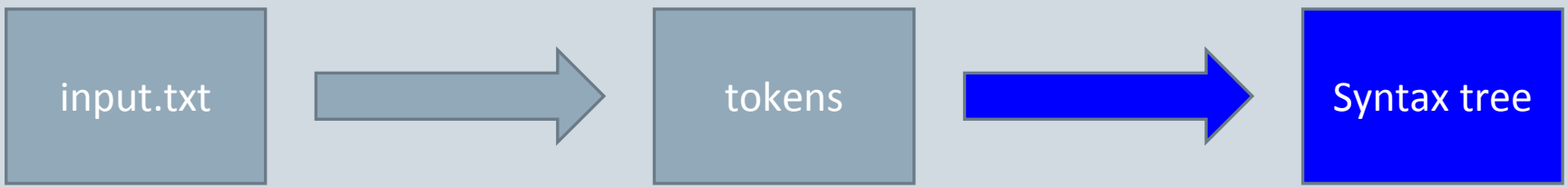
COS**341** 2020

PROJECT Specification: **Task Booklet 01**

Introduction

Your task is to implement a parser that can build a syntax tree from a list of tokens. This list of tokens will be created by your lexer from the previous part of this project.



Grammar of **SPL**

The following slides define the grammar of SPL using productions, (similar to what is found in your textbook).

Productions will be of the form **N** → $\mathbf{X_1 \ldots X_n}$

- Where N is a **non-terminal** symbol.
- $\mathbf{X_1 \ldots X_n}$ are zero or more symbols which are either **terminal** or **non-terminal.**
  - ***Terminal*** symbols that are italic refer to **tokens** defined by regular expressions from the previous part of this project.

Grammar of an SPL Program

PROG → CODE

PROG → CODE ; PROC_DEFS

PROC_DEFS → PROC

PROC_DEFS → PROC PROC_DEFS

PROC → proc *userDefinedIdentifier* { PROG }

CODE → INSTR

CODE → INSTR ; CODE

Grammar of an Instruction

INSTR → halt

INSTR → DECL

INSTR → IO

INSTR → CALL

INSTR → ASSIGN

INSTR → COND_BRANCH

INSTR → COND_LOOP

Grammar of IO

IO → input (VAR)

IO → output (VAR)

Grammar of a Call

CALL → ***userDefinedIdentifier***

Grammar of a Declaration

DECL → TYPE NAME

DECL → TYPE NAME ; DECL

Grammar of a Type

TYPE → num

TYPE → string

TYPE → bool

Grammar of a Name

NAME → ***userDefinedIdentifier***

Grammar of a Variable

VAR → ***userDefinedIdentifier***

Grammar of an Assignment

ASSIGN → VAR = *stringLiteral*

ASSIGN → VAR = VAR

ASSIGN → VAR = NUMEXPR

ASSIGN → VAR = BOOL

Grammar of a Numeric Expression

NUMEXPR → VAR

NUMEXPR → *integerLiteral*

NUMEXPR → CALC

Grammar of a Calculation

CALC → add (NUMEXPR , NUMEXPR)

CALC → sub (NUMEXPR , NUMEXPR)

CALC → mult (NUMEXPR , NUMEXPR)

Grammar of if-statements

COND_BRANCH → if (BOOL) then { CODE }

COND_BRANCH → if (BOOL) then { CODE } else { CODE }

Grammar of a Logic Expression

BOOL → eq (VAR , VAR)

BOOL → (VAR < VAR)

BOOL → (VAR > VAR)

BOOL → not BOOL

BOOL → and (BOOL , BOOL)

BOOL → or (BOOL , BOOL)

BOOL → T

BOOL → F

BOOL → VAR

Grammar of Loops

COND_LOOP → while (BOOL) { CODE }

COND_LOOP → for (VAR = 0 ; VAR < VAR ; VAR = add (VAR , 1)) { CODE }

SPL Program **Example**

```
input(x);
n = x;
r = "unknown";
s = "even";
checknumber;
if (eq(r, s)) then {
    output(s)
} else {
    output( r )
};
halt;
```

Example (cont.)

```
proc checknumber {
    num zero;
    zero = 0;
    m = n;
    if (( m < zero ))
        then { m = mult(m, -1) };
    while ((m < zero)) { m = sub(m, 2) };
    if (eq(m, zero))
        then { r = "even" }
        else { r = "odd" }
}
```

Your Tasks

- **Determine** with pen and paper **whether the SPL grammar is ambiguous**.
  - **If it is ambiguous: apply the appropriate grammar-transformation-techniques** to make it unambiguous. But **do not change the actual language** SPL itself!
    - **If you'd really want to work with an ambiguous SPL grammar, then you'd have to implement a GLR parser, which is difficult!**
- After you have dealt with the ambiguity question: **Determine** with pen and paper **whether you can write an LL(1) parser for your grammar**:
  - **If "yes",** then write an LL(1) parser.
  - **If "no",** then choose:
    - whether you want to write an SLR parser, or
    - whether you want to modify the grammar once more (without changing the SPL language itself!) in order to make the grammar suitable for LL(1) parsing.
- **Implement a parser** on the basis of chapter 2 of the book and on what you discovered in your theoretical analyses. **Help-Literature may be consulted**.

