

Nullable, First and Follow

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1 de novembro de 2017

$E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow \mathbf{id}$
 $F \rightarrow \mathbf{num}$
 $F \rightarrow (E)$

Esta é a gramática livre de contexto!

E → T E'
E' → + T E'
E' → - T E'
E' →
T → F T'
T' → * F T'
T' → / F T'
T' →
F → **id**
F → **num**
F → (E)

Acertando a gramática

Símbolo inicial: **E**

Novo símbolo inicial: **S**

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow \text{id}$
 $F \rightarrow \text{num}$
 $F \rightarrow (E)$

Acertando a gramática

Símbolo inicial: **E**

Novo símbolo inicial: **S**

Nova regra de produção: $S \rightarrow E \$$

$S \rightarrow E \ \$$
 $E \rightarrow T \ E'$
 $E' \rightarrow + \ T \ E'$
 $E' \rightarrow - \ T \ E'$
 $E' \rightarrow$
 $T \rightarrow F \ T'$
 $T' \rightarrow * \ F \ T'$
 $T' \rightarrow / \ F \ T'$
 $T' \rightarrow$
 $F \rightarrow \text{id}$
 $F \rightarrow \text{num}$
 $F \rightarrow (\ E \)$

NT	Nullable	First	Follow

Tabela de símbolos anuláveis, conjuntos first e conjuntos follow

$S \rightarrow E \ \$$
 $E \rightarrow T \ E'$
 $E' \rightarrow + \ T \ E'$
 $E' \rightarrow - \ T \ E'$
 $E' \rightarrow$
 $T \rightarrow F \ T'$
 $T' \rightarrow * \ F \ T'$
 $T' \rightarrow / \ F \ T'$
 $T' \rightarrow$
 $F \rightarrow \text{id}$
 $F \rightarrow \text{num}$
 $F \rightarrow (\ E \)$

NT	Nullable	First	Follow
S			
E'			
T			
T'			
F			
E			

Tabela de símbolos anuláveis, conjuntos first e conjuntos follow

$S \rightarrow E \ \$$
 $E \rightarrow T \ E'$
 $E' \rightarrow + \ T \ E'$
 $E' \rightarrow - \ T \ E'$
 $E' \rightarrow$
 $T \rightarrow F \ T'$
 $T' \rightarrow * \ F \ T'$
 $T' \rightarrow / \ F \ T'$
 $T' \rightarrow$
 $F \rightarrow \text{id}$
 $F \rightarrow \text{num}$
 $F \rightarrow (\ E \)$

NT	Nullable	First	Follow
S	×		
E'	×		
T	×		
T'	×		
F	×		
E	×		

Encontrando os símbolos não terminais anuláveis

Inicialmente nenhum símbolo não terminal é anulável

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow \text{id}$
 $F \rightarrow \text{num}$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	x		
E'	x		
T	x		
T'	x		
F	x		
E	x		

Regra com terminal no lado direito é inútil

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow \text{id}$
 $F \rightarrow \text{num}$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	x		
E'	x		
T	x		
T'	x		
F	x		
E	x		

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$S \rightarrow E \$$
 $E \rightarrow T E'$
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 $T' \rightarrow$
 $F \rightarrow \text{id}$
 $F \rightarrow \text{num}$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	x		
E'	x		
T	x		
T'	x		
F	x		
E	x		

Regra com terminal no lado direito é inútil

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
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 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	x		
E'	x		
T	x		
T'	x		
F	x		
E	x		

Regra com terminal no lado direito é inútil

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
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 $T \rightarrow F T'$
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 $F \rightarrow \text{num}$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	x		
E'	x		
T	x		
T'	x		
F	x		
E	x		

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 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	x		
E'	x		
T	x		
T'	x		
F	x		
E	x		

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NT	Nullable	First	Follow
S	x		
E'	x		
T	x		
T'	x		
F	x		
E	x		

Regra com terminal no lado direito é inútil

$S \rightarrow E \$$
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 $T' \rightarrow / F T'$
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 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	x		
E'	x		
T	x		
T'	x		
F	x		
E	x		

Regra com terminal no lado direito é inútil

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
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 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	x		
E'	x ✓		
T	x		
T'	x		
F	x		
E	x		

Lado direito da regra é vazio

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	x		
E'	x ✓		
T	x		
T'	x ✓		
F	x		
E	x		

