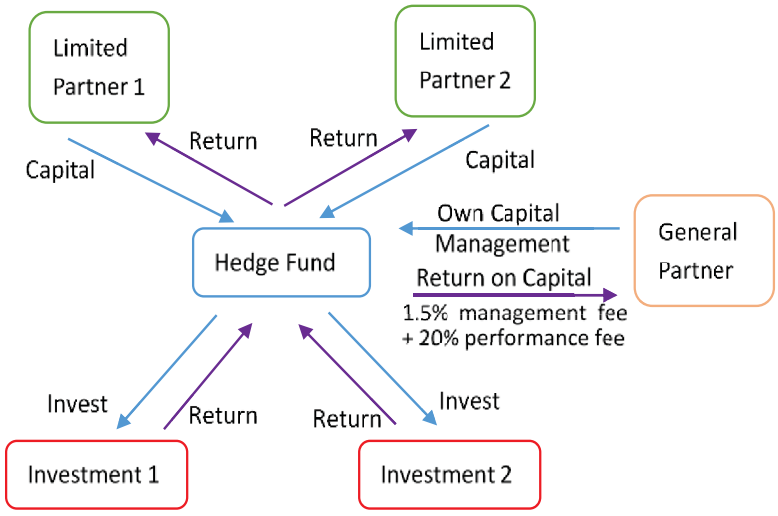
Data source: Bloomberg

Renaissance Technology, founded by James Simons, an award-winning mathematician, was perhaps the first highly successful hedge fund to apply mathematical models and algorithmic trading. The most famous quant hedge fund, however, was Long Term Capital Management (LTCM), which was founded by Wall Street veterans and Nobel laureates in 1994. Their enormous success in the mid-1990s and spectacular debacle after the Russian bond default in

1998, were documented in books such as *When Genius Failed.* Known as quant hedge funds, these funds differed from traditional hedge funds because they encrypted their strategies into mathematical models and computer programs - algorithms or "algos." They then executed their strategies with powerful computers and the lightning-speed internet in an automated manner. Some of the major benefits enjoyed by quant hedge funds included less emotional interruption, 24/7 and multi-market opportunity-discovery ability, less human cost and high frequency trading potential. Thus, investors' preference for quant hedge funds consistently increased over time.

Though quant hedge funds had become increasingly popular, the business model of the overall hedge-fund industry remained virtually unchanged. The most common structure of a hedge fund in the U.S. is shown in Figure 3 below. A fund was usually founded by one or more general partners (GP), who had extensive experience and broad social connections with related parties, such as law firms and brokerage firms. Interested clients invested their money and became limited partners (LP) of the fund. GPs and their fund managers raised capital from high-net-worth clients and institutional investors. Direct sales, either through investor engagement with management staff or the fund director's own marketing channels, was still the primary method of fundraising.[23] The PwC Global Hedge Fund Distribution Survey 2015 also indicated that the experience and reputation of hedge fund managers were two main drivers for investors in selecting funds [see **Exhibit 6b**]. The fee structures of most hedge funds were similar. They consisted of a small percentage (e.g., 1.5%) as a management fee and a larger (e.g., 20%) performance fee if the hedge fund achieved certain financial goals, such as making a profit net of all transaction costs and management fees. Quant hedge funds often recruited quants and analysts as full-time employees to develop models and algorithms. These models and algorithms were often considered key assets of those funds and kept proprietary.

Figure 3: Typical Structure of Hedge Funds in U.S.



[23] PwC (2015) "Global Hedge Fund Distribution Survey 2015", http://www.pwc.com/gx/en/industries/financial-services/asset-management/publications/hedge-fund-distribution-survey-2015.html (accessed 10 March 2017).

The existing hedge-fund model was facing continual pressure. A survey released by Ernst & Young (EY) in 2016 showed that asset growth and talent management were the two top strategic priorities and challenges facing hedge-fund managers [see **Exhibit 6c**].[24] As reported in the same survey, the hedge-fund industry was experiencing continual pressure on the cost-reduction side. The average management fee declined from 1.45% in 2015 to 1.35% in 2016, significantly below the former 2% management-fee benchmark [see **Exhibit 6d**]. On the talent side, it was well known that due to its highly competitive nature, the entire industry suffered from a lack of portfolio managers who could develop profitable strategies, otherwise referred to as "lack of alpha." Talented portfolio managers were rare animals. They often had impeccable educations from Ivy League schools and years of experience on Wall Street. By the time they founded their hedge funds, they could leverage their records to demand hefty fees from investors.

Potential to Change the Industry

Seeing the weakness of the traditional hedge-fund model, Quantopian aimed at revolutionizing the industry with a completely different mindset. In late 2015, Quantopian formally joined the game with its first "crowdsourced" hedge fund.[25] Unlike traditional hedge funds, Quantopian's fund did not hire quants from top universities or leading financial institutes, but crowdsourced algorithm development from its community.

Quantopian published the formal rules of its algorithm-selection and reward structure on its website. Beginning in Q1 2017, all algorithms with six months of out-of-sample testing results would be considered. Algorithm performance was evaluated on an ongoing basis using the same criteria as in the Quantopian Open. Once an algorithm was selected and licensed by its author(s), it would be allocated an average of US$5 to 10 million to start a micro hedge fund, with all administrative support coming from Quantopian. During the following period, the author could keep 10% of the net profit generated by the micro hedge fund, while retaining intellectual property rights to the algorithm.

Compared to the conventional model, Quantopian's new crowdsourced hedge fund solved many problems facing the industry. To investors, algorithms and their trading strategies were no longer a black box. Backtesting and out-of-sample paper-trading results were available to investors and could be compared. With Quantopian's model, people invested only in a trading strategy with outstanding and trustworthy backtest results, instead of seeking potentially talented hedge fund managers who claimed superior returns with self-generated backtest results. The transparency of the investment process would certainly boost the investor confidence that was critical for hedge funds.

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[24] Ernst & Young (2016) "Will Adapting to Today's Evolving Demands Help You Stand out Tomorrow?" http://www.ey.com/Publication/vwLUAssets/ey-2016-global-hedge-fund-and-investor-survey/US$FILE/ey-2016-global-hedge-fund-and-investor-survey.pdf (accessed 10 March 2017).

[25] Wigglesworth, R. (5 April 2016) "Fund Using Freelance Programmers Beats US Stock Market", *Financial Times*, https://www.ft.com/content/0808729a-faa6-11e5-b3f6-11d5706b613b (accessed 13 March 2017).

Besides the benefits to investors, the new crowdsourcing model opened a gate for thousands of quants who wanted to make money on their own ideas and millions of engineers, university students, researchers, and other non-professionals who aspired to become quants. Through this channel, the talent pool for quant hedge fund developers became significantly wider. Facilitated by Quantopian's easy-to-use coding platform and open community, anyone who had an interest in algorithm trading could easily learn the basics of programming and finance, develop an algorithm, and make money with their own talent. The talent base Quantopian gathered would be unprecedented.

Quantopian could also reduce the operational risks, as well as associated costs of traditional hedge funds. Instead of hiring full-time quants and, with much uncertainty, relying on them to develop profitable algorithms, Quantopian's crowdsourced hedge fund only signed contracts with quants whose algorithms had been carefully tested and benchmarked alongside numerous other algorithms. The risk of employing incompetent quants was therefore minimized and the costs associated with such employment significantly reduced. According to a recent Glassdoor survey, Citibank paid its quantitative analysts an average annual salary of US$148,000 in New York City, regardless of whether or not the quants were competent in producing profitable algorithms.[26] Based on Quantopian's 10% net profit rule, the author of an algorithm that was allocated Quantopian's goal of US$5 million and achieved an annual return of 15% would only cost the hedge fund US$75,000 annually. The fund also had a large algorithm pool, which allowed it to diversify across numerous algorithms with different approaches, thus reducing the systematic investment risk, such as over-investing using similar strategies, which had killed LTCM as a quant hedge fund.

