• 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.

FORMATS

- Activities
- Books
- Show
- Web site
- Videos
- Outdoor events
- Garden
**COUNT THE DOTS**

- Data in computers is stored and transmitted as a series of zeros and ones.
  - How can we represent words and numbers using just these two symbols?

**COUNT THE DOTS**

- What numerical property do you see in the dots on the cards?
- Display the cards so the following number of dots are showing:
  - 6
  - 15
  - 21
When a binary number card is **not** showing, it is represented by a zero. When it **is** showing, it is represented by a one. This is the binary number system (base 2).

- What are the following binary numbers?
  - $01001_2$
  - $10011_2$

What is the highest number we can represent using 5 cards?
- $11111_2 = 31$

What is the lowest number we can represent using 5 cards?
- $00000_2 = 0$

Count from 0 to 31 in binary.
• Letters are represented in computers in binary also!
• blank 0 $0000_2$
  A 1 $0001_2$
  B 2 $0010_2$
  C 3 $0011_2$
...  
  Z 26 $11010_2$

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$\text{blank} \quad 0 \quad \text{N} \quad 14 \quad 01001 \quad \text{I}$
A 1 N 14 01001 I
B 2 O 15 00011 C
C 3 P 16 00101 E
D 4 Q 17
E 5 R 18 00000 _
F 6 S 19 00111 C
G 7 T 20
H 8 U 21 10010 R
I 9 V 22
J 10 W 23 00101 E
K 11 X 24 00001 A
L 12 Y 25
M 13 Z 26 01101 M
COUNT THE DOTS

HAPPY BIRTHDAY, SUZANNE VEGA!

“My name is Luka, I live on the 2nd floor”

“I am sitting in the morning
At the diner on the corner
(do do doo do do doo do)

Born July 11, 1959

COLOR BY NUMBERS

• Computer screens are divided up into a grid of small dots called *pixels* (*picture elements*). In a black and white picture, each pixel is either black or white.
• Computers store drawings, photographs and other pictures using only numbers.
• The following activity demonstrates how a computer image can be stored efficiently.
• The letter a has been magnified to show the pixels. When a computer stores a picture, all that it needs to store is which dots are black and which are white.
COLOR BY NUMBERS

• This technique is called run-length encoding.
  ▪ Fax transmission
  ▪ Compression of images
• Color encoding
  ▪ Use two numbers per run
    • First number is how many pixels as before
    • Second number is what color (1=red, 2=green, ...)

YOU CAN SAY THAT AGAIN!

PITTER PATTER
PITTER PATTER
LISTEN TO THE RAIN
PITTER PATTER
PITTER PATTER
ON THE WINDOW PANE
YOU CAN SAY THAT AGAIN!

• The arrows and boxes are presented with 2 numbers.
• PITTER PA(7,4)
  ▪ 7: count back 7 positions
  ▪ 4: copy 4 letters/spaces
• Sometimes boxes point back to a box with a blank inside.

BEFORE: 78 letters

AFTER: 29 letters
YOU CAN SAY THAT AGAIN!

- The storage capacity of computers is growing at an unbelievable rate.
  - In the last 25 years, the amount of storage provided on a typical computer has grown about a million fold.
- We can *compress* the data so that it takes up less space.
  - This exercise uses Ziv-Lempel coding, or LZ coding, invented by two Israeli professors in the 1970s.
  - ZIP files, GIF images

YOU CAN SAY THAT AGAIN!

- Since computers only have a limited amount of space to hold information, they need to represent information as efficiently as possible. This is called *compression*.
- By coding data before it is stored, and decoding it when it is retrieved, the computer can store more data, or send it faster through the Internet.
- This exercise illustrates how a children's rhyme can be compressed.
When data is stored on a disk or transmitted from one computer to another, we usually assume that it doesn't get changed in the process. But sometimes things go wrong and the data is changed accidentally.

This activity uses a magic trick to show how to detect when data has been corrupted, and to correct it.
• This exercise illustrates even parity.
• When computer data is transmitted to another computer, extra bits are added so that the number of 1s is even.
• The receiving computer can detect if something gets messed up during the transmission and can correct it if there is one error.
• What happens if there are two errors?

• Other examples of parity (checksum digits):
TWENTY GUESSES

• Can you read the following sentence?

Ths sntnce hs th vwls mssng.

• You probably can, because there is not much "information" in the vowels.
• This activity introduces a way of measuring information content.

TWENTY GUESSES

• I am thinking of a number between 0 and 127.
• Start 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 127, 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 1,023, you would only need 3 additional guesses.
- You can guess a number between 0 and 1,048,575 in only 20 guesses!

BATTLESHEIPS

- 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.

Your Ships

<table>
<thead>
<tr>
<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>
</tr>
<tr>
<td>1630 0205 3429 7113 3176 2015 7976 80 3469 1571 8625</td>
</tr>
</tbody>
</table>

1A

FIND SHIP # 717
GAME 2: Ships are in increasing order.

Your Ships

<table>
<thead>
<tr>
<th>Number of Shots Used:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
</tr>
<tr>
<td>33</td>
</tr>
<tr>
<td>N</td>
</tr>
</tbody>
</table>

FIND SHIP # 5905

2A

GAME 3: Ships are ordered into 10 groups based on the sum of the digits of the ship modulo 10.

Your Ships

<table>
<thead>
<tr>
<th>Number of Shots Used:</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>9305</td>
</tr>
</tbody>
</table>

FIND SHIP # 9503

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?

LIGHTTEST & 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.
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!
BEAT THE CLOCK
VIDEO & ONLINE MATERIAL

• csunplugged.org
• video.google.com
  ▪ Search for “computer science unplugged”

• National Center for Women in Information Technology
  ▪ Promising Practices flyers

THE MUDDY CITY

• 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.
A graph
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!
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.

THE ORANGE GAME

• Alternate Configurations
THE ORANGE GAME

- 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.

TREASURE HUNT

- Computer programs often need to process a sequence of symbols such as words in a document or even the text of another program.
- Computer scientists use a Finite State Automaton (FSA), a set of instructions to see if the sequence is acceptable or not.
- This exercise uses the FSA idea using treasure maps!
TREASURE HUNT

- Goal: Find Treasure Island, starting from Pirates' Island.
- Friendly pirate ships sail along fixed routes between islands offering rides to travelers.
- Each island has two departing ships, A and B.
- Determine all possible sequences of ships that a traveler can take to arrive at Treasure Island.
- Use your map to record all the ship routes.
TREASURE HUNT

Musket Hill

A  B

TREASURE HUNT

Treasure Island

PLAY AGAIN
MARCHING ORDERS

- Computers are usually programmed using a "language", which is a limited vocabulary of instructions that can be obeyed.
- One of the most frustrating things about programming is that computers always obey the instructions to the letter, even if they produce a crazy result.
- This activity gives kids some experience with this aspect of programming.
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.

10100 01000 00001 01110 01011

11001 01111 10101

(THANK YOU)