Welcome to CS106A

We are going to have fun!
Lecturer: Frankie Cerkvenik

- Stanford undergrad in CS (systems) and MS in CS (Computer and Network Security)

- Interests: CS Education and the future of safety on the internet

- From Minnesota, I love canoeing and fishing and hockey :)
Head TA: Ecy King

- Stanford SymSys undergrad (Human-Centered AI)

- currently a CS coterm (HCI)!

- born in Scotland; raised in Fresno/Clovis, CA; family from Sierra Leone

- Interests: Educational Empowerment, Fractal Gridding, psychology, doodling, music, writing, racquet sports
Section Leaders

*these are SLs of years past...spot frankie!
Course Mechanics
What you need to do

- Lecture
  - Just show up!
  - Tues, Thurs, Fri 1:30-245 in SkillAud
- Optional Weekly Review Sessions (starting next week)
  - Wednesdays 1:30-2:45 in SkillAud
- Section
  - Weekly 50-min section with a section leader
  - Sections signups on class webpage **not Axess**
  - Signups close **today at 5** and start **this week**
- Assignments
  - 6 assignments (about 1/wk) throughout the quarter
- Exams
  - Midterm 7/26 in the afternoon/evening
  - **Final exam 8/18 at 3:30pm**
Sections and IGs

- Lectures go fast! We don’t expect you to retain all of it
- Sections are an opportunity to go over problems with a section leader
- Extra section problems are given for you to go over on your own
- IGs = Interactive Grading sessions: you will meet with your section leader after most assignments to go over your code!
Grading Breakdown

- 6 programming assignments (65%)
  - Assignments turned in on time receive a 2% on time bonus
  - After the due date, each assignment will have a full-credit "grace period" of 24 hours unless documented otherwise on the assignment.
  - Contact Frankie and Ecy if you need to arrange extra time on homework for extenuating circumstances

- Midterm exam (10%)
- Final Exam (15%)
- Section and IG attendance and participation (10%)
Assignment Grading

++ A submission so good it “makes you weep”

+ Exceeds requirements (and has great style)

✅ Satisfies all requirements, with good functionality and style

✅ Meets the requirements, but with small problems

✅ Has some somewhat serious problems

- Is worse than that, but shows real effort

-- Better than nothing
Office Hours

- Frankie’s office hours - Fridays 3 - 4:30 in Durand
  - Get conceptual help and talk about assignments, lecture topics, or anything else on your mind
- Ecy’s office hours - Tuesdays 3 - 4:30 in Durand
  - Group office hours about assignments, concepts, and life
- LAIR
  - In Durand 353 Thurs-Sun 5-9pm starting today, schedule posted on website
  - Get conceptual and debugging help from section leaders!
- Frankie and Ecy’s tea time - after lecture on Th outside
  - Come talk to us about anything outside of CS106A!
Ed Discussion Forum

- An online discussion forum for asking questions
- Great for:
  - Clarifying questions about lecture or section problems
  - Clarifying or conceptual homework questions
  - Logistical questions
  - Conceptual or what if… questions
- Medium good for:
  - Debugging questions
  - Please do not post code publicly!
Exams

- Midterm 7/26 in the afternoon/evening
  - If you have an immovable academic conflict, email Frankie **before Friday** to arrange an alternate time
  - If you emailed before the first day of class, email again!
- Final 8/18 at 3:30pm-6:30pm: no alternate exam
- Please send OAE letters to Frankie **by Friday**
What is CS106A?
What is Computer Science?

“Computer science is no more about computers than astronomy is about telescopes, biology is about microscopes or chemistry is about beakers and test tubes. Science is not about tools, it is about how we use them and what we find out when we do.”

— Michael Fellows and Ian Parberry

“Instead of imagining that our main task is to instruct a computer what to do, let us concentrate rather on explaining to human beings what we want a computer to do.”

