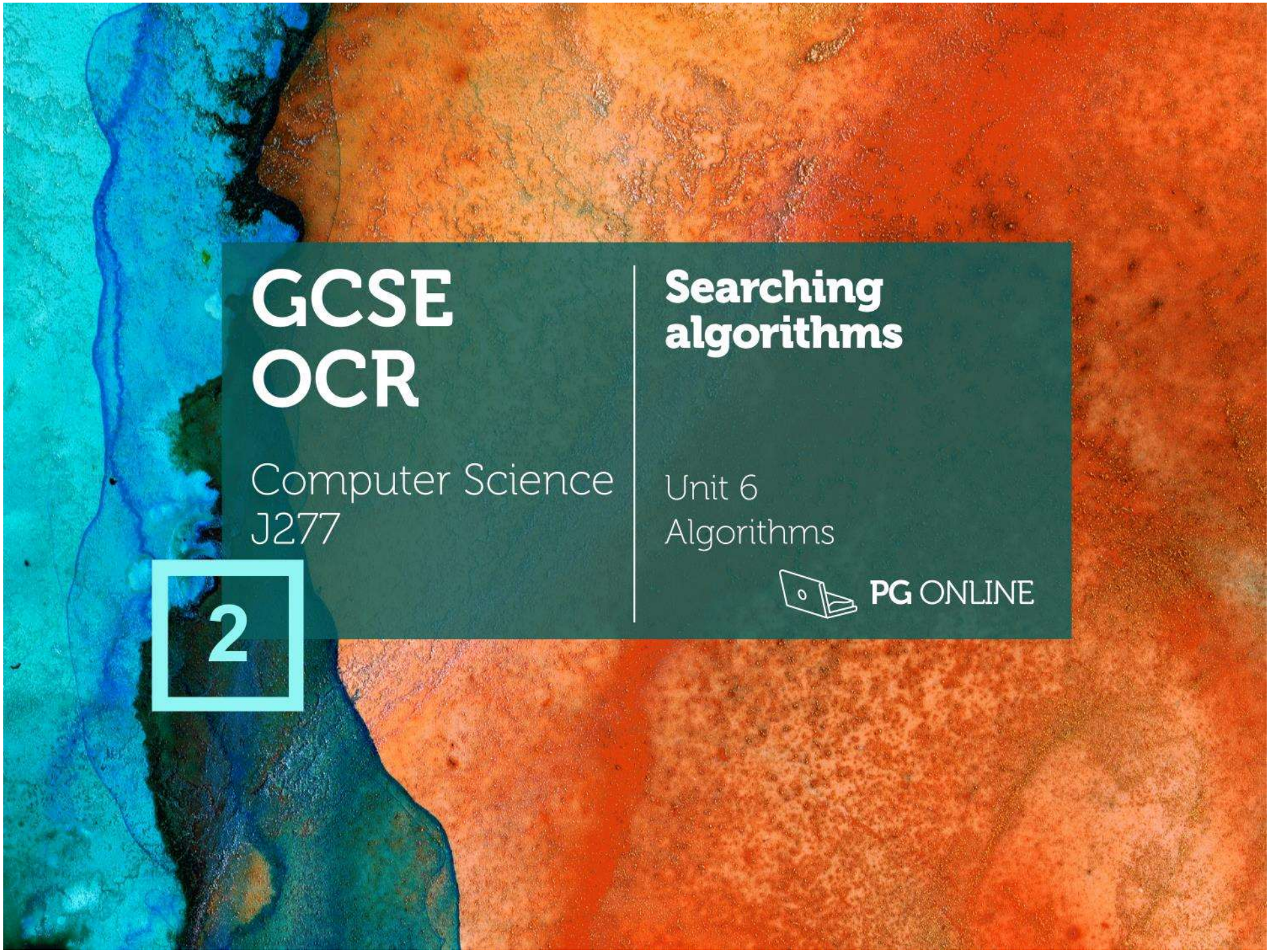

GCSE
OCR
Computer Science
J277
2
Searching algorithms
Unit 6
Algorithms
PG ONLINE

Objectives

- Understand and use different types of search
  - Binary search
  - Linear search

Starter

- We search for items many times a day
- Physical objects such as:
  - Clothes
  - Homework
- What are **five** items that we search for on computers or the Internet?

