

# 122COM: Searching algorithms

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## 1 Introduction

This week we are looking at the problem of locating elements in a data structure. Searching is a classic problem in computer science and there are a range of different approaches available. From this week onwards the majority of labs will be taught in a combination of C++ and Python.

### **BIT, Media and 110 resit students**

Unless stated otherwise, BIT, Media and 110 resit students can solve the lab problems using Python. If you want to use C++ you can but it is not a requirement.

### **Everyone else (e.g. Computer Science, Computing, Ethical Hacking, Games)**

You are expected to use C++. If you want, you can solve the problems in Python first and then adapt your code to C++ but the final version should be in C++.

This weeks work is being kept relatively light as the majority of students will still be getting used to programming in C++. If you are struggling with the move to C++ or with programming in general then you should be attending programming support sessions.

The source code files for this lab and the lecture are available at:

`https://github.com/dscroft/122COM\_searching\_algorithms.git`

`git@github.com:dscroft/122COM_searching_algorithms.git`

## 2 Linear search

Linear search is the simplest method for finding a specific value in a sequence.

Starting at the beginning of the sequence of elements, step through and compare each element to the value being search for until either the end of the sequence is reached or a matching element is found.

**Pre-lab work:**

1. Complete the `pre_linear_search` program.
  - The function `linear_search` should return `true` if `value` is in `sequence` and `false` otherwise.
  - There are starter programs in C++ and Python already written for you.
2. Complete `pre_string_search` program.
  - 110 resit students can skip this task and come back to it later, it is more important for you to complete the binary search question.
  - The function `search_string` should return `true` if `substr` is in `text` and `false` otherwise.
  - Use the naive string search method shown in the lecture slides where the substring is tested in every possible position.
  - You cannot use any built in functions such as `in`, `find` or `strstr`.
  - Notice that the provided code comes with a series of tests to check that your function is working correctly.

### 3 Binary search

Binary search is a faster method of searching a sequence than linear search. Binary search is a divide and conquer algorithm, it is, however, limited to searching sorted sequences.

A full demonstration of the binary search algorithm is in the lecture slides but as a reminder:

1. Find middle value of sequence.
2. If `search value == middle value` then success.
3. If `search value < middle value` then forget about the top half of the sequence.
4. If `search value > middle value` then forget about the bottom half of the sequence.
5. Repeat from step 1 until `len(sequence)==0`.

**Lab work:**

3. Write a program that will binary search an ordered, linear, indexed sequence.
  - You can use either a recursive or an iterative solution.
  - `lab_binary_search_recursive` and `lab_binary_search_iterative` have been provided to get you started.
  - Note that the supplied code comes with a series of tests to check that your code works correctly.
4. Write a program that reads in and stores integer values provided by a user.
  - The program should keep reading until the user enters a value for a second time.
  - Some starter code can be found in `lab_duplicates`.
  - Write some tests to confirm that your code works correctly.

**Extended work:**

5. Modify your duplicates code so that when it encounters a duplicate, it prints out all the values the user entered in reverse order.
6. Try and implement the Boyer-Moore algorithm as explained in the lecture.
  - If researching elsewhere you may find Boyer-Moore described in terms of two rules, the "bad character rule" and the "good suffix rule". Ignore the "good" rule and focus just on the "bad" rule.