Time to Write Another Program

Let’s say that we want to do the following:
- given an ASCII string (a sequence of characters terminated by a NUL, ASCII x00),
- count the occurrences of each letter (regardless of case), and
- count the number of non-alphabetic characters.

Let’s Develop a Flow Chart

Ready?
My work here is done.
Now you can apply systematic decomposition.

What’s a histogram?
A function on a set of categories.

These Are Examples of Histograms
We Need to Count Each Kind of Letter

So we want a set of counts for a string:
- How many A's (either case)?
- How many B's?
- ...
- How many Z's?
- How many non-alphabetic characters?

How would you perform this task?

Let's Do an Example

“Try this string as an example.”

How many A's? 3
How many B's? 0
How many C's? 0
How many D's? 0
How many E's? 2

Algorithm 1: Look Through String Once for Each Letter

Maybe something like this?

for each letter (and once for non-letters)
    count = 0
    for each character in the string
        if character matches letter (either case)
            count = count + 1
    store count for the letter in histogram

Another Example: a Book

Second example: the Patt and Patel textbook.

How many A's? 61,341
How many B's? 10,821
How many C's? Do you really think
How many D's? I counted these?
How many E's?

Would you approach the problem differently with a longer string?
Algorithm 2: Look through String Once

For a longer string, maybe we just want to look through it once?

initialize 27-bin histogram to all 0s
for each character in the string
increment the appropriate histogram bin

But figuring out which bin to increment may be complicated.

Algorithm 3: Build a Bigger Histogram

What if we build a bigger histogram first:
initialize 128-bin histogram to all 0s
for each character in the string
increment bin for that character for each letter
add the two corresponding bins
sum all non-letter bins
Now finding the bin is easy, but we need extra memory and computation.

Which Algorithm is Best?

Which approach is better?
What is the metric?
• Number of instructions executed?
• Number of clock cycles (time) required?
• Amount of memory needed?
Does our answer depend on the length of the string?
What if the string is sorted alphabetically?

Let’s Pick Algorithm 2

The answer depends on the context and the application of our program.
We’re going to go with Algorithm 2:
initialize 27-bin histogram to all 0s
for each character in the string
increment the appropriate histogram bin
Why? Implementing the complex decision in the middle will be interesting.