

**Nurdle Count – A machine learning approach to nurdle classification and quantification -
Year 1 Quarter 1 Report
(May 1st, 2024 – July 31st, 2024)**

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August 5th, 2024

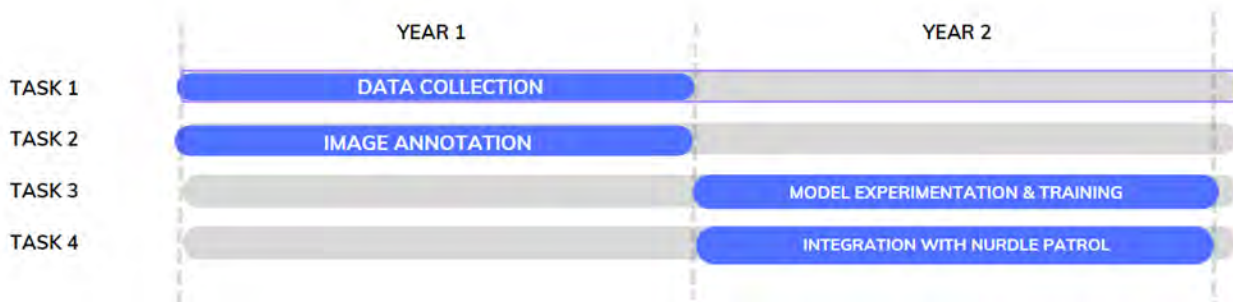
Administration:

The Nurdle Count – A machine learning approach to nurdle classification and quantification was approved for funding on January 8th, 2024, with a requested start date of May 1st, 2024.

Risks and Impacts:

None

Project Tasks:



1) Task 1 - Data collection:

- a. Collect training and test nurdle image data.
- b. QA/QC collected nurdle image data.
- c. Research and design AI training methods.
- d. Develop a standard operating procedure (SOP) for capturing nurdle images.

Task 1 – Subtasks a and d: In preparation for collecting training and testing the Nurdle image data, the Nurdle Count team first developed two Standard Operating Procedures (SOPs). After extensive review, two Standard Operating Procedures (SOPs) were created, each tailored to different audiences: internal and external. The internal SOP is designed for use by the research team, while the external SOP is intended for 8th-grade students. Although both SOPs share similar content and workflow, the external SOP is written in language that is accessible and understandable at an 8th-grade reading level. Based on the research team's work with nurdle images, the two SOPs are outlined as follows:

Internal SOP

The internal SOP was developed as a baseline SOP from which SOPs for citizen scientists would be developed.

1. Equipment Preparation

- **Smartphone:** Use a smartphone with a camera.
 - For Android, it should be Google Pixel 6a or newer model.
 - For iOS (Apple), it should be iPhone SE or newer model.
- **Stable Surface:** Ensure the smartphone is placed on a stable surface or use a simple phone stand.
- **Lighting:** Utilize natural light or consistent artificial lighting.
- **Background:** Use the petri dishes and fabrics provided in the nurdle kit.

2. Nurdle Placement

- **Surface:** Use the petri dishes which are provided in the nurdle kit.
- **Spacing:** Softly shake the petri dish to space the nurdles without overlapping.
- **Quantity:** Maintain an easy-to-track amount of nurdles per image (e.g., 10-30).

3. Location and Setup

- **Location:** Choose a consistent, well-lit location. Try to make sure all your pictures are taken in a consistent way -- try to keep the lighting conditions the same from one picture to the
- **Setup:** Position the smartphone directly above the surface where the nurdles will be placed.

4. Lighting Conditions

- **Natural Light:** Preferably use diffused natural light, such as near a window with indirect sunlight.
- **Artificial Light:** If natural light is insufficient, use a consistent artificial light source without harsh shadows.

5. Smartphone Settings

- **Resolution:** Set the camera to the highest resolution.
- **Focus:** Use the manual focus or tap to focus on the nurdles.
- **Exposure:** Adjust exposure to ensure clear and well-lit images.
- **Grid Lines:** Enable grid lines to help with alignment and spacing.