Quantopian's crowdsourced hedge fund achieved a quarterly net gain of 1.93% in the first quarter of 2016, net of a common fee structure of a 2% management and 20% performance fee, compared with only a 0.8% increase in the S&P 500 during the same period.[27] Quantopian's move to a crowdsourced hedge fund and its initial performance caught the attention of Wall Street specialists and investors. In June 2016, Jonathan Larkin, a former portfolio manager at Hudson Bay Capital, was hired as Quantopian's chief investment officer.[28] In July 2016, Steve Cohen, the founder of Point72 Asset Management and an experienced hedge-fund manager who *Forbes* ranked the 72nd richest man in the world in 2016, invested US$250 million in Quantopian's crowdsourced hedge fund.[29]

[26] Glassdoor (2017) "Quantitative Analyst Salaries in New York City, NY," https://www.glassdoor.com/Salaries/new-york-city-quantitative-analyst-salary-SRCH_IL.0,13_IM615_KO14,34.htm (accessed 10 March 2017).

[27] Wigglesworth, R. (5 April 2016) "Fund using Freelance Programmers Beats US Stock Market", *Financial Times*, https://www.ft.com/content/0808729a-faa6-11e5-b3f6-11d5706b613b (accessed 10 March 2017).

[28] Wigglesworth, R. (6 June 2016) "Quantopian Hires Investment Chief Ahead of Investor Push", *Financial Times*, https://www.ft.com/content/a31f1f2a-29d3-11e6-8b18-91555f2f4fde (accessed 13 March 2017).

[29] Hall, T. (28 July 2016) "Point72's Cohen Bets US$250 Million on Crowd-Sourced Quantopian", *Bloomberg*, https://www.bloomberg.com/news/articles/2016-07-27/point72-s-cohen-bets-250-million-on-crowd-sourced-quantopian (accessed 13 March 2017).

Crowdsourcing Model in Fintech

General Crowdsourcing Models

Jeff Howe first proposed "crowdsourcing" as a unique business model in 2006.[30] Crowdsourcing meant that business operations, such as design or production, could be outsourced to a large population of unknown people, particularly through online channels. The next decade witnessed the flourishing of crowdsourcing in many different industries. Howe identified four types of crowdsourcing models in 2009.[31] Inspired by his work, three types of crowdsourcing models, with different levels of crowd involvement in business operations, have been identified as follows:

1) Crowd Judgment. Assuming that each user is an independent "judge," a crowd judgment model pools judgments or ratings from a large member pool to reach a collective opinion. The level of crowd involvement remains shallow, as members merely contribute simple numbers or brief comments. For example, TripAdvisor members rate and comment on each place (from tourist sites to hotels to restaurants) that they have visited on tours or vacations. TripAdvisor is therefore able to aggregate ratings and comments from a crowd of unknown users to evaluate millions of tourist sites. A similar crowd-judgment model is present in virtually all professional-service businesses, such as doctors, lawyers, professors, VC firms and even in relation to stock-market predictions.

2) Crowd Resource. A crowd-resource model pools slack or fragmented resources from a crowd of unknowns to achieve its business goals. Going beyond quick ratings or brief comments, a crowd-resource model, at almost no cost to itself, asks the crowd to contribute real resources such as financial capital or slack computing power. For instance, Collaction is a platform where social-activity initiators indicate the resources that they need, such as used phones and ask for contributions from the public. Crowdfunding platforms such as Kickstarter or Indiegogo, which enable startups or project initiators to raise funds, are also good examples.

3) Crowd Wisdom. This last type, and the one with the highest level of crowd involvement, curates thoughts and synthesizes collective intelligence from a crowd of unknowns to accomplish more sophisticated business tasks, such as design and research. The crowd, instead of contributing simple ratings (Crowd Judgment) or donating resources (Crowd Resource), often contributes to the community via extensive discussion, coordination and frequent modification. Local Motors, for example, is a U.S. automobile manufacturer that relies on its designer community to create automotive designs. The company then joins with its customers to assemble the automobiles in micro-factories.[32]

[30] Howe, J. (1 June 2006) "The Rise of Crowdsourcing", *Wired*, https://www.wired.com/2006/06/crowds/ (accessed 13 March 2017).

[31] Howe, J. (2009) *Crowdsourcing: How the power of the crowd is driving the future of business*. New York: Crown Business.

[32] For details, see Local Motor's website: https://www.localmotors.com/ (accessed 13 March 2017).

Applications of Crowdsourcing in Fintech

Financial technology or Fintech, a combination of finance and technology, is an on-going trend that challenges all aspects of the financial sector. For example, marketplace or P2P lending undermines the foundation of commercial bank loan services. Robot advisory or automated financial-advice services disrupt the conventional services provided by human financial advisors. Crowdfunding portals provide alternative fundraising channels for millions of individuals and startups. Cryptocurrencies (such as Bitcoin) inspired Fintech entrepreneurs to develop novel services in currency exchange, payment, and remittance. [See **Exhibit 7** for Fintech categories and examples.]

One Fintech trend is crowdsourcing. Many professions, such as financial advisors, financial analysts, venture capitalists, and credit-rating agencies, have long been dominated by specialists with extensive experience and special certificates, such as the CFA designation (chartered financial analyst). Nonetheless, crowdsourcing is becoming a feasible alternative model that disrupts fields that were dominated by professionals and specialists in the past. Here are a few examples of crowdsourcing models in Fintech:

Table 1: Crowdsourcing Business Models in Fintech

Company	Sub Industry	Crowdsourcing Application	Type of Crowdsourcing
Vetr	Stock Advisory	Stock monitoring, rating and prediction by crowd users	Crowd Judgment
Estimize	Market Forecast	Crowdsourced earnings and economic forecasts	Crowd Judgment
Augur	Market Forecast	Market-event prediction by means of the price of crowd-traded one-dollar shares, facilitated by Blockchain	Crowd Judgment
Kickstarter	Venture Funding	Seed funding for new ventures in the form of crowd pre-orders	Crowd Resource
CircleUp	Venture Funding	Equity crowdfunding for consumer product ventures	Crowd Resource
Quantopian	Hedge Fund	Quant hedge fund with crowdsourced trading algorithms	Crowd Wisdom
Numerai	Hedge Fund	Macro hedge fund with crowdsourced mathematical models	Crowd Wisdom

Crowdsourced Hedge Fund: Wall Street vs. Crowd Wisdom

Crowdsourcing models seemed to have a promising future as a new approach to solving existing inefficiencies in the hedge-fund industry. Quantopian's crowdsourced hedge fund, however, also faced criticism and practical challenges. The success of such a new model clearly depended on how Quantopian addressed these concerns.

Challenges of the New Model

The first challenge Quantopian faced was the generally low quality of its community members. Despite its large membership base, the majority of Quantopian's community members were amateurs. Even though Quantopian had engaged in educating its members and provided easy-

to-use tools, algorithmic trading was still not an easy job. A feasible and profitable strategy usually required a deep understanding of financial markets and their operations, where education, experience and professional training all helped. For example, a sample algorithm on "Kalman Filtering pairs trading" provided by Quantopian had 260 lines.[33] To understand and further build an algorithm on this strategy required sophisticated knowledge of the CAPM model and the Python language. Without enough talented quants, the community would become stagnant and its algorithms uncompetitive.

The second hurdle was that its relatively small allocation to each algorithm and 10% performance fee might not seem attractive when compared to Wall Street salaries. As of January 2017, even with the money raised from investors, Quantopian could only allocate less than US$5 million per algorithm.[34] Even if the algorithm performed quite well, with a monthly return of 1%, annualized to 12.7%, the performance fee the author could collect would be no more than US$5,000 per month. Wall Street could offer quants significantly more attractive remuneration packages. According to a 2017 survey by Glassdoor, Citibank paid its quantitative analysts an average annual salary of US$120,695[35], or around USUS$10,000/month, apart from the employer's visibility and other on-the-job benefits. If a quant could stand out in Quantopian's contests, why wouldn't she or he seek a better-paid position on Wall Street?

