Lecture 8: Debugging

University of Colorado Boulder

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Outline

- Types of errors
- Examples
- How to use the debugger function in

"Bugs"

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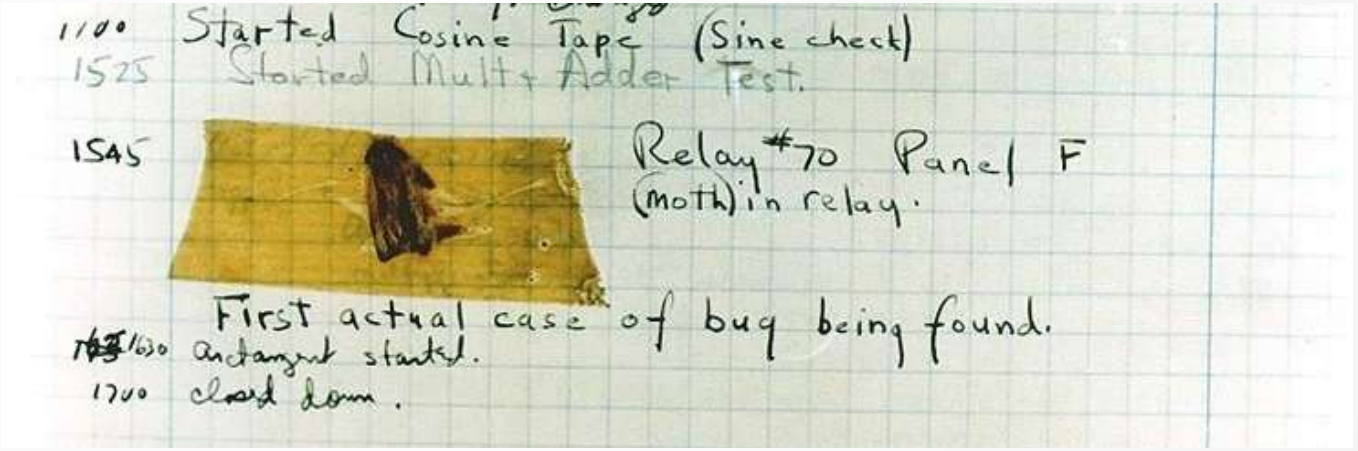


An incident at Harvard Mk II that led to the phrase "bug" being popularized by RDML Grace Hopper

"Bugs"

- Bugs are errors in computer code
- There are three different categories of errors:
  - Syntax errors
  - Runtime errors
  - Logic errors

Syntax errors

- Incomplete commands, e.g. missing brackets, parentheses
- Will be detected by MATLAB's built-in Code Analyzer **before** it runs the script

Examples

```
A = [1 2 3
```

Missing closing] bracket

```
B = min(A
```

Missing closing) parentheses

```
B = min(A,)
```

Missing argument? Or additional comma

Runtime errors

- Errors that are **NOT detected** by MATLAB **until it runs the code**

- Causes program to terminate abnormally (but previous lines are executed)

Examples of runtime errors

```
A = [1 2 3 4];
A(5)
```

Indexing a non-existent element

```
A = [1 2 3 4];
A(1) = 1:3
```

Assignment size mismatch

```
A = 10
B = 20
C = [a b]
```

Misspelled/Capitalized variables

```
C = mni(B)
```

Misspelled functions

Logic errors

- Errors that are **not detected** by MATLAB before running, and **do not cause the program to terminate abnormally**

- Results in incorrect operation (e.g. undesired/unintended outputs of behavior)

- These are the hardest to find

Examples of logic errors

```
A = [1 2 3; 4 5 6]
minRowsA = min(A, 2)
```

Incorrect argument
Check documentation

```
average = 1 + 2 + 3/3
```

Error in operator precedence

```
%Compute sine of 32 degrees
sin(32)
```

Incorrect units
Check documentation

Other mistakes to look out for

- Using the wrong type of operator (e.g. matrix instead of array)
- Entering equations incorrectly
- To minimize these, **test, test, test** your code
  - Use the "comment" function of the editor to comment blocks of code to test
  - If you can't find the error, talk to your classmates, reach out to us

Warnings

- Highlighted by the Code Analyzer in the editor
- May or may not cause errors
- Examples:
  - Unused variables
  - Not terminating lines with semicolons
  - Growing arrays in loops (we'll see this later in the course)

Questions?

