COMP 141

CS1: Programming Fundamentals

Rhodes College

Announcements

Reminder

- Program 8 due Friday, April 27th by 11:55pm.

2-D List Lab from Last Time

Underlying Data Representation

- Remember back to the beginning of the semester
- We said that all data in a computer is stored in sequences of 0s and 1s
- **Byte**: just enough memory to store letter or small number
  - Divided into eight bits
  - **Bit**: electrical component that can hold positive or negative charge, like on/off switch
  - The on/off pattern of bits in a byte represents data stored in the byte

Binary Numbers

A Binary Number is made up of only **0**s and **1**s.

Example of a Binary Number

110100

There is no 2,3,4,5,6,7,8 or 9 in Binary!

How do we count using binary?

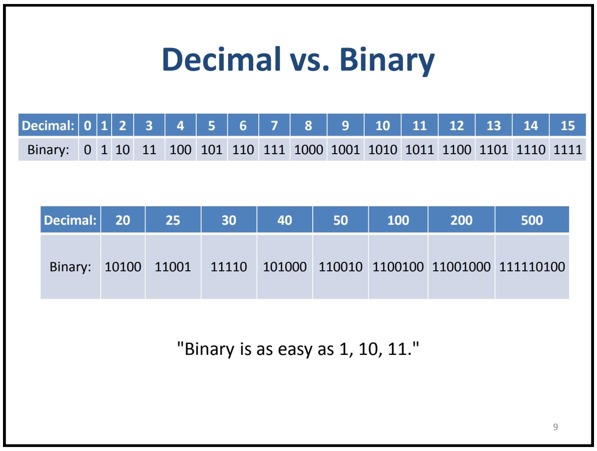
Binary	
0	We start at 0
1	Then 1
???	But then there is no symbol for 2…what do we do?

How do we count in Decimal?

Decimal	
0	Start at 0
…	Count 1,2,3,4,5,6,7,8
9	This is the last digit in Decimal
10	So we start back at 0 again, but add 1 on the left

Applying to Binary

	Binary	
	0	We start at 0
*	1	Then 1
**	10	Now we start back at 0, and add 1 to the left
***	11	1 more
****	100	Start back at 0 again, and add one to the number on the left… … but that number is already at 1 so it also goes back to 0 … … and 1 is added to the *next position* on the left

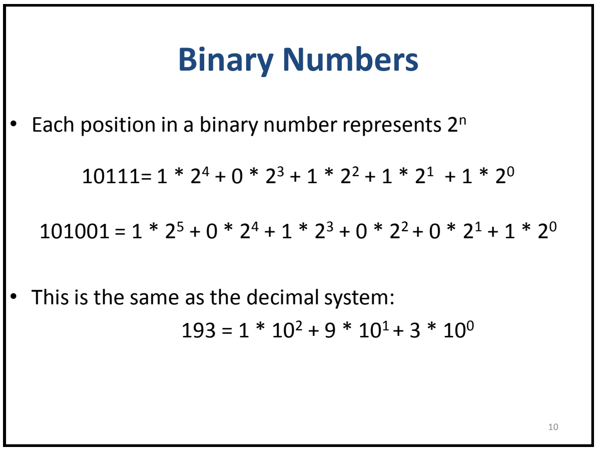


Decimal vs. Binary

Decimal:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Binary:	0	1	10	11	100	101	110	111	1000	1001	1010	1011	1100	1101	1110	1111

Decimal:	20	25	30	40	50	100	200	500
Binary:	10100	11001	11110	101000	110010	1100100	11001000	111110100

"Binary is as easy as 1, 10, 11."



Binary Numbers

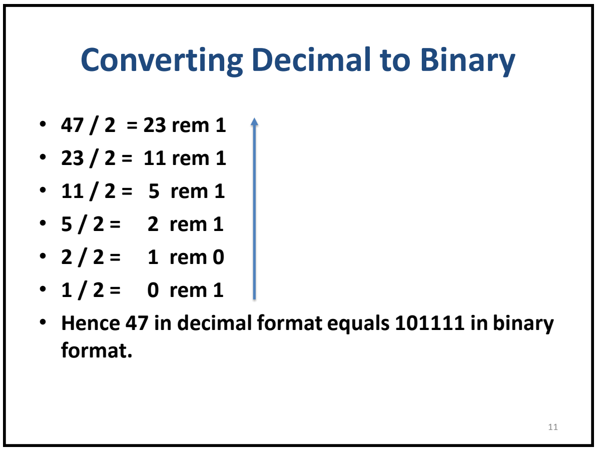
- Each position in a binary number represents 2^n

