

OCR A Level

Computer Science
H446 – Paper 1



Thinking abstractly

Unit 10
Computational thinking



PG ONLINE

Objectives

- Understand the nature of and need for abstraction
- Describe the differences between an abstraction and reality
- Devise an abstract model for a variety of situations

What is computational thinking?

Computational thinking is simply working out how to work things out, or:

‘The ability to think logically about a problem and apply techniques for solving it’

- It is closely related to the skill of designing algorithms which can be turned into computer programs



Computational thinking

“Computational thinking involves solving problems, designing systems, and understanding human behaviour, by drawing on the concepts fundamental to computer science.”

Jeannette M Wing

Vice President, Head of Microsoft Research International

Computer Science

- ...is about using mathematical principles to solve problems
- ...is not about how to use a spreadsheet, a word processor or a graphics package
- ...involves learning to think computationally
- ... and applying the principles of **abstraction**

Computational thinking

- What information is relevant to solving a particular problem?
- What computations need to be performed in order to solve the problem?
- How can we be sure that the problem has been solved?

What is abstraction?

- Abstraction is a way of separating the logical and physical aspects of a problem
- If you are learning to drive a car, you concentrate on the function of the steering wheel, accelerator, brakes and so on
- If you are learning to be a mechanic, you will concentrate on how these things actually work



Thinking abstractly

- Abstraction typically involves:
 - devising a model that represents the reality – for example, think of a simple queue, or something as complex as a climate change model
 - removing details that are not relevant to the problem
- What details about a queue are irrelevant to figuring out how many tills are needed in a new store?



Another queueing problem

- Suppose you are trying to find a solution to the problem of bottlenecks at toll booths on a motorway
- What factors would be relevant, and what would be irrelevant?



Abstraction and reality

- Abstraction is an important tool in problem-solving
- All the details that do not contribute to the essential characteristics of the problem are omitted
- The **London Underground map** is a good example of information hiding
 - Can you think of others?

A robot vacuum cleaner... this?

