Matlab for Engineers: Debugging - warnings and errors

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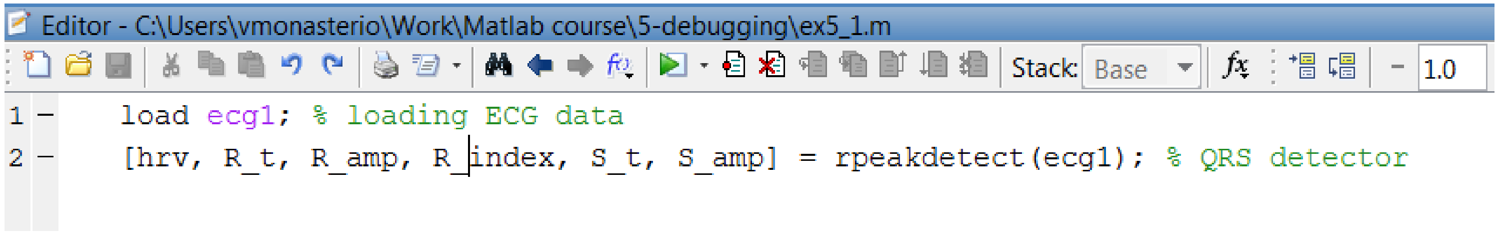
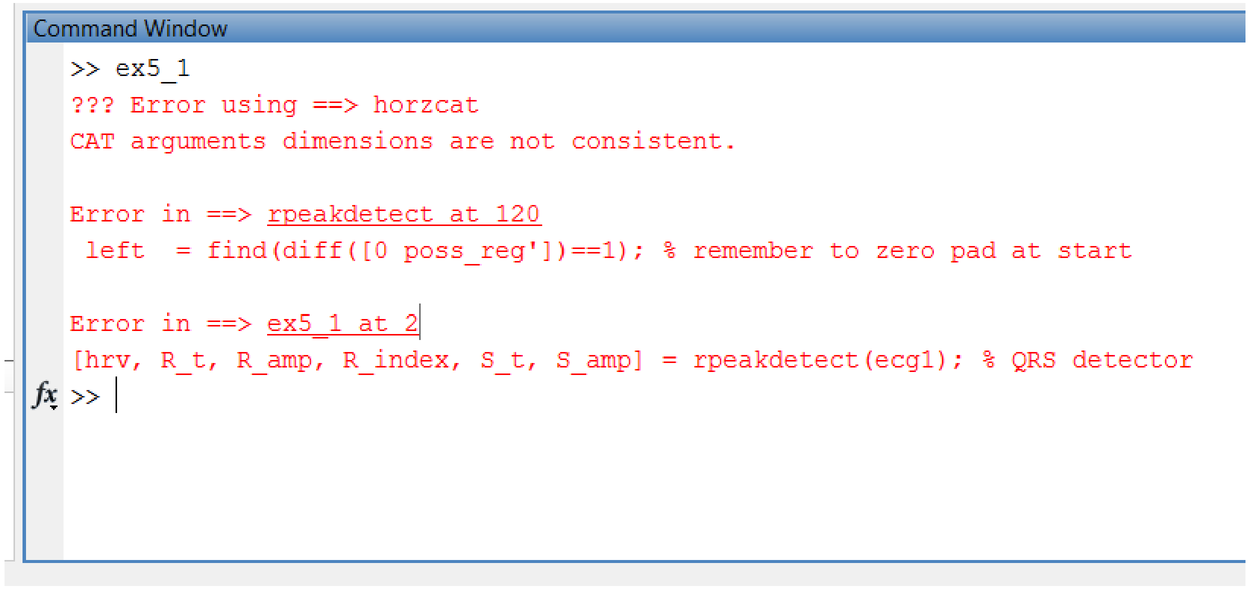
There are two types of errors

- Syntax errors: detected by matlab compiler
- Runtime errors: due to wrong logic used by the programmer:
  - Usually become apparent when one obtains erroneous or unexpected results
  - It is necessary to find the erroneous statements that caused the error: debugging

- Example:


Editor - C:\Users\vmonasterio\Work\Matlab course\5-debugging\ex5_1.m
Stack: Base
1.0

```
load ecg1; % loading ECG data
[hrv, R_t, R_amp, R_index, S_t, S_amp] = rpeakdetect(ecg1); % QRS detector
```