Lado direito da regra é vazio

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	x		
E'	x ✓		
T	x		
T'	x ✓		
F	x		
E	x		

Lado direito da regra não é anulável

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	x		
E'	x ✓		
T	x		
T'	x ✓		
F	x		
E	x		

Lado direito da regra não é anulável

$S \rightarrow E \ \$$
 $E \rightarrow T \ E'$
 $E' \rightarrow + \ T \ E'$
 $E' \rightarrow - \ T \ E'$
 $E' \rightarrow$
 $T \rightarrow F \ T'$
 $T' \rightarrow * \ F \ T'$
 $T' \rightarrow / \ F \ T'$
 $T' \rightarrow$
 $F \rightarrow \text{id}$
 $F \rightarrow \text{num}$
 $F \rightarrow (\ E \)$

NT	Nullable	First	Follow
S	x		
E'	x ✓		
T	x		
T'	x ✓		
F	x		
E	x		

Encontrando os conjuntos first

Inicialmente são vazios

$S \rightarrow E \ \$$
 $E \rightarrow T \ E'$
 $E' \rightarrow + \ T \ E'$
 $E' \rightarrow - \ T \ E'$
 $E' \rightarrow \epsilon$
 $T \rightarrow F \ T'$
 $T' \rightarrow * \ F \ T'$
 $T' \rightarrow / \ F \ T'$
 $T' \rightarrow \epsilon$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (\ E \)$

NT	Nullable	First	Follow
S	x		
E'	x ✓	+ -	
T	x		
T'	x ✓		
F	x		
E	x		

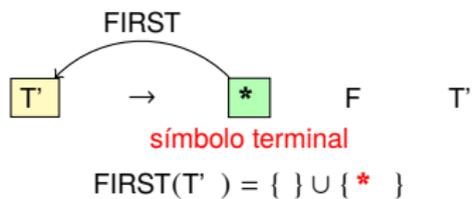
$E' \rightarrow$

O lado direito da regra é ϵ

Logo a regra é inútil

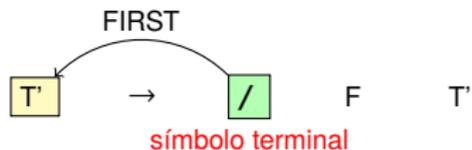
$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow \text{id}$
 $F \rightarrow \text{num}$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	x		
E'	x ✓	+ -	
T	x		
T'	x ✓	*	
F	x		
E	x		



$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	x		
E'	x ✓	+ -	
T	x		
T'	x ✓	* /	
F	x		
E	x		



$$\text{FIRST}(T') = \{ * \} \cup \{ / \}$$

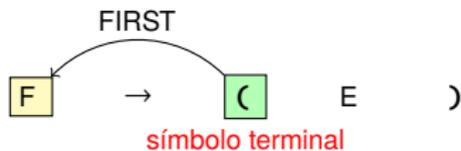
$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow \text{id}$
 $F \rightarrow \text{num}$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	x		
E'	x ✓	+ -	
T	x		
T'	x ✓	* /	
F	x		
E	x		

$T' \rightarrow$
 O lado direito da regra é ϵ
 Logo a regra é inútil

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

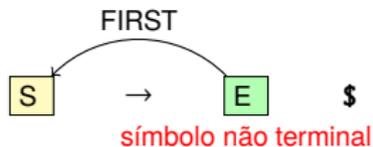
NT	Nullable	First	Follow
S	x		
E'	x ✓	+ -	
T	x		
T'	x ✓	* /	
F	x	id num (
E	x		



$$\text{FIRST}(F) = \{id, num\} \cup \{($$

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

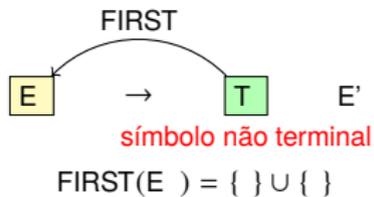
NT	Nullable	First	Follow
S	x		
E'	x ✓	+ -	
T	x		
T'	x ✓	* /	
F	x	id num (
E	x		



$$\text{FIRST}(S) = \{ \} \cup \{ \}$$

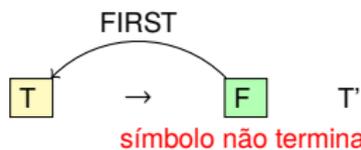
$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	x		
E'	x ✓	+ -	
T	x		
T'	x ✓	* /	
F	x	id num (
E	x		



