What Are Algorithms?

Algorithm

- Step-by-step instructions
  - Not specific to a language
  - Could be a cooking recipe
- **Outline** for a program

Implementation

- Program for an algorithm
  - In a specific language
  - What we often call coding
- The **filled in** outline

- Good programmers can separate the two
  - Work on the algorithm first
  - Implement in language second
- Why approach strings as **search-cut-glue**

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Difficulties With Programming

Syntax Errors

- Python can't understand you
- **Examples**:
  - Forgetting a colon
  - Not closing a parens
- Common with beginners
  - But can quickly train out

Conceptual Errors

- Does what you say, not mean
- **Examples**:
  - Forgot last char in slice
  - Used the wrong argument
- Happens to everyone
  - Large part of CS training

Proper algorithm design
reduces **conceptual errors**

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Testing First Strategy

- **Write the Tests First**
  Could be script or written by hand
- **Take Small Steps**
  Do a little at a time; make use of **placeholders**
- **Intersperse Programming and Testing**
  When you finish a step, test it immediately
- **Separate Concerns**
  Do not move to a new step until current is done

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Using Placeholders in Design

- **Strategy**: fill in definition a little at a time
- We start with a function *stub*
  - Function that can be called but is unfinished
  - Allows us to test while still working (later)
- All stubs must have a function header
  - But the definition body might be "empty"
  - Certainly is when you get started

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A Function Stub

```
def last_name_first(s):
    """Returns: copy of s in form 'last-name, 'first-name'

    Precondition: s is in form 'first-name last-name'
    with one blank between the two names"""
    pass
```

Now pass is a note that is unfinished.
Can leave it there until work is done.

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Outlining Your Approach

```
def last_name_first(s):
    """Returns: copy of s in form 'last-name, 'first-name'

    Precondition: s is in form 'first-name last-name'
    with one blank between the two names"""
    # Find the space between the two names
    # Cut out the first name
    # Cut out the last name
    # Glue them together with a comma
```

Psuedocode

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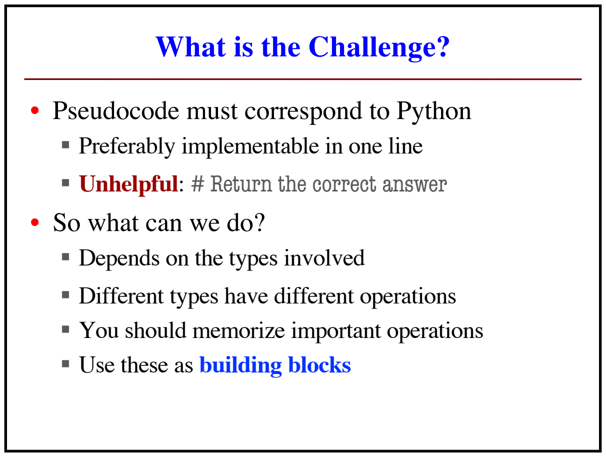

What is the Challenge?

- Pseudocode must correspond to Python
  - Preferably implementable in one line
  - **Unhelpful**: `# Return the correct answer`
- So what can we do?
  - Depends on the types involved
  - Different types have different operations
  - You should memorize important operations
  - Use these as **building blocks**

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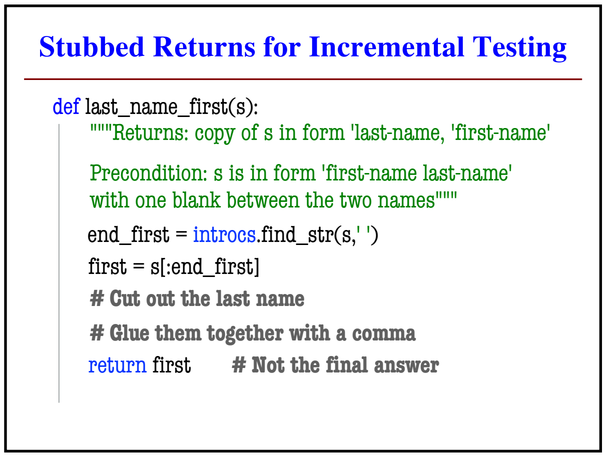

Stubbed Returns for Incremental Testing

```
def last_name_first(s):
    """Returns: copy of s in form 'last-name, 'first-name'

    Precondition: s is in form 'first-name last-name'
    with one blank between the two names"""
    end_first = introcs.find_str(s,' ')
    first = s[:end_first]
    # Cut out the last name
    # Glue them together with a comma
    return first     # Not the final answer
```