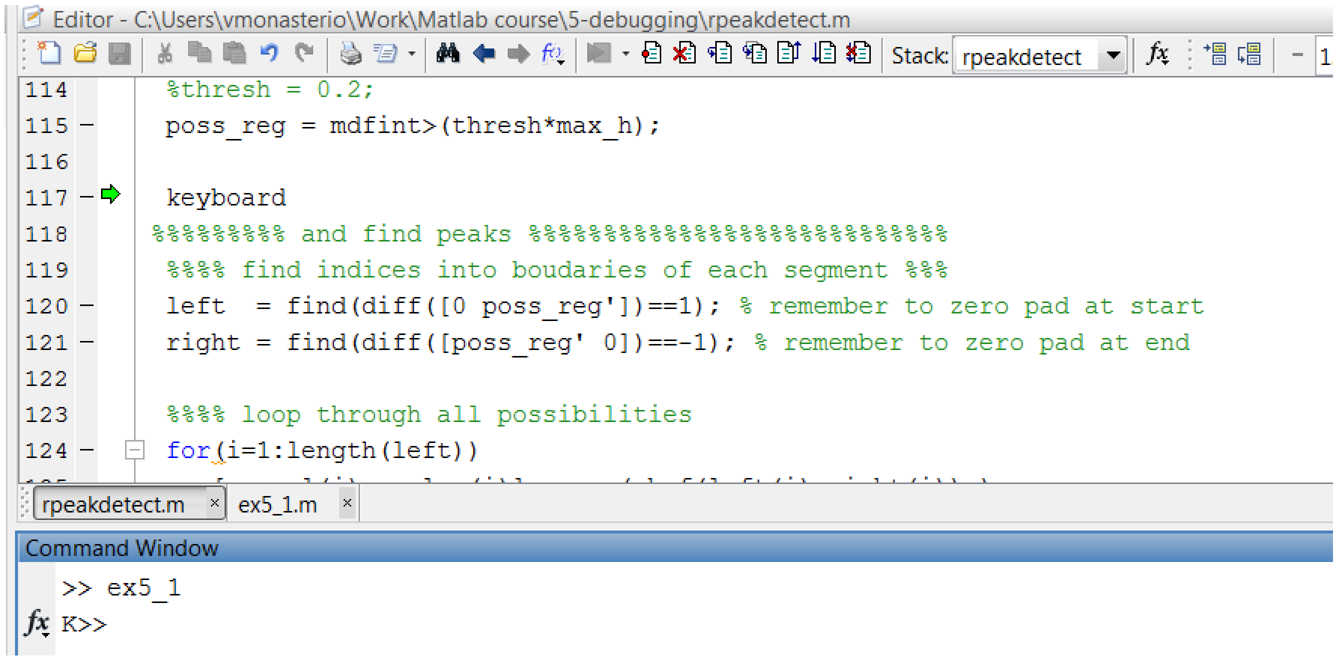
```
>> ex5_1
??? Error using ==> horzcat
CAT arguments dimensions are not consistent.

Error in ==> rpeakdetect at 120
 left  = find(diff([0 poss_reg'])==1); % remember to zero pad at start

Error in ==> ex5_1 at 2
[hrv, R_t, R_amp, R_index, S_t, S_amp] = rpeakdetect(ecg1); % QRS detector
>> 
```

Techniques to track down errors

- Use “Code Analyzer” (mlint)
- Removing / deleting semicolons
- Executing function as a script
  - The inputs can be fixed for which the results are known
- `Keyboard` statement
- Matlab debugger

Using the `Keyboard` statement

- `Keyboard` stops the execution
- Allows the programmer to examine the local workspace and execute statements from the command prompt `(whos, size,...)`

