Emergent Remix Culture in an Anonymous Collaborative Art System

Kathleen Tuite
Dept. of Computer Science & Engineering
University of Washington
ktuite@cs.washington.edu

Adam M. Smith
Expressive Intelligence Studio
UC Santa Cruz
amsmith@soe.ucsc.edu

Abstract

Many crowdsourcing systems have a contribution model that is shallow but massively parallel, with contributors rarely processing or iterating upon the work of others. Few systems, even those crowdsourcing creativity or artistic talent, are designed to allow deep chains where the ideas of one individual feed into and directly inspire another individual. To explore the ways in which creative ideas arise and evolve under the influence of specific artifacts created by others, we examine patterns from over 50,000 sketches created and uploaded with Sketch-a-bit, a collaborative mobile drawing application in which each sketch is directly prompted by a previous sketch. In this paper, we report results from two analyses of content created in the system's first two years of deployment. First, we apply qualitative coding to survey the range of effort and creativity in user actions (including actions ranging from unintentioned scribbles to subtly inspired reimaginations of source material through the unexpected preparation of blank canvases for others). Second, we perform an exploratory analysis of large-scale behaviors manifest in chains or trees of sketches (such as open-ended conversations and structured gameplay). The intent of this work is to describe an iterative model of collaborative creativity and to demonstrate a range of remixing behaviors that can be expected to arise in unrestricted, anonymous collaborative creativity applications.

Introduction

Crowdsourcing is the method of breaking down a large task into small pieces that can be accomplished by a large number of often non-expert individual contributors. Typically, the tasks require little to no creativity and the primary mode of interaction is between contributors and the task itself. While this architecture fits the model of the crowd as a collection of human processing units (Davis et al. 2010) it misses the chance to exploit the collaborative creativity of many different contributors drawing inspiration directly from each other. We believe crowdsourcing can be used for more creative tasks (and we will discuss some existing examples below) and that iteration, or remixing, may be a key method of driving creativity. The goal of this paper is not necessarily to show the benefits of iterative creativity (remixing) in general, but to catalog the types of remixes that occur in our simple, expressive, anonymous environment in order to better understand the expected remixing behaviors of the crowd.

Remixing is the process of taking elements from existing artifacts and changing or recombining these elements to create something new (Lessig 2008). We can already find may examples of remixing, often for entertainment purposes, such as video mashups on YouTube, all throughout popular music, and even in software when the services from multiple applications are combined to fulfill a new function.

To explore the idea of collaborative creativity through iteration or remixing, we developed Sketch-a-bit, a collaborative mobile drawing application in which each sketch is prompted directly by a previous sketch. Unlike most crowdsourcing applications, which aim to complete a specific task or deliver a concrete artifact at the end, the value created in Sketch-a-bit comes from enjoyment of participating in the collaborative drawing process, although browsing the hierarchy of sketches (through the website[1] only) is also a source of entertainment.

In the rest of this paper, we will analyze samples from the 50,000 sketches gathered over a two-year period from with Sketch-a-bit. We will categorize the most common actions performed by individuals using a qualitative coding scheme and perform an exploratory analysis of large-scale patterns involving chains of sketches by multiple users. As we go along, we will speculate on what aspects of Sketch-a-bit led to these behaviors and suggest patterns to watch for in future crowdsourcing applications that employ similar design choices.

Related Work

Crowdsourcing has been used for artistic endeavors, such as Eric Whitacre's *Virtual Choir*[2] (in which people sing individual parts of a choral piece and the tracks of voices are combined into a final composition) or the *Johnny Cash Project*[3] (in which people hand-illustrate frames from a music video using simple grayscale painting tools). Aaron

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[1] http://www.superfiretruck.com/sketchabit
[2] http://ericwhitacre.com/the-virtual-choir
[3] http://www.thejohnnycashproject.com/

Koblin,[4] a creative director of the Johnny Cash Project, has released several similar crowdsourced art experiments involving drawing vehicles, drawing sheep, drawing a small piece of a $100 bill, and singing a miniscule clip of a song. Each of these individual contributions is then combined with the others in a visual or audible mosaic, with a browsing option allowing a viewer to zoom in on the work of an individual. The value of these collaborative works of art comes from the distinct style that each individual brings to the piece and how no single artist would have been capable of such variety. Similar to these projects, the purpose of Sketch-a-bit is to generate interesting artistic artifacts exploring the individual and collaborative styles of our users, and providing users with a novel and intrinsically motivated collaborative sketching experience. The key difference from past work is how Sketch-a-bit users work from the output of an anonymous peer who had access to the same tools and peer-inspirations they did, as opposed to a single, centrally-provided reference artifact (such as a blank canvas or a music video frame).

