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DARTMOUTH COLLEGE

Repcoin: The Only Reputation Market

by

Matthew Ritter

Dartmouth Computer Science Technical Report TR2015-782

A thesis submitted in partial fulfillment for the degree of
Bachelor of Arts

in the

Department of Computer Science

June 2015

Contents

Abstract	iii
1 What is Repcoin?	1
1.1 The Problem with Reputation	1
1.1.1 Finding the Right Content	1
1.1.2 Finding Trustworthy Content	1
1.1.3 Creating an Internet Presence	2
1.2 Existing Solutions	2
1.2.1 The Reputation of Things	2
1.2.2 Domain-Specific Reputation	2
1.2.3 Real-Life Reputation	3
1.3 The Power of the Market	4
1.4 The Repcoin Paradigm	5
1.4.1 How it Works	5
1.5 Applications	6
1.5.1 Content Discovery	6
1.5.2 Prediction Market	6
1.5.3 Social Rewards Network	7
2 User Interface and Experience	8
2.1 Onboarding	8
2.1.1 Login	8
2.1.2 Prompts to Get Involved	9
2.2 Finding the Right Experts	10
2.2.1 Home Page	10
2.2.2 Categories Page	10
2.2.3 Category Page	11
2.2.4 Search Bar	11
2.3 Making an Investment	11
2.4 Paying Dividends	12
2.5 Staying Engaged	13
2.5.1 The Feed	13
2.5.2 Trending Tables and Leaderboards	14
2.5.3 Tracking Progress	14
3 The Repcoin Guts	15
3.1 Top Level View	15

3.2	Some Component Details	16
3.2.1	Image Management	16
3.2.2	MongoDB for Complex data	17
3.2.3	Content Moderation System	18
3.2.4	Search Bar and Latency	19
3.3	Building a Data Pipeline	19
3.4	Testing	20
4	Problems and Solutions	21
4.1	Cleaning up for Beta Release	21
4.2	Market Exploits	21
4.3	Latency Issues	23
5	User Analysis	24
5.1	Data Analysis	24
5.2	Interview Feedback	27
5.3	Survey Data	27
6	Next Steps	30
6.1	Ghost Users	30
6.2	Kudos System	31
6.3	Stock Exchange	31
7	Conclusion	33
8	Bibliography	34

DARTMOUTH COLLEGE

Abstract

Department of Computer Science

Bachelor of Arts

by **Matthew Ritter**

With the internet taking over as a one-stop shop for information, finding credible material is becoming difficult. People look increasingly to the web to satisfy their questions along with their professional and entertainment needs. For the content seeker, the right content can be hard to find. Forums are cluttered with unreliable answers, entertainment sites overflow with mediocre artists, and professional searches yield countless novices. For the content creator, building a credible online presence is also difficult. Bloggers and professionals can be drowned out by similar candidates. Repcoin attempts to alleviate problems for both the content creator and the content seeker with a one-stop shop for user credibility. Repcoin uses a market to facilitate consolidated and reliable reputation, hoping to make it easier for strong content providers to get discovered and for content seekers to find what they want. I will discuss Repcoin's market approach to reputation compared to its competitors, its user experience, and its technical architecture. Finally, I will discuss Repcoin's successes, failures, and possible next steps.

Chapter 1

What is Repcoin?

1.1 The Problem with Reputation

1.1.1 Finding the Right Content

The average Internet user sifts through more media than ever before, a difficult and time consuming process. There are hundreds of access points for entertainment. For example, an audiophile might search iTunes, Youtube, Pandora, Pitchfork, RapGenius, Spotify, and Reddit for new music. The process is fragmented and slow. And, many of these sites employ automated recommendation systems that can be unreliable. Repcoin's market attempts to replace automated content evaluation with crowd-sourcing, and it aims to produce results that are more reliable than fragmented exploration.

1.1.2 Finding Trustworthy Content

An Internet user also has trouble determining what content is credible. This problem is relatively new. Prior to the takeover of the internet, there were fewer sources, and many of them were established books or journals. Content is much less trustworthy on blogs, LinkedIn, Disqus, Quora, WebMD, Yahoo Answers, and other platforms. Nonetheless, these platforms have become de facto information sources. 3 billion people read Disqus comments per month (Disqus). Wordpress, a popular blogging tool, serves 74.6 million websites (Ewer). Whether a user is looking for an opinion or planning a vacation, traditional sources like The New York Times or The Atlantic are no longer the first stop. Getting widespread Internet credibility up to par with these more established sources is a top priority.

1.1.3 Creating an Internet Presence

In addition to problems for the content seeker, the Internet creates problems for the content creator. While a content creator can reach a larger audience than ever before, that audience is usually quite fragmented. A freelance writer might work for a dozen blogging sites, and she is a new face on each site. A musician might get mentioned in thirty different publications, but most people will only notice a few of them. These content creators need a way to consolidate their sources of reputation. They need to display their accomplishments from all over the web in one place. There should be a virtual analogue to a producer's films, a painter's portfolio, or a writer's collection.

1.2 Existing Solutions

1.2.1 The Reputation of Things

Consolidated reputation is largely solved for businesses and products. Yelp rates approximately 66 million local businesses, and it contains over 71 million reviews (Yelp). In the United States, Amazon sells 232 million products (Grey), and many of them have comprehensive ratings. These platforms have become the default for assessing new places and products. When a local restaurant makes a great impression on hundreds of diners, they can share their experience on Yelp. A fantastic widget, sold by thousands of vendors, can enjoy a single source of praise on Amazon. Making smart purchases and choosing fun destinations is easier than ever.

For corporations, the stock market serves as a consolidated reputation source. With constant fluctuations based on the aggregate valuation of the public, a stock price describes a public company's perceived value. This single number is derived from a myriad of factors like revenue, executive staff members, and growth. The stock market is a reasonably reliable and accessible way to ascertain a company's value.

1.2.2 Domain-Specific Reputation

While there is not an effective solution for overall online reputation, many sites provide good domain-specific solutions. These platforms use content-rating systems like upvoting and downvoting to curate their users. This allows more reputable users to become more visible. Information is topic-specific, and content creators are judged solely by what they provide on the site. Most importantly, these systems produce high quality content.

It is helpful to study these models and assess how they generate content that people trust.

StackExchange provides Q&A for a variety of topics, mostly related to STEM. Members ask and answer questions. Answers are evaluated by the community, and good answers receive points. As a user gains points, he gets more privileges on the site. StackExchange pushes the best users to the top, but they are only evaluated by what they produce on the site. This means that StackExchange is detached from its members' actions in daily life. Additionally, the platform requires questions to be objective and answerable. The community frowns on questions that are vague or open-ended.

Genius.com is attempting to annotate all web content. Users post textual content from song lyrics to articles, and the community annotates it with various interpretations. Popular annotations rise to the top, which creates quality insights. Creators are rewarded with "IQ" points, which come from their annotations.

Reddit is a general content platform. Users post essentially any type of content grouped under various "subreddits", and their content gets votes. A user receives "karma" points for his submissions on the site. While Reddit comes closer than other competitors to a general reputation hub, its ratings are still content-specific.

