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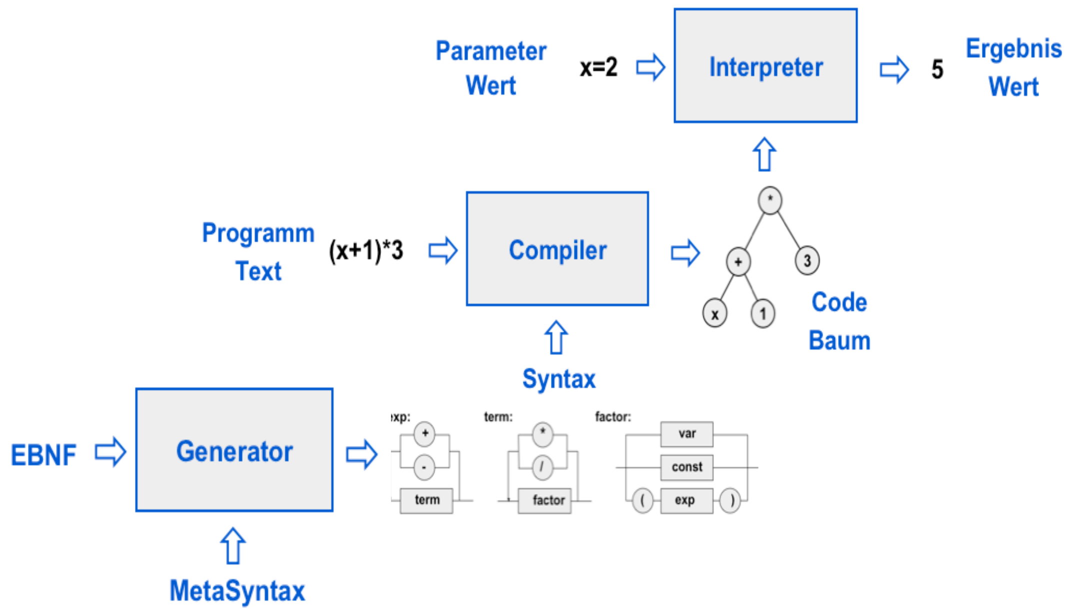
Syntaxanalyse



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Beispiel:
Syntax für arithmetische Ausdrücke in Erweiterter Backus-Naur Form (EBNF)

```
exp = term {("+"|"-") term}.
term = factor {("*"|"/") factor}.
factor = var | const | ( "(" exp ")" ).
```

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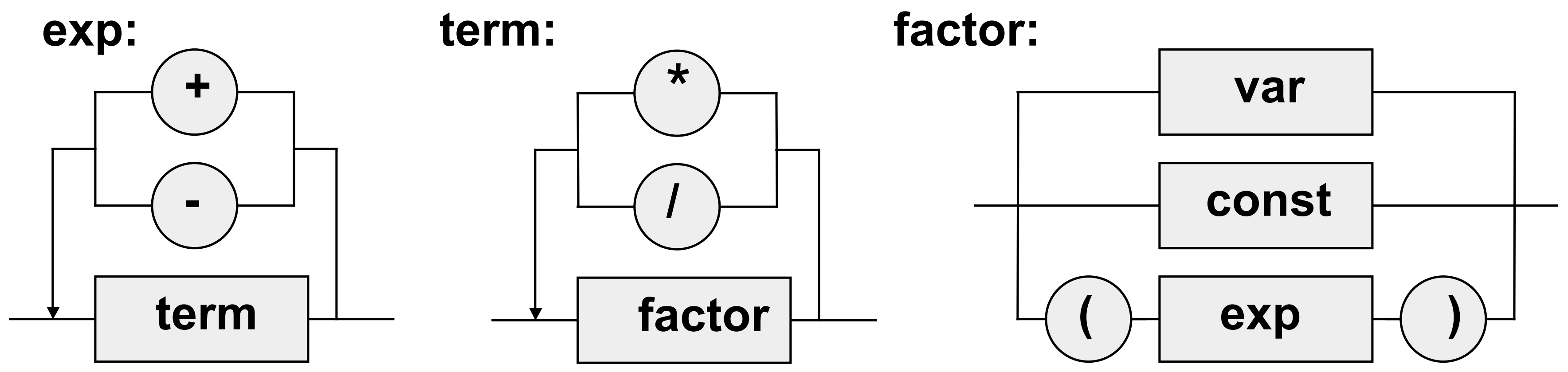
Beispiel: Syntaxdiagramme für arithmetische Ausdrücke