The third challenge for Quantopian was the contradiction between its pursuit of open community and each member's profit-taking motives. Quantopian started as an open community where members shared their code, provided suggestions to others and actively interacted with one another. With the emergence of a profit opportunity, concerns about "algorithm-stealing" and the feeling that "I am helping others to make money without a reward" could erode fundamental community spirit. After all, Quantopian was not like open-source software such as Linux, where members contributed without any material return because the software would benefit a large public and the contributors earned non-pecuniary returns (such as reputation). Such a psychological contract was breached at Quantopian, because the benefit from a profitable algorithm was completely private and exclusive. This issue appeared to be trivial because fund size and profit potential were still negligible compared to regular hedge funds, but it would surface or even escalate when these became substantial.

Other concerns needed to be addressed. For instance, Quantopian's control over its algorithm authors was weak compared to how hedge-fund firms managed their full-time employees. This left room for unethical behavior such as front-running (taking action in the stock market before other players, based on insider knowledge). For example, a winner of the Quantopian Open who later joined the Quantopian Managers Program was supposed to carry out transactions with his own algorithm but with Quantopian's money, could front-run by buying the same equities

[33] Edwards, D. (6 August 2015) "Quantopian Lecture Series: This Time You're More Wrong," https://www.quantopian.com/posts/quantopian-lecture-series-this-time-youre-more-wrong (accessed 10 March 2017).

[34] For details, see Quantopian's website: https://www.quantopian.com/allocation (accessed 13 March 2017).

[35] Citi Quantitative Analyst Salaries. (2017, May 7). Retrieved May 17, 2017, from https://www.glassdoor.com/Salary/Citi-Quantitative-Analyst-Salaries-E8843_D_KO5,25.htm

a little earlier with his own money, thus making a profit. In the long run, Quantopian needed to develop its own internal control mechanisms to enhance external stakeholders' trust and deal with future regulatory scrutiny.

Crowd Wisdom vs. Wall Street Elites

Besides the aforementioned technical and operational challenges, a more interesting question faced many similar businesses that relied on "collective intelligence": could crowd wisdom outperform a specific group of highly trained elite professionals?

Evidence from academia is still thin, but recent research seems to support the claim that a crowd of unknowns perform as well as professionals, or even better in certain circumstances. In one study with a sample of 120 art projects on Kickstarter, the largest donation-based crowdfunding platform, researchers found that a crowd and a group of invited experts often converged on similar funding decisions. For those projects on which experts and crowds diverged, no significant difference in terms of project quality was found.[36] In another study on prosper.com, the second-largest marketplace or peer-to-peer lending platform in the U.S., researchers found that crowd lenders predicted a borrower's likelihood of default on a loan with 45% greater accuracy than the borrower's credit score, as calculated by an official system designed by professionals.[37]

Other crowd-wisdom hedge-fund models exist. Numerai, founded in 2015, joined this trend but with an entirely different approach.[38] Unlike Quantopian, which crowdsourced algorithm development, Numerai crowdsourced predictions with data analysis. Specifically, Numerai users developed their own prediction models, such as the logit regression, to predict an event, such as an increase in the Apple stock price, with a "training dataset" Numerai provided. Users then applied their models to predict events with all the inputs from another "tournament dataset." Numerai intentionally inserted some past events with known outcomes in the "to be predicted" column, and used these known outcomes to evaluate a model's predicting power. Depending on this predicting power, Numerai determined whether, and to what degree, it would utilize the model to predict the remaining "unknown" events. The greater predictive power a model had, the more monetary reward the author could claim. As opposed to Quantopian's open discussions, Numerai users did not disclose any information about their models. They only needed to submit the predictions—numbers ranging from 0 to 1 indicating probability—calculated from their models. Numerai did not disclose the real meaning behind each "training dataset" or "tournament dataset." This approach leveraged crowd wisdom and at the same time ensured member privacy and intellectual property ownership.

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[36] Mollick, E. and Nanda, R. (2015) "Wisdom or Madness? Comparing Crowds with Expert Evaluation in Funding the Arts", *Management Science*, 62(6), pp.1533-1553.

[37] Lyer, R., Khwaja, A.I., Luttmer, E.F.P. and Shue, K. (2015) "Screening Peers Softly: Inferring the Quality of Small Borrowers", *Management Science*, 62 (6), pp.1554-1577.

[38] For details, see Numerai's website: https://numer.ai/ (accessed 13 March 2017).

Looking Forward: Endless Possibilities

As the founder-CEO of a five-year old startup, Fawcett was still contemplating fundamental questions about the viability and sustainability of the company's novel business model. In fact, there were momentous possibilities for the Fintech startup. Quantopian could feasibly diversify or shift away from its crowd-wisdom hedge-fund model.

Quantopian provided a common ground for quant traders to evaluate their trading algorithms. It had developed a comprehensive scoring system with several performance metrics for different algorithms. With the increasing popularity of algorithm trading and the ever-growing popularity of its platform, was it possible for Quantopian to transform into a rating agency for all quant hedge funds, like Morningstar.com for mutual funds?

Due to its user-friendliness and community-development efforts, some institutions of higher learning such as New York University began to use Quantopian as a teaching tool in their finance courses.[39] Students developed and tested their portfolio management and trading strategies with tools and data provided by Quantopian. Online lectures on financial theory by MIT professors were also now available on Quantopian's platform.[40] Could Quantopian tap into higher education? For example, could it develop teaching and assessment tools and packages, and become a CFA-like institute?

More and more users on Quantopian started to include the backtesting performance of their algorithms in their CVs or LinkedIn profiles to help find better employment [see **Exhibit 9].** For a new graduate who wanted to be a quant, what could be more convincing when job-hunting than a brilliant algorithm tested by credible tools? Was it possible for Quantopian to convert itself into a human-resources platform for quants and related professionals, in the manner of a mini-LinkedIn?

[39] NYU Stern (2017) "Portfolio Management", http://web-docs.stern.nyu.edu/old_web/finance/docs/pdfs/Outlines/2017-1/1701-b403332.30-koijen.pdf (accessed 13 March 2017).

[40] Granizo-Mackenzie, D. (16 July 2015) "The Quantopian Summer Lecture Series has Arrived", https://www.quantopian.com/posts/the-quantopian-summer-lecture-series-has-arrived (accessed 13 March 2017).