These specific examples are just a few domain-specific reputation solutions. Others include Airbnb for housing, Ebay for sellers, Instagram for photographers, and more. These businesses are reliable solutions for reputation created inside the application, and they are always topic-specific.

1.2.3 Real-Life Reputation

While domain-specific applications generate reputation based on content created on the site, other platforms try to connect to a user's actions outside of the platform. These sites are worth examining because many have massive user bases and enticing user experiences. It can be difficult to convince users to spend time translating real world actions to a web service. And, it is helpful to explore what these sites do not offer in terms of consolidated reputation.

Facebook leads the world in social networking. With over a billion users, Facebook is the primary way to find people online (Statista). A user's profile speaks volumes about her friends, interests, and activities. Facebook's system of "likes" allows the community to choose what content is valuable. But, Facebook does not give users any kind of overall rank. It is meant to help users connect with friends, rather than helping users discover content creators.

LinkedIn owns the professional social network space (Hueber). It serves as a powerful recruiting tool, and credibility is connected to careers. But, LinkedIn lacks a mechanism to verify accomplishments and proficiency. The platform has an Endorsements feature that allows users to “endorse” someone’s skills, but it is unreliable. Endorsements are not taken seriously, and there is no way to verify the credibility of the user giving the endorsement. For example, users who cannot code at all can endorse an engineer’s proficiency in Java.

1.3 The Power of the Market

Examining the competition reveals a major factor in reliable reputation: *the raters must be credible*. This is what makes domain-specific applications so powerful. It is also what makes LinkedIn endorsements so useless. Making an endorsement has no cost, and there is no way to validate the endorser’s knowledge. A reliable reputation system must have incentives aligned such that endorsers are compelled to make smart choices. There must be a way to evaluate both the endorsers and the endorsees.

Interestingly, when many individuals express an opinion or predict an outcome, the aggregate response becomes fairly accurate (Wolfers). This phenomenon motivates the research behind prediction markets, where people bet on outcomes. In fact, the Defense Advanced Research Projects Agency (DARPA) ran a prediction market that asked many people for their predictions on global events, and it often out-performed expert opinions (Wolfers). Prediction markets have also been shown to out-predict traditional barometers for movie sales, weather, printer sales, and elections (Hanson). This evidence suggests that aggregated opinions could also be used to evaluate a user’s skills. For subjective skills like writing, singing, or cooking, a crowdsourced system could outperform artificial recommendation systems.

In addition to prediction markets, it makes sense to discuss the stock market in the context of Repcoin. A company’s stock price is tied to the public’s valuation. Trends in a company’s stock price indicate its success, and the same theory could be applied to a person’s skill over time. Like investors purchasing stock in a favorable company, Repcoin users can give reps to people they believe in for a given skill. If faith wavers in that person’s skill, the users can pull out. The same way that the stock market tracks a company’s success, a person’s reps could track her credibility.

The stock market works because it leverages the credibility of investors and companies. First, it allows prominent investors to be noted, since skilled investors generally accrue better returns on their investments. Second, the stock market holds investors responsible

for their choices. Lastly, the stock market rewards successful investors with increased purchasing power.

Overall, a market produces accurate predictions due to aggregate opinions and liability on the part of investors. Repcoin copies this dynamic to create more reliable reputation than its competitors.

1.4 The Repcoin Paradigm

1.4.1 How it Works

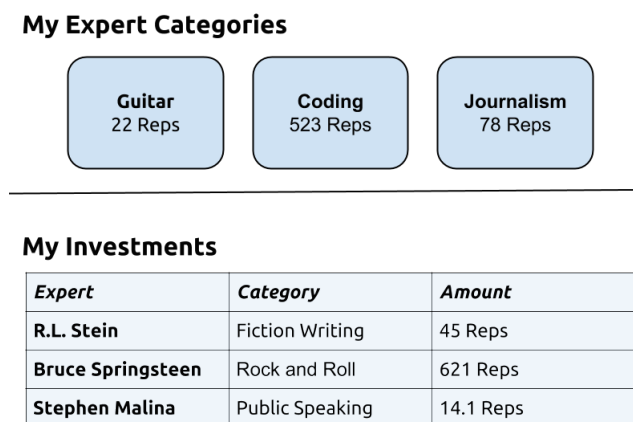


FIGURE 1.1: The division between expert categories and investments

On Repcoin, users give reps, a virtual currency, to users with a proclaimed skill. The users giving reps are called investors, and the users with skills are called experts. The two roles overlap for many users. Every Repcoin user starts with five reps to spend, so that a growing userbase slowly inflates the currency. Inflation also occurs from nightly dividends, since each Repcoin investment has an associated dividend. The reps that are given to experts cannot be spent; only the yields from dividends can be put back into the market.

Repcoin aims to create a virtuous cycle with the following user flow:

- 1) Users join Repcoin and add categories as skills. Users can create new categories if they are not already present. Each category has its own designated page where prominent experts and investors are listed.
- 2) Users start to invest in these experts. Investors quickly get hooked into the site by examining a sortable table of experts on the home page. This table sorts users by metrics like time on Repcoin and total reps.

3) Nightly dividends are paid. These dividends can be positive or negative, and they affect a user's reps to spend. Dividends reward investors for their choices, and they inspire them to invest more.

4) Accurate ranking starts to take hold for experts and investors. Experts with the most reps given to them are ranked highest with respect to a certain category. Trending experts are also noted. Experts that are new may have many fewer reps in their categories, but they can be noticed for growing quickly. Investors with the most dividends are also noted. Similarly to the way trending boosts new experts, a percent return metric also boosts up small investors who are making smart picks.



1.5 Applications

1.5.1 Content Discovery

Working properly, Repcoin's market could expose valuable experts. This has powerful implications for undiscovered talent across many skillsets. Using Repcoin's search features and leaderboards, Repcoin could serve as a content discovery platform. Any new user could peruse Repcoin's leaderboards or trending boards to find new talent in skills like carpentry, baseball, or reggae.

1.5.2 Prediction Market

As discussed, prediction markets can outperform other methods for determining specified outcomes. Repcoin could apply these predictions to expert success. Repcoin could make those outcomes the success of its experts. Repcoin could also challenge investors to bet on finite outcomes for a given expert, like album sales or home runs. This type of

application would provide insight for fields like talent recruiting, music production, or psychology.

1.5.3 Social Rewards Network

Repcoin also strives to be fun. It provides a new way for friends to express gratitude to one another, using reps as a kind of kudos. Other simple social networks like Yo or Snapchat have shown that users are interested in briefly contacting each other with simple messages. Repcoin could allow users to show goodwill by giving reps.

Chapter 2

User Interface and Experience

The Repcoin market is fairly complex. It presents a significant User Experience and User Interface challenge, since competing social networks have fantastic design and simpler goals. While Repcoin is really more analogous to the New York Stock Exchange than Facebook, by nature of being a social web application users expect an effortless experience. The Repcoin interface needs to communicate the Repcoin market for both investors and experts. This means that the processes of joining, finding valuable experts, investing, and tracking leaderboards need to be very explicit.

