# A2 - Parser

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# Questions

(Copied and pasted from word doc)

## CSC 446

## Assignment #2

Instructor: Hamer
Due Date: Monday, February 10

## Grammar Rules

### Given Grammar for a Subset of Ada

```
Prog           ->  procedure idt Args is
                   DeclarativePart
                   Procedures
                   begin
                   SeqOfStatements
                   end idt;

DeclarativePart -> IdentifierList : TypeMark ; DeclarativePart | ε

IdentifierList  -> idt | IdentifierList , idt

TypeMark       -> integert | realt | chart | const assignop Value

Value          -> NumericalLiteral

Procedures     -> Prog Procedures | ε

Args           -> ( ArgList ) | ε

ArgList        -> Mode IdentifierList : TypeMark MoreArgs

MoreArgs       -> ; ArgList | ε
```

```
Mode            -> in | out | inout | ε

SeqOfStatements -> ε
```

---

## Programs

### Instructions

Draw the parse trees for the following programs. **Underline all tokens**

#### (a)

```
procedure one is
    two : integer;
begin

end one;
```

#### (b)

```
procedure two is
    three, four : integer;
    procedure five is
    begin

    end five;
begin

end two;
```

#### (c)

```
procedure three is
    four, five : integer;
    procedure six ( in seven : integer ; eight : integer ) is
    begin

    end six;
begin

end three;
```

---

### Hint:

You may want to use your paper sideways for drawing the parse trees.
Note: Save this grammar as it will be used in the next assignment.

---

## Program 1

```
procedure one is
    two : integer;
begin

end one;
```

First broke it into this production
`Prog -> procedure idt Args is DeclarativePart Procedures begin SeqOfStatements end idt ;`

