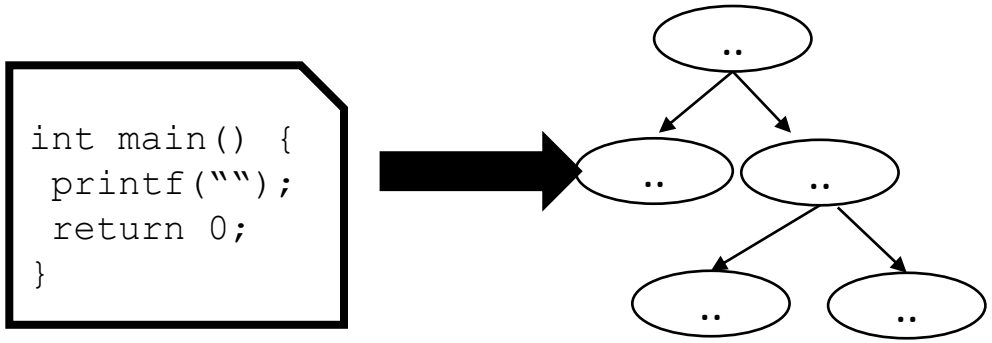
CSE110A: Compilers

Topics:

- *Syntactic Analysis continued*
  - *Top down parsing*
    - *Recursive Descent Parsing*



Moving on to a simpler implementation:

Recursive Descent Parser

Let’s look at the grammar

```
1: Expr  ::= Unit Expr2
2: Expr2 ::= Op Unit Expr2
3:       | “”
4: Unit  ::= ‘(‘ Expr ‘)’
5:       |    ID
6: Op    ::= ‘+’
7:       |   ‘*’
```

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```

How do we parse an Expr?

Let’s look at the grammar

```
1: Expr  ::= Unit Expr2
2: Expr2 ::= Op Unit Expr2
3:       | “”
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```

How do we parse an Expr?
We parse a Unit followed by an Expr2

Let's look at the grammar

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1: Expr   ::= Unit Expr2
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```

How do we parse an Expr?
We parse a Unit followed by an Expr2

We can just write exactly that!

```
def parse_Expr(self):
    self.parse_Unit();
    self.parse_Expr2();
    return
```

Let’s look at the grammar

```
1: Expr  ::= Unit Expr2
2: Expr2 ::= Op Unit Expr2
3:         | “”
4: Unit  ::= ‘(‘ Expr ‘)’
5:         |    ID
6: Op    ::= ‘+’
7:         |   ‘*’
```

How do we parse an Expr2?

Let’s look at the grammar

```
1: Expr  ::= Unit Expr2
2: Expr2 ::= Op Unit Expr2
3:         | “”
4: Unit  ::= ‘(‘ Expr ‘)’
5:         |    ID
6: Op    ::= ‘+’
7:         |   ‘*’
```

How do we parse an Expr2?

```
First+ sets:
1: {‘(‘, ID}
2: {‘+’, ‘*’}
3: {None, ’)’}
4: {‘(‘}
5: {ID}
6: {‘+’}
7: {‘*’}
```

Let's look at the grammar

```
1: Expr  ::= Unit Expr2
2: Expr2 ::= Op Unit Expr2
3:         | “”
4: Unit  ::= '(' Expr ')'
5:         |    ID
6: Op    ::= '+'
7:         |   '*'
```

How do we parse an Expr2?

```
First+ sets:
1: {'(', ID}
2: {'+', '*'}
3: {None, ')'}
4: {'('}
5: {ID}
6: {'+'}
7: {'*'}
```

```
def parse_Expr2(self):

    token_id = get_token_id(self.to_match)

    # Expr2 ::= Op Unit Expr2
    if token_id in ["PLUS", "MULT"]:
        self.parse_Op()
        self.parse_Unit()
        self.parse_Expr2()
        return

    # Expr2 ::= ""
    if token_id in [None, ”RPAR"]:
        return
    else:
        raise ParserException(self.linennumber    # line number (for you to do)
                              self.to_match,                    # observed token
                              ["PLUS", "MULT", ”RPAR"])     # expected token
```

Let’s look at the grammar

```
1: Expr  ::= Unit Expr2
2: Expr2 ::= Op Unit Expr2
3:       | “”
4: Unit  ::= ‘(‘ Expr ‘)’
5:       |    ID
6: Op    ::= ‘+’
7:       |   ‘*’
```

How do we parse a Unit?