2.1 Onboarding

The Repcoin onboarding process is filled with complications. Users can join and immediately become overwhelmed with information. They may sign up but refrain from adding any expert categories or making any investments, leaving an essentially stale profile. Their new profiles also expose edge cases involving empty tables, lack of profile information, etc. They may also forget their credentials or feel hesitant about giving their email addresses. Repcoin takes a number of steps to mitigate these pitfalls.

2.1.1 Login

The first step to building a user base is the initial signup. Many users balk at signing up for a platform when it requires yet another username and password. At the same time, an easy login process encourages robots and malicious users to join the site. Repcoin encourages users with a traditional login and a Facebook login.

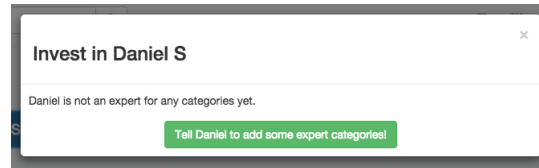


FIGURE 2.1: A prompt to "nudge" a user to add categories

Facebook login grabs a user's profile picture, name, and primary email address. Integration with Facebook required registering Repcoin as a Facebook application and using special authentication to integrate with their system. Facebook login proved to be overwhelmingly popular, and it seamlessly filled Repcoin with profile pictures.

Traditional login has a user give a first name, last name, email address, and password. This login form includes robust input checking and error handling. The form also detects spam email addresses and inappropriate language. After passing these tests, users have to confirm their email address to sign up.

Repcoin also includes invitational with rewards. Repcoin members can invite their friends to Repcoin through the Facebook API, and the inviter gets 5 reps for every invitee who joins.

Lastly, Repcoin is open to the public. This entices newcomers to peruse the site and then sign up, rather than being turned away at the login page. The open site is also valuable for search engine optimization, since bots can view every page.

2.1.2 Prompts to Get Involved

Immediately after signing up, new users are routed to a modified version of the home page. This page contains a modal that displays hot categories. These categories are the most popular on the platform, and the top experts for each one are also displayed. This explicitly prompts a new user to look at these expert profiles and invest.

Additionally, Repcoin tries to entice experts to expand their profiles. Signing up adds an entry to the Repcoin feed to welcome the new user. A similar feed entry appears every time a user becomes an expert in or creates a category. When a user visits his profile, it is obvious that they have no posted content, description, or expert categories. These empty spaces are filled with messages prompting to the user to get more involved. Lastly, Repcoin includes a "nude button". When a user visits a profile with no expert categories, she can prompt the new member to sign up for some. This reaches the new user as a notification.

2.2 Finding the Right Experts

Repcoin wants investors to efficiently find and invest in experts. The UI is meant to make it easy to sort users according to a variety of metrics. The interface includes tables and search bars that make it simple to find experts. Notably, each user-filtering table features invest buttons next to experts' names, which compels investors to make investments on the spot.

2.2.1 Home Page

The Repcoin home page features a large table that ranks all users. The users can be sorted by total dividends, reps given, and other metrics. Each row in the table is a different user, and there are columns for a user's top expert categories and investor categories. This table is meant to rank users on a general scale and to funnel users to category-specific pages.


User	About	Top Expert (Rank)	Top Investor (Rank)
Invest Tim Tregubov 	omnicompetent	technology (1) swift (1) game development (1)	fashion (3) web development (18)

FIGURE 2.2: A row in the home page table

2.2.2 Categories Page

The categories page also serves as a funnel to category-specific content. The categories page lists each category along with its number of investors, number of experts, and market size. Categories are presented as a grid, and they can be sorted by the various details included. In interviews, many Repcoin users reported that the Categories Page was their first stop before making investments.



FIGURE 2.3: An item in the categories page

2.2.3 Category Page

Each Repcoin category has a dedicated page. Like the more general tables, this page features a category-specific table that ranks users according to various metrics. Unlike the homepage table, the category page table can be toggled between investors and experts, since different columns are displayed depending on the option.


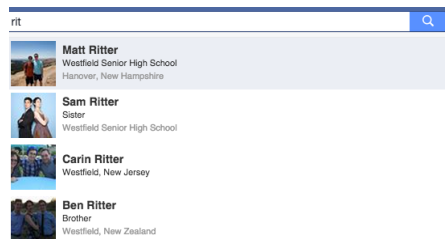
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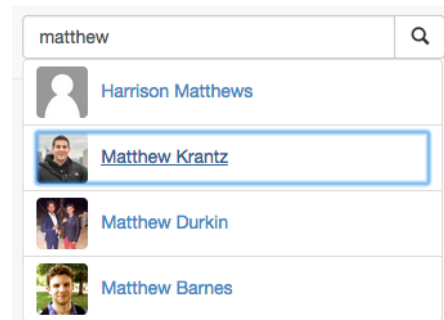
FIGURE 2.4: A category table row with rank, dividends, and average return

2.2.4 Search Bar

Repcoin includes a number of reactive search bars to peruse both users and categories. Every page includes a search bar at the top that finds users and categories. Additionally, every profile page features a search bar in the Categories Table, which holds a user's expert categories. This makes it very easy for a new user to start adding expert categories. The search bar is heavily based on the look and feel of Facebook's reactive search bar, and it acts similarly in terms of speed.



(A) Facebook Search Bar



(B) Repcoin Search Bar

2.3 Making an Investment

The main goal of Repcoin's interface is to bring users to the investment modal. Clicking the investment button from anywhere on the site brings up the investment modal. This modal shows the investor's existing investments in the user. It allows the investor to choose whether they want to "give" or "revoke" reps. Revoking reps allows the investor to choose an existing investment and revoke some portion of it. Giving reps allows the investor to create a new investment in the expert. The investor can choose to make the investment anonymous.

The investment modal has some interesting technical challenges. When an investment is made, the modal automatically updates to reflect the changes in reps, investments, dividends, etc. Additionally, the modal does not allow a user to make rapid transactions. In production, Repcoin struggled with handling transactions made in a rapid succession, since race conditions occurred in the database. To mitigate this issue, the investment modal shows a pending message in place of the submit button until a transaction finishes.