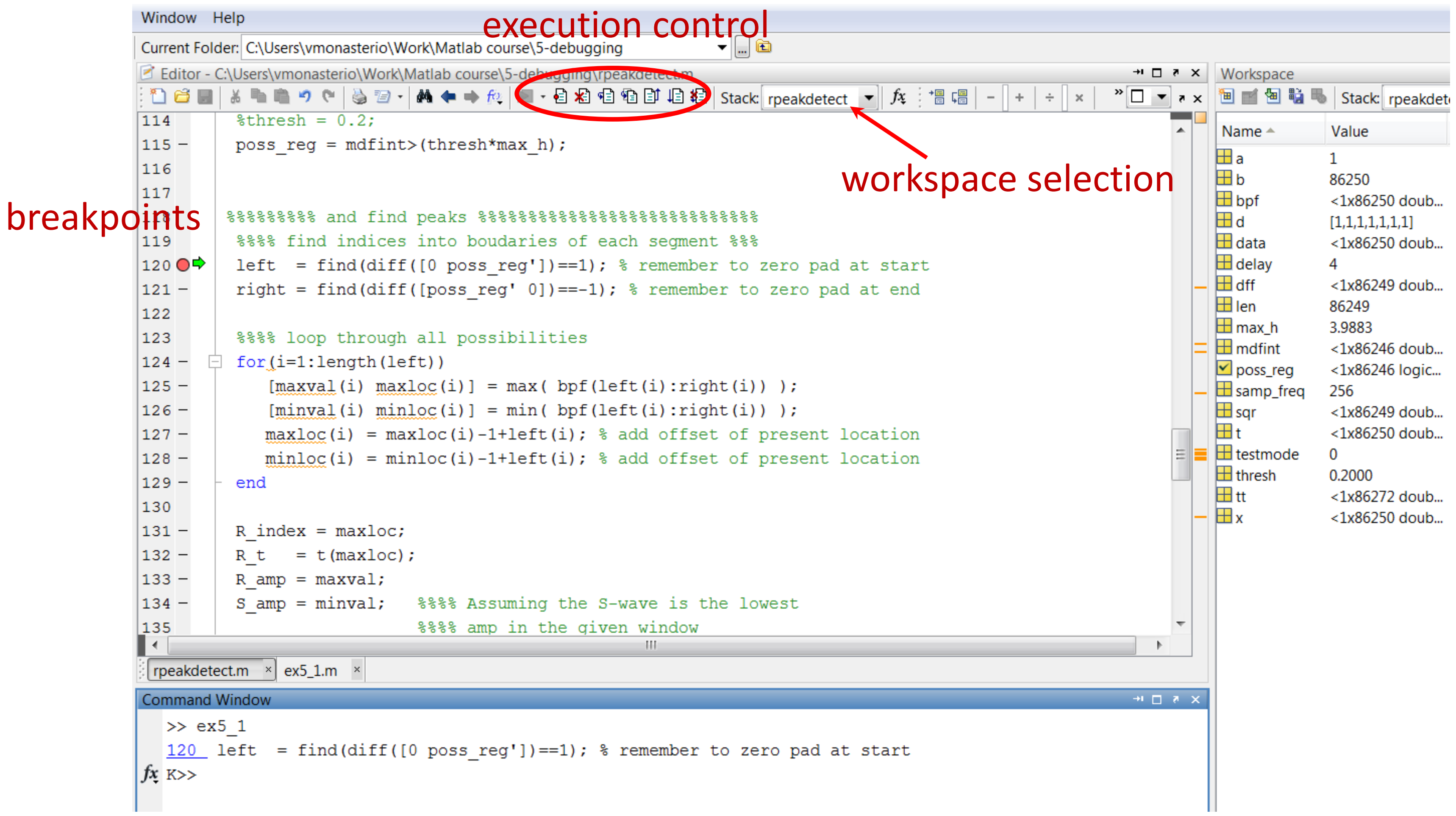


Editor - C:\Users\vmonasterio\Work\Matlab course\5-debugging\rpeakdetect.m
Stack: rpeakdetect
rpeakdetect.m
ex5_1.m
Command Window

```
 %thresh = 0.2;
 poss_reg = mdfint>(thresh*max_h);

 keyboard
%%%%%%%%% and find peaks %%%%%%%%%%%%%%%%%%%%%%%%%%%
 %%%% find indices into boudaries of each segment %%%
 left  = find(diff([0 poss_reg'])==1); % remember to zero pad at start
 right = find(diff([poss_reg' 0])==-1); % remember to zero pad at end

 %%%% loop through all possibilities
 for(i=1:length(left))
```

```
>> ex5_1
K>>
```

