PRINCIPLES OF PROGRAMMING LANGUAGES

Names, Bindings and Scope

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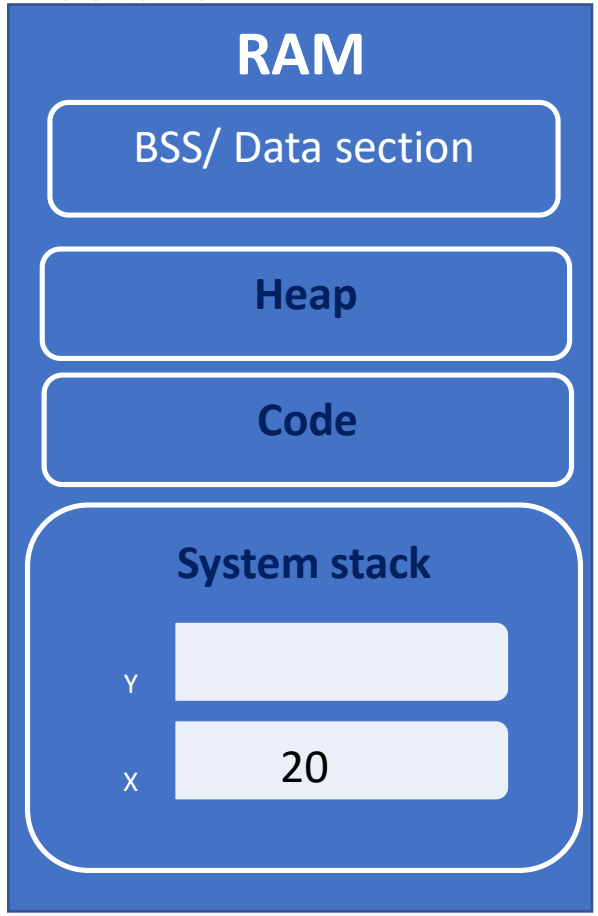
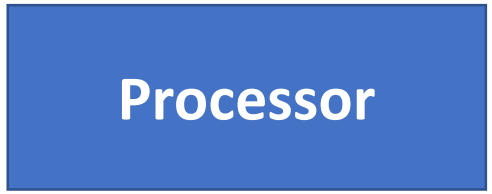
Names, Bindings and Scope

- Imperative languages are abstractions of von Neumann architecture
  - Memory
  - Processor

```
#include<stdio.h>
int main()
{
int x=20, y=x;
printf("%d\n%d\n",x,y);
return 0;
}
```





Variables

- Variables characterized by attributes
  - Name
  - Type
  - Scope
  - Lifetime
  - Address
  - Value

Names: Identifier naming

- Design issues for names:
  - Maximum length?
  - Are connector characters allowed?
  - Are names case sensitive? – readability ?
  - Are special words reserved words or keywords?
    - Context sensitive
    - Contextual keywords…

Variable attributes

- Name - not all variables have them
  - Dynamic variables (C) – through malloc…
- Address - the memory address with which variable is associated
  - A variable may have different addresses at different times during execution
  - A variable may have different addresses at different places in a program
  - If two variable names can be used to access the same memory location, they are called aliases
    - Aliases are created via pointers, reference variables, C and C++ unions

Variable attributes

- A variable may have different addresses at different times during execution

```
int fact(int x)
{
if(x==1)
return 1;
else
return (x *
   fact(x-1));
}
```

```
int main()
{
int f=fact(3);
… }
```

stack
X=1, return 1
X=2, 2 * (return..)
X=3, 3 * (return..)
Return to main

Variable attributes

- A variable may have different addresses at different places in a program

```
int f(int x)
{
int m = x;
…
{
int m=100;
…
}

}
```

Variable attributes

- If two variable names can be used to access the same memory location, they are called aliases
  - Aliases are created via pointers, reference variables, C and C++ unions
  - C and Python examples for pointers and reference types
  - (Union example in next Unit…)

Variable attributes

- *Type* - determines the range of values of variables and the set of operations that are defined for values of that type; in the case of floating point, type also determines the precision
- *Value* - the contents of the location with which the variable is associated
  - *Abstract memory cell* - the physical cell or collection of cells associated with a variable

Binding

- A **binding** is an association, such as between an attribute and an entity, or between an operation and a symbol
- **Binding time** is the time at which a binding takes place.

Possible Binding Times

- Language design time -- bind operator symbols to operations
- Language implementation time-- bind floating point type to a representation
- Compile time -- bind a variable to a type in C or Java
- Load time -- bind a FORTRAN 77 variable to a memory cell (or a C `static` variable)
- Runtime -- bind a non-static local variable to a memory cell

Possible Binding Times

- A binding is **static** if it first occurs before run time and remains unchanged throughout program execution.
- A binding is **dynamic** if it first occurs during execution or can change during execution of the program

Type Binding

- How is a type specified?
- When does the binding take place?
- If **static**, the type may be specified by either an explicit or an implicit declaration
  - Examples
    - C (Explicit)
    - Fortran (Implicit)

```
int f(int x)
{
int m = x;
…
{
int m=100;
…
} }
```

Type Binding - Dynamic

- Dynamic Type Binding (JavaScript, PHP, Python)
- Specified through an assignment statement e.g., JavaScript

```
list = [2, 4.33, 6, 8];
list = 17.3;
```

  - Advantage: flexibility (generic program units)
  - Disadvantages:
    - High cost (dynamic type checking and interpretation)
    - Type error detection by the compiler is difficult

Type Inferencing

- Examples – Haskell Functions

Value Binding - Initialization

- Examples – C, Java, C++

Do It Yourself

- Auto initialization in C for,
  - Array variable
  - Global variable
    - Only constants allowed or can it be dynamic?
  - Static variable in global & local scopes

THANK YOU

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