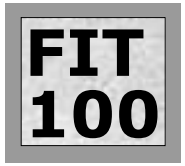
When Trouble Comes: The Basics of Debugging



No one is capable of writing a flawless program of more than several lines on the first try. Therefore, algorithm design, programming and any other logical activity will require debugging or trouble shooting. Though debugging is very case-specific, there are some principles.

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Bugs vs Faults

- When the car doesn't start because of a dead battery, figuring out the problem uses debugging skills … but it is not technically debugging, but rather "fault identification"
  - When the error is a failing component of a correct design, it is a fault … when the battery is fixed the car runs
  - When the error is a failure of the design, it is a bug
- While programming the chances are overwhelming that the error is a bug, since you've likely made a reasoning error
- In "mature" systems it could be either one since the error could be a fault or a latent logical error

It is impossible to say that a program is perfectly correct

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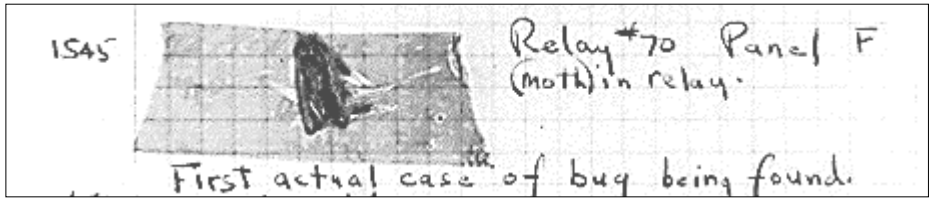
The First Computer Bug Was A Moth

- The term “bug” for a computer glitch was coined by Adm. Grace Murray Hopper when working on the Harvard Mark II computer



The moth was found in Relay #70 -- an electro-mechanical switch -- and taped into the logbook with the caption “First actual case of a bug being found”

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A Word Of Warning ...

- Sometimes when solving a problem, it is tempting to skip working out all of the logical details and go directly to the programming ⇒**MISTAKE**⇐
- Sometimes when programming, it is tempting to skip working out all of the logical details and plan to "fix them up" when debugging ⇒**MISTAKE**⇐

There is no substitute for reasoning in algorithm or program design; it must be done eventually, and *it is always easier earlier in the process*

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When Debugging, Think Abstractly

- Debugging is like solving a mystery … except you don't want to know who dunit, so much as what dunit
- An effective way to proceed is to …

> Watch yourself debug

- Think about what you know … the facts
- Consider what should be true … the assumptions
- Formulate a test hypothesis … gather evidence
- Work intelligently … assess if you're making progress

> Though debugging can be frustrating, many times the "solving a mystery" aspect of it is rewarding.

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Guidelines For Debugging

- There is no recipe for successful debugging because every situation is different … but there are guidelines

1. Verify that the error is reproducible, i.e. make it happen again
   - "Transient errors" can occur
   - The error may have been caused by a state or configuration that was unknowingly set … get a "clean" instance of the bug
   - When reproducing the error, try to formulate a "minimal" version of the system or program with the bug

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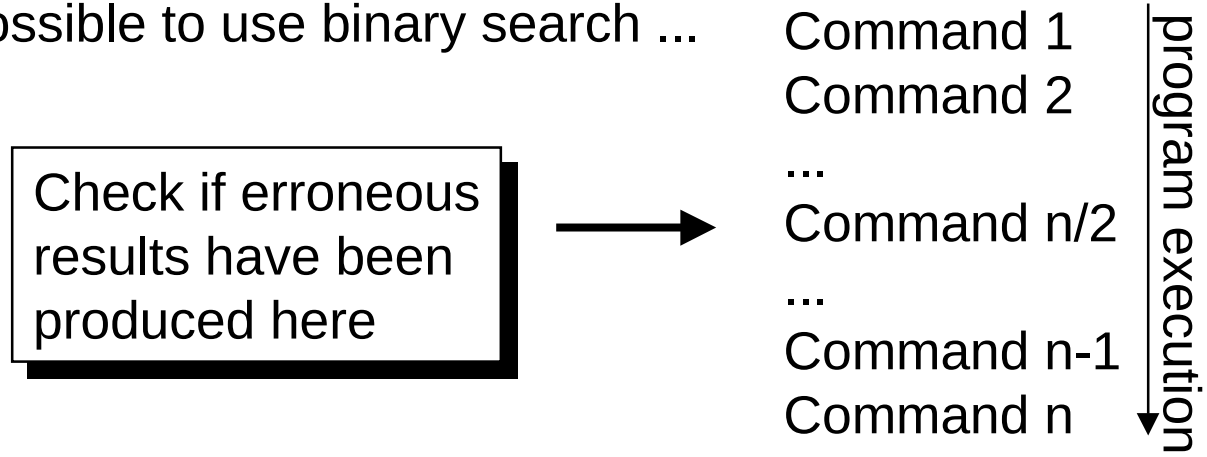
Guidelines -- Check obvious

2. Check for the “obvious” problems
   - Verify that the inputs are as required -- case, syntax, etc.
     - Are there 0-O 1-l I-l or other substitution mistakes
   - If there are multiple components or files in the buggy system, establish that these are properly “connected”
   - Has anything been changed recently
   - When there are multiple inputs, does the order matter
   - In programming, are all variables ...
     - Declared
     - Initialized

The chances that the problem is something “obvious” are small because if it were so “obvious” you would have already found the problem … but you must check

FIT 100 Guidelines -- Isolate error

3. Isolate the problem -- since the error is likely located in a specific place in the system or program, large sections of it are correct and should be removed from consideration
   - Isolating the problem to a specific procedure is best
   - Verifying that parts thought to be correct are correct is essential
   - It is even possible to use binary search ...



FIT 100 Guidelines -- Step through process

4. Once the error is isolated, reason through the process start-to-finish, predicting what should be computed and then verifying that it has been
   - When a prediction is inconsistent with an observation, the problem has been further isolated to the current step
     - The process was OK prior to this step
     - The process is incorrect after this step
   - Check the inputs and reason through the step
   - If bug not found, continue applying the guidelines

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Guidelines -- Assess Objectively

5. It frequently occurs that everything checks out and is found to be OK … but the bug still persists

   Don’t become frustrated. Rather, evaluate your progress objectively ... how are you doing

   - ❑ Are you making a wrong assumption
   - ❑ Do you misunderstand what the data means
   - ❑ Have you made a wrong deduction

> Remember … it’s a mystery and you are Jane Marple or Hercule Poirot … using those “little gray cells” you can find the culprit

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VB6 Assistance in Debugging

- Visual Basic assists you in avoiding bugs (Option Explicit) and in finding bugs with *breakpoints*
- A breakpoint stops the program execution at a designated location so you can examine the variable's values

Demo of Breakpoints