CPE360

Infix to Postfix conversion

Stack Applications

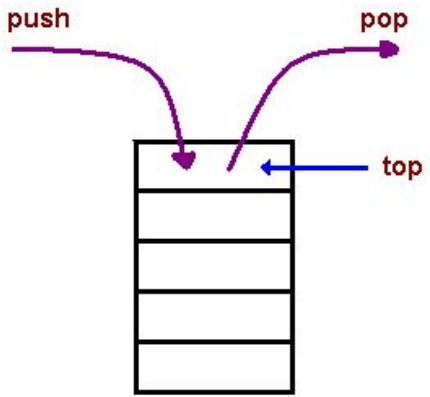
LIFO Philosophy

Subroutines

Recommendation Engines

Memory Management modules

Etc.,



Stack Applications

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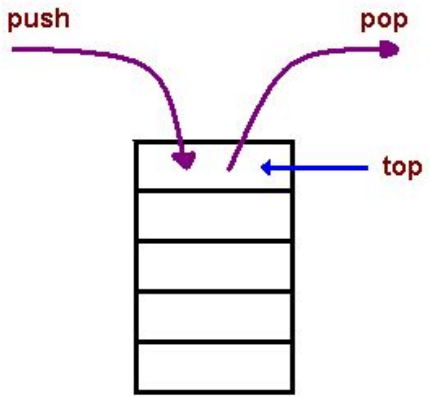


Infix to Postfix Expressions!

What is postfix?

2 + 3

2 + 3 * 5

Postfix

A way of “preserving” the order of operations

Postfix implies that the *operation* is written at the *end* of the expression (‘post’) in a way that captures the desired *order* for a machine that reads from left to right.

a + b

ab+

a + b * c

abc*+

What are we going to do?

We’ll use a **stack** to convert infix expressions **to postfix expressions**

Recall PEMDAS

Before we proceed, we assume you know this rule

Parentheses
Exponents
Multiplication
Division
Addition
Subtraction

Using Stacks to build Postfix

a+b*c = abc*+

What we want

Input: a+b*c

Output: abc*+

Few ground rules

Our program is constrained by the following:

- We read one symbol at a time, left to right
- A symbol is either an operand or an operator
- When we encounter *operands*, we just write them to postfix (e.g., a b c d)
- But, every time we encounter an *operation*, we have a job to do.. (e.g., +, -, \, *, ^)

Terminology

a + b * c - d / e ^ f + g

Operands: a, b, c, d, e, f, g
Operators: +, *, -, /, ^, +

(in that order)

The algorithm

Step 1: Scan the next symbol, terminate if NULL (i.e., no more symbol)
Step 2: If symbol is an *operand*, write straight to *postfix* expression
Step 3: If symbol is an operator:

.....**3.1** If the precedence of the scanned operator is *greater* than the precedence of the operator in the stack (or the stack is empty), **push** it.

.....**3.2** Else, **Pop all the operators** from the stack which are greater than or equal to in precedence than that of the scanned operator. **After doing that Push** the scanned operator to the stack.

Step 4: Repeat 1-3 for all symbols. When all symbols are scanned, pop the contents of the Stack onto the postscript.

Let's start simple

A + B + C

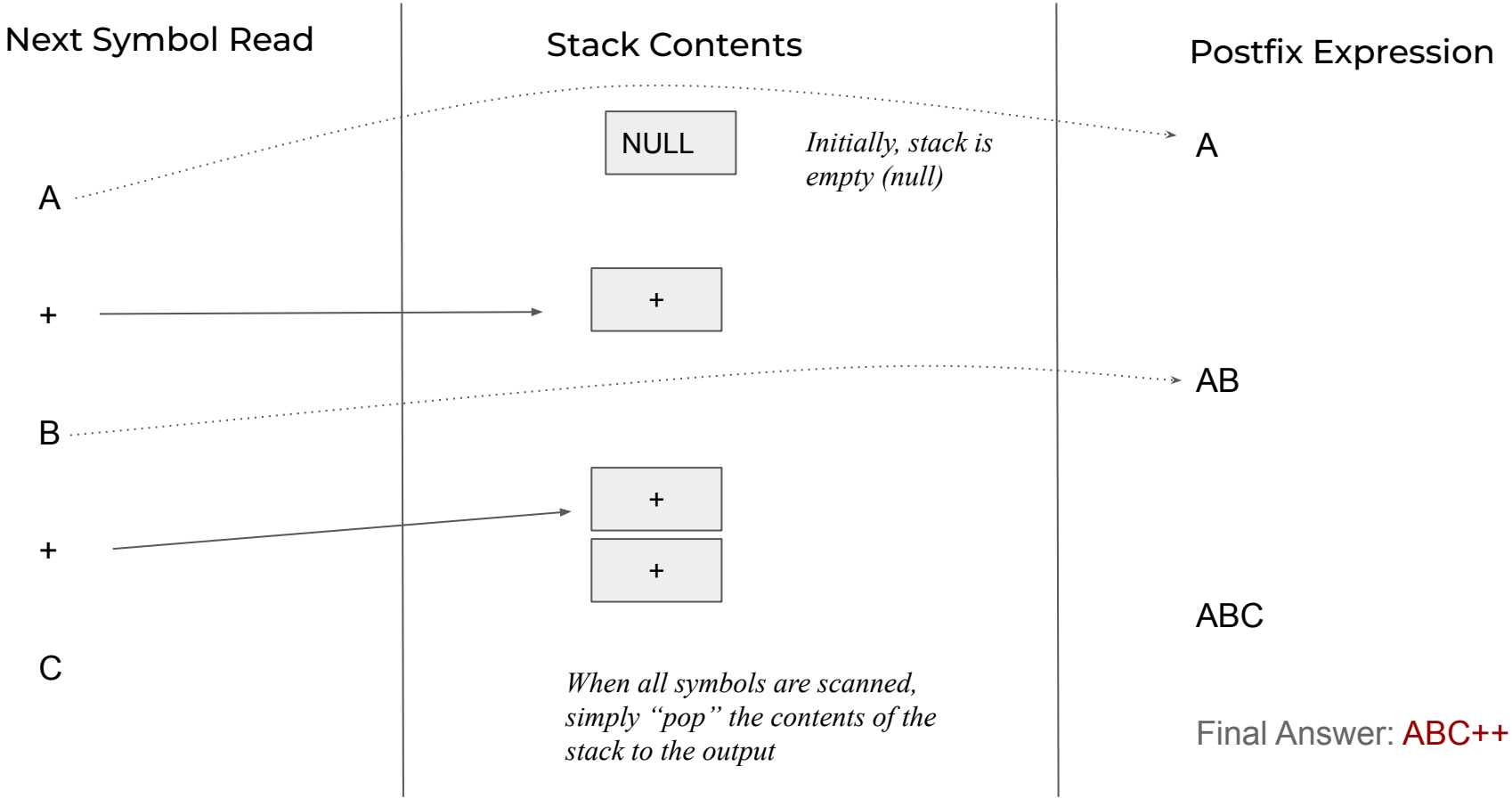
A + B + C

Next Symbol Read	Stack Contents	Postfix Expression
	NULL *Initially, stack is empty (null)*	

A + B + C

Next Symbol Read	Stack Contents	Postfix Expression
A	NULL *Initially, stack is empty (null)*	
+		
B		
+		
C		

