MATLAB concepts

- Matlab likes to give results

```
>> 'Free' + 3
[73   117   104   104]

>> log(0)
Inf

>> 10/0
Inf

>> 0^0
1
```

MATLAB concepts - NaN

- Undefined mathematical operations yield NaN

  ```
  >> 0/0
  NaN
  ```

- NaN is an undefined number

  ```
  >> NaN == NaN
  false
  >> NaN > 1
  false
  >> NaN <= 1
  false
  ```

MATLAB concepts – Operators

- Matlab knows the following Operators:
  - +, -, *, /, \, ^, '
  - Can be used on on scalars or matrices
  - ' is the complex conjugate transpose of a matrix or scalar

```
>> [2+i,1;3-i,4-2i]'
2-i          3+i
1          4+2i
>>(3+i)'
3-i
```

MATLAB concepts – Operators

- Some operators (*, /, \, ^, ') can be combined with .
  - This indicates that it is a pointwise operation (.* , ./ , -\ , .^) and is commonly applied to matrices.

```
>> [1 , 2].*[3 , 4]
[3 , 8]
```

  - For ' this indicates the transpose instead of the complex conjugate transpose

MATLAB concepts – Operator precedence

- Operators have an order (like in math)
  - In Matlab this order is:

    ', ^

    *, / , \

    + , -
  - Therefore brackets have to be used

```
>> -2^1/2
   -1
>> -2^(1/2)
   -1.4142
>> (-2)^(1/2)
   0.0000 + 1.4142i
```

MATLAB concepts – Visibility

- Matlab needs to know what a certain variable/command means

- It looks it up as follows:
  - In the current workspace variables
  - Additional functions in a function file
  - Functions in the current working directory
  - Functions in a folder on the Matlab path
  - Within the path from top to bottom

MATLAB concepts – Visibility

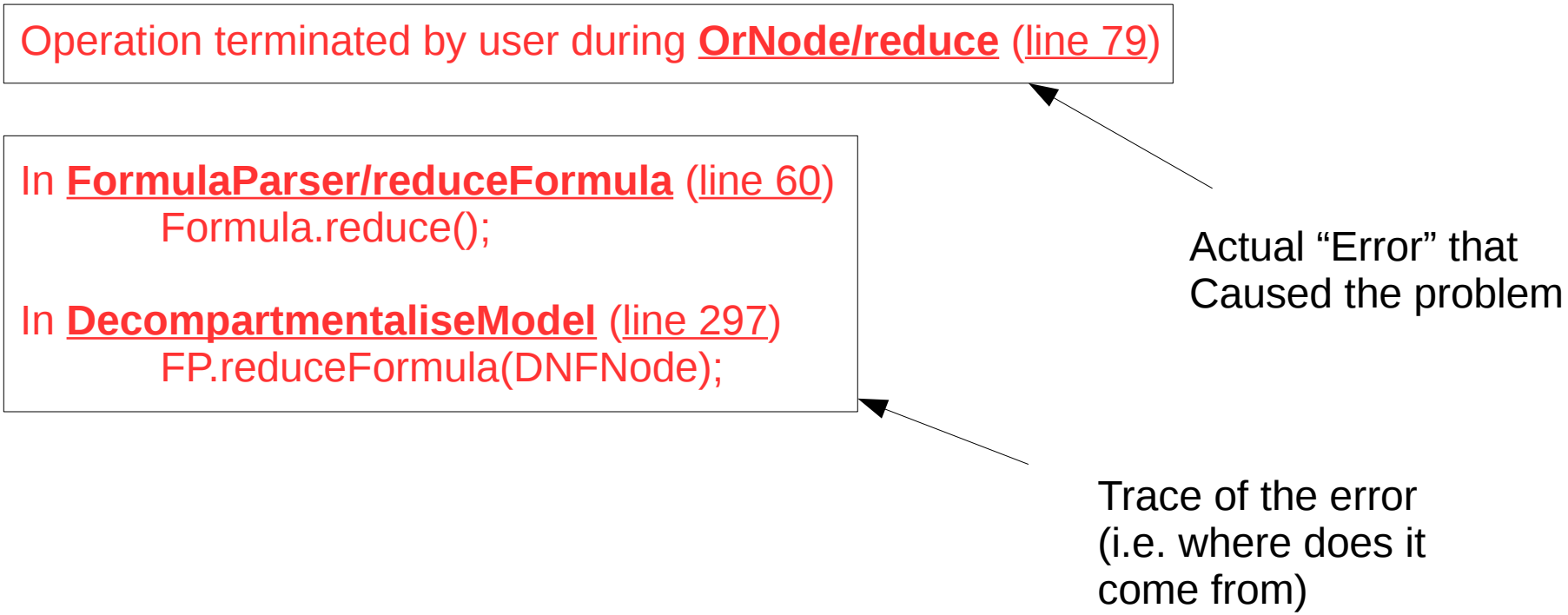
```
>> plot = scatter(X,Y)
...
...
>> plot(X,Y)
```

Subscript indices must either be real positive integers or logicals.

