Computer Science Unplugged

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CS Unplugged is a book of activities that illustrate computer science principles without using a computer.

Activities are short and are designed to be easily integrated into classes and include exercises and lesson plans for teachers.
The basic edition of Computer Science Unplugged has 12 classroom exercises for you to use with your students.

Each exercise has a number of extensions, activities and background information.

All activities can be done without the use of computers, but they all demonstrate fundamental principles used in computers today.

How much information is there in a 1000-page book? Is there more information in a 1000-page telephone book, or in Tolkien's *Lord of the Rings*?

- If we can measure this, we can estimate how much space is needed to store the information.

This activity introduces a way of measuring information content.
TWENTY GUESSES

• Can you read the following sentence?

Ths sntnc hs th vwls mssng.

• You probably can, because there is not much "information" in the vowels.

TWENTY GUESSES

• I am thinking of a number between 1 and 100.
• I will start you off with 20 pieces of candy.
• You may only ask questions that have a "yes" or "no" answer.
• For each incorrect guess, you will lose one piece of candy.
• Once you guess correctly, you can keep whatever candy remains.
TWENTY GUESSES

• To pick a number between 0 and 100, you only need 7 guesses.
  ▪ Always shoot for the middle number of the range and eliminate half the possibilities!
  ▪ This concept is called binary search.
• If the number was between 0 and 1000, you would only need 3 additional guesses.
• You can guess a number between 0 and 1 million in only 20 guesses!

LIGHTEST & HEAVIEST

• Computers are often used to put lists into some sort of order (e.g. names into alphabetical order, appointments or e-mail by date, etc.)
  ▪ If you use the wrong method, it can take a long time to sort a large list into order, even on a fast computer.
• In this activity children will discover different methods for sorting, and see how a clever method can perform the task much more quickly than a simple one.
• Start with 8 containers with different amounts of sand or water inside. Seal tightly.
• Children are only allowed to use the scales to compare the relative weights of two containers.
• Only two containers can be compared at a time.

• METHOD 1 is called Selection Sort.
• METHOD 2 is called Quick Sort.

• Generally, quick sort is a lot faster than selection sort is.
• Computers are often required to find information in large collections of data.
• Computer scientists study quick and efficient ways of doing this.
• This activity demonstrates three different search methods so children can compare them.

• Battleships are lined up at sea.
• Each battleship has a number that is hidden.
• How many guesses does it take for you to find a specific battleship?
  ▪ The number of guesses is the child’s score.
  ▪ The lowest score wins.
GAME 1: Ships are randomly ordered.

<table>
<thead>
<tr>
<th>Your Ships</th>
<th>Number of Shots Used:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A B C D E F G H I J K L M</td>
<td></td>
</tr>
<tr>
<td>N O P Q R S T U V W X Y Z</td>
<td></td>
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</tbody>
</table>

FIND SHIP # 717

GAME 2: Ships are in increasing order.

<table>
<thead>
<tr>
<th>Your Ships</th>
<th>Number of Shots Used:</th>
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</thead>
<tbody>
<tr>
<td>A B C D E F G H I J K L M</td>
<td></td>
</tr>
<tr>
<td>N O P Q R S T U V W X Y Z</td>
<td></td>
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</tbody>
</table>

FIND SHIP # 5897
GAME 3: Ships are ordered into 10 groups based on a mystery function.

<table>
<thead>
<tr>
<th>Your Ships</th>
<th>Number of Shots Used:</th>
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<tbody>
<tr>
<td>A</td>
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</table>

FIND SHIP # 8417

These three games illustrate
- linear search
- binary search
- hashing

What is the maximum number of guesses required for each of these search techniques?
- for 26 battleships?
- for n battleships?
Our society is linked by many networks: telephone, utilities, roads.
For a particular network, there is usually some choice about where the links can be placed.
This exercise examines a complete network to determine the links necessary to connect all the components of the network at minimal cost.
THE MUDDY CITY

a graph
THE MUDDY CITY
THE MUDDY CITY

• This exercise illustrates how to build what we call the “minimal spanning tree”.
  ▪ A tree does not have any cycles where you can get back to where you were before.
• This exercise does not give us the shortest path from one location to another.
  ▪ But there is another algorithm for that!

BEAT THE CLOCK
**BEAT THE CLOCK**

- This activity illustrates structures used in parallel sorting networks.
- Kids sort data by walking through a sorting network laid out on the floor.
- The network simulates how a parallel network would sort data.
  - Kids find out that data can be sorted a lot faster in parallel!

**THE ORANGE GAME**

- When you have a lot of people using one resource (such as cars using roads, or messages getting through the Internet), there is the possibility of "deadlock".
  - A way of working cooperatively is needed to avoid this happening.
- This exercise illustrates cooperative problem solving and (potentially) deadlock.
THE ORANGE GAME

• A shared resource in Pittsburgh:

THE ORANGE GAME

• A shared resource in New York:
THE ORANGE GAME

• Set up:
  ▪ Each child is assigned a label or color.
  ▪ Give two labeled oranges (or colored balls) to each child except one child, who gets only one.
    - Each child should not hold his or her own label or color initially.
  ▪ The children form a circle.

• Goal:
  ▪ Each child must end up with the orange(s)/ball(s) of his or her own label/color.

THE ORANGE GAME

• Passing Rules:
  1. Only one orange/ball may be held in each hand.
  2. An orange/ball can only be passed to an empty hand of an immediate neighbor in the circle. (A child can pass either of their two oranges/balls to their neighbor.)
  3. (optional) No talking.
Alternate Configurations

Routing and deadlock are problems in many networks, such as road systems, telephone and computer systems. Engineers spend a lot of time figuring out how to solve these problems - and how to design networks that make the problems easier to solve.
The teacher's version of Computer Science Unplugged is available online at

http://www.csunplugged.org

- The book is FREE to download and use!
- Additional material will be published soon to add even more activities, including video to demonstrate how to use these activities effectively in your classroom.