University of Illinois at Urbana-Champaign
Dept. of Electrical and Computer Engineering

ECE 120: Introduction to Computing

Letter Frequency Planning

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

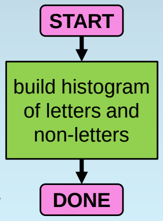
Ready?

My work here is done.

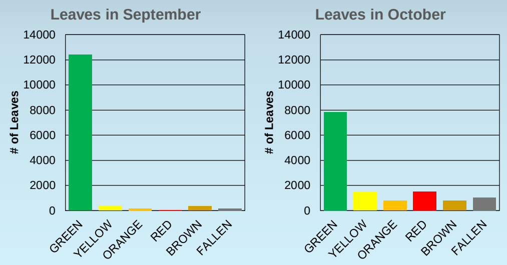
Now you can apply **systematic decomposition**.

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

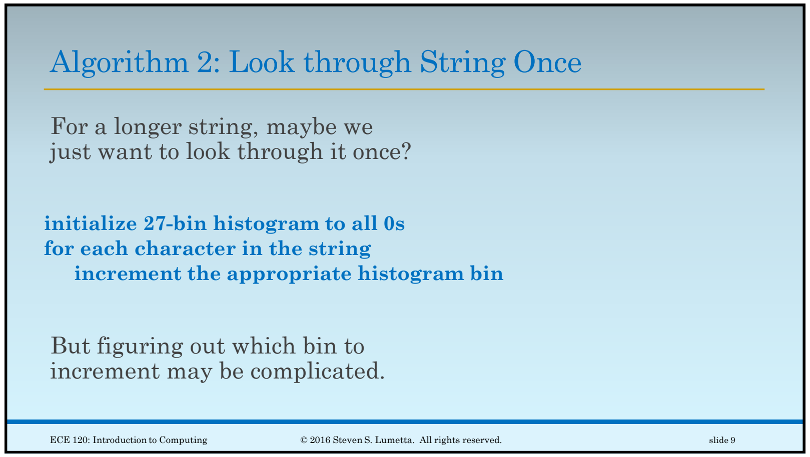
How many B's? 10,821

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?

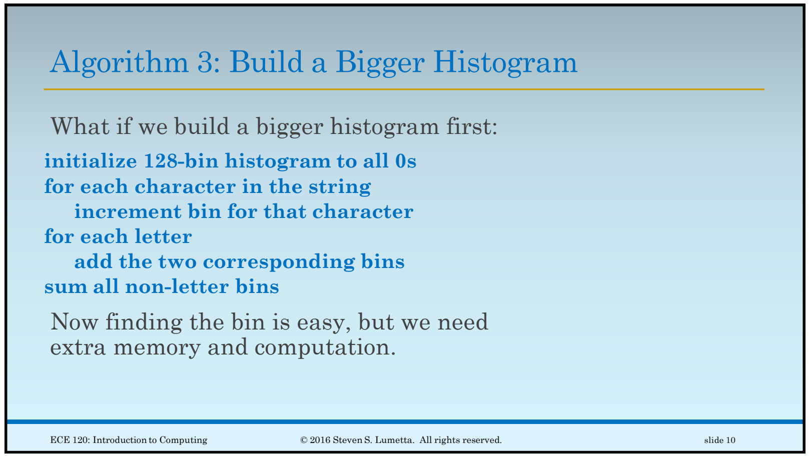


Algorithm 2: Look through String Once

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.

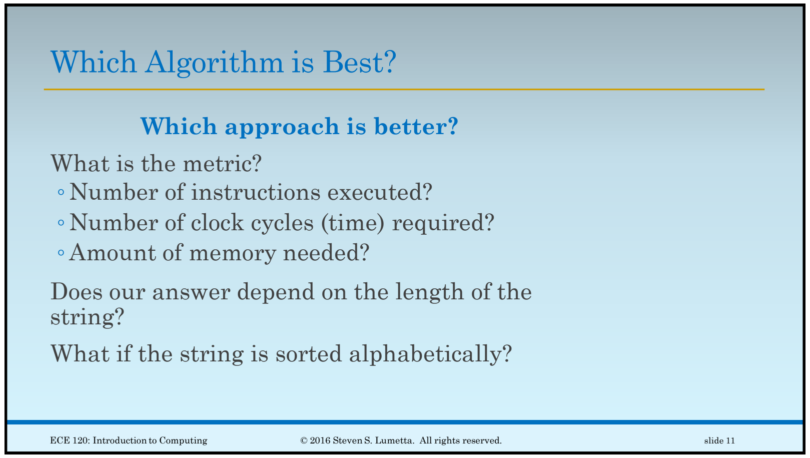


Algorithm 3: Build a Bigger Histogram

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.



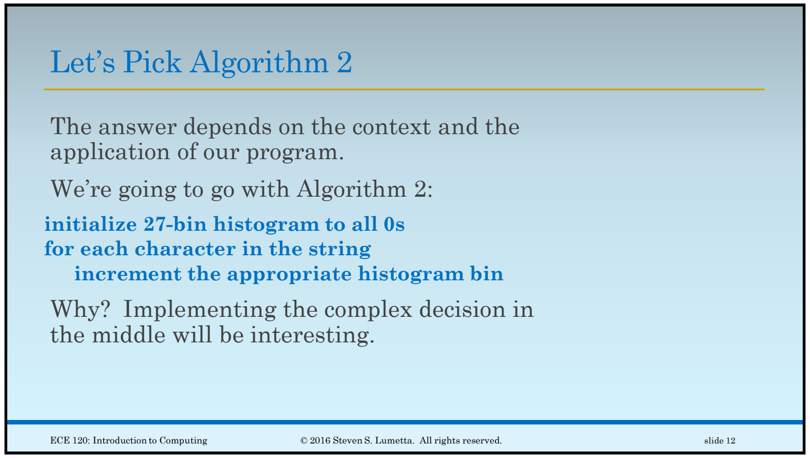
Which Algorithm is Best?

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.