EXHIBIT 1A: QUANTOPIAN'S HOME PAGE

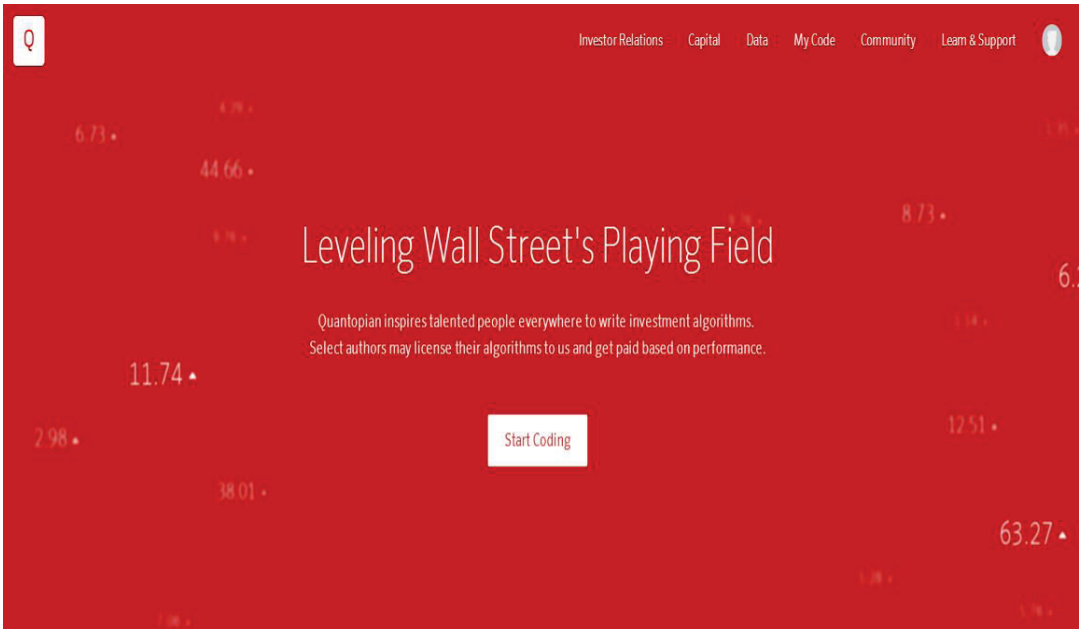


EXHIBIT 1B: ALGORITHM BUILDER AND BACKTESTER

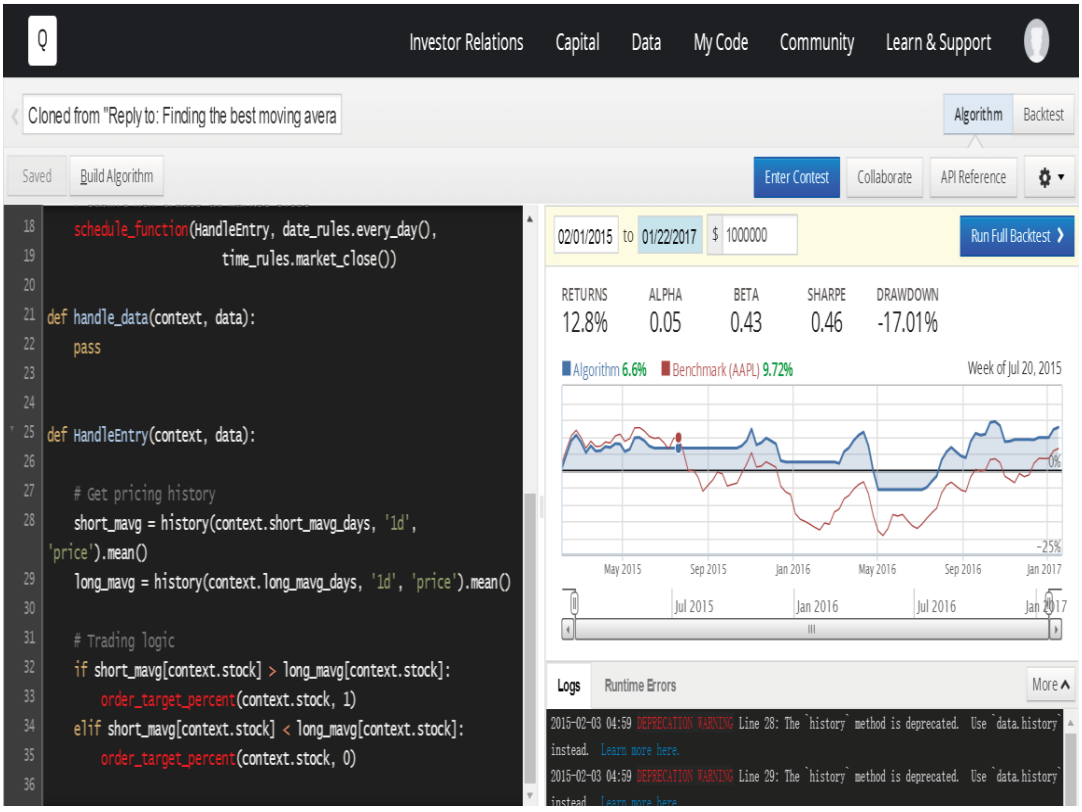
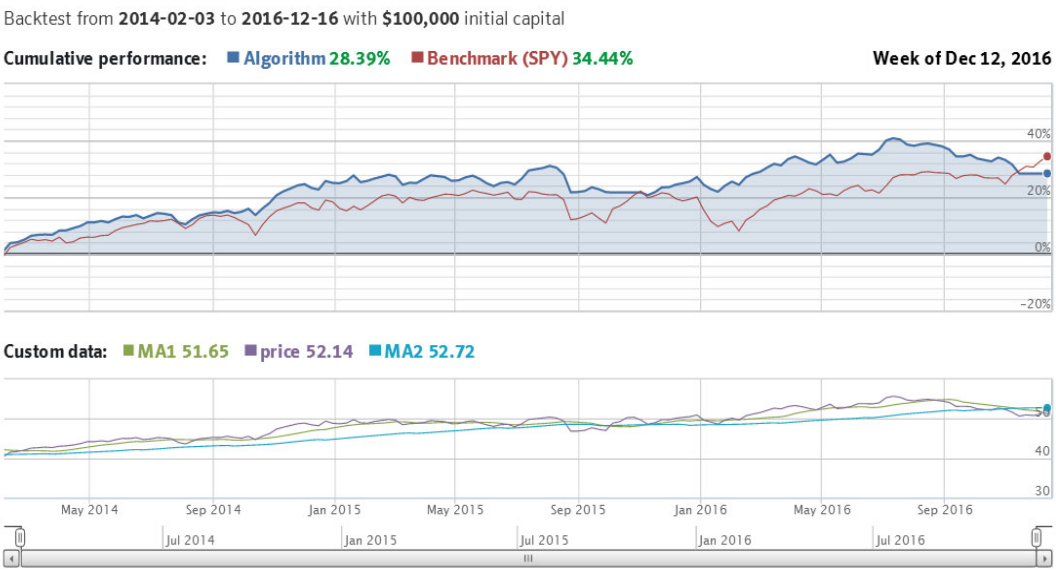


