Revision

Main topics:

- Looping (lecture 1)
- Macro recording (lecture 2)
- Curve fitting (lecture 4)
- Interactive In and Output (lecture 5)
- Arrays and array functions (lecture 6)
- Customized User Forms (lectures 7 and 8)

Looping:

- Loops are mechanisms for repeating the same procedure
- Two structures in VBA for this: Do ... Loop and For ... Next
  - Do ... Loop is used when the loop terminates when a logical condition applies

Syntax: **Do** {**While**|**Until**} condition
[statements]
[**Exit Do**]
[statements]
Loop

- In the DO WHILE ...LOOP the looping continues while the condition is true
- In the DO UNTIL ...LOOP the looping continues until the condition is true
- EXIT DO terminates the looping

- For ... Next is used when you know in advance how many times you want to iterate

Syntax: **For** counter = first **To** last [Step step]
[statements]
[**Exit For**]
[statements]
Next [counter]

► Exercises: Verify the following identities using looping:

(see Labsession 1 task 1)

$$\sum_{a=1}^{n}(2a-1)^5 = \frac{1}{3}n^2(16n^4-20n^2+7)$$

$$\sum_{a=1}^{n}(3-2a)^3 = n(2-n)(2n^2-4n+3)$$

- Example:

$$\sum_{a=1}^{n}(2a-1)^3 = n^2(2n^2-1)$$

```
Function LHS1(n)
  a = 1
  Do Until a = n + 1       (Do While a < n + 1)
     LHS1 = LHS1 + (2 * a - 1) ^3
     a = a + 1
  Loop
End  Function
Function LHS2(n)
  a = 1
  Do
    LHS2 = LHS2 + (2 * a - 1) ^3
    If a = n Then Exit Do
    a = a + 1
  Loop
End Function
```

```
Function RHS(n)
     RHS = n ^2 * (2 * n ^2 - 1)
End Function
```

Curve Fitting

- On many occasions one has sets of ordered pairs of data $(x_1, \ldots, x_n, y_1, \ldots, y_n)$ which are related by a function y(x)

  e.g. some experimental data with a theoretical prediction

- suppose y(x) is a linear function

$$y = a\,x + b$$

- Excel offers various ways to determine a and b

  i) SLOPE, INTERCEPT - functions

$$\text{SLOPE}(y_1, \ldots, y_n; x_1, \ldots, x_n) \rightarrow a$$

$$\text{INTERCEPT}(y_1, \ldots, y_n; x_1, \ldots, x_n) \rightarrow b$$

ii) LINEST - function

this function is more sophisticated than the previous one

LINEST($y_1,...,y_n,x_1,...,x_n$, *constant*,*statistics*)

- if *constant* = TRUE or omitted the intercept is computed otherwise it is zero
- if *statistics* = TRUE the function returns regression statistic values with the output:

slope	intercept
standard error in the slope	standard error in the intercept
r-squared	standard error in the y estimation

- we restrict ourselves here to

- notice that LINEST is an array function, such that you have to prepare for an output bigger than one cell:
  - · select a range for the output, e.g. 2×3 cells
  - · type the function, e.g. =LINEST(.....)
  - · complete with Ctrl + Shift + Enter

iii) adding a trendline

- this option also works for nonlinear, logarithmic, exponential ... correlations between the x- and y-values
  - · choose an scatter-chart with the subtype which has no line
  - · right click any of the plotted points
    ⇒ Add Trendline windows opens
  - · select the type of correlation, e.g. Linear, polynomial, ...
  - · in Options decide if you want to add the computed equation the r-squared value etc on the chart

Example:

