Laboratory Session 5

1. Introduction

In this lab you will use MATLAB to break a weakened form of the RSA public key encryption algorithm using a very short key and determine the plaintext from a ciphertext message.

You will need to set up a Mathworks account to access Matlab Online. To do this go to:

https://matlab.mathworks.com

And follow the prompts. You will need to use your Swinburne account to set up the account.

You can copy text from Matlab Online onto your desktop using CTRL-c and CTRL-v to paste it.

A summary of how the RSA algorithm works is described in Section 3. You will need to understand this section in order to determine the private key from the given public key.

Should you need it, an introduction / revision of MATLAB is in Section 4. All the commands you need to do the lab are included in this section. If you are unfamiliar with MATLAB do this section first.

2. Method

You are to decrypt the following message c which you know was encrypted with the given public key of [n,e] = [2407,57].

```
c = [2050  2296  640   479   640   2377  1274  479   640   2377
     2395  194   476   2377  2395  602   2014  640   1205  2377
     476   1888  2377  640   1142  1421  479   602   2014  2395
     586   476   1142  749   2377  476   1142  640   2377  2395
     2296  1274  2395  2377  194   586   1285  1285  2377  2014
     479   640   1904  640   1142  2395  2377  602   476   540
     479   2377  1205  586   1205  2395  640   479   2377  1888
     479   476   2011  2377  479   640   1274  1741  586   1142
     1019  2377  602   476   540   479   2377  1741  586   1274
     479   602   2377]
```

1. Install the routine `decryptString.m` in the work directory. This can be done by dragging the file from the desktop directly into the left-hand panel as shown below:

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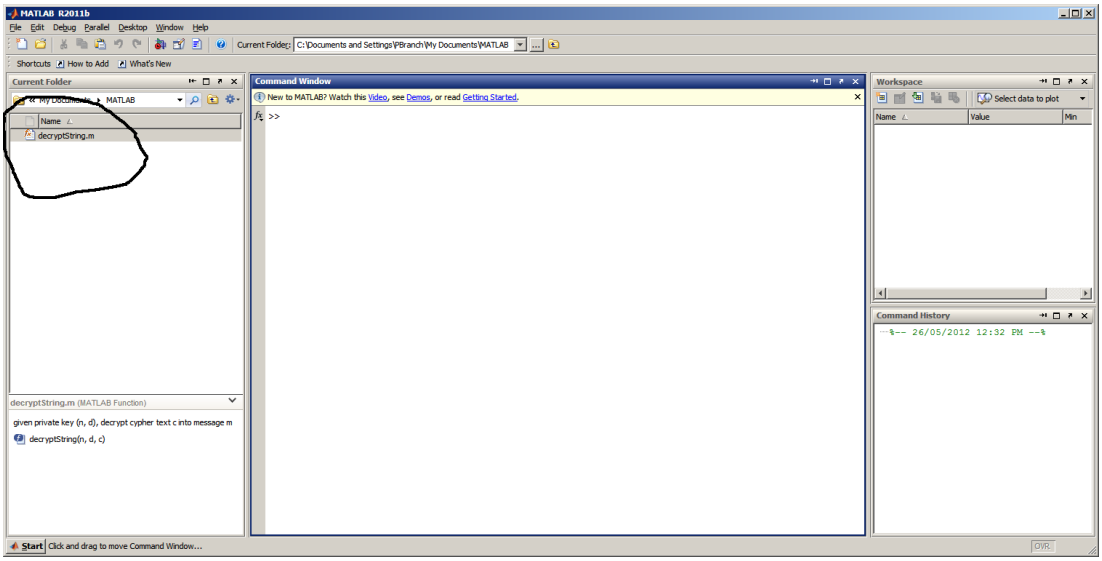

This routine decrypts a string of cipher text using the appropriate key. You have to determine the private key from the public key.

2. Determine the private key [n, d] associated with the public key [n, e] = [2407, 57]. You may assume that d is less than n and is unique. You will need to construct a **for** loop to test different values of d.

3. Use the private key to decrypt the message. This can be done using the `decryptString.m` routine. Its use is

```
decryptString(n, d, c)
```

where n and d is the private key and c is a vector containing the cipher text.

4. To obtain the full message, repeat with the public key [n, e] = [7663, 89] and for the cipher text c below.

```
c = [2980  3647  1145  7023  4485  3647  7130  7023  6069  5363
     2980  6069  7023  3911  2971  5943  5943  7023  1889  5561
     7130  454   7130  3647  6069  7023  3243  4485  2957  5561
     7023  5465  4485  454   7130  5561  3647  1883  7130  3647
     6069  656   7023  6689  2206  5561  2957  4580  7130  7023
     6238  4580  5363  3647  7130  2971  5561  1603]
```

3. RSA Algorithm

To create the public key select two large positive prime numbers p and q

Compute $n = p*q$

Compute $x = (p-1)*(q-1)$

Choose an integer e which is relatively prime to x.