- A nondescript error message that is really difficult to understand!

MATLAB Debugging

- Error messages try to point at the problem



MATLAB Debugging

- What to do about errors
  - Many Errors tell you what is wrong:

```
>> A = ismember({'a','b','c',{'a'})
 A = ismember({'a','b','c',{'a'})
                           |
Error: Unbalanced or unexpected parenthesis or bracket.
```

  - And Matlab even tries to offer you a solution

```
Did you mean:
>> A = ismember({'a','b','c',{'a'}})
```

  - Unfortunately this is not always helpful

```
>> A = ismember({'a','b','c',{'a'}})
Error using cell/ismember (line 102)
Not enough input arguments.
```

MATLAB Debugging

- Common error messages

```
>> n = 9;
>> foo = zeros(n,1);
...
>> for i=1:10:
       bar(i) = foo(i);
   end
```

Error: Index exceeds matrix dimensions.

- Reason: foo only has 9 elements but the 10th is requested.
- Fix: either initialise foo with 10 elements or reduce the loop to 1:9

MATLAB Debugging

- Common error messages

```
>> linspace = 1:30;
>> square = linspace^2;

Error using  ^
Inputs must be a scalar and a square matrix.
```

- Reason: You cannot square a vector.
- Fix: What you can do is square each element of a vector with $.\hat{}$

MATLAB Debugging

- Common error messages

```
>> Variable1 = [];
>> Variable2 = [ 2, 3 ,4];
>> Variable1(2)  = Variable2;
Error: In an assignment  A(I) = B,
the number of elements in B and I must be the same.
```

- Reason: Only accessing 1 dimension of Variable1 and trying to assign 2-dimensional data.
- Fix: Depends on what is the desired outcome:
  - Assign Variable2 to Variable1
  - Assign a slice of Variable1 to contain the values of Variable2

MATLAB Debugging

- Common error messages

```
>> solfe('x-1 = 0','x')
Error: Undefined function 'solfe' for input arguments of type 'char'.
```

- Reason: Probably a typo and we wanted to call another function
- Fix: Matlab already suggests:

```
Did you mean:
>> solve('x-1 = 0','x')
```

MATLAB Debugging

- Common error messages

```
>> plot(1:9,2:11,'v--')
Error using plot
Vectors must be the same lengths.
```

- Reason: 1:9 is of length 9, while 2:11 is of length 10, so plot doesn't know which values correspond
- Fix: Correct the sizes of both vectors

MATLAB Debugging

- Common error messages

```
>> plot(1:9,2:10,'j--')
Error using plot
Error in color/linetype argument
```

- Reason: j is neither a colour indicator (only b,c,g,k,m,r,w,y) nor a marker specifier (various, have a look at the line specification on the mathworks reference website)
- Fix: adjust to the line format you actually wanted (like the above 'v--')

MATLAB Debugging

- How to track down the error - Options

  1.) Matlab Debugger

  - Convenient for complex problems
  - Offers information about all workspace variables
  - Can necessitate stepwise iteration of loops

  2.) “printf” debugging

  - Only shows what it was told
  - Output can be too big to interpret

Cell arrays and Indexing

- Cell arrays are a special instance of matlab types
  - Can contain any kind of data
  - Initialisation with :

```
>>A = {} % empty array of size 0
>>A = cell(n,m) % empty array of size n,m
```

  - Useful to store sets of strings

Cell arrays and Indexing

- Cell arrays can be accessed in two ways

  Cell Assignment:

  >>A(1) = X % X must be of type cell (and correct size)

  >>X = A(1) % X will be the cell contained at position 1 of A

  Cell Value Assignment

  >>A{1} = Val % Val can be anything

  >>Val = A{1} % Val will be the element contained in the cell at position 1 of A

Cell arrays and Indexing

- Wrong indexing/inconsistent sizes
  - Probably the most common error.

```
>> temp = cell(1,3);
>> temp{:} = 'a';
```

The right hand side of this assignment has too few values to satisfy the left hand side.

```
>> A = [1,2,3;4,5,6]
>> A(1:2,1) = [2,5,4]
```

Subscripted assignment dimension mismatch.

```
>>A([1,2]) = [2,5,4]
```

In an assignment A(I) = B, the number of elements in B and I must be the same.

Cell arrays and Indexing

- Applying functions to all entries of a cell array

  >>[Res1,Res2,...] = cellfun(@function , cellarray1, cellarray2,...)

  The function is applied to all entries in cellarray1, cellarray2 etc and the results stored in Res1, Res2 etc...

  - If the output is not necessarily uniform, the parameter pair 'UniformOutput',false needs to be added, but this always leads to a resulting cell array.