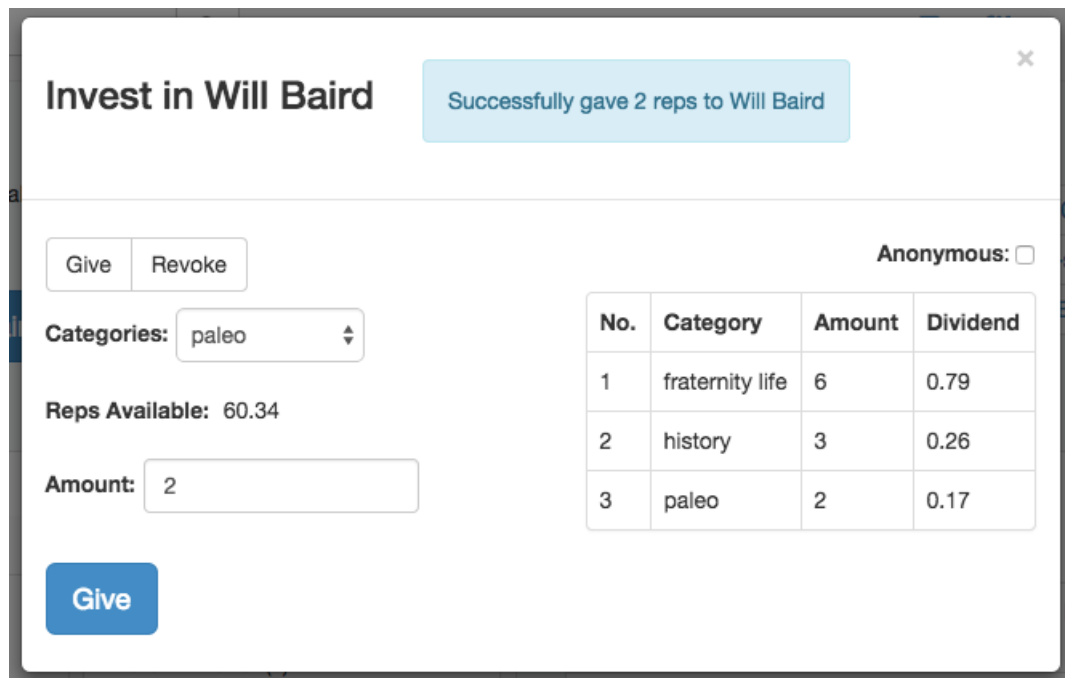


FIGURE 2.6: The investment menu

2.4 Paying Dividends

Repcoin investors profit from nightly dividends on their investments. This system differs significantly from the traditional stock market. Every time an investor gives to an expert, a new investment is created with a dividend value. This is different from the stock market because investments are discrete; they are not lumped together into a pile of stock. Unlike the stock market, experts do not have a stock price, so investors do not have to invest a minimum amount.

Repcoin uses this system to avoid some complications with an exact stock market replica. Skyrocketing stock prices could make it impossible for new investors to purchase stock for given users. Second, a slow stock market can have liquidity problems. On Repcoin, there is not actually a “seller” and a “buyer”, so there can never be a liquidity crisis. Investors are simply placing their reps on a given user’s skill.

Every investment has an associated dividend value. This value is calculated with the formula:

$$\text{Dividend} = p * (t - q) * r \quad (2.1)$$

where p = percentage of the expert's reps for the given category at buy time (amount / total)

t = the expert's total reps for the given category

q = the amount of reps the investor has given to this expert for this category before

r = a scaling factor currently set to 0.1

This dividend formula ensures that an investor's prior investments are not boosted by a current investment. Subtracting the investor's prior investment amounts from the equation prevents certain market exploits that will be discussed in greater depth later. The formula also encourages early investing. While investing in a popular expert can be a stable choice, investing in a new expert can produce large returns.

Investors can view their dividends in their Portfolio Table, featured on the profile page. This table shows investments for each category along with their dividends and return percentage. Dividends are paid nightly at 12:30 with a Heroku worker.

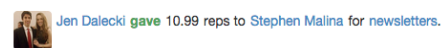
2.5 Staying Engaged

2.5.1 The Feed

The Repcoin feed serves as a general log for activity on the site. Its primary function is listing all transactions that have occurred. In addition, it contains other events like a user becoming an expert in a category or a user joining the site. The feed always shows the last 15 events, and it uses pagination to allow users to scroll backwards in time. The home page shows a general feed listing all events. The category page shows a category-specific feed, and the profile page contains a feed specific to a given user. The feed helps users peruse Repcoin, and it makes them feel like they have a presence on the platform. The feed item display was heavily influenced by the display used by Venmo for payments.



(A) Venmo Item



(B) Repcoin Feed Item

2.5.2 Trending Tables and Leaderboards

Repcoin gives recognition to successful experts and investors. Tables can be sorted to show trending experts, overall leading experts, and overall leading investors. The metric for "leading" can be determined by overall reps, total dividends, and other options. How much an expert is determined by how many gives they have received in a specified period of time.

2.5.3 Tracking Progress

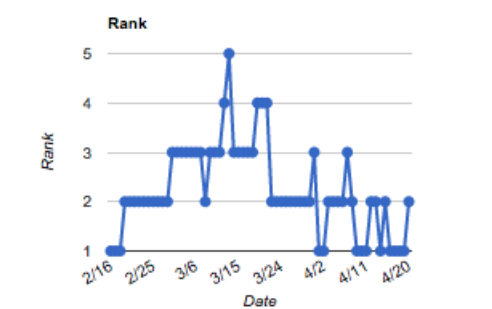


FIGURE 2.8: A chart of rank over time for a given category

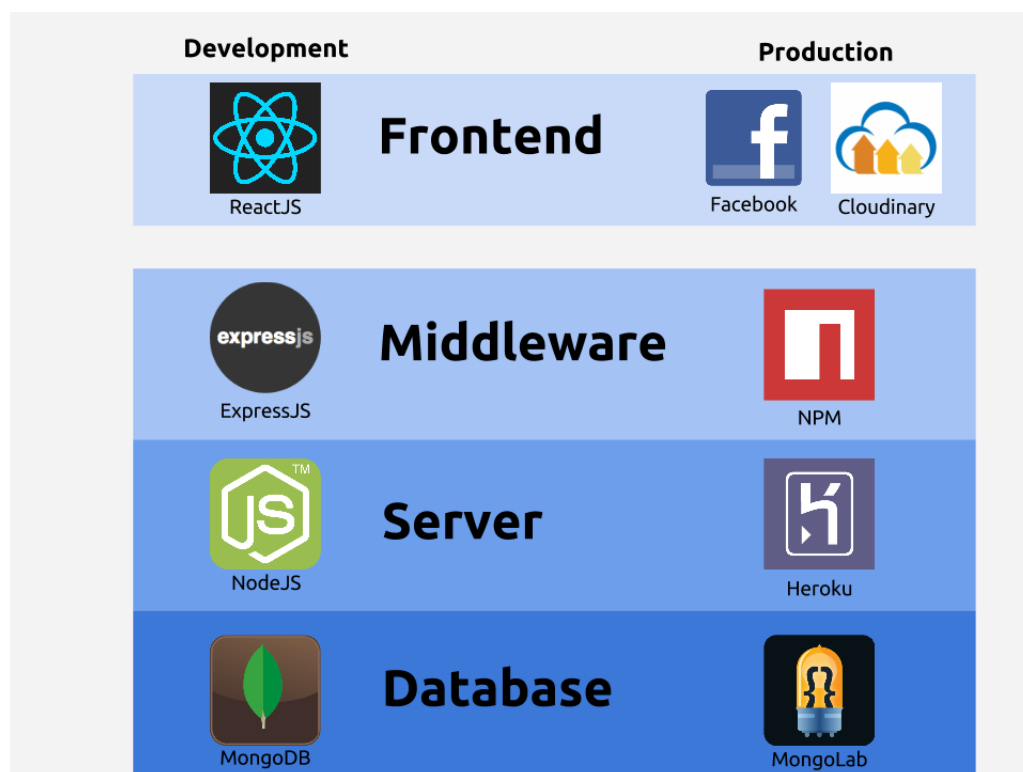
Repcoin provides graphs for users to track their progress on the site. Experts can see their rank, reps, and volume over time for each category. Volume is defined as the gives minus revokes on a given day. Investors can see their rank, total dividends, and percent return over time for each category. Graph support is provided by Google Charts.