Remixing is becoming more widely studied (Aragon et al. 2009; Cheung and Huang 2012), especially as our notions of copyright and original work change (Hill, Monroy-Hernndez, and Olson 2010). Canvas[5], an image-based remix website from the creator of the popular online forum 4chan (which helped popularize LOLcats and other internet memes (Bernstein et al. 2011)) revolves entirely around threads of related image posts where captions and parts of the images change humorously from one post to the next. Remixing is the idea behind some websites for larger collaborative creativity efforts, including MIT's Scratch[6] and HitRECord[7]. Although these two sites are targeted at different audiences (Scratch is for children who are learning to program to produce videos and games while HitRECord is for adults interested in collaborating to produce publishable media) the premise is the same: multiple people collaborate on a project (a story, movie, or interactive game) by adding to or modifying either a Scratch "project" or a HitRECord "record". Both sites are explicit about anyone on the site being able to download and remix anyone else's project, although even young children using Scratch are occasionally wary of people remixing or outright plagiarizing their work (Hill, Monroy-Hernndez, and Olson 2010). Scratch and HitRECord provide two fairly structured environments for enabling people to work together on creative projects, but similar types of collaboration occur in a wide range of situations, from product design by a distributed team to remote researchers writing a paper together to scientists stationed around the world working on the same problem. In order to better understand collaborative creativity, researchers, such as those in the field of computer supported collaborative work (CSCW), study how these distributed groups operate, including the social dynamics and affect that goes with the creative innovation (Aragon and Williams 2011).

There is a wide gap between environments fostering collaborative creativity and what crowdsourcing systems, even creative-crowdsourcing systems, ask of users. Crowdsourcing systems are often designed to have each worker contribute independently at the same level, or sometimes at a few separate levels with clear pathways between them, such as Kittur et al's CrowdForge system (Kittur et al. 2011) which performs the map-reduce algorithm with humans. Rarely are the systems set up to support the free flow of ideas back and forth between workers. Public knowledge bases that take the form of wikis are capable of supporting this type of creative flow but it is not their primary function. The protein folding game Foldit[8] is one of the few exceptions in which infrastructure to support the sharing and evolving of ideas us built into the system. In Foldit, players share mini-algorithms or macros (Cooper et al. 2011; Khatib et al. 2011a). The best protein solutions so far were found through collaborative creativity by teams of players sharing and evolving each other's solutions (Khatib et al. 2011b). Projects like Foldit have been designed to support and encourage collaborative creativity, which they draw great benefits from, but collaboration is not required. By contrast, Sketch-a-bit's core idea is collaboration: evolve (or remix) a random sketch by another user to create a new sketch.

SYSTEM DESCRIPTION

Before examining the artifacts created by Sketch-a-bit users, we should review the software system itself to clarify the context of the sketching activity and what tools were made available to the users/artists.

Sketch-a-bit is an application for the Android mobile operating system, capable of running on both smartphones and tablets. It is a black-and-white charcoal-style drawing application in which, instead of drawing on a blank canvas, the user draws on top of a sketch created by one of their anonymous peers. The premise is that someone looking to casually sketch something on her phone may not know what she wants to draw but find inspiration in a drawing chosen at random from the existing pool of images.

Initial presentation

When users first encounter Sketch-a-bit (free of charge) in the Android market (now called Google Play), they are visually presented with the application's icon and two example sketches. The icon is a cropped view of a spiral figure created with the application during its brief development period. One of the example screenshots shows the spiral in detail while the other shows a relatively detailed sketch of shiny spheres on a dark background (both images required several hundred strokes to create from much more primitive parent images). These details serve to prime the user to expect to see and create similar images. Whether it was a result of the icon and example or not, spirals were a common visual motif within the larger image pool we analyzed (some

[4] http://www.aaronkoblin.com/work.html
[5] http://canv.as
[6] http://scratch.mit.edu/
[7] http://hitrecord.org/
[8] http://fold.it/

Figure 1: Screen capture of the application with brush buttons

spiral images descended directly from the example screenshot in the market while others were freshly introduced on top of unrelated images).