---

### Mermaid Code

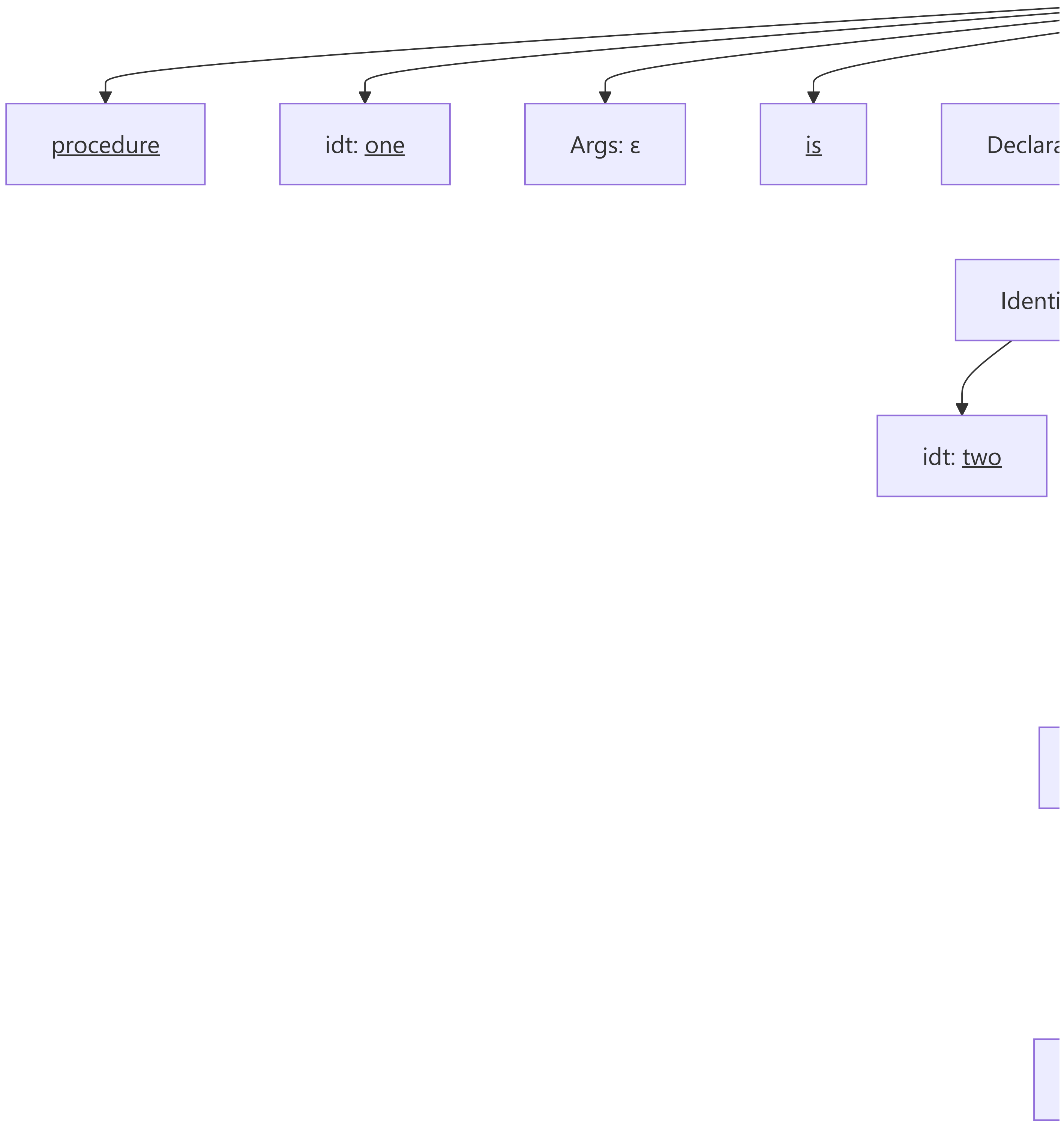
I've used mermaid code for previous projects, and i used it's html properties to add the underlining.

```
flowchart TD
%% Top-level node for Program (a):
    A[Prog]
    A1[<u>procedure</u>]
    A2[idt: <u>one</u>]
    A3[Args: ε]
    A4[<u>is</u>]
    A5[DeclarativePart]
    A6[Procedures: ε]
    A7[<u>begin</u>]
    A8[SeqOfStatements: ε]
    A9[<u>end</u>]
    A10[idt: <u>one</u>]
    A11[<u>;</u>]

    A --> A1
    A --> A2
    A --> A3
    A --> A4
    A --> A5
    A --> A6
    A --> A7
    A --> A8
    A --> A9
    A --> A10
    A --> A11

    %% DeclarativePart subtree:
    A5 --> DP1[IdentifierList]
    DP1 --> DP2[idt: <u>two</u>]
    DP1 --> DP3[<u>:</u>]
    DP3 --> DP4[TypeMark]
    DP4 --> DP5[integert: <u>integer</u>]
    DP5 --> DP6[<u>;</u>]
    DP6 --> DP7[DeclarativePart: ε]
```

---

## First Visualization

I tried using the mermaid renderer of my markdown editor, Obsidian. But, it doesn't quite work well.



## Resolving to Mermaid Chart

I searched for other good mermaid editors online and found MermaidChart.

Mermaid Chart - Create complex, visual diagrams with text. A smarter way of creating diagrams.