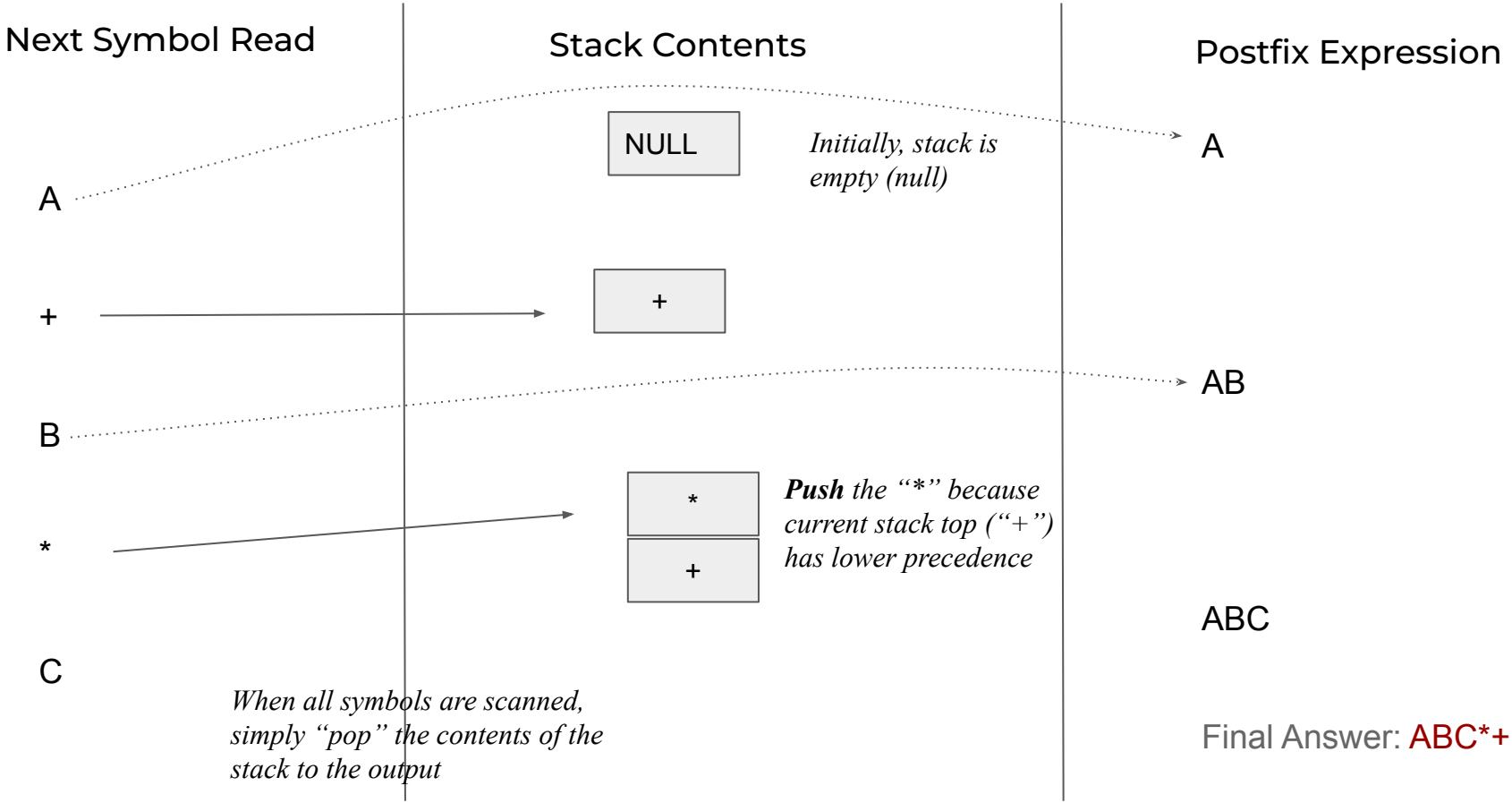
A + B + C


Next Symbol Read
Stack Contents
Postfix Expression
A
+
B
+
C
NULL
Initially, stack is empty (null)
+
+
+
A
AB
ABC
When all symbols are scanned, simply "pop" the contents of the stack to the output
Final Answer: ABC++

Let's try something more tricky

A + B * C

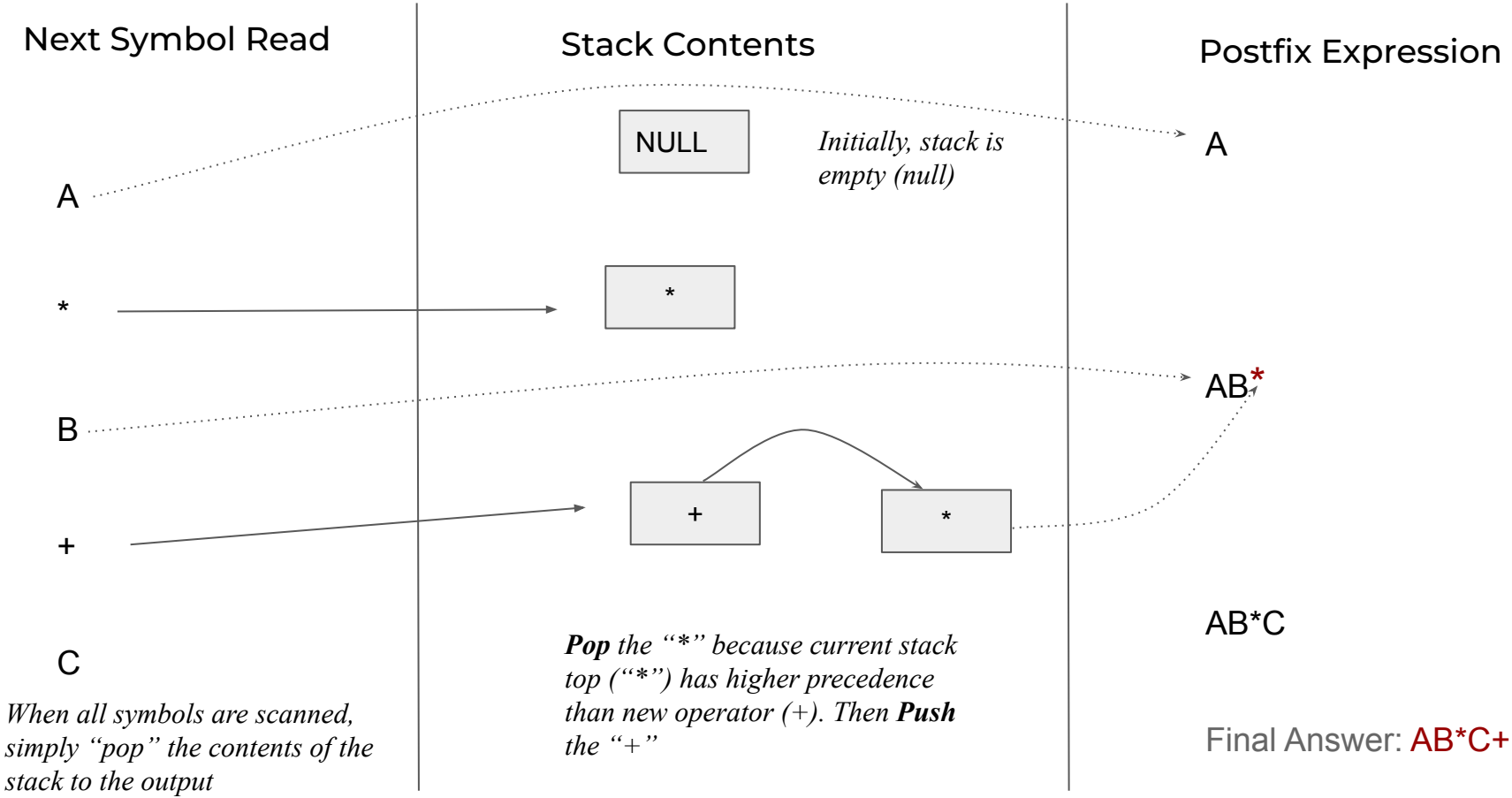
A + B * C


Next Symbol Read
Stack Contents
Postfix Expression
A
+
B
*
C
NULL
Initially, stack is empty (null)
+
A
AB
*
+
Push the "*" because current stack top ("+") has lower precedence
ABC
When all symbols are scanned, simply "pop" the contents of the stack to the output
Final Answer: ABC*+

If it were this instead

A * B + C

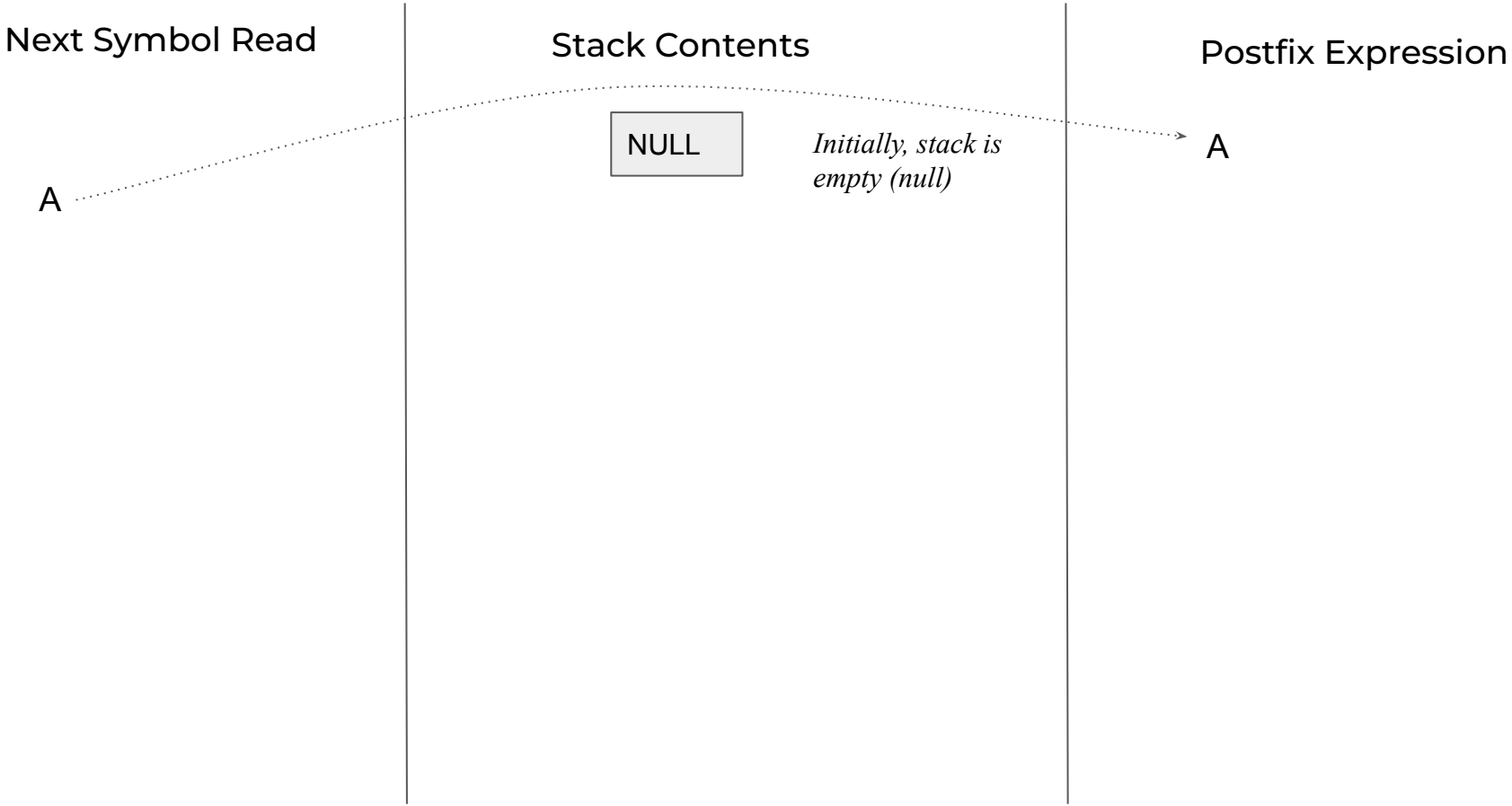
A * B + C


Next Symbol Read
Stack Contents
Postfix Expression
NULL
Initially, stack is empty (null)
A
*
B
+
C
*
+
*
A
AB*
AB*C
Pop the "*" because current stack top ("*") has higher precedence than new operator (+). Then Push the "+"
When all symbols are scanned, simply "pop" the contents of the stack to the output
Final Answer: AB*C+