$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

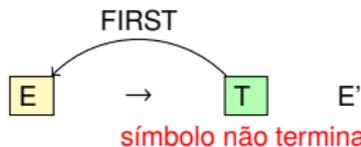
NT	Nullable	First	Follow
S	x		
E'	x ✓	+ -	
T	x	id num (
T'	x ✓	* /	
F	x	id num (
E	x		



$$\text{FIRST}(T) = \{ \} \cup \{ id, num, (\}$$

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

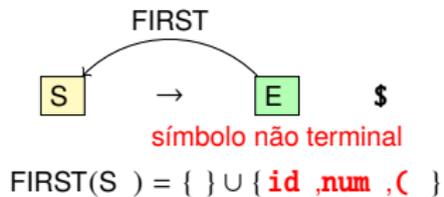
NT	Nullable	First	Follow
S	x		
E'	x ✓	+ -	
T	x	id num (
T'	x ✓	* /	
F	x	id num (
E	x	id num (



$$\text{FIRST}(E) = \{ \} \cup \{ id, num, (\}$$

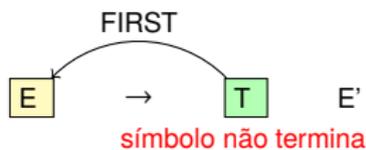
$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	x	id num (
E'	x ✓	+ -	
T	x	id num (
T'	x ✓	* /	
F	x	id num (
E	x	id num (



$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

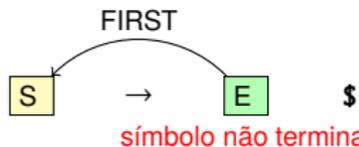
NT	Nullable	First	Follow
S	x	id num (
E'	x ✓	+ -	
T	x	id num (
T'	x ✓	* /	
F	x	id num (
E	x	id num (



$$\text{FIRST}(E) = \{id, num, (\} \cup \{id, num, (\}$$

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
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 $T' \rightarrow$
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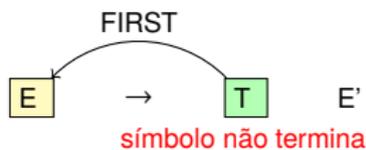
NT	Nullable	First	Follow
S	x	id num (
E'	x ✓	+ -	
T	x	id num (
T'	x ✓	* /	
F	x	id num (
E	x	id num (



$$\text{FIRST}(S) = \{id, num, (\} \cup \{id, num, (\}$$

$S \rightarrow E \$$
 $E \rightarrow T E'$
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 $E' \rightarrow - T E'$
 $E' \rightarrow$
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NT	Nullable	First	Follow
S	x	id num (
E'	x ✓	+ -	
T	x	id num (
T'	x ✓	* /	
F	x	id num (
E	x	id num (



$$\text{FIRST}(E) = \{id, num, (\} \cup \{id, num, (\}$$

S → E \$
 E → T E'
 E' → + T E'
 E' → - T E'
 E' →
 T → F T'
 T' → * F T'
 T' → / F T'
 T' →
 F → id
 F → num
 F → (E)

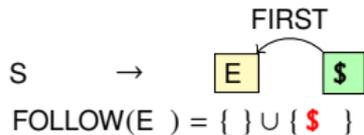
NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	
T	×	id num (
T'	× ✓	* /	
F	×	id num (
E	×	id num (

S → E \$
 E → T E'
 E' → + T E'
 E' → - T E'
 E' →
 T → F T'
 T' → * F T'
 T' → / F T'
 T' →
 F → id
 F → num
 F → (E)

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	
T	×	id num (
T'	× ✓	* /	
F	×	id num (
E	×	id num (

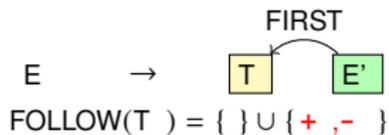
$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
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 $T' \rightarrow$
 $F \rightarrow \text{id}$
 $F \rightarrow \text{num}$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	
T	×	id num (
T'	× ✓	* /	
F	×	id num (
E	×	id num (\$



$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	
T	×	id num (+ -
T'	× ✓	* /	
F	×	id num (
E	×	id num (\$



$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
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 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