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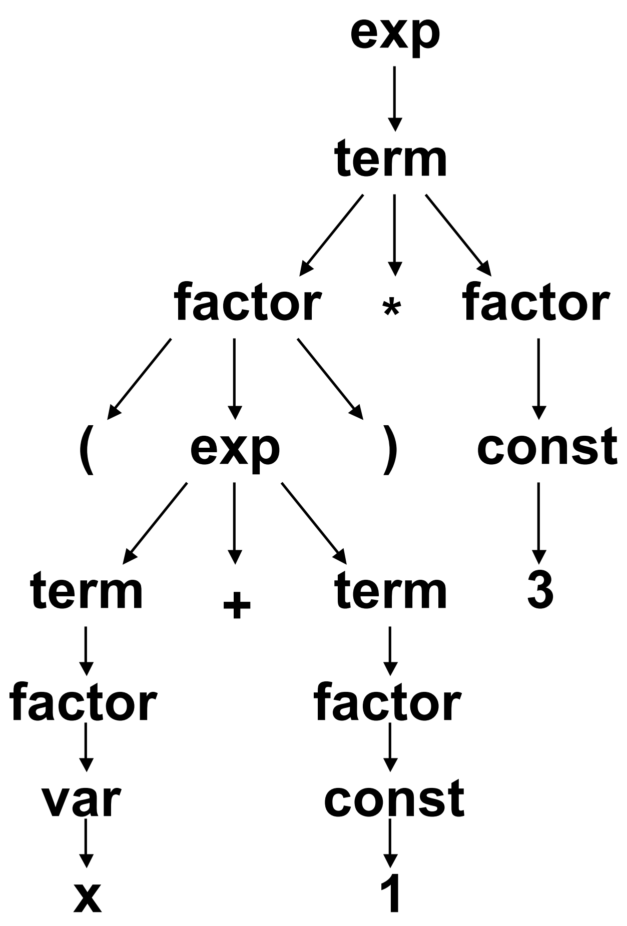
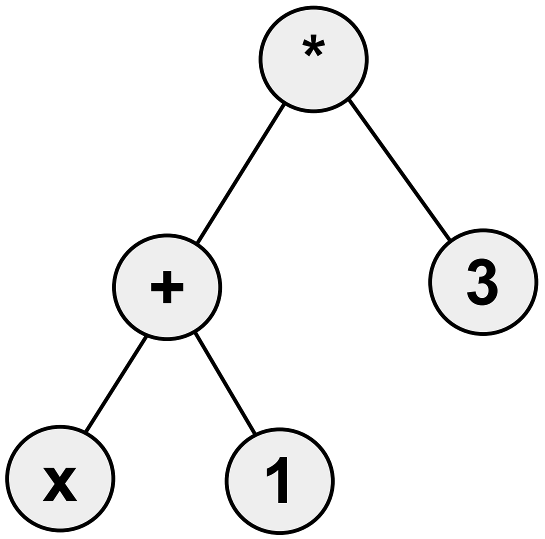
Beispiel: (x+1)*3



Parsebaum



Codebaum

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Beispiel:
Syntax für Lexical Scan

var = letter { letter | digit }.
const = digit { digit }.
letter = "a"|"b"| ... |"z".
digit = "0"|"1"| ... |"9".

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Beispiel:
Lexical Scan

```
public class LexicalScanner extends StringTokenizer {
    public LexicalScanner(String string) {
        super(string.trim(),"+-*/^=?()' \n",true);
    }
    public String nextToken() { //  return words, numbers, operators,
                                    brackets or empty string
        String token;
        do {
            if (hasMoreElements()) token = super.nextToken().trim();
            else return ""; // return empty string for end of text
        }
        while (token.equals("")||token.equals("\n")); // skip spaces and \n
        return token;
    }
}
```