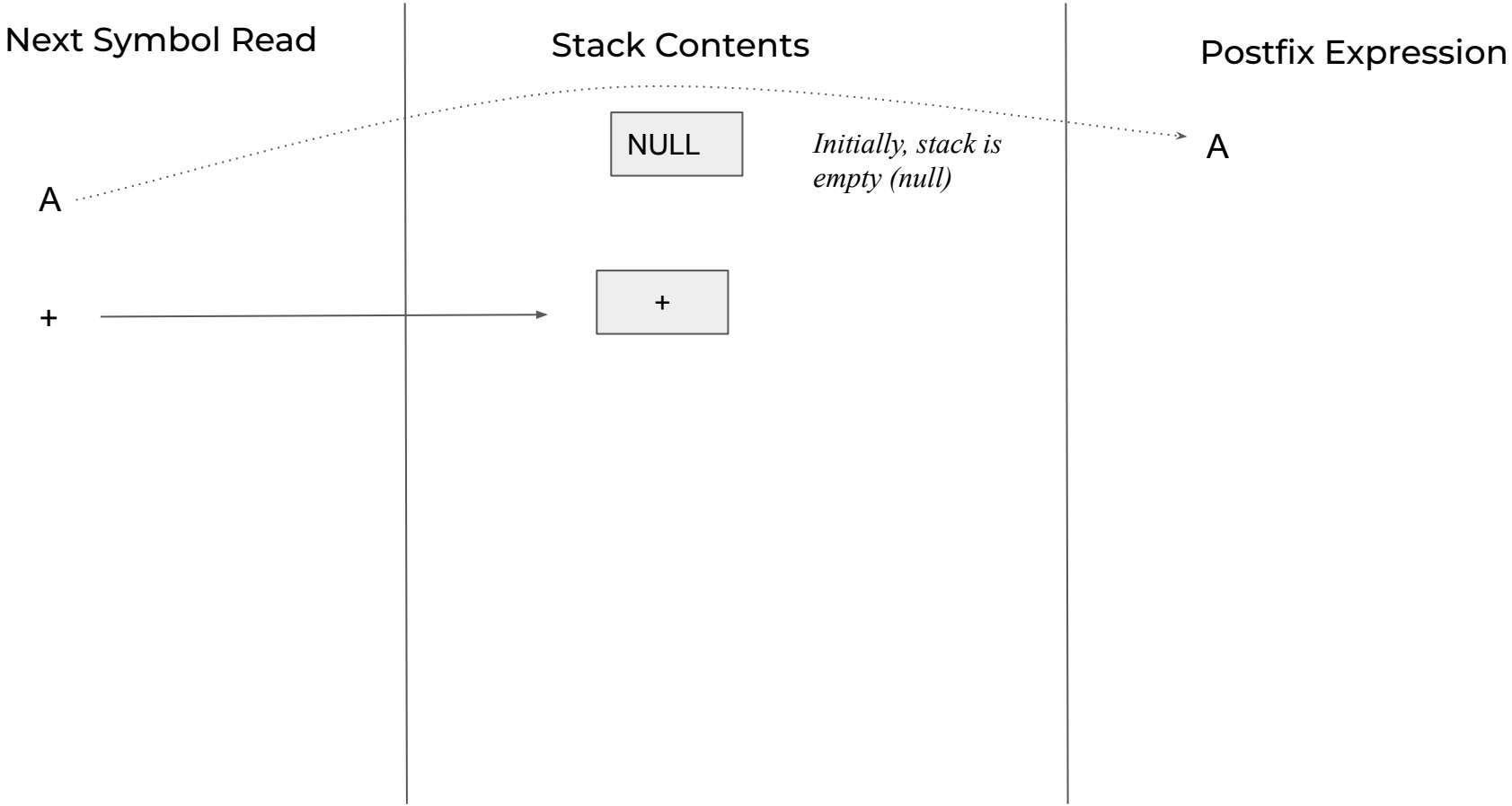
Alright, let's try this one now

A + B * C - D/F

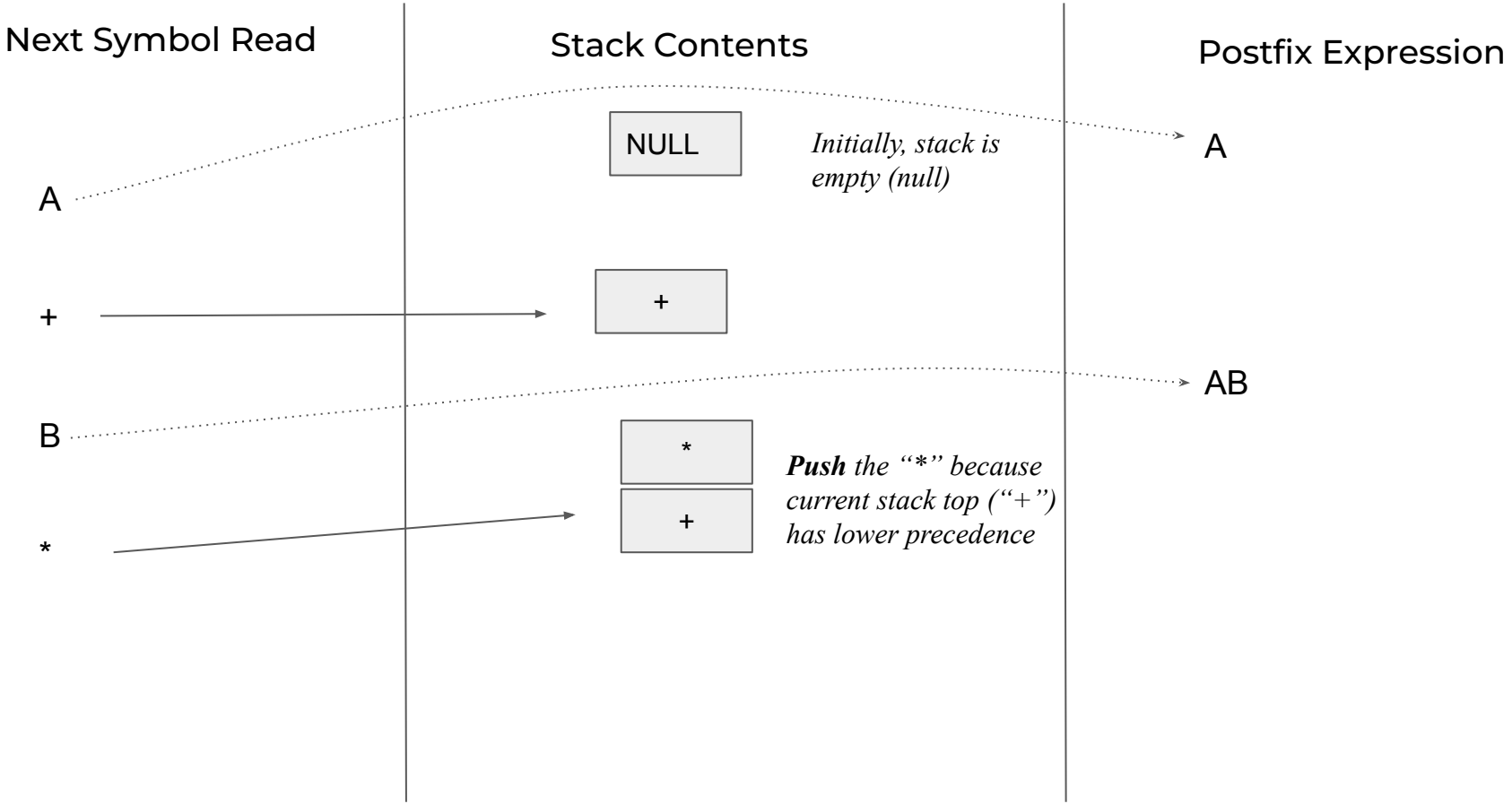
A + B*C - D/F


Next Symbol Read
Stack Contents
Postfix Expression
A
NULL
Initially, stack is empty (null)
A