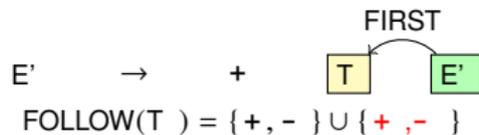
NT	Nullable	First	Follow
S	×	id num (
E'	×	+ -	
T	×	id num (+ -
T'	×	* /	
F	×	id num (
E	×	id num (\$

$E \rightarrow T E'$

Não há nenhum símbolo após o último não terminal

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow \text{id}$
 $F \rightarrow \text{num}$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	
T	×	id num (+ -
T'	× ✓	* /	
F	×	id num (
E	×	id num (\$



$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

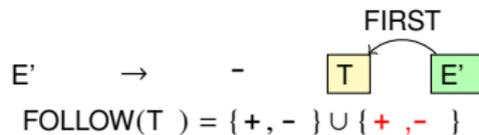
NT	Nullable	First	Follow
S	×	id num (
E'	×	+ -	
T	×	id num (+ -
T'	×	* /	
F	×	id num (
E	×	id num (\$

$E' \rightarrow + T E'$

Não há nenhum símbolo após o último não terminal

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	
T	×	id num (+ -
T'	× ✓	* /	
F	×	id num (
E	×	id num (\$



$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	
T	×	id num (+ -
T'	× ✓	* /	
F	×	id num (
E	×	id num (\$

$E' \rightarrow - T E'$

Não há nenhum símbolo após o último não terminal

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	
T	×	id num (+ -
T'	× ✓	* /	
F	×	id num (
E	×	id num (\$

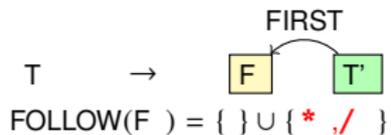
$E' \rightarrow$

Nenhum símbolo não terminal no lado direito da regra

Regra inútil

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	
T	×	id num (+ -
T'	× ✓	* /	
F	×	id num (* /
E	×	id num (\$



$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

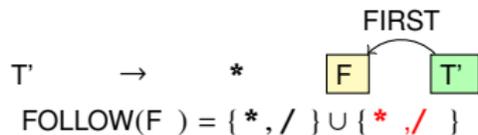
NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	
T	×	id num (+ -
T'	× ✓	* /	
F	×	id num (* /
E	×	id num (\$

T → F T'

Não há nenhum símbolo após o último não terminal

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	
T	×	id num (+ -
T'	× ✓	* /	
F	×	id num (* /
E	×	id num (\$



$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

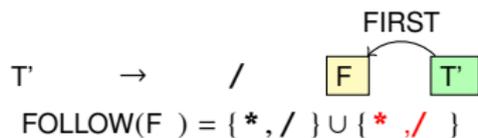
NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	
T	×	id num (+ -
T'	× ✓	* /	
F	×	id num (* /
E	×	id num (\$

$T' \rightarrow * F T'$

Não há nenhum símbolo após o último não terminal

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	
T	×	id num (+ -
T'	× ✓	* /	
F	×	id num (* /
E	×	id num (\$



$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	
T	×	id num (+ -
T'	× ✓	* /	
F	×	id num (* /
E	×	id num (\$

$T' \rightarrow / F T'$

Não há nenhum símbolo após o último não terminal

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	
T	×	id num (+ -
T'	× ✓	* /	
F	×	id num (* /
E	×	id num (\$

$T' \rightarrow$

Nenhum símbolo não terminal no lado direito da regra

Regra inútil

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	
T	×	id num (+ -
T'	× ✓	* /	
F	×	id num (* /
E	×	id num (\$

$F \rightarrow id$

Nenhum símbolo não terminal no lado direito da regra

Regra inútil

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	
T	×	id num (+ -
T'	× ✓	* /	
F	×	id num (* /
E	×	id num (\$

$F \rightarrow num$

Nenhum símbolo não terminal no lado direito da regra

Regra inútil

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	
T	×	id num (+ -
T'	× ✓	* /	
F	×	id num (* /
E	×	id num (\$)

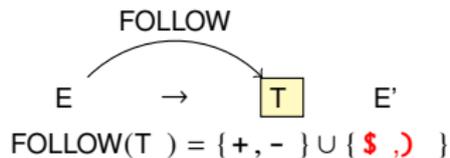
$F \rightarrow (E)$

FIRST

$FOLLOW(E) = \{ \$ \} \cup \{) \}$

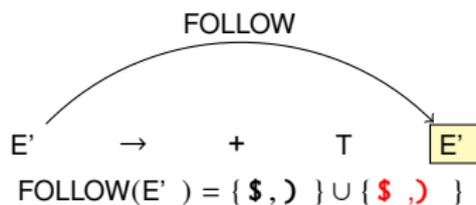
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 $E' \rightarrow$
 $T \rightarrow F T'$
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NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	
F	×	id num (* /
E	×	id num (\$)