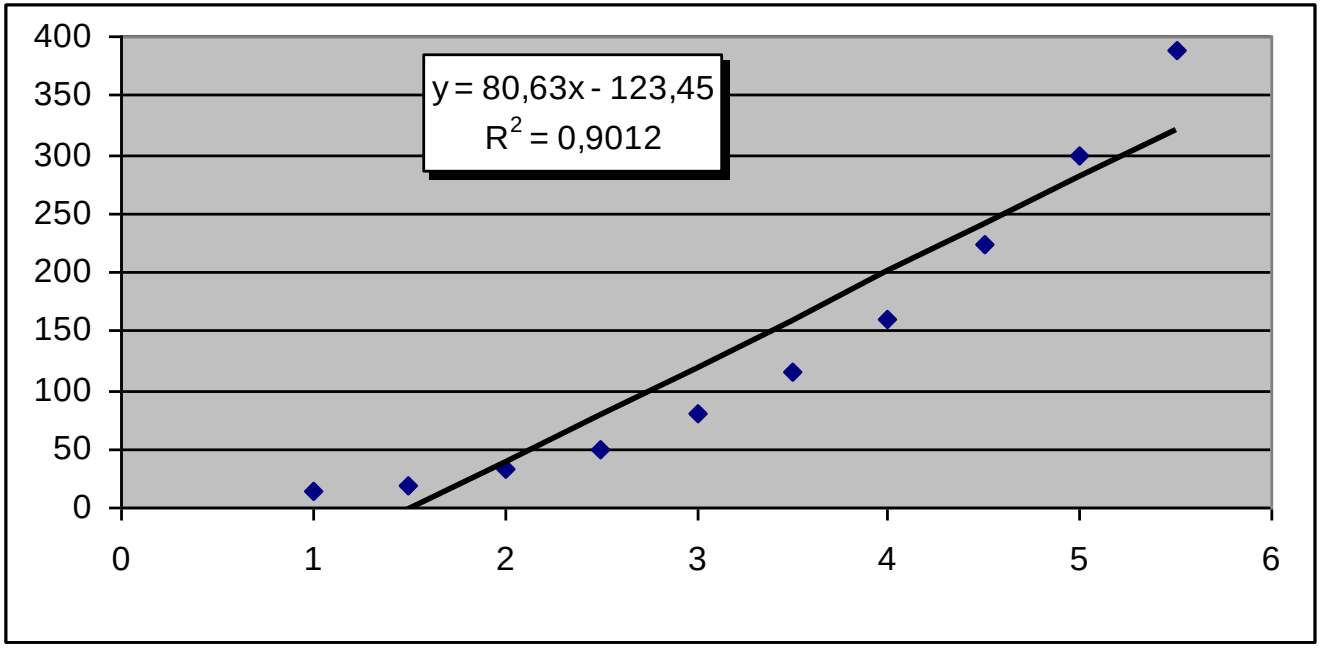
Consider the data (exam 2006):

1	14
1,5	19
2	34
2,5	50
3	81
3,5	116
4	160
4,5	223
5	300
5,5	389

Assume linear correlation:

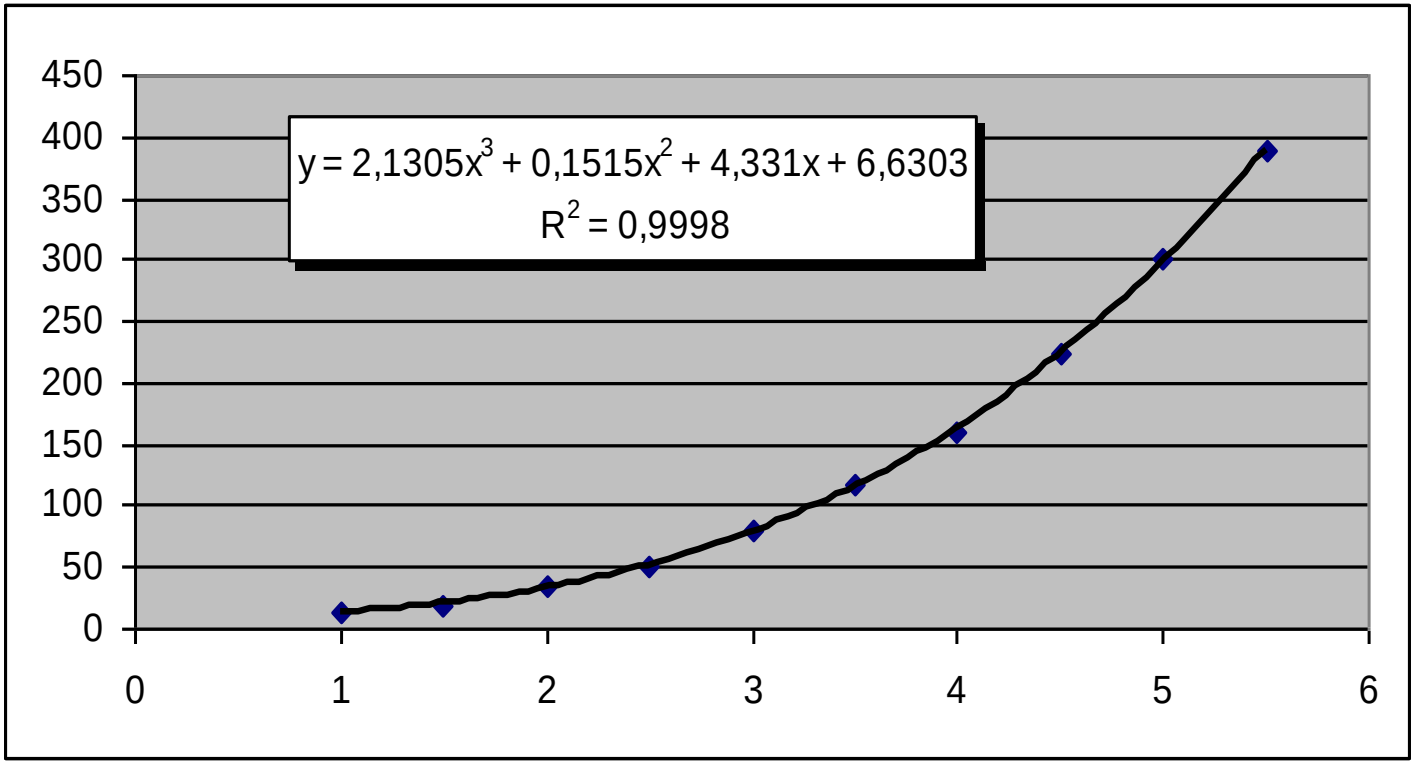
slope $\rightarrow$ 80.6303 intercept $\rightarrow$-123.448

Adding a trend line: (right-click in any of the points and choose the option “add Trendline”)



We see that a linear fit is clearly not the best choice!