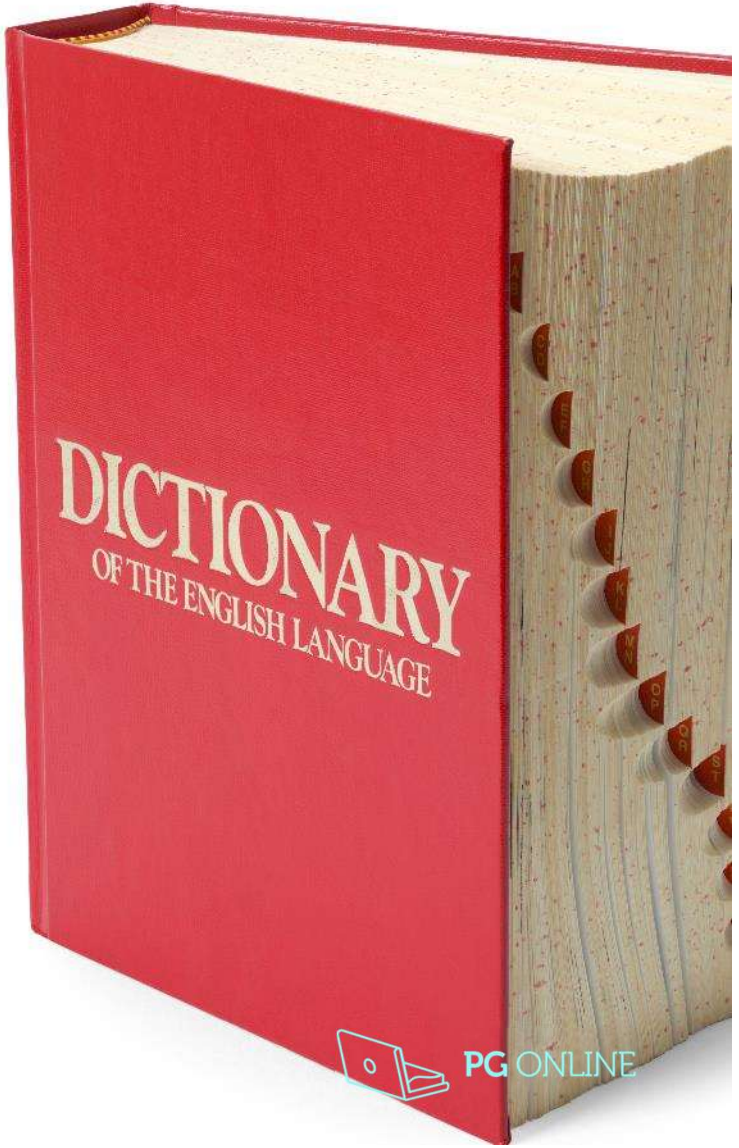
Searching a list

Answers

- Searching is a very common operation in computing
  - A doctor might search for a patient's notes
  - A policeman can search with a vehicle identification number (VIN) to find the owner of an abandoned car
  - A web browser can search for a word in a web page
  - There are numerous other examples of searches

Searching a sorted list

- Suppose you have a dictionary and you want to look up the word nebula
- What will be your strategy for finding the word?
  - One way is to start at the first word and go through every word in the dictionary one by one
  - What other methods could you use?



A binary search

- Here is a list of names:

Ali	Ben	Carl	Joe	Ken	Lara	Mo	Oli	Pam	Stan	Tara

The quickest way to find if a particular name is in a sorted list is to do a binary search

- Suppose we are searching for the name Mo
- The list has 11 items
- Examine the middle one first

A binary search

- The middle item in the list is Lara

Ali	Ben	Carl	Joe	Ken	Lara	Mo	Oli	Pam	Stan	Tara

- Lara comes before Mo alphabetically so we can discard all the names from Ali to Lara
- Now we only have five names to search

A binary search

- Here is a list of names:

Ali	Ben	Carl	Joe	Ken	Lara	Mo	Oli	Pam	Stan	Tara

- Examine the middle name of the remaining list
- The middle name is Pam
- Mo comes before Pam so we can discard all the names from Pam to Tara

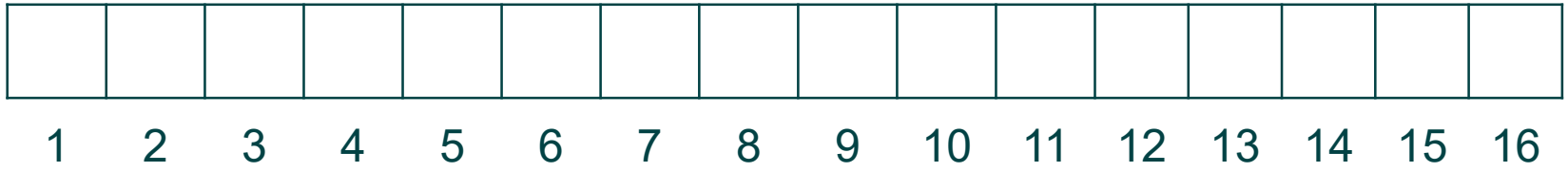
A binary search

- Here is a list of names:

Ali	Ben	Carl	Joe	Ken	Lara	Mo	Oli	Pam	Stan	Tara

- Now we only have two names
- The ‘middle’ name is taken to be the left of the middle point
- Examine the name, Mo
  - Bingo! How many names did we look at for the binary search?

Divide and conquer



- In a binary search, the size of the list is halved each time an item is examined
- How many items, at most, would have to be examined in a list of 16 items to find the one you are looking for?
- Try looking for the number 23 in this hidden list of numbers
  - Which box will you look at first?

