Computer Science Unplugged

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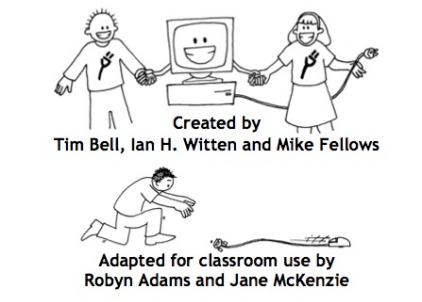


- CS Unplugged is a book of activities that illustrate computer science principles without using a computer.
- Activities are short and are designed to be easily integrated into classes and include exercises and lesson plans for teachers.

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.

BATTLESHIPS

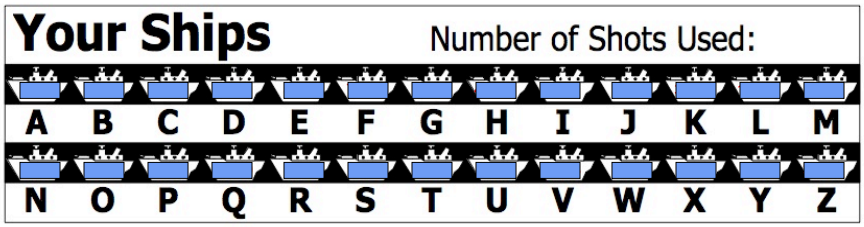
- Computers are often required to find information in large collections of data.
- Computer scientists study quick and efficient ways of doing this.
- This activity demonstrates three different search methods so children can compare them.

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.

BATTLESHIPS

GAME 1: Ships are randomly ordered.

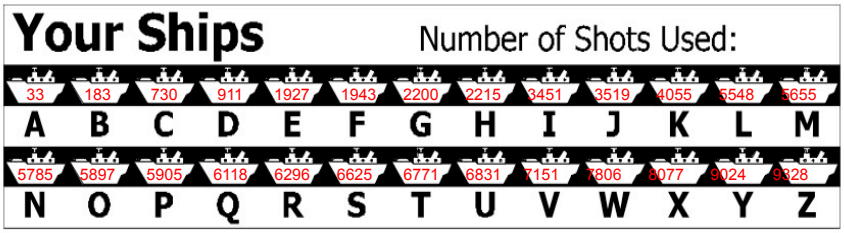


1A

FIND SHIP # 717

BATTLESHIPS

GAME 2: Ships are in increasing order.



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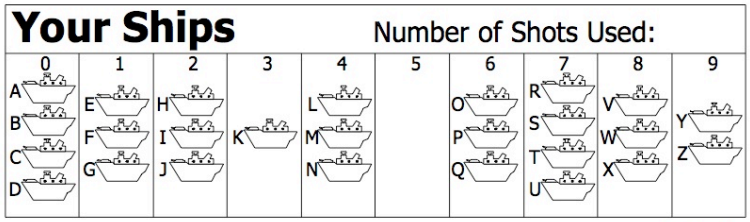
BATTLESHIPS

GAME 3: Ships are ordered into 10 groups based on a mystery function.



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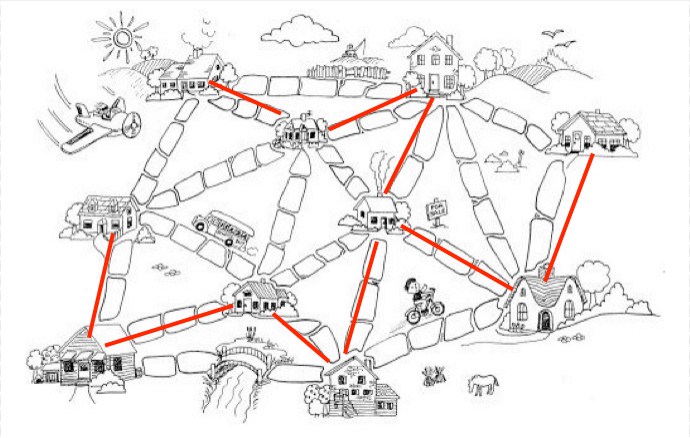
BATTLESHIPS

- 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?

