Parsing With Precedence

Rolling your own recursive decent parser correctly handling operator precedence is easier than you think!™

PRECEDENCE

Operators apply operations to one or more **operands**. When an expression contains several operators, they get applied in order of their **precedence**, highest to lowest. When equal, **associativity** decides. When parsing, compound expressions are seen as rooted trees, where internal nodes are operators, and the leaf nodes are **atomic expressions**.[1] When building this tree, we informally say that higher precedence "binds tighter".

EXAMPLE OPERATORS

a() a[] a.member	Function call, indexing[2] Member access[3]	POST	9	Left-to-right
-a +a !a await a	Unary minus, plus, not Await expression	PRE	8	Right-to-left
a*b a/b	Multiplication, division	INFIX	7	Left-to-right
a+b a-b	Addition, subtraction	INFIX	6	Left-to-right
a<b a>b	Relational comparisons	INFIX	5	Left-to-right
a==b a!=b	Equality comparisons	INFIX	4	Left-to-right
a&&b	Logical AND	INFIX	3	Left-to-right
a||b	Logical OR	INFIX	2	Left-to-right
a=b a+=b	All assignments	INFIX	1	Right-to-left

[1] Atomic expressions include: numbers, variables, parenthesized expressions.

[2] These operators consist of multiple tokens, and can have sub-expressions. A single call to lexer.advance() is thus not enough, for most postfix operators.

[3] Member access is often listed as infix, with RHS required to be an identifier. I chose postfix, since having infix operators above prefix often gets confusing.

RUST

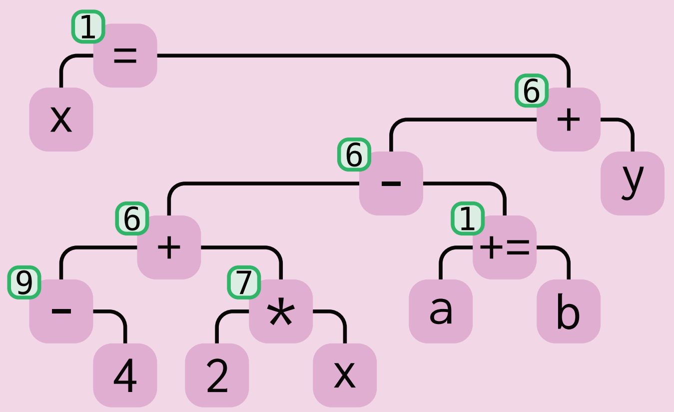
```rust
/// Consumes expressions and operators to build an expression tree.
/// Call with min_precedence 0 to parse the entire expression.
/// Recurses with higher min_precedence to parse sub-expressions.
fn parse_expression(lexer: &mut Lexer, min_precedence: u32) -> ParseResult<Expression> {
    // If we have a prefix operator, always consume it, and recurse to parse its operand.
    // Otherwise, parse an atomic expression, e.g. 5 or (2+2) in parentheses
    let mut expression = if let Ok(op) = PrefixOp::try_from(lexer.current()) {
        lexer.advance(); // Consume the prefix operator token
        let rhs = parse_expression(lexer, op.precedence())?;
        Expression::PrefixOp(op, Box::new(rhs))
    } else {
        parse_atomic_expression(lexer)?
    };

    // Now we expand the expression as far as possible to the right by looping
    // to consume all infix and postfix operators where precedence >= min_precedence.
    // If an operator has too low precedence, we return to a parent parse_expression call.
    loop {
        if let Ok(op) = InfixOp::try_from(lexer.current()) {
            if op.precedence() < min_precedence { break; }
            lexer.advance(); // Consume the infix operator token
            // We recurse to parse its RHS, taking min_precedence from the operator.
            // If we are left associative, make min_precedence one higher.
            let rhs = parse_expression(lexer, op.precedence() + op.is_left_associative() as u32)?;
            expression = Expression::InfixOp(Box::new(expression), op, Box::new(rhs));
        }
        else if let Ok(op) = PostfixOp::try_from(lexer.current()) {
            if op.precedence() < min_precedence { break; }
            lexer.advance(); // Consume the postfix operator token
            expression = Expression::PostfixOp(Box::new(expression), op);
        }
        else { break; }
    }

    Ok(expression)
}
```

Full code at github.com/haved/operator-prec-poster

EXAMPLE

Lexer tokens

x = - 4 + 2 * x - (a += b) + y



Notice how "-" is both prefix and infix.
Also note how "+" and "-" grow down-left.