

Memory Mosaic

Final Report

Basic project information

- Name of your project
 - Memory Mosaic
- Name of your teammates
 - Liam Dodds, Ani Petrosyan, Dea Rrozhani, Lakshman Swaminathan
- Give a one sentence description of your project. Please use the name of the project in your description.
 - MemoryMosaic is a digital platform that lets users build collaborative visual 'memory boards' by crowdsourcing images related to specific events or places.
- Logo for your project.



- What problem does it solve?
 - Memory Mosaic addresses the challenge of centralizing and preserving personal memories tied to significant events or eras, which are often scattered across multiple digital platforms. The project provides a creative, interactive format to consolidate and share these memories meaningfully. Our app works by crowdsourcing images from users and combining them into a mosaic of the best/most popular images from the event.
- What similar projects exist?

Several projects share similarities with Memory Mosaic in terms of concept and functionality, though Memory Mosaic distinguishes itself with its unique focus on collaborative memory boards. Here are a few similar projects:

- Pinterest
- Collaborative Scrapbooks

- Historypin
- Social Media Platforms (e.g., Instagram, Facebook)
- Google Photos Shared Albums
- What type of project is it?
 - A business idea that uses crowdsourcing
- What was the main focus of your team's effort
 - Engineering a complex system
 - Conducting an in depth analysis of data
 - Something in between

The project involves engineering a complex system combined with in-depth data analysis. Building a platform like Memory Mosaic poses technical challenges and analyzing multimedia data requires more complex algorithms than analyzing text input.

- How does your project work? Describe each of the steps involved in your project. What parts are done by the crowd, and what parts will be done automatically.
 - Users sign up and are added to a mongoDB collection. Users can then register for events. Each event contains a set of images. Users that are registered for an event are able to upvote/downvote images in any event that they are registered for.
 - Images that receive more upvotes are made larger in a mosaic for the event, while images that are downvoted get flagged
 - Users must be members of an event in order to upload an image to the event. Upon uploading, images are stored in S3, and then sent to OpenAI for checking if the image meets TOS. If not, the image is removed from S3.
 - The mosaic formation process aggregates images from S3 and metadata from DynamoDB, including likes, dislikes, and comments. After sorting the images by likes, the most popular image is placed in the center of the mosaic with prominence. Each subsequent image is positioned around the center with random rotations and boundary distances, creating a circular format with a defined radius. Users can view individual images via a pop-up component, enhancing interactivity. This process, combined with user-generated data, drives the visual representation of collaborative memory boards.
- Provide a link to your final presentation video.
 - https://drive.google.com/file/d/1TZ-fzSye4L3oVTWDpE-PIVTa_tj3MBhv/view?usp=sharing
- Which two sections below did you pick for your in-depth analysis?

Quality Control and Scaling Up

The Crowd

- Who are the members of your crowd?

The members of the crowd for Memory Mosaic are individuals with shared experiences related to specific events, themes, or eras. This includes groups like attendees of a wedding, fans of a historical era, or residents of a neighborhood. These participants contribute personal photos and other media that are central to building the collaborative memory boards.

- For your final project, did you simulate the crowd or run a real experiment?
 - Simulated crowd
- If the crowd was simulated, how did you collect this set of data?
 - Images were taken by photographers at events that occurred previously in the school year. Upvotes were provided by us
- If the crowd was simulated, how would you change things to use a real crowd?
 - We would create a group of popular events (such as concerts, sporting events, etc) and upload some base images. This would encourage users to post their own photos increasing engagement
- How many unique participants did you have?

We had 53 unique participants who actively contributed to the project. Together, they provided 1,476 photos that formed the foundation of our memory boards. This real crowd provided valuable insights into user behavior, preferences, and the effectiveness of our incentives.

Incentives

- What motivation does the crowd have for participating in your project?
 - Enjoyment
- How do you incentivize the crowd to participate? Please write 1-3 paragraphs giving the specifics of how you incentivize the crowd. If your crowd is simulated, then what would you need to do to incentivize a real crowd?