Textually, the user is presented with the application's brief description:

> Draw inspiration from cloud(s) with this collaborative, evolutionary-drawing app. Download a random work, make your adjustments, and contribute it back. Try moving your finger very fast for broad strokes and very slowly for fine details. This app requires internet connectivity to participate.

This introduction likely had its own priming effects with the mention of "inspiration", "collaborative", "contribute" and "participation" prompting more direct cooperation than might have occurred otherwise.

As the icon, screenshots and description were fixed throughout the application's deployment, the degree of impact of these priming effects can only be speculated upon. Nonetheless, we report them because we expect the details of first impressions to have had a strong influence on user behavior.

Drawing interface

There are two brush tools in Sketch-a-bit: a "Light" brush and a "Shadow" brush. Each draws semi-transparent rectangles of either white or black, creating a chunky light or dark stroke when the user drags his finger across the display. The speed-based stroke control, along with the semi-transparency of the strokes, can produce a variety of effects, from neat, geometric shapes to noisy, charcoal-like drawings. Figure 1 shows a screenshot of the application with brush selection buttons visible.

Downloading and uploading sketches

When a user starts up Sketch-a-bit, a random sketch is downloaded and displayed. If the user does not like that image, he can select the "Fetch" menu option to get a new image, repeating this until he finds an image that inspires him to draw. After using the brushes to craft a new image, the user selects the "Upload" menu option and the sketch is added to the full collection of other sketches, noting which previous image was its immediate inspiration (or "parent"), and then a new random image is downloaded to their device to replace it. Uploading without changing the image is possible, effectively making a copy of that picture in the image pool. Uploads always expand the image pool, never modifying or replacing previous sketches.

Image pool

The first image (the common ancestor of all sketches) is a blank white canvas, and it is still possible for users to randomly download that original image (although this grows increasingly unlikely over time). In two years since the application was deployed in March 2010, over 50,000 sketches have been uploaded to this image pool, each equally likely to be the starting canvas for the next user.

Emergent Patterns in Individual Actions

As we looked through the different images, we assigned codes to describe the actions taken to create those images. Were people changing a tiny portion of the image or the whole thing? Were they spending their time refining the previous sketch, or were they adding something new?

Method

To analyze the actions taken in creating each image from its parent, we developed a custom, web-based qualitative coding tool. This software presented parent and child (before and after) images side-by-side with a supporting "difference" image computed as the absolute value of brightness differences between the two images. The difference image was invaluable for spotting the detailed yet near imperceptible changes made when one user touches up the highlights and shading in an image without adjusting its overall composition. Because our analysis focused on the final uploaded image (as opposed to the list of strokes that created it), we could not observe some actions such as applying the lighten tool to a white background or abandoning a partial work and starting over with the use of the "Revert" menu option.

We performed a grounded analysis similar to (Charmaz 2006) on the types of actions and after several iterations with our analysis tool, we arrived at nine codes that roughly lie on a spectrum of user effort and creativity. This analysis is orthogonal to a separate coding of subject and themes that we do not report. The list of codes in our action study is shown below and a detailed discussion of each category follows.

1. Duplicating (20%)
2. Scribbling (3%)
3. Refining (13%)
4. Adding/removing/changing a detail (25%)
5. Reworking (9%)
6. Reimagining (7%)
7. New, unrelated (17%)