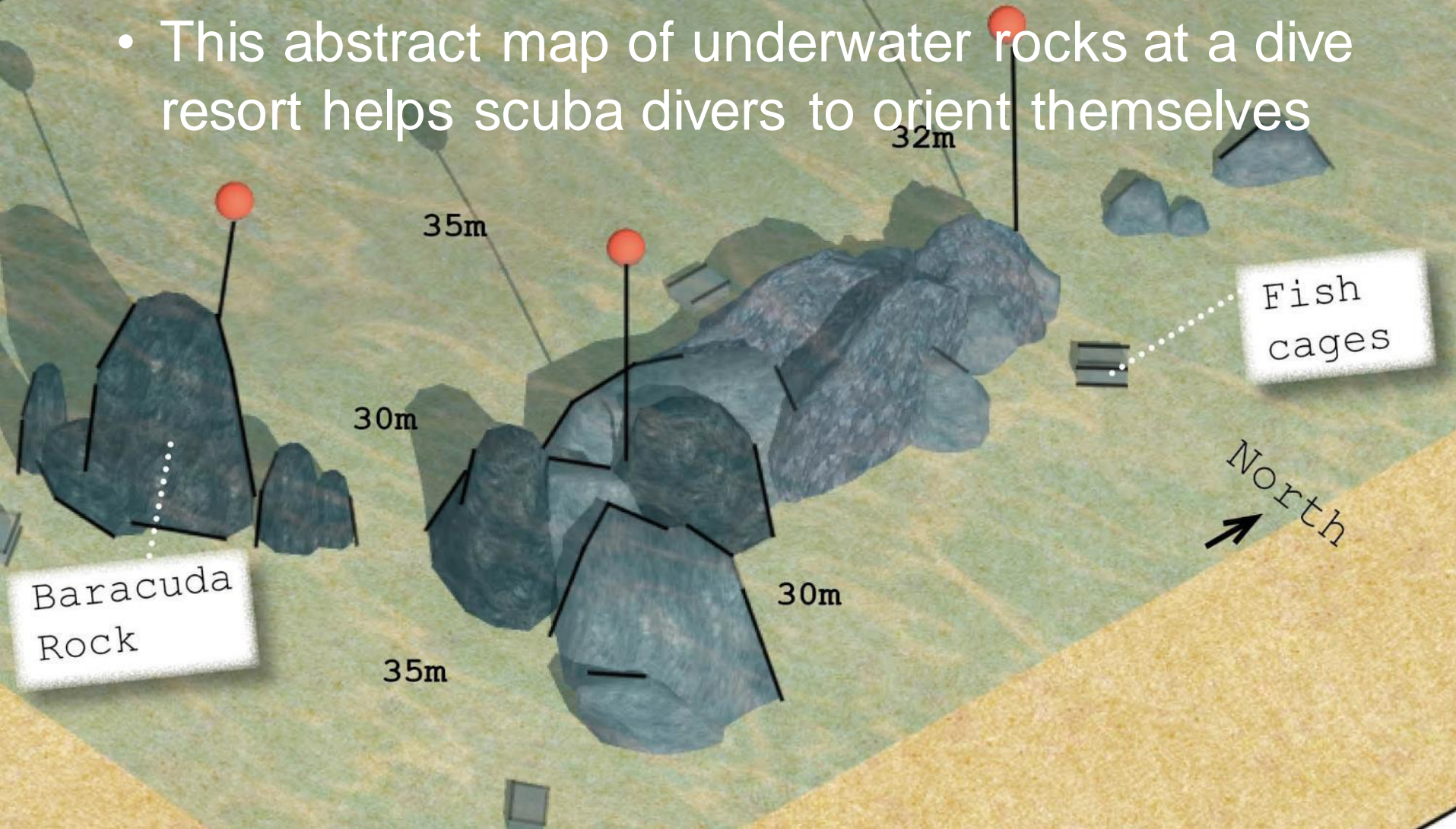


... or this?



Scuba diving map

- This abstract map of underwater rocks at a dive resort helps scuba divers to orient themselves



Problem abstraction

- This involves removing details until the problem reduces to one which has already been solved
- What do maps of a town, of the ocean floor, of a country, have in common?
- What do fingerprint recognition, iris scanning, footprint scanning, text recognition, number plate recognition, have in common?



Modelling and simulation

- Building a model of a real world object or phenomenon may be used to help solve a particular problem
- Computer scientists have to decide what details are relevant to the problem and discard everything else
- Algorithms and data structures can then be designed to solve the problem
- The algorithm is then implemented in program code and executed

Models of real-world problems

- A financial model which calculates the likely profit from a coffee shop, based on the available data



Models of real-world problems

- A climate change model which predicts the consequences of a 2°C rise in temperature



Models of real-world problems

- An aircraft simulator which can be used to train pilots



Worksheet 1

- Now try **Task 1** on the worksheet



Plenary

- Abstraction in its many forms is a fundamental concept used in computational thinking and problem solving
- Removing irrelevant details allows the computer scientist to focus on the essence of a problem

Worksheet 1

- Now try **Task 2** on the worksheet



Copyright

© 2016 PG Online Limited

The contents of this unit are protected by copyright.

This unit and all the worksheets, PowerPoint presentations, teaching guides and other associated files distributed with it are supplied to you by PG Online Limited under licence and may be used and copied by you only in accordance with the terms of the licence. Except as expressly permitted by the licence, no part of the materials distributed with this unit may be used, reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic or otherwise, without the prior written permission of PG Online Limited.

Licence agreement

This is a legal agreement between you, the end user, and PG Online Limited. This unit and all the worksheets, PowerPoint presentations, teaching guides and other associated files distributed with it is licensed, not sold, to you by PG Online Limited for use under the terms of the licence.

The materials distributed with this unit may be freely copied and used by members of a single institution on a single site only. You are not permitted to share in any way any of the materials or part of the materials with any third party, including users on another site or individuals who are members of a separate institution. You acknowledge that the materials must remain with you, the licencing institution, and no part of the materials may be transferred to another institution. You also agree not to procure, authorise, encourage, facilitate or enable any third party to reproduce these materials in whole or in part without the prior permission of PG Online Limited.