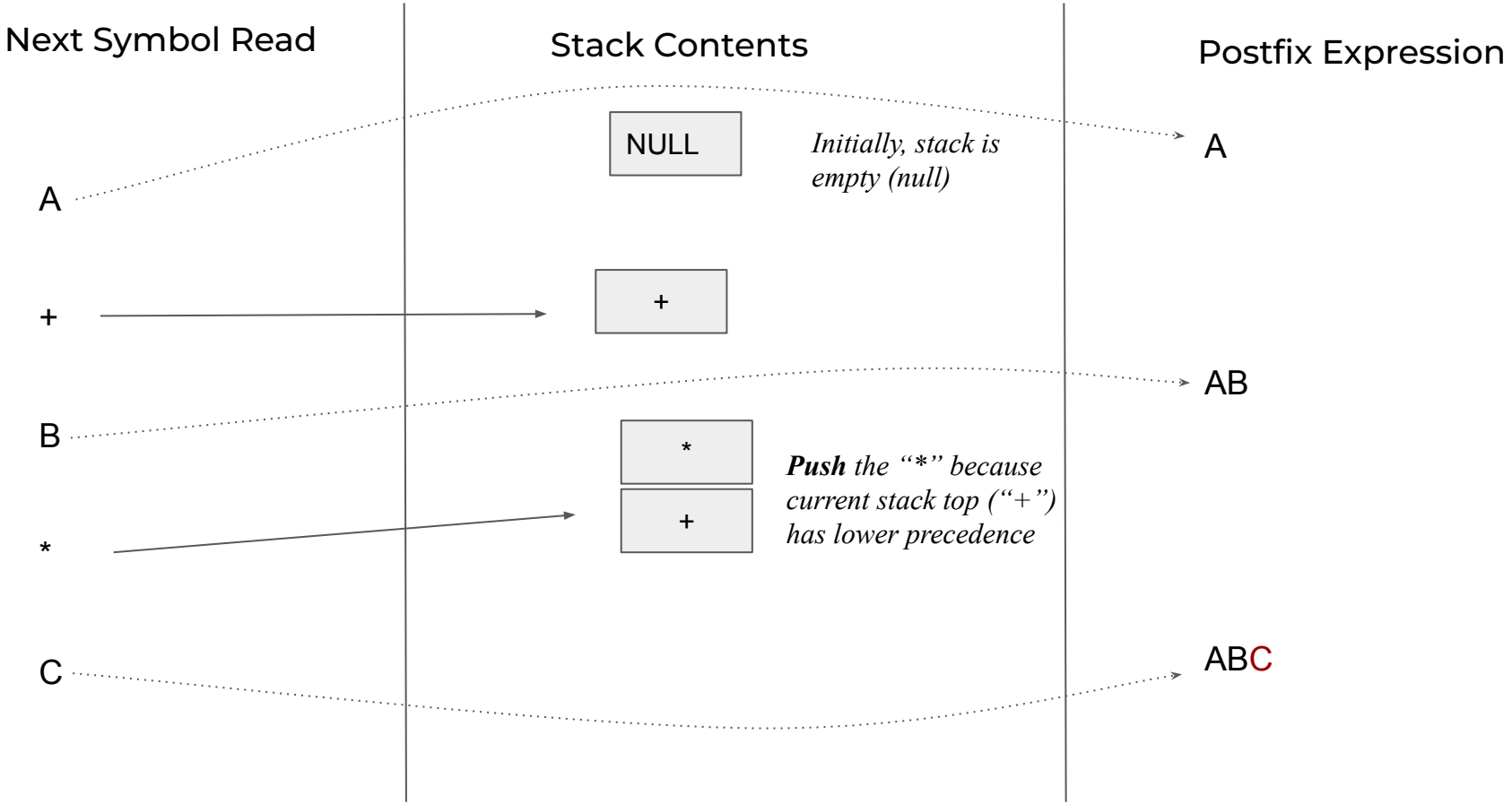
A + B*C - D/F


Next Symbol Read
Stack Contents
Postfix Expression
NULL
Initially, stack is empty (null)
A
A
+
+

A + B*C - D/F


Next Symbol Read
Stack Contents
Postfix Expression
NULL
Initially, stack is empty (null)
A
A
+
+
B
AB
*
*
+
Push the "*" because current stack top ("+") has lower precedence

A + B*C - D/F

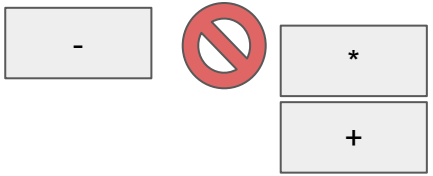

Next Symbol Read
Stack Contents
Postfix Expression
NULL
Initially, stack is empty (null)
A
A
+
+
AB
B
*
+
Push the "*" because current stack top ("+") has lower precedence
*
C
ABC

A + B*C - D/F

Next Symbol Read

Stack Contents

Postfix Expression

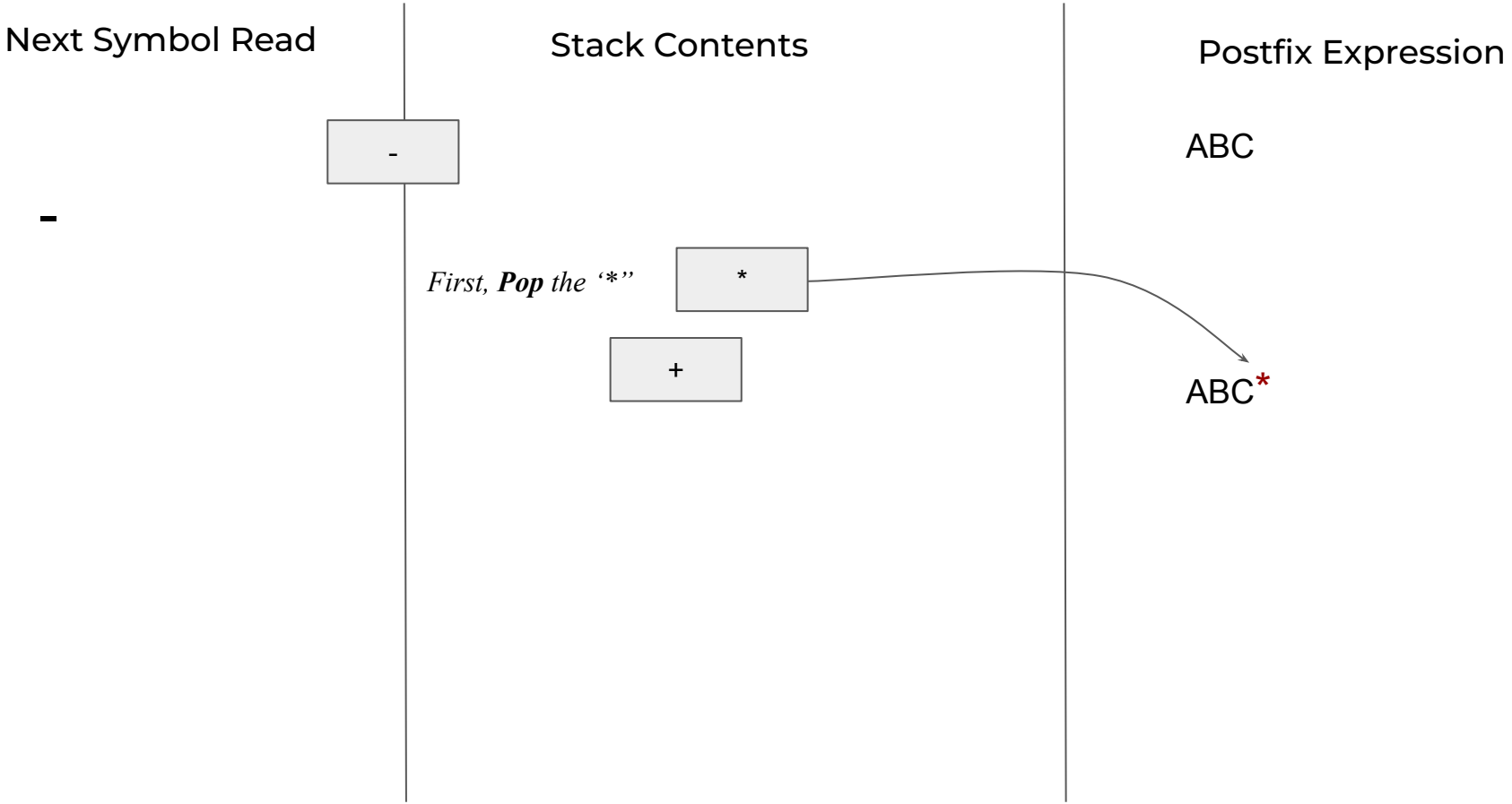


"-" has a lower precedence than "", and "+".*

*We have to pop both the * and + to make room for "-"*

ABC

A + B*C - D/F

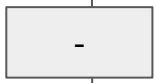

Next Symbol Read
Stack Contents
Postfix Expression
-
ABC
-
First, Pop the "*"
*
+
ABC*