Chapter 3

The Repcoin Guts

3.1 Top Level View

Repcoin is built on a Javascript development stack, and it is deployed with helpful production technologies. The following diagram describes the major building blocks of the production stack and the technology. Each component is briefly described below.



MongoDB is Repcoin's NoSQL database. It contains collections for models like users, categories, and transactions. MongoDB stores data in a JSON format, which is convenient for a flexible schema.

NodeJS is a JavaScript runtime environment for server-side technologies. It exposes an API to Repcoin's frontend.

ExpressJS is a web framework for NodeJS. It provides lots of valuable functionality like middleware, request parsing, and backend routing.

ReactJS is a robust frontend framework. It breaks a web page into nested components. For example, a blog may have components for a navigation bar, a search bar, a collection of posts, and an individual post. ReactJS has also been combined with Flux architecture, a best practice designed by Facebook, to be scalable and as stateless as possible.

MongoLab is a cloud storage system for MongoDB databases. Repcoin uses a paid MongoLab cluster to house Repcoin data so that it almost never has database connection problems. MongoLab can also be leveraged to take scheduled backups and manage the database.

Heroku is a hosting service for web applications. It runs the Repcoin application. Heroku comes with scheduled jobs, easy scalability, logging, monitoring, and other interesting add-ons.

NPM is a package manager for nodeJS plugins. Repcoin takes advantage of dozens of open source packages that add to NodeJS, a thin technology on its own. NPM makes it very simple to manage packages across environments.

The **Facebook API** is used to log users in and invite new users. It gives Repcoin access to a user's profile picture and email address. Facebook is also used to invite new friends to Repcoin.

Cloudinary is a content delivery network that hosts all of Repcoin's images. It associates each file with a unique identifier and URL. Since file uploads can be a security hole and a latency nightmare, Repcoin uses Cloudinary to handle these pitfalls.

3.2 Some Component Details

3.2.1 Image Management

In an effort to make Repcoin more personable, it gives each user a profile picture. These pictures are all of a standard size, and they can be changed from the profile page. While images seem to come as a standard feature on most popular social networks, managing them is not trivial.

Repcoin needs a clean way to grab profile pictures from the user. Repcoin handles this nicely in two ways. For Facebook signups, a Facebook user's current profile page is stored upon joining the site. For regular signups, users start with a default image. From the profile page, the user can upload, resize, and crop an image. Repcoin uses `cropit`, a package created by an undergraduate at Stanford (Cheng), to adjust the size and center of an image.

Finally, the image is stored. `Cropit` gives back a data URI for the new image, which is sent to the Repcoin backend. The backend contains `upload/` and `delete/` routes, which connect to the Cloudinary API. Cloudinary returns a URL and ID for the image, which are stored in the user's document.

3.2.2 MongoDB for Complex data

MongoDB has been a powerful tool for Repcoin. A deep knowledge of the database makes it possible to leverage complex functionality onto queries. This is important because it reduces latency, code complexity, and bugs. MongoDB also provides NoSQL storage that reduces the complexity of data models.

MongoDB's document storage system allows data to be stored as a JSON blob. A user's expert categories and investor portfolio can be stored as arrays in the user document. This makes the data consolidated and straightforward, but it can be dangerous: with a NoSQL schema, two documents in the same collection (analogous to two rows in a SQL table) can actually have different fields. In a standardized application like Repcoin, which expects every user to have certain properties, this can lead to excessive field validation in the code. Fortunately, a package called `Mongoose` can be used in conjunction with MongoDB. It provides wrappers for storing documents in an object-oriented way, and it can validate fields.

MongoDB's real savings come from its powerful aggregation framework. Mongo's `aggregate()` command can perform operations like sorts, complex comparisons, and calculating new fields. For example, Repcoin's sorted tables require experts and investors sorted by various metrics. In MongoDB, this logic can be put in the database query. The code layer simply calls the query and returns the data. When fetching investors, the query calculates fields like total dividends and percent return. These fields are not stored in the documents, but Mongo can calculate and return them as if they are.

Additionally, MongoDB does not require scary data migrations. SQL databases require largely automated migrations to add a field to a model, add a new model, or change a field name. These migrations are extremely sensitive, and the state of the database

is totally separate from the state of the application. Meanwhile, Mongoose configures schema properties in code, the same way a class would be described. Fields can be added to the database by simply adding them to the models, and creating a new model file creates a corresponding collection. Mongoose and MongoDB have been easy to integrate with NodeJS and the application code, and they do not require intensive database management.

But, MongoDB does not come without its pitfalls. Data can sometimes become corrupted if validation fails in an edge case. And, while storing arrays of JSON is conceptually convenient, it can make queries difficult. For example, a user has an array of investor categories. Each category contains an array of investments. Finding the investors with the best percent return for a given category is not easy, since Mongo is not friendly to queries that examine nested arrays.

Finally, MongoDB and Mongoose are not ideal for very relational or atomic queries. This made creating transactions painful, since the process requires many fields to be updated and validated. When a transaction is created, a the expert, the investor, and the category must also be updated. If anything goes wrong, then all of those changes should be rolled back. This type of behavior can be given for free in a SQL database, but they must be handled manually with Mongoose and MongoDB. Add the fact that all of these database queries have callbacks, and rewinding a failed transaction becomes a tangle of callbacks.

3.2.3 Content Moderation System

When Repcoin opened for alpha testing with approximately 50 users, illicit content surfaced immediately. Repcoin existed in an alpha stage from January 6th to February 12 before reaching the general public, but it was actually still open at repcoin.com during that time. Scattered Internet users managed to find Repcoin and become experts in categories like “sex”. It became apparent that other user inputs like name, description, and location were also access points for inappropriate content. We reacted to the problem with a system for content moderation.

We protect all of Repcoin’s input fields with Express middleware. Middleware allows specified functions to execute before a request is actually handled. Repcoin includes customized middleware that makes sure no field has “naughty” words, given a list provided by Nook Harquail (SCOWL).

Repcoin has a more involved system for category moderation. Users need to be able to invent their own categories, but Repcoin obviously cannot let any category get created.

We must approve any new category over email before it can officially be created, and the user attempting to make a new category is notified of our decision.

3.2.4 Search Bar and Latency

Since discovery is one of Repcoin's core values, it has sophisticated search functionality. As mentioned earlier, Repcoin includes a reactive search bar similar to Facebook's. While this type of search bar can be borrowed from existing JQuery plugins, these tools do not mesh well with ReactJS. The natural solution was to build a custom version.

The custom search bar is borrowed heavily from a tutorial (Shan), but it has specialized backend functionality. A more engineered reactive search bar like Facebook's takes advantage of caching features to avoid constant ajax calls, but we were making ajax calls every time the search text changed. We replaced this with our own simplified cache. As soon as the search bar is touched, every username and category is loaded. While fetching all of this data could eventually become very expensive, it works well for Repcoin's size. User documents are truncated, since they can grow bloated from hundreds of investments.