In the exam, students were asked to perform a polynomial fit of the type $y=a\,x^3 + b\,x^2 + c\,x + d$. Doing that we obtain:



Note: Remember that in order to have the equation for y and the value of R^2 written in the graph you have to choose that option when you add the trendline. There will be a window called options which allows you to fix that!

Macros and macro recording

Macros are VBA programs. They are also called subroutines.

They always have the structure:

Sub Nameofmacro()

…..

End Sub

The easiest way of creating a macro is by using the Macro recorder.

Recording a Macro:

i) open a worksheet

ii)) select View → Macros → Record Macro ↵

⇒ the record Macro dialog box opens up

iii) enter Macro Name, e.g. “ferrari“

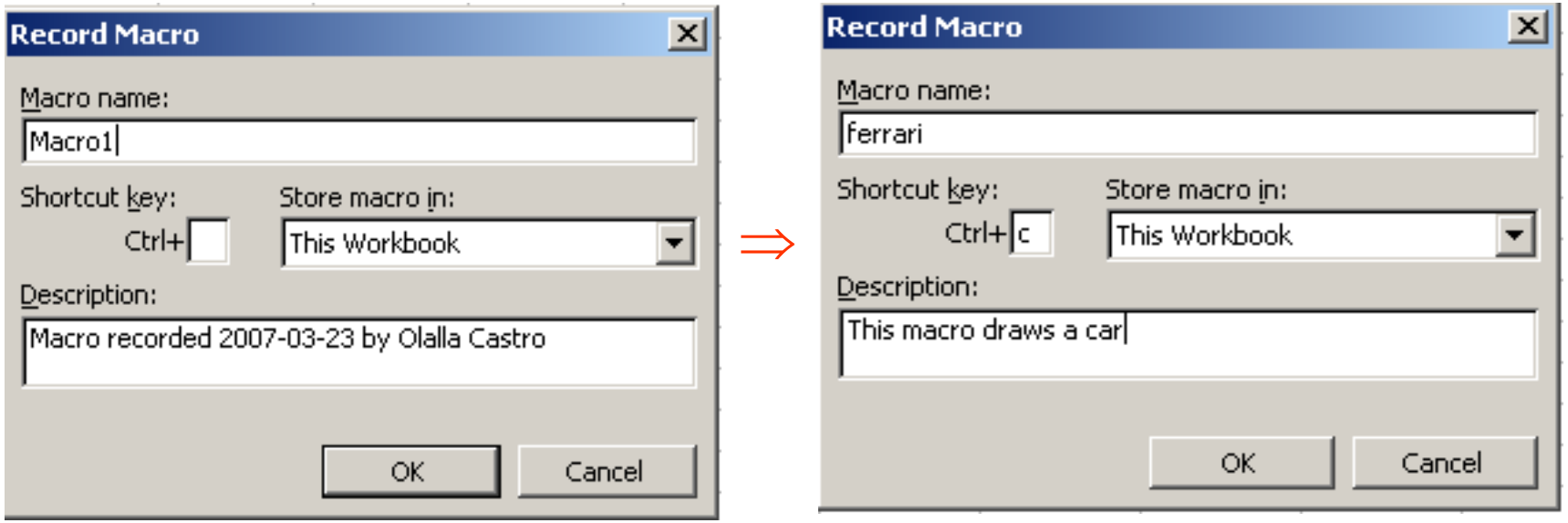
- not all names are allowed, such as function names, special signs in the name as !,?, blank,... are also not possible

