

# Cost of Your Programs

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In the class, we have defined the RAM computation model. In turn, this allowed us to define rigorously **algorithms** and their **cost**.

In reality, we do not write programs under the RAM model—instead, we do so in a programming language like C++, JAVA, Python, etc. Thus, how would you measure the cost of your programs? Also, what are the connections to the RAM model?

This side talk will clarify these issues.

## Measuring the Cost of Your Program

Rule of Thumb:

Count the number of statements executed.

In other words, to make your program fast, minimize the number of statements that need to be run.

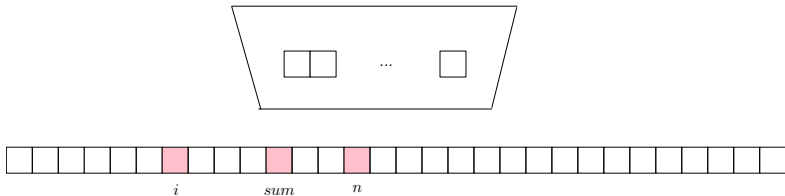
## Example

```
int i = 0;
int n = 100;
int sum = 0;
for (i = 1; i <= n; i ++) {
    sum = sum + i;
}
return sum;
```

Number of statements executed =  $3n + 5$  (in this example,  $n = 100$ ).  
This is an accurate indication of the cost of your algorithm in the RAM model, up to only a **constant factor**.

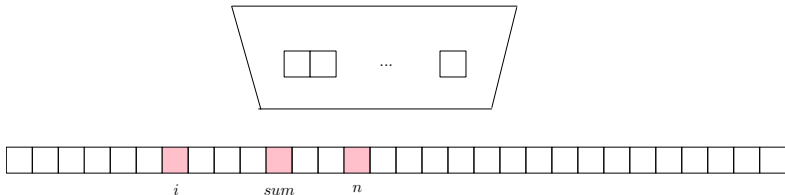
The next slide explains why.

## Example



When your program is executed, the computer (the real one where your program is run) assigns a memory cell for each variable. The figure above shows an example—note that the 3 memory cells can be anywhere, and in any order.

## Example

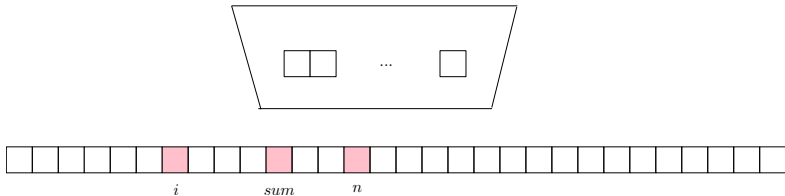


A statement like  $i = 0$  gets **automatically** translated into a sequence of atomic operations in the RAM model, e.g.:

```
set Register 1 to value 0
set Register 2 to value the address of i
write the contents of Register 1 into memory cell i
```

In this example, the statement  $i = 0$  entails a cost of 3 in the RAM model.

## Example



As another example, statement  $sum = sum + i$  may get translated into 6 atomic operations:

```
set Register 1 to the address of i
load i into Register 2
set Register 1 to the address of sum
load sum into Register 3
Register 3  $\leftarrow$  Register 2 + Register 3
write the contents of Register 3 into memory cell sum
```

## Who Does the Translation?

The **compiler**.

When you are coding, you are writing in a so-called “high level language” where each statement encapsulates multiple atomic operations, so that you do not need to worry about the low-level details such as registers.

When you are done, the compiler does the dirty work by transforming your code into a form that can actually be executed—perhaps you have heard about the name of that “form”: the **assembly language**.