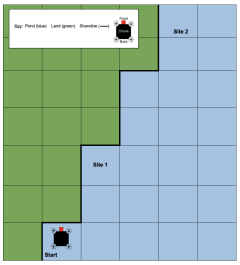
URI Robotics Lab: Programming Drones to Help our Community (Teacher Guide)



The following engineering transfer tasks have been created to be used in conjunction with the URI Robotics Lab Video. The tasks are designed to be completed in order as they build upon one another.

Teacher Notes:

- Please note printed copies will be in black and white, but projected documents will be in color.
- Here's a video of Dr. Stegagno introducing the tasks: bit.ly/algaedrone
- Here's a sample of actual images the drone has captured: bit.ly/pondimage
- Task 1: You may consider doing this together as a think aloud
    - Have students turn and talk/think-pair-share/discuss their ideas
- Task 2: You may consider having students complete with a partner
    - Have a sense-making discussion with the whole group after students complete the task
- Task 3: You may consider having students complete independently
    - Have a sense-making discussion with the whole group after students complete the task
- This is an engineering task and students will need to consider the criteria (goals) and the constraints (limitations).

Teacher Guiding Questions: You may use these guiding questions for all of the tasks, depending on how you scaffold it.

- What information did you get from the text?
- What information did you get from the diagram?
- What information do we get from the key?
- What is the task?
- What are the criteria, or goals, of the task?
- What are the constraints, or limitations, of the task?
- How do you know? How did you figure that out?
- Does anyone have a different idea?
- Does anyone have any ideas to add?
- What pattern did you notice?
- How could you use this pattern to predict future motion?

URI Robotics Lab: Programming Drones to Help Our Community

Biologists are studying algae blooms in a pond in Exeter, Rhode Island. Algae are plant-like organisms that grow in water. If there is too much algae it can affect the other organisms that live in the pond. The biologists need to know how much algae was in the pond. They asked Dr. Stegagno, an electrical engineer at the University of Rhode Island to program a drone to fly over and photograph the water's edge of a Rhode Island pond so they can measure the amount of algae.

Dr. Stegagno would like to share a bit about the project with you here, bit.ly/urialgeadrone.
Here is a short video clip of the drones test flight. bit.ly/uridronetest
He has also shared a sample of the images (Figure 1) the drone captures, bit.ly/pondimage.

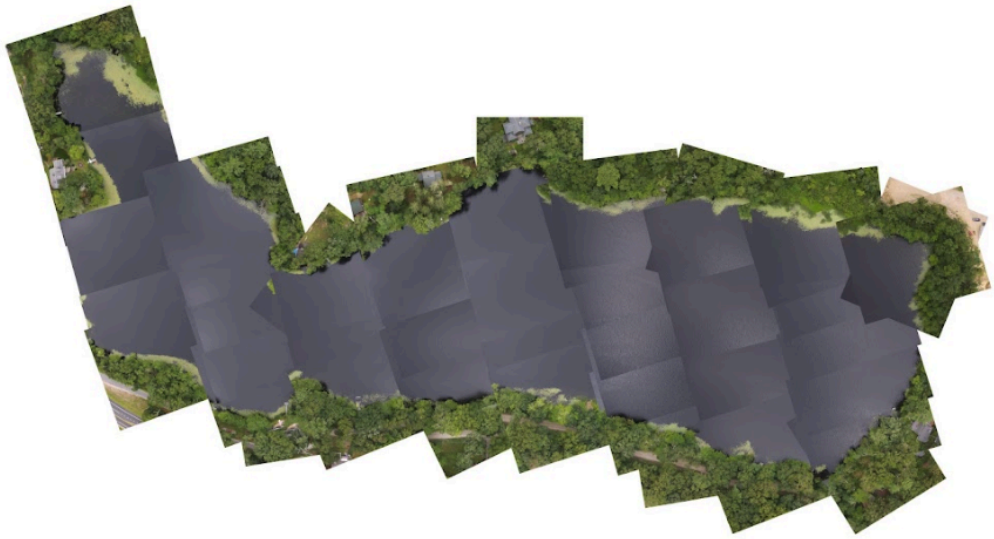


Figure 1: Drone images of Pond in Exter, Rhode Island

GEMS-Net & The UConn-URI Navy STEM Coalition would like to acknowledge funding and support from the Department of Defense National Defense Education Program (NDEP) grant #HQ00342110016

URI Robotics Lab: Programming Drones to Help Our Community

Task 1: The diagram (Figure 2) below shows a birds eye view of the drone, the pond, and the land. There are 2 sites that Dr. Stegagno needs to photograph.