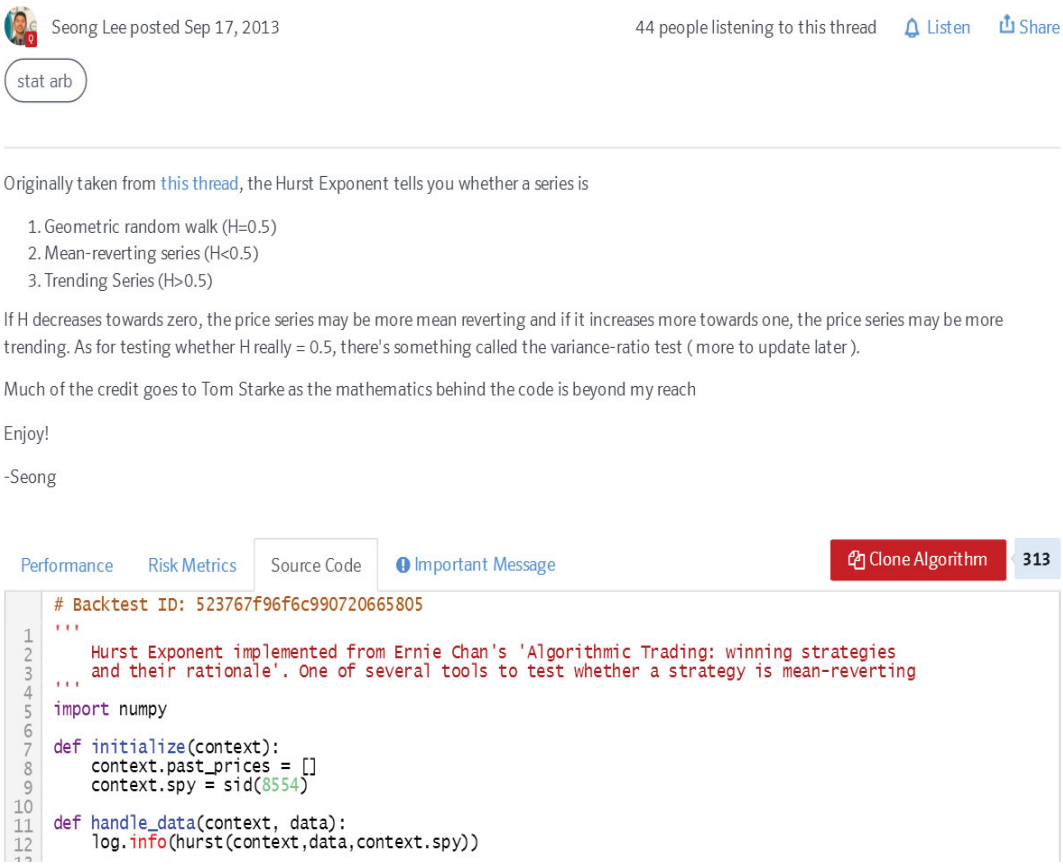
EXHIBIT 2: A SIMPLE "MOVING AVERAGE CROSSOVER" ALGORITHM

```
# Backtest ID: 585883468b5c015e86a4bd1b
# MAC 50-200

def initialize(context):
    schedule_function(trade, date_rules.every_day(), time_rules.market_close(minutes = 60))

def trade(context, data):
    stock = symbol('XLP') # EGLT

    price = data.current(stock, 'price')
    mavg_fast = data.history(stock, 'price',  50, '1d').mean()
    mavg_slow= data.history(stock, 'price',  200, '1d').mean()

    if get_open_orders(stock): return

    if mavg_fast > mavg_slow  and data.can_trade(stock):
        order_target_percent(stock, 1.0)
    elif mavg_fast < mavg_slow and data.can_trade(stock):
        order_target(stock, 0)

    record(MA1= mavg_fast, MA2 = mavg_slow, price = price)
```



Total Returns	Alpha	Beta
0.28	0.02	0.65
Sharpe	**Sortino**	**Max Drawdown**
0.81	1.16	-0.10
Benchmark Returns	**Volatility**	
0.34	0.12	

EXHIBIT 3: THOUGHTS AND SOURCE CODES SHARED ON QUANTOPIAN



Seong Lee posted Sep 17, 2013 — 44 people listening to this thread — Listen — Share

stat arb

Originally taken from this thread, the Hurst Exponent tells you whether a series is

1. Geometric random walk (H=0.5)
2. Mean-reverting series (H<0.5)
3. Trending Series (H>0.5)

If H decreases towards zero, the price series may be more mean reverting and if it increases more towards one, the price series may be more trending. As for testing whether H really = 0.5, there's something called the variance-ratio test (more to update later).

Much of the credit goes to Tom Starke as the mathematics behind the code is beyond my reach

Enjoy!

-Seong

Performance | Risk Metrics | Source Code | Important Message — Clone Algorithm 313

```
# Backtest ID: 523767f96f6c990720665805
'''
    Hurst Exponent implemented from Ernie Chan's 'Algorithmic Trading: winning strategies
    and their rationale'. One of several tools to test whether a strategy is mean-reverting
'''
import numpy

def initialize(context):
    context.past_prices = []
    context.spy = sid(8554)

def handle_data(context, data):
    log.info(hurst(context,data,context.spy))
```

EXHIBIT 4: FUNDING INFORMATION OF QUANTOPIAN

Date	Amount/ Round	Lead Investor	Co-investors
Jan 2013	US$2.1M / Seed	Spark Capital	GETCO
Oct 2013	US$6.7M / Series A	Spark Capital	Khosla Ventures
Oct 2014	US$15M / Series B	Bessemer Venture Partners	Khosla Ventures; Spark Capital; Wicklow Capital
Nov 2016	US$25M / Series C	Andreessen Horowitz	Bessemer Venture Partners; Point72 Ventures
Total	**US$48.8M**		