— Don Knuth
CS106A learning goals

1. Learn about what computers can do
   - Computers are not magic boxes! They are problem-solvers!
   - They can solve specific problems using a specific set of instructions (code)
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2. Learn how to use computers to solve problems
   - Explore fundamental techniques in computer programming.
   - Develop good software engineering style.
   - Gain familiarity with the Python programming language.
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   - Explore fundamental techniques in computer programming.
   - Develop good software engineering style.
   - Gain familiarity with the Python programming language.

3. Frankie’s agenda: get you to love it enough to keep going!
CS106A Topics

- Image processing
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- Image processing
- Animation and games
CS106A Topics

- Image processing
- Animation and games
- Text-based problems (ciphers and language processing)
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- Data Processing and analytics
CS106A Topics

- Image processing
- Animation and games
- Text-based problems (ciphers and language processing)
- Data Processing and analytics
- Sneak peek at how the internet works!

The sky is the limit!
Announcements

- Section signups are out on the website and will be due **tonight at 5pm**

- Assignment 0 (not graded) is released and due **this Friday**

- Assignment 1 will be released **Wednesday** and is due **next Friday**

- If you would like to switch to 106B, try to decide **this week**, as both classes have assignments due next Friday.
Let’s dive in!
Code looks weird at first

- Computers solve very **specific** problems very well

- And are otherwise very **bad** at solving problems

- Particularly, computers need their instructions in a **very specific format** (code)

- We need to start with a bunch of weird and intimidating **syntax rules** and **definitions**

- There are **many** but they are all very **simple**
Definitions

- **Program**: A collection of code for a computer to run, which may take in specific inputs like a file name or a number

- **Function**: A logical unit of code that may be used and reused in a program

Computer programs are made up of different functions. Like organisms are made of different types of cells.
Python Syntax

- A python program with python functions would be written in a file named something like “example.py”

example.py file:

```python
def function1(x, y):
    # some code goes here

def function2():
    # a different piece of code here

def main():
    # main functions are usually where "the big picture" of the program is
```

Program
Python Syntax

element.py file:

```
# Lines starting with # are comments and ignored by
# the computer

def function1():
    # Underneath def function_name(): is the code for
    # what should happen when the function is used

    # This code won’t run until the function is called

def main():
    function1()  # functions are "called" like this!

    # The main function is usually where "the big
    # picture" of the program is - more on that later
```
Bit and the Experimental Server

- We will learn more about files on our computer and the main function soon
- To get started, we will write and run code on our experimental server (thanks Nick Parlante!)
- Our programs will focus on a little robot named Bit
do_bit1
bit1

This code is complete - run it to see how it works. Bit starts facing the right side of the world. The square in front of bit and the square below that are clear. Move bit forward and paint that square blue. Then paint the square below that green.

```python
def do_bit1(filename):
    # Code
```
What happened?

bit1
This code is complete - run it to see how it works. Bit starts facing the right side of the world. The square in front of bit and the square below that are clear. Move bit forward and paint that square blue. Then paint the square below that green.

```python
def do_bit1(filename):
    bit = Bit(filename)
    bit.move()
    bit.paint('blue')
    bit.right()
    bit.move()
    bit.paint('green')
```

Ran this code...

...To make bit do this!
def do_bit1(filename):
    bit = Bit(filename)  # Set up world
    bit.move()
    bit.paint('blue')
    bit.right()
    bit.move()
    bit.paint('green')
bit1

This code is complete - run it to see how it works. Bit starts facing the right side of the world. The square in front of bit and the square below that are clear. Move bit forward and paint that square blue. Then paint the square below that green.

