CS Summer Challenge

Day 0x2

How does code work?

What is a Programming Language?

A language **that can be translated** to a language that the digital machine can understand.

A language that can be translated to binary code.

e.g. C, Python

C Demo

How does code work?

The First PL

Assembly Language

A set of basic operations that translate directly to runnable binary encodings.

Structure of an Assembly Operation

<operator> <*operand_1*> <*operand_2*>

```
add   <arg_1>, <arg_2>
subt  <arg_1>, <arg_2>
and   <arg_1>, <arg_2>
or    <arg_1>, <arg_2>
mov   <arg_1>, <arg_2>
```

Assembling: Translating Assembly to Binary

Every assembly **operator** has a corresponding **unique binary code**.

```
add     -->     0001
subt    -->     0010
and     -->     0011
or      -->     0100
mov     -->     0101
```

Every assembly **operand** has a **rule of translation** to binary encoding **based on its type**.

```
123     -->     1111011
‘c’     -->     1100011
```

Assembling: Translating Assembly to Binary

The translated binary operation is ready for sending to the processor to execute.

```
       add      $123,      $15
-->   0001     1111011    0001111
```

How does code work?

The PL Translator

Translator Software

- Takes a PL source file as input..
  - e.g. demo.c
- Parses the text of the source file..
- Detects structure in the source code that it understands..
  - e.g. `int main() { ... }`
    - This is a function: a sequence of related instructions).
  - e.g. `int year = 2022;`
    - This is a variable: a piece of identifiable data.
- Translates source code structure to binary code structure..
  - Instructions are decomposed into binary encodings.
  - Data is translated into its binary representation.

Types of Translators

- Compiler
  - Parses and translates full source file.
  - Produces a binary executable file that can be run separately.
    - e.g. *gcc* compiler for C PL

- Interpreter
  - Parses and translates source file line-by-line.
  - Runs each line after translating it.
  - Does not produce an output binary file.
    - e.g. *python3* interpreter for Python PL

Types of Translators

- Every translator is programmed to detect the structure of its corresponding PL.
  - We write code in a PL following the language’s rules.
  - The translator detects language rules in the source code.

How does code work?

Python, C

Python	C
# this is a comment...	// this is a comment...

variable = value	type variable = value;
	variable = value2;

var = val +/-* varX	type var = val +/-* varX;
function(varX, valY, ...)	function(varX, valY, ...);
var = func(varX, valY, ...)	type var = func(varX, valY, ...);

def func(var1, var2, ...):
    var = var1
    varX = func2(var2)
    return var + varX
	type func(type var1, ...) {
	    type var = var1;
	    type varX = func2(var2);
	    return var + varX;
	}