What Makes Program Reasoning Harder

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Mistakes that make reasoning harder

Beginners often commit some common mistakes that make reasoning of programs harder. These mistakes later turn into deeply ingrained habits that become doubly harder to unlearn.

- Spaghetti code
- Side-effects
- Duplicate code
- Unconditional jumps
- Programming by permutation
- Too many variables
- Redundant code
- Lack of modularity
- Lack of indentation

Note:

- This list is not exhaustive. You may refer to various resources in the web for tips for healthy programming.
- The scope of this list is based on the fact that you have learnt only C language.
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Bottomline: Badly written code ⇒ Difficult to reason
Spaghetti code

Refers to long code with no or little software structure. They are difficult to comprehend and maintain. This kind of coding style is more common among beginners.

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Recommendation

- Decompose code into smaller meaningful units (functions).
- Each function must implement exactly one functionality.
- Functions can delegate part of their job to other functions thus forming a hierarchical structure.
Side effects

Refers to modifying state of a variable outside its local environment. i.e. another effect besides the main effect. In the presence of side effects, a program’s behaviour may depend on history.

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```c
int y = x++; assign + increment
```

```c
int a = 0;
int foo(int b) {
    return b*b + a;
}
void bar() {
    scanf("%d", &a);
}
```

⇒

```plaintext
foo’s return value depends on global variable a. For same b, foo returns different values influenced by bar.
```
Duplicate code

Also known as copy-paste code, refers to a statement or a block of statements that is replicated at multiple sections in the code. Any change or correction in one must be carried out in each replica.

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**Recommendation**

- **Mantra**: Define once and reuse as many times necessary.
- Replace occurrences of an oft used value by a variable.
- Define a function for oft performed computation and call it whenever required.
Use of \texttt{goto} makes the control jump to random points in the code. This severely makes the reasoning difficult.

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Program using \texttt{goto}

```c
int a, b;
a = 1;
L1: a++;
b = 2 * a;
if (b > 100)
    goto L2;
goto L1;
L2: printf("%d", b)
```
Programming by permutation

Refers to the approach of writing program with poor understanding and making incremental changes (try different permutations) to test for desired behavior. It gives no assurance of program quality.

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Known by other names

- Programming by accident
- By-try programming
- Shotgunning
- Trial-and-error
- Poke-and-hope
- Bird-shot method
- Million monkeys style
Too many variables

Use of too many variables usually means increased interdependencies between them. As variables change their states often, they affect each other making analysis complex.

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**Recommendation**

- Avoid using global variables.
- Decompose program into several smaller functions.
- Each function with its local variables implements a single functionality.
Redundant code

Refers to code that will not be executed (unreachable), no more in use (dead) or repeat computation (recomputation). These are more of a distraction.

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```
#define min(x,y) x <= y ? x : y
```

#define causes repeat code
Lack of modularity

Modularity refers to code that is partitioned into logical units where each unit implements a set of closely interrelated functionalities and interact with other units by well-defined interfaces.

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Units can be objects, modules, files, packages or libraries.

Units are hierarchically arranged to build layers of abstractions.

Care should be taken to ensure a unit does not implement unrelated functionality.

Note, for I/O operations you included stdio.h, for Math operations, math.h.
Lack of indentation

Indentation helps better convey the structure of a program to human readers and therefore easy to comprehend and analyze. However, automated reasoning does not benefit from indentation.

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For a comprehensive discussion on indentation of C programs you may please refer to https://www2.cs.arizona.edu/mccann/indent_c.html.