Using the debugger


Window
Help
execution control
Current Folder: C:\Users\vmonasterio\Work\Matlab course\5-debugging
Editor - C:\Users\vmonasterio\Work\Matlab course\5-debugging\rpeakdetect.m
Stack: rpeakdetect
workspace selection
breakpoints
Workspace
Stack: rpeakdet
rpeakdetect.m
ex5_1.m
Command Window

```
114     %thresh = 0.2;
115 -   poss_reg = mdfint>(thresh*max_h);
116
117
118    %%%%%%%%% and find peaks %%%%%%%%%%%%%%%%%%%%%%%%%%%%
119     %%%% find indices into boudaries of each segment %%%
120 ●   left  = find(diff([0 poss_reg'])==1); % remember to zero pad at start
121 -   right = find(diff([poss_reg' 0])==-1); % remember to zero pad at end
122
123     %%%% loop through all possibilities
124 -   for(i=1:length(left))
125 -       [maxval(i) maxloc(i)] = max( bpf(left(i):right(i)) );
126 -       [minval(i) minloc(i)] = min( bpf(left(i):right(i)) );
127 -      maxloc(i) = maxloc(i)-1+left(i); % add offset of present location
128 -      minloc(i) = minloc(i)-1+left(i); % add offset of present location
129 -   end
130
131 -   R_index = maxloc;
132 -   R_t   = t(maxloc);
133 -   R_amp = maxval;
134 -   S_amp = minval;   %%%% Assuming the S-wave is the lowest
135                     %%%% amp in the given window
```

Name	Value
a	1
b	86250
bpf	<1x86250 doub...
d	[1,1,1,1,1,1]
data	<1x86250 doub...
delay	4
dff	<1x86249 doub...
len	86249
max_h	3.9883
mdfint	<1x86246 doub...
poss_reg	<1x86246 logic...
samp_freq	256
sqr	<1x86249 doub...
t	<1x86250 doub...
testmode	0
thresh	0.2000
tt	<1x86272 doub...
x	<1x86250 doub...

```
>> ex5_1
120   left  = find(diff([0 poss_reg'])==1); % remember to zero pad at start
K>>
```

Debugging from the command line

Command	Description
`dbstop`	set breakpoint
`dbclear`	clear breakpoint
`dbclear all`	clear all breakpoints
`dbstop if`	stop on warning, error or NaN/Inf
`error`	NaN/Inf generation
`dbstep`	single step execution
`dbstep in`	step into a function
`dbstep nlines`	execute one or more lines
`dbcont`	continue execution
`dbquit`	quit debugging
`dbstack`	list function call stack
`dbstatus`	list all breakpoints
`dbtype`	list M-file with line numbers
`dbdown / dbup`	change local workspace down / up

Preventing common errors

- Avoid dividing by zero: `1/x` → `1/(x + eps)`
- Default `else` for `if-elseif`,
  Default `otherwise` for `switch-case`

```
if condition1,
    statement1;
elseif condition2
    statement2;
...
elseif conditionN,
    statementN;
else default_statement
end
```

Preventing common errors

- Check inputs: number, type, size
  - assume default values where possible
  - if a required input is missing: throw error and exit (`assert`)

```
function write2file(varargin)
min_inputs = 2;
assert(nargin >= min_inputs, 'You must call function...
       %s with at least %d inputs', mfilename, min_inputs)

infile = varargin{1};
assert(ischar(infile), 'First argument must be a filename.')

fid = fopen(infile, 'w');
assert(fid > 0, 'Cannot open file %s for writing', infile)

fwrite(fid, varargin{2});
```

Handling errors

- Try / catch block

```
try
    [hrv, R_t] = rpeakdetect(ecg1); % QRS detector
catch err
       if(strcmp(err.identifier,...
              'MATLAB:catenate:dimensionMismatch'))
       try % try again with transposed input
            [hrv, R_t] = rpeakdetect(ecg1);
        catch
            rethrow(err) % rethrow original error
        end
    end
end
```

