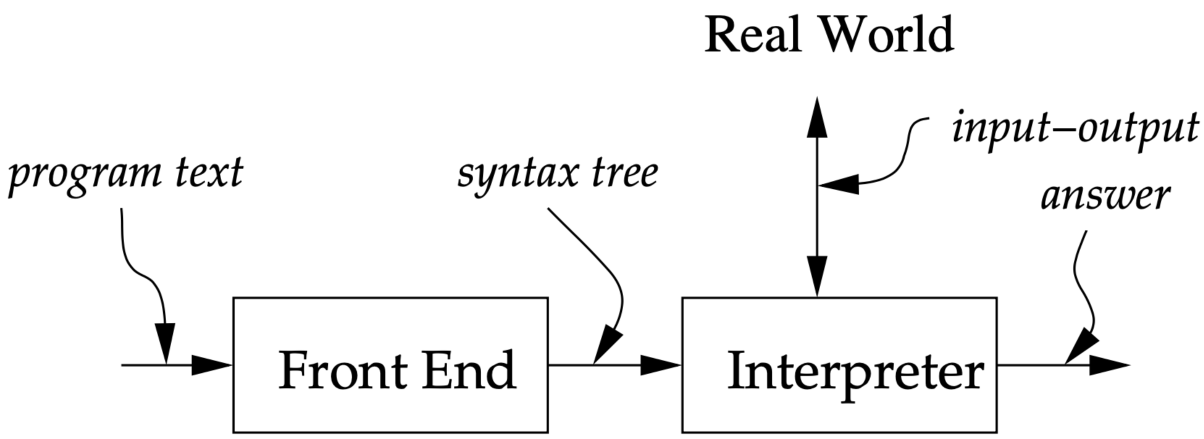
COMP301 Project 2

Project completed by Altun Hasanli. Code passess all tests provided.

Part A.

Write the 5 components of the language. For each component, specify where or which racket file (if it applies) we define and handle them.



Execution via an interpreter — the 5 components:

- **Program Text:** Input Program in Source Language
- **Front End:** Scanner & Parser (implemented using a parser generator)
- **Syntax Tree**: AST of expressions that the parser generates
- **Interpreter:** Evaluates the AST into one of the expressed values (datatypes)
- **Answer:** Expressed Values given by the interpreter

The corresponding 5 components of MY-LET:

1: Lexical Specification - specifies how an input program written in the source language gets scanned and tokenized by the **Scanner (lexical analyzer)**. **MY-LET** allows for integers (negative and positive constants) and identifiers only, separated by comments and arbitrary whitespace. Lexical specification is defined in **`lang.rkt`**.

2: Grammar (Syntax) - specifies the source language (defined language) syntax in `PL BNF` rule format, and how it gets parsed into an **AST** by the **Parser (syntactic analyzer)**. Grammar specification is defined in **`lang.rkt`**. Programs in **MY-LET** are nested expressions that get evaluated to an expressed value. There are 10 different expression types.

3: Analyzer (Scanner & Parser: the two stages of the Front-End) - takes a program in source language and builds an AST. Lexical and grammar specifications are used in `**SLLGEN**` (Scheme **`LL(1)`** parser generator, defined in EOPL) procedures to generate another procedure that inputs an input program in the source language (PL syntax) and outputs an AST: `scan&parse` in `**lang.rkt**`.

4: Expressed Values (datatypes) - specifies the final results (evaluated values) of expressions in **MY-LET**. They are: *`num`*, *`rational`*, *`bool`*, *`list-of-nums`*. These are structs with fields to hold the corresponding values in the **implementation language**. Defined and handled in **`data-structures.rkt`**. Datatypes, procedures to convert values from implementation language to defined language, and vice versa (extractors) are handled in the same file.

5: Interpreter (evaluator) - evaluates the different expressions of the language, extracts their semantic value (evaluation). Uses an environment to keep track of bound variables (defined and handled in `**environments.rkt**` and **`data-structures.rkt`**). Evaluation of a **MY-LET** program is handled in `value-of-program` **in `interp.rkt`**, and the recursive procedure `value-of` ****that it uses the handle the different expressions of** MY-LET**.

Part B.

The initial environment is defined in `init-env` ****in** `environments.rkt` **.

```
;; init-env : () -> Env
;; usage: (init-env) = [z=304, y=302, x=301]
(define (init-env) (extend-env 'z (num-val 304)
                               (extend-env 'y (num-val 302)
                                     (extend-env 'x (num-val 301)
                                             (empty-env))))))
```

Using the syntax in EOPL, p.61,

```
(init-env) => ρ
= [z=[304]]([y=[302]([x=[301]][]))
= [z=[304]]([y=[302][x=[301]])
= [z=[304]][y=[302], x=[301]]
= [z=[304], y=[302], x=[301]]
```

Part C.

In MyProc, expressed and denoted values are the same, and are as follows:
`ExpVal` = `DenVal` = `Int` + `Bool` + `Pair<Int, Int>` + `List<Int>`

Interface for them:

- **`num-val`** : Int -> ExpVal
- **`bool-val`** : Bool -> ExpVal
- **`rational-val`** : Pair<Int, Int> -> ExpVal
- **`list-of-nums-val`** : List<Int> -> ExpVal
- **`expval->num`** : Expval -> Int
- **`expval->bool`** : Expval -> Bool
- **`expval->rational`** : Expval -> Pair<Int, Int>
- **`expval->list`** : Expval -> List<Int>
- **`list-val`** : List<Int> -> ExpVal(List<ExpVal(Int)>)

Part D.

Check the corresponding files for implementations. Notes:

- `list-exp` is named **`new-list-exp`**
- Because of the way `sloppy->expval` is defined, I had to separate the logic for lists. `list-of-nums-val` creates a struct with a single field for the list. `list-val` calls the same procedure but turns the list of numbers into list of number structs first. This logic can further be expanded for `car` and `cdr` accessors for the `list-of-nums`, or better yet, the list can be constructed as a pair of a pair of a pair of a ..., but it wasn't required.
- rational can be made into a struct with two fields: numerator and denominator, instead of a pair
- op-exp uses four helpers defined in **`interp.rkt`**
- `simpl-exp` uses `euclid-gcd` helper in **`interp.rkt`** which is O(log(n))