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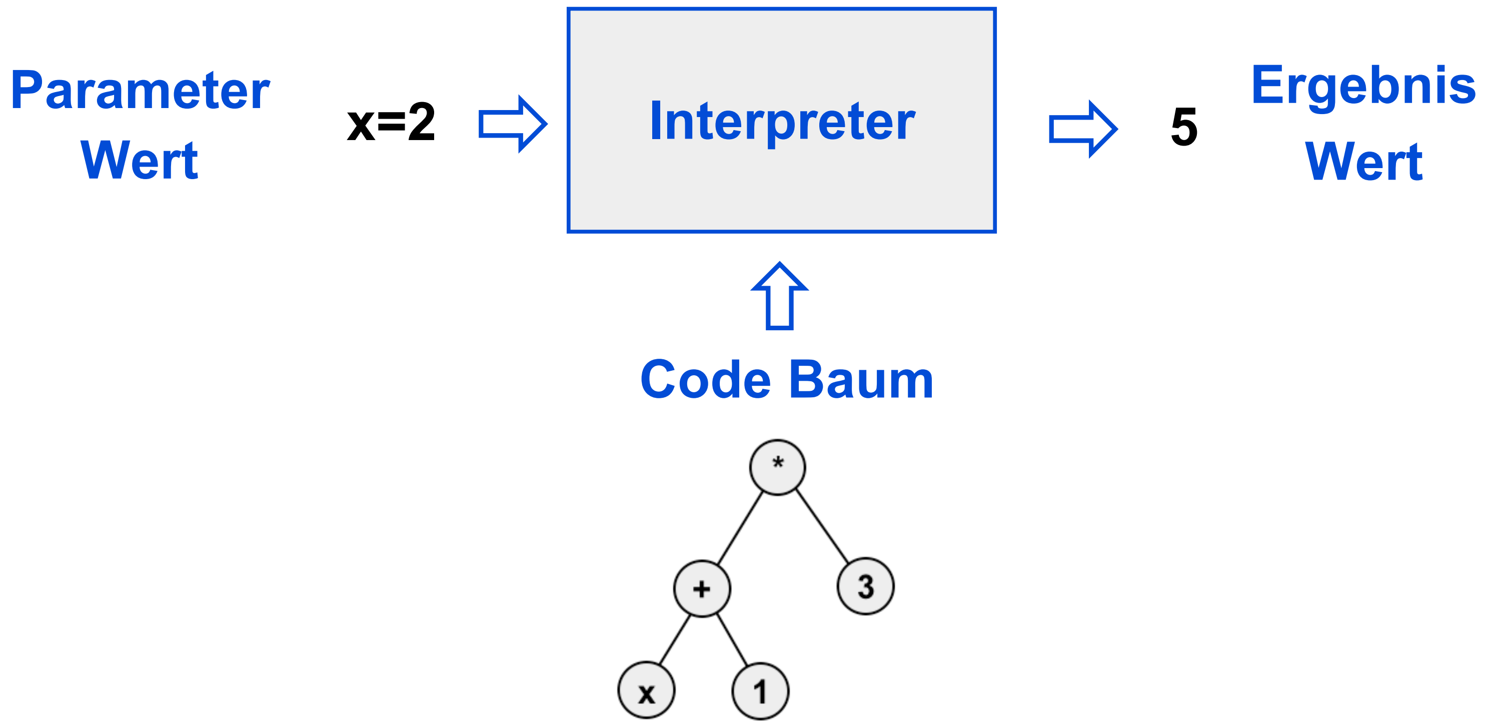
Interpreter



