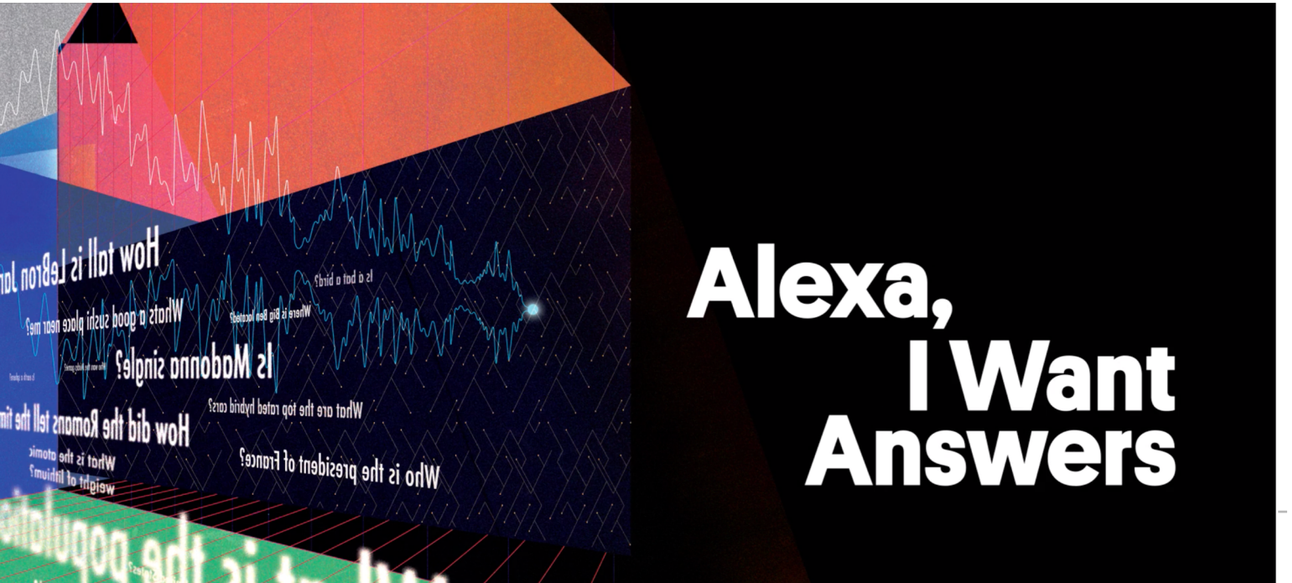
AMAZON ALEXA AND THE SEARCH FOR THE ONE PERFECT ANSWER

www.wired.com/story/amazon-alexa-search-for-the-one-perfect-answer



"According to one market survey, people ask their smart speakers to answer questions more often than they do anything else with them. … Computers responding to our queries in a single pass—providing one-shot answers, as they are known in the search community—has gone mainstream. The internet and the multibillion-dollar business ecosystems it supports are changing irrevocably. So, too, is the creation, distribution, and control of information—the very nature of how we know what we know. … Market analysts estimate that, by 2020, up to half of all internet searches will be spoken aloud. The conventional web, with all of its tedious pages and links, is giving way to the conversational web, in which chatty AIs reign supreme. The payoff, we are told, is increased convenience and efficiency. But for everyone who has economic interests tied to traditional web search—businesses, advertisers, authors, publishers, the tech giants—the situation is perilous"

Announcements

(From Lecture 13) Tree Processing Uses Recursion

Processing a leaf is often the base case of a tree processing function

The recursive case typically makes a recursive call on each branch, then aggregates

```
def count_leaves(t):
    """Count the leaves of a tree."""
    if is_leaf(t):
        return 1
    else:
        branch_counts = [count_leaves(b) for b in branches(t)]
        return sum(branch_counts)
```

(Demo5)

(From Lecture 13) Discussion Question

Implement `leaves`, which returns a list of the leaf labels of a tree

Hint: If you `sum` a list of lists, you get a list containing the elements of those lists

```
>>> sum([ [1], [2, 3], [4] ], [])
[1, 2, 3, 4]
>>> sum([ [1] ], [])
[1]
>>> sum([ [[1]], [2] ], [])
[[1], 2]
```

```
def leaves(tree):
    """Return a list containing the leaf labels of tree.

    >>> leaves(fib_tree(5))
    [1, 0, 1, 0, 1, 1, 0, 1]
    """
    if is_leaf(tree):
        return [label(tree)]
    else:
        return sum(List of leaf labels for each branch, [])
```

```
branches(tree)                                  [b for b in branches(tree)]
leaves(tree)                                    [s for s in leaves(tree)]
[branches(b) for b in branches(tree)]           [branches(s) for s in leaves(tree)]
[leaves(b) for b in branches(tree)]             [leaves(s) for s in leaves(tree)]
```