While programming the drone, here are the constraints that Dr. Stegagno had to consider:

- The camera is on the front of the drone.
- The drone can move in the following directions: forward, turn right, or turn left.
- As the drone flies, it must stay over the water while following the water's edge.

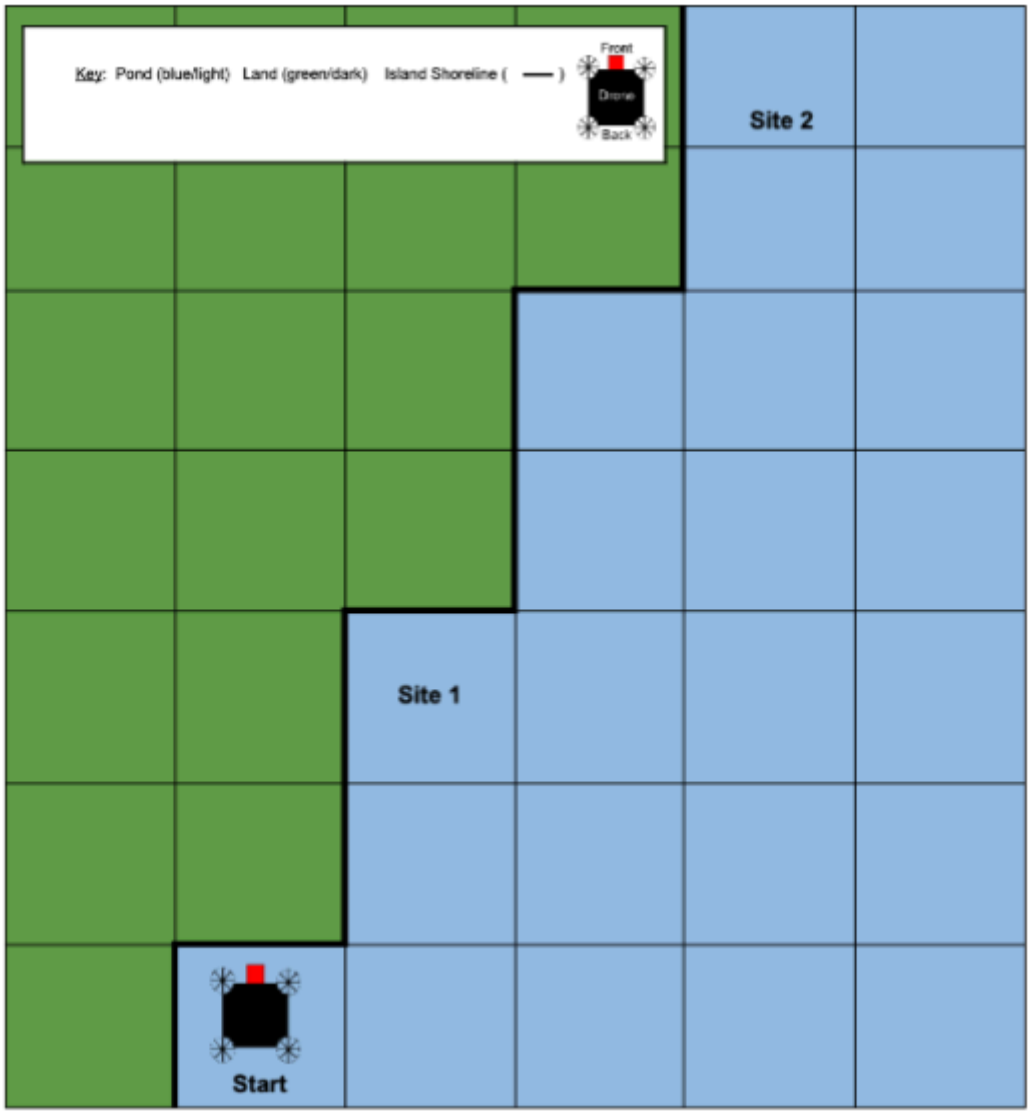


Figure 2: Diagram of pond marking Site 1 and Site 2

GEMS-Net & The UConn-URI Navy STEM Coalition would like to acknowledge funding and support from the Department of Defense National Defense Education Program (NDEP) grant #HQ00342110016

