Lend Me Your Brains for a Minute?

I had a busy break.
I need to ask your help.

Can you help me sort these numbers?

“41,962” “41321” “9874”
biggest middle smallest

Are You Sure About Your Answers?

Hmm. Are you sure?
I just ask because, well ...
I asked my computer, too.
And it gave different answers:
“41,962” “41321” “9874”
humans biggest middle smallest
computers smallest middle biggest

A Side-by-Side Comparison of the Numbers

Let’s compare them side by side.

41,962
41321
9874

What’s bigger, “4” or “9”?
Oh, so “9874” is the biggest!
Please be more careful when you help me!
A Side-by-Side Comparison of the Numbers

What's the next largest?
- 41,962
- 41321
- 9874

“4” is equal to “4.”
“1” is equal to “1.”
What’s bigger, “,” or “3?”
Ah, so “41321” is the middle value. Good.

So the Computer is Right?

It seems that the computer is right.
At least, for some definition of “right.”
This type of answer is what you get if you sort strings in ASCII order (instead of numerical order).

humans biggest middle smallest
computers smallest middle biggest

Remember: Computers are Dumb

Think it’s just a silly example?

Take a look at the index of Patt and Patel.
Should “EXTERNAL” come before “Equality?”

“ASCII” before “Address?”

Computers do exactly what they are told.

Another Example: Adding Strings

Here’s a software representation for a string of text (the string is “19”).
The address of the first ASCII character in memory, x4012, is used to represent the string.

<table>
<thead>
<tr>
<th>Address</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>x4012</td>
<td>x0031</td>
</tr>
<tr>
<td>x4013</td>
<td>x0039</td>
</tr>
<tr>
<td>x4014</td>
<td>x0000</td>
</tr>
</tbody>
</table>

To “read” the string,
- look at consecutive memory locations
- until we find a 0 (an ASCII NUL character),
- which indicates the end of the string.
Can We Add Two Strings?

Here's another string. x4012 x0031 '1'
What is it? “23” x4013 x0039 '9'
Say that the LC-3 executes:

R1 ← x4012
R2 ← x7196
R3 ← R1 + R2

What is R3? xB1A8

What is stored at xB1A8? Bits!

You Understand Why Adding Addresses Doesn’t “Work”

Obviously, if we want to add two strings that represent numbers, we need to do more work. People who have never seen representations using bits often cannot understand such failures. Almost every bug you write will seem this dumb when you find it. I’ve seen bugs take months. People don’t like to talk about them afterward.