Front Phases of Compiler

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Next Step: Understand the Structure of Sentence

Are the following sentences structurally correct?

- We are living in an era of pandemic.
- We is living in an era of pandemic.

Structure of the sentence needs to verified without looking at the context information.

Parsing (also Known as Syntax Analysis)

Once the tokens are identified, the next phase is to recognize the structure of the sentence.

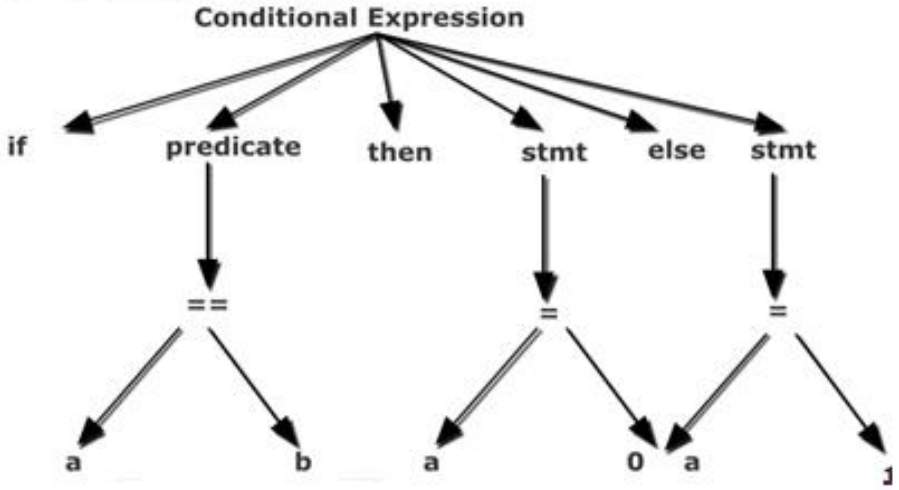
This process is known as syntax analysis/parsing.

Example of Parsing

Syntax Rule is as follows:

Conditional Expression → if predicate then stmt else stmt

Parse Tree for if a==b then a=0 else a=1

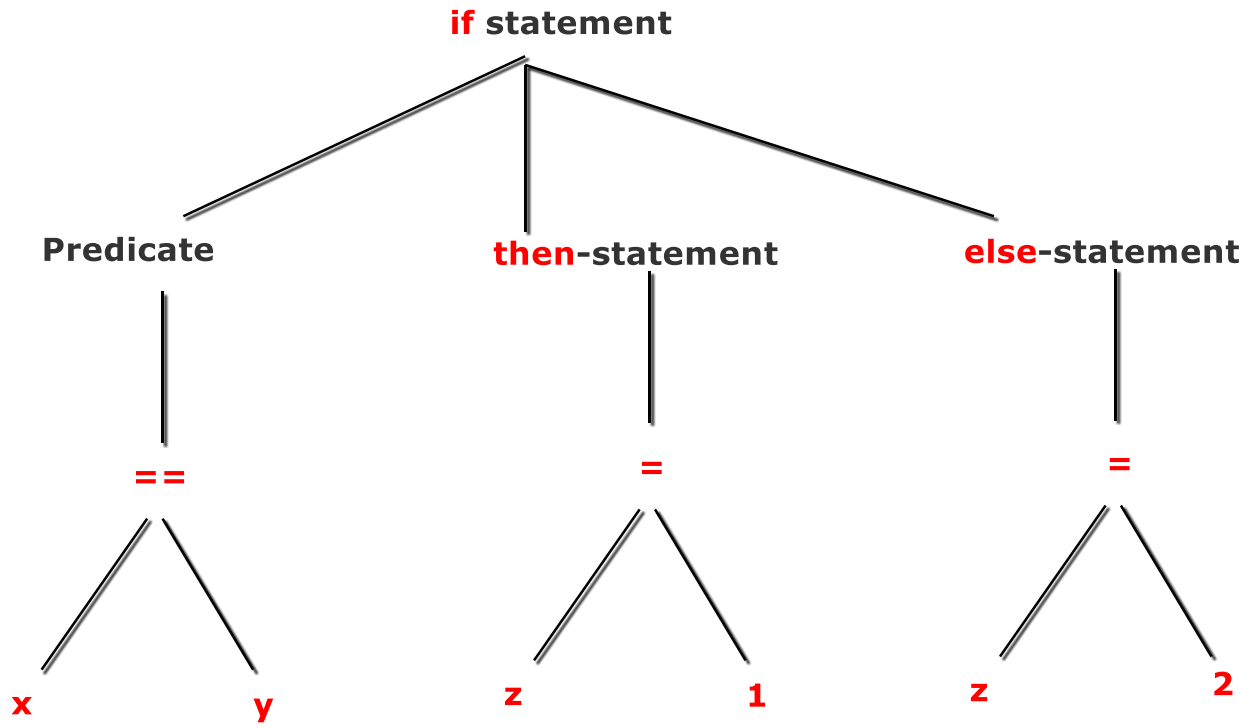


Parsing

Parsing

- Consider an expression

  if x == y then z = 1 else z =2



Syntax Analysis

Check Syntax and construct the parse tree.

