

# §1.8-§2.1: Software Abstractions and Control Structures

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CMPT14x

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• *HW1 due today*

# A note about IDLE: subprocess

- You should see “=== RESTART ===” each time you press F5 or do Run→“Run Module”
  - In the default installation, the **right-click** context menu “**Edit with IDLE**” starts IDLE in a slightly different mode
- Details for those interested:
  - “-n” command-line option causes IDLE not to use a separate **subprocess** for each run
  - Using the “-n” option will cause **problems** for you later when creating your own modules
- **Screen capture** on the Macs: **Alt-F14**
  - Copies into clipboard: Ctrl-V to paste image

# What's on for today (§1.8 - §2.1)

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- Expressions and precedence
- Logical operators
- Hardware abstractions
- Software abstractions: levels of translation
- Control/structure abstractions
- Pseudocode
- Library functions

# Logical operators

- Logical operators are operators on the **bool** type:
  - GodLovesMe = True
  - ILoveGod = False
- **not**: flips True to False and vice-versa
  - **not** GodLovesMe >>> False
- **and**: evaluates to True if **both** operands are True
  - GodLovesMe **and** ILoveGod >>> False
- **or**: evaluates to True if at least **one** operand is True
  - GodLovesMe **or** ILoveGod >>> True

# Operator Precedence



- How would you **evaluate** this?
  - $5 + 4 * 2$
  - $(5 + 4) * 2 \gg \gg 18$ : Addition first
  - $5 + (4 * 2) \gg \gg 13$ : Multiplication first
- **Precedence** is a convention for which operators get evaluated first (higher precedence)
  - Usually multiplication has higher precedence than addition
- When in doubt, use **parentheses**!

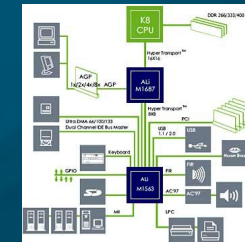
# Expression compatibility

- `5 + True` doesn't make sense: incompatible types
- What about `5(int) + 2.3(float)`?
  - Works because the two types are expression compatible
- The “+” operator is overloaded:
  - It works for multiple types: both int and float
- It turns out that in Python, `5+True` does evaluate:
  - `5+True >>> 6`  
(interprets True as 1 and False as 0)

# Hardware abstractions





- Generally, most computers have these basic hardware components:

- Input
- Memory
- Processing
- Control
- Output



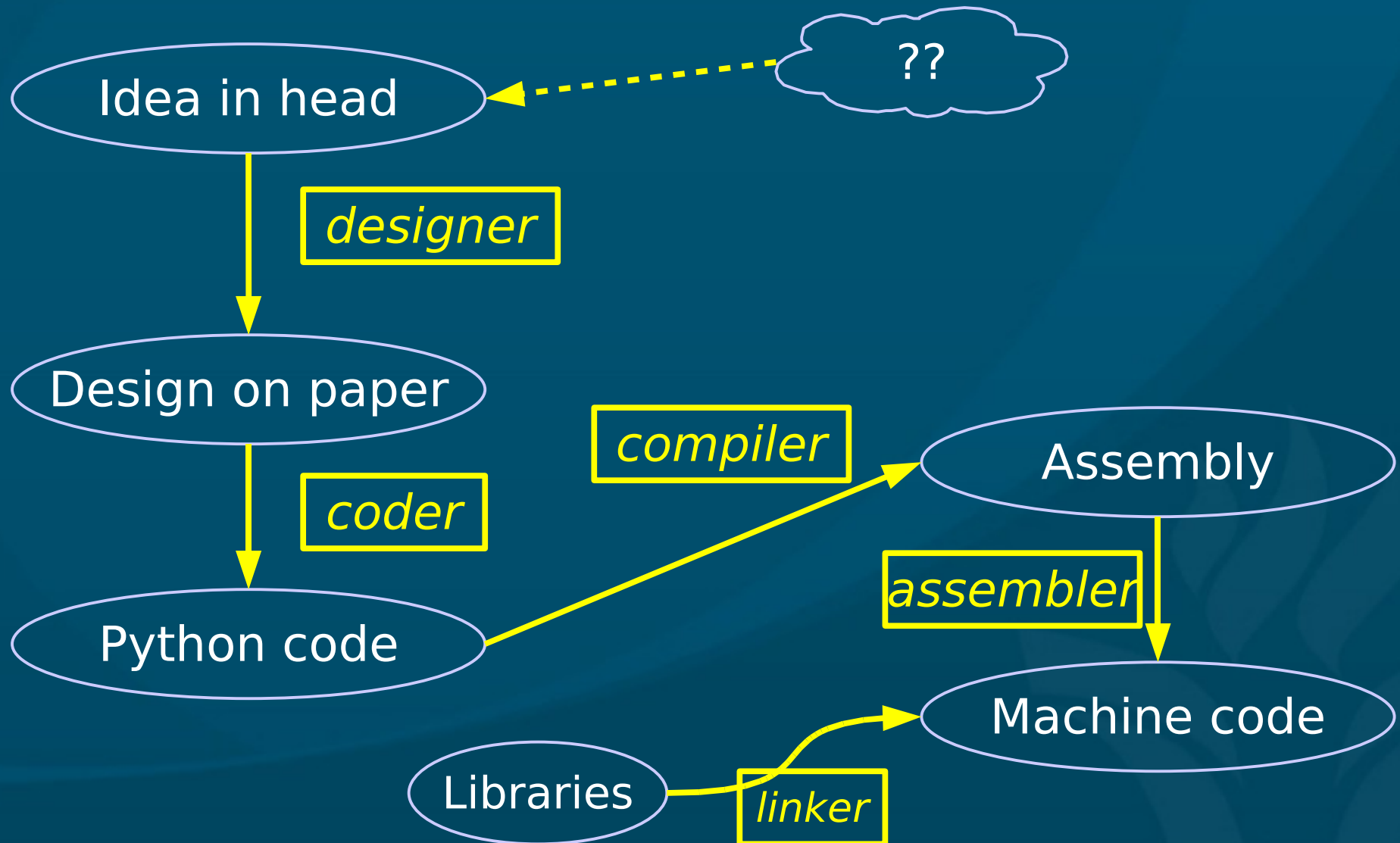
- Together with the software, the environment presented to the computer user by these is the **virtual machine**

