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 basic statements executed.

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

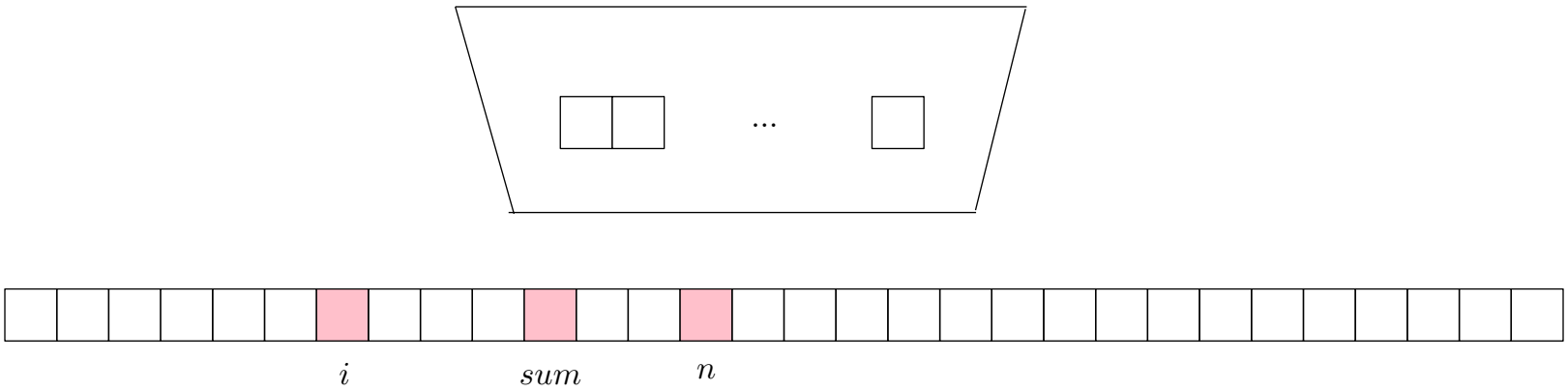
Example

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

Number of basic 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.

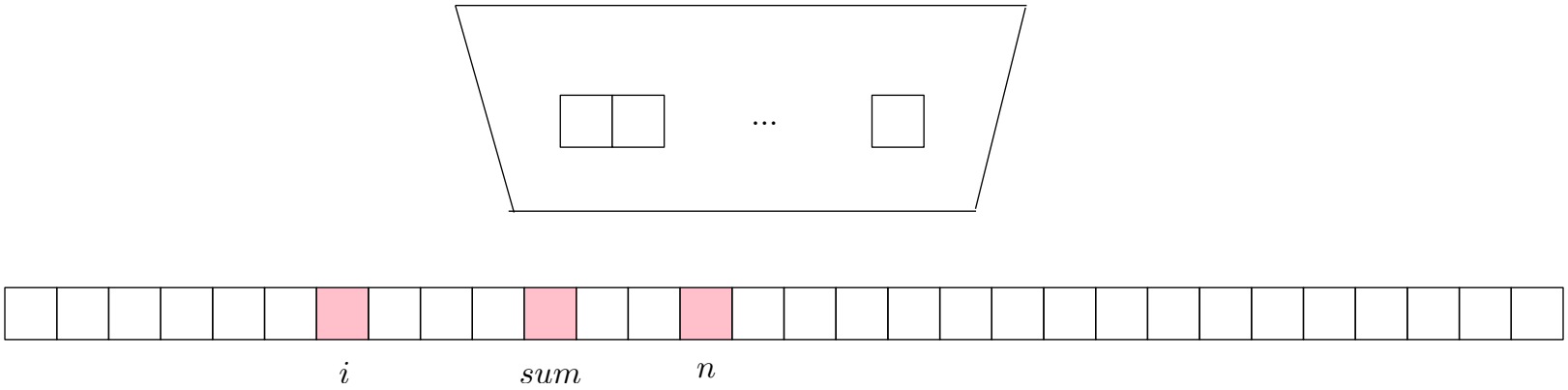
The next slide explains why.

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

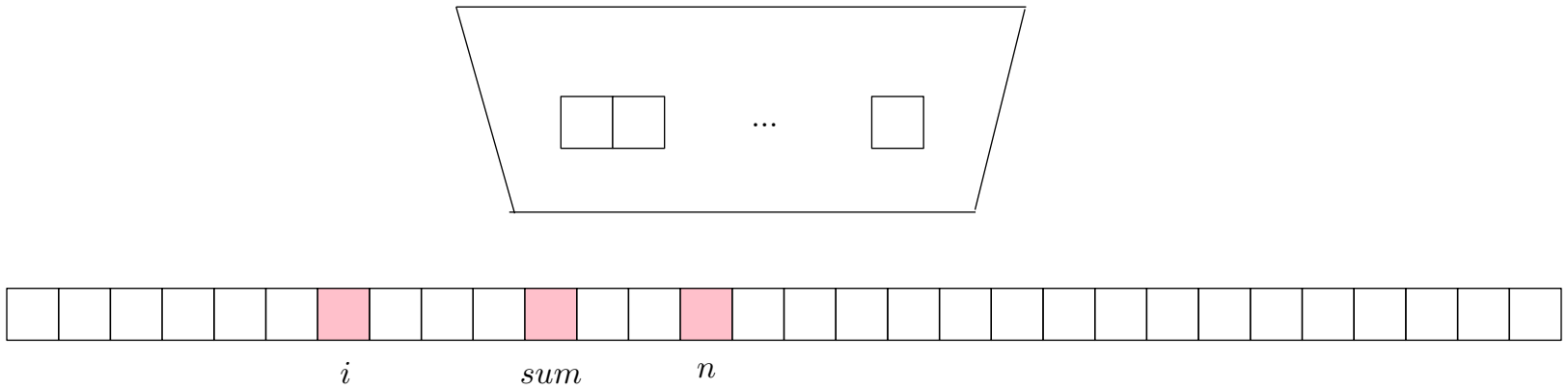


A statement like `i = 0` gets automatically translated into a sequence of atomic operations in the RAM model, e.g.:

```
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 ← 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.