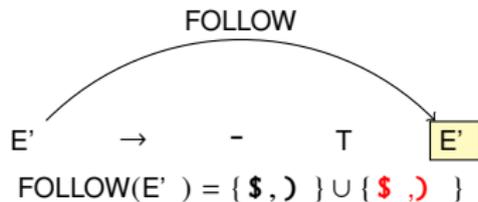
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 $T \rightarrow F T'$
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 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	x	id num (
E'	x ✓	+ -	\$)
T	x	id num (+ - \$)
T'	x ✓	* /	
F	x	id num (* /
E	x	id num (\$)



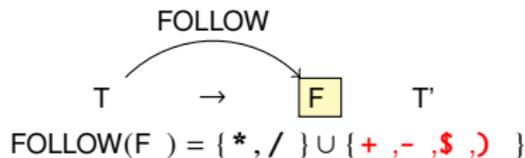
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 $T \rightarrow F T'$
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NT	Nullable	First	Follow
S	x	id num (
E'	x ✓	+ -	\$)
T	x	id num (+ - \$)
T'	x ✓	* /	
F	x	id num (* /
E	x	id num (\$)



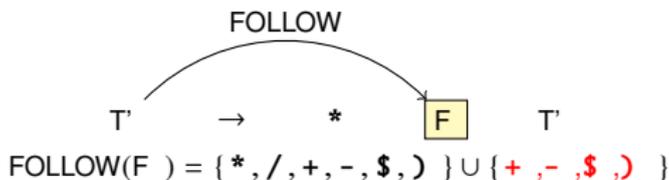
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 $T \rightarrow F T'$
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 $T' \rightarrow / F T'$
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 $F \rightarrow num$
 $F \rightarrow (E)$

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T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)



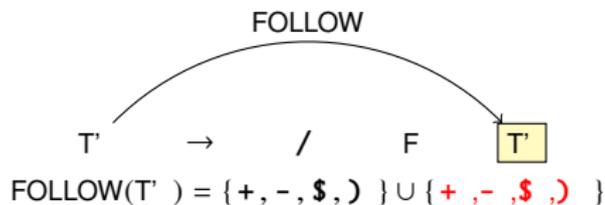
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E'	x ✓	+ -	\$)
T	x	id num (+ - \$)
T'	x ✓	* /	+ - \$)
F	x	id num (* / + - \$)
E	x	id num (\$)



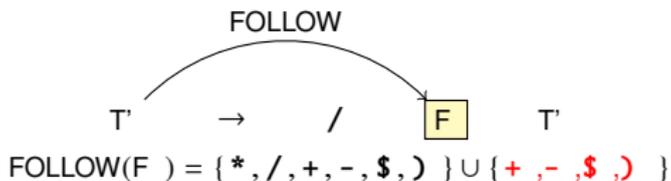
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NT	Nullable	First	Follow
S	x	id num (
E'	x ✓	+ -	\$)
T	x	id num (+ - \$)
T'	x ✓	* /	+ - \$)
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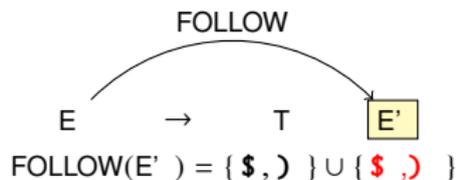
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NT	Nullable	First	Follow
S	x	id num (
E'	x ✓	+ -	\$)
T	x	id num (+ - \$)
T'	x ✓	* /	+ - \$)
F	x	id num (* / + - \$)
E	x	id num (\$)



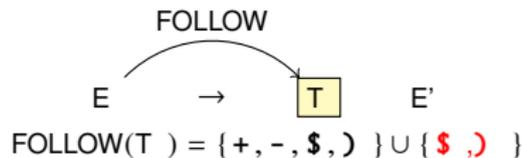
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 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	×	+ -	\$)
T	×	id num (+ - \$)
T'	×	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)