EXHIBIT 5: CRITERIA OF QUANTOPIAN OPEN CONTEST

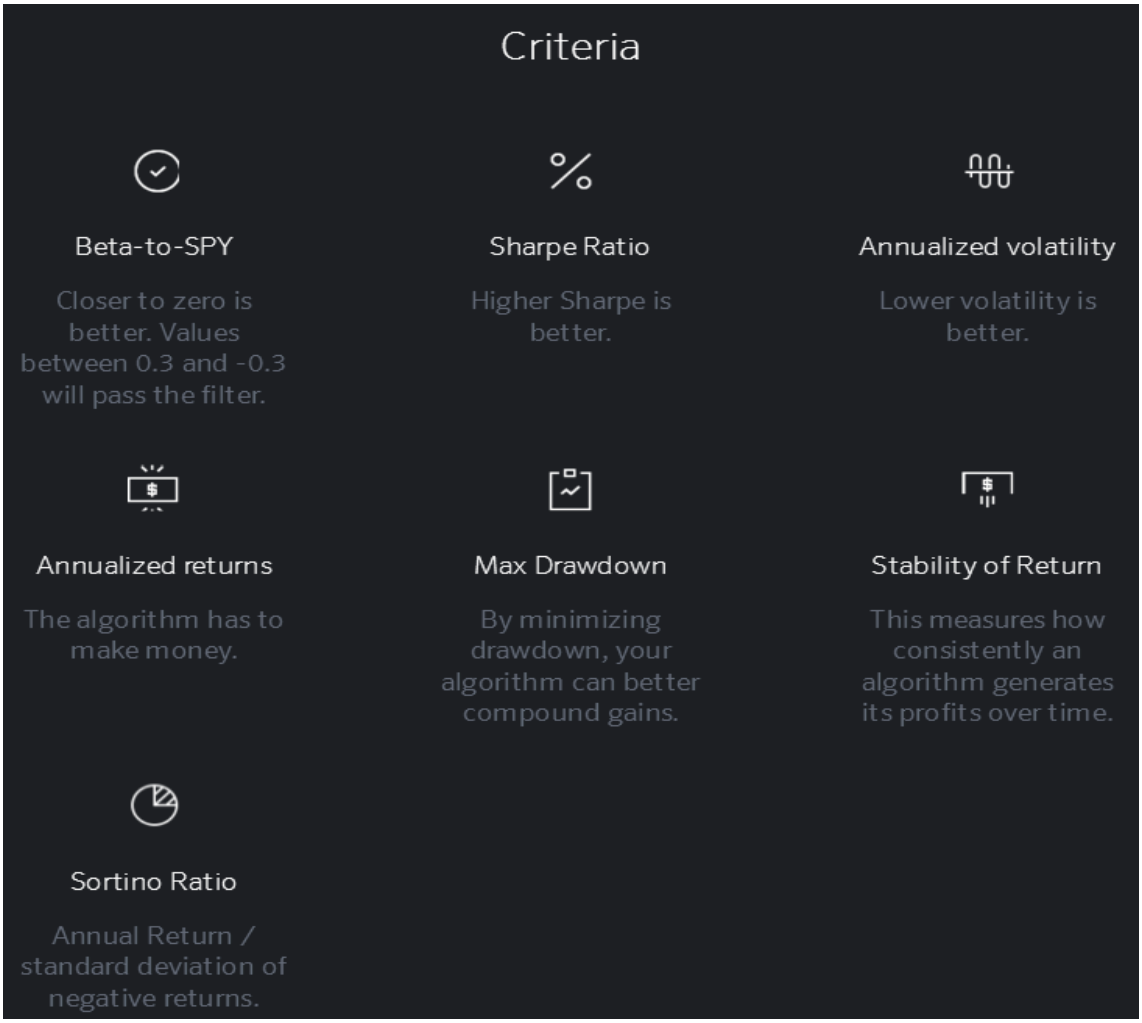


EXHIBIT 6A: HEDGE FUND STRATEGY CLASSIFICATION

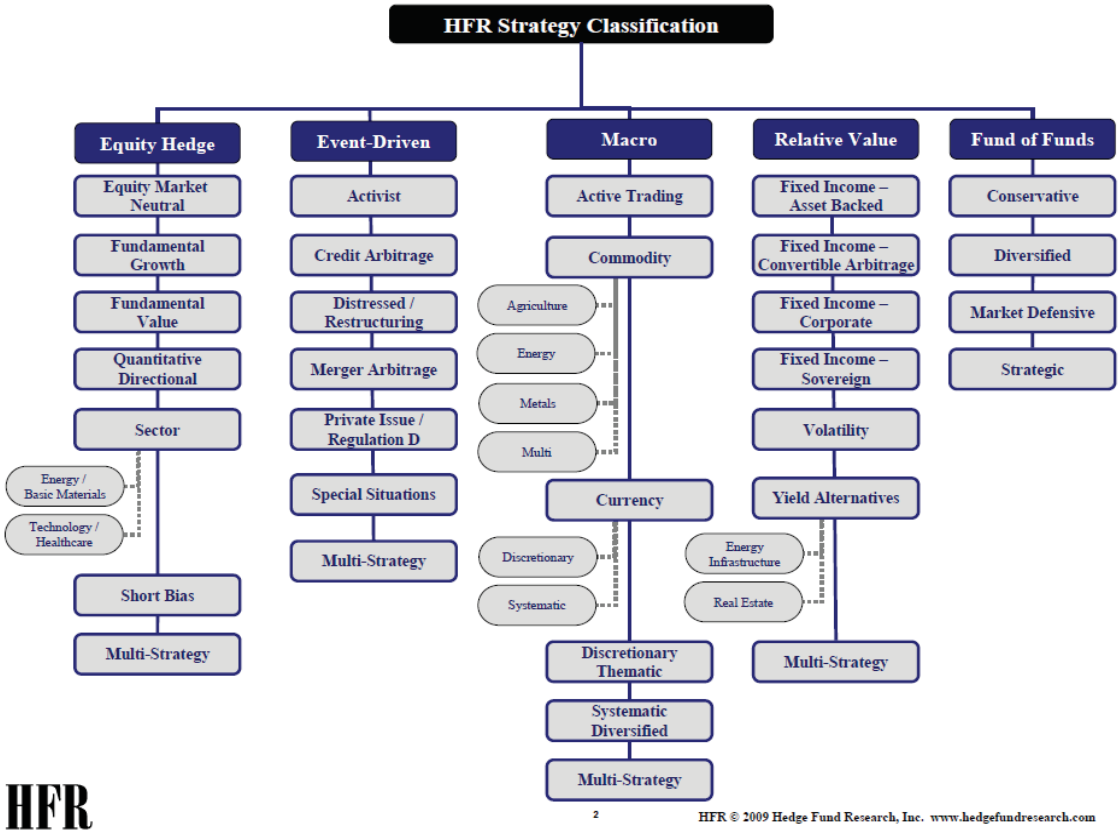


EXHIBIT 6B: KEY DRIVERS FOR INVESTORS WHEN SELECTING HEDGE FUNDS

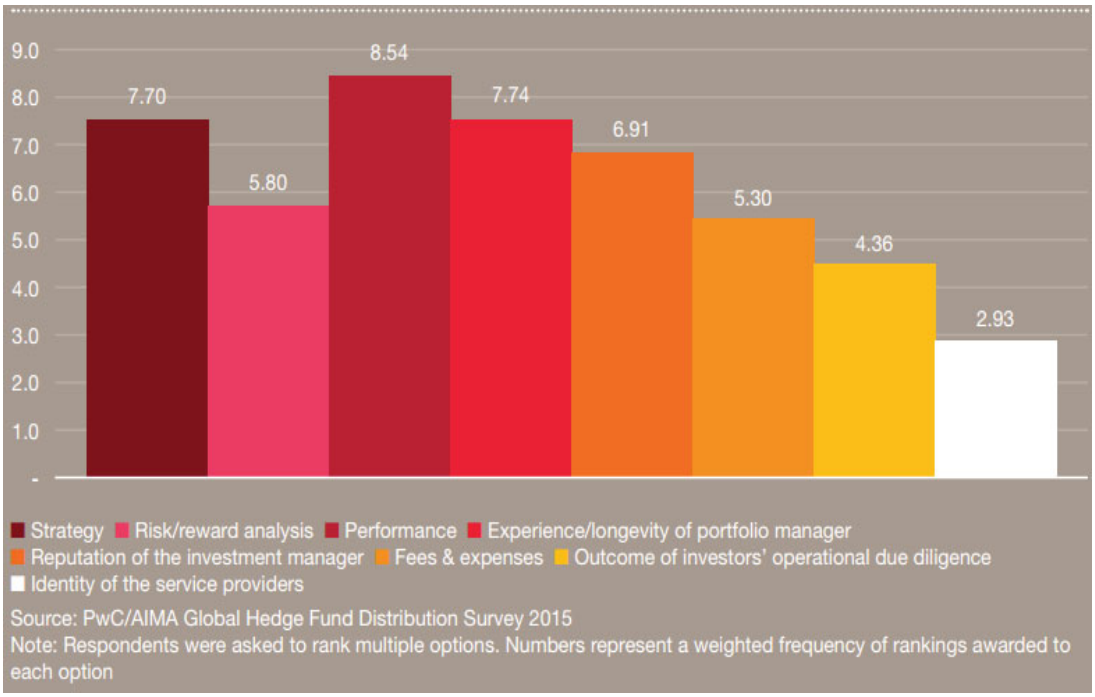


EXHIBIT 6C: STRATEGIC PRIORITIES FOR HEDGE FUND MANAGERS IN 2016

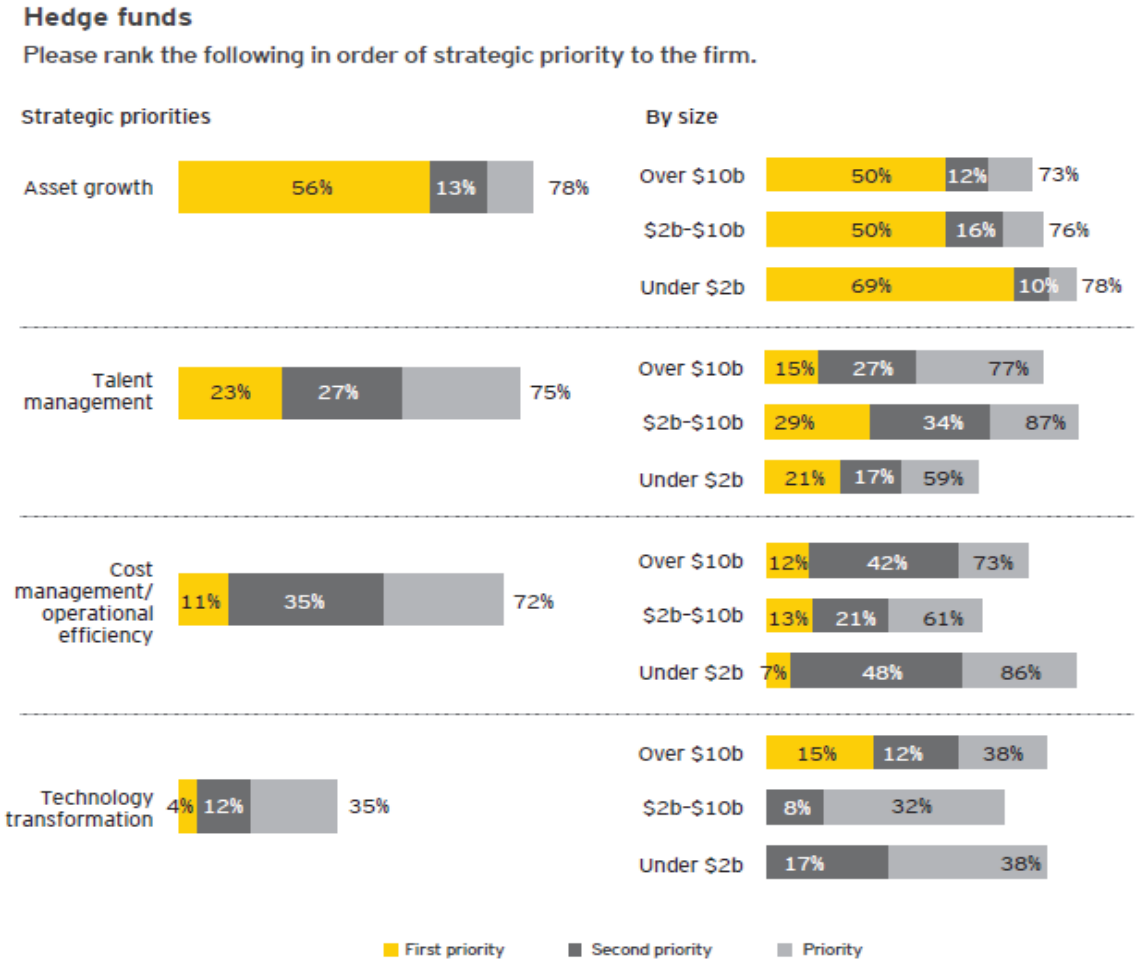
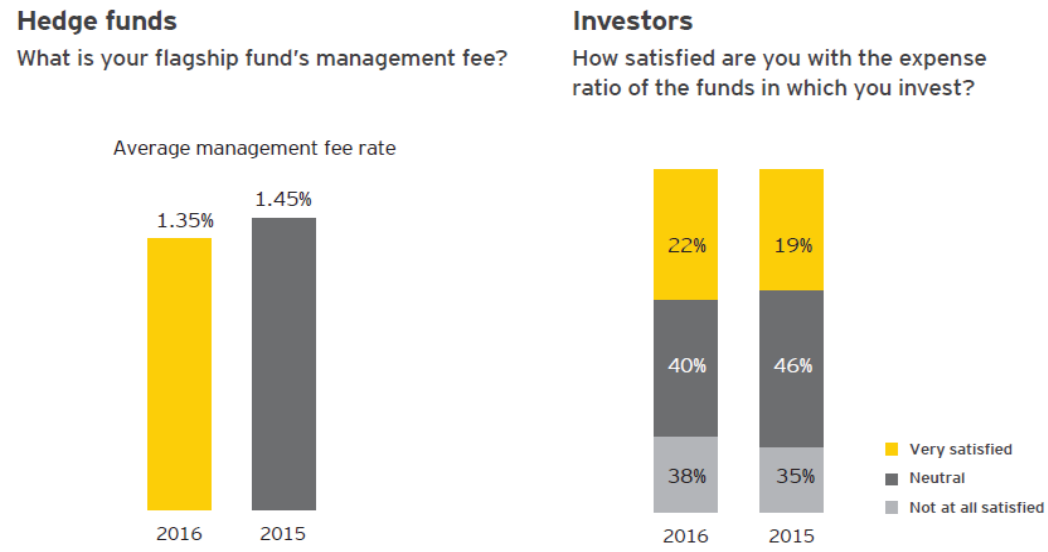


EXHIBIT 6D: MANAGEMENT FEE AND INVESTORS' RESPONSE



Source: EY (2016) "Will adapting to today's evolving demands help you stand out tomorrow?"

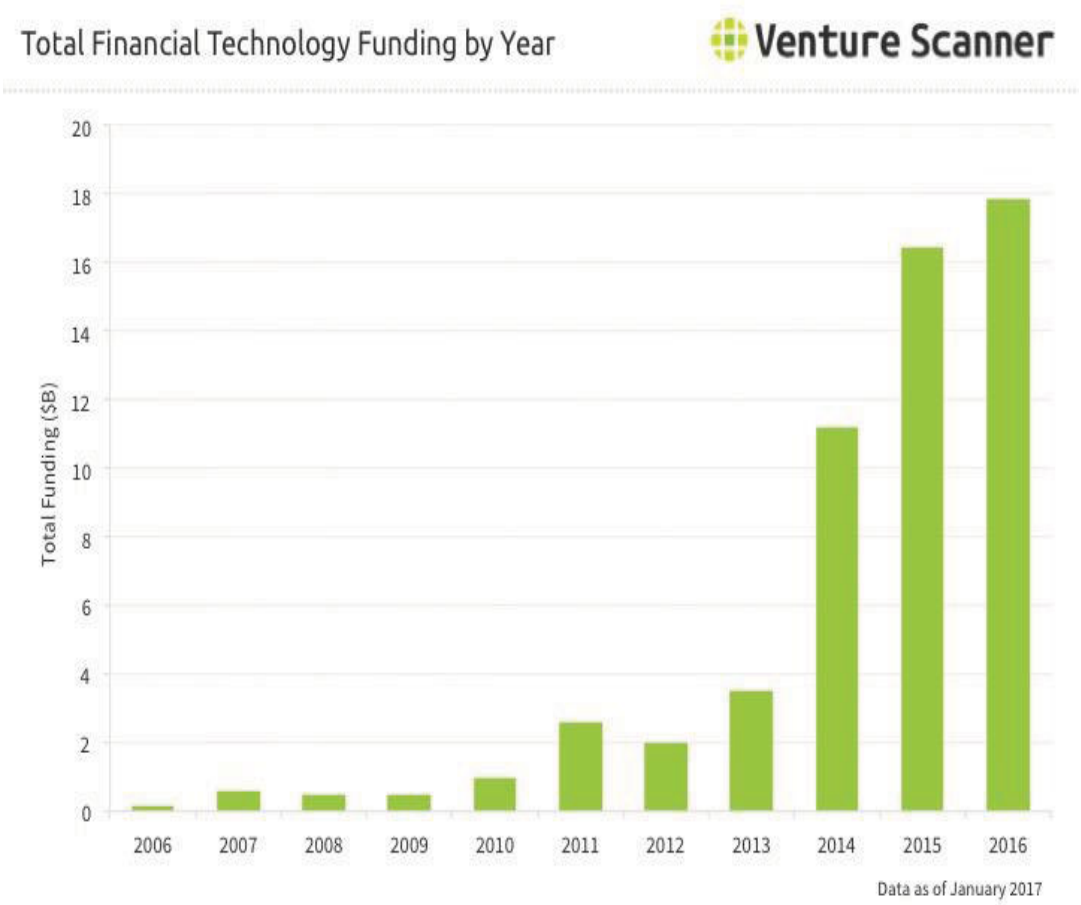
EXHIBIT 7A: FINTECH CATEGORIES

Category	Description
Business Tools	Offer solutions that help small and medium-sized businesses manage their finances. Examples include tools for taxes, payroll, invoicing, and accounting.
Crowdfunding	Provide new methodologies to raise non-equity and non-debt financing. Examples include crowdfunding platforms for products, social causes, and creative projects.
Equity Financing	Allow private businesses to raise capital in exchange for equity and for investors to participate in private securities markets. Examples include crowdsourcing equity platforms and secondary market solutions.
Infrastructure	Improve the operations of financial institutions. Examples include API integration with banks, white-label mobile solutions, and big-data analytics.
Institutional Investing	Help wealth managers, hedge fund managers, and professional traders to manage their portfolios and optimize returns. Examples include tools for stock sentiment analysis, alternative investment platforms, and algorithmic trading tools.
Lending	Offer new ways for businesses and consumers to raise debt financing and have their credit risk assessed. Examples include peer-to-peer lending platforms, asset-based lines of credit, consumer credit scoring services, micro-financing, and big data risk analytics
Online Banking	Allow businesses and consumers to access banking services via online or mobile channels. Examples include Internet-only banking services and virtual credit cards.
Payments	Offer technology and services centered on payment issuers and consumers. Examples include mobile wallets, credit card aggregators, prepaid card innovations, and peer-to-peer payments.
Personal Finance	Provide improved personal finance management for customers. Examples include tools for tracking expenses, managing budgets, addressing wrongful credit card charges, and optimizing credit card rewards.
Remittance	Allow businesses and individuals to send money domestic or abroad easily and cheaply. Examples include remittances via cryptocurrencies and mobile top-off services.
Research and Data	Provide information services that enable investors to make better investment decisions. Examples include news, research, and data sources.
Retail Investing	Provide new ways for consumers to improve their investment return and experience. Examples include theme-based investments, crowdsourced investment expertise, unbiased algorithmic investment advice, and investment social networks.
Security	Provide solutions to secure transactions, authenticate users, and prevent fraud. Examples include identify verification, big data analytics, and fraud detection algorithms.