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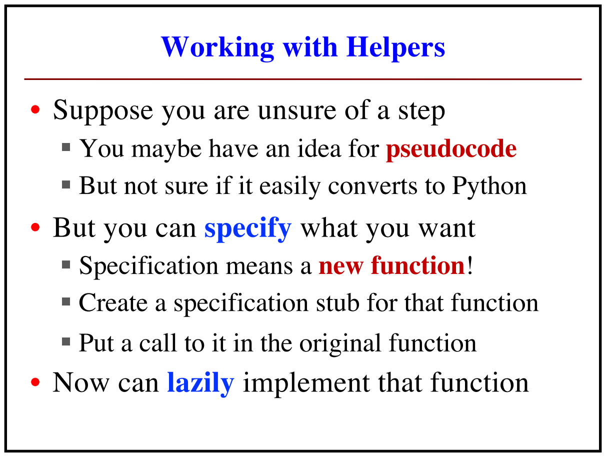

Working with Helpers

- Suppose you are unsure of a step
  - You maybe have an idea for **pseudocode**
  - But not sure if it easily converts to Python
- But you can **specify** what you want
  - Specification means a **new function**!
  - Create a specification stub for that function
  - Put a call to it in the original function
- Now can **lazily** implement that function

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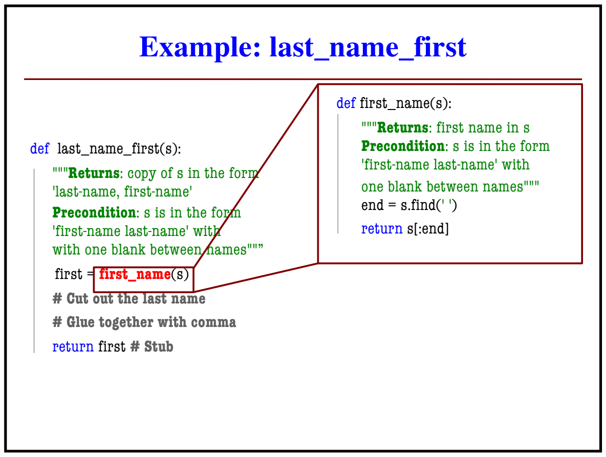

Example: last_name_first

```
def  last_name_first(s):
    """Returns: copy of s in the form
    'last-name, first-name'
    Precondition: s is in the form
    'first-name last-name' with
    with one blank between names"""
    first = first_name(s)
    # Cut out the last name
    # Glue together with comma
    return first # Stub
```

```
def first_name(s):
    """Returns: first name in s
    Precondition: s is in the form
    'first-name last-name' with
    one blank between names"""
    end = s.find(' ')
    return s[:end]
```

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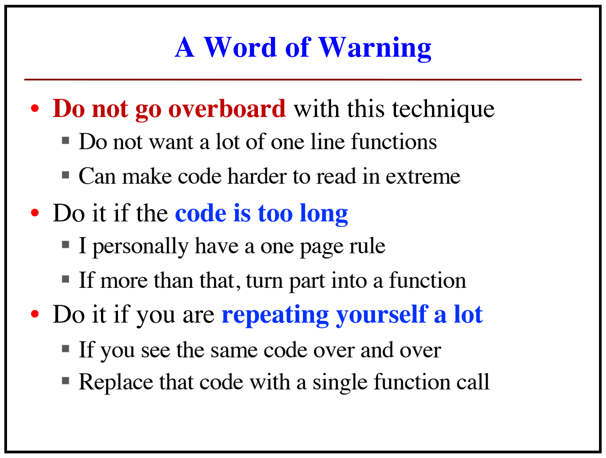

A Word of Warning

- **Do not go overboard** with this technique
  - Do not want a lot of one line functions
  - Can make code harder to read in extreme
- Do it if the **code is too long**
  - I personally have a one page rule
  - If more than that, turn part into a function
- Do it if you are **repeating yourself a lot**
  - If you see the same code over and over
  - Replace that code with a single function call

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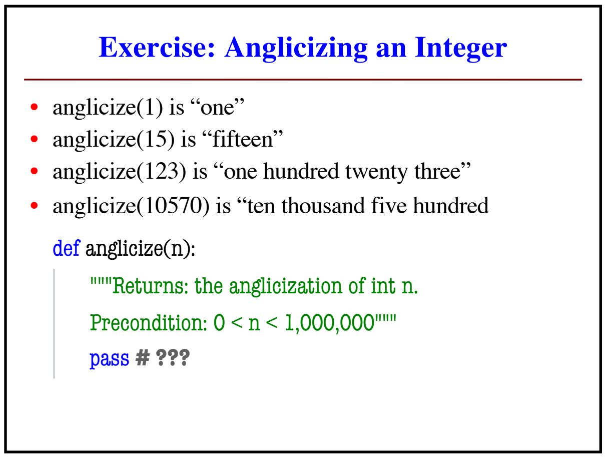

Exercise: Anglicizing an Integer

- anglicize(1) is "one"
- anglicize(15) is "fifteen"
- anglicize(123) is "one hundred twenty three"
- anglicize(10570) is "ten thousand five hundred

```
def anglicize(n):
    """Returns: the anglicization of int n.
    Precondition: 0 < n < 1,000,000"""
    pass # ???
```

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