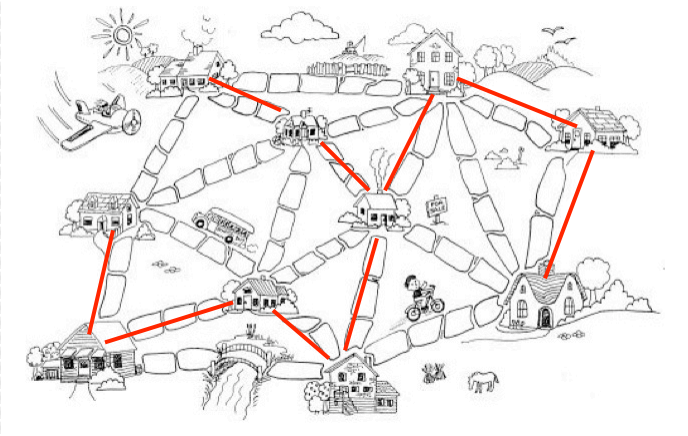
THE MUDDY CITY

- 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.

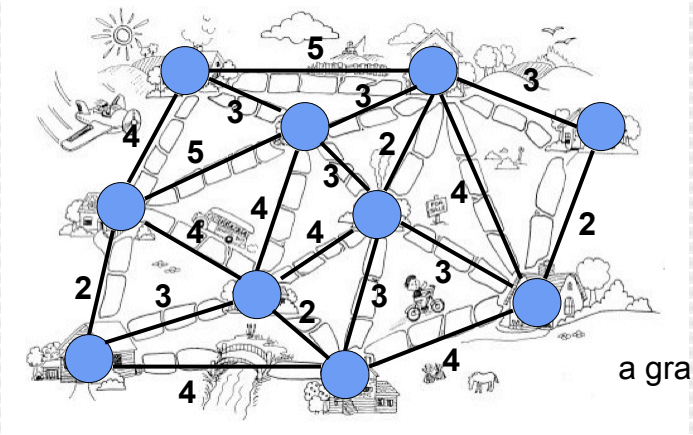
THE MUDDY CITY



THE MUDDY CITY

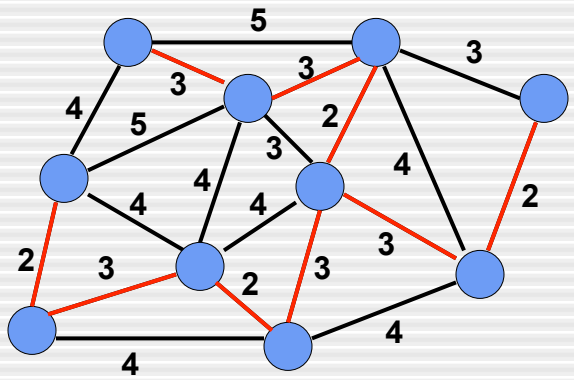


THE MUDDY CITY

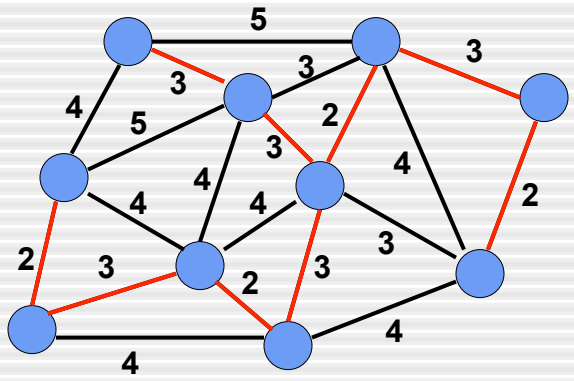


a graph

THE MUDDY CITY



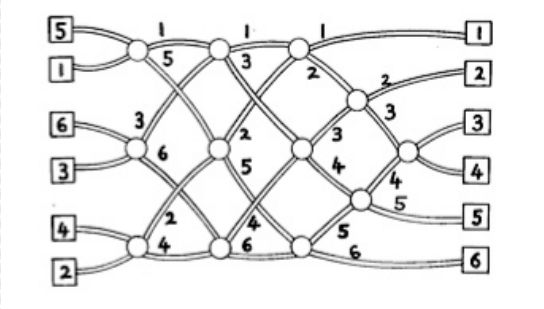
THE MUDDY CITY



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 <u>not</u> give us the shortest path from one location to another.
  - But there is another algorithm for that!

BEAT THE CLOCK



BEAT THE CLOCK

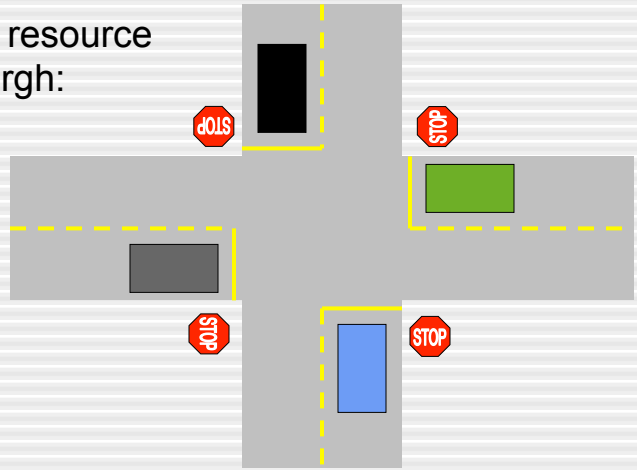