The primary motivations for crowd participation in Memory Mosaic are enjoyment and the opportunity to organize shared memories in a creative and interactive way. Memory Mosaic allows users to create public or private memory boards, offering flexibility and personalization that appeals to a wide range of contributors. By providing integrations with popular platforms like Instagram, users can easily import their content and build engaging boards with minimal effort. This makes the process of compiling and sharing

memories—whether for a friend group, an event, or a shared passion—both fun and convenient.

Specific Incentives:

- Enjoyment: Users derive pleasure from seeing their photos seamlessly integrated into a dynamic, visually engaging memory board.
- Community Building: The boards bring people together, creating a sense of belonging around shared events.
- Flexibility and Accessibility: The option to make boards public or private encourages participation from a variety of users—whether for personal reflection or wider sharing.
- Enhanced Features: Integration with Instagram and other platforms lowers barriers to participation, allowing users to import their media effortlessly and focus on the creative aspect of building mosaics.

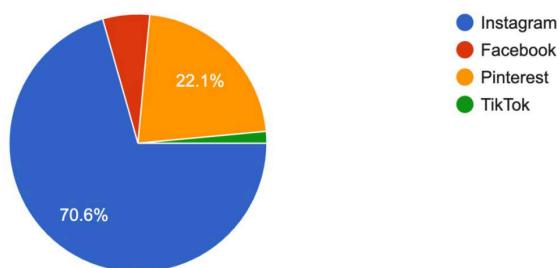
We understand that breaking into the saturated market of social platforms is inherently difficult, but we believe that through strategic integrations and targeted marketing efforts, Memory Mosaic has the potential to carve out a niche. Partnerships with existing platforms, outreach to event organizers, and campaigns targeting users who enjoy memory-sharing tools like Pinterest can help grow a committed user base.

- Did you perform any analysis comparing different incentives?

To better understand user motivations, we conducted a survey among prospective users. A key insight was the overwhelming preference for platform integrations, with Instagram being the most requested feature. Users also expressed strong interest in tools that allow easy collaboration and curation of content. While a detailed comparison of incentives has not been finalized, initial feedback highlights that offering features that enhance ease-of-use and collaboration is a highly effective motivator.

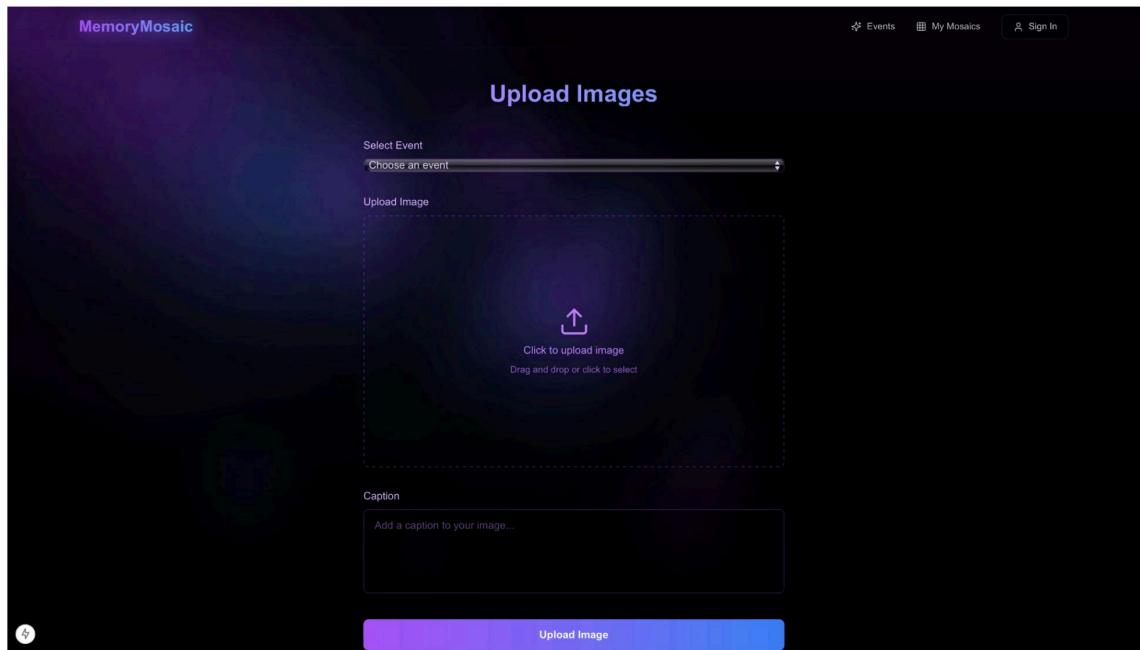
Which social media platform would you like Memory Mosaic to integrate with?