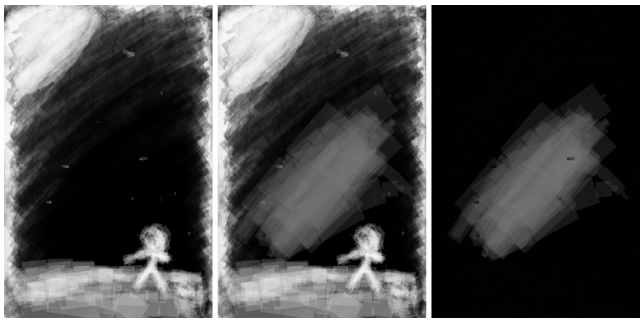

Figure 2: Scribbling

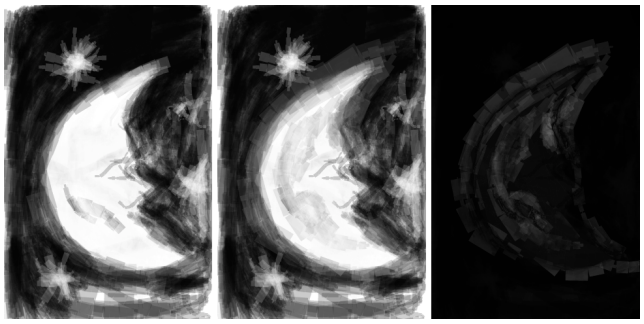

Figure 3: Refining

8. New on blank (6%)
9. Making blank canvas (1%)

Results & Discussion

Using our analysis tool and the nine codes above, we coded a random sample of 300 non-duplicate sketches. Recall that our codes roughly reflect varying levels of user effort and creativity. The most common actions are in the direction of low effort (casual) but still contributing something creative.

Duplicating Approximately 20% of images are duplicates of their parent, caused by a user uploading the same sketch that he or she downloaded. This behavior is likely either due to not understanding the way the application works, or purposefully re-uploading the same sketch to add another copy of it to the image pool. We suspect the former is most likely, given that we (the registered contacts for the application) have received several emails with questions indicating misunderstandings of the system's mechanics.

Scribbling Approximately 3% of sketches were categorized as scribbling or drawing purposelessly on top of another sketch before uploading. The fact that Sketch-a-bit is a drawing application for touch-screen mobile devices easily affords this kind of experimentation for new users. Interestingly, a common response to the appearance of scribbling is for other users to carefully redraw the details destroyed by the scribble. We suspect users exploring the brushes for the first time can explain a large fraction of scribbling actions. This interpretation is backed up by examples such as the one shown in Figure 2 in which the scribbles appear to be created with a graying brush. Due to a quirk in the application, gray paint is used if the user attempts to draw something before selecting the light or dark brushes. Once one of the standard brushes is selected, the graying brush is inaccessible without restarting the application (which usually only happens after a device restart because of how Android caches application instances). In very rare circumstances, we have observed users using the graying brush (in concert with other brushes in a single image) as part of intricate, non-scribbling actions, suggesting they have expert control over their use of this otherwise hidden brush.

Refining Refining a sketch is a way to practice sketching or go through the physical motions of sketching without having to decide what to draw. Types of refinements or touch-ups included emphasizing edges, changing the shading (brightening highlights, darkening shadows), or smoothing out chunky artifacts from a coarse brush stroke with a series of finer strokes. These were easiest to identify by looking at the difference image for strokes that trace the original sketch, and, in our last coding scheme refining was the third most popular action. Refining is a low-effort way to make a contribution, usually towards improving the boldness or detail of the image. Occasionally, refining and scribbling are seen together, suggesting a transition from exploration to intentioned action in new users.

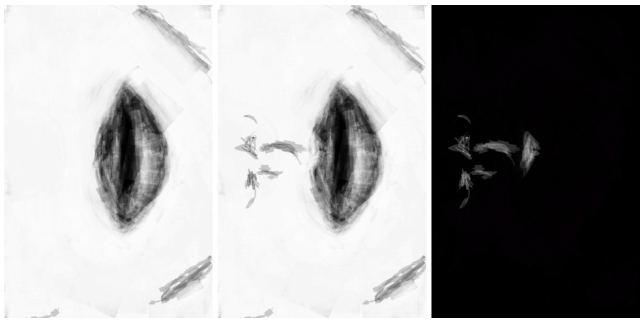

Figure 4: Adding (or removing or changing) detail

Adding/removing/changing a detail The act of adding detail (or changing or removing a detail) differs from simply refining a sketch when the user contributes a unique style or design element. This is the most popular action and includes additions such as faces, eyes, pupils, text, or new objects that fit within the context of the original scene. For example, if there is an empty chair in the parent image, a user might draw a person sitting in the chair. Or if there is an offensive word or symbol, a user might remove it or change it to reference a different topic. Like refinement, adding or changing a portion of the image is a creative but relatively low-effort way of contributing. It is more assertive than refining, though, with one user responding to another through drawing about what is missing or how she interprets the scene differently.