URI Robotics Lab: Programming Drones to Help Our Community

Directions: Use the pond diagram (Figure 2) to help you answer the following questions.

1) Discuss with your class or your group how the drone will get from Start to Site 1 following the water's edge. You might try modeling the path using your body.

   Teacher Note: You may consider having the students use the floor tiles, graphing paper, white board, etc. to model the movements of the drone. Consider students sharing with a partner and then discussing as a whole class. You might also want to project the graph in color.

2) Using the words or symbols in the table below, can you record the sequence of movements needed so that the drone follows the edge of the water from Start to Site 1?

Word	Arrow	Letter
Forward		F
Turn Right		Ⓡ
Turn Left		Ⓛ

   Sequence of Start to Site 1:

   Sample Answer: Turn right, Forward, Turn Left, Forward, Forward

3) How will the drone get from Site 1 to Site 2 following the water's edge? Record the sequence of movements in words or symbols.

   Sequence of Site 1 to Site 2:

   Sample Answer:
   Turn right, Forward, Turn Left, Forward, Forward, Turn Right, Forward, Turn Left, Forward, Forward

GEMS-Net & The UConn-URI Navy STEM Coalition would like to acknowledge funding and support from the Department of Defense National Defense Education Program (NDEP) grant #HQ00342110016

URI Robotics Lab: Programming Drones to Help Our Community

4) What is the complete sequence of moves to get the drone from the Start all the way to Site 2 following the water's edge?

Complete Sequence:

Sample Answer:

Turn right, Forward, Turn Left, Forward, Forward, Turn Right, Forward, Turn Left, Forward, Forward, Turn Right, Forward, Turn Left, Forward, Forward

5) Do you notice a repeating pattern in the complete sequence? Can you circle the pattern in your complete sequence recorded above?

See sample answer above.

6) How many times does the drone need to repeat the pattern to get from the Start all the way to Site 2?

Sample Answer: Dr. Stegagno will need to repeat the pattern 3 times to get from Start to Site 2.

7) Based on what you have discovered, write a letter to Dr. Stegagno recommending the moves he should use to program the drone to be sure he is able to photograph both sites. Remember that the drone needs to begin at the Start and follow the water's edge all the way to Site 1 and then Site 2.

Teacher Note: Answers will vary. See sample response below for guidance.

Dear Dr. Stegagno,

I would recommend using the following sequence of movements to program the drone to follow the edge of the shoreline. The pattern is: Turn right, Forward, Turn Left, Forward, Forward. If you program the drone to repeat this pattern 3 times, it will be able to photograph Site 1 and Site 2. I hope this is helpful for you. Good Luck with your project!

