

Ocean Lu
CS 4080
Professor Lan Yang
10 September 2019

Programming Languages: Assignment #1

1. What does syntax describe? Give three examples of syntax errors (three different kinds of syntax errors – do not use the exact same examples discussed in the lectures). Name three different ways of defining syntax.

The syntax of a programming language is the form of its expressions, statements, and program units, meaning to describe a language's definition for implementation and programmers. The errors discussed in the lecture were missing semicolon, not specify variable type, and mismatched curly braces `{ }`. Three examples of syntax error not discussed in lectures are:

- Incorrect arguments (ex: `while(.)` //where `while()` cannot contain `“.”` as an argument)
- Missing quotation marks (ex: `System.out.println(Hello World);`)
- Incorrect equation (ex: `“12*+5”`)

Three different ways of defining syntax are:

- The arrangement of words and phrases to create well-formed sentences in a language. (<https://www.lexico.com/en/definition/syntax>)
- the way in which linguistic elements (such as words) are put together to form constituents (such as phrases or clauses) (<https://www.merriam-webster.com/dictionary/syntax>)
- Syntax, the arrangement of words in sentences, clauses, and phrases, and the study of the formation of sentences and the relationship of their component parts. (<https://www.britannica.com/topic/syntax>)

2. What does semantics describe? Give three examples of semantics errors (three different kinds of semantics errors – do not use the exact same examples discussed in the lectures). Name two different ways of defining semantics.

Semantics describe is the meaning of those expressions, statements, and program units. Semantics should follow directly from syntax; that is, the appearance of a statement should strongly suggest what the statement is meant to accomplish. Three kinds of semantics errors are:

- Non-initialized variable (ex: `int i; i++`)
- Type incompatibility (ex: `int a = “hello”;`)
- Array index out of range (ex: `int[] v = new int[10]; v[10] = 100;`)

Two different ways of defining semantics are:

- The branch of linguistics and logic concerned with meaning.
(<https://www.lexico.com/en/definition/semantics>)
- Scientific study of the meaning of words: how people assign meaning to words. (<http://www.businessdictionary.com/definition/semantics.html>)

3. Use EBNF or BNF to describe the syntax of Java if statements, no need to further define other statements or Boolean expressions.

The BNF to describe the syntax of Java if statement:

- `<if then statement> ::= if (<expression>) <statement>`
- `<if then else statement> ::= if (<expression>) <statement no short if> else <statement>`
- `<if then else statement no short if> ::= if (<expression>) <statement no short if> else <statement no short if>`

4. Python uses indention in its program structures. How do you define the syntax of a language construct that uses indention? Give an example to describe. (Note: do online search to find the complete BNF grammar rules for Python.)

Parsing an indention-sensitive language uses the lexical analyzer, which turns leading whitespace into INDENT and DEDENT tokens. For example:

suite ::= stmt_list NEWLINE | NEWLINE INDENT statement+ DEDENT

5. Use pseudo code such as

```
a = b op c      (note: op could be any common operators such as +, -, ..., <, >, ...)
```

```
if a < b goto L
```

```
goto L          (note: goto L means "jump-to L" or "j L".)
```

to describe the semantics of the following Java-like while statement

```
while (a < b ) {
    s = s + b * c;
    a = a + 1;
}
```

while (a op (<) b)

set s equal to s op (+) b op (*) c

set a equal to a op (+) 1

end

6. (optional) Repeat problem 5 but now we change while (a < b) to while (a < b && b < c)
 { ... }

while (a op (<) b and b op (<) c)

 set s equal to s op (+) b op (*) c

 set a equal to a op (+) 1

end

Note: optional problem could be used to substitute any above problem, for example, if you did problem 4 wrong but problem 6 correctly you could use problem 6 to fulfill the points requirement of problem 4. However, there won't be any bonus points beyond 10 points for this assignment (i.e. maximum points is 10.)