Reworking A user might start by touching up the shadows or changing one detail of an image but then end up work-

Figure 5: Reworking

Figure 6: Reimagining

Figure 7: New, unrelated

Figure 8: New on blank

ing with the entire image to create something very different. These massive changes are usually a combination of the previous categories, refining and adding/removing/replacing details. Reworking a sketch results in a drawing that is different overall, but still has major structural similarities to the original. At this point, when the user is adding both light and dark strokes, the difference image (shown on the right in Figure 5) becomes harder to interpret because it starts to look an intentioned sketch on its own. The brightest patches in the difference image indicate where the user has made significant changes to the original images (note the added jaw at the bottom of the figure). Reworking is the fourth most common action and moves the user from casual participant to serious contributor.

Reimagining These sketches are the metaphorical gems of Sketch-a-bit's creative evolutionary concept, what it was designed to allow. Unlike the reworked sketches described above, a reimagined sketch is significantly different from its predecessor, while still sharing only some element of the original, be it the subject matter, shading, or composition of shapes, as in Figure 6 in which a wineglass becomes a flowing river. Also included in this category are hallucinations, in which a user perceives something not actually present, such as hallucinating a face in scribbles, or the waterfall in the wineglass shape. Drawing a new image inspired directly by another sketch is a serious creative contribution, well beyond the tracing and minor tweaking seen in some of the previous categories.

New sketch, unrelated Sketch-a-bit's speed-sensitive brushes are different from other Android drawing applications in their simplicity, feel, and expressiveness, and some users prefer to use it only for wholly original drawing, completely wiping out traces of the parent image before creating their own. Simply drawing a new picture on top of the previous one is the second most popular type of change. Entirely new sketches directly introduce new topics into the image pool, expanding the range of culture captured by the application. However, they also represent missed opportunities to participate in large-scale structures.

New sketch on blank canvas Sketching on a blank canvas is the most conventional category here, resulting from the downloaded image being the blank, white starting canvas (or one of its blank, white descendants) or a blank canvas that another user has explicitly prepared. Users have prepared both blank white and blank black canvases in the image pool for users to draw on with the contrasting color.

Making blank canvases This was not a common occurrence, but users who realized that the application always provided an existing sketch as the canvas occasionally prepared blank canvases for others, sometimes even leaving a decorative border. Interestingly, more than half of the explicitly prepared blank canvases we saw uploaded were direct responses to an obscene image. For some users, it seems, it was more important that no trace be left behind of the original content than that the content be replaced with something new.

Emergent Patterns Across Many Actions

We give non-quantitative findings of sparse but interesting patters uncovered during our previously reported analyses. While these patterns were very specific to the visual nature of Sketch-a-bit, we hope to show the variety of cultural influences that can seep in to collaborative creativity applications that are structured similarly to ours.

Method

Having found several fragments of what appeared to be large-scale patterns, we exhaustively explored all related ancestors and descendants, noting the complete extent of the pattern. As many of the larger patterns started within the first month of deployment, the root of many of these patterns occur in the first 5,000 sketches. There are likely other interesting types of patterns that we have not uncovered yet that are not rooted in that range.

As these large-scale patterns are played out on trees of parent and children, we capture the patterns with an indented list format. In the example below, a picture with description "A" is the root of the pattern with at least the two related children (amongst other unrelated children) with descriptions "B" and "C" while the image described by "D" is the child of "C". The note in brackets is the serial number for the image recording the order in which it was uploaded to the image pool.

```
[111] A
  [222] B
  [333] C
    [444] D
```

Results & Discussion

Several interesting patterns emerged (more than can be described here), so we review an informal grouping of these patterns and only show one or two examples from each group.

Seeking communication with others Since there is no explicit communication channel between users, people find ways to use the sketches themselves to communicate. Recognizing and embracing anonymity, people reach out and respond to complete strangers. In the conversation tree below, one user explicitly addresses their message to the unknown, future viewer.

```
[8157] Dear complete stranger, hi.
  [31114] Facebook me
  [34110] I Love u
    [34423] (added smiley face)
    [46417] I (heart) u 2
```