Uncheck Auto Play

See how Bit’s world starts before running more code!
def do_bit1(filename):
    bit = Bit(filename)  # Set up world
    bit.move()
    bit.paint('blue')
    bit.right()
    bit.move()
    bit.paint('green')
def do_bit1(filename):
    bit = Bit(filename)  # Set up world
    bit.move()  # Step forward one square
    bit.paint('blue')
    bit.right()
    bit.move()
    bit.paint('green')
def do_bit1(filename):
    bit = Bit(filename)  # Set up world
    bit.move()  # Step forward one square
    bit.paint('blue')  # Paint current square blue
    bit.right()
    bit.move()
    bit.paint('green')
def do_bit1(filename):
    bit = Bit(filename)  # Set up world
    bit.move() # Step forward one square
    bit.paint('blue') # Paint current square blue
    bit.right() # Turn 90 degrees to the right
    bit.move()
    bit.paint('green')
Code line by line

```python
def do_bit1(filename):
    bit = Bit(filename)  # Set up world
    bit.move()  # Step forward one square
    bit.paint('blue')  # Paint current square blue
    bit.right()  # Turn 90 degrees to the right
    bit.move()  # Step forward one square
    bit.paint('green')
```

Case-1
def do_bit1(filename):
    bit = Bit(filename)  # Set up world
    bit.move()  # Step forward one square
    bit.paint('blue')  # Paint current square blue
    bit.right()  # Turn 90 degrees to the right
    bit.move()  # Step forward one square
    bit.paint('green')  # Paint current square green
Coding with Bit step by step

1. Read the instructions

2. Uncheck “Auto Play” and Run - see how Bit is positioned and what Bit’s world looks like

3. One line at a time, tell Bit exactly what to do

4. Hit Run again and see if you got it right!

5. Repeat steps 3-4 until you are happy :
Bit knows how to do 4 things

- `move()`
  Bit will take one step in the direction Bit is facing
- `left()`
  Bit will turn 90 degrees left
- `right()`
  Bit will turn 90 degrees right
- `paint(color)`
  Bit will paint its current position `color`
  Options for color are `red`, `green`, `blue`
Bit knows how to do 4 things

- `move()`
  Bit will take one step in the direction Bit is facing
- `left()`
  Bit will turn 90 degrees left
- `right()`
  Bit will turn 90 degrees right
- `paint(color)`
  Bit will paint its current position `color`
  Options for color are ‘red’, ‘green’, ‘blue’

Only bit knows these instructions, so we need to say `bit.move()`, not just `move()`
do bit2
(if time)
Coding with Bit step by step revisited

1. Read the instructions

2. Uncheck “Auto Play” and Run - see how Bit is positioned and what Bit’s world looks like

3. One line at a time, tell Bit exactly what to do
   
   This can be very tedious :/

4. Hit Run again and see if you got it right!

5. Repeat steps 3-4 until you are happy :)
Painting a row

Instructions: With Bit starting in the upper left corner facing right, paint the entire first row green
One solution...

Instructions: With Bit starting in the upper left corner, paint the entire first row green

```python
def do_row(filename):
    bit = Bit(filename)
    bit.paint('green')
    bit.move()
    bit.paint('green')
    bit.move()
    bit.paint('green')
    bit.move()
    bit.paint('green')
    bit.move()
    bit.paint('green')
```
Does it work on all maps?

Instructions: With Bit starting in the upper left corner, paint the entire first row green

```python
def do_row(filename):
    bit = Bit(filename)
    bit.paint('green')
    bit.move()
    bit.paint('green')
    bit.move()
    bit.paint('green')
    bit.move()
    bit.paint('green')
    bit.move()
```
How easy it is to change a just little?

Instructions: With Bit starting in the upper left corner, paint the entire first row **red**

```python
def do_row(filename):
    bit = Bit(filename)
    bit.paint('green')
    bit.move()
    bit.paint('green')
    bit.move()
    bit.paint('green')
    bit.move()
    bit.paint('green')
    bit.move()
    bit.paint('green')
```

How many lines of code need to change?
Introducing the **while** loop

We can run certain lines of code over and over **while** some condition is true

```python
def do_row(filename):
    bit = Bit(filename)
    while #some condition:
        # all indented lines run
        # while the condition is True
        # these lines out here
        # only run once
        # (after condition becomes False)
```
Introducing the **while** loop

