Sorting Lesson Plan

Overview—*Sorting*

Summary

Many tasks are easier completed if the data is sorted (for example, searching for an item. You may want to do Binary Search activity prior to Sorting). Records in schools, libraries, dentists, and hospitals are often found in alphabetical order. Even your contacts on your cell phone are sorted. There are many different ways to sort data.

Timeline

What	Time	Where
Demonstration	10	Lesson plan
Sorting Cards	20	PirateCards or PirateCardsFullPage PetRocksCards.pdf
Sorting Colors	10	SortingColorsWeights.pdf SortingColorsDots.pdf SortingColorsWorksheet.pdf
What's It All About	10	Lesson plan

Materials

- ✓ Balance Scale and Weights (See Sorting Demo)
- ✓ One copy of either PirateCards.pdf or PirateCardsFullPage.pdf
- ✓ One copy of PetRocksCards.pdf
- ✓ One copy SortingCardsKey.pdf
- ✓ SortingColorsWeights (each page has 5 weight keys; need one key per each pair of students)
- ✓ SortingColorsDots – one page per pair. Students can cut into 6 pieces.
- ✓ SortingColorsWorksheet – one page per pair of students.

Lesson Preparation

Before diving into the lesson, it is recommended that you watch "Selection Sort" (which can be found here: https://youtu.be/f8hXR_Hvybo) and "Insertion Sort" (which can be found here: https://www.youtube.com/watch?v=DFG-XuyPYUQ).The videos will give a brief introduction into two sorting algorithms: Insertion Sort and Selection Sort.

Introduction- Whole Class

Lesson Vocabulary (you may want to write on board)

- sorting
- algorithm

Start off by discussing sorted data. How do you sort things? Can the students come up with an algorithm for sorting a list of numbers from least to greatest? A white board comes in handy to write down their ideas.

Let the students know that computers can only compare two numbers at a time. The algorithms that have been demonstrated shows us how only comparing two things at a time can eventually lead to a sorted list!

Demo

To see a video of this demonstration, take a look at:
https://www.youtube.com/watch?v=cVMKXKoGu_Y

Prep: You will need a balance scale (this could be created using a hanger, string, and a couple of cups) and 7 weights. Label each weight with a color in the following order from lightest to heaviest:

Orange, Blue, Yellow, Red, Purple, Green and Black.

For an engaging demo, line these up in the following order to be sorted:

Red, Blue, Orange, Yellow, Green, Purple, and then Black.

As shown in the video, you will start by finding the heaviest item. Compare the items one at a time, and keep track of the heaviest so far. Have a student volunteer help you select which items to weigh. After you have compared all the items, put the heaviest item at one end. Then do the same process again to find the next heaviest. At some point, if the class is getting restless, you may want to stop and ask if they are convinced that the approach will ultimately put the items in order, and point out that, since computers can only compare two items at a time, it's important to come up with a fast ***algorithm*** *- step by step process to complete a task.*

Sorting Cards– Whole Class Activity

Prep: Print the pirate treasure object pages and the pet rock cards. Be sure to print the Key files (you will hold on to these).

The purpose of this activity is to give students interactive practice with *selection sort* and compare that to a new type of sorting, *insertion sort.* See videos listed in *Lesson Preparation*.

Demo: Pirate Object Selection Sort

Select student volunteers to line up in front of the class. Assign every pirate object card to a student (there are 15 cards, but you may want to use only 12, to limit the time spent on this demo and to be consistent with Pet Rock sort). Have these students line up in a non-sorted order. Explain that this time they will use the method shown in the demo (selection sort) to order themselves. To engage the class, have them guess which is the heaviest and which is the lightest. Tell them just to remember, and at the end we'll see if anyone guessed correctly.

Remind students that the goal is to first find the heaviest item and put it in place, then the next heaviest, and so forth. Choose an additional student to stand at the write board and add a tick mark every time a comparison is made. This will be used to show that the next algorithm (insertion sort) is more efficient.

Start with the first two students on the left stepping forward. Based on the answer key, tell them which is heavier. The heavier item stays in front of the list, the other student steps back in line and the next student comes forward. Tell them which is heavier. Continue until all items have been compared. When the final two have been compared, have the student with the heaviest item swap places with the student at the right end of the line.

Point at that we now know the heaviest. You may want to have that student indicate s/he is in order, maybe by holding the card up in the air, or down low, or turning it over. Repeat the process. By this time the students should have the idea, so challenge them to step forward and back quickly. If possible, continue to the end, so that we have an accurate number of comparisons. This value can be calculated (as a math sidebar) as:

$12+11+10+9+8+7+6+5+4+3+2+ 1 = 66$

A formula for this (if students are mathematically inclined) is $n(n-1)/2 = (12*11)/2$

For fun: Did anyone guess the heaviest? The lightest?

Does anyone think the list can be sorted with less work?