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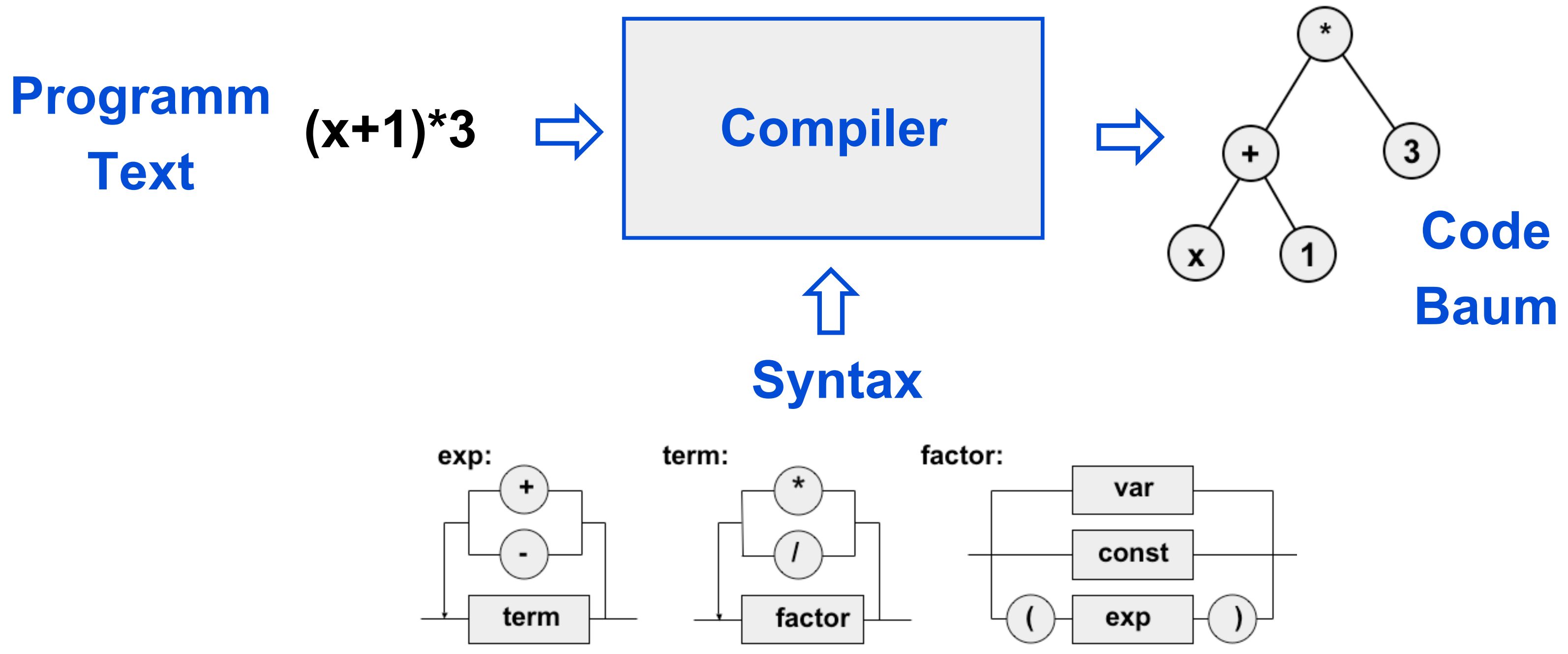
Compiler