www.mermaidchart.com

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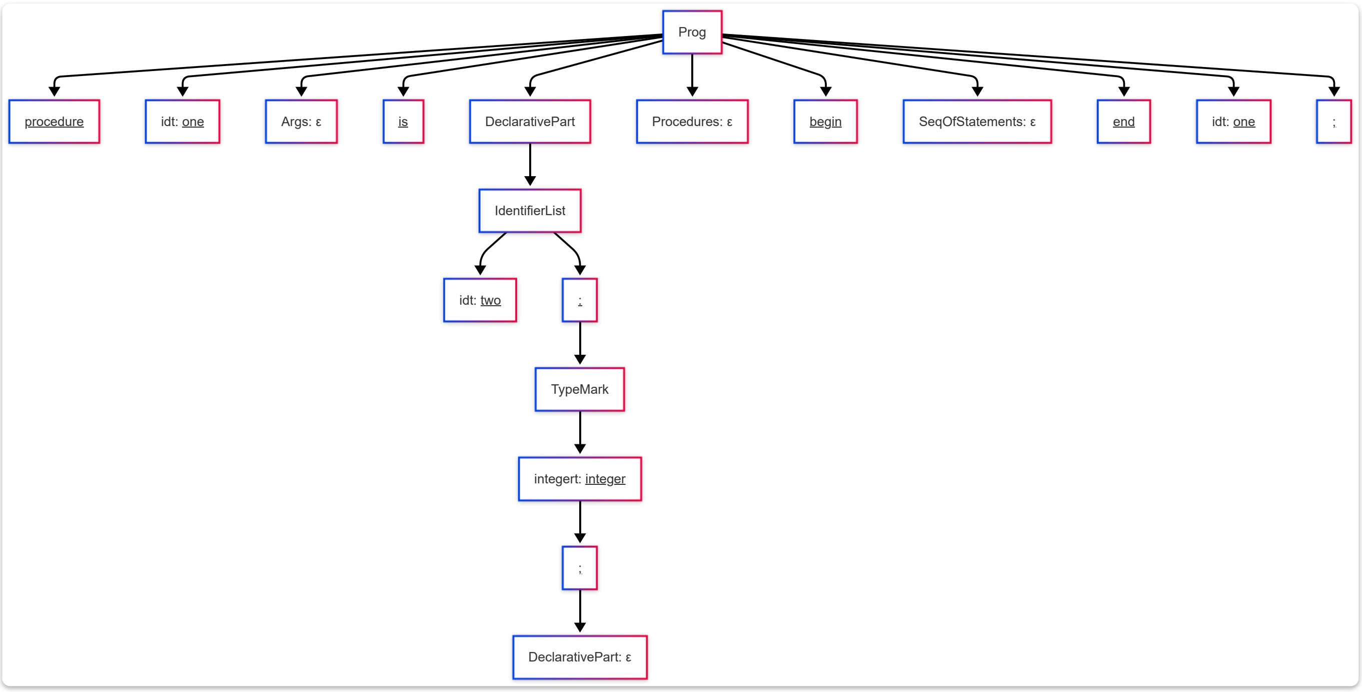
## Visualized the Parse tree using Mermaid Code



The png file is attached to this homework pdf. Also, here is a card link to the image

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**Note**

The `;` semicolon is formatted as underlined, but doesn't show clearly
For example the semicolon below formatted as `<u>;</u>` doesn't display clearly
;

---

## Program 2

```
procedure two is
    three, four : integer;
    procedure five is
    begin

    end five;
begin

end two;
```

---

## Breakdown

Outer part
`Prog -> procedure idt Args is DeclarativePart Procedures begin SeqOfStatements end idt ;`