(From Lecture 13) Creating Trees

A function that creates a tree from another tree is typically also recursive

```
def increment_leaves(t):
    """Return a tree like t but with leaf labels incremented."""
    if is_leaf(t):
        return tree(label(t) + 1)
    else:
        bs = [increment_leaves(b) for b in branches(t)]
        return tree(label(t), bs)

def increment(t):
    """Return a tree like t but with all labels incremented."""
    return tree(label(t) + 1, [increment(b) for b in branches(t)])

def tree_map(t,f):
    """Return a tree like t but with all labels having f applied to them."""
    return tree(f(label(t)), [tree_map(b,f) for b in branches(t)])
```

Objects

(Demo1)

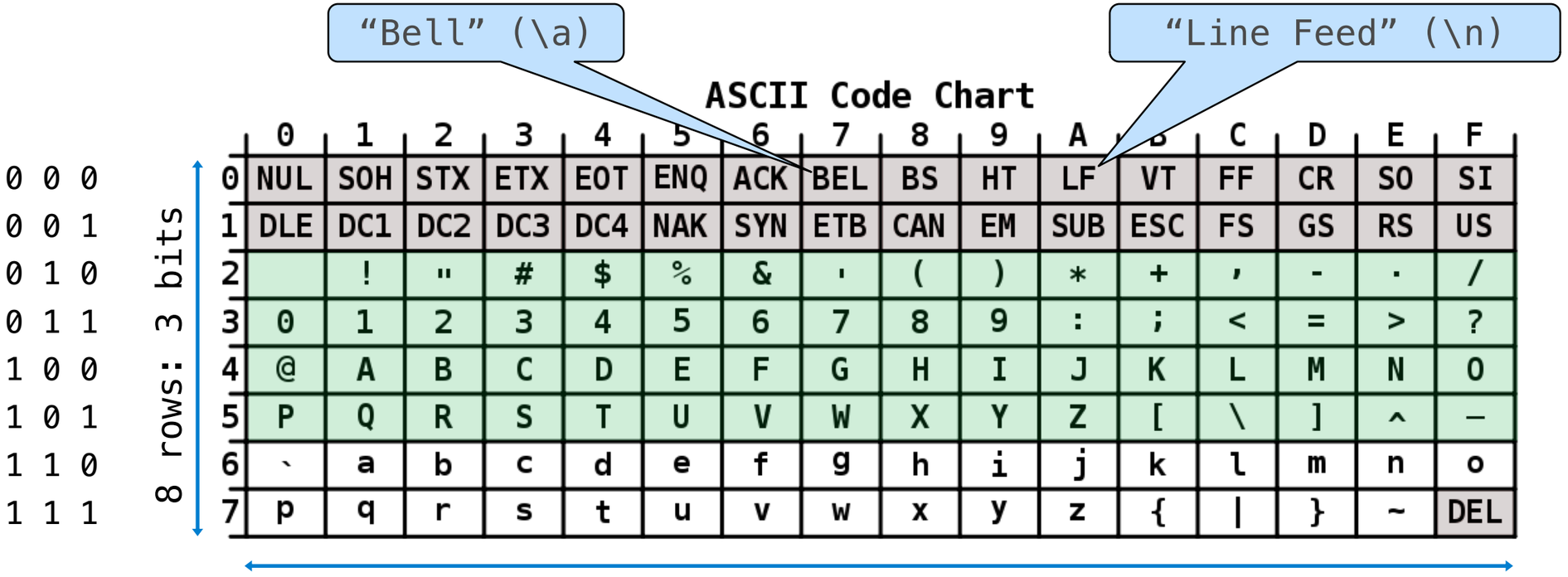
Objects

- Objects represent information
- They consist of data and behavior, bundled together to create abstractions
- Objects can represent things, but also properties, interactions, & processes
- A type of object is called a class; **classes** are first-class values in Python
- Object-oriented programming:
  - A metaphor for organizing large programs
  - Special syntax that can improve the composition of programs
- In Python, every value is an object
  - All **objects** have **attributes**
  - A lot of data manipulation happens through object **methods**
  - Functions do one thing; objects do many related things

Example: Strings

Representing Strings: the ASCII Standard

American Standard Code for Information Interchange



- Layout was chosen to support sorting by character code
- Rows indexed 2–5 are a useful 6-bit (64 element) subset
- Control characters were designed for transmission

(Demo2)

https://en.wikipedia.org/wiki/List_of_Unicode_characters

Representing Strings: the Unicode Standard

- 137K characters
- 146 scripts (organized)
- Enumeration of character properties, such as case
- Supports bidirectional display order
- A canonical name for every character

http://ian-albert.com/unicode_chart/unichart-chinese.jpg

LATIN CAPITAL LETTER A

BASKETBALL AND HOOP

EIGHTH NOTE

(Demo3)