A + B*C - D/F

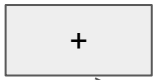
Next Symbol Read

-

Stack Contents



*Next, **Pop** the '+"*



Postfix Expression

ABC*

ABC*+

A + B*C - D/F

Next Symbol Read

Stack Contents

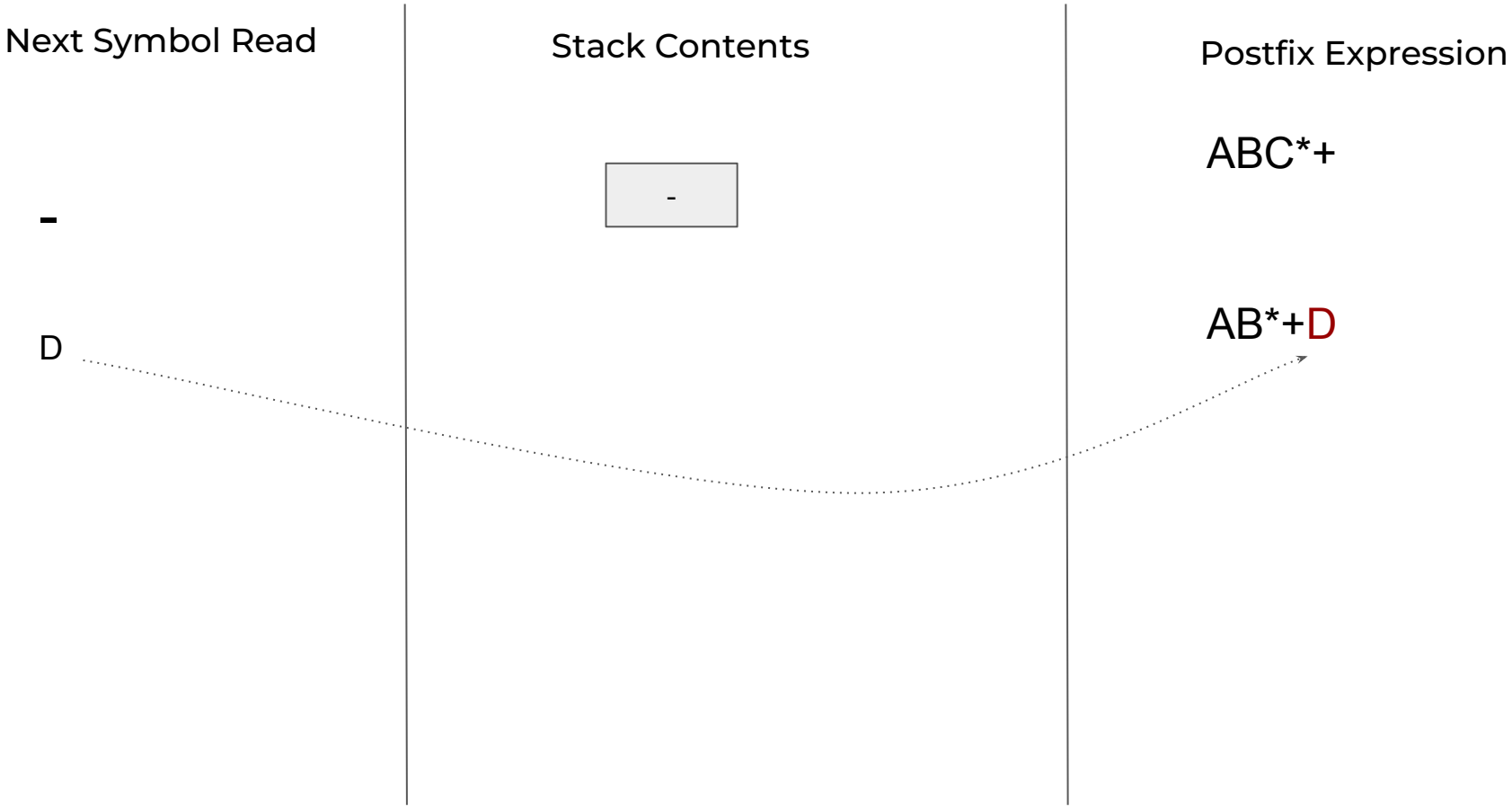
Postfix Expression

-

-

ABC*+

A + B*C - D/F

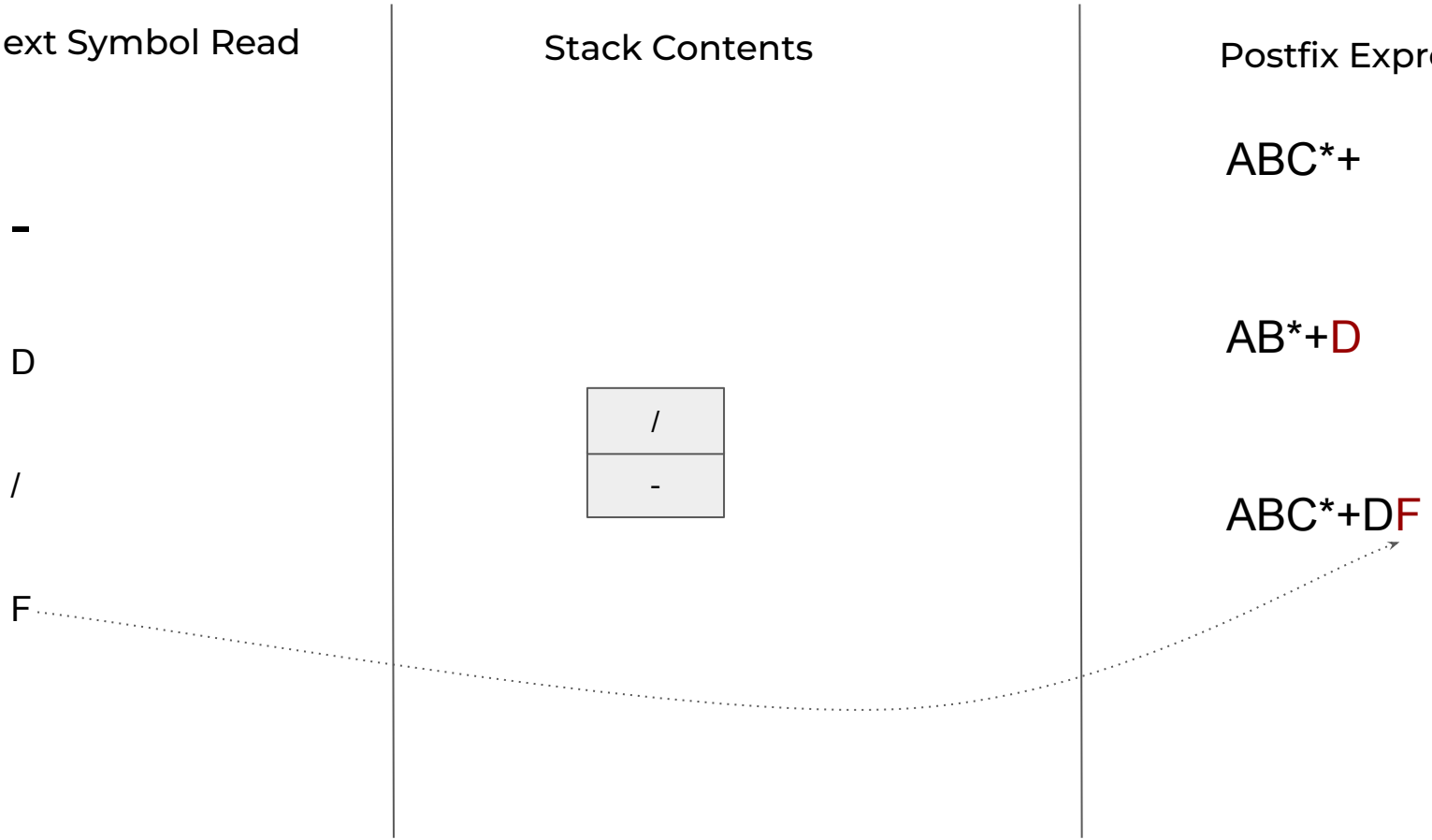

Next Symbol Read
Stack Contents
Postfix Expression
-
D
-
ABC*+
AB*+D

A + B*C - D/F

Next Symbol Read	Stack Contents	Postfix Expression
-		ABC*+
D		AB*+D
/	/ -	

A + B*C - D/F

Next Symbol Read	Stack Contents	Postfix Expression
-		ABC*+
D		AB*+D
/	/ -	
F		ABC*+DF



A + B*C - D/F

Next Symbol Read	Stack Contents	Postfix Expression
-		ABC*+
D		AB*+D
/	/ -	ABC*+DF
F		ACB*+DF/-

When all symbols are scanned, simply "pop" the contents of the stack to the output

Parentheses

(a+b)*c = ab+c*

The algorithm

Step 1: Scan the next symbol, terminate if NULL (i.e., no more symbol)
Step 2: If symbol is an *operand*, write straight to *postfix* expression
Step 3: If symbol is an operator:

.....**3.1** If the precedence of the scanned operator is *greater* than the precedence of the operator in the stack (or the stack is empty), **push** it.

If the symbol is a "(", simply push it

.....**3.2** Else, **Pop all the operators** from the stack which are greater than or equal to in precedence than that of the scanned operator. **After doing that Push** the scanned operator to the stack.