3.3 Building a Data Pipeline

Soon after Repcoin's launch, users wanted to track their progress over time. While the database was backed up daily, there was no way that the application could access past data.

We created this functionality with a data pipeline. In addition to storing every current user and category, we store daily snapshots of every user and category. Different from database backups, these snapshots can be retrieved by the application. A nightly process takes a snapshot of every user and category.

Next, the data had to be mined and displayed. For a given category, experts can track their reps, rank, and volume. Volume is defined as the number of transactions on a given day minus the revokes that day. Investors can track their total dividends, rank, and average percent return over time. These data types were made available with dedicated backend routes. A flexible API and Mongo's aggregate framework made it possible to build the pipeline with only a few functions.

Data is displayed on the frontend using Google Charts, mostly because it is quick, reliable, and free. The charts add a feeling of depth and progress to Repcoin.

3.4 Testing

As Repcoin grew without any test coverage, debugging became increasingly scattered and complicated. Unit tests were introduced to the backend as a sanity check and a way to speed up development. Every backend utility function is unit tested with Jasmine's test framework, and there are currently 194 tests. Jasmine makes it simple to mock requests, responses, and database calls. This way, nearly every code path in Repcoin's backend is tested before it enters production. Tests have made the site stable, and it has only crashed a handful of times.

Chapter 4

Problems and Solutions

4.1 Cleaning up for Beta Release

Before being exposed to the general public, Repcoin was available in an Alpha release for roughly 50 users from the Dartmouth campus. These users found bugs and commented on their experience. When Repcoin was finally ready to launch on a larger scale, a decision had to be made with respect to these users and their activity. While they had been instrumental for improving the platform, they had also created nonsensical categories and users in an effort to game the system. More importantly, their early presence on the site had earned them a very large number of reps.

To clean up the site while keeping early users happy, the Repcoin market was entirely reset, but Alpha users were given a small amount of reps to spend. This reset was done with a complicated data migration that vetted inappropriate users and categories. The Alpha users have continued to be some of our heaviest users, and the market was fair for the public.

4.2 Market Exploits

Repcoin's largest threat to a stable market is inflation. Currency inflates from users signing up, invited users joining, and dividends. This system inflates at a reasonable rate, provided dividends do not get too high. Very large dividends could create a major disparity in power on the site. Until Repcoin reached a modest size of a few hundred users, some gaming techniques remained undiscovered. However, some savvy users exposed ways to radically increase their dividends.

The heart of Repcoin's market problems came from its original dividends formula. Recall that the current dividend formula is:

$$\text{Dividend} = p * (t - q) * r \quad (4.1)$$

where p = percentage of the expert's reps for the given category at buy time. (amount / total),

t = the expert's total reps for the given category,

q = the amount of reps the investor has given to this expert for this category before,

r = a scaling factor currently set to 0.1

Originally, reps that the investor had given to the expert prior to the current investment were not subtracted. This meant that there was an incentive to invest in the same user twice, since the dividend for the first investment would actually increase! The goal was for dividends to rise when other users noticed an expert and invested. And in a large market, this probably would have been the case. But in a small market, the original investor could act as the "other users" by simply investing again.

Savvy investors started making 100 investments of 1 rep each, rather than 100 reps at a time. And, it became far more profitable to invest in existing experts than to find new ones. Before long, the feed was crowded with hundreds of micro-transactions. A cluster of experts started receiving the vast majority of attention, and a couple of investors had amassed vast amounts of reps. The market felt very prohibitive to new users, and it was certainly not advancing the proclaimed application of credibility.

A couple of measures gradually fixed this problem. Solutions had to be delicate, since the savvy users were still the most active users by far. First, we made it impossible to make rapid transactions. Originally, an investor could rapidly click the "give" button. This was changed to make it impossible to make a second investment until the first one finished. Second, each expert was given 5 reps just for joining a new category. Before, an expert's first investor would have a percentage of 100% for their dividend calculation. This highly incentivized giving small amounts of reps to as many new experts as possible. Starting experts with 5 reps made it nearly impossible for an investor to get such a large percentage for their dividend calculation. And lastly, the dividend formula was revised to subtract existing investments from the current one. Pumping up prior investment was no longer possible.

Despite these changes, the market had slid out of control. Some investors had their initial 5 reps, while others had thousands. We decided to reset the Repcoin market to fix market dynamics. Investments were wiped, expert reps were wiped, and the richest investors were given a modest sum of reps as consolation. Though this lowered traffic

from some users who had genuinely enjoyed gaming the site, Repcoin has stayed stable since.

4.3 Latency Issues

Another issue that Repcoin faced was latency. Over time, each user grew to be a large JSON blob, since user documents store all of their investments. Given the exploit just described, a single user could have several hundred investments. Repcoin does not have sophisticated latency metrics, but this issue became noticeable just from refreshing a page. As with the search bar, the solution was to send a truncated version of user documents to the sorting tables. Only the investment modal and the profile page require a user's full document.

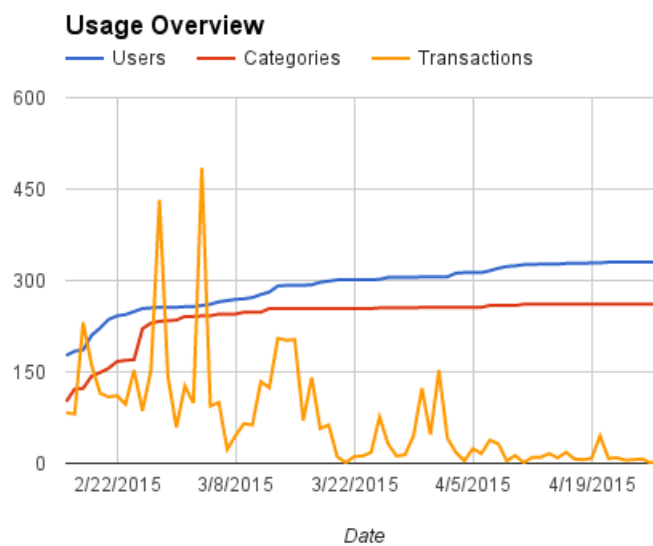
Chapter 5

User Analysis

After a few months of production, Repcoin sought to better its user experience and evaluate success. Studies were conducted via surveys, interviews, and data analysis.

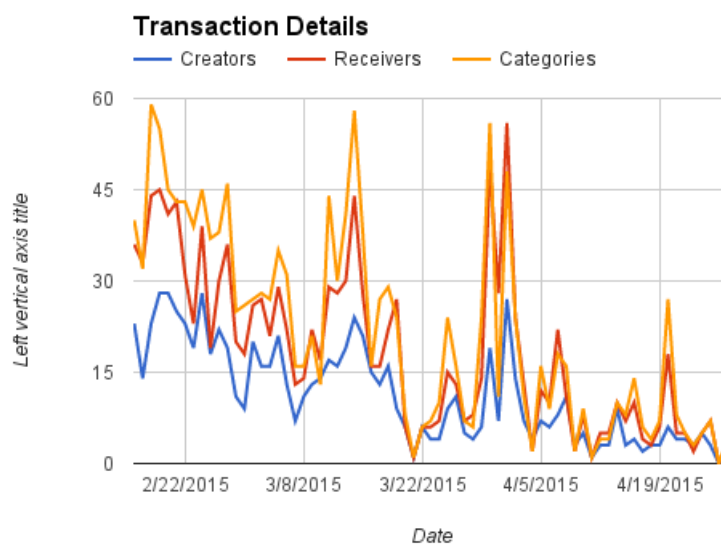
5.1 Data Analysis

Recoin's data pipeline was valuable for monitoring site traffic. Repcoin has stored essentially all of its site activity since February 16. Site use can be measured by examining the number of users, categories, and transactions. Combined, these numbers reflect how many users have signed up for Repcoin and how much activity is taking place on the site.



