

# Welcome to CS61A!

## This week

- Yes, we don't all fit in Pauley Ballroom! Anyone who does not insist on seeing my face can use the screencasts and the posted lecture slides, and not actually come to lecture.
- Please see the course web site (<http://cs61a.org>), esp. the announcements and *Course Info* link. (Bear with us: the web site is under construction).
- If you did not complete the lab this week, you should try to to get it done offline (see <http://cs61a.org/lab/lab00>).
- Next week, labs (between Monday and Wednesday lecture) and discussions meet according to the published schedule.
- Try to find a lab and discussion section with the same TA, if possible. If enrolled, don't worry about changing things on CalCentral. If waitlisted, choose **some** discussion/lab if possible. Will try to resolve conflicts next week.

# What's This Course About?

- This is a course about *programming*, which is the art and science of constructing artifacts ("programs") that perform computations or interact with the physical world.
- To do this, we have to learn a *programming language* (Python in our case), but programming means a great deal more, including
  - *Design* of what programs do.
  - *Analysis* of the performance of programs.
  - *Confirmation* of their correct operation.
  - *Management* of their *complexity*.
- This course is about the "big ideas" of programming. We expect most of what you learn to apply to any programming language.

# Course Organization

- **Readings** cover the material. Try to do them before...
- **Lectures** summarize material, or present alternative “takes” on it.
- **Laboratory exercises** are “finger exercises” designed to introduce a new topic or certain practical skills. Unlimited collaboration.
- **Homework assignments** are more involved than lab exercises and often *require some thought*. Plan is to have them due on Monday. Feel free to discuss the homework with other students, but turn in your own solutions.
- **Projects** are four larger multi-week assignments intended to teach you how to combine ideas from the course in interesting ways. We’ll be doing at least some of these in pairs.
- Use the discussion board (Piazza) for news, advice, etc.

# Mandatory Warning

- We allow unlimited collaboration on labs.
- On homework, feel free to collaborate, but try to keep your work distinct from everyone else's.
- Likewise on projects, except that you and your partner submit a joint project.
- You can take small pieces of code within reason (ask if unsure), but you *must* attribute it!
- Otherwise, copying is against the Code of Conduct, and generally results in penalties.
- Most out-and-out copying is due to desperation and time pressure. Instead, see us if you're having trouble; that's what we're here for!

# What's In A Programming Language?

- Values: the things programs fiddle with;
- Primitive operations (on values);
- Combining mechanisms, which glue operations together;
- Some predefined names (the “library”);
- Definitional mechanisms, which allow one to introduce symbolic names and (in effect) to extend the library.

# Python Values (I)

- Python has a rich set of values, including:

Type	Values	Literals (Denotations)
Integers	0 -1 16 13 36893488147419103232	0 -1 0o20 0b1101 0x20000000000000000000
Boolean (truth) values	true, false	True False
"Null"		None
Functions		operator.add, operator.mul, operator.lt, operator.eq

- Functions take values and return values (including functions). Thus, the definition of "value" is **recursive**: definition of function refers to functions.
- They don't look like much, perhaps, but with these values we can represent anything!

## Python Values (II)

- ...but not conveniently. So now we add more complex types, including:

Type	Values	Literals (Denotations)
Strings	pear, I ♥ NY Say "Hello"	"pear" "I \u2661 NY" "Say \"Hello\""
Tuples		(), (1, "Hello", (3, 5))
Ranges	0-10, 1-5	range(10), range(1, 5)
Lists		[], [1, "Hello", (3, 5)] [ x**3 for x in range(5) ]
Dictionaries		{ "Paul" : 60, "Ann" : 59, "John" : 56 }
Sets	{}, {1, 2}, $\{x \mid 0 \leq x < 20$ $\wedge x \text{ is prime}$	set([]), { 1, 2 }, { x for x in range(20) if prime(x) }



# What Values Can Represent

- The tuple type (as well as the list, dictionary, set class types) give Python the power to *represent* just about anything.
- In fact, we could get away with allowing just *pairs*: tuples with two elements:
  - Tuples can contain tuples (and lists can contain lists), which allows us to get as fancy as we want.
  - Instead of (1, 2, 7), could use (1, (2, (7, None))),
  - But while elegant, this would make programming tedious.

# Python's Primitive Operations

- Literals are the *base cases*.
- Functions in particular are the starting point for creating programs:  
`sub(truediv(mul(add(add(3, 7), 10), sub(1000, 8)), 992), 17)`
- To evaluate a function call:
  - Evaluate the caller (left of the parentheses).
  - Evaluate the arguments (within the parentheses).
  - The caller then tells what to do and what value to produce from the operand's values
- For the convenience of the reader, though, Python employs a great deal of "*syntactic sugar*" to produce familiar notation:  
 $(3 + 7 + 10) * (1000 - 8) / 992 - 17$

# Evaluating a Function Call

- Consider

`(3 + 7 + 10) * (1000 - 8) / 992 - 17`

which “sugars”

`sub(truediv(mul(add(add(3, 7), 10), sub(1000, 8)), 992), 17)`

- The numerals all evaluate in the obvious way.

- Then proceed from the inside out:

`sub(truediv(mul(add(add(3, 7), 10), sub(1000, 8)), 992), 17)`

`sub(truediv(mul(add( 10, 10), 992 ), 992), 17)`

`sub(truediv(mul( 20 , 992 ), 992), 17)`

`sub(truediv( 19840 , 992), 17)`

`sub( 20, 17)`

3

# Combining and Defining

- Certain primitives are needed to allow **conditional execution**:

```
print(1 if x > 0 else -1 if x < 0 else 0)
# or equivalently
if x > 0:
    print(1)
elif x < 0:
    print(-1)
else:
    print(0)
```

- Defining a new function:

```
def signum(x):
    return 1 if x > 0 else -1 if x < 0 else 0
```

Now signum denotes a function.

- Doesn't look like we have a lot, but in fact we already have enough to implement *all the computable functions on the integers!*

## Getting repetition

- Haven't explicitly mentioned any construct to "repeat  $X$  until ..." or "repeat  $X$   $N$  times." Technically, none is needed.
- Suppose you'd like to compute  $x + 2x^2 + 3x^3 + \dots + Nx^N$  for any  $N$ :

```
def series(x, N):  
    if N == 1:  
        return x  
    else:  
        return N * x**N + series(x, N-1)
```

- But again, we have syntactic sugar (which is the usual approach in Python):

```
def series(x, N):  
    S = 0  
    for k in range(1, N+1):  
        S += k * x**k  
    return S
```

# A Few General Rules

- Whatever the assignment, start now.
- "Yes, that's really all there is. Don't fight the problem."
- Practice is important. Don't just assume you can do it; do it!
- *ALWAYS* feel free to ask us for help.
- DBC
- RTFM
- Have fun!