Input

Your parser must be able to take in a text file that has an SPL program. Some files will be valid programs in SPL and some might be grammatically incorrect (i.e.: containing syntax errors).

This input file should already be “tokenized” by your already existing lexer before it gets consumed by your parser.

Output

If your parser encounters something that it cannot parse it must output a descriptive error of where and why the error has occurred. For example the following could be the output that your parser prints:

Syntax Error [line: 2, col: 13]: Expected semicolon after INSTR.

Syntax Error [line: 4, col: 3]: Cannot compare EXPRs.

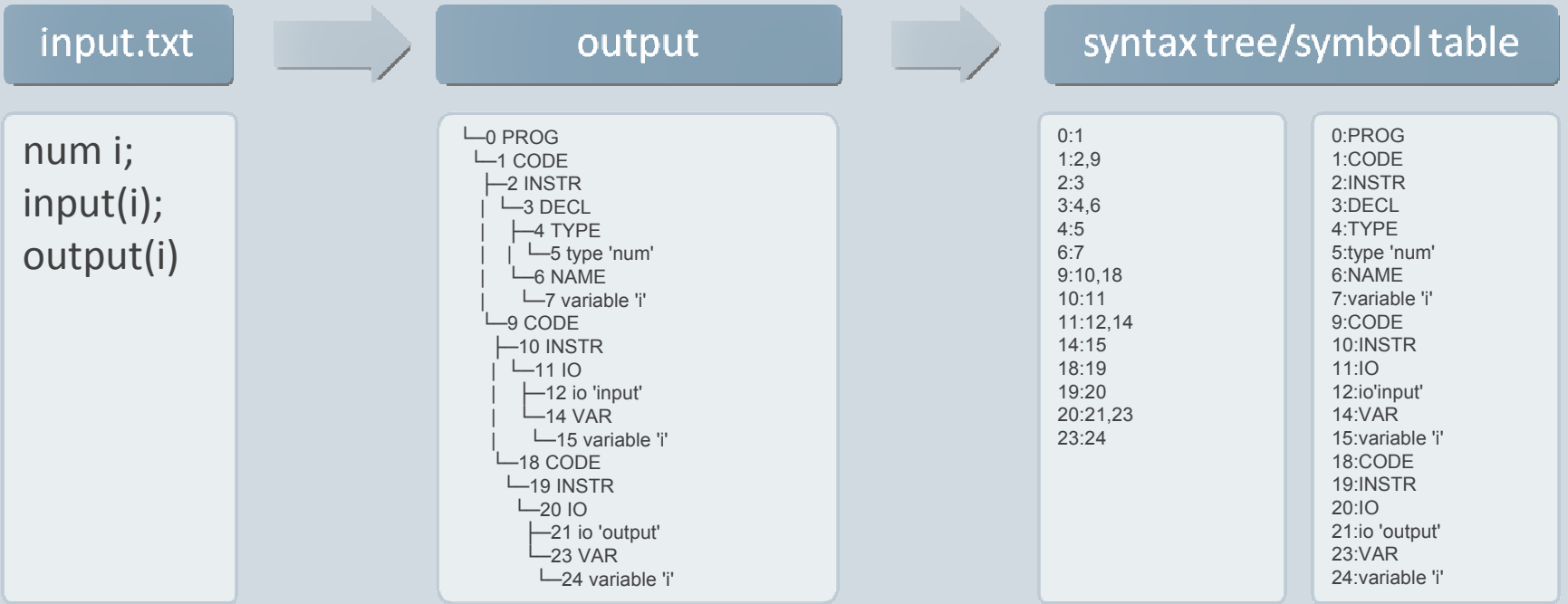
Output (cont.)

If no errors occur you must **first build a concrete syntax tree** which should **then be pruned creating an abstract syntax tree** (unnecessary tokens should be removed). **This abstract syntax tree and its symbol table must then be saved in (a) persistent file(s).**

- **Symbol Table ➔** Forthcoming: **Chapter 3** of our book.

Each tree node should have a unique ID and a pointer to its children nodes. **Each node should also have a pointer to the symbol table** where more information will be stored **(later),** such as each node's scope and value information, type information, etc...

Output: **Example**



Note: The syntax tree represents its nodes in the form NodeID:ChildrenIDs…
Note: You do not have to structure your tree or table exactly as shown above nor do your ID's have to correspond to the above example.

Additional Notes

- **You may not use any parser-generator tools!** Tools such as YACC and ANTLR are strictly forbidden. You must hand code your parser.
- **Plagiarism is not allowed!** You or your group may not use any code written by someone not within your own group.
- In the implementation language of your choice, you may not use any libraries or built-in language features that provide parser-combinator-like features such as “fastparse”.

And now: HAPPY CODING ☺ ☺ ☺