Computer Science Unplugged

Dr. Tom Cortina
Carnegie Mellon University

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.
CS UNPLUGGED

• 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.

TWENTY GUESSES

• 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.
LIGHTEST & HEAVIEST

• 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.

LIGHTEST & HEAVIEST

• 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

• 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.

FIND SHIP # 717

GAME 2: Ships are in increasing order.

FIND SHIP # 5897
BATTLESHIPS

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>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>E</td>
</tr>
<tr>
<td>B</td>
<td>F</td>
</tr>
<tr>
<td>C</td>
<td>G</td>
</tr>
<tr>
<td>D</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

FIND SHIP # 8417

3A

BATTLESHIPS

• 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

Diagram 1:

Diagram 2:
• 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

• 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!

CS UNPLUGGED

• 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.