68 responses



What the crowd gives you

- What does the crowd provide for you?
 - The crowd provides both images and quality control. The quality control comes from the upvote and downvote process
- Is this something that could be automated?
 - Likely not, since which images people like is very subjective it would be difficult to train a model that can predict which images will make it to the top
- Did you train a machine learning component from what the crowd gave you?
 - No, we used a pretrained model from OpenAI for detecting TOS violations
- If you have a graph analyzing a machine learning component, include the graph here.
- Did you create a user interface for the crowd workers? Answer yes even if it's something simple like a HTML form on CrowdFlower.
 - Yes
- If yes, please include a screenshot of the crowd-facing user interface in your report. You can include multiple screenshots if you want.



Create New Event

Event Date

12/09/2024

Location

e.g., Central Park, NYC

Attendees

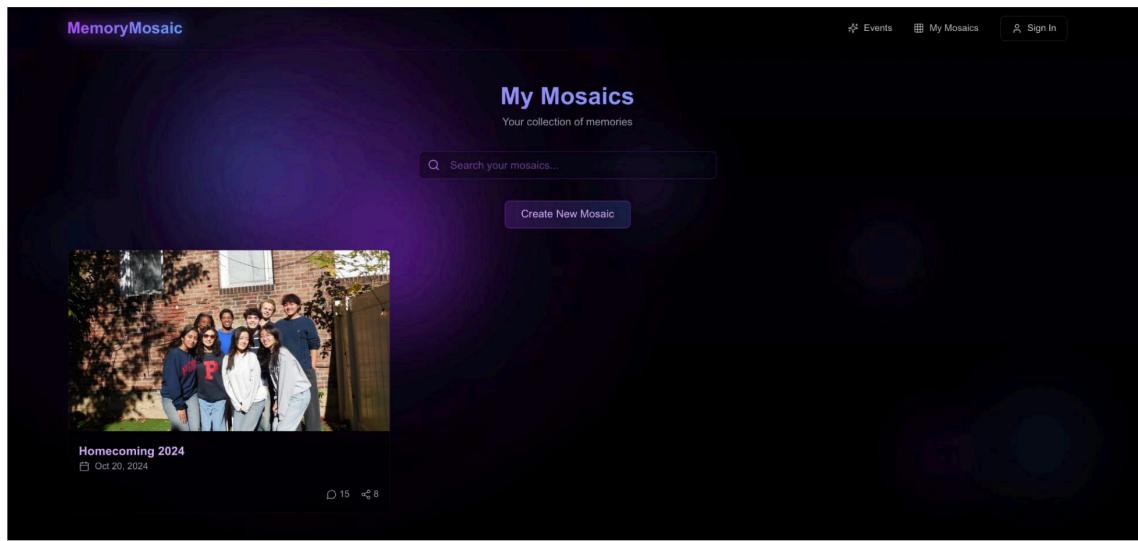
0



Description

Enter event description

Add Event



- Describe your crowd-facing user interface. This can be a short caption for the screenshot. Alternatively, if you put a lot of effort into the interface design, you can give a longer explanation of what you did.
 - There are 3 key pages that users interact with: events page, image upload, and the final mosaic. To create an event, users must specify the date, location, number of attendees, and provide a brief description of the event. This then creates an event on the users' page where they can upload images and see images uploaded by others. After creating or joining an event, users can view the images that have been uploaded or upload their own. When uploading an image, users can specify which event they want to participate in and provide a caption of the image. Users can then view the mosaics for all of the events that they are parts of. This is visible as a list with the top image as the thumbnail. Clicking on the image will bring users to the final mosaic, which is explained in more detail in the Aggregation section.