6. Image Capture

- **Angle:** Capture images from a top-down angle, holding the phone perpendicular to the surface.
- **Distance:** Maintain a consistent height for all shots (e.g., roughly 20 cm or 8 inches above the surface).
- **Method:**
 - Set a consistent focal length: 26mm
 - Enable gridline on the camera.
 - Enable aspect ratio of 4:3.
 - Align the petri dish containing nurdles in the center grids of the camera view (The idea is to have consistent focal height, need to have justification on how this is done).
 - Don't put the petri dish cover on.
- **Multiple Shots:** Take at least 3 multiple shots for each setup to choose the best image out of the series. Consider using burst mode if available.

7. Post-Processing

- **File Format:** Save images in the highest quality available (usually the default setting).
- **Cropping:** Crop images to remove any unnecessary background if needed.

8. Documentation

- Write down the **total number of nurdles** in the image, and **number of nurdles by color**.
- **Device Information:** For Android devices, note down the device model and Android version. For iOS devices, note the device model and iOS version.
- Access the Nurdle Patrol website to submit the images and the above information.

9. Quality Control

- **Review:** Establish a regular review schedule (e.g., weekly or bi-weekly) to assess the image quality.
- **Adjustments:** Create a feedback log to document any changes or improvements made to the procedure.

External SOP

1. Get Your Stuff Ready

- Phone: Make sure you have a phone with a working camera.
- Stable Surface: Put the petri dish provided in the Nurdle Count Kit on a steady surface like a table.
- Lighting: Use natural light from a window or a consistent artificial light.
- Background: Use the petri dish and fabric/felt from the Nurdle Count Kit.
- App:
 - On an Apple phone, use the default Camera app.
 - On an Android phone, use the Open Camera app available in the Google Play Store: [Open Camera App](#).

2. Place the Nurdles

- Surface: Use the petri dish from the Nurdle Count Kit.
- Place Nurdles in the petri dish: Use the tweezers from the kit to place the nurdles into the petri dish one by one so you can keep count. Also, add a few non-nurdle objects for variety.
- Spacing: Gently shake the petri dish to spread out the nurdles.
- Quantity: Keep track of the number of nurdles you put in the petri dish. It would be best to keep track of 10 to 30 nurdles to be easily able to.

3. Find a Good Spot and Set Up

- Location: Try to make sure all your pictures are taken in a consistent way -- try to keep the lighting conditions the same from one picture to the next.
- Setup: Place your phone directly above the petri dish.

4. Check the Lighting

- Natural Light: Use sunlight from a window if possible.
- Artificial Light: Avoid strong shadows and try to keep the area around petri dishes have an even exposure to light.

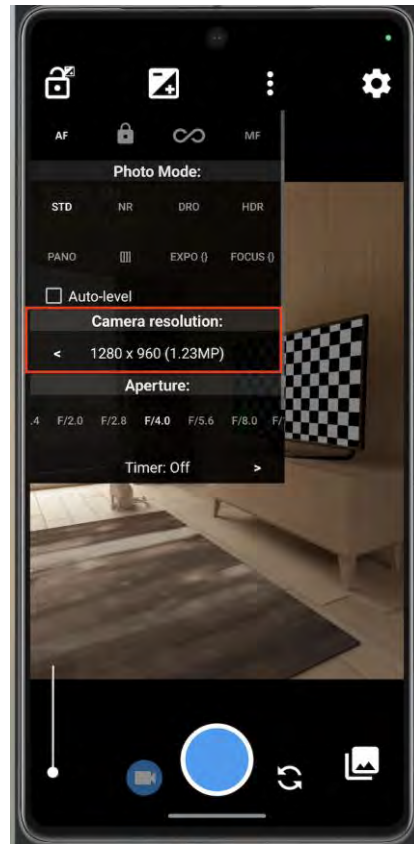
5. Adjust Your Phone Settings

- Resolution: Set your camera to the highest resolution.
- Camera app:
 - For iPhone (iOS) the default camera settings should be fine.
 - On Android, press the three dots button on Open Camera and ensure that it is at the highest possible resolution. If the right arrow is shown, that means that the resolution can be set higher.