Error reporting and error recovery must be done.

Model using Context-free Grammars that will be recognized using Pushdown Automata/Table driven parsers.

Common Syntactic Errors

Missing Operator

Unbalanced Parenthesis

Understanding the Meaning

Once the syntax of sentence is identified, the next step is to recognize the meaning of the sentence.

It is also known as Semantic Analysis.

Understanding the Meaning

For e.g. Ram said Shyam completed his compiler project as an open book assignment.

- What does his refer to ? Ram ? Shyam ?

Ram said Ram completed his compiler project as open book assignment.

Semantic Analysis

- Compilers carry out analysis for recognizing the meaning and identify discrepancies.
- Programming languages outline firm guidelines for escaping such ambiguities
- {int p = 1;

```
    { int p = 2;
        printf (p);
    }
}
```

More on Semantic Analysis

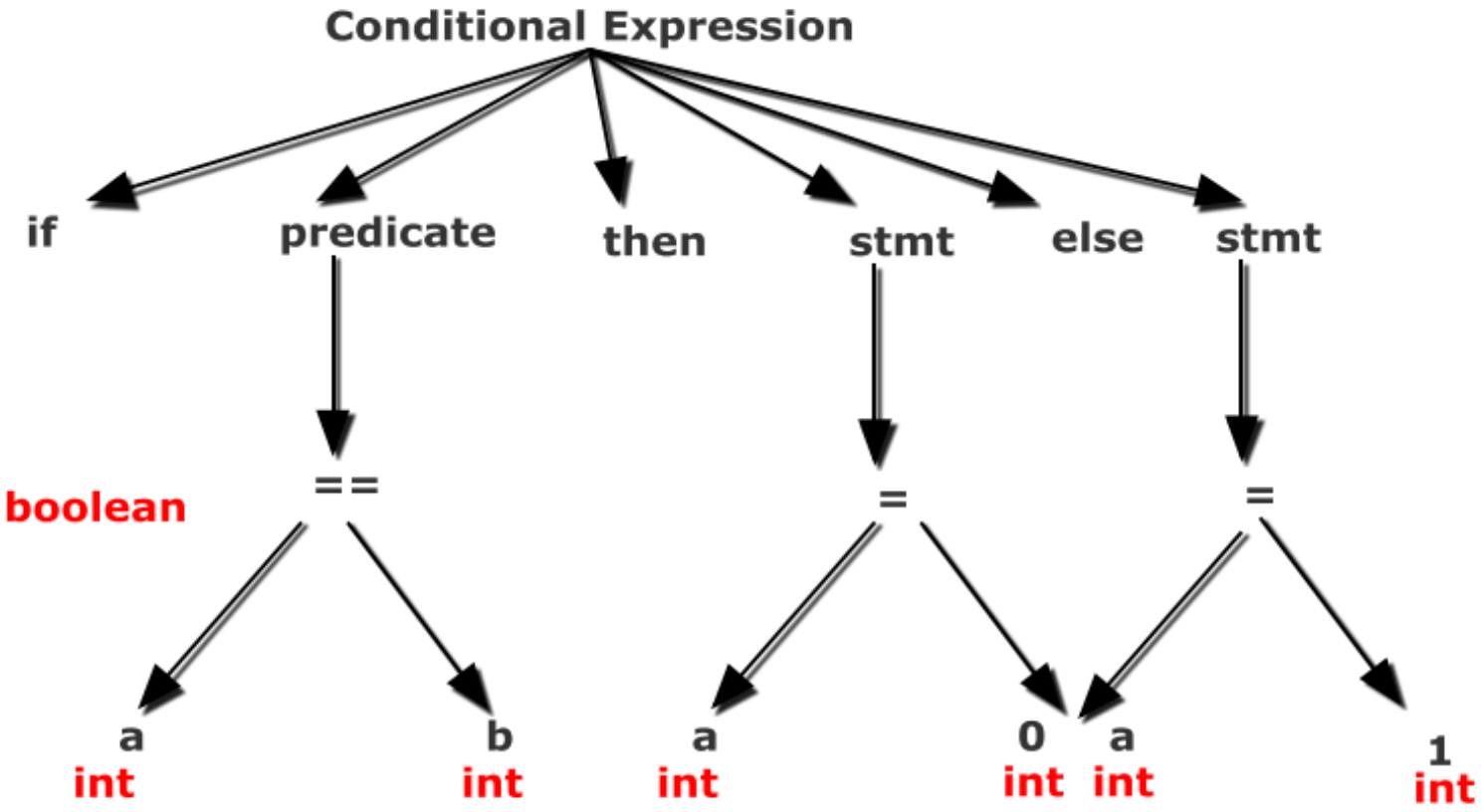
Compilers perform many other checks besides variable bindings.