Ethics

Your report should include a discussion of ethics. One method of addressing this requirement is to nominate one of your teammates to ask ethics questions of the whole group.

- Should my application exist at all?
 - We think this application should exist as it is a fun and potentially harmless way for users to share and remember their experiences
- Does this task potentially expose workers to harm (for example, content moderation)? What effect can it have on them?

- The tasks in Memory Mosaic involve submitting personal memories and multimedia, which carry minimal risk. However, there is a potential for harm if the platform is misused (e.g., uploading inappropriate content or cyberbullying through comments). To mitigate this, we employ AI filters for content moderation and provide reporting tools to allow users to flag harmful or offensive submissions.
- Are you fairly compensating the workers for their time?
 - Participants are not paid but are incentivized through enjoyment, social interaction, and rewards such as free prints of the mosaics. The voluntary nature of the contributions aligns with the platform's goal of fostering a sense of community and collective memory-sharing.

Skills

- Do your crowd workers need specialized skills?
 - No
- What sort of skills do they need?
 - Users just need the ability to take and upload photos
- Did you analyze the skills of the crowd?
 - No
- If you analyzed skills, what analysis did you perform? How did you analyze their skills? What questions did you investigate? Did you look at the quality of their results? Did you analyze the time it took individuals to complete the task? What conclusions did you reach?
 - N/A
- Do you have a graph analyzing skills? If you have a graph analyzing skills, include the graph here.
 - N/A

Quality Control

- Is the quality of what the crowd gives you a concern?
 - The quality is a concern, since people might upload images that are not high quality. However, this can be offset by the upvoting feature of the website, which will push the higher quality images to the front of the mosaic for users to see
- How do you ensure the quality of the crowd provides?
 - The crowd regulates the quality of data that is provided using the upvote/downvote feature
- If quality is a concern, then what did you do for quality control? If it is not a concern, then what about the design of your system obviates the need for explicit QC? This answer should be substantial (several paragraphs long).

- Quality is a concern for Memory Mosaic because the visual appeal and value of the mosaics depend heavily on the quality of the images contributed by users. Without proper quality control, the platform risks including low-resolution, irrelevant, or inappropriate images, which could harm the user experience and the overall effectiveness of the mosaics.

To address this, the design of Memory Mosaic incorporates several layers of quality control:

1. One of the primary mechanisms for quality control is the upvote/downvote system, where users participating in an event can vote on uploaded images. This system uses the collective judgment of the crowd to determine which images are most relevant, visually appealing, and meaningful for the memory board. High-quality images naturally rise to the top due to positive feedback, while irrelevant or lower-quality images are downvoted and flagged for removal.

This approach reduces the need for manual intervention or automated quality checks, as the crowd's preferences drive the selection process. It also ensures that the mosaic reflects the shared values and aesthetic standards of the contributors.

2. The design of Memory Mosaic inherently reduces the need for explicit QC by ensuring that images are contextual and relevant. For instance:
 - Users must register for specific events before uploading images. This step naturally filters out unrelated contributions, as participants are more likely to upload event-specific images.
 - The mosaic generation process itself is designed to highlight top-voted images prominently while downplaying or excluding those with minimal engagement. This layout ensures that the final product showcases the best contributions without requiring manual curation.
 - The similarity score is also integrated into the mosaic-building process to ensure a diverse and representative visual composition.

- Did you analyze the quality of what you got back? For instance, did you compare the quality of results against a gold standard? Did you compare different QC strategies?
 - We did not get an opportunity to compare different QC strategies. However, it would be interesting to play with the algorithm for determining the best image based on certain criteria. Something that we would like to try would be weighting upvotes and comments differently, as well as boosting users who consistently upload high quality images. This could be done by averaging the number of

upvotes of users images and weighting the performance of an image by that.

However, this requires a significantly larger network in order to do an analysis.