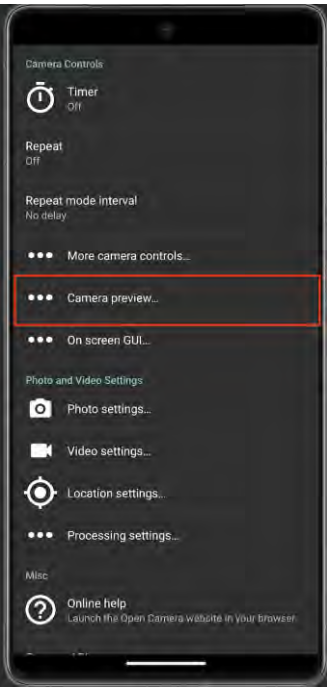
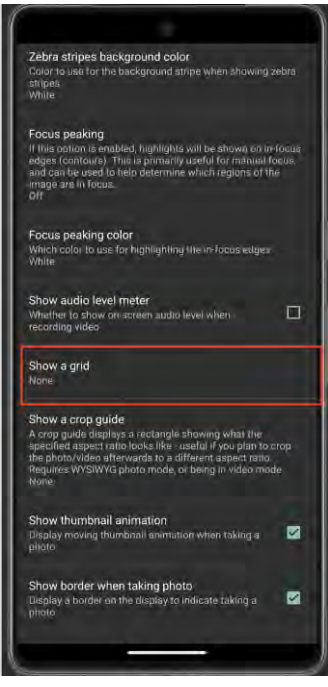
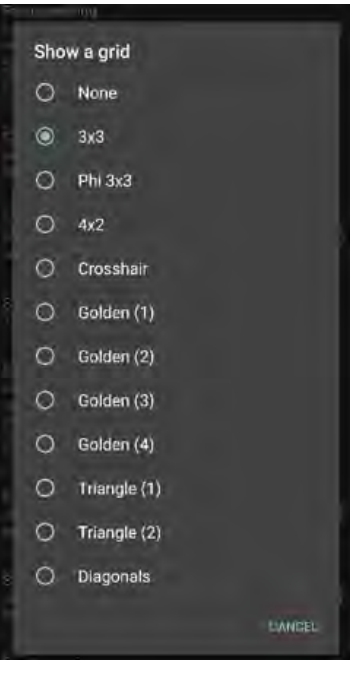
1. Three dots



2. Resolution option



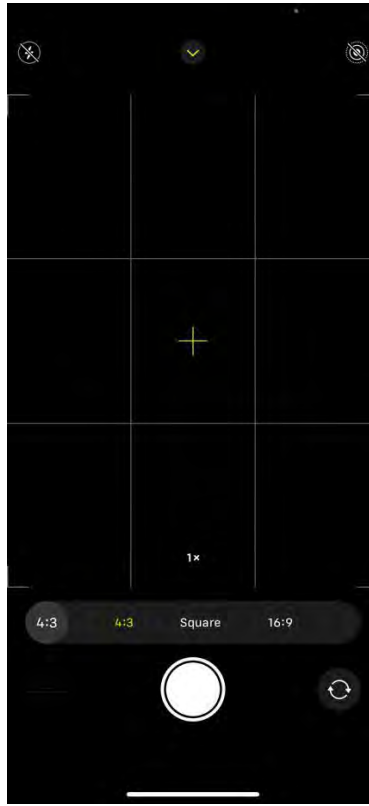
- Focus: Tap the screen to focus on the nurdles.
- Exposure: Make sure the image is bright and clear.
- Grid Lines: Turn on grid lines to help with alignment.
 - iPhone: Go to Settings > Camera > Composition > Turn on the “Grid”.
 - Android w/ Open Camera: Press the settings button, "Camera preview...", Show a grid, 3x3.

1. Setting buttons	2. Camera preview	3. Show a grid	4. Chose 3x3
			

- Camera Settings:
 - Set the focal length to 26mm.

