Instituto Tecnológico y de Estudios Superiores de Monterrey
Campus Estado de México
Escuela de Ingeniería y Ciencias, Región Ciudad de México
Departamento de Computación

Compiler Design Final Mock Exam
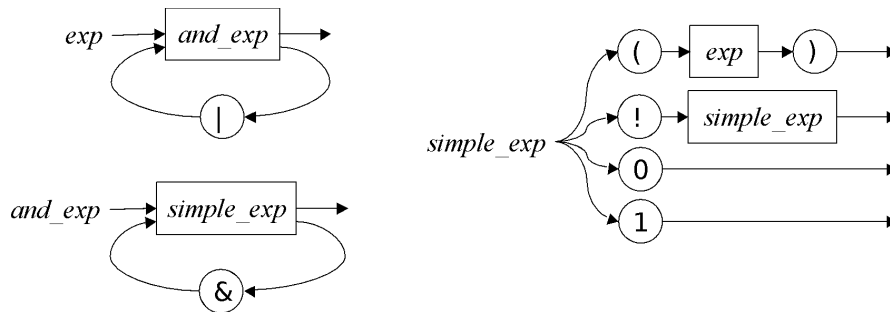
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INSTRUCTIONS

You must solve the following problem on your own using your mobile computer. You are allowed to use any information and/or software contained in your computer, as well as any written material (manuals, program listings, books, notes). During the exam you may not speak to anyone, or use material belonging to somebody else.

The complete solution to the problem must be stored in one, and only one, source file called `A0MMMMMMM.cs` (where `A0MMMMMMM` is your student ID). Hand this file to your instructor. Make sure the source file includes at the top your personal information (name and student id) within comments.

Time limit: 120 minutes.

PROBLEM DESCRIPTION

Boolang is a small boolean expression language. The following is a syntax diagram for this language (where *exp* is the start symbol):

The language has the following semantics:

1.   The symbols `0` and `1` represent the literal values of false and true, respectively.
2.   The symbol `!` represents the conventional *not* prefix unary operator.
3.   The symbol `&` represents the conventional *and* infix binary operator.
4.   The symbol `|` represents the conventional *or* infix binary operator.
5.   The precedence and associativity of the operators is defined in the syntax diagram itself.
6.   Parenthesis may be used for grouping sub-expressions and forcing a specific evaluation order.
7.   Any space and tab characters contained within an expression should be ignored.

Write a C# program that compiles a *Boolang* expression. For any given input, your program must parse it, build an abstract syntax tree, and generate WebAssembly text code. Have this in mind:

●   The input expression is always received as a command line argument.
●   If a syntax error is detected, a "parse error" message should be displayed, and the program should end.
●   If no syntax errors are detected, the AST should be displayed.
●   The WebAssembly text code output must always be stored in a file called `output.wat`.
●   The purpose of the generated code is to evaluate at runtime the input expression and return its result.
●   The `execute.py` command will be called manually from the terminal.

A COMPLETE EXAMPLE

When given the next command at the terminal:

```
mono boolang.exe '!(0 | 0) | 0 & 1'
```

the following AST should be displayed at the standard output:

```
Program
  Or
    Not
      Or
        Literal_0
        Literal_0
    And
      Literal_0
      Literal_1
```

and the contents of the generated `output.wat` file should be:

```
(module
  (func
    (export "start")
    (result i32)
    i32.const 0
    i32.const 0
    i32.or
    i32.eqz
    i32.const 0
    i32.const 1
    i32.and
    i32.or
  )
)
```

Note that the WebAssembly text code always has the same `start` function signature. Use this previous example to deduce by yourself the mapping between WebAssembly instructions and the different Boolang language elements.

The provided `execute.py` script takes care of compiling and running the WebAssembly code. At the terminal, this command:

```
python execute.py
```

should produce the following output:

```
1
```

GRADING

The grade depends on the following:

1. **10**   The C# code compiles without errors.
2. **30**   Fulfills point 1, plus: performs lexical and syntax analysis without any errors.
3. **50**   Fulfills points 1 and 2, plus: builds and prints the AST without any errors.
4. **100**   Fulfills points 1, 2, and 3, plus: generates WebAssembly text code without any errors.

"There are only two kinds of programming languages:
those people always bitch about and those nobody uses."

– Bjarne Stroustrup, creator of C++.