- What questions did you investigate? What conclusions did you reach?
 - We investigated different strategies for weighting images in the final mosaic. This included weighting comments more than upvotes, weighting only based on upvotes, and weighing both equally. We qualitatively found that weighting comments and upvotes equally produced better looking mosaics. We believe that this is due to the fact that people are more likely to upvote an image. However, we hypothesize that as the quantity of data grows, different weighting algorithms may produce higher quality mosaics.
- Do you have a graph analyzing quality? If you have a graph analyzing quality, include the graph here.
 - We do not have a graph analyzing quality, as in our case quality is subjective (i.e. there is no gold standard metric for determining the quality of an image, it varies from person to person).

Aggregation

- How do you aggregate the results from the crowd?
 - Our aggregation is the final mosaic. As users post and upvote more photos on the platform, our algorithm dynamically chooses which images to bring to the front of the mosaic. It determines which images to push based on the engagement with the photo: photos with more upvotes and comments get more space in the mosaic. This aggregation requires complex engineering to ensure that popular images are brought to the front of the image.
- Did you create a user interface for the end users to see the aggregated results? If yes, please include a screenshot of the user interface for the end user in your final report. You can include multiple screenshots, if you want.

- We created a template of what the final mosaic would look like.



- Describe what your end user sees in this interface. This can be a short caption for the screenshot. Alternatively, if you put a lot of effort into the interface design, you can give a longer explanation of what you did.
 - There are roughly 1-2 dozen images in the final product, with the most prominent ones occupying the best real estate in the image. Upon hovering over an image, users can see the number of upvotes and comments that the image received. Additionally, clicking on the image will highlight the image, making it larger and clearer than in the mosaic. Users can then upvote or downvote the image, changing its rank and position in the final product.

Scaling Up

- What is the scale of the problem that you are trying to solve?
 - The problem we are trying to solve affects many people on social media, likely in the thousands to millions of users.
- Would your project benefit if you could get contributions from thousands of people?
 - Absolutely. One of the best forms of quality control comes from users choosing which images they prefer. The knowledge of the crowd would dramatically improve the quality of content on the platform. For example, on an app with 100 users, a post with 10 upvotes is likely okay, while on an app with 100,000 users, 10,000 suggests that this image is high quality. This can be extended to negative images: the more downvotes a post has, the more likely it is to break our terms of service or be low quality. This would provide our models with better data on which images we want on the platform or not.

- What challenges would scaling to a large crowd introduce?
 - One of the hardest parts of scaling to a large crowd would likely be creating the final mosaic. We can only include a small number of images in the final product. As the number of users increases, so does the number of uploaded images. This makes it harder to determine which images to include and which to reject. Additionally, users may feel less inclined to upload images if they are consistently not in the final result. Balancing the quality of images with user enjoyment and interaction on the platform would be very difficult as the project grows.
- Did you perform an analysis about how to scale up your project? For instance, a cost analysis?

Yes, we performed a cost and interactions analysis

- What analysis did you perform on the scaling up?

1. Voting System Simulation

- Current user base: 53 users
- Average upvotes per image: 5–10
- Scaled user base:
 - 1,000 users: Expected upvotes per image = 100–200
 - 10,000 users: Expected upvotes per image = 1,000–2,000
 - 100,000 users: Expected upvotes per image = 10,000–20,000

A larger crowd improves the reliability of upvote-based content ranking. But we also understand that the system will need optimized algorithms to handle the higher volume of interactions efficiently.

2. Algorithm Load Testing

Current system processes:

- 1,476 images: Duplicate detection runtime = 0.5 seconds per image, total = 12 minutes.

Projected dataset sizes:

- 10,000 images: Runtime = 1.4 hours.
- 100,000 images: Runtime = 14 hours.

If we transition to parallel processing or implement more efficient algorithms (e.g., SSIM), potentially reducing runtime by 50–70%.

3. Image Moderation

Model: OpenAI omni-moderation model

Cost: \$0.005525 / image

- 1,476 images: cost * (image count) = \$8.1549
- 10,000 images: \$55.25
- 10,000 images: \$552.5

4. Infrastructure Needs

Current storage requirements

- Average image size = 2 MB
- Storage for 1,476 images = ~3 GB.

