Activity 8

Beat the Clock—*Sorting Networks*

Summary

Even though computers are fast, there is a limit to how quickly they can solve problems. One way to speed things up is to use several computers to solve different parts of a problem. In this activity we use sorting networks which do several sorting comparisons at the same time.

Curriculum Links

- ✓ Mathematics: Number level 2 and up. Exploring number: Greater than, less than

Skills

- ✓ Comparing
- ✓ Ordering
- ✓ Developing algorithms
- ✓ Co-operative problem solving

Ages

- ✓ 7 years and up

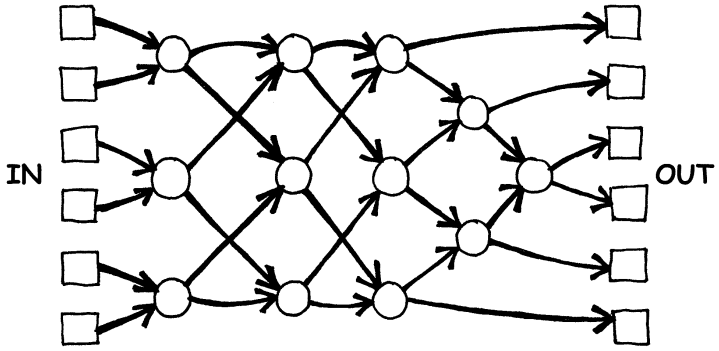
Materials

This is an outdoor group activity.

- ✓ Chalk
- ✓ Two sets of six cards.
  Copy Photocopy Master: Sorting networks (page 73) onto card and cut out
- ✓ Stopwatch

Sorting Networks

Prior to the activity use chalk to mark out this network on a court.



Instructions for Children

This activity will show you how computers sort random numbers into order using a thing called a sorting network.

1. Organise yourselves into groups of six. Only one team uses the network at a time.

2. Each team member takes a numbered card.

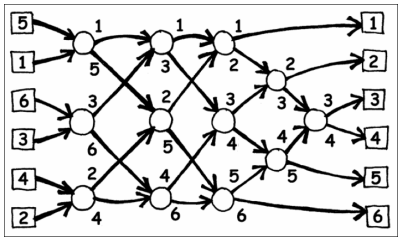
3. Each member stands in a square on the left hand (IN) side of the court. Your numbers should be in jumbled order.

4. You move along the lines marked, and when you reach a circle **you must wait for someone else to arrive.**

5. When another team member arrives in your circle compare your cards. The person with the smaller number takes the exit to their left. If you have the higher number on your card take the right exit.

6. Are you in the right order when you get to the other end of the court?

If a team makes an error the children must start again. Check that you have understood the operation of a node (circle) in the network, where the smaller value goes left and the other goes right. For example:



Photocopy Master: Sorting networks

1	2
3	4
5	6

156	221
289	314
422	499

Variations

1. When the children are familiar with the activity use a stopwatch to time how long each team takes to get through the network.

2. Use cards with larger numbers (e.g. the three-digit ones in the photocopy master).

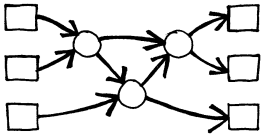
3. Make up cards with even larger numbers that will take some effort to compare, or use words and compare them alphabetically.

Extension Activities

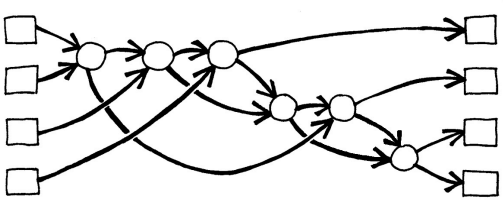
1. What happens if the smaller one goes right instead of left and vice versa? (The numbers will be sorted in reverse order.)

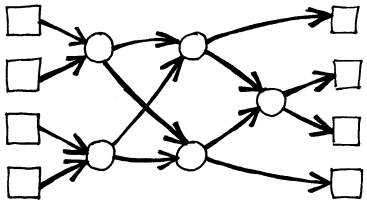
   Does it work if the network is used backwards? (It will not necessarily work, and the children should be able to find an example of an input that comes out in the wrong order.)

2. Try to design smaller or larger networks. For example, here is a network that sorts just three numbers. The children should try to come up with this on their own.



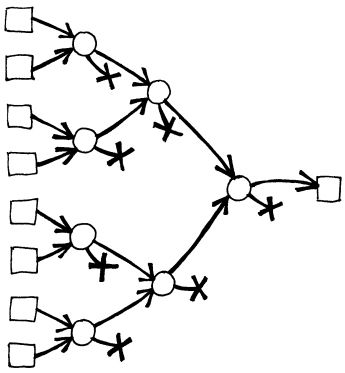
3. Below are two different networks that will sort four inputs. Which is the faster? (The second one is. Whereas the first requires all comparisons to be done serially, one after the other, the second has some being performed at the same time. The first network is an example of serial processing, whereas the second uses parallel processing to run faster.)





4. Try to make a larger sorting network.

5. Networks can also be used to find the minimum or maximum value of the inputs. For example, here is a network with eight inputs, and the single output will contain the minimum of the inputs (the other values will be left at the dead ends in the network).



6. What processes from everyday life can or can't be accelerated using parallelism? For example, cooking a meal would be a lot slower using only one cooking element, because the items would have to be cooked one after another. What jobs can be completed faster by employing more people? What jobs can't?

What's it all about?

As we use computers more and more we want them to process information as quickly as possible.

One way to increase the speed of a computer is to write programs that use fewer computational steps (as shown in Activities 6 and 7).

Another way to solve problems faster is to have several computers work on different parts of the same task at the same time. For example, in the six-number sorting network, although a total of 12 comparisons are used to sort the numbers, up to three comparisons are performed simultaneously. This means that the time required will be that needed for just 5 comparison steps. This parallel network sorts the list more than twice as quickly as a system that can only perform one comparison at a time.

Not all tasks can be completed faster by using parallel computation. As an analogy, imagine one person digging a ditch ten metres long. If ten people each dug one metre of the ditch the task would be completed much faster. However, the same strategy could not be applied to a ditch ten metres deep—the second metre is not accessible until the first metre has been dug. Computer Scientists are still actively trying to find the best ways to break problems up so that they can be solved by computers working in parallel.