Problems with
Recursive Descent Parsing

Recursive descent is simple. What could possibly go wrong?

Problem 1 -- Recursive Descent can't handle left-recursive rules.

Rule E ::= E+T | T

becomes

```
void E() {
        E()
        .....
}
```

You know that can't work.

This is a real problem. We have already seen that left-recursive rules are important for expression grammars because they give us left-associative operators, and these are an important part of most programming languages.

The solution used in APL was to make all operators right-associative so you don't need left-recursive rules, but this feels wrong to most programmers.

We will handle this by modifying the recursive descent algorithm for left-recursive rules.

Consider a typical left-recursive rule:

E ::= E+T | E-T | T

For the moment think of T as a terminal symbol, as if our grammar was

E ::= E + t | E - t | t

This rule generates a chain of t's, with a + or - operator between each pair:

t1 ± t2 ± t3 ± ... ± tn

$t1 \pm t2 \pm t3 \pm \ldots \pm tn$

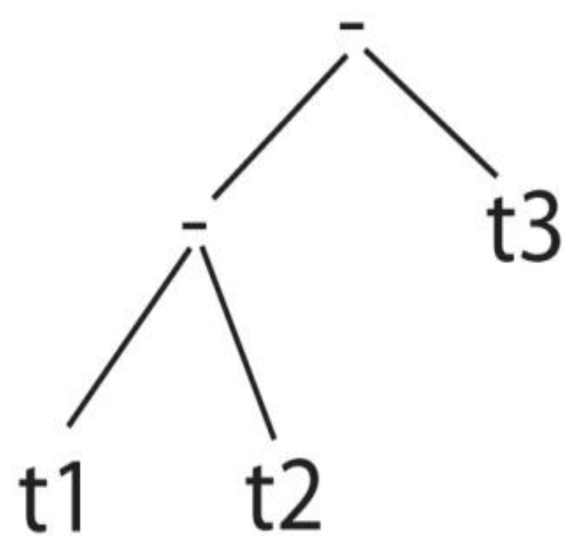
Instead of recursing to get the prefix of this, we'll think about it as follows. We know it has to start with a t, so we grab that t, and consume its tokens. If the next token is a + or -, we are still in the E expression so we do a getNextToken() to get past this operator, and get another t. This continues until the token following one of our t's is not a + or -

This leads to the following code:

```
void E( ) {
        T( );
        while (IsAddOp( currentToken )) {
                getNextToken();
                T();
        }
}
```

Here IsAddOp() is a simple function that returns true if its argument is a token that represents + or -.

This is fine as far as recognizing strings, but we usually want our parser to build a parse tree. We know we want this to be a left-associative tree, so the expression t1- t2 -t3 parses to



```
TreeNode E( ) {
        TreeNode t = T( );
        while (IsAddOp( currentToken )) {
                TreeNode t1 = new TreeNode();
                t1.token = currentToken;
                getNextToken();
                t1.leftChild = t;
                t1.rightChild = T();
                t = t1;
        }
        return t;
}
```

The BPL grammar contains rules

E ::= E+T | E-T | T
T ::= T*F | T/F | T%F
F ::= -F | &Factor | *Factor | Factor
...

The E and T procedures need to have loops that build left-associative trees. The F rule is not left-recursive, so you can use the usual recursive descent techniques for it

There is no general fix for the problem of left-recursive rules -- if you find one in a grammar that you are parsing, you either need to find a trick to modify your recursive descent techniques to fit the rule, or use a different parsing technique. This is one of the reasons that commercial compiler shops generally don't use recursive descent.

Problem 2: Recursive descent only works if we can tell which rule to use. If you have grammar rules A ::= B | C and rules B and C start with the same tokens, we can't tell which to use.

For example, consider the grammar

A ::= aBa | B | a (A is the start symbol)

B ::= aBb | b

This is an unambiguous grammar that generates

$\{ a^n b^n b, a^n b^n a: n >= 0\}$

If our input string is aaaaaaabbbbbbba we want the first rule we use (the top of our parse tree) to be A ::= aBa; if the input string is aaaaaaabbbbbbbb, we want the first rule to be A ::= B. We have to read across 15 symbols before we determine which rule to use, and by the time we have done that our current token is the end-of-input symbol.