iv) enter a letter for the shortcut key, e.g. “c“

v) store the macro somewhere, e.g. “This workbook“

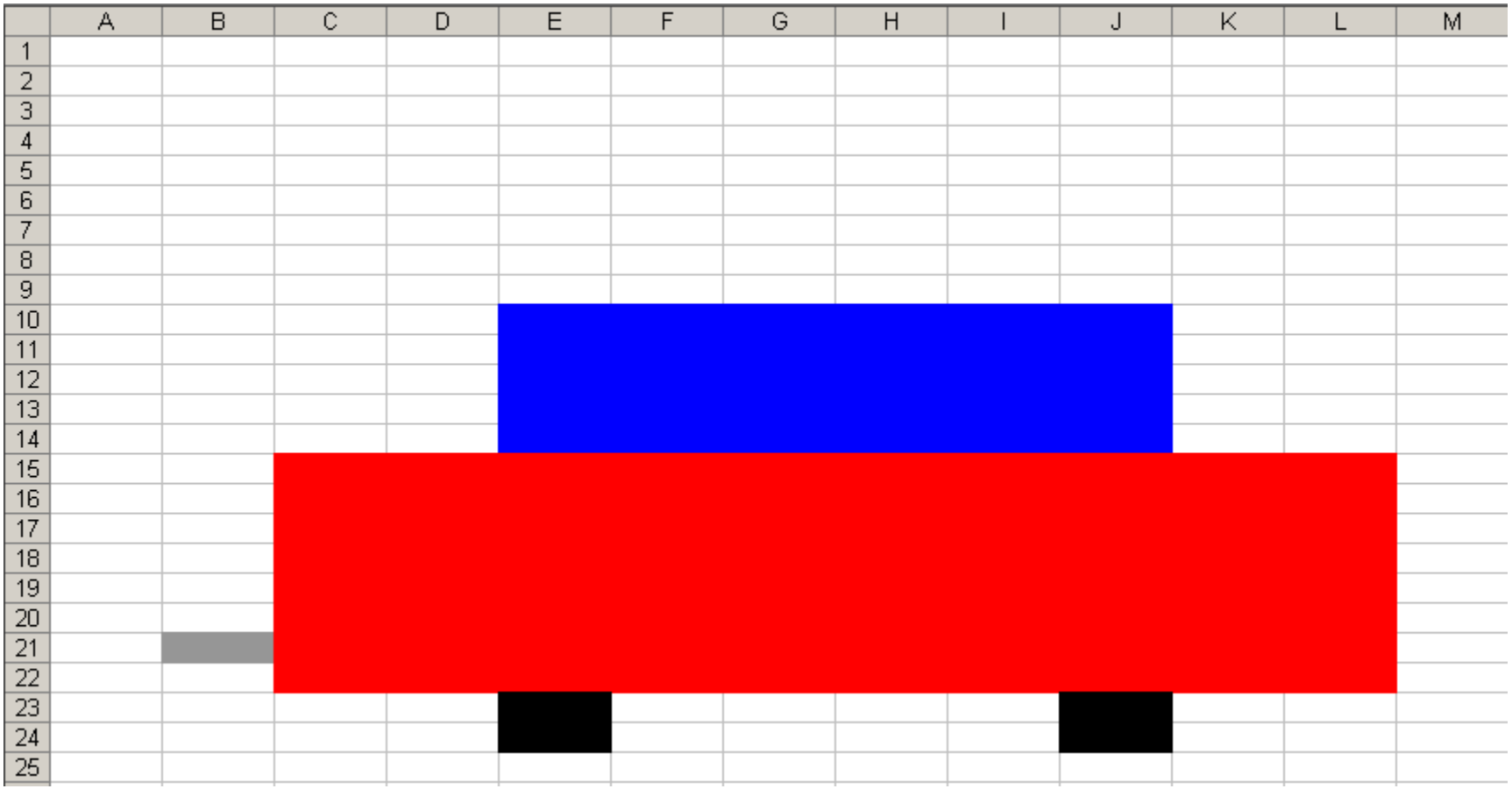
vi) fill in the decription box, e.g. “this macro draws a car“

vii) Ok ↵ , the recording is on. Now all actions you carry out on the worksheet will be recorded and its code will be produced.



The exam problem was: Record a Macro such that when run it colours the range C15:L22 in red, the range E10:J14 in blue, the range E23:E24 and J23:J24 in black and the cell B21 in gray.

This is how it looks in the Excel Worksheet:



Once you have finished: select View → Macro → Stop Recording ↵

And this is how the corresponding code will look:

```
Sub ferrari()
‘
‘ ferrari Macro
‘ This macro draws a car
‘
‘ Keyboard Shortcut: Ctrl+c
  Application.Left = 193
    Application.Top = 16.75
    Range("C15:L22").Select
    With Selection.Interior
        .ColorIndex = 3
        .Pattern = xlSolid
    End With
    Range("E10:J14").Select
    With Selection.Interior
        .ColorIndex = 5
        .Pattern = xlSolid
    End With
```

(continues in the next column!)

```
Range("E23:E24").Select
    With Selection.Interior
        .ColorIndex = 1
        .Pattern = xlSolid
    End With
    Range("J23:J24").Select
    With Selection.Interior
        .ColorIndex = 1
        .Pattern = xlSolid
    End With
    Range("B21").Select
    With Selection.Interior
        .ColorIndex = 48
        .Pattern = xlSolid
    End With
End Sub
```

To see the code: Select
View → Macros → View macros → ferrari → edit

Arrays

- Arrays are VBA variables which can store more than one item.
  - the items held in an array are all of the same variable type
  - one refers to an item by the array name and a number

syntax: declaration:	Dim Name(number)		
usage:	Name(x)	where	$0 \leq x \leq$ number