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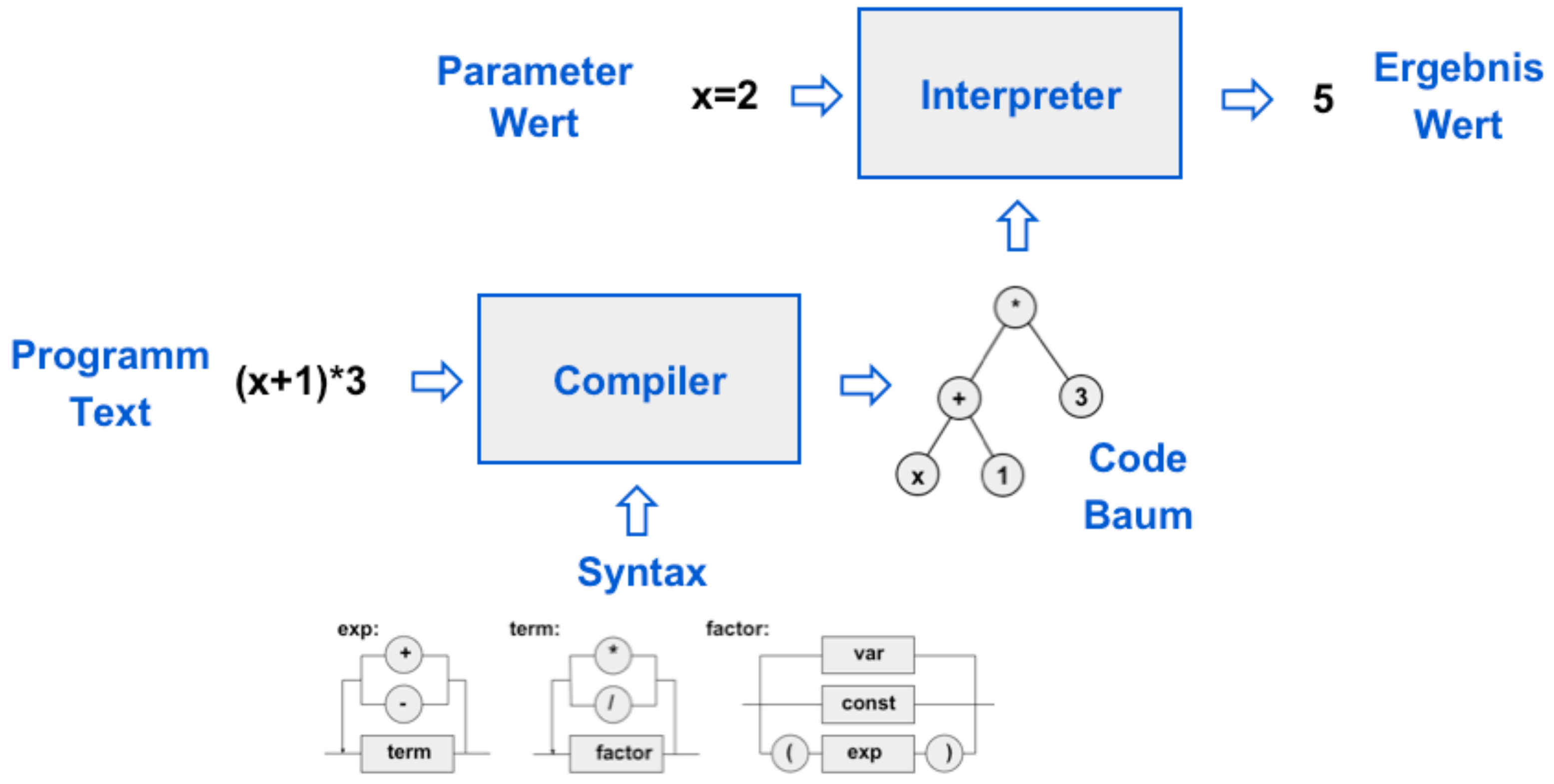
Compiler und Interpreter



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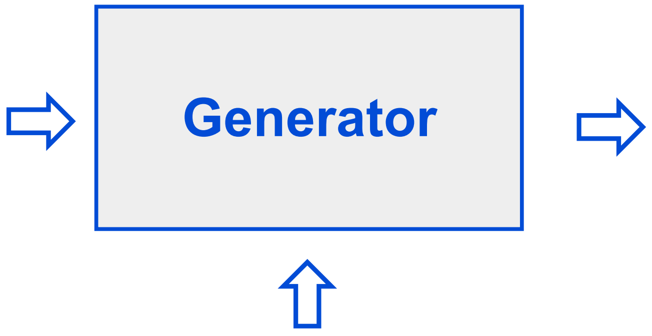
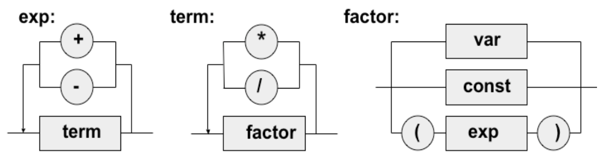
Generator

exp = term {("+"|"-") term}.
term = factor {("*"|"/") factor}.
factor = var | const | ("(" exp ")").

EBNF



MetaSyntax



Syntax

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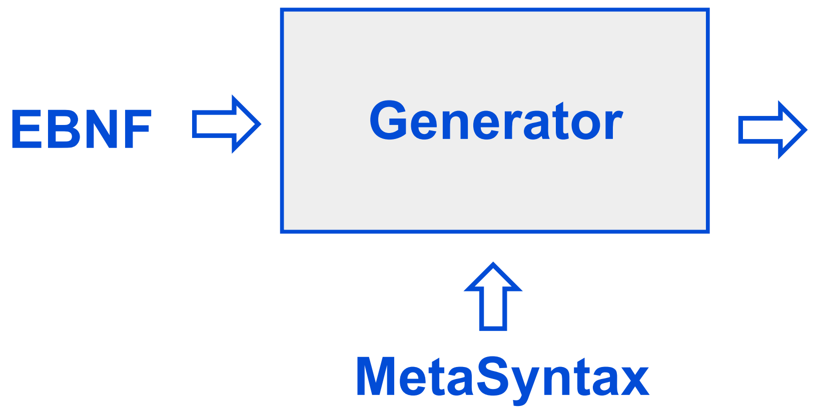
Generator