In another example, a user attempted to start a satisfaction poll of other users with the prompt "Fun?" above two columns labeled "yes" and "no". They added a single tally mark to the "yes" column before uploading. This image garnered a total of eight responses (direct and indirect), all of which consisted of edits that clearly identified a yes/no response. One user voted "no" with a phallic image (with an appropriate size and position with the image to indicate its intention to be counted as a tally). This image prompted a response in which the phallus was carefully removed and a new tally was added to the "yes" column (potentially indicating pride in the action of cleaning up the image). In a chain of interaction spanning almost the entire two years of deployment, aggregating votes across all responses yields five positive and three negative votes. It is unlikely that any of the participants in the poll ever saw any of the results.

```
[3484] Fun? yes (tally)
  [11005] no (circle)
    [22993] yes (tally)
      [52736] yes (tally)
    [23264] yes (tally)
      [32953] yes (thick tally)
  [11281] no (where tally is a phallus)
    [21527] yes (tally, removing phallus)
  [52771] no (tally)
```

Discussion of controversial topics Without a concrete topic, response chains often lose coherence after one or two layers. However, when a controversial topic (e.g. religion) or a multi-word phrase is clearly present, much deeper chains of related responses form. In the abridged linearized exchange below (a single chain in a much larger tree), people seemed compelled to respond, either by changing it to match their own beliefs, or modifying or re-uploading the same picture if they agree with it.

```
[1552] there is no god
[1850] there is a god
[1981] God is within you
[2641] God is within you FAG
[6977] God is within you (manual cleanup)
[8620] God is within you (dup.)
[12030] God is within you (dup.)
[31713] SATN is within you
[34765] The Force is within you
[42510] The Force is within you (dup.)
[45290] the holy ghost is within
    your temple
```

Structured play Sometimes, a sketch seems to setup rules by which response images should play. Although these rules are never explicitly written, other users seem to be able to infer them from minimal textual prompts or familiar diagrams.

In one instance, a user drew an empty oval with protruding ears with the label "face". Although this image is ambiguous, it seems to us (and several responders) to be a request to draw a face in the oval. In fact, this image's three children are all responses that fulfill the request. One is a face with big white lips, another is a quick, 12-stroke face with an ambiguous expression, and the last is an angry, one-eyed troll. Interestingly, each of these responses confined their drawing within oval delimited in the first image. It was not until a response to the big-lips face (adding a tongue sticking out) that the boundary was violated. In that case, the contributor adding the tongue did not have access to the original blank face to infer the rules of play.

Independent games of Tic-tac-toe spontaneously arose at least twice, both times beginning with an image of a game board and one move made. Of the several children of each

Tic-tac-toe sketch, a few would produce a valid next state in the game (whereas many jumped to the end of the game, played out of turn, or introduced unrelated symbols to the game grid). Because the rule that the X player goes first is not universally observed, some users added "x's turn" and "o's turn" annotations below the game board to help responders decide which side to play. At least one chain exists (shown in Figure 9) with six valid, alternating moves that realize perfect play for both players, forcing a move that causes a draw (a cat's game). Despite other users' efforts to derail a game in progress by defacing the board or changing the topic, the fact that every sketch is always available for response (if randomly selected) means that, over time, even play by strict rules can be sustained.

Intentioned multi-party artistic collaboration Finally, outside of conversation and play, many of the interesting large-scale patterns we found related to the nominal purpose of the application (as suggested in its market description): artistic collaboration.

In Figure 10, a well-dressed person sits in a chair, holding a rose. This result was incrementally hallucinated from a grittier, ambiguous figure that in other variations (not shown) was refined into a person using a laptop computer from an office chair or a person reading a book in a thicker chair. The "X" mark in the bottom-left of some of these images was introduced by single user (we assume) who added an identical insignia to many of images in a row. As in this sequence, some users were not bothered by this marking that added nothing to the semantics of the scene, while others (such as the creator of the last image) felt it was a distraction in need of a cleanup.

Figure 11 shows every ancestor, including the root, of a bitten-apple sketch. In this sketch's history, there are scribbles, step-wise refinements, and complete restarts. For each one of these intermediate images, there are several other chains that took the sequence of common ancestors in a new direction. In fact, the fifth image is the very same spiral presented to users as an example screenshot in the Android market.

A bolder child of the official example spiral (the left-most image of Figure 12) was particularly productive of thematically related children. Whereas the previous example looked at inspiration along deep chains, this spiral example show breadth of inspiration across children occurring at a single node in the tree. In all, this bold spiral has twelve children. The size of its progeny is, of course, related to this sketch being in the pool for random selection longer than almost every other sketch (its serial number is #17). As many of the early sketches were created by the developers, many users are, years later, directly or slightly indirectly collaborating with us despite our having uploaded only a fraction of a percent of the images ourselves.