Already, a fairly obvious narrative emerges about Repcoin. Users initially joined en masse during launch week. From there, the Dartmouth community became saturated, and the number of users leveled off. Similarly, a boom in the number of categories leveled out as well. Notably, the number of categories should theoretically taper long before the number of users, since the range of possible skills has a ceiling. Lastly, the number of transactions also slows down after an initial spike.

Conclusions are bolstered by taking a closer look at the users and transactions. The following figure describes the number of unique transaction receivers per day, unique transaction creators per day, and unique categories that had transactions on a given day.

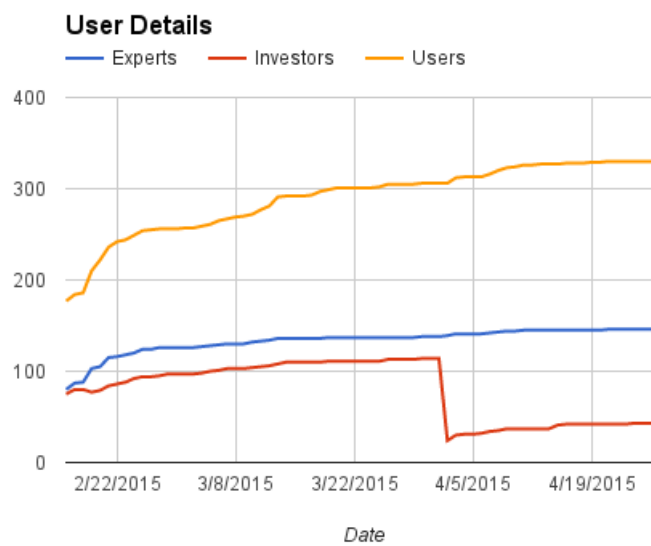


Clearly, few users on Repcoin are particularly active. The number of active users on the site has gone from a little less than 10% of the user base to almost nothing. And, the number of users creating transactions is far less than the receivers and the categories. This reveals a tendency to invest in a wide range of experts and categories. Being an expert on Repcoin appears to be a far more static activity than being an investor.

Also, this graph speaks volumes about the Repcoin market spinning out of control. Looking back at the Basic Usage graph, the two transaction spikes are not reflected in the more detailed chart. Clearly, only a few users made a very large number of transactions, and this spot is probably when the market first exploded. Then, there is a spike in both overall transactions and unique users around April 1st. This corresponds directly to resetting the market and notifying the users about that change. This seems like good news for Repcoin, since it shows that users are eager to be early investors, and contacting the users compels them to check the site. Looking at transactions in more

detail demonstrates the tendency to maintain a wide portfolio, the attentiveness of users to email mentions, and the causes of market problems.

Examining the users more carefully speaks to how users act on the platform. This chart compares the number of total users, investors, and experts. Experts are users with at least one expert category, and investors are users with at least one investment.



Unsurprisingly, the number of experts tracks the number of users. As users join the site, some add expert categories. Very few users have ever deleted any of their expert categories, so becoming an expert is a fairly stagnant metric. A similar number of users make investments. Noticeably, after the market was reset, fewer users were interested in returning to the platform and starting over. The most recent number of investments is much more indicative of the active users. Lastly, it is important to notice that a user can be both an expert and an investor. This means that the number of active users is not the sum of the experts and investors in this chart. In fact, about 45% of Repcoin users have at least one investment or at least one expert category.

Some metrics were also collected regarding how users update their profiles. As it turns out, only 36 users provided content links, 33 provided a location, and 35 added about text. Overall, it seems clear that users were not particularly interested in fortifying an expert profile. It also seems clear that users were more interested in making widespread investments, and a handful of users contributed a very large portion of site activity. To explain these phenomena better, interviews were conducted to get more direct feedback.

5.2 Interview Feedback

A handful of Repcoin users were interviewed to get a better sense of exactly how users viewed the site and what they wanted from it. Some quotes would shed light on why users did not take their profile pages very seriously and how they made investing decisions.

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In general, users were often confused by the interface. Users commented that while they respected the functional nature of the site, they did not feel like the information was presented in a clear enough format. One user reported, “I never used the dashboard. Matt told me two days ago that the graphs exist.” Unfortunately, this problem was mainly caused by a lack of design experience and high priority fixes that continued to push back a design overhaul.

Second, users felt that the site was not social or connected enough. They commented that “it was a static experience”, and they asked for new features like “images, friends, and more sharing”. Repcoin’s market paradigm lends itself to investing, a quick process, and then waiting to watch those investments grow. The site should incorporate more features that keep users active.

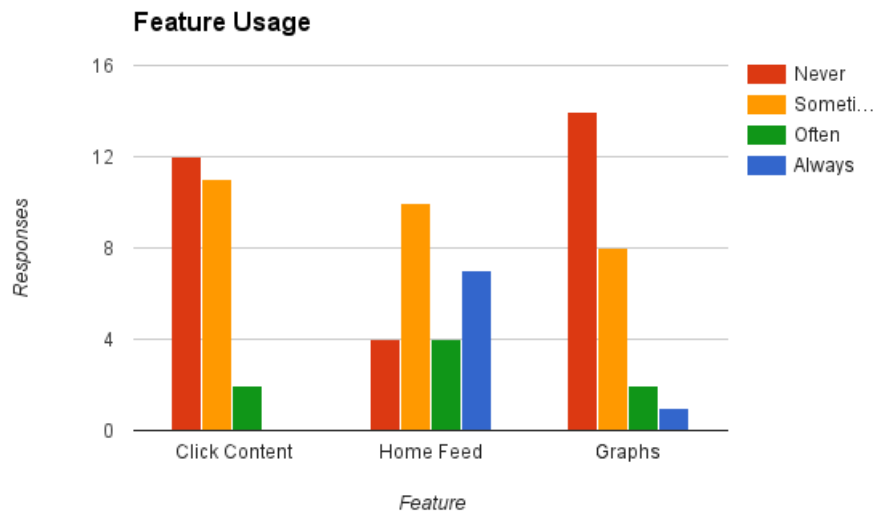
Finally, users did not enhance their profile pages or use profile page information. Experts told that they did not care about updating their description or location. Almost nobody uploaded content links, and no one reported clicking any of the links. Many users wished that the content in links was more directly hosted on the site. Without guiding information, they were unable to make informed investments on experts they did not already know.

5.3 Survey Data

On top of interviews and analysis, a survey was sent out to get more general feedback. The survey asked questions about user experience and specific features.