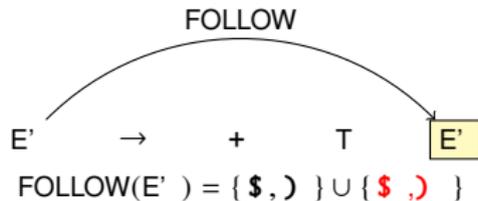
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 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)



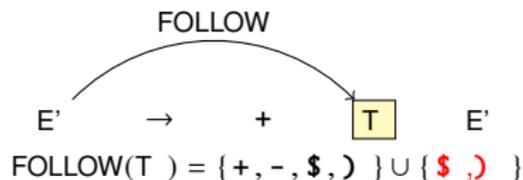
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 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
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T	x	id num (+ - \$)
T'	x ✓	* /	+ - \$)
F	x	id num (* / + - \$)
E	x	id num (\$)



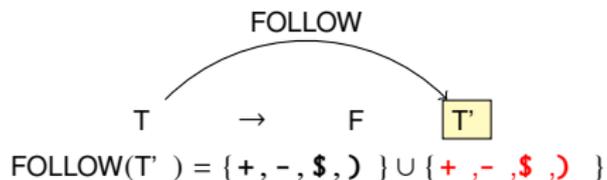
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S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)



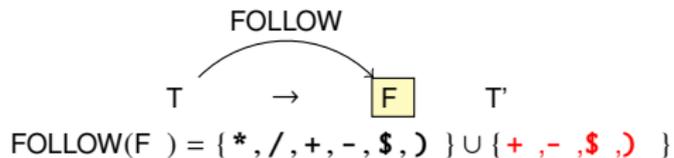
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T'	x ✓	* /	+ - \$)
F	x	id num (* / + - \$)
E	x	id num (\$)



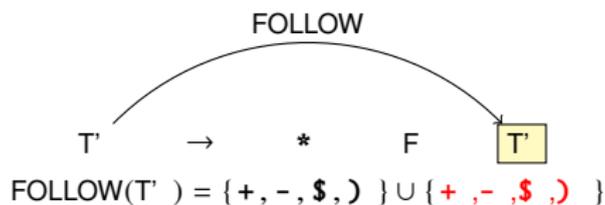
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S	×	id num (
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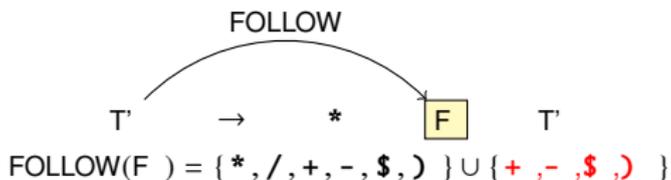
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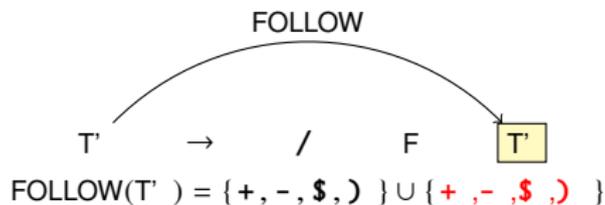
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S	x	id num (
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T	x	id num (+ - \$)
T'	x ✓	* /	+ - \$)
F	x	id num (* / + - \$)
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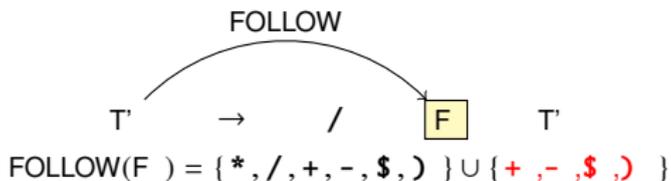
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$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
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NT	Nullable	First	Follow
S	x	id num (
E'	x ✓	+ -	\$)
T	x	id num (+ - \$)
T'	x ✓	* /	+ - \$)
F	x	id num (* / + - \$)
E	x	id num (\$)



S → E \$
 E → T E'
 E' → + T E'
 E' → - T E'
 E' →
 T → F T'
 T' → * F T'
 T' → / F T'
 T' →
 F → id
 F → num
 F → (E)

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)

	\$	(	)	*	+	-	/	id	num
S									
E'									
T									
T'									
F									
E									

Construção da tabela LL(1)

S → E \$
 E → T E'
 E' → + T E'
 E' → - T E'
 E' →
 T → F T'
 T' → * F T'
 T' → / F T'
 T' →
 F → id
 F → num
 F → (E)

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)