Reflection

The key idea of designing a collaborative creativity system that operates through iteration and remixing is that the inputs are the same as the outputs; in other words, the produceable artifacts are the same type as the consumables, as are the drawings in Sketch-a-bit. Unlike a pipeline with a predetermined structure or distinct phases (such as performing map-reduce with the crowd) allowing artifacts to form chains of arbitrary length places fewer limits on the ingenuity of the crowd.

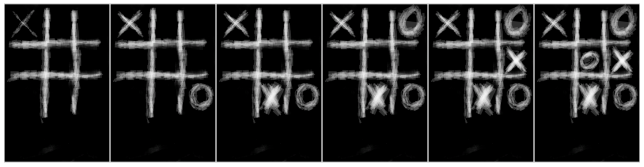

Figure 9: A partial game of Tic Tac Toe played out through six validating alternating moves by anonymous individuals over the course of many months

Figure 10: Intentioned multi-party artistic collaboration

Many artistic crowdsourcing endeavors ask for one artifact from one person in isolation and then compile the results into a single artifact. Some examples not already mentioned include YouTube's Life in a Day project,[9] the Single Lane Superhighway[10] and the mechanical turk fueled Amazing But True Cat Stories,[11]. In each of these instances, the majority of submissions are pruned from the final artifact, with the Life in a Day's 90 minute video edited down from over 4500 hours (Watercutter 2011). Sketch-a-bit, while not promising to include a user's sketch in a final artifact some day, does offer the possibility that *someone* will see the sketch eventually and have the opportunity to respond to it. Furthermore, a user always sees what someone else has drawn, instead of drawing a car for the Single Lane Superhighway or writing an Amazing but True Cat Story without any idea what anyone else has done.

We think of Sketch-a-bit as a drawing playground, a place to exercise one's creativity, both through practicing the technical skill of drawing to produce an artifact, as well as through consuming (interpreting, appreciating, critiquing) the creative works of others. Again, we believe that the consumables and products being the same type is an important property and would like to see more creativity playgrounds similar to our Sketch-a-bit model grow and flourish.

[9] http://www.youtube.com/lifeinaday

[10] http://www.thesinglelanesuperhighway.com/

[11] http://bjoern.org/projects/catbook/

Figure 11: Tracing this apple with a bite out of it back to the root, through the initial inspiration and collaborative refinement of the apple

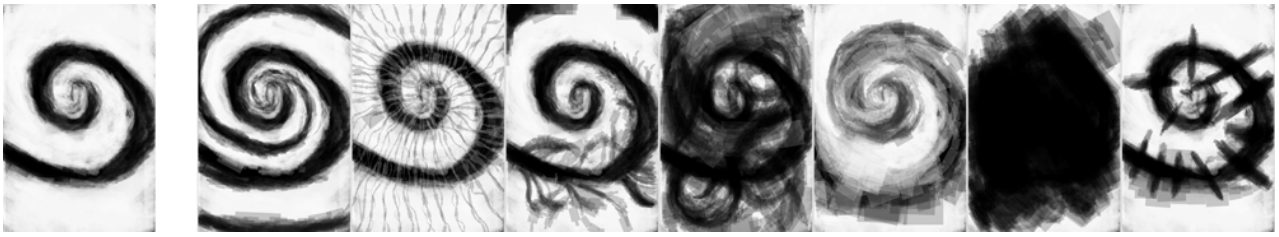

Figure 12: The parent spiral is shown on the left along with several immediate children

Conclusion

We have presented our collaborative mobile drawing application Sketch-a-bit and analyzed thousands of sketches in order to uncover patterns of collaborative creativity and emergent remixing behavior. The anonymity and visual-only features of our design allow our analysis to focus purely on the sketched artifacts and the relations between them. Our analysis has two parts: qualitatively coding single-step difference between pairs of sketches, and exploring emergent patterns in chains or families of related sketches. The intent of this work is to demonstrate a range of remixing behaviors that can be expected to arise in future unrestricted, anonymous collaborative creativity applications and to provide insight on enabling shared creativity through a collaborative, iterative sketching ecosystem.

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