Projected storage requirements:

- 10,000 images = ~20 GB
- 100,000 images = ~200 GB
- 1,000,000 images = ~200 TB

Cost projection for cloud storage

- \$0.02/GB/month (e.g., AWS S3 Standard Tier)
- Current cost: \$0.06/month
- 100,000 images: ~\$4/month

Bandwidth Usage

- Current user base: 53 users
- Average download/upload per session = 5 MB/user
- Total bandwidth = 265 MB/session
- Scaled to 10,000 users:
- Bandwidth = ~50 GB/session

4. Cost Analysis for Scaling

Current costs:

Manual moderation (53 users, 1 moderator) = 2 hours/week.

Total cost = \$50/week.

Scaled costs:

10,000 users:

Moderators required: 10 (5 moderators x \$25/hour x 2 hours/week) = \$500/week.

Automation reduces cost by 50%: \$250/week.

Cloud services:

Storage: \$4/month

Compute: \$10/month

Total cost: \$14/month

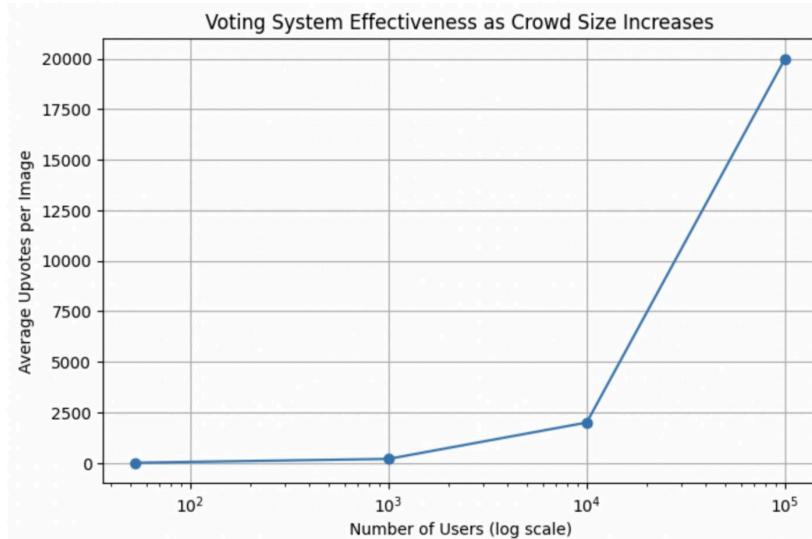
- What questions did you investigate? What conclusions did you reach?

Questions

- How does upvote reliability change with crowd size?
 - Larger crowds provide exponentially better quality control.
- Can the system handle 10x or 100x scaling?
 - With current infrastructure, 10x scaling is manageable. 100x scaling would require algorithm optimization and infrastructure upgrades.
- How to retain users at scale?
 - Introducing thematic mosaics and contributor recognition (e.g., badges) will sustain engagement even when not all submissions are included.

We realized that scaling up improves the quality of contributions because having more people involved leads to better upvotes and downvotes for quality control. However, this means we need strong systems and smart algorithms to handle the extra content. We'll also need more storage, faster processing, and better internet resources to keep everything running smoothly. Keeping users interested as the platform grows is also important. To do this, we could try things like creating smaller themed mosaics or giving badges and shoutouts to contributors to keep them motivated, even if all their uploads don't make it into the final mosaics.

- Do you have a graph analyzing scaling? If you have a graph analyzing scaling, include the graph here.



Project Analysis

- Did your project work? How do you know? Analyze some results, discuss some positive outcomes of your project.

