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

ECE 220: Computer Systems & Programming

Review: Computers are Dumb

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
```

Compare these two.

"4" is equal to "4."

"1" is equal to "1."

What's bigger, "," or "3?"

Comma (x2C) is smaller than '3' (x33).

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).

	"41,962"	"41321"	"9874"
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**.

x4012	x0031	'1'
x4013	x0039	'9'
x4014	x0000	NUL

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.

What is it? "23"

Say that the LC-3 executes:

```
R1 ← x4012
R2 ← x7196
R3 ← R1 + R2
```

What is R3? xB1A8

What is stored at xB1A8? Bits!

x4012	x0031	'1'
x4013	x0039	'9'
x4014	x0000	NUL
x7196	x0032	'2'
x7197	x0033	'3'
X7198	x0000	NUL

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.