Sincerely,
Eliana Smith

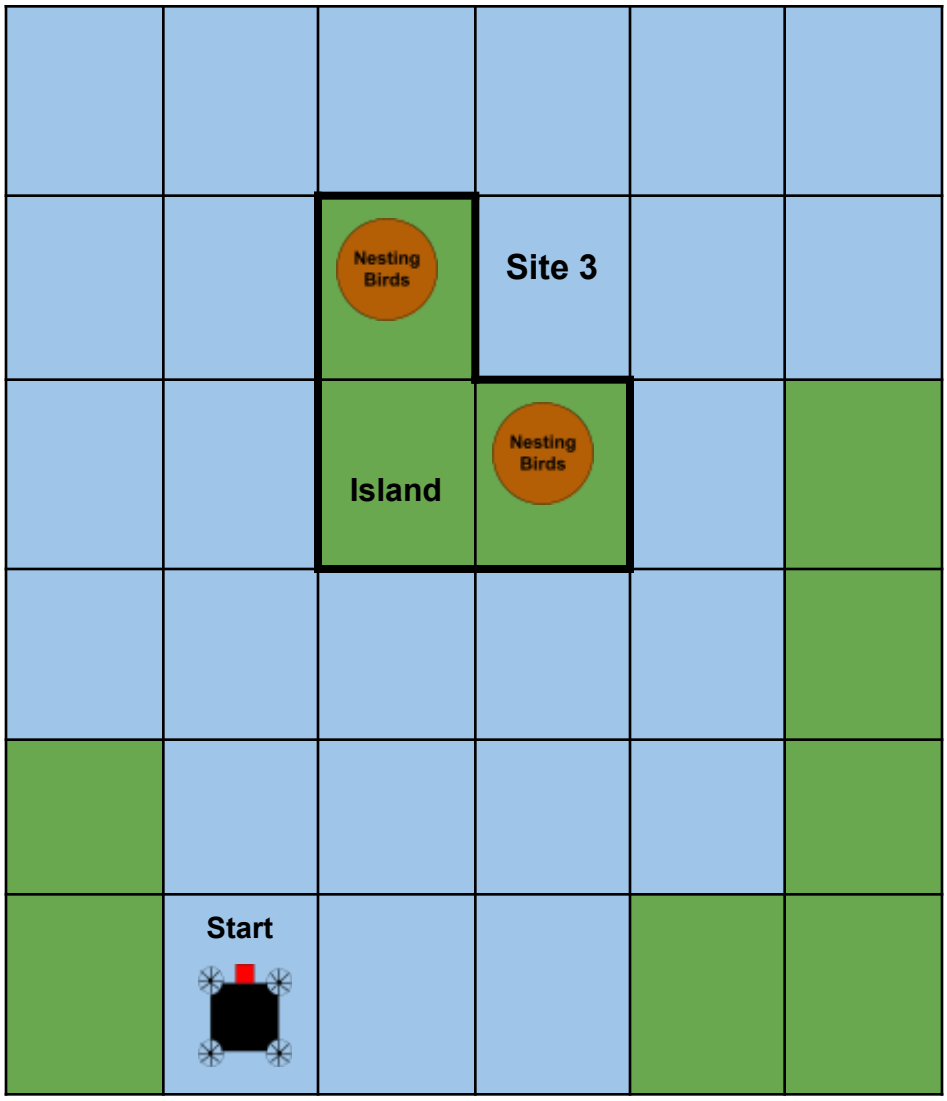
GEMS-Net & The UConn-URI Navy STEM Coalition would like to acknowledge funding and support from the Department of Defense National Defense Education Program (NDEP) grant #HQ00342110016

URI Robotics Lab: Programming Drones to Help Our Community

Task 2: Dr. Stegagno needs your help again to program a drone to photograph an algae bloom in another part of the pond. The diagram (Figure 3) below shows an area of the pond with an island in the middle. The area that needs to be photographed is Site 3.

While programming the drone, the constraints you need to consider are:

- The camera is on the front of the drone.
- The drone can move in the following directions: forward, turn right, or turn left.
- As the drone flies, it must stay over the water and cannot fly over the island because we can't disturb the protected nesting birds.



Key: Pond (blue) Land (green) Island Shoreline (■)

Figure 3: Diagram of pond marking Site 3

GEMS-Net & The UConn-URI Navy STEM Coalition would like to acknowledge funding and support from the Department of Defense National Defense Education Program (NDEP) grant #HQ00342110016

URI Robotics Lab: Programming Drones to Help Our Community

Directions: Use the pond diagram (Figure 3) to help you answer the following questions.

1. What is one possible sequence of moves you could use to get to Site 3? Record the sequence of moves in words or symbols.

   Sample Answers:

   a. F, Ⓡ, F, F, F, Ⓛ, F, F, F, Ⓛ, F

   b. Forward, Forward, Forward, Forward, Forward, Turn Right, Forward, Forward, Turn Right, Forward

   c. 

2. Did someone in your class find a different route to Site 3? Or can you find a second route? Record the sequence of moves for this alternate route using words or symbols.