Demo: Pet Rock Insertion Sort

Students will line up exactly like they did in the last activity except for this time they will be given different pet rocks rather than pirate objects. The instructor should hold the key which shows with the rocks ordered from lightest to heaviest.

Have students line up and hand them the cards. To ensure the first few steps are engaging and get across how the algorithm works, give the first four students on the left the rocks:

Meanie, Star, Frustrated, Happy

Explain that this time they will use an insertion sort to order themselves. The idea is that we start with a sorted list of size one, and continue to add one item to the list at a time, always ensuring the list is still sorted. Again have a volunteer student count the number of comparisons.

The student to the farthest left starts as the only element in the sorted portion of the list. Have that student step forward. Get the class to agree that if there's only one item, the list must be sorted.

Now have the second student come forward. Tell them which is heavier (if you followed the order above, Meanie is heavier than Star). Since Star is lighter, have those two swap. Now you have a sorted list of size 2. Figure 1 shows this first step.

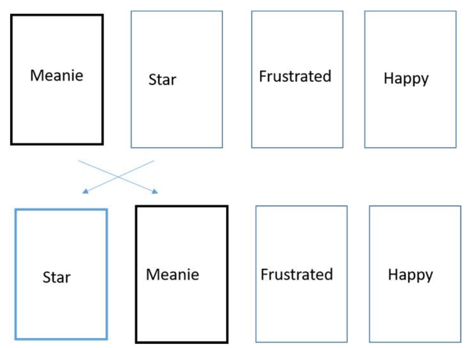

Figure 1: First Step of Insertion Sort with Pet Rocks

Now have the third student come forward. Frustrated is heavier than Meanie, so no swap is necessary (and we have a sorted list of 3).

Now the fourth student comes forward. Happy is lighter than Frustrated, so they swap. Happy is also lighter than Meanie, so they swap. Happy is also lighter than Star, so they swap.

Figure 2 shows the order after these swaps.

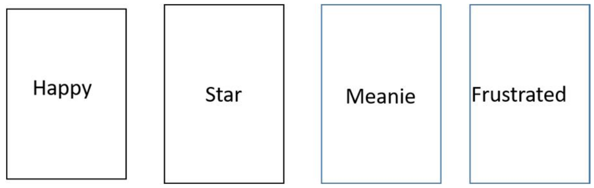

Figure 2: Order after first four students

Continue this process until the entire list is in order.

Unlike selection sort, we don’t have an exact formula for the number of comparisons.

Ask the students to think about what would happen if the list were already in order. How many comparisons would be made? [**answer**: n-1, or 11 in this case.]

See if the students can figure out what the worst case would be. [**answer**: a list in reverse order, because each item will have to swap with all the items to the left.]

Discuss the pros and cons of each method. Emphasize that insertion sort is much quicker. Selection sort, on the other hand, is a much simpler algorithm to understand.

Sorting Colors– Worksheet

Prep: Cut “Secret Weight” Slips from the Sorting Colors Weights document. Cut colors from the Sorting Colors document (or have students do this).

Split students into groups of 2. Each pair will be given a set of colors. This will enable students to move the colors around. One partner will have the Sorting Colors worksheet, and the other will have the “Secret Weights” slip of paper (only this partner is allowed to see this!).

Students will then have to sort their colors by asking questions about any two colors. Challenge students to see who can sort their colors with the fewest questions. Students are encouraged to use either insertion or selection sort.

What's It All About Discussion – Whole Class

To conclude, discuss with the class some real life computing examples where sorting is really important. Things like iPods are great examples because they store so many songs. What a pain it would be if the songs weren't sorted!

Humans often try to stay organized by keeping things sorted. We look at book indexes to find certain sections, libraries by author, and so on. Computers, even though they could easily do a linear search – look at one item at a time - much faster than a human, if there are lots of items they need to search as efficiently as possible. Imagine the Library of Congress with millions of titles. If the titles are not sorted, they would have to look at each item in order, which could potentially mean looking at millions of titles to find one item. If the titles are sorted, then it's *much* quicker to find an item using binary search. If you've covered binary search, you might remind students that if there are 1000 items in a collection, you'd have to look at a maximum of 10 items to find the one you want. If there are a million items, you'd have to look at a maximum of 20 items… compared to as many as a million items if the list is not sorted. Sorting saves time!

Since computers use such large amounts of data, sorting data using slow, inefficient methods can waste time. We don't like to wait, so computer scientists are continuing to develop better, smarter algorithms to get these jobs done quicker than ever before.

Demo – Sorting Speeds

Now that students have started to grasp the idea that we can construct a pattern in order to sort a list, explain that there are many ways to methodically sort lists, but some methods are faster than others. There are a number of sites that visually demonstrate sort speed, such as:

- http://www.sorting-algorithms.com/
- http://sorting.at

Explain that computer scientists are interested in how to make these sorting methods as fast as possible.