- This activity illustrates structures used in parallel sorting networks.
- Kids sort data by walking through a sorting network laid out on the floor.
- The network simulates how a parallel network would sort data.
  - Kids find out that data can be sorted a lot faster in parallel!

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.

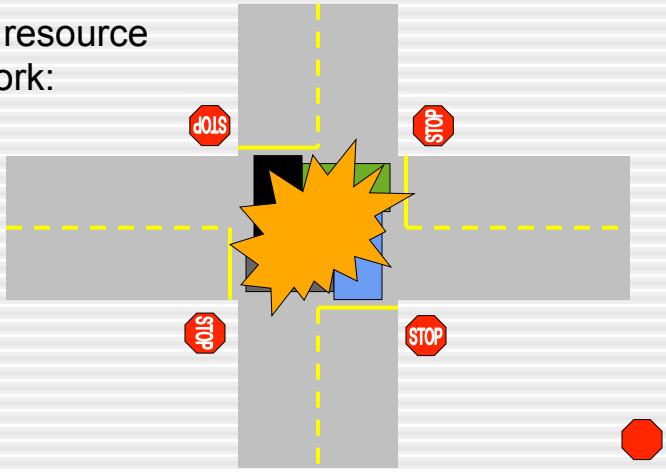
THE ORANGE GAME

- 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.

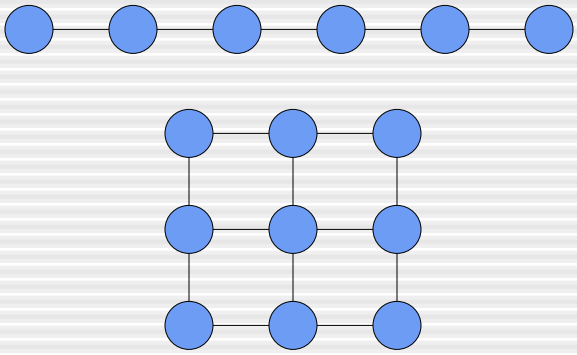
THE ORANGE GAME

- 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.

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.

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.