Searching A List: Review

- If there’s no order to the list (or the Yellow Pages)... best you can do is start at the beginning: linear search

- Binary search is a simple, common sense way to search through an ordered set of items.
  - Questions, often referred to as queries or probes, are asked to find if the desired item is smaller or larger.
  - If the question, hereafter called probe, is chosen from the middle of the sequence, ½ the possibilities are eliminated with each answer.
  - It’s a bit like 20 questions, but MUCH more specific.

Use binary search to locate L in the alphabet ABCDEFGHIJKLMNOPQRSTUVWXYZ
After M?

Use binary search to locate a letter in the alphabet

Another Example of the Algorithm at Work

Use binary search to locate a letter in the alphabet ABCDEFGHIJKLMNOPQRSTUVWXYZ
After M? No
After G?
Use binary search to locate a letter in the alphabet.

After M? No

After G? Yes

After J? Yes

After L? No

The Letter is L
How Good is a Particular Algorithm?

- You might think we can’t answer this question without programming a computer and trying it.
- Amazingly, it is possible to make very good comparisons between algorithms without programming them!
- Basic idea: estimate the number of “steps” each algorithm needs to solve the problems.
- Computers run at different speeds, but they are all alike enough that the number of steps they need for a particular algorithm doesn’t vary by as much as you might think.
- This gives us an abstract, mathematical way to compare the speed of different algorithms.

Algorithm vs. Program

- Remember that an algorithm is an abstraction.
- We can apply it, at least mentally, to a variety of situations, even without a computer.
- A program incorporates all the details needed for a computer to perform the algorithm.
- A program for binary search will encode the algorithm for a specific situation, in a specific language, with specific assumptions.

Battle of the Algorithms

- Binary Search: Each question allows you to throw out half of the unexamined items (throw half of the phone book away each time)
- Linear Search: Each question lets you tear out only one page.

Do The Math for Searching 200 Items

<table>
<thead>
<tr>
<th>Step</th>
<th>Linear</th>
<th>Binary</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>1</td>
<td>199</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>198</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>197</td>
<td>25</td>
</tr>
</tbody>
</table>
Bottom Line

- It can be shown mathematically when a sorted list of $N$ items is to be searched:
- Linear sort needs on average about $N/2$ steps
- Binary sort needs on average about $\log_2 N$ steps
- The bigger $N$ is, the bigger the improvement.
- Project for someone: Calculate and present some numbers based on these formulas (see me).

Trade-Offs

- If we know algorithm A has a better formula than algorithm B:

Would we ever still want to use algorithm B??

Procedures: Review

- Procedures (also known as ___, ___, ___ etc.) are sets of statements that accomplish some purpose.
- Procedures "encapsulate functionality" (package together useful operations, algorithms) so that they can be used anytime needed.
- For example, you only write the cmdOK-Click function once, but it executes many times – each time there is a click on that button.

Procedure Terminology

```
Private Sub txtScoops_KeyPress(KeyAscii As Integer)
    lblScoops.Caption = txtScoops.text & " scoops, please."
    txtScoops.text = ""
End Sub
```

Procedures have the following features:
- Name: term used to refer to the task the procedure performs.
- Definition: The steps that will accomplish the task. Also known as the procedure body.
- Parameters: the names of the data sent to or from the procedure.
- Declaration: the entire package of the name, definition and parameters.
### Calling A Procedure

- The procedure declaration only specifies how the procedure works and only needs to be given once.
- A procedure call causes the procedure to execute.
- A procedure call can be used anywhere that the task to be performed is needed.

**Example:** The system "calls" cmdOK_Click automatically.

**Surprise:** you could call that event handler yourself if you wanted to.

**Why might you want to?**

**How would you do it?**

### Procedural Abstraction

- Whenever the same operations are performed in different places in a program, there is an opportunity for "procedural abstraction": wrapping the operations into a procedure.

```
Private Sub anynameIchoose()
    ' any statements I want
End Sub
```

- You can then call the function from different parts of the program.

### Mini-Exercise #1

**What is the value of x after the form has been loaded?**

```
Option Explicit
Dim x As Integer

Private Sub squid()
    x=x+2
End Sub

Private Sub Form_Load
    x=0
    Call squid
End Sub
```

### Mini-Exercise #2

**What is the value of y after the form has been loaded?**

```
Option Explicit
Dim y As Integer

Private Sub squid()
    y=y+2
End Sub

Private Sub clam()
    Call squid
    Call squid
End Sub

Private Sub Form_Load
    y=0
    Call squid
    Call clam
End Sub
```
Collections: Review

- Let’s make an appointment book.
- Declare it.
- Give it some initial dates.
- Display all the dates.
- Display a particular date.
- Add a date and display again

Creating and Showing The Collection

Showing One Date on Request

- I want to display in more than one place on the form
Displaying the Dates: Problem two

- If you add or delete a date while the program runs – how do you display the whole, changed, collection??

Mid: A String Function

- From VB textbook, p. 81:
- \( \text{Mid}(x, s, n) \) Returns the middle \( n \) characters of string \( x \) starting at character number \( s \)

Make a Prediction

What is returned by this?

\( \text{Mid}("Gong Xi Fa Cai", 2, 4) \)

Test your prediction on the computer!

Getting Each Character From A String

Dim count as Integer
Dim i as Integer
For i = 0 to count
    MsgBox (Mid("Gong Xi Fa Cai", 2, 4))
next i