Mutation Operations

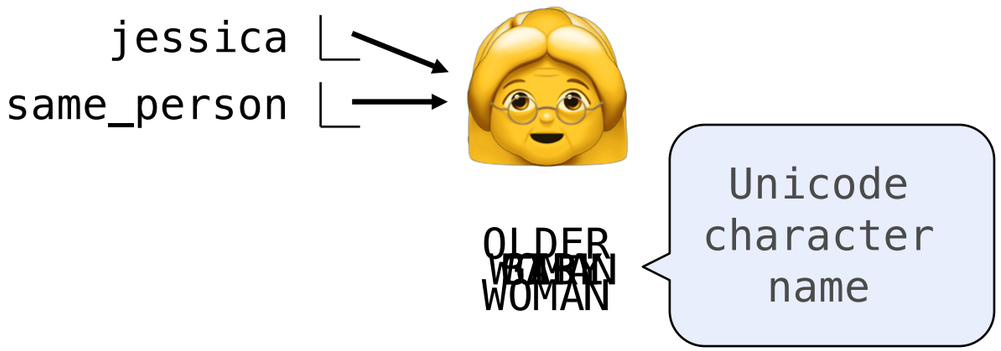
https://en.wikipedia.org/wiki/Playing_card_suit

Some Objects Can Change

[Demo4]

First example in the course of an object changing state

The same object can change in value throughout the course of computation



All names that refer to the same object are affected by a mutation

Only objects of *mutable* types can change: lists & dictionaries

{Demo5}

Mutation Can Happen Within a Function Call

A function can change the value of any object in its scope

```
>>> four = [1, 2, 3, 4]
>>> len(four)
4
>>> mystery(four)
>>> len(four)
2
```

```
>>> four = [1, 2, 3, 4]
>>> len(four)
4
>>> another_mystery() # No arguments!
>>> len(four)
2
```

```
def mystery(s):
    s.pop()
    s.pop()
```

or

```
def mystery(s):
    s[2:] = []
```

```
def another_mystery():
    four.pop()
    four.pop()
```


pythontutor.com/composingprograms.html#code=def%20mystery%28s%29%3A%0A%20%20%20%20s.pop%28%29%0A%20%20%20%20s.pop%28%29%0A%0Afour%20%3D%20[1,%202,%203,%204]%0Amystery%28four%29&mode=display&origin=composingprograms.js&cumulative=true&py=3&rawInputLstJSON=[]&curInstr=0

Tuples

(Demo6)

Tuples are Immutable Sequences

Immutable values are protected from mutation

```
>>> turtle = (1, 2, 3)
>>> ooze()
>>> turtle
(1, 2, 3)
```

Next lecture: ooze can change turtle's binding

```
>>> turtle = [1, 2, 3]
>>> ooze()
>>> turtle
['Anything could be inside!']
```

The value of an expression can change because of changes in names or objects

Name change:

```
>>> x = 2
>>> x + x
4
>>> x = 3
>>> x + x
6
```

Object mutation:

```
>>> x = [1, 2]
>>> x + x
[1, 2, 1, 2]
>>> x.append(3)
>>> x + x
[1, 2, 3, 1, 2, 3]
```

An immutable sequence may still change if it *contains* a mutable value as an element

```
>>> s = ([1, 2], 3)
>>> s[0] = 4
ERROR
```

```
>>> s = ([1, 2], 3)
>>> s[0][0] = 4
>>> s
([4, 2], 3)
```

Mutation

Sameness and Change

- As long as we never modify objects, a compound object is just the totality of its pieces
- A rational number is just its numerator and denominator
- This view is no longer valid in the presence of change
- A compound data object has an "identity" in addition to the pieces of which it is composed
- A list is still "the same" list even if we change its contents
- Conversely, we could have two lists that happen to have the same contents, but are different

```
>>> a = [10]
>>> b = a
>>> a == b
True
>>> a.append(20)
>>> a
[10, 20]
>>> b
[10, 20]
>>> a == b
True
```

```
>>> a = [10]
>>> b = [10]
>>> a == b
True
>>> b.append(20)
>>> a
[10]
>>> b
[10, 20]
>>> a == b
False
```

Identity Operators

Identity

`<exp0> is <exp1>`

evaluates to True if both <exp0> and <exp1> evaluate to the same object

Equality

`<exp0> == <exp1>`

evaluates to True if both <exp0> and <exp1> evaluate to equal values

Identical objects are always equal values

(Demo)

Mutable Default Arguments are Dangerous

A default argument value is part of a function value, not generated by a call

```
>>> def f(s=[]):
...     s.append(3)
...     return len(s)
...
>>> f()
1
>>> f()
2
>>> f()
3
```