Yes, Memory Mosaic worked as intended. This was evidenced by:

- **User Engagement:** Over 53 users contributed 1,476 images, and the voting system successfully highlighted the best and most relevant ones.
- **Positive Feedback:** Participants, including event organizers and photographers, expressed satisfaction with the mosaics and found the platform intuitive and impactful.
- **Algorithm Performance:** The quality control measures, such as image similarity detection and upvoting, successfully filtered out duplicates and low-quality submissions.
- What were the biggest challenges that you had to deal with?
 - The biggest challenge in building this project was setting up the frontend. Figuring out how to configure the mosaic in a way that was aesthetically pleasing took a lot of tweaking in order to get the sizing right. We also spent a significant portion of time configuring the backend to make sure that users and events were organized efficiently.
- Were there major changes between what you originally proposed and your final product?
 - We did not make significant changes to the project from what we originally intended. The primary difference between our original proposal was a larger user base, however, we believe that given more time spent on this project, we could have built a self-sustaining user base that would supply our platform with content.
- What are some limitations of your product? If yours is an engineering-heavy project, what would you need to overcome in order to scale (cost/incentives/QC...)? If yours was a scientific study, what are some sources of error that may have been introduced by your method.
 - **Scalability:** Handling larger datasets would need better systems and tools for quality control.
 - **Incentives:** Attracting a broader user base remains a challenge, as new social platforms face high competition.
 - **Diversity of Contributions:** The quality and relevance of submissions could vary widely depending on user demographics and event types.

Scaling up would involve:

- **Increased Infrastructure Costs:** For hosting and processing large datasets.

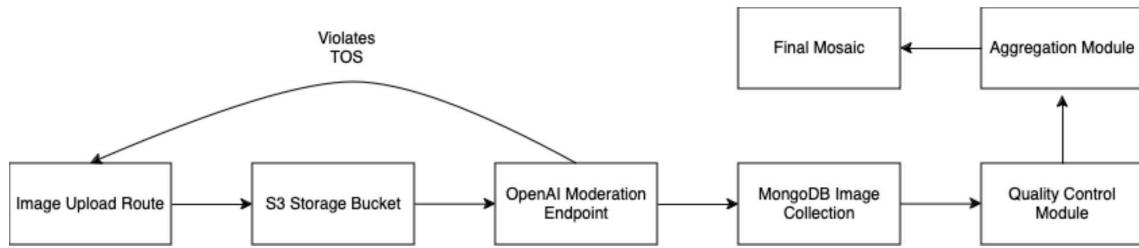
- **Enhanced Algorithms:** For automated quality control and mosaic generation.
- **Improved Incentive Structures:** To attract and retain contributors.

Technical Challenges

- Did your project require a substantial technical component? Did it require substantial software engineering? Did you need to learn a new language or API?

Our project required substantial technical components.

- For the backend, we used MongoDB for storing information about users, events, and images. This involves 3 separate collections with foreign keys to one another. Users are able to register for different events. Registering for an event allows users to upvote and upload images to the event. This requires linking between the 3 tables so we can keep track of where users can upload, and which collections the images are uploaded to. We also use the OpenAI API for moderating image submissions. Upon uploading an image, we add it to an S3 bucket. We then send the S3 link to OpenAI's moderation endpoint to determine whether the image contains any sensitive content that does not belong on the site. If the image is flagged, we remove it from S3 and return a message saying that the image is not okay for our site. Otherwise, we add the image to a collection in MongoDB for tracking images with some information about the event. Our frontend also required significant thought. Compiling a mosaic was very challenging and we bounced between several frameworks before landing on React.
- If the project required a substantial technical component, describe the largest technical challenge you faced.
 - The largest technical challenge was compiling the mosaic in a nice way. We ended up hardcoding the mosaic's shape, however, this took significant effort on our part.
- How did you overcome this challenge? What new tools or skills were required? Feel free to nerd out a bit, to help us understand the amount of work that was required.
 - We had to experiment with different database systems and frontend systems. For backends, we debated between PostgreSQL and a noSQL database. We eventually decided on a noSQL database (MongoDB), since it provides us with more flexibility and is frequently used for systems with social components. This also provided us with more flexible object types, allowing us to store the events users are registered for, which events an image belongs to, etc. For the frontend, we eventually decided on React, since we had the most experience with it.
- Do you have any screenshots or flow diagrams to illustrate the technical component you described? If so, include the graph here.



- Is there anything else you'd like to say about your project?
 - We believe that with more time, we could have more events and get an increased user base. This would provide more interesting analysis, as we could periodically survey users on different mosaics to determine which they prefer. This would help provide a metric for the quality of our final product by allowing users to compare and contrast different mosaics.