  - by default the indexing starts at 0
  - Alternatively:

syntax: declaration:	Dim Name(x to y)		
usage:	Name(z)	where	$x \leq z \leq y$

  - In this case the indexing starts at x and finishes at y

Examples:

1) Write a program that adds up the vectors (1,0,3) and (4,3,9) and writes the result in the cells A1:C1

```
Sub vector1()
Dim A(1 To 3), B(1 To 3), C(1 To 3)
A(1) = 1
A(2) = 0
A(3) = 3
B(1) = 4
B(2) = 3
B(3) = 9
C(1) = B(1) + A(1)
C(2) = B(2) + A(2)
C(3) = B(3) + A(3)
Range("A1:C1").Value = C
End Sub
```

2) Write a program that reads two vectors from cells A1:D1 and cells A2:A5 and writes their product in cell A3.

```
Sub vector2()
Dim A,B as Variant
A=Range("A1:D1").Value
B=Range("A2:A5").Value
Range("A3").Value =A(1,1)*B(1,1)+
A(1,2)*B(2,1)
+A(1,3)*B(3,1)+A(1,4)*B(4,1)
End Sub
```

- Multidimensional arrays are VBA variables which can hold more than one item related to several index sets (up to 60)

syntax: declaration:	Dim Name(num1,num2,num3,...)	
usage:	Name(x,y,z,...)	$0 \le x \le num1$
		$0 \le y \le num2$
		$0 \le z \le num3$
		.....

- When there are only two index sets, then the array is a matrix.

For example:

Dim A(1 to 3, 1 to 3) → defines a 3 x 3 matrix with entries
A(1,1), A(1,2), A(1,3), A(2,1),A(2,2), A(2,3),A(3,1),A(3,2),A(3,3)

Dim B(2,2) → defines also a 3 x 3 matrix with entries B(0,0), B(0,1), B(0,2), B(2,0),B(2,1), B(2,2),B(2,0),B(2,1),B(2,2)

Therefore, arrays can be employed to write programs that do operations on matrices.

Example: (done in the lab) A program that reads a 3 x 3 matrix from cells A1:C3, computes its transpose and writes it into cells D1:F3

```
Sub Transpose()
  Dim MA  As Variant     (MA is defined as variant because it is an array)
  Dim MB(1 To 3, 1 To 3) As Integer       (the entries of MB are integers)
  MA = Range("A1:C3").Value
      For i = 1 To 3
        For j = 1 To 3
           MB(i, j) = MA(j, i)
        Next j
      Next i
  Range("D1:F3").Value = MB
End Sub
```

Interactive In and Output

- Message box:
  - displays a message in a dialog box and returns an integer value which depends on the answer of the user

```
syntax:    return = MsgBox(prompt [, buttons] [, title])
```

  - or:

```
syntax:    return = MsgBox(prompt:= "..." , title:= " ..."] ... )
```

- Input box:
  - displays a prompt in a dialog box, waits for the user to enter a text or click a button, and returns a string containing the content of the text box or the value FALSE if cancel is chosen.

```
syntax:
  return = InputBox(prompt [,title] [,default] [,xpos] [,ypos])
```

► Exercise:

- Write a VBA code which simulates the following dialog:

  · When executed the function should start with an Input Box which states "Did you finish your revision?". The title of this box should be "Revision".

  · The entry into the input box should be assigned to a variable named "Answer". Declare the type of this variable as string.

  · Design three message boxes with just an OK button and title “Revision”. If the “Answer” is “Yes” the message box should say “Then do the revision test”, if “Answer” is “No” then it should return “You have time until May” otherwise “Answer with Yes or No!”.

```
Sub revision()
Dim Answer As String
Answer = InputBox(“Did you finish your revision?”, “revision”)
If Answer = “Yes” Then
MsgBox (“Then do the revision test!”, “revision”)
ElseIf Answer = “No” Then
MsgBox (“You have time until May”, “revision”)
Else
MsgBox (“Answer Yes or No!”, “revision”)
End If
End Sub
```

You will find more complicated MsgBox examples in former years exams! (see also the notes for lecture 7)

Some programs use GOTO to go back to a certain place in the program! (see the notes for lecture 7).