   Teacher Note: See sample answers above for other patterns.

3. Dr. Stegagno is interested in conserving, or saving as much of the battery power in the drone as possible. A turn uses up more battery power than a forward move. Which route conserves the most battery power? What's your evidence?

   Teacher Note: Answers will vary. See sample response below for guidance.

   The route that conserves the most battery power is: Forward, Forward, Forward, Forward, Forward, Turn Right, Forward, Forward, Turn Right, Forward. This route only has 10 moves (8 Forward and 2 Turn Right). The other patterns have more moves and turns. Since this pattern has less movements and turns, it will use the least battery power.

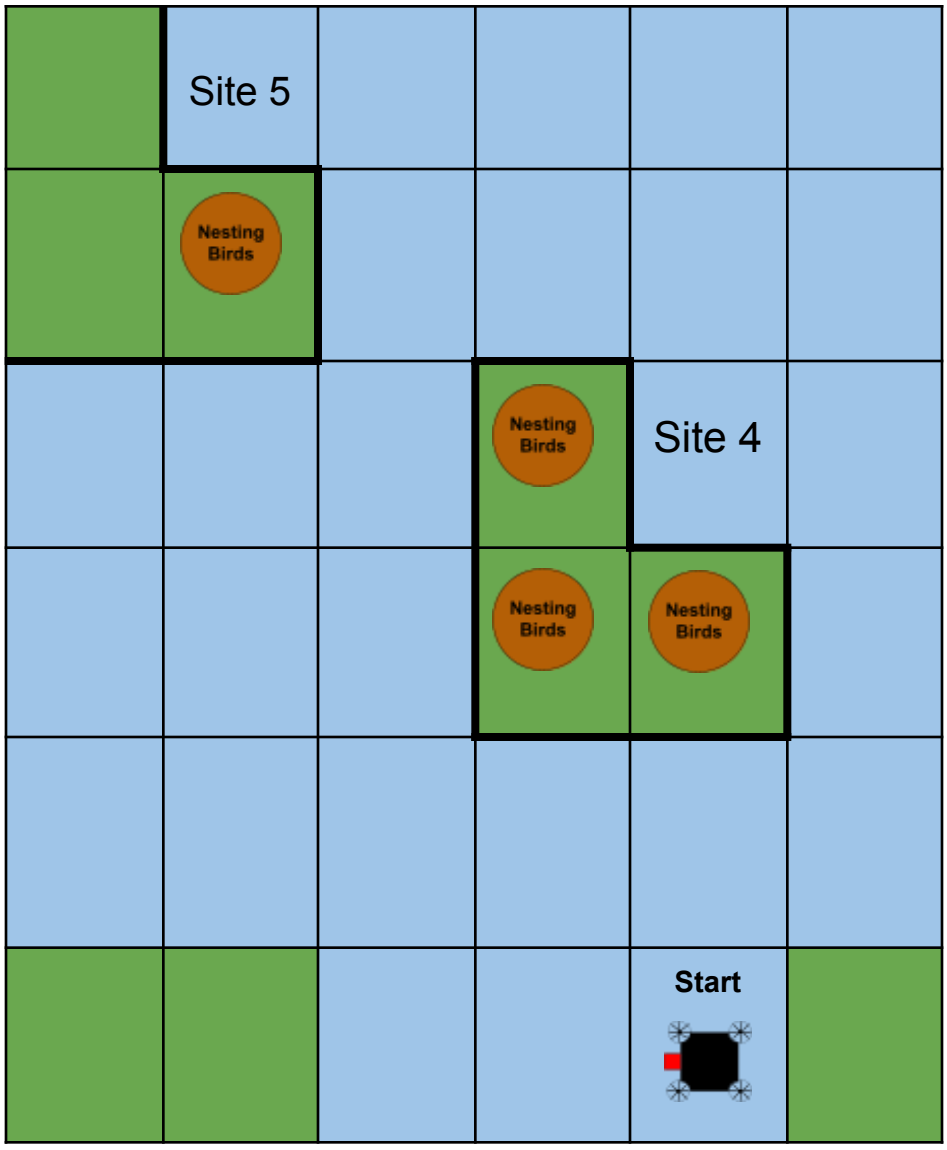
GEMS-Net & The UConn-URI Navy STEM Coalition would like to acknowledge funding and support from the Department of Defense National Defense Education Program (NDEP) grant #HQ00342110016

URI Robotics Lab: Programming Drones to Help Our Community

Task 3: It's getting late in the day and the drone battery is running low. The diagram (Figure 4) below shows Site 4 and Site 5 which you still need to photograph. You need to make the movement of the drone as efficient as possible in order to finish the work before the battery dies.