We can run certain lines of code over and over **while** some condition is true.

```python
def do_row(filename):
    bit = Bit(filename)
    bit.paint('green')
    bit.move()
    while #something:
        bit.paint('green')
        bit.move()
        bit.paint('green')
        bit.move()
        bit.paint('green')
        bit.move()
        bit.paint('green')
```

```python
def do_row(filename):
    bit = Bit(filename)
    while #something:
        bit.paint('green')
        bit.move()
```
Introducing the **while** loop

Now we just need syntax to ask if Bit is blocked

```
def do_row(filename):
    bit = Bit(filename)
    while #Bit is not blocked:
        bit.paint('green')
        bit.move()
```
Questions Bit can ask

- `front_clear()`
  returns True or False if the square Bit is facing is blocked
- `left_clear()`
  returns True or False if the square to Bit’s left is blocked
- `right_clear()`
  returns True or False if the square to Bit’s right is blocked
- `get_color()`
  returns ‘green’, ‘red’, ‘blue’ or None for the color of the square Bit is currently on
Introducing the **while** loop

Let’s run this and see if it worked!

```python
def do_row(filename):
    bit = Bit(filename)
    while bit.front_clear():
        bit.paint('green')
        bit.move()
```
Introducing the **while** loop

1st loop

```python
def do_row(filename):
    bit = Bit(filename)
    while bit.front_clear():  # returns True!
        bit.paint('green')
    bit.move()
```
Introducing the **while** loop

1st loop iteration

```python
def do_row(filename):
    bit = Bit(filename)
    while bit.front_clear():
        bit.paint('green')
        bit.move()
```

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Introducing the **while** loop

1st loop iteration

```python
def do_row(filename):
    bit = Bit(filename)
    while bit.front_clear():
        bit.paint('green')
        bit.move()
```
Introducing the `while` loop

2nd loop iteration!

```python
def do_row(filename):
    bit = Bit(filename)
    while bit.front_clear():
        bit.paint('green')
        bit.move()
```
Introducing the **while** loop

End of 2nd loop iteration!

```python
def do_row(filename):
    bit = Bit(filename)
    while bit.front_clear():
        bit.paint('green')
        bit.move()
```
Introducing the `while` loop

End of 3rd loop iteration!

```python
def do_row(filename):
    bit = Bit(filename)
    while bit.front_clear():
        bit.paint('green')
        bit.move()
```

![Diagram of a loop iteration]
Introducing the **while** loop

End of 4th loop iteration!

```python
def do_row(filename):
    bit = Bit(filename)
    while bit.front_clear():
        bit.paint('green')
        bit.move()
```
Introducing the \texttt{while} loop

Beginning of 5th loop iteration?

\begin{verbatim}
def do_row(filename):
    bit = Bit(filename)
    while bit.front_clear():
        bit.paint('green')
        bit.move()
\end{verbatim}
Introducing the `while` loop

Beginning of 5th loop iteration?

def do_row(filename):
    bit = Bit(filename)
    while bit.front_clear():  # returns False
        bit.paint('green')
        bit.move()
Introducing the `while` loop

Beginning of 5th loop?

```python
def do_row(filename):
    bit = Bit(filename)
    while bit.front_clear():  # returns False
        bit.paint('green')
    bit.move()

# skip loop code, done
```
Introducing the `while` loop

Didn’t paint last square :( How to fix the bug?

```python
def do_row(filename):
    bit = Bit(filename)
    while bit.front_clear():  #returns False
        bit.paint('green')
        bit.move()
    # skip loop code, done
```
Introducing the `while` loop

Didn’t paint last square :( How to fix the bug?

```python
def do_row(filename):
    bit = Bit(filename)
    while bit.front_clear():
        bit.paint('green')
        bit.move()
    # paint last square
    bit.paint('green')
```
Does it work on all maps?

