Programming Paradigms

Type Systems (Part 3)

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Overview

- Introduction
- Types in Programming Languages
- Polymorphism ←
- Type Equivalence
- Type Compatibility
- Formally Defined Type Systems

Meaning of “Type”

Three interpretations

- Denotational: Set of values
- Structural: Built-in, primitive type or composite type created from simpler types
- Abstraction-based: Interface that provides a set of operations

In practice: Combination of all three

Polymorphism

- **Greek origin: "Having multiple forms"**
- **Two kinds**
  - Parametric polymorphism: Code takes (set of) type(s) as parameter
    - E.g., generics in Java, containers in C++
  - Subtype polymorphism: Extending of refining a supertype
    - E.g., subclasses in Java or C++

Demo

ParametricPolymorphism.java

Demo

SubtypePolymorphism.java

Polymorphic Variables

In some PLs, a single variable may refer to objects of completely different types

Example (pseudo language):

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a = "abc"
b = 42
a = b
a = "def"
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Type-correct in most dynamically typed (and even some statically typed) PLs

Special Types and Values

- `void` **type: Indicates the absence of a type and has only one (trivial) value**
- `null` **value: Means “does not hold a value of its type”**
- **Option types: Indicates that the value may or may not hold a value of a specific type**
  - □ E.g., `Option[int]` in Python means `int` or `None`

Quiz

Which of the following statements is true?

- A type system checks whether all types in a program are equivalent.
- PLs with dynamic scoping may be statically typed.
- Subclasses are a form of polymorphic typing.
- Option types cannot exist in strongly typed PLs.

Please vote in Ilias.

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Which of the following statements is true?

- Types are compatible if and only if they are equal
- Coercions mean that a programmer casts a value from one type to another type
- Type conversions are guaranteed to preserve the meaning of a value
- PLs with type inference may provide static type guarantees

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