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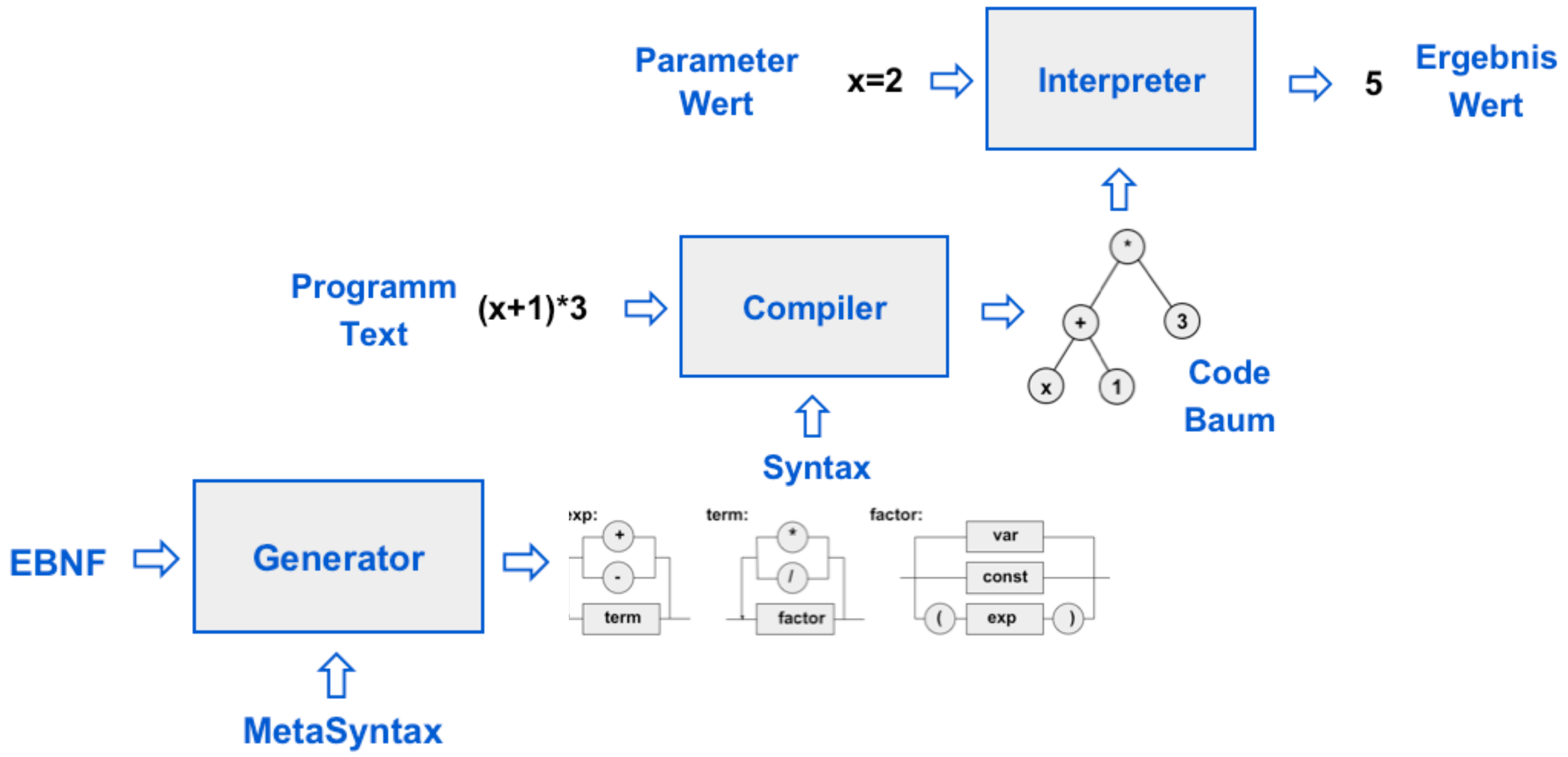
Generator, Compiler und Interpreter