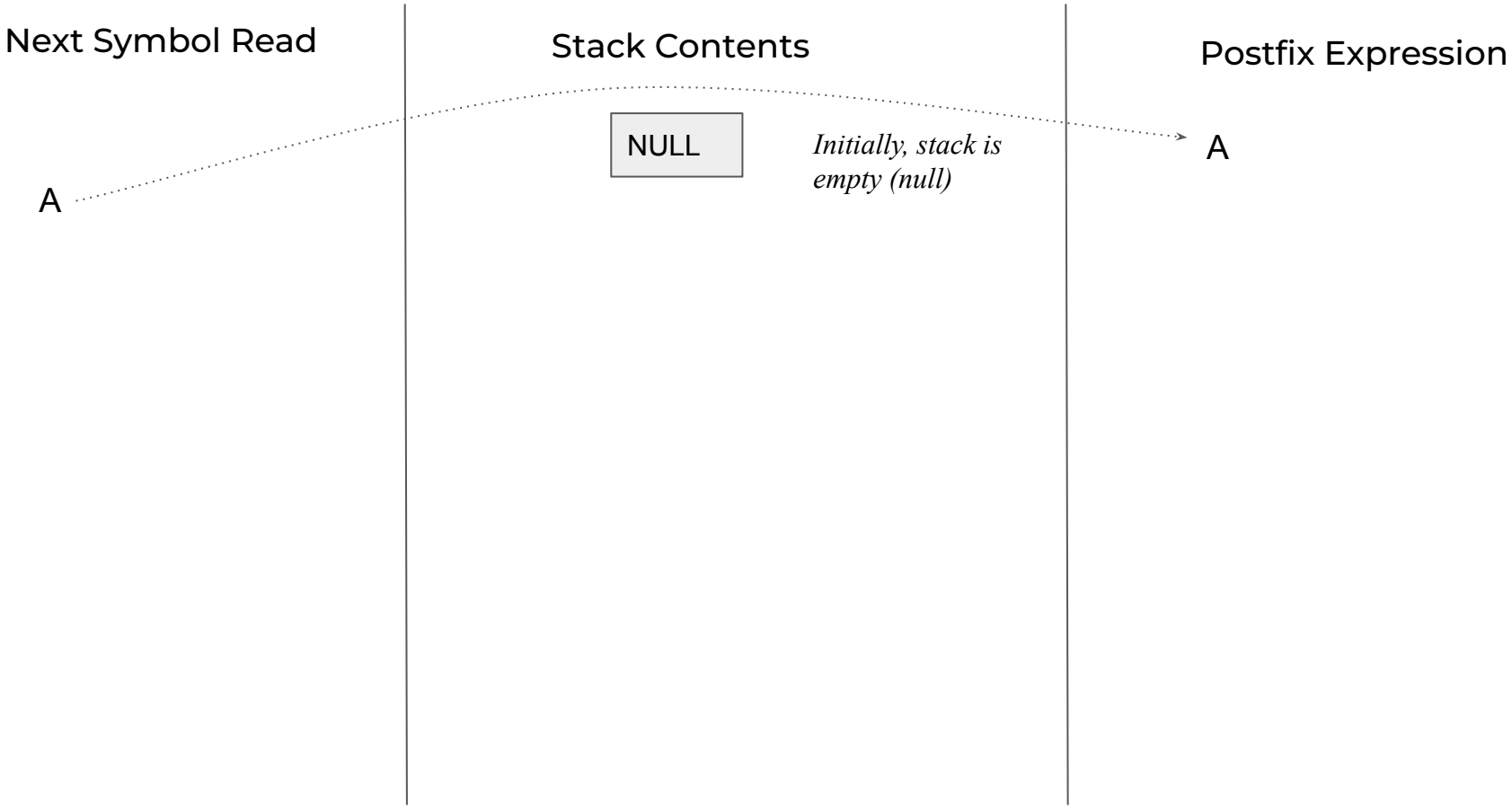
If the symbol is a ")", pop all operators until you encounter "(". DO NOT write parentheses to postfix

Step 4: Repeat 1-3 for all symbols. When all symbols are scanned, pop the contents of the Stack onto the postfix.

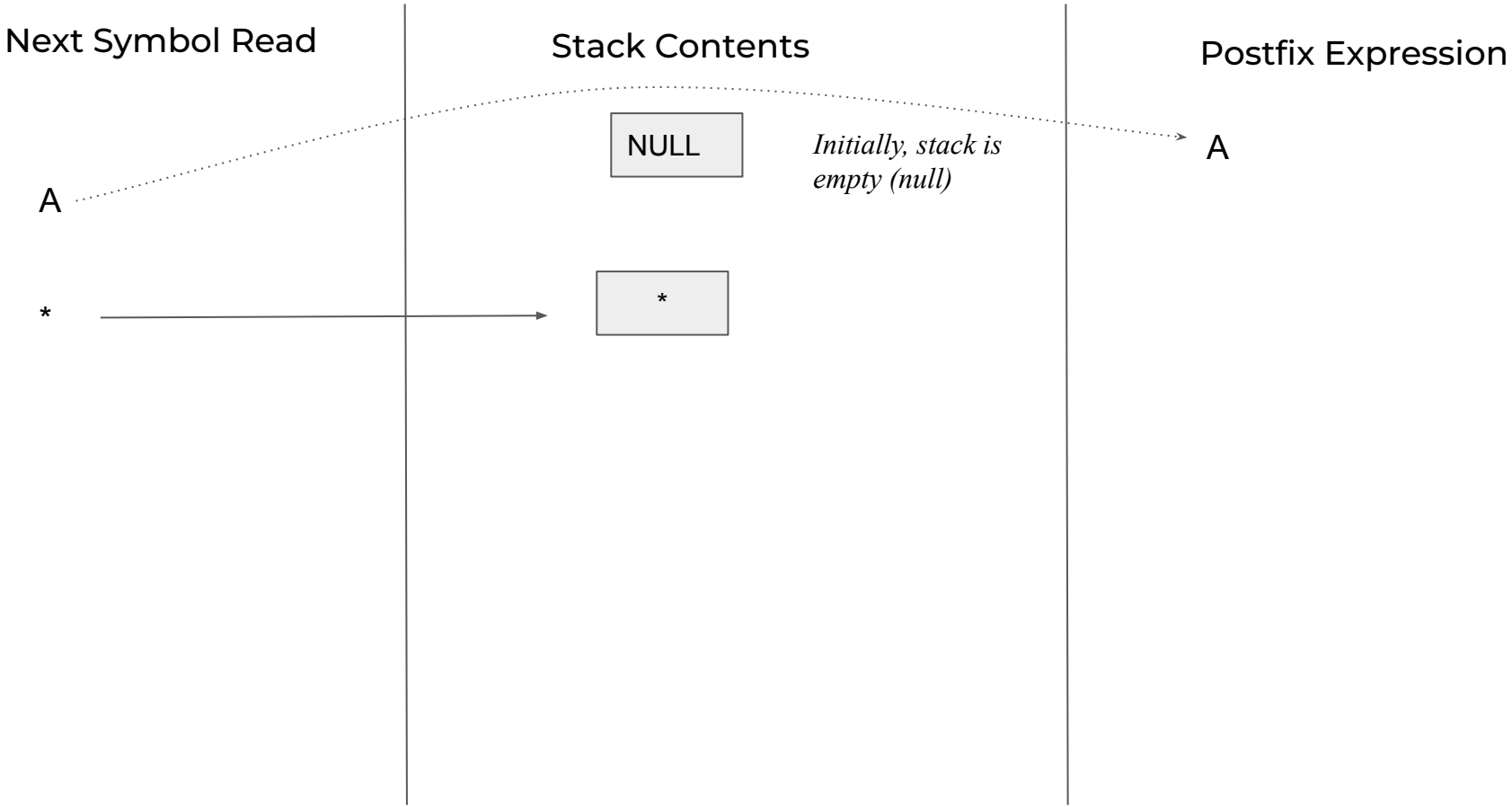
Alright, let's try this one now

A * (B + C) / D

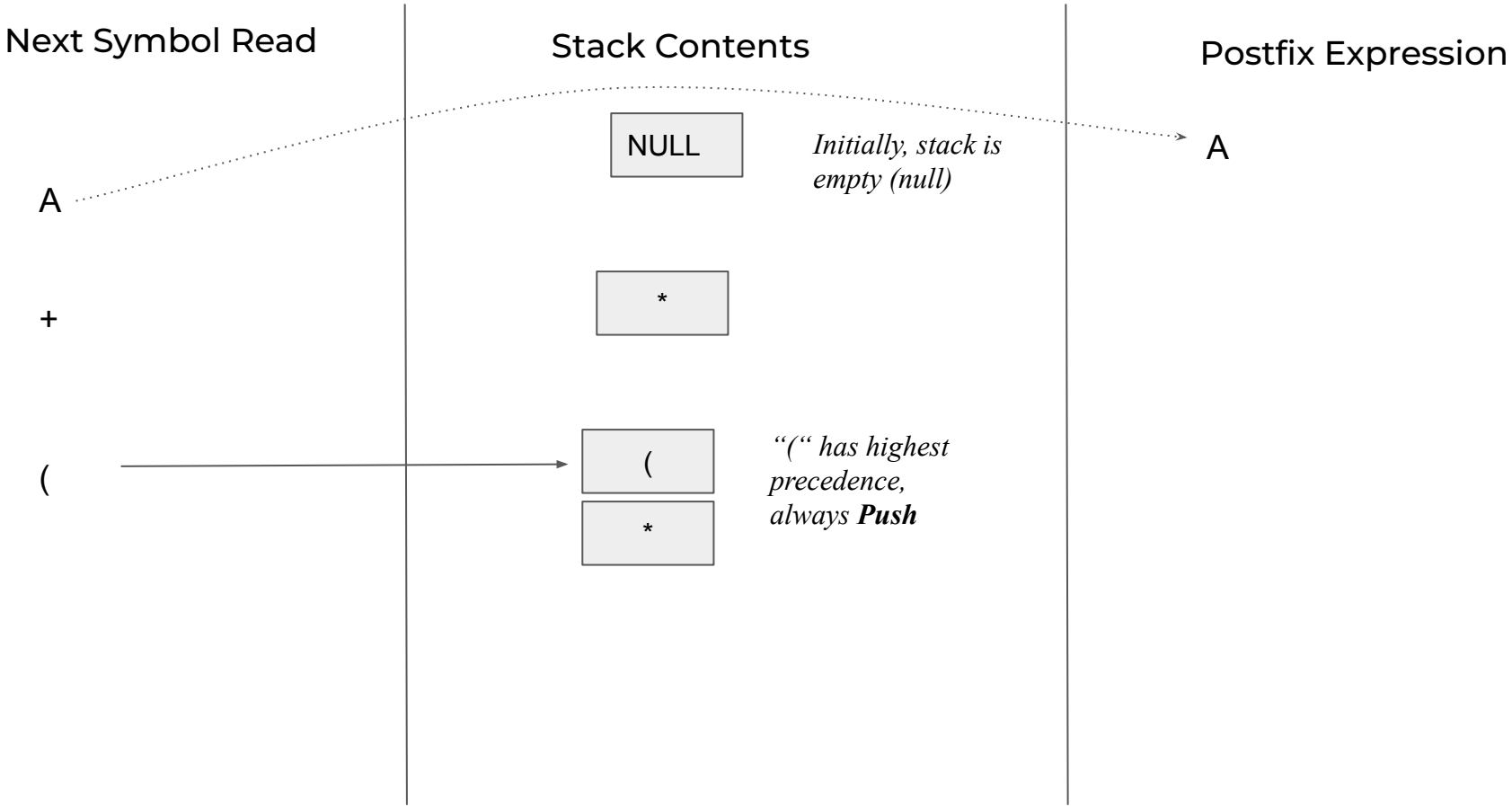
A * (B + C) / D


Next Symbol Read
Stack Contents
Postfix Expression
A
NULL
Initially, stack is empty (null)
A