DeclarativePart
`DeclarativePart -> IdentifierList : TypeMark ; DeclarativePart`

Inner Procedure
`Procedures -> Prog Procedures

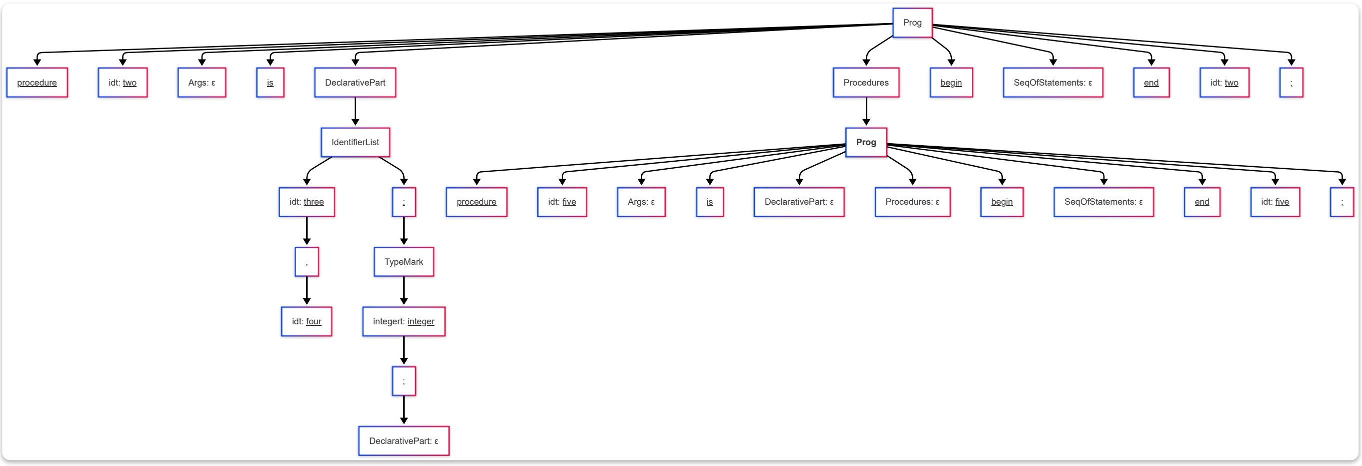
---

## Mermaid Code

```
flowchart LR
    B[Prog]
    B1[<u>procedure</u>]
    B2[idt: <u>two</u>]
    B3[Args: ε]
    B4[<u>is</u>]
    B5[DeclarativePart]
    B6[Procedures]
    B7[<u>begin</u>]
    B8[SeqOfStatements: ε]
    B9[<u>end</u>]
    B10[idt: <u>two</u>]
    B11[<u>;</u>]

    B --> B1
    B --> B2
    B --> B3
    B --> B4
    B --> B5
    B --> B6
    B --> B7
    B --> B8
    B --> B9
    B --> B10
    B --> B11

    %% DeclarativePart subtree for outer procedure:
    B5 --> BD1[IdentifierList]
    BD1 --> BD2[idt: <u>three</u>]
    BD2 --> BD3[<u>,</u>]
    BD3 --> BD4[idt: <u>four</u>]
    BD1 --> BD5[<u>:</u>]
    BD5 --> BD6[TypeMark]
    BD6 --> BD7[integert: <u>integer</u>]
    BD7 --> BD8[<u>;</u>]
    BD8 --> BD9[DeclarativePart: ε]

    %% Procedures subtree (nested procedure):
    B6 --> BP1[<b>Prog</>]
    BP1 --> BP2[<u>procedure</u>]
    BP1 --> BP3[idt: <u>five</u>]
    BP1 --> BP4[Args: ε]
    BP1 --> BP5[<u>is</u>]
    BP1 --> BP6[DeclarativePart: ε]
    BP1 --> BP7[Procedures: ε]
    BP1 --> BP8[<u>begin</u>]
    BP1 --> BP9[SeqOfStatements: ε]
    BP1 --> BP10[<u>end</u>]
    BP1 --> BP11[idt: <u>five</u>]
    BP1 --> BP12[<u>;</u>]
```

Also available as mermaid markdown file

## Parse Tree Visualized



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---

# Program 3

```
procedure three is
    four, five : integer;
    procedure six ( in seven : integer ; eight : integer ) is
    begin

    end six;
begin

end three;
```

---

## Breakdown

Top level

`Prog -> procedure idt Args is DeclarativePart Procedures begin SeqOfStatements end idt ;`

Declarative subtree

`DeclarativePart -> IdentifierList : TypeMark ; DeclarativePart`

Nested procedure

`procedure six ( in seven : integer ; eight : integer ) is ... end six;`

---

## Mermaid Code

⚠ Warning

Unique error i found here was that mermaid has issues with rendering `(` parenthesis `)`.