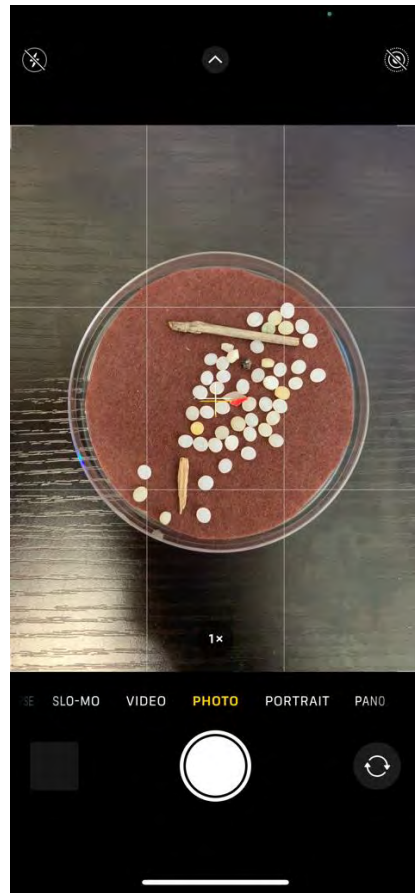


- Use the 4:3 aspect ratio.



6. Take the Photo

- Angle: Hold the phone straight above the nurdles.
- Distance: Keep the phone about 20 cm (8 inches) above the petri dish.
- Method:
 - Center the petri dish in the grid lines on your screen.
 - Leave the petri dish cover out.
 - Take at least 3 photos and choose the best one.



7. Edit the Photos

- Cropping: Crop the photo if needed to remove extra background.



8. Document the Details

- Write down the total number of nurdles in each photo into the Nurdle Count Sheet.
- Write down the number of nurdles by their color into the Nurdle Count Sheet.
- Note your device information:
 - For Android, the device model and Android version. (need support with this).
 - For iOS, the device model and iOS version. Go to Settings > General > About. On this screen, you can see the info for iOS Version and Model Name.
- Go to the Nurdle Patrol website to submit your images with all the information above. Remember to take a photo of your Nurdle Count Sheet as well.

Task 1 – Subtask b: QA/QC collected nurdle image data

Year 1 Quarter 2 will focus on the development of this subtask.

Task 1 – Subtask c: Research and design AI training methods

Over the past quarter, researchers on the Nurdle Count team have been exploring research and designing AI training methods. The research team is in the process of setting up the environment necessary for implementing the Nurdle Count ML/AI model on the high-performance computing (HPC) resources. They are currently taking initial steps to adapt the annotation data to various pre-trained models to gain insights for the next stages of the project. The models being tested include Mask-RCNN and detectron2.

The team is focusing on preparing the system infrastructure and ensuring that all necessary tools and libraries are in place. This involves configuring the HPC resources to handle the data processing and model training tasks efficiently. The use of pre-trained models such as Mask-RCNN and detectron2 allows the team to leverage existing, well-established techniques in machine learning and artificial intelligence. By experimenting with these pre-trained models, the team aims to identify the best approaches for analyzing the annotation data.

This work is critical for laying the groundwork and ensuring that the subsequent phases can proceed smoothly and effectively. The insights gained from these experiments will inform the team's strategy to address the Nurdle Count problem in the next phases.

Task 2 – Image Annotation

In the first quarter of the Nurdle Count project, the research team began working on data annotation, which is part of the next quarter's objectives. They performed image annotation on the CVAT platform and experimented with exporting the annotation data for manipulation using Python, the programming language chosen to develop the AI/ML model for Nurdle Count.

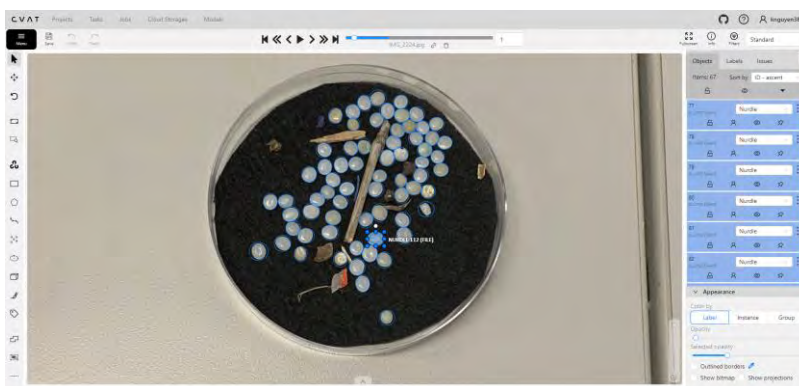


Figure 1: Annotated Nurdle Image

It is our hope that, in preparing the annotation data for use with Python and machine learning libraries, the collected nurdle image data can be used to train and develop an accurate, efficient, and useful model for identifying and quantifying nurdles in images taken by everyday citizen scientists.