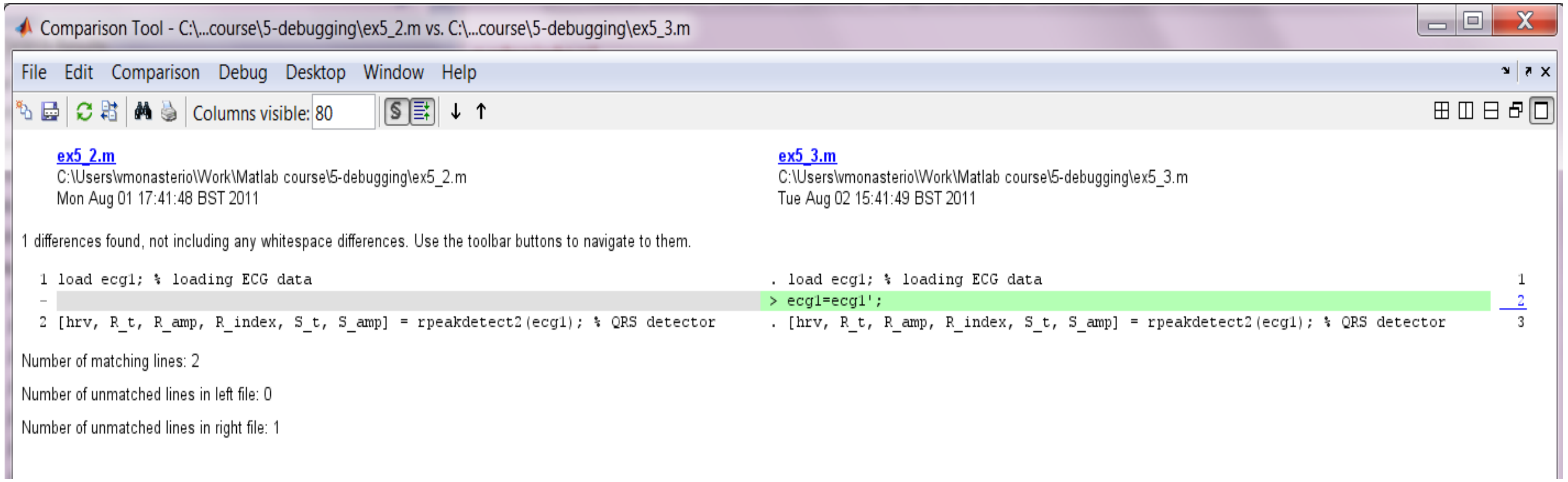
Keeping things tidy `(onCleanup)`

- Leave your program environment in a clean state:
  - close any open files
  - restore the MATLAB path
  - set the working folder back to its default
  - make sure global variables are in the correct state

```
function openFileSafely(fileName)
fid = fopen(fileName, 'r');
c = onCleanup(@()fclose(fid));
s = fread(fid);
     .
     .
     .
end
```

Other tools

- In the editor -> Tools -> Compare against
  - compares M-files, MAT-files and directories


Comparison Tool - C:\...course\5-debugging\ex5_2.m vs. C:\...course\5-debugging\ex5_3.m
File Edit Comparison Debug Desktop Window Help
Columns visible: 80

ex5_2.m
C:\Users\wmonasterio\Work\Matlab course\5-debugging\ex5_2.m
Mon Aug 01 17:41:48 BST 2011

ex5_3.m
C:\Users\wmonasterio\Work\Matlab course\5-debugging\ex5_3.m
Tue Aug 02 15:41:49 BST 2011

1 differences found, not including any whitespace differences. Use the toolbar buttons to navigate to them.

```
1 load ecg1; % loading ECG data                                          . load ecg1; % loading ECG data                                          1
-                                                                        > ecg1=ecg1';                                                            2
2 [hrv, R_t, R_amp, R_index, S_t, S_amp] = rpeakdetect2(ecg1); % QRS detector   . [hrv, R_t, R_amp, R_index, S_t, S_amp] = rpeakdetect2(ecg1); % QRS detector   3
```

Number of matching lines: 2

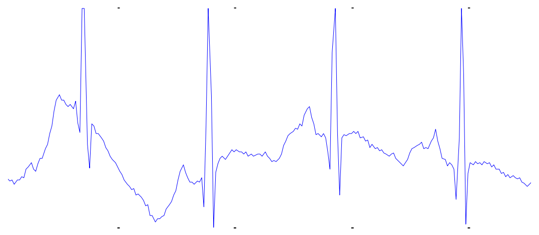
Number of unmatched lines in left file: 0

Number of unmatched lines in right file: 1

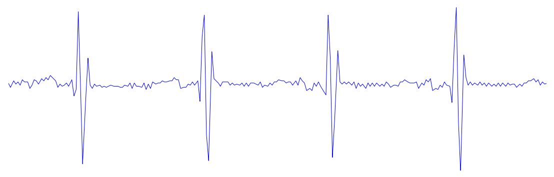
Practice: QRS detector

`(practice_5.m)`

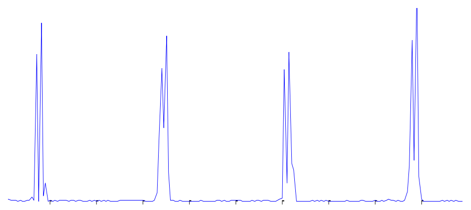
1. Low-pass filter



2. Derivation



3. Squaring



4. Integration
5. Thresholding