✓ Success

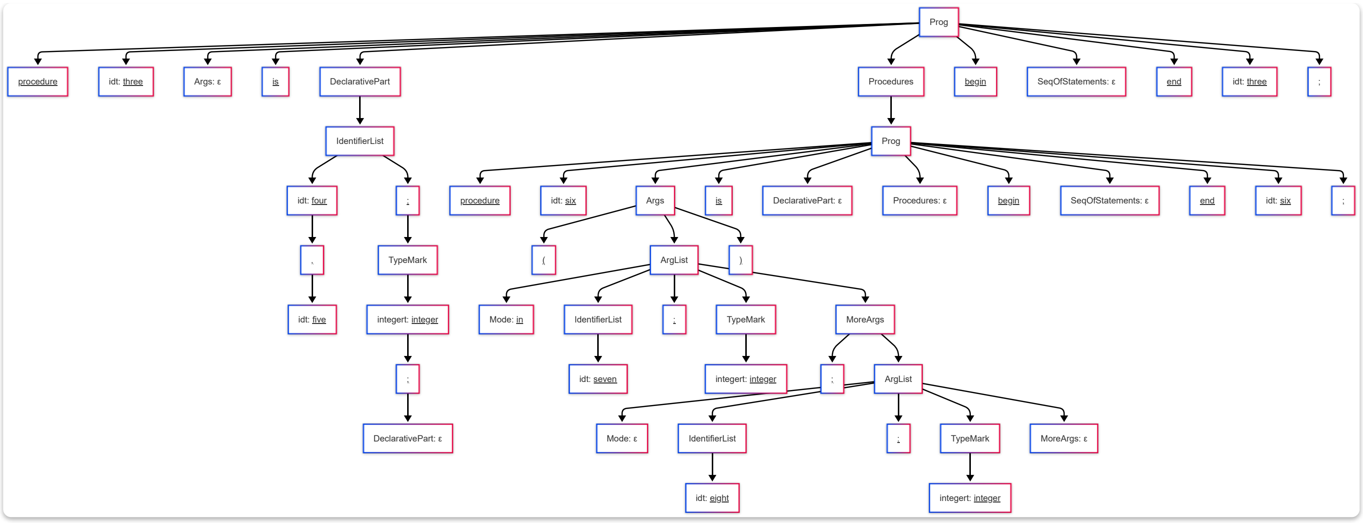
So i searched and found a fix on stack overflow.