Customized User Forms (CUF)

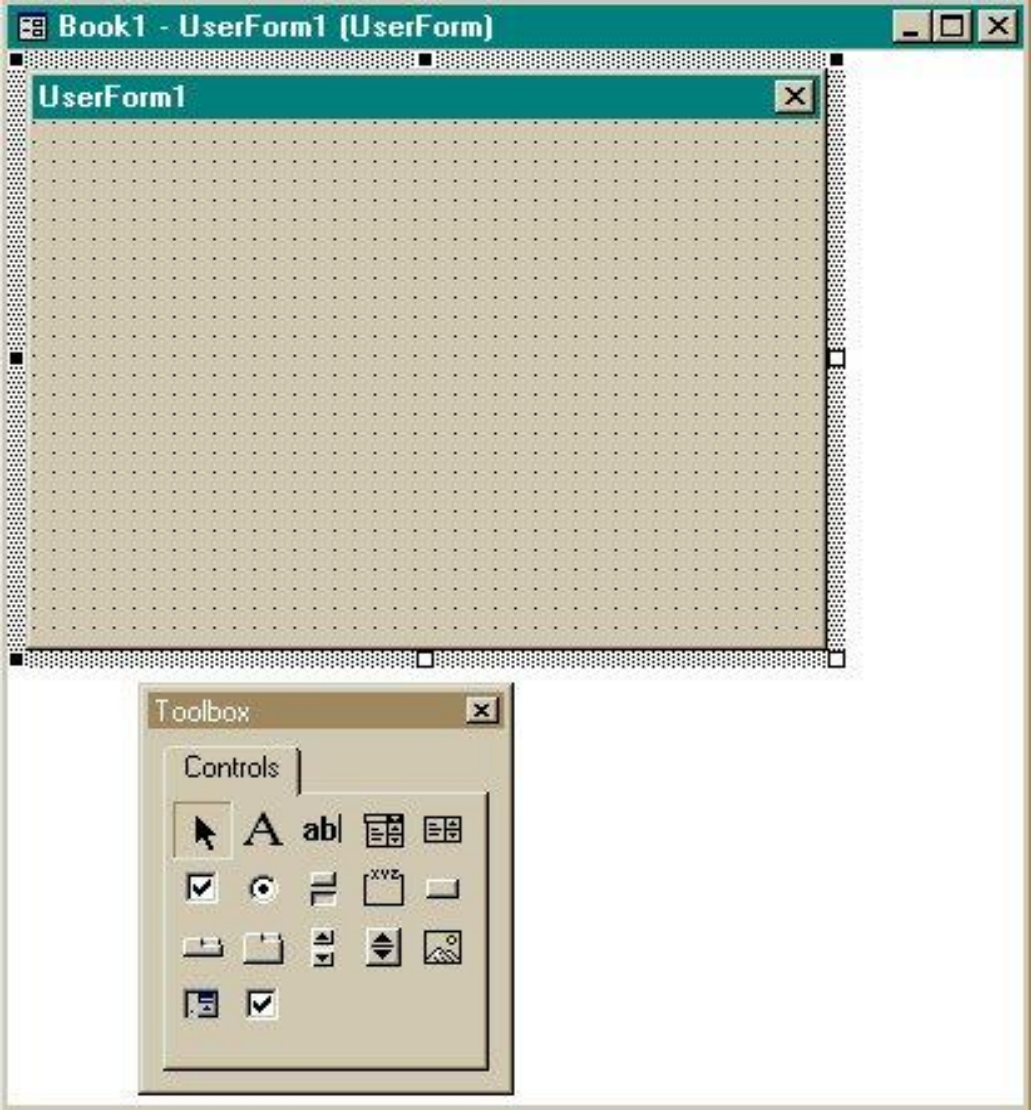
- CUF are user defined dialog boxes
  (similar to MsgBox and InputBox, but far more flexible)

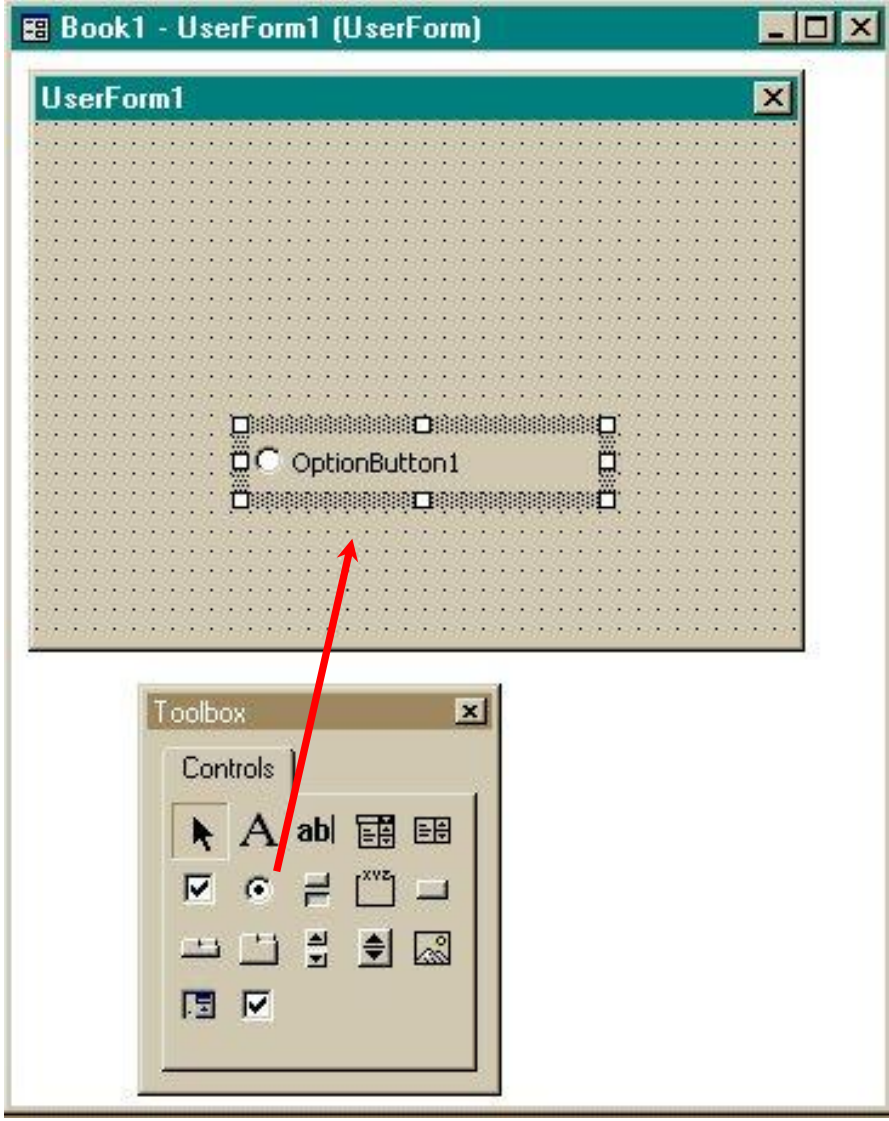
Creating and designing a CUF:

- Open the VBA editor
- Select Insert → UserForm ↵

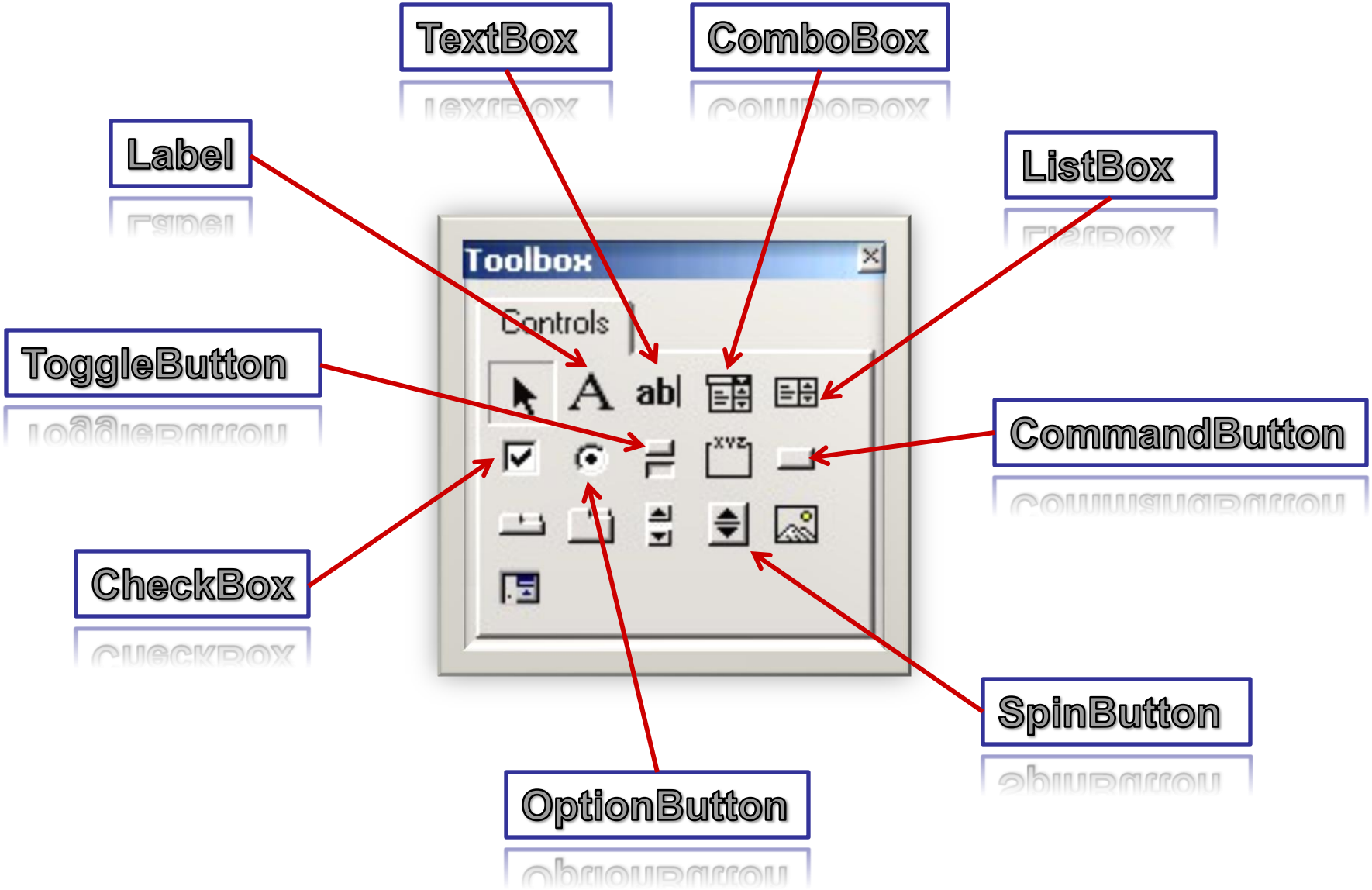
⇒ a new user form object with the default name "UserForm1" is created