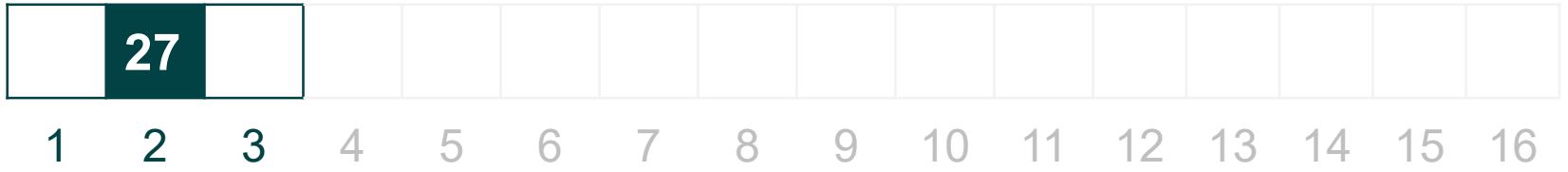
Divide and conquer

- You're looking for the number 23
- You've found the number 42
  - Which box will you look at next?

Divide and conquer

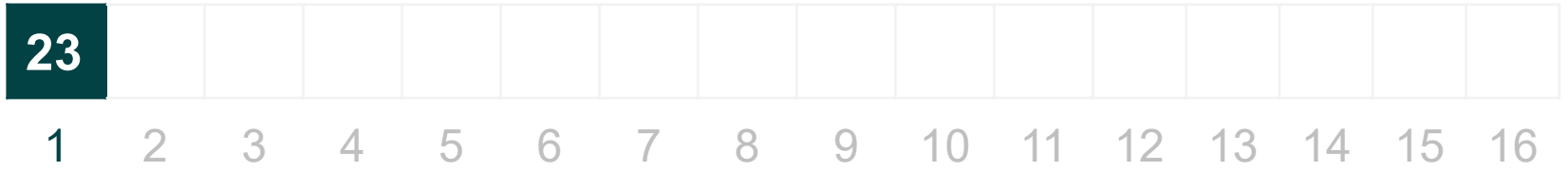
- You're looking for the number 23
- You've found the number 35
  - Which box will you look at next?

Divide and conquer



- You're looking for the number 23
- You've found the number 27
  - Which box will you look at next?

Divide and conquer



- You've found the number 23!
  - How many numbers did you look at?

Divide and conquer

23	27	32	35	37	38	41	42	45	50	52	53	54	58	61	67
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

- You looked in boxes 8, 4, 2 and 1
- In a list of 2^n items, the maximum number of items you will need to look at will be $n + 1$
- How many items would be examined if you were searching for 67 instead of 23?
- Try searching for 61 in a list of 15 numbers (delete 67 from the list)
  - How many items need to be examined?

Worksheet 2

- Now complete **Task 1** on **Worksheet 2**

Linear search

- If the list to be searched is not sorted, it is not possible to do a binary search
- A linear search may be carried out instead

145	27	83	777	492	588	91	678	399	123

- Items are examined in the sequence

  145, 27, 83, 777….

Comparison of searches

- In a sorted list of 1,000,000 items, how many items will have to be examined to establish that an item is NOT in the list?

Comparison of searches

Answers

- With a binary search, only 20 items have to be examined to discover that an item is not in the list
  - That's because 1,000,000 is less than 2^{20} but greater than 2^{19}
  - If the list were unsorted, 1,000,000 items would need to be checked to prove that the item is not in the list
- With a linear search, 1,000,000 items would need to be examined

Worksheet 2

- Now complete **Task 2** on **Worksheet 2**

A search algorithm

```
1   numbers = [5,1,9,8,7,6,4,10]
2   searchItem = int(input())
3   for i=0 to numbers.length - 1
4       if numbers[i] == searchItem:
5           print("searchItem found")
6       endif
7   endfor
```

- The above algorithm asks the user to input a number and then searches for it in the array `numbers`
  - What is the value of `numbers.length - 1` ?
  - When will "`searchItem found`" be output?
  - Name the type of search algorithm

A search algorithm

Answers

```
1   numbers = [5,1,9,8,7,6,4,10]
2   searchItem = int(input())
3   for i=0 to numbers.length - 1
4       if numbers[i] == searchItem:
5           print("searchItem found")
6       endif
7   endfor
```

- Answers:
  - What is the value of `numbers.length - 1` ?
    7
  - When will "`searchItem found`" be output?
    Each time it finds a matching item in the array
  - Name the type of search algorithm
    Linear search

Plenary

- With a partner explain how the following searching algorithms work:
  - Binary search
  - Linear search
- Report back your answers to the class

Plenary

Answers

- Binary search
  - This only works on a sorted list
  - The middle item of the list is first checked
  - If the item searched for is less than this item the right of the list is discarded, and a binary search is carried out on the left of the list
- Linear search
  - Each item in the list is checked against the search item in order

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