Type Checking

- Ram left her Slide Changer in lecture theatre.
- There is a type mismatch between her and Ram. Apparently, Ram is a male.

Semantic Analysis

Output of Semantic Analysis: Disambiguated Parse Tree



More on Semantic Analysis

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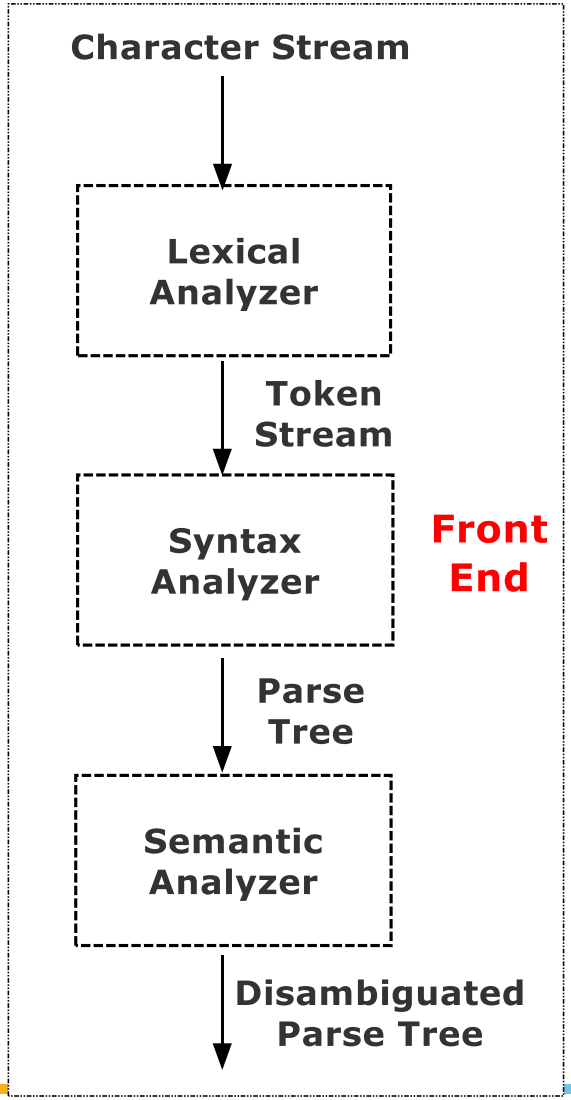
Check Semantics

- Error Reporting
- Disambiguate Overloaded Operators
- Type Coercion
- Uniqueness Checking

Compiler Translation Phases (Covered Till Now)



Code Optimization (Optional)

Optimization does not change the representation of the program.

Automatically modifies the programs so that they

Run faster.

Consume less resources like memory, registers, etc.

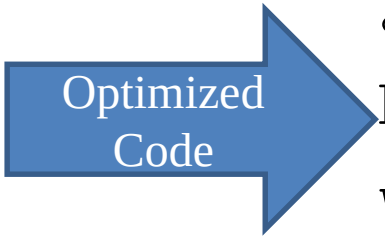
Examples of Machine-Independent Source Code Optimization

- Common sub-expression elimination
- Copy Propagation
- Dead Code Elimination
- Code Motion
- Strength Reduction
- Constant Folding

Examples of Code Optimization

Before Optimization

```
a = 200;
 while(a>0)
 {
      b = x + y;
      if (a % b == 0}
      printf("%d", a);
   }
```



After Optimization

```
a = 200;
b = x + y;
while(a>0)
  {
      if (a % b == 0}
      printf("%d", a);
   }
```

Examples of Code Optimization

Before Optimization

```
B = A x 2
```

After Optimization

```
B = A + A
```

Examples of Code Optimization

Before Optimization

```
PI = 3.14
A = 4 * PI * R^2
V = (4/3) * PI * R^3
```

After Optimization

```
X = 3.14 * R * R
A = 4 * X
V = 1.33 * X * R
```