```
First+ sets:
1: {‘(‘, ID}
2: {‘+’, ‘*’}
3: {None, ’)’}
4: {‘(‘}
5: {ID}
6: {‘+’}
7: {‘*’}
```

Let's look at the grammar

```
1: Expr   ::= Unit Expr2
2: Expr2  ::= Op Unit Expr2
3:          | “”
4: Unit   ::= ‘(‘ Expr ‘)’
5:          |    ID
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```

```
First+ sets:
1: {‘(‘, ID}
2: {‘+’, ‘*’}
3: {None, ’)’}
4: {‘(‘}
5: {ID}
6: {‘+’}
7: {‘*’}
```

How do we parse a Unit?

```
def parse_Unit(self):

    token_id = get_token_id(self.to_match)

    # Unit  ::= ‘(‘ Expr ‘)’
    if token_id == "LPAR":
        self.eat("LPAR")
        self.parse_Expr()
        self.eat("RPAR")
        return

    # Unit :: = ID
    if token_id == "ID":
        self.eat("ID")
        return
```

```
def eat(self, expected_token):
    if self.to_match == expected_token:
        self.advance()  # move to the next token
    else:
        raise ParserException(
                self.current_line,    # line# (for you to do)
                self.to_match,        # observed token
                [expected_token])  #   i.e. PAR or RPAR
```

Let's look at the grammar

How do we parse a Unit?

```
1: Expr  ::= Unit Expr2
2: Expr2 ::= Op Unit Expr2
3:       | “”
4: Unit  ::= ‘(‘ Expr ‘)’
5:       |    ID
6: Op    ::= ‘+’
7:       |   ‘*’
```

```
First+ sets:
1: {‘(‘, ID}
2: {‘+’, ‘*’}
3: {None, ’)’}
4: {‘(‘}
5: {ID}
6: {‘+’}
7: {‘*’}
```

```
def parse_Unit(self):
    token_id = get_token_id(self.to_match)

    # Unit  ::= ‘(‘ Expr ‘)’
    if token_id == "LPAR":
        self.eat("LPAR")
        self.parse_Expr()
        self.eat("RPAR")
        return

    # Unit :: = ID
    if token_id == "ID":
        self.eat("ID")
        return
```

Note: function eat must ensure that to_match has the expected token ID and advances to the next token, i.e. something like this:

```
def eat(self, expected_token):
    if self.to_match == expected_token:
        self.advance()  # move to the next token
    else:
        raise ParserException(
                    self.current_line,      # line# (for you to do)
                    self.to_match,          # observed token
                    [expected_token])       # LPAR or RPAR or ID)
```

```
class ParserException(Exception):
    def __init__(self, line_number, found_token, expected_tokens):
        self.line_number = line_number
        self.found_token = found_token
        self.expected_tokens = expected_tokens
        # Create a readable error message
        message = (f"Parse error on line {line_number}: found '{found_token}', "
                   f"expected one of {expected_tokens}")
        super().__init__(message)
```

Let’s look at the grammar

```
1: Expr  ::= Unit Expr2
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3:       | “”
4: Unit  ::= ‘(‘ Expr ‘)’
5:       |    ID
6: Op    ::= ‘+’
7:       |   ‘*’
```

How do we parse an Op?

```
First+ sets:
1: {‘(‘, ID}
2: {‘+’, ‘*’}
3: {None, ’)’}
4: {‘(‘}
5: {ID}
6: {‘+’}
7: {‘*’}
```

Let's look at the grammar

```
1: Expr  ::= Unit Expr2
2: Expr2 ::= Op Unit Expr2
3:       | “”
4: Unit  ::= '(' Expr ')'
5:       |    ID
6: Op    ::= '+'
7:       |   '*'
```

```
First+ sets:
1: {'(', ID}
2: {'+', '*'}
3: {None, ')'}
4: {'('}
5: {ID}
6: {'+'}
7: {'*'}
```

```
def parse_Op(self):

    token_id = get_token_id(self.to_match)

    # Op  ::= '+'
    if token_id == "PLUS":
        self.eat("PLUS")
        return

    # Op  ::= '*'
    if token_id == "MULT":
        self.eat("MULT")
        return
```

How do we parse an Op?

```
def eat(self, expected_token):
    …
    raise ParserException(
            self.current_line,
            self.to_match,      # observed token
            [expected_token]) # expected token
    …
```

Recursive Descent

IS THAT SIMPLE