$$10111 = 1 * 2^4 + 0 * 2^3 + 1 * 2^2 + 1 * 2^1 + 1 * 2^0$$

$$101001 = 1 * 2^5 + 0 * 2^4 + 1 * 2^3 + 0 * 2^2 + 0 * 2^1 + 1 * 2^0$$

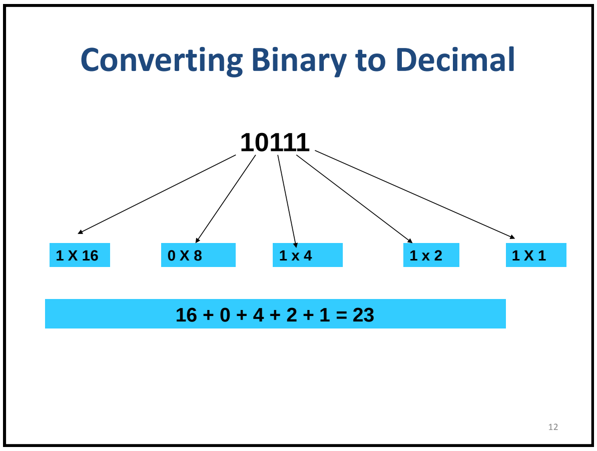
- This is the same as the decimal system:

$$193 = 1 * 10^2 + 9 * 10^1 + 3 * 10^0$$



Converting Decimal to Binary

- **47 / 2 = 23 rem 1**
- **23 / 2 = 11 rem 1**
- **11 / 2 = 5 rem 1**
- **5 / 2 = 2 rem 1**
- **2 / 2 = 1 rem 0**
- **1 / 2 = 0 rem 1**
- **Hence 47 in decimal format equals 101111 in binary format.**



Converting Binary to Decimal

10111

1 X 16

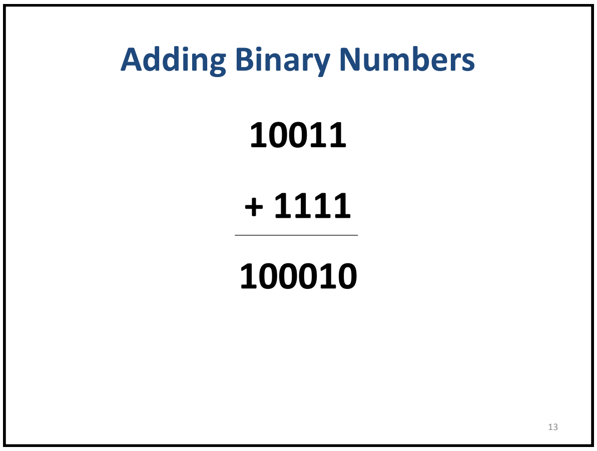
0 X 8

1 x 4

1 x 2

1 X 1

16 + 0 + 4 + 2 + 1 = 23

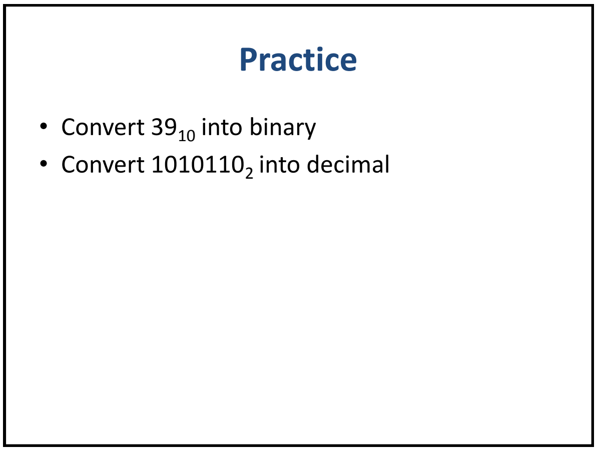


Adding Binary Numbers

10011

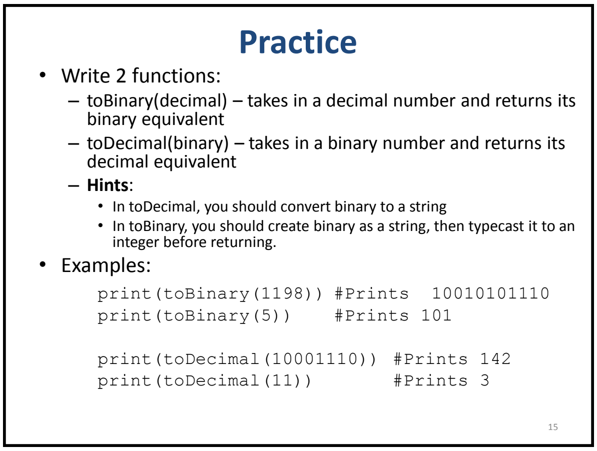
+ 1111

100010



Practice

- Convert 39_{10} into binary
- Convert 1010110_2 into decimal



Practice

- Write 2 functions:
  - toBinary(decimal) – takes in a decimal number and returns its binary equivalent
  - toDecimal(binary) – takes in a binary number and returns its decimal equivalent
  - **Hints**:
    - In toDecimal, you should convert binary to a string
    - In toBinary, you should create binary as a string, then typecast it to an integer before returning.
- Examples:

```
print(toBinary(1198)) #Prints  10010101110
print(toBinary(5))    #Prints 101

print(toDecimal(10001110)) #Prints 142
print(toDecimal(11))       #Prints 3
```