Numeric Representation I

CSCI 2050U - Computer Architecture

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Lecture Outline

- Decimal numbers
- Other bases

Decimal Numbers

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Why do humans use decimal?

- Computers use binary to represent numbers
- Humans (mostly) use decimal (base 10) to represent numbers

- Why?

Why do humans use decimal?

- Computers use binary to represent numbers
- Humans (mostly) use decimal to represent numbers

- Why?
  - Humans have ten fingers, and we often use (or have used) our fingers to count
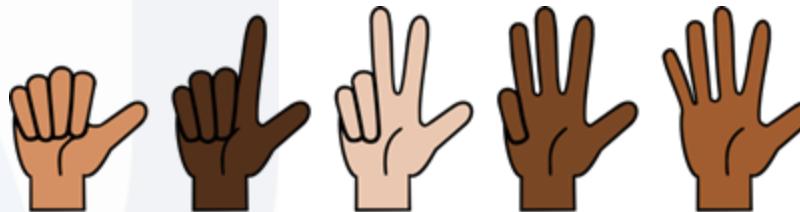
The Decimal Number System

- Review: how does the decimal number system work?

- What do the digits in the following decimal number mean?

7450

The Decimal Number System

- Review: how does the decimal number system work?

- What do the digits in the following decimal number mean?

$$7450 = 7 \times 10^3 + 4 \times 10^2 + 5 \times 10^1 + 0 \times 10^0$$

The Decimal Number System

- Review: how does the decimal number system work?

- The digits can be any number in the range [0..9] (10 unique digits)

$$7450 = 7 \times 10^3 + 4 \times 10^2 + 5 \times 10^1 + 0 \times 10^0$$

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The Decimal Number System

7450

The Decimal Number System

- The leftmost digit is referred to as the most significant digit, since it has the biggest influence on the magnitude of the number

most significant digit

7450
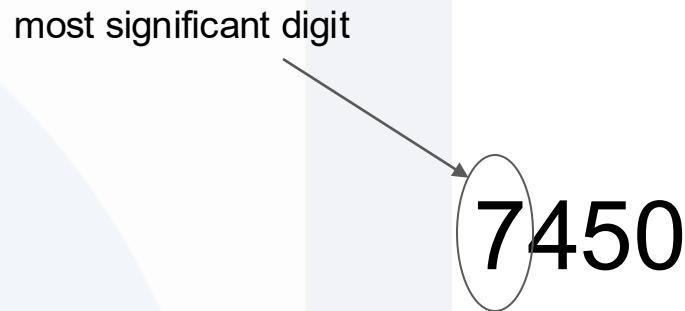
The Decimal Number System

- The rightmost digit is referred to as the least significant digit, since it has the smallest influence on the magnitude of the number

least significant digit

7450

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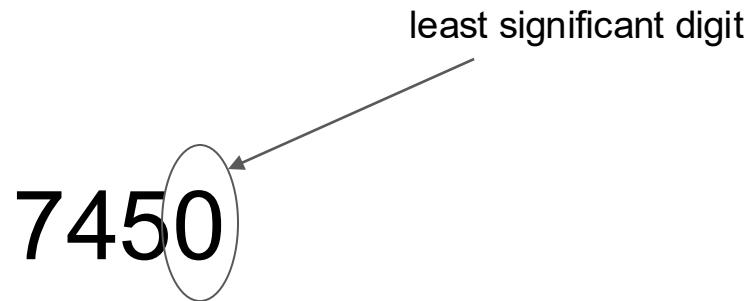
The Decimal Number System

- Zeroes to the left of the number do not affect its magnitude

leading zeroes
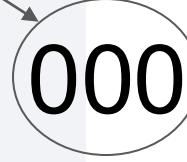
0007450

Other Bases

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What if our bodies were different?

- Imagine that we're intelligent octopi

- What kind of number system would we likely use?
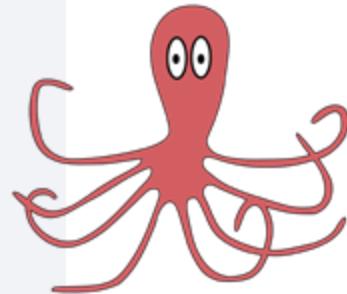
What if our bodies were different?

- We might count using our tentacles
- A base 8 system might make more sense for an octopus
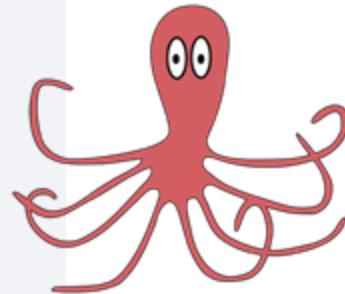
An Octal (Base 8) System

- A base 8 system would have 8 unique digits, in the range [0..7]

$$1073_8 = 1 \times 8^3 + 0 \times 8^2 + 7 \times 8^1 + 3 \times 8^0$$

Converting from Octal to Decimal

- Converting from octal to decimal is rather easy:
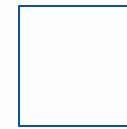
Converting from Octal to Decimal

- 1. Add each octal digit to the boxes below:

| 1 | 0 | 7 | 3 |

Converting from Octal to Decimal

- ● 2. Multiply each times the corresponding power of 8:

1	0	7	3
$\times 8^3$	$\times 8^2$	$\times 8^1$	$\times 8^0$

Converting from Octal to Decimal

- 2. Multiply each times the corresponding power of 8:

1	0	7	3
x512	x64	x8	x1
512	0	56	3

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Converting from Octal to Decimal

- 3. Add up the results:

1	0	7	3
x512	x64	x8	x1

$$512 + 0 + 56 + 3 = 571$$

Converting from Decimal to Octal

- **Converting** from decimal to octal is also easy:

Converting from Decimal to Octal

- 1. Write the number into the left-most box

571			

Converting from Decimal to Octal

- 2. Divide by the largest possible power of 8

571			
÷512	÷64	÷8	÷1

Converting from Decimal to Octal

- 3. Write the (integer) quotient in the box, below

571			
÷512	÷64	÷8	÷1
1			

Converting from Decimal to Octal

- ● 4. Write the remainder in the box to the right

571	59		
÷512	÷64	÷8	÷1
1			

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Converting from Decimal to Octal

- ● 5. Repeat for successively lower powers of 8

571	59		
÷512	÷64	÷8	÷1
1	0		

Converting from Decimal to Octal

- ● 5. Repeat for successively lower powers of 8

571	59	59	
÷512	÷64	÷8	÷1
1	0		

Converting from Decimal to Octal

- 5. Repeat for successively lower powers of 8

571	59	59	
÷512	÷64	÷8	÷1
1	0	7	

Converting from Decimal to Octal

- ● 5. Repeat for successively lower powers of 8

571	59	59	3
÷512	÷64	÷8	÷1
1	0	7	

Converting from Decimal to Octal

- 5. Repeat for successively lower powers of 8

571	59	59	3
÷512	÷64	÷8	÷1
1	0	7	3

Wrap-up

- Decimal numbers
  - Positional numbering
  - Most/least significant digits
  - Leading zeroes
- Other bases
  - Octal
    - Converting octal to decimal
    - Converting decimal to octal

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What is next?

- Binary
- Hexadecimal
- Error detection and correction
- Representing characters