Three useful categories

Learning a programming language involves:

Syntax: The grammar rules defining a program fragment.

Semantics: The meaning of various programming fragments.

Pragmatics: How to *effectively* use language features, libs, IDEs, …

All three of these are important in how easy it is to easily write high-quality software.

For all categories, consider: Principle of least surprise.

Some vocabulary

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- *variable*:

- *type*:

- *expression*:

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  E.g. Java's `short` = {-32768,..., -1,0,+1,+2, ..., +32767}.
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  E.g. Java's `short` = {-32768,..., -1,0,+1,+2, ..., +32767}.

- *expression*: a piece of syntax which evaluates to some particular value.

  E.g. `3+4*5` or `sqrt(16)`.

Some vocabulary (cont.)

- *literal:* a piece of syntax which evaluates immediately to a particular value.

  E.g. Java `37` or `045` are both literals representing the value 37, which is of *type* `int`. And `37.`, `37d`, `37e0` are each literal `double` s.

  (We *will* often conflate a literal with the value it represents, and only say "literal" when we're emphasizing that we're dealing with syntax.)

trivia: Interning Java string-literals

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"Cathay".substring(3).equals("hay")
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Morever: string-literals with + are computed at compile-time.

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"Cat".concat("hay") == "Cathay" // false
"Cat" + "hay" == "Cathay"       // true (!)
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typing: when?

statically-typed: At compile-time, the types of all declared names are known.

Can be provided by programmer and checked by type-system, or inferred by the language (ML, Haskell).

(C# allows simple `var n = 5;` and infers `n` ∈ int).

dynamically-typed: Language knows the type of every value.

But a variable might hold values of different types, over its lifetime. php, javascript, racket. Each value may include some extra bits, indicating its type.

typing: other approaches

duck typing: Care about an object having a field/method, not any inheritance.

E.g. javascript

untyped:

E.g. assembly

type-safe: Any type error is caught (either dynamically or statically).

Note that C is not type-safe, due to casting. Java's casting *is* type-safe (since a bad cast will fail at run-time).

typing: strong/weak/non

These terms are often used in different ways:

strongly typed: no/few implicit type conversions,
or statically typed

weakly typed: many implicit type conversions,
or dynamically typed

Consider Java `Math.sqrt(16)`, and Java vs php `"50" + 60`.

Compiling vs Interpreting

- A compiler is a function

  $compile : source\text{-}code \rightarrow machine\text{-}code$

  The resulting machine-code, when executed, runs the program which produces a resulting value.

- An interpreter is a function

  $eval : expr \rightarrow value$

  which evaluates an expression, producing a resulting value.

Compiling vs Interpreting (cont.)

- Running interpreted code, you are running the interpreter, which is looking at the source-expression as if it were data.
- Running interpreted code, you are running the interpreter, which is looking at the source-expression as if it were data.
- Running compiled code, you are running the program directly.
- Compiled code: faster, but platform-specific.

The distinction is practical, but not fundamental: You can even claim that CPUs are simply interpreters: they read compiled-code as data (from memory), and update their internal state accordingly.