

What Are Algorithms?

Algorithm	Implementation
• Step-by-step instructions ▪ Not specific to a language ▪ Could be a cooking recipe • Outline for a program	• 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	Conceptual Errors
• Python can't understand you • Examples: ▪ Forgetting a colon ▪ Not closing a parens • Common with beginners ▪ But can quickly train out	• 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
```

Pseudocode

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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 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]
```

```
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
```

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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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