How to Find a Bug

Debugging Approaches

There are two parts to debugging, the locating and fixing of bugs. We'll look at locating the bugs first, so if the program runs but doesn't give us the results we are expecting, there is some error in the code that we need to find. The computer is only doing what it is told, so there must be a wrong instruction somewhere. There are a number of debugging approaches that can be taken to find that instruction:

- ***Brute Force Approach***: The is probably the most common approach to debugging, and it typically involves adding a number of `PRINT` statements throughout the program to determine the values of variables in different parts of the program, to see if it possible to locate the cause of the error. There are also tools that can be used in this approach, these include both tracing tools and debugging tools.
- ***Backtracking Approach***: The backtracking approach is exactly what it sounds like, you start at the end of the program where the results are being printed out from, and go backwards, manually reviewing each important line to see if it is correctly written, until the wrong instruction is found.
- ***Cause Elimination Approach***: This approach involves creating a list of possible causes (or hypothesis) for the error, and initial tests are carried out to eliminate each hypothesis. Of the ones that cannot be eliminated in the initial testing, further tests are carried out to eliminate more and more hypotheses, until there is only one cause left. The error is then located.

One More Thing….

This may be just me, but when I'm trying to debug a program, and I don't feel like I'm making progress; sometimes if I recite a verse of poetry, or part of a song, and I do that a couple of times, and it gives me the fortitude to continue and succeed. The two verses below are the ones I most commonly use, if it's any help.

There's nothing you can do that can't be done
Nothing you can sing that can't be sung
Nothing you can say, but you can learn how to play the game
It's easy

From the song "All You Need Is Love" by John Lennon and Paul McCartney (1967)

Great bugs have little bugs upon their backs to bite 'em,
And little bugs have lesser bugs, and so ad infinitum.
And the great bugs themselves, in turn, have greater bugs to go on;
While these again have greater still, and greater still, and so on.

"Siphonaptera" from Augustus De Morgan's *A Budget of Paradoxes* (1872)