- By using the ToolBox, many different types of Controls can be added to the form





The toolbox contains a set of «controls» which you can click on and drag into the Userform. They include Optionbuttons, Textboxes, Labels, Listboxes etc.


TextBox
ComboBox
Label
ListBox
Toolbox
Controls
ToggleButton
CommandButton
CheckBox
SpinButton
OptionButton

Example:

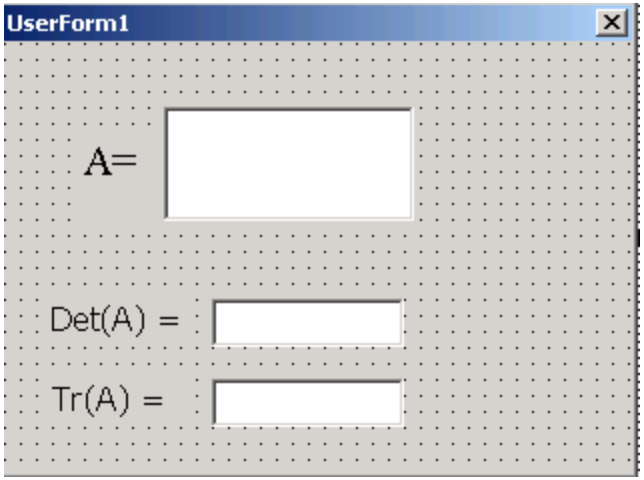
- Create a Customized UserForm which contains a ListBox, two TextBoxes and three Labels.

- The ListBox should be associated to a two-dimensional array called A consisting of 2 columns and 2 rows with values A(1,1)=1, A(1,2)=6, A(2,1)=5 and A(2,2)=9.

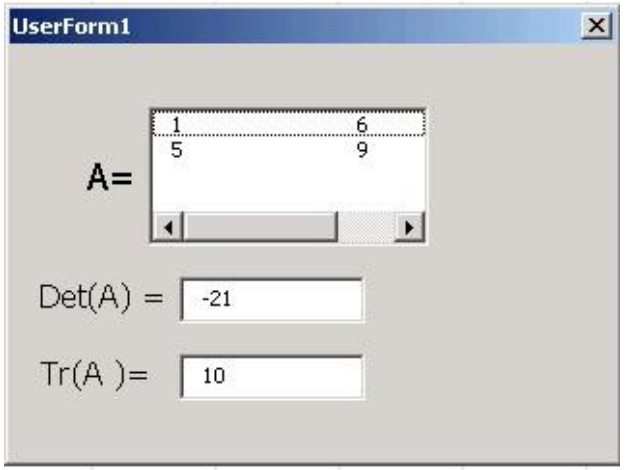
- The UserForm should be linked to a program, which when run would display the value of the determinant of the Matrix A in the first TextBox and its trace in the second TextBox.

- Finally there should be one Label “A=“ to the left of the ListBox, a Label “Det(A) =“ to the left of the first TextBox and a Label “Tr(A)=“ to the left of the second TextBox.

The form should look like this:



When the program is run and you click on the form:



Remember to set ColumnCount=2 so that the whole matrix is shown!

The associated program would be:

```
Private Sub UserForm_Click()
Dim A(1 To 2, 1 To 2) As Integer
A(1, 1) = 1
A(1, 2) = 6
A(2, 1) = 5
A(2, 2) = 9
matrix.List = A
deter.Value = A(1, 1) * A(2, 2) - A(1, 2) * A(2, 1)
trace.Value = A(1, 1) + A(2, 2)
End Sub
```

The ListBox is called “matrix”

The TextBoxes are called “deter” and “trace”

About the progress test

The progress test date is April 28th, 10-11:30 am

It is an open book exam. You may use your lecture notes as well as task- and solution-sheets from previous lab-sessions. Books will not be allowed.

You will be able to use a computer to verify your answers. You will have to write your answers in the booklet provided.

The exam will consist of 4 questions. Each questions carries 25 marks. Full marks may be obtained for correct answers to all four questions.

To avoid possible accusations of cheating all applications except Excel & VBA must be closed before and during the exam.

The final mark for the module will be the average of the marks of the 1st and 2nd progress test. This average must be at least 40 in order to pass.