In support of this task, the Nurdle Count Research Team has deployed a self-hosted CVAT (Computer Vision Annotation Tool) platform. This platform provides a robust and efficient solution for the annotation process, giving users a friendly interface to annotate nurdles. The platform helps organize and manage the annotated images, making it easier for the team to analyze the data and draw conclusions about nurdle pollution.

By using CVAT, the Nurdle Count Research Team can more efficiently and accurately process large numbers of images, leading to better insights and more effective strategies to address the Nurdle Count problem.

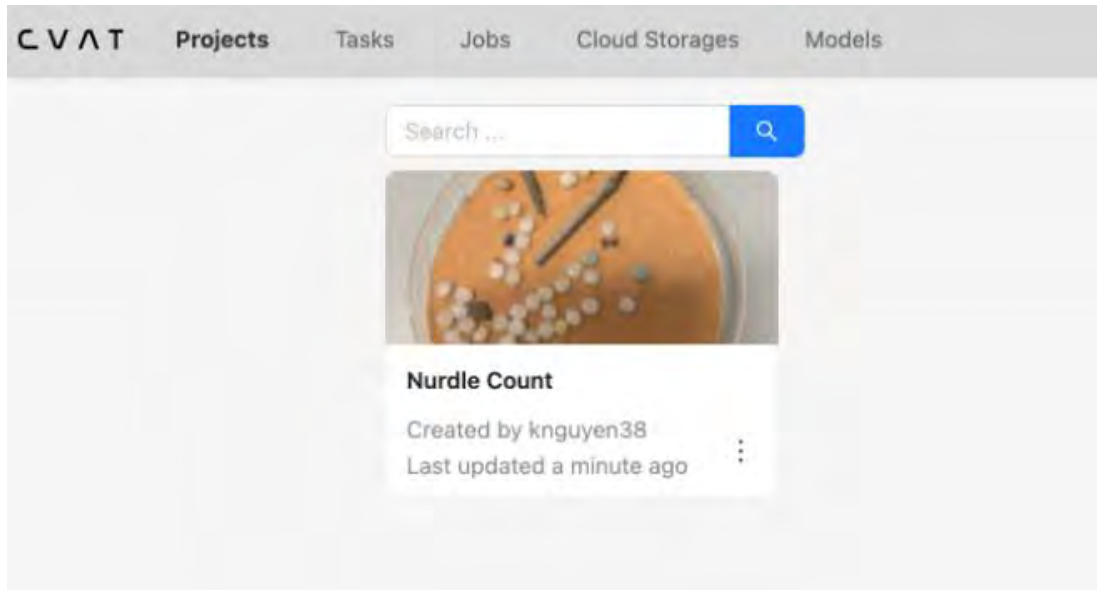


Figure 2: CVAT platform for Nurdle Count Annotation

Task 3 - Model experimentation and training: *to be completed in year 2*

- a. Train Nurdle Count AI.
- b. Collect feedback and improve the AI model.

Task 4 - Integration with Nurdle Patrol: *to be completed in year 2*

- a. Implement the Nurdle Count feature on NurdlePatrol.org.
- b. Implement the Nurdle Count feature in the Nurdle Patrol Apple iOS mobile application.
- c. Implement the Nurdle Count feature in the Nurdle Patrol Android mobile application.
- d. Publish AI model to the public.

Summary:

Tasks 1 and 2 are well underway in Year 1 Quarter 1. Over the summer, researchers on the Nurdle Count team reached out to three middle school educators in coastal Texas communities with the goal of collaborating with their classes on Nurdle Count on the following tasks:

- Collecting nurdle image data via the external SOP
- Training the Nurdle Count AI by classifying nurdles
- Collect feedback and improve the Nurdle Count application

This synergistic activity will allow for the education of microplastic pollution as well as the emergence of AI as a scientific tool while providing useful data and feedback to the Nurdle Count team.

Obstacles: None