Source: Venture Scanner

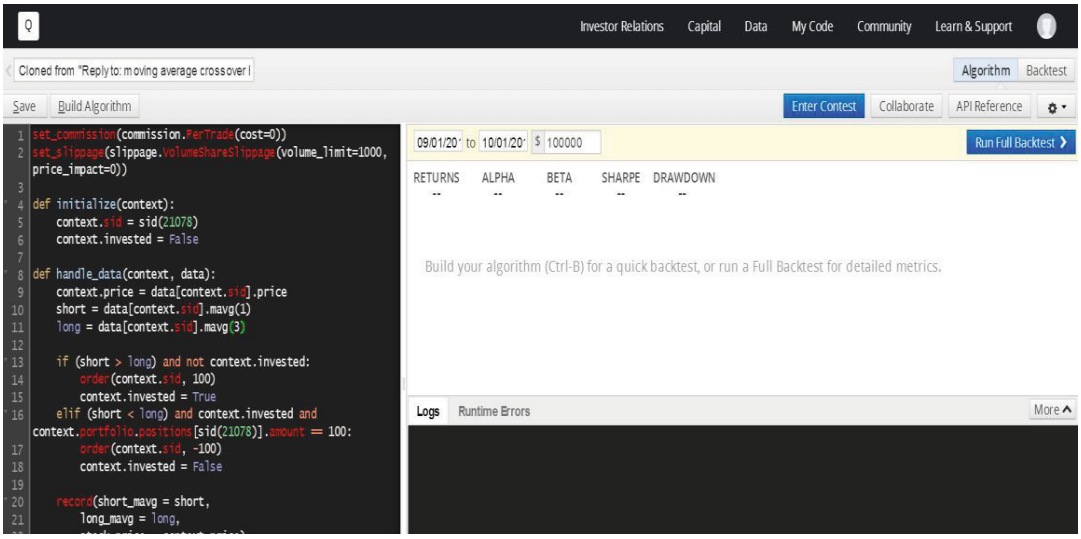
EXHIBIT 7B: REPRESENTATIVE FINTECH STARTUPS

EXHIBIT 7C: ANNUAL TOTAL FUNDING ON FINTECH STARTUPS



Source: Venture Scanner

EXHIBIT 8A: QUANTOPIAN'S AND ITS COMPETITORS' USER INTERFACE



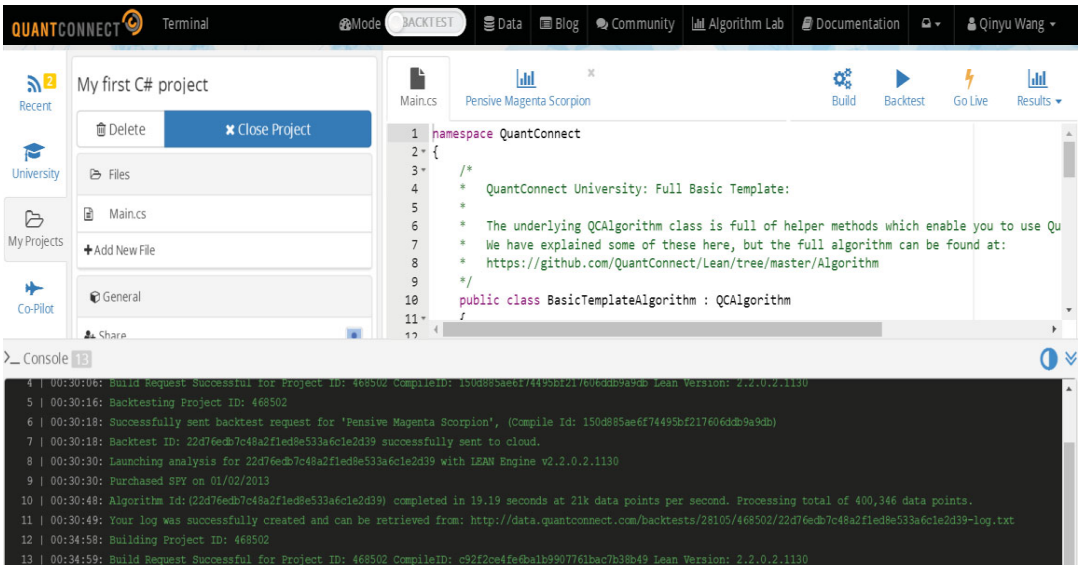


EXHIBIT 8B: SUMMARY TABLE OF QUANTOPIAN AND ITS COMPETITORS

Items	Quantopian	QuantConnect	UQER
Programme Language	Python	fully support C# beta support Python, F#, Visual Basic and Java	Python
Supported Brokerage	IB, Robinhood	FXCM, IB, Oanda	
Supported Live Trading Instruments	US Stocks, ETFs	US Equities, Forex, CFD, Options, Futures	China Equities, Listed Open-Ends Funds
Supported Paper Trading Instruments	US Stocks, ETFs	US Equities, Forex (options, futures in beta version)	China Equities, Listed Open-Ends Funds, Futures
Number of Users	more than 100000	more than 28500	
Earliest Backtest Date	2002/1/1	1998/1/1	2006/1/1
Comission Fee and Slippage Model	supported	supported	supported
Precisest Backtest Level	minute	tick	minute
Fundamental Data Source	Morningstar	Morningstar	
Supported Order Type	Market Order, Stop Market Order, Limit Order, Stop Limit Order	Market Order, Market On Open, Market On Close, Stop Market Order, Limit Order, Stop Limit Order	Market Order, Limit Order
Get Filled Price of Market Order in Backtest	unsupported	supported	unsupported
numpy, scipy, pandas, ta-lib	supported	unsupported	supported
Backtest Speed	generally slower than quantconnect	generally faster than quantopian	
Vectorized or Event Driven Backtesting	Event Driven Backtesting	Event Driven Backtesting	Event Driven Backtesting

Note: comparison made as of Mar 13, 2017

EXHIBIT 9: SPENCER SINGLETON, THE WINNER OF QUANTOPIAN OPEN CONTEST

Spencer Singleton 3rd

Student

Houston, Texas Area | Logistics and Supply Chain

Current Texas A&M University
Previous EDF Trading
Education Texas A&M University

Send Spencer InMail

71 connections

https://www.linkedin.com/in/spencer-singleton-792ba9b4

Background

Experience

Student
Texas A&M University
August 2013 – Present (3 years 7 months)

Honors & Awards

Winner, Quantopian Open Algorithmic Trading Contest
Quantopian
July 2015

Won the July 2015 Quantopian Open Algorithmic Trading Contest, using a long/short statistical arbitrage strategy written in Python.

Source: LinkedIn[41]

[41] https://www.linkedin.com/in/spencer-singleton-792ba9b4/ (accessed 13 March 2017).