# Software abstractions

- **Instructions:** basic commands to computer
  - e.g., ADD x and y and STORE the result in z
- **Programming language:** set of all available instructions
  - e.g., Python, C++, machine language 
- **Program:** sequence of instructions
  - e.g., your “Hello World” program
- **Software:** package of one or more programs
  - e.g. Microsoft Word, Microsoft Office 
- **Operating system:** software running the computer: provides environment for programmer
  - e.g., Windows XP, Mac OSX, Linux, etc.  



# Programming is translation



# Control abstractions

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- **Sequence**: first do this; then do that
- **Selection (branch)**: IF ... THEN ... ELSE ...
- **Repetition (loop)**: WHILE ... DO ....
- **Composition (subroutine)**: call a function
- **Parallelism**: do all these at the same time
  
- These are the basic building blocks of program control and structure

# Pseudocode

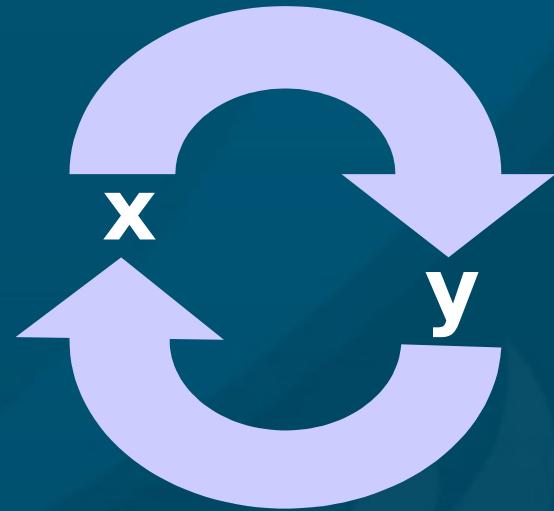
- Pseudocode is sketching out your design
  - General enough to not get tied up in details
  - Specific enough to translate into code
- Use the five control abstractions
- Usually several iterations of pseudocode, getting less abstract and closer to real code
- Don't worry about syntax; worry about semantics
  - Repetition can be done with WHILE ...

DO ...

or LOOP ... UNTIL ...

# Example pseudocode: swap

- Problem: **swap** the values of  $x$  and  $y$
- Initial solution:
  - $x \leftarrow y$
  - $y \leftarrow x$
- Will this work?
- Try again:
  - $temp \leftarrow x$
  - $x \leftarrow y$
  - $y \leftarrow temp$



# Example pseudocode: add 1..20

- Problem: add the integers between 1 and 20
- Initial solution:
  - Initialize sum to 0
  - Initialize counter to 1
  - Repeat:
    - ◆ Add counter to sum
    - ◆ Add one to counter
  - Until counter = 20
- Will this work?

# Example: add 1..20 (second try)

## ■ Try again:

- Initialize sum to 0
- Initialize counter to 1
- Repeat:
  - ◆ Add counter to sum

- ◆ Add one to counter

## ■ Same semantics, different syntax

- Until counter = 21

## ■ Top-of-loop test vs. bottom-of-loop test

## ■ Alternate version:

- Initialize sum to 0
- Initialize counter to 1
- While counter < 21, repeat:
  - ◆ Add counter to sum

- ◆ Add counter to sum

- ◆ Add one to counter

# Pseudocode: you try (group effort!)

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- Problem: print the **largest** of a sequence of numbers



# Importing library functions

- Library functions are **building blocks**:
  - Tools that others wrote that you can use
- Functions are grouped into **libraries**:
  - If you want to use a pre-written function, you need to specify which library to **import** it from

```
import math
```

```
math.sqrt( 2 )           >>>  1.4142135623730951
```

```
math.pow( 3, 5 )        >>>  243.0
```

```
math.pi                 >>>  3.1415926535897931
```



# Review of today (1.8-2.1)

- Expressions and precedence
- Logical operators
- Five abstract components of hardware
- Software: instructions, languages, programs, operating system
- Designer -> coder -> compiler -> assembler + linker
- Five control/structure abstractions of programs
- Pseudocode
- Importing library functions

# Writeups for Labs 1-2 *(L1 due next wk)*

- Full writeups required starting with Lab3
- Labs1-2 can have **short** writeup:
  - **Design** (10 marks)
    - ◆ Name, student#, CMPT14x, lab section, Lab#1, date
    - ◆ Statement of the problem
    - ◆ Discussion of solution strategy
  - **Code** (30 marks)
    - ◆ Name, etc. again in code header
    - ◆ Well-commented code, formatted and indented
  - **Output** (10 marks)