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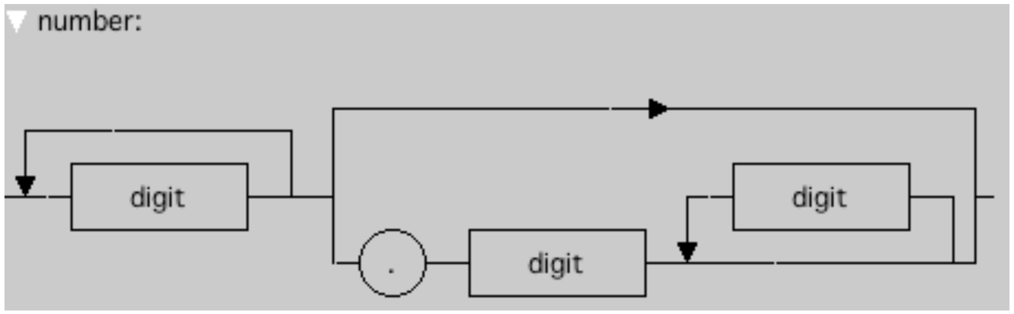
Automaten (1)

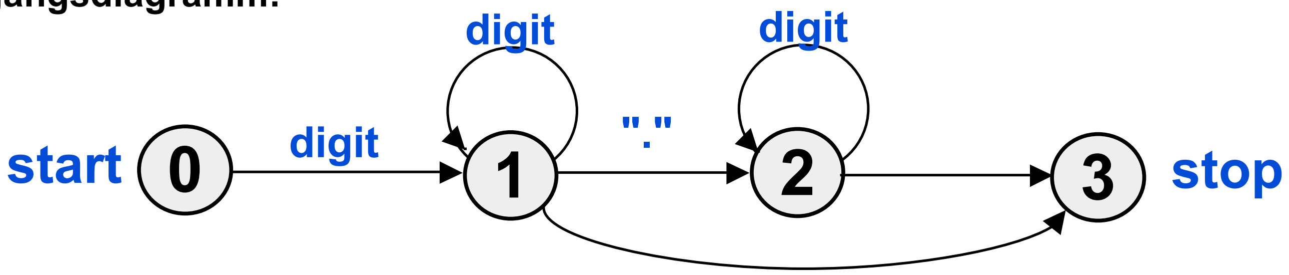
Beispiel: Berechnung des Wertes einer Dezimalzahl mittels eines Automaten

EBNF: number = digit {digit} ["."{digit}]

Syntaxdiagramm:



Übergangsdiagramm:



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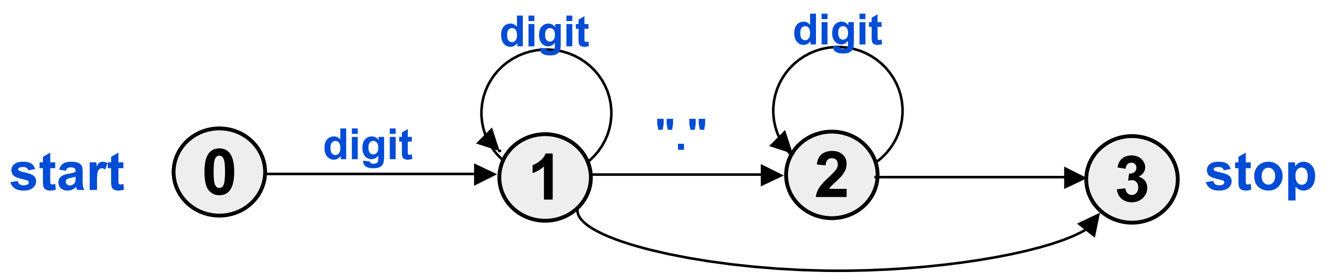
Automaten (2)

Übergangsdiagramm:


$$\begin{tikzcd}
\text{start} & 0 \arrow[r, "\text{digit}"] & 1 \arrow[loop above, "\text{digit}"] \arrow[r, "\text{"."}"] \arrow[rr, bend right] & 2 \arrow[loop above, "\text{digit}"] \arrow[r] & 3 & \text{stop}
\end{tikzcd}$$

