

Objectives

- Computer's representations of data types

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Review

- How can we find out the number of characters in a string?
- How can we “get” the last character of a string? (2 ways)
- How can we “get” the first 3 characters of a string?
- What are the two ways to iterate through a string?
- How can we tell if some string comes before another string, alphabetically?

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Review: Strings

- Actually a *sequence* of characters

➤ Example:

band = “The Beatles”

characters

'T'	'h'	'e'	' '	'B'	'e'	'a'	't'	'l'	'e'	's'
0	1	2	3	4	5	6	7	8	9	10

Start at 0

index or
position of
characters

Length of the string: 11
Built-in function: len(string)
to find length of a string

End at len()-1

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Review: Iterating Through a String

- For each character in the string

string of length 1

```
for char in string:  
    print char
```

'T'	'h'	'e'	' '	'B'	'e'	'a'	't'	'l'	'e'	's'
0	1	2	3	4	5	6	7	8	9	10

An integer

```
for pos in xrange(len(string)):  
    print string[pos]
```

- For each position in the string

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Review: Substrings Operator []

- Look at a particular character in the string
 - Syntax: `mystr[<integer expression>]`
 - [Positive value]: index of character
 - [Negative value]: count backwards from end
- Look at a sequence of characters in the string
 - Syntax: `mystr[<start>:<end>]`

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Review: Testing for Substrings

- Using the **in** operator
 - Used **in** before in **for** loops
- Syntax:

```
substring in mystring:
```

 - Evaluates to True or False
- Example:

```
if "Jr." in name:  
    print name, "contains 'Jr.'"
```

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HOW THE COMPUTER REPRESENTS DATA

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Representations of Data

- Computer needs ways to represent different types of data
 - Eventually, all boils down to 1s and 0s
- Computer needs to translate between what humans know to what computer knows and back again



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Seems like a divergence on strings but just wait...

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Decimal Representations

- Decimal is base 10
- Digits: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9
- Each *position* in a decimal number represents a power of 10

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Decimal Representations

- Decimal is base 10
- Digits: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9
- Each *position* in a decimal number represents a power of 10
- Example: 54,087

5	4	0	8	7
10^4	10^3	10^2	10^1	10^0

- $= 5 \cdot 10^4 + 4 \cdot 10^3 + 0 \cdot 10^2 + 8 \cdot 10^1 + 7 \cdot 10^0$
- $= 5 \cdot 10,000 + 4 \cdot 1000 + 0 \cdot 100 + 8 \cdot 10 + 7 \cdot 1$

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Number Representations

Characteristic	Decimal	Binary
Base	10	2
Digits	0, 1, 2, 3, 4, 5, 6, 7, 8, 9	0, 1
Position represents	Power of 10	Power of 2

- Binary: two values (0, 1)
 - Like a light switch (either **off** or **on**) or booleans (either True or False)
- 0 and 1 are *binary digits* or **bits**
 - 64-bit machine: represents numbers (and other data) with 64 bits

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Binary Representation

- Binary number: 1101

1	1	0	1
2^3	2^2	2^1	2^0

- $= 1 \cdot 2^3 + 1 \cdot 2^2 + 0 \cdot 2^1 + 1 \cdot 2^0$
- $= 1 \cdot 8 + 1 \cdot 4 + 0 \cdot 2 + 1 \cdot 1$
 - Decimal value: 13

Practice: what is the decimal value of the binary number **10110?**

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Binary Representation

- Binary Number: 10110

1	0	1	1	0
2^4	2^3	2^2	2^1	2^0

- $= 1*2^4 + 0*2^3 + 1*2^2 + 1*2^1 + 0*2^0$
- $= 1*16 + 0*8 + 1*4 + 1*2 + 0*1$
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Generalize this process into an algorithm...

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Algorithm: Converting Binary → Decimal

Accumulator design pattern

1. Read in the binary number as a string
 - The starting exponent will be the length of the string-1
2. Initialize the result to zero
3. For each bit in the binary number
 - Multiply the bit by the appropriate power of 2
 - Add this to the result
 - Reduce the exponent by 1
4. Display the result

Implement algorithm
binaryToDecimal.py

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Algorithm: Converting Decimal → Binary

1. Read in the decimal as an integer
2. Initialize the result to the empty string
3. Repeat until the decimal is 0:
 - $\text{result} = \text{str}(\text{decimal} \% 2) + \text{result}$
 - $\text{decimal} = \text{decimal} / 2$
4. Display the result

Try out algorithm with 22

Implement algorithm
decimalToBinary.py

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String Representations

- A **string** is a *sequence* of characters
- Each character is stored as a binary number
- **ASCII** (American Standard Code for Information Interchange) is one standard encoding for characters
 - Limitation: ASCII is based on the English language
 - Cannot represent other types of characters
- Unicode is a new standard

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ASCII Table Handout 16

ASCII Questions

- Lowercase letters are represented by what range of numbers?
- Uppercase letters are represented by what range of numbers?
- What is the difference between the decimal encoding of 'M' and 'N'?
 - Between 'm' and 'n'?

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ASCII Questions

- Lowercase letters are represented by what range of numbers?
 - 97—122
- Uppercase letters are represented by what range of numbers?
 - 65—90
- What is the difference between the decimal encoding of 'M' and 'N'?
 - Between 'm' and 'n'?
 - 1

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Translating to/from ASCII

- Translate a character into its ASCII numeric code using **built-in function ord**
 - `ord('a')` ==> 97
- Translate an ASCII numeric code into its character using **built-in function chr**
 - `chr(97)` ==> 'a'

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`ascii_table.py`
`ascii.py`

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Encryption

- Process of encoding information to keep it secure
- One technique: Substitution Cipher
 - Each character in message is replaced by a new character

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Caesar Cipher

- Replace with a character X places away
 - X is the **key**
- Julius Caesar used it to communicate with his generals
- “Wrap around”
- Write program(s) to do this in next lab

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Caesar Cipher

- Using the ASCII handout, what would be the encoded messages?

Message	Key	Encoded Message
apple	5	
zebra	5	
the eagle flies at midnight	-5	

Generalize this process into an algorithm...

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Looking Ahead

- Tonight: last night for Jeopardy! EC
 - Hillel House, 203
- Friday
 - Broader Issue: A Comparison of Bugs
 - Lab 5
- Next lab
 - Write an encoding/decoding program
 - Encode a message
 - Give to a friend to decode

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