While programming the drone, the constraints you need to consider are:

- The camera is on the front of the drone.
- The drone can move in the following directions: forward, turn right, or turn left.
- As the drone flies, it must stay over the water and cannot fly over the island because we can't disturb the protected nesting birds.
- A turn uses up more battery power than a forward move.



Key: Pond (blue) Land (green) Island Shoreline ( ) Front Drone Back

Figure 4: Diagram of pond marking Site 4 and Site 5

GEMS-Net & The UConn-URI Navy STEM Coalition would like to acknowledge funding and support from the Department of Defense National Defense Education Program (NDEP) grant #HQ00342110016

URI Robotics Lab: Programming Drones to Help Our Community

Directions: Use the pond diagram (Figure 4) to help you answer the following questions.

1. Determine two different pathways you could use to get from Start to both sites and back to Start. Record the sequence of moves for each pathway using words or symbols. You can visit the sites in any order you choose. The camera does not have to face the same direction at the end, since you are all done taking pictures.

Teacher Note: Students may create their own maps or graphs to help them determine the sequence. Below are 2 sample answers.

Sequence 1:

Right Turn, Forward, Right Turn, Forward, Left Turn, Forward, Forward, Left Turn, Forward, Right Turn, Forward, Forward, Left Turn, Forward, Forward, Forward, Left Turn, Left Turn, Forward, Right Turn, Forward, Forward, Forward, Forward, Forward, Left Turn, Forward, Forward

Sequence 2:

Forward, Forward, Right Turn, Forward, Forward, Forward, Forward, Forward, Left Turn, Forward, Left Turn, Left Turn, Forward, Forward, Forward, Right Turn, Forward, Forward, Left Turn, Forward, Right Turn, Forward, Forward, Left Turn, Forward, Left Turn, Forward,

2. Which pathway is more efficient? What is your evidence?

   Teacher Note: Answers will vary. See sample response below for guidance.

   Sequence 2 is more efficient because it only has 27 steps, whereas Sequence 1 has 28 steps. In addition, Sequence 2 only has 9 turns and 18 forward moves, but Sequence 1 has 10 turns and 18 forward moves. Since the battery is running low, we need to choose the most efficient sequence. Sequence 2 is more efficient because it has less turns and moves than Sequence 1.

Thanks for helping Dr. Stegagno program the drone to photograph algae blooms in the pond. It's cool to see how patterns of motion can be used to help solve engineering problems! 😁

GEMS-Net & The UConn-URI Navy STEM Coalition would like to acknowledge funding and support from the Department of Defense National Defense Education Program (NDEP) grant #HQ00342110016

URI Robotics Lab: Programming Drones to Help Our Community

This task supports students in working towards:

Computer Science Teachers Association K-12 Standards (3-5)

Algorithms & Programming

- 1B-AP-08: Compare and refine multiple algorithms for the same task and determine which is the most appropriate.
- 1B-AP-10: Create programs that include sequences, events, loops, and conditionals.
- 1B-AP-11: Decompose (break down) problems into smaller, manageable subproblems to facilitate the program development process.
- 1B-AP-15: Test and debug (identify and fix errors) a program or algorithm to ensure it runs as intended.
- 1B-AP-17: Describe choices made during program development using code comments, presentations, and demonstrations.

Data & Analysis

- 1B-DA-07: Use data to highlight or propose cause-and-effect relationships, predict outcomes, or communicate an idea.

NGSS Engineering Design

3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

GEMS-Net & The UConn-URI Navy STEM Coalition would like to acknowledge funding and support from the Department of Defense National Defense Education Program (NDEP) grant #HQ00342110016