CS201 - PL'S

Data Types - 01

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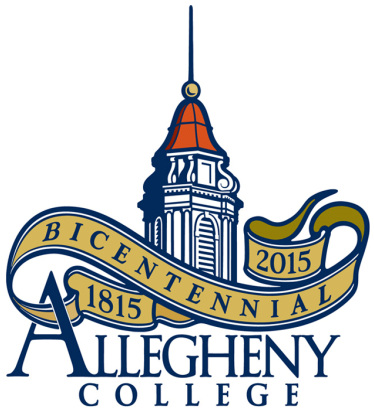

Example of Data Types

- Primitive Data Types
- Reference data types
- ADT (abstract data types)

Data Types

- What are types good for?

  Implicit context, checking, make sure that certain meaningless operations do not occur.
- *Type checking:* cannot prevent all meaningless operations. It catches enough of them to be useful.
- *Polymorphism:* results when the compiler finds that it doesn't need to know certain things.

What Does “Implicit Context” Mean?

When we see a statement such as: `x = y + z;` are we:

- adding two int values, storing in an int?
- adding two int values, storing in a double?
- concatenating a string and an int, storing in a string
- adding an int and a double, storing in a double?

What Does "Implicit Context" Mean?

When we see a statement such as: `x = y + z;` are we:

- If we were writing machine code, WE WOULD HAVE TO SPECIFY THIS
  (e.g., we would have to explicitly convert int to double before adding to a double or storing as a double; we would have to reserve space for the new string; etc.).
- Type information gives the compiler or interpreter a context that enables it to figure this out.

What is Polymorphism?

- In this context we are concerned with situations when the same variable can refer, at different times, to values of different types.
- The most familiar example to Java programmers occurs in subclasses.

Polymorphism

```
public class A
{
 int x;
     ... }
public class B extends A
{
  String x;
     ... }
```

```
A first = new A();
B second = new B();
A third = new B();
```

What is the type of "third.x"?

int or String?

What is Polymorphism?

In Java, a subclass cannot override an instance variable of the parent class; however, it can "shadow it".
On the other hand, methods CAN be overridden.

Data Types

STRONG TYPING has become a popular buzz-word

– like structured programming
– informally, it means that the language prevents you from applying an operation to data on which it is not appropriate

STATIC TYPING

means that the compiler can do all the checking at compile time

Type System Examples

- Common Lisp is strongly typed, but not statically typed
- Ada is statically typed
- Pascal is almost statically typed
- Java is strongly typed, with a non-trivial mix of things that can be checked statically and things that have to be checked dynamically

Type System Common Terms

- **Discrete types** - countable
  integer, boolean, char, enumeration, subrange
- **Scalar types** - one-dimensional
- **Composite types**
  records (unions), arrays, sets, pointers, lists, files

Composite Types: Structs

- Several values of varying types under a common name.
- Made somewhat obsolete by classes and instances in object-oriented programming.

```
struct rec { /* declare the type */
     int i; double x; char s[10];
};
/* declare variables */
struct rec a,b,c;
a.i = 10; b.x = 4.14
```

Composite Types: Unions

Several values of varying types under a common name and sharing the same memory.

```
union share { /* declare the type */
        int i; double x; char s[10];
    };
    /* declare variables */
    union share a,b,c;
    /* this changes a.x and a.s also */
    a.i = 10;
```

Composite Types: Enums

Symbolic names (actual underlying values not important).

```
enum weekday {mon,tue,wed,thu,fri,sat,sun};
    enum weekday d;
    d = mon;
    if (d < fri) ...
```

Composite Types: Sub ranges

- Lets you put bounds on the allowed values for certain variables.
- E.g., if we really want an integer variable to hold only values between 1 and 31, we can create a subrange type. (Pascal and Ada both have this.)

Example (Ada):

```
subtype Day is Integer range 1..31;
   ...
-- d may hold only values 1,...,31
d: Day;
```

Type Systems

A collection of features is orthogonal if there are no restrictions on the ways in which the features can be combined

ORTHOGONALITY is a useful goal in the design of a language, particularly its type system

Orthogonality Example

Pascal is more orthogonal than Fortran, (because it allows arrays of anything, for instance), but it does not permit variant records as arbitrary fields of other records (for instance).

Orthogonality is nice primarily because it makes a language easy to understand, easy to use, and easy to reason about

Type Checking

A TYPE SYSTEM has rules for:

- **type equivalence** (when are the types of two values the same?)
- **type compatibility** (when can a value of type A be used in a context that expects type B?)
- **type inference** (what is the type of an expression, given the types of the operands?)

Reading Assignment

PLP Chapter 07 [7.1, 7.2]

Questions

Ask Questions from this class discussion?