- represent `(` with `#40;`
- represent `)` with `#41;`
- Also saw that there was a lot more that mermaid can do

```
flowchart TD
    C[Prog]
    C1[<u>procedure</u>]
    C2[idt: <u>three</u>]
    C3[Args: ε]
    C4[<u>is</u>]
    C5[DeclarativePart]
    C6[Procedures]
    C7[<u>begin</u>]
    C8[SeqOfStatements: ε]
    C9[<u>end</u>]
    C10[idt: <u>three</u>]
    C11[<u>;</u>]

    C --> C1
    C --> C2
    C --> C3
    C --> C4
    C --> C5
    C --> C6
    C --> C7
    C --> C8
    C --> C9
    C --> C10
    C --> C11

    %% DeclarativePart subtree for outer procedure:
    C5 --> CD1[IdentifierList]
    CD1 --> CD2[idt: <u>four</u>]
    CD2 --> CD3[<u>,</u>]
    CD3 --> CD4[idt: <u>five</u>]
    CD1 --> CD5[<u>:</u>]
    CD5 --> CD6[TypeMark]
    CD6 --> CD7[integert: <u>integer</u>]
    CD7 --> CD8[<u>;</u>]
    CD8 --> CD9[DeclarativePart: ε]

    %% Procedures subtree (nested procedure):
    C6 --> CP1[Prog (nested)]
    CP1 --> CP2[<u>procedure</u>]
    CP1 --> CP3[idt: <u>six</u>]
    CP1 --> CP4[Args]
    CP1 --> CP5[<u>is</u>]
    CP1 --> CP6[DeclarativePart: ε]
    CP1 --> CP7[Procedures: ε]
    CP1 --> CP8[<u>begin</u>]
    CP1 --> CP9[SeqOfStatements: ε]
    CP1 --> CP10[<u>end</u>]
    CP1 --> CP11[idt: <u>six</u>]
    CP1 --> CP12[<u>;</u>]

    %% Args subtree for nested procedure:
    %% Old one, nope didn't work
    %% CP4 --> CA1[<u>(</u>]
    %% CP4 --> CA2[ArgList]
    %% CP4 --> CA3[<u>)</u>]

    %% new one!
    CP4 --> CA1[<u>#40;</u>]
    CP4 --> CA2[ArgList]
    CP4 --> CA3[<u>#41;</u>]

    %% ArgList subtree:
    CA2 --> CA4[Mode: <u>in</u>]
    CA2 --> CA5[IdentifierList]
    CA5 --> CA6[idt: <u>seven</u>]
    CA2 --> CA7[<u>:</u>]
    CA2 --> CA8[TypeMark]
    CA8 --> CA9[integert: <u>integer</u>]
    CA2 --> CA10[MoreArgs]
    CA10 --> CA11[<u>;</u>]
    CA10 --> CA12[ArgList]
    CA12 --> CA13[Mode: ε]
    CA12 --> CA14[IdentifierList]
    CA14 --> CA15[idt: <u>eight</u>]
    CA12 --> CA16[<u>:</u>]
    CA12 --> CA17[TypeMark]
    CA17 --> CA18[integert: <u>integer</u>]
    CA12 --> CA19[MoreArgs: ε]
```

---

## Parse Tree Vixualized



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## Other Context

I used the analyzer from the past homework to identify all tokens. Even though it did not perfectly match the new grammar rules, it was helpful.

```
Token Type      | Lexeme                      | Value
------------------------------------------------------------
PROCEDURE       | procedure                   | None
ID              | one                         | None
IS              | is                          | None
ID              | two                         | None
COLON           | :                           | None
INTEGER         | integer                     | None
SEMICOLON       | ;                           | None
BEGIN           | begin                       | None
END             | end                         | None
ID              | one                         | None
SEMICOLON       | ;                           | None


PROCEDURE       | procedure                   | None
ID              | two                         | None
IS              | is                          | None
ID              | three                       | None
COMMA           | ,                           | None
```

```
ID              | four                | None
COLON           | :                   | None
INTEGER         | integer             | None
SEMICOLON       | ;                   | None
PROCEDURE       | procedure           | None
ID              | five                | None
IS              | is                  | None
BEGIN           | begin               | None
END             | end                 | None
ID              | five                | None
SEMICOLON       | ;                   | None
BEGIN           | begin               | None
END             | end                 | None
ID              | two                 | None
SEMICOLON       | ;                   | None



PROCEDURE       | procedure           | None
ID              | three               | None
IS              | is                  | None
ID              | four                | None
COMMA           | ,                   | None
ID              | five                | None
COLON           | :                   | None
INTEGER         | integer             | None
SEMICOLON       | ;                   | None
PROCEDURE       | procedure           | None
ID              | six                 | None
LPAREN          | (                   | None
ID              | in                  | None
ID              | seven               | None
COLON           | :                   | None
INTEGER         | integer             | None
SEMICOLON       | ;                   | None
ID              | eight               | None
COLON           | :                   | None
INTEGER         | integer             | None
RPAREN          | )                   | None
IS              | is                  | None
BEGIN           | begin               | None
END             | end                 | None
ID              | six                 | None
SEMICOLON       | ;                   | None
BEGIN           | begin               | None
END             | end                 | None
ID              | three               | None
SEMICOLON       | ;                   | None
EOF             | EOF                 | None
```

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