First, users were asked to discuss what features they examined most. Users spent a considerable amount of time looking at the feed. This speaks to the desire for a more social site, since the feed makes users feel connected but provides little insight. As predicted by interviews, users almost never clicked on content links. And, very few

users checked their progress graphs. This is probably because the graphs were hard to find, as reported in interviews.

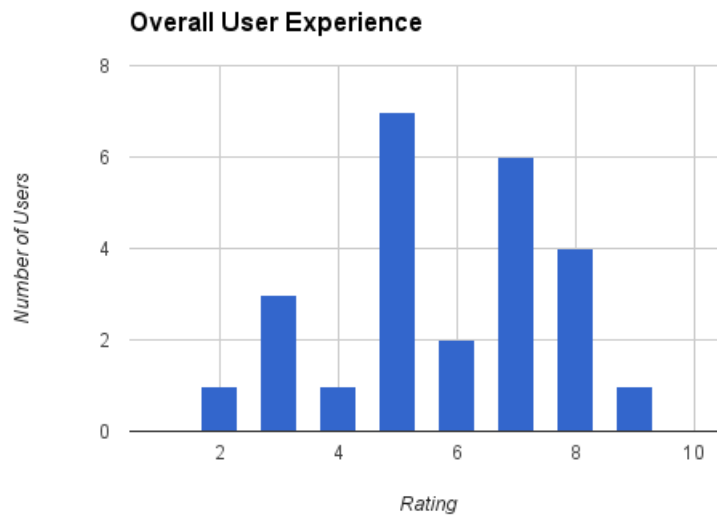


Then, users were asked where they spent most of their time on the site and how often. Users spent roughly equal amounts of the time on the profile page, category page, and home page. Each of these pages had similar amounts of information, and these metrics suggest that Repcoin spread information well. The only shortcoming was the lack of time spent on the page for browsing categories. Interviewed users reported that this page was overwhelming and difficult to narrow down. As for overall time, a number of users consistently visited the site. Almost 10% of users visit the site daily.



Finally, users were asked to rate their overall Repcoin experience. Their results showed a fairly generic curve that may be more representative of how users take surveys than how users enjoyed Repcoin. Allegedly, most users had an average experience.

All of these different feedback messages revealed a similar story: Repcoin is compelling but lacking in terms of addiction and simplicity. The feedback seems reasonable for a first iteration on a large scale product; most first attempts are not as clean as they could be or as bustling.



Chapter 6

Next Steps

At this point, Repcoin has lost most of its site traction. Its initial excitement produced some interesting production problems, and it has been a fascinating exploration into social networking and prediction markets. But, if Repcoin were to move forward, it would have to change significantly. Based on the way users have interacted with Repcoin thus far, a few solutions and additions have been proposed.

6.1 Ghost Users

Users are much more interested in investing than acting as experts on Repcoin. Additionally, being an expert is a fairly stagnant position, while being an investor is active. A future version of Repcoin needs to give investors more things to examine. The current system limits investors by the number of current experts. One solution would be the implementation of ghost accounts. If an investor wants to place bets on an expert that is not on the platform, he can simply create that expert as a ghost. Just like Twitter handles, a ghost profile could be claimed in the future. This feature would require an extensive content moderation system, since no expert should be embarrassed as a ghost user. It would also require complex methods to fill an expert's skills and profile information like crowd sourcing or web scraping. But, a working ghost user feature would allow the market to continue moving even if site membership stopped growing. Catering to a niche group of investors seems integral to Repcoin's success.

6.2 Kudos System

One of the major hangups with Repcoin's current state is the fact that users do not discover new people on the platform. Looking through transactions and speaking with users showed that they generally invest in people they already know. And, investors do not often choose based on real credibility metrics. For example, much of the market inflation that took place a couple months ago occurred as part of a game to push favored experts in web development to the top of the leaderboards. These intentions had little to do with the credibility of those experts and much more to do with friendships.

Rather than fighting this dynamic, it might be easier to comply with it. Repcoin could morph into a fun tool for giving "kudos" to a friend or colleague. Kudos would replace reps as the virtual currency, and they could be given for good deed or favors. This network would provide a fun outlet to reward friends for their actions, rather than a source of credibility. It would require a more friendly and less quantitative user interface. It would also need more social functionality like messaging. With significant remodeling and rebranding, Repcoin could be a mildly competitive network for compliments and rewards.

6.3 Stock Exchange

The Kudos System addresses the faction of Repcoin users who are not interested in quantitative rigor. But, another faction of users cared dearly about their position in the market. Though reps are entirely virtual, some superusers looked for and found complicated market exploits. In addition, some users gravitated to more quantitative portions of the site like progress graphs and percent return data. In fact, expert reps and investor dividends are only displayed publicly because users asked for them. Originally, these direct metrics were going to be hidden under softer measures like percentile and rank. So while some users only want to interact with friends, this faction only wants to conquer the market.

The best way to indulge market aficionados and prevent market exploits would be a move towards a rigorous stock market. This market would give every expert a current stock price, and trades would be made as they are on the New York stock exchange. Investors would have to offer to sell or buy stock in an expert's skill. A more exact market would provide much cleaner metrics about an expert's progress. And, the pure stock system is much tougher to game than the dividend system.

But, a market would come with some unique challenges. The market could suffer from a constant liquidity crisis if not enough users were buying or selling. An automated bot could agree to trades that are about to expire, but building that functionality would be difficult. Additionally, a stock market raises problems like handling an initial public offering and determining the number of shares for a user's skill. Furthermore, Repcoin's reputation market is not strongly tied to real life events. Stock price is not based purely on perception; it correlates to factors like earning statements and future projections. Repcoin intended for an expert's content links to serve that purpose, but content links are almost never clicked.

This system already exists for actors on the Hollywood Stock Exchange. The exchange matches an actor's IPO with her first major film, and stock price tracks her career. Repcoin could move towards this formula, which essentially replicates the stock exchange.

Chapter 7

Conclusion

Repcoin has been a fascinating experiment. We built a robust web application that serves real traffic every single day. Repcoin is an engineering project and a psychological experiment. It evolved from hundreds of hours of coding, professional artwork, an aggressive marketing campaign, and a lot of time at the whiteboard. Originally a pitch winner in the fall of 2014, Repcoin became a household name on the Dartmouth campus. It has been followed in Dartmouth Now, TheDartmouth, and the Repcoin Twitter account.

Since its brief time under the spotlight, Repcoin has grown less active. Experts do not seem to care very much about their profiles, and investors do not seem to use content links as a form of market research. The product serves as a lesson in examining what users want and need. While Repcoin is fun and technically robust, it does not solve a painful problem. Internet reputation contains a host of subproblems that should really be addressed individually. Great startups almost always attack a niche market first, and Repcoin circumvented that plan. The result was a fun and modern platform that confused many of its users.

Repcoin is one of the first attempts at a pressing and gargantuan challenge. The Internet will continue to expand, and credibility will continue to fragment. Repcoin in this initial iteration may not solve the problem, but it is certainly a step in the right direction. The Internet needs a one-stop-shop for reputation. Repcoin may not have enticed users to crowd-source that repository, but its core goal will not go away anytime soon.

Chapter 8

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