Zustandstabelle s:

	digit	"."	else
0	1	error	error
1	1	2	3
2	2	error	3

Aktionstabelle a:

	digit	"."	else
0	1	5	5
1	2	0	4
2	3	5	4

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Automaten (3)

```
void action(int i) throws Exception {
   switch (i) {
         case 1: w = digit; n = 1; break;
         case 2: w = 10*w+digit; break;
         case 3: w = 10*w+digit; n = 10*n; break;
         case 4: result = w/n; break;
         case 5: throw new Exception("bad number");
   }
}
```

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Automaten (4)

```
final int start = 0;
final int stop = 3;
final int error = 4;
int state = start;
int symbol;
do {
    symbol = nextSymbol();
    action(a[state][symbol]);
    state = s[state][symbol];
} while (state < stop);
action(a[state][symbol]);
```

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Shift-Reduce Syntaxanalyse (1)

Operator-Precedence:

	var	+	*	empty
var		•>	•>	•>
+	<•	•>	<•	•>
*	<•	•>	•>	•>
empty	<•	<•	<•	

Precedence-Funktionen:

	f	g
var	4	5
+	2	1
*	4	3
empty	0	0

x <• y ⇔ f(x) < g(y)
x •> y ⇔ f(x) > g(y)

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Shift-Reduce Syntaxanalyse (2)

```
final String empty = "";
LexicalScanner lexer = new LexicalScanner(text);
String token = lexer.nextToken();
Stack s = new Stack();
s.push(empty);
while (!(s.top().equals(empty)&token.equals(empty))) {
    if (f(s.top())<=g(token)) { // shift
        s.push(token);
        token = lexer.nextToken();
    } else { // reduce
        do {op = s.pop(); action(op);}
        while (f(s.top())<=g(token));
    }
}
```

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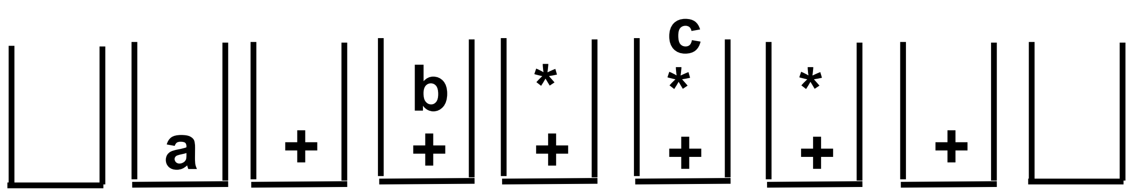
Shift-Reduce Syntaxanalyse (3)
Beispiel: text = "a+b*c"



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InfixAnalyzer (1)

```
class InfixAnalyzer {    // recursive descent syntax analysis:
    public Operand exp() throws Warning {
        Operand op = term();
        while (true) {
            if (nextTokenEquals("-")) op = Operand.genDiff(op,term());
            else if (nextTokenEquals("+")) op = Operand.genSum(op,term());
            else break;
        }
        return op;
    }
```

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InfixAnalyzer (2)

```
public Operand term() throws Warning {
   Operand op = factor();
   while (true) {
      if (nextTokenEquals("/")) op = Operand.genQuot(op,factor());
      else if (nextTokenEquals("*")) op = Operand.genProd(op,factor());
      else break;
   }
   return op;
}
```

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InfixAnalyzer (3)

```
    public Operand factor() throws Warning {
        Operand op = Operand.UNDEF;
        if (token.equals("")) throw new Warning("factor is missing!");
        if (isNumber()) { // factor = constant
            try {op = Operand.genConst(Integer.parseInt(token));}
            catch(NumberFormatException e) {
                throw new Warning(token+" is not a number!");
            }
            token = lexer.nextToken();
        } else if (isVariable()) { // factor = variable
            op = Operand.genVar(token);
            token = lexer.nextToken();
        } else if (nextTokenEquals("(")) { // factor = ( exp )
            op = exp();
            if (!nextTokenEquals(")")) throw new Warning(") is missing!");
        } else throw new Warning("factor is missing!");
        return op;
    }
}
```