Debugging code

- Access the debugger by setting a breakpoint or using the keyboard command

`keyboard`

Keyword. Pauses execution and enters the debugging mode

Which of the following indicates that MATLAB is in debugging mode?

a) The prompt in the Command Window shows `K>>`

b) The status bar says "Paused in debugger"

c) The Run buttons in the Editor have changed to Debug

d) The code seems to have stopped running

e) All the above

In debugging mode

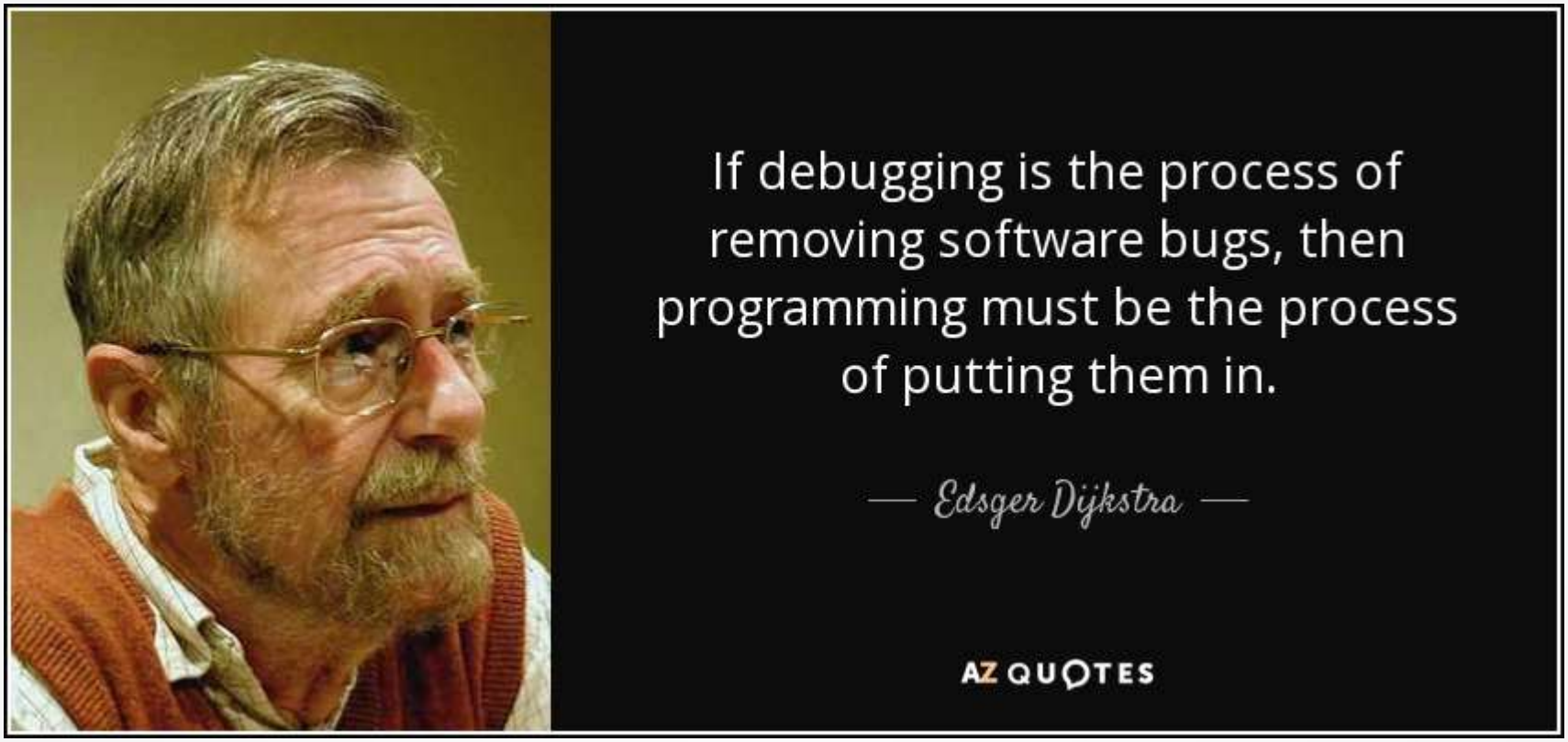
you can inspect, add, and modify variables

These changes are permanent in the workspace when debugging scripts

Debug functions

- `dbcont` – Continue code execution until the next breakpoint or end of file
- `dbstep` – Executes current line of code
- `dbquit` – Exits debugging mode

Questions?


If debugging is the process of removing software bugs, then programming must be the process of putting them in.
— Edsger Dijkstra —
AZ QUOTES

Tips for programming

- Plan out your program
  - Write down steps, equations
- Write and **test** your code in chunks
  - Mistakes in code will be harder to find later
- Document your code
  - Use comments to explain WHY the code exists and HOW it works

Summary of Section 1: Introduction to MATLAB

- Important elements of the graphical interface
  - Command Window
  - Workspace
  - Current Folder
  - Editor
  - Figure Window

Summary of Section 1: Introduction to MATLAB

- Important elements of the graphical interface
- Matrices
  - How to declare matrices
  - How to index: subscript and linear indexing
  - How to modify and delete
  - How to concatenate (join) matrices together

Summary of Section 1: Introduction to MATLAB

- Important elements of the graphical interface
- Matrices
- Writing and debugging code