Instructions: With Bit starting in the upper left corner, paint the entire first row green

```python
def do_row(filename):
    bit = Bit(filename)
    while bit.front_clear():
        bit.paint('green')
        bit.move()
    # paint last square
    bit.paint('green')
```
How easy it is to change a just little?

Instructions: With Bit starting in the upper left corner, paint the entire first row red

```python
def do_row(filename):
    bit = Bit(filename)
    while bit.front_clear():
        bit.paint('green')
        bit.move()
    # paint last square
    bit.paint('green')
```

How many lines of code need to change?
Recap: **While Loop**

```python
while #condition:
    # code that loops
# code that doesn't loop
```

1. First the condition is checked (it should be `True` or `False`, more on that later)
2. If the condition is `True`, the “code that loops” runs, then back to step 1.
3. If the condition is `False`, the “code doesn’t loop” runs, and the looping process is over
Conditions

- Conditions are statements that evaluate to either True or False
Conditions

- Conditions are statements that evaluate to either True or False

```python
while #condition:
    # code that loops

while bit.front_clear():
    #if bit.front_clear returns True, loop

while True:
    # Always loops forever!
    # maybe a bad idea... don’t do this :)
```
Conditions

- Conditions are statements that evaluate to either True or False
- The statement left == right is True if left is equal to right and False otherwise

```python
while bit.get_color() == 'green':
    # loop if bit is standing on a green

while bit.front_clear() == True:
    #if bit.front_clear returns True, loop
    #Redundant! Don’t need ‘== True’
```
Conditions

- Conditions are statements that evaluate to either True or False
- The statement `left == right` is True if `left` is equal to `right` and False otherwise
- Adding the word `not` in front of a conditions changes it from False to True or from True to False

```python
while not bit.get_color() == 'green':
    # loop if bit is standing on anything
    # except a green

while not bit.front_clear():
    # loop if bit.front_clear returns False
    # AKA loop while bit is blocked!
```
Unblock Bit

- Assume there is at least one direction that Bit is not blocked (and Bit may be facing it!)
- Write the function `unblock(filename)`, in which Bit finds a direction she is not blocked and takes one step in that direction
Unblock Bit

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- Write the function `unblock(filename)`, in which Bit finds a direction she is not blocked and takes one step in that direction

```python
def unblock(filename):
    # implementation of unblock function
```
Unblock Bit

- Assume there is at least one direction that Bit is not blocked (and Bit may be facing it!)
- Write the function `unblock(filename)`, in which Bit finds a direction she is not blocked and takes one step in that direction

```python
def unblock(filename):
    while not bit.front_clear():
        bit.right()
        # bit.front_clear must have been True!
        bit.move()
```
Syntax Errors

- AKA typos!
- Humans can usually understand code that has typos, but computers are not as smart as humans :)
- Python catches syntax errors either:
  - **before runtime**: before any code runs - also known as a compile error. Ex: `biterr1`
  - **during runtime**: while the code is running - also known as a runtime error. Ex: `biterr4`
Fixing Syntax Errors Step by Step

1. Run your code!

2. Oh no! My code didn’t run all the way through:(

3. Read the error message, **pay attention to the line number**

4. Go to that line number, fix the issue

5. Try step 1 again
Syntax Errors

- AKA typos!
- Humans can usually understand code that has typos, but computers are not as smart as humans :)
- Python catches syntax errors either:
  - **before runtime**: before any code runs - also known as a compile error. Ex: `biterr1`
  - **during runtime**: while the code is running - also known as a runtime error. Ex: `biterr4`

Syntax errors are not the same as bugs! Bugs happen when your code *can* run all the way through, but it doesn’t do what you wanted it to
Recap

- Welcome to 106A!
- Remember to fill out that section signup form ASAP
- Bit is a robot that can move, turn left and right, and paint
- We can make certain lines of code run over and over with while loops
- while loops require a condition that tells them if it’s okay to keep looping
- Conditions are True/False statements
- Syntax errors happen! Luckily, Python tells us how to fix them
See you next time!