

## Darwinian Math – The Ant Algorithm & the Distance Formula

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**Date of Lesson:** N/A

**Length of Lesson:** Three 50 minute class periods

**Lesson Topic:** The chemical biology of ants and how it relates to the distance formula.

**Grade Level:** 8-12 (To be taught as an introduction to the distance formula.)

**Florida SSS Addressed:**

| Benchmark    | Descriptor   |
|--------------|--|
| MA.8.G.2.4   | Validate and apply Pythagorean Theorem to find distances in real world situations or between points in the coordinate plane. |
| MA.912.A.2.1 | Create a graph to represent a real-world situation.  |

**Concept(s):** Ants use pheromones to communicate with one another about different things such as food sources, threatening enemies, and the death of other ants. This communication on how to function has become deeply ingrained in the DNA of ants. Ants are hard-wired to find the shortest path possible to their food sources and as they travel they leave pheromones to mark their path which tells the other ants the path they took. Over time the shortest path accumulates the most pheromone chemical on it, making it the strongest which tells new ants on the hunt which path is best.

Distance is how far apart two points (or objects) are; the distance formula can help us figure out that distance. The distance formula can be derived from the Pythagorean Theorem. Using the distance formula we can compare different distances until we find the shortest path. It is known that the shortest distance between two points is a straight line, but which line to use is the ultimate question.

### **Materials List & Advanced Preparations:**

- Observation log book (one for each student)
- Blank white paper (one sheet per class)
- Video camera
- Computer access (one for each student)
- Food for ants
- “Ant Colony Algorithm” Handout (one for each student)
- <http://mathworld.wolfram.com/AntColonyAlgorithm.html>
- PBS video: <http://video.pbs.org/video/980049632/>
- Projector/DVD player to show video
- Graph paper (one sheet for each student)
- Notebook paper (multiple sheets for each student)
- Poster board (one for each pair of students)

- Poster decorating materials (markers, colored pencils, etc.)
  - “Traveling Salesman” Handout (One for each student)
- <http://mathworld.wolfram.com/TravelingSalesmanProblem.html>

### **Performance Objectives:**

Students will be able to:

- discuss the chemical biology of ants and how they communicate about food sources.
- show where the distance formula comes from and how it is applied.
- relate their mathematical knowledge to a real-world problem.

**Safety Considerations:** For this lesson the teacher needs to find out if any of the students are allergic to ants and if so they need to make the necessary accommodations. Additionally, the teacher needs to review the safety precautions about why students shouldn't play with, pick up or taunt the ants in any way. Students are to only observe the ants.

### **Day One: Our Initial Study of Ants**

Begin the three day unit with a discussion on ants. Ask students what they know about ants, what they hate about them, love about them, etc. Discuss the ways in which ants are beneficial and whether or not Earth could sustain without ants. What would be different if ants were extinct?

Then as a class each student should bring their observation log books outside and observe ants on campus. This is where the teacher should go over the safety considerations. Students can compare different ants they see and make notes about the location of each type, the size of each type, etc. As a class, congregate around one area of ants. Place a blank white sheet of paper on the ground near the ants. Turn on the video camera and begin to record the path of the ants as food is put down in different areas (probably no more than 3 areas) of the paper. Place one piece of food close to the colony and the others further away. Students are to observe and make note of the paths of the ants. Which food source was attacked first by the ants? Second? Third? What inferences can you make from this? At what rate did the second and third food source become populated? (All the ants headed there at the same time or one ant then a few more then a lot?)

The class will then return to the classroom to continue writing up their observations and the video recording should be posted on the internet so that all the students can view it simultaneously in class as well as outside of class.

Students' assignment for homework is to read “Ant Colony Algorithm” and to write a reflection on the piece. Students should then draw parallels between what they saw in class (by referencing the online video) and the article assigned. Students then need to research which scientist (Darwin) was the first (known) to make this discovery and how he did so.

### **Day Two: Discussion on Ants & Deriving the Distance Formula**

Resume the class discussion on the characteristics of ants (their pheromones & DNA) and have students share their reflections and conclusions from the in class experiment and the article.

Following the discussion play the PBS Nova video “Lord of Ants”

(<http://video.pbs.org/video/980049632/>) depending on time the teacher may want to go straight to the second chapter and focus on the video from 17 minutes to 31minutes.

After the video ask students if there is any additional information that they learned from the video that they thought was interesting.

Next, begin a discussion on distance and the distance formula. Ask students what distance measures and how they can measure distance (in meters, feet, miles, etc.). Ask students how they might find distance if they did not have a measuring tape with them.

Guide the conversation to the Pythagorean Theorem. If the two points where our legs meet our hypotenuse represent the location of the ants’ colony and the food, we want to find the distance between the two. How might we do this? Let’s plot of points on this graph paper. Using the Pythagorean Theorem we can find the distance between the two points.

For students’ homework they are to derive the distance formula from the Pythagorean Theorem. Provide students with the distance formula and ask them to show their steps from one formula to the other.

### **Day Three: Practical Applications of the Distance Formula**

Have students share the results from their homework. Poll the class to find different possible methods. If nobody was able to get from one to the other then as a class walk through the derivation. If a student was successful, have them share their steps in front of the class.

Pair students up and have them create a real-world problem on poster board in which the distance between two points is to be found. Groups should get about twenty minutes to create and write up this scenario before they will switch with another group. Students are to then work with their partners to solve the other group’s problem. Once the groups have had sufficient amount of time to solve the problem(s) students should suggest specific posters which they felt were exceptional and should be shared before the class.

After the posters are shared the remainder of the class period should be spent working on the “Traveling Salesman Problem”.

(<http://mathworld.wolfram.com/TravelingSalesmanProblem.html>)

This is an extended thinking problem in which students will be challenged and can work together to exchange ideas. Students are to take the problem home and for homework should continue thinking about the problem and are encouraged to look up information on it.

### **Bibliography**

Macura, Wiktor K. "Ant Colony Algorithm." From MathWorld--A Wolfram Web Resource, created by Eric W. Weisstein.<http://mathworld.wolfram.com/AntColonyAlgorithm.html>.

Weisstein, Eric W. "Traveling Salesman Problem." From MathWorld--A Wolfram Web Resource.<http://mathworld.wolfram.com/TravelingSalesmanProblem.html>.

Wilson, E.O.. "Lord of Ants." *Nova*. Performed May 25, 2008. PBS . Web, <http://video.pbs.org/video/980049632/>.