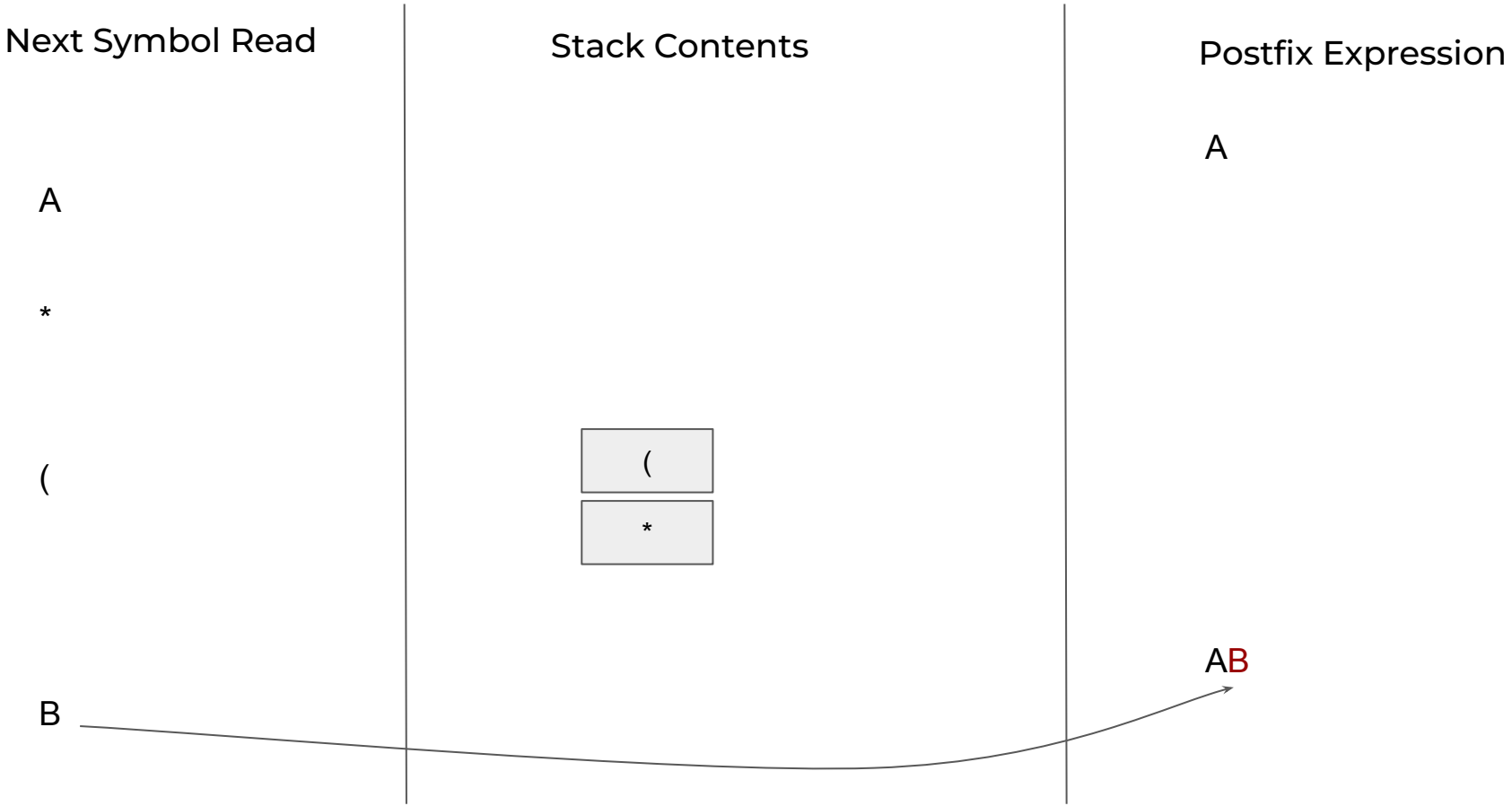
A * (B + C) / D


Next Symbol Read
Stack Contents
Postfix Expression
NULL
Initially, stack is empty (null)
A
A
*
*

A * (B + C) / D


Next Symbol Read
Stack Contents
Postfix Expression
NULL
Initially, stack is empty (null)
A
A
+
*
(
(
*
"(" has highest precedence, always **Push**

A * (B + C) / D

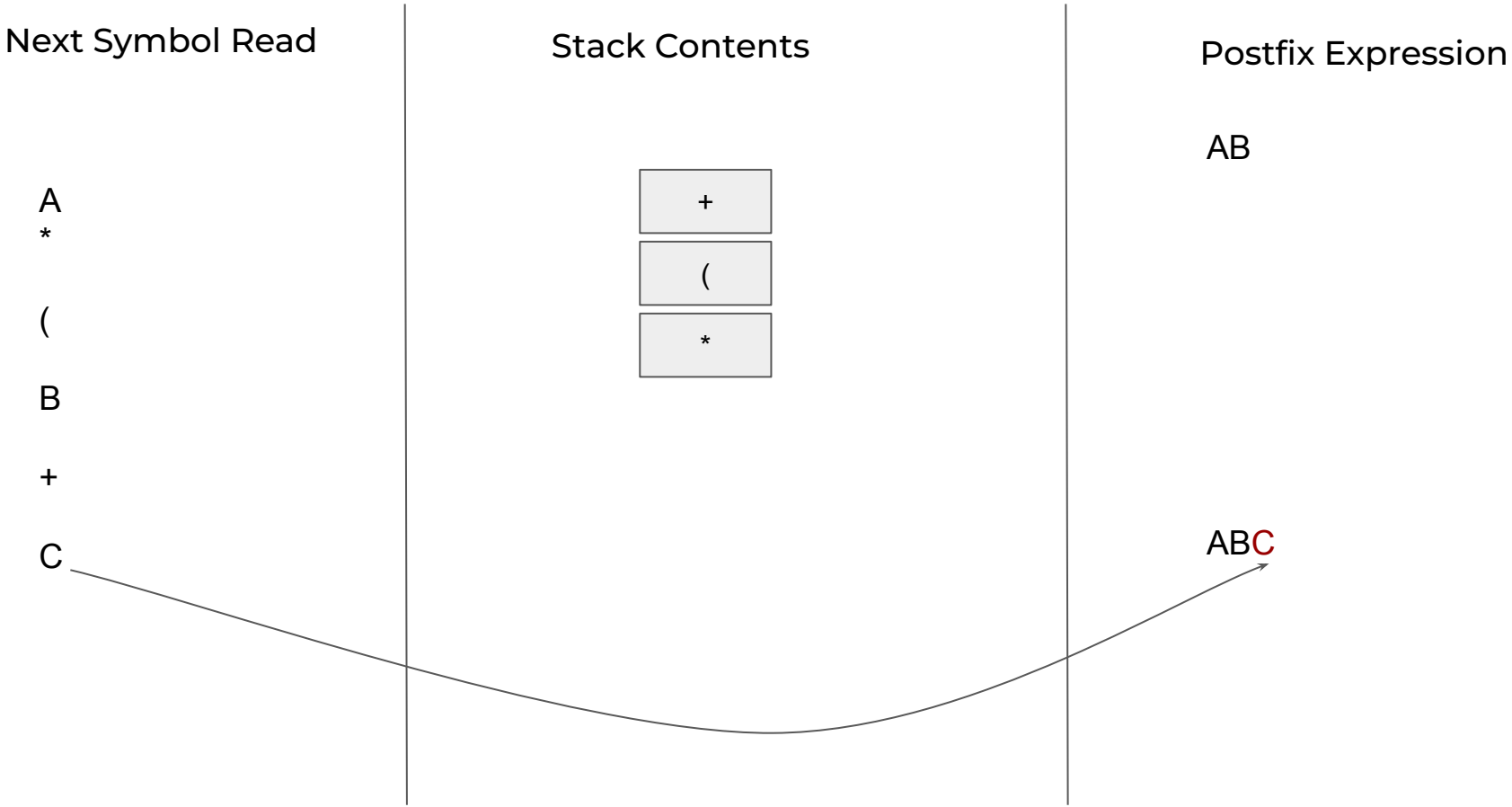


A * (B + C) / D

Next Symbol Read	Stack Contents	Postfix Expression
A		A
*		
(		
B		
+	+ (*	AB

"(" at the top of Stack almost creates a brand new scope -- notice that "+" is pushed.