Public key is then $[e, n]$

To create the private key

compute d such that $(d*e) \bmod x = 1$

Private key is then $[d, n]$

Data to encrypt is m

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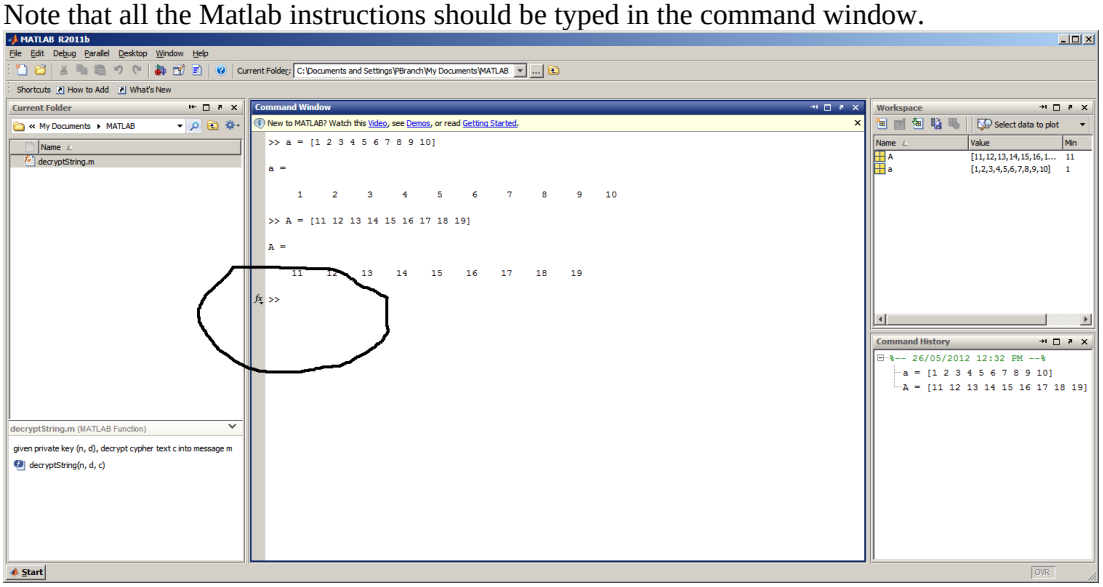
To encrypt m, compute $c = (m^e) \bmod n$

To decrypt c, compute $m = (c^d) \bmod n$

4. MATLAB Revision / Introduction

MATLAB is designed primarily to operate on matrices and vectors. We only need to deal with operations on vectors. The command window is used to run the MATLAB instructions. The Command History window keeps a record of all the instructions.

Note that all the Matlab instructions should be typed in the command window.



Vector definition

The simplest way to define a matrix is to list its elements in order

Try `a = [ 1 2 3 4 5 6 7 8 9]`

Note : You can suppress the listing of the array by adding a semi-colon at the end. Also note that MATLAB is case sensitive.

Try `A = [ 11 12 13 14 15 16 17 18 19];`

Accessing vector elements

Individual elements of an array A or string S are accessed by A(i)

Try `A(7)`

Putting a semicolon after a command suppresses output.

Try `a;`

Now try `a`

Displaying values

`disp (x)` displays the value of `x`

Try `disp(A)` and `disp(A(2)`

Putting a semicolon after a command suppresses output.

Try `disp(a);`

'for' loop

for loops in MATLAB can be implemented with

```
for count = start value : end value
   statement
end
```

Try

```
for i = 1:20
  x(i)= i;
  disp(x(i))
end;
```

`disp(x)` displays the value of `x`

Strings in MATLAB

Strings of characters can be defined in MATLAB with the ' delimiter.

Try `textstring = 'a string of text'`

Individual elements of the string can be accessed with the number of the element (starting from 1) in parentheses.

Try `textstring(5)`

Useful MATLAB commands

`factor(n)` `returns the prime factors of n`

`for loop` `for i = 1:20 x(i)= i; end`

`if statement` `if (x==1) disp(x)`

`mod(x, y)` `returns x mod y`

`length(x)` `returns the length of a vector x`

`break` `ends execution of current for loop`

`disp(x)` `displays the value of x`

5. Assessment

Assessment of this lab is from a short report explaining what you did, what you observed and explanation as to what you saw. Grade is either pass / not pass. If the report is not passed you will be asked to resubmit an improved version of it.

The report is to comprise:

Title

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This is to be “NSR/AS Lab 4 – Public Key Cryptography” followed by the student’s name and student id.

Abstract

No more than 200 words summarising the report.

Introduction to Public Key Cryptography

This is to be no more than 1 A4 page describing RSA public key algorithm (NOTE: One page is a maximum, not a recommendation.) It is to outline of the RSA algorithm.

Breaking the RSA algorithm

This is to be no more than one A4 page. This is to include your MATLAB code for breaking the algorithm with explanation as to what the code does.

Results

This is to be no more than two A4 pages.

This section is to include:

- The results from running your code and the first decrypted message
- The results from running your code and second decrypted message

Conclusion

No more than half a page summarising the main points of the report.

References

All sources are to be properly referenced. Use IEEE referencing. DO NOT JUST PROVIDE A LIST OF WEBPAGES.

Diagrams

All diagrams are to be numbered and captioned. If they are not the student’s original work, they are to be referenced.

You may use any standard formatting you like, although IEEE is preferred.