A * (B + C) / D


Next Symbol Read
Stack Contents
Postfix Expression
A
*
(
B
+
C
+
(
*
AB
ABC

A * (B + C) / D

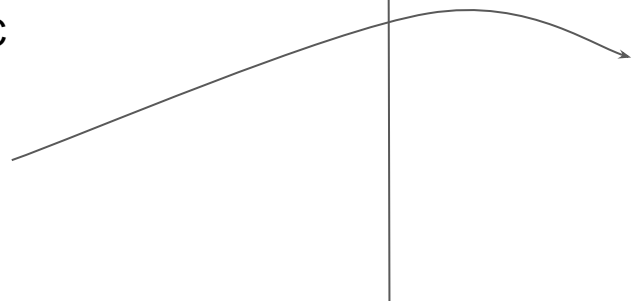
Next Symbol Read

Stack Contents

Postfix Expression

A
*
(
B
+
C

)

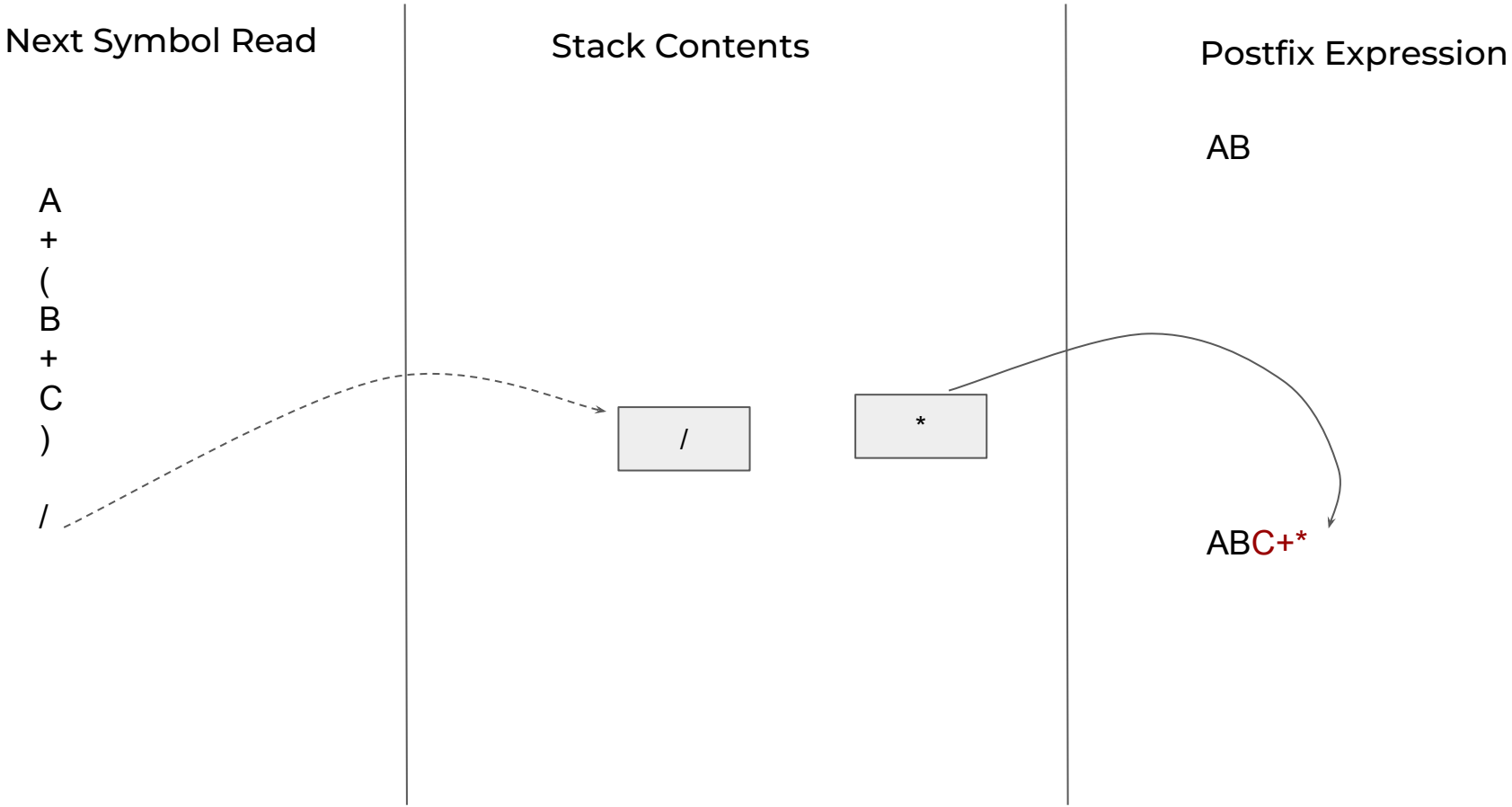


")" Pop everything until you encounter "(" -- and do not write parentheses to postfix

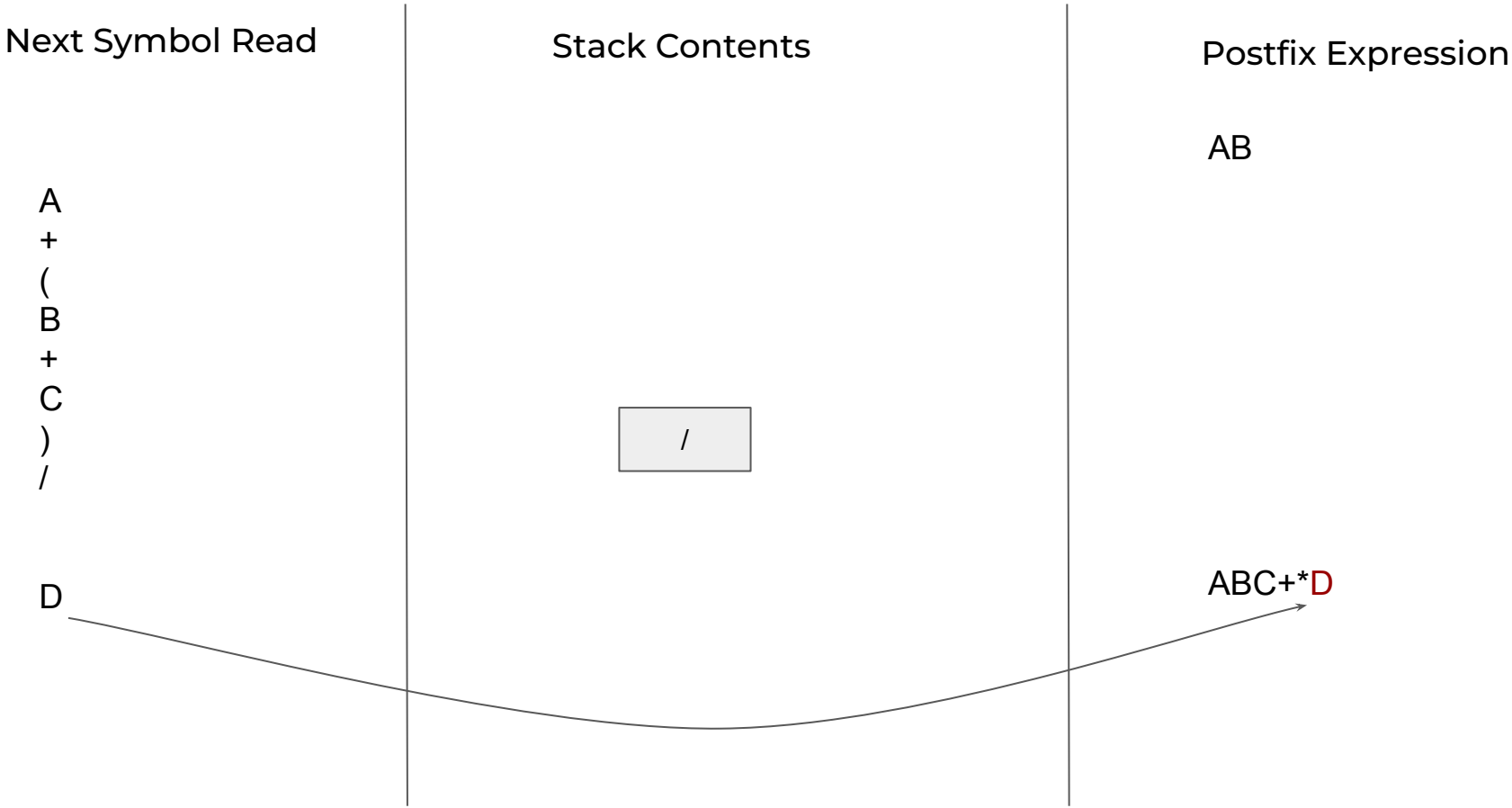
AB

ABC

A * (B + C) / D


Next Symbol Read
Stack Contents
Postfix Expression
AB
A
+
(
B
+
C
)
/
/
*
ABC+*

A * (B + C) / D


Next Symbol Read
Stack Contents
Postfix Expression
AB
A
+
(
B
+
C
)
/
/
D
ABC+*D

A * (B + C) / D

Next Symbol Read	Stack Contents	Postfix Expression
A		AB
+		
(		
B		
+		
C		
)	*	
/		
D		ABC+*D/

When all symbols are scanned, simply "pop" the contents of the stack to the output

Hope this was fun!