	\$	(	)	*	+	-	/	id	num
S									
E'									
T									
T'									
F									
E									

$$\text{FIRST}(E \$) = \{ \} \cup \{ \text{id num (} \}$$

S → E \$
 E → T E'
 E' → + T E'
 E' → - T E'
 E' →
 T → F T'
 T' → * F T'
 T' → / F T'
 T' →
 F → id
 F → num
 F → (E)

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)

	\$	(	)	*	+	-	/	id	num
S		E \$						E \$	E \$
E'									
T									
T'									
F									
E									

S → E \$
 id num (

$S \rightarrow E \ \$$
 $E \rightarrow T \ E'$
 $E' \rightarrow + \ T \ E'$
 $E' \rightarrow - \ T \ E'$
 $E' \rightarrow$
 $T \rightarrow F \ T'$
 $T' \rightarrow * \ F \ T'$
 $T' \rightarrow / \ F \ T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (\ E \)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)

	\$	(	)	*	+	-	/	id	num
S		E \$						E \$	E \$
E'									
T									
T'									
F									
E									

$$\text{FIRST}(T \ E') = \{ \} \cup \{ id \ num \ (\}$$

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)

	\$	(	)	*	+	-	/	id	num
S		E \$						E \$	E \$
E'									
T									
T'									
F									
E		T E'						T E'	T E'

$E \rightarrow T E'$
 $id \ num \ ($

S → E \$
 E → T E'
 E' → + T E'
 E' → - T E'
 E' →
 T → F T'
 T' → * F T'
 T' → / F T'
 T' →
 F → id
 F → num
 F → (E)

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)

	\$	(	)	*	+	-	/	id	num
S		E \$						E \$	E \$
E'									
T									
T'									
F									
E		T E'						T E'	T E'

$$\text{FIRST}(+ T E') = \{ \} \cup \{ + \}$$

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)

	\$	(	)	*	+	-	/	id	num
S		E \$						E \$	E \$
E'					+ T E'				
T									
T'									
F									
E		T E'						T E'	T E'

$E' \rightarrow + T E'$
 +

S \rightarrow E \$
 E \rightarrow T E'
 E' \rightarrow + T E'
 E' \rightarrow - T E'
 E' \rightarrow
 T \rightarrow F T'
 T' \rightarrow * F T'
 T' \rightarrow / F T'
 T' \rightarrow
 F \rightarrow id
 F \rightarrow num
 F \rightarrow (E)

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)

	\$	(	)	*	+	-	/	id	num
S		E \$						E \$	E \$
E'					+ T E'				
T									
T'									
F									
E		T E'						T E'	T E'

$$\text{FIRST}(- T E') = \{ \} \cup \{ - \}$$

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)

	\$	(	)	*	+	-	/	id	num
S		E \$						E \$	E \$
E'					+ T E'	- T E'			
T									
T'									
F									
E		T E'						T E'	T E'

$E' \rightarrow - T E'$
 -

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)

	\$	(	)	*	+	-	/	id	num
S		E \$						E \$	E \$
E'	€		€		+ T E'	- T E'			
T									
T'									
F									
E		T E'						T E'	T E'

$E' \rightarrow$
 $\$)$

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	x	id num (
E'	x ✓	+ -	\$)
T	x	id num (+ - \$)
T'	x ✓	* /	+ - \$)
F	x	id num (* / + - \$)
E	x	id num (\$)

	\$	(	)	*	+	-	/	id	num
S		E \$						E \$	E \$
E'	ε		ε		+ T E'	- T E'			
T									
T'									
F									
E		T E'						T E'	T E'

$$\text{FIRST}(F T') = \{ \} \cup \{ id \text{ num } (\}$$

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow \text{id}$
 $F \rightarrow \text{num}$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)

	\$	(	)	*	+	-	/	id	num
S		E \$						E \$	E \$
E'	ε		ε		+ T E'	- T E'			
T		F T'						F T'	F T'
T'									
F									
E		T E'						T E'	T E'

$T \rightarrow F T'$
 id num (

S → E \$
 E → T E'
 E' → + T E'
 E' → - T E'
 E' →
 T → F T'
 T' → * F T'
 T' → / F T'
 T' →
 F → id
 F → num
 F → (E)

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)

	\$	(	)	*	+	-	/	id	num
S		E \$						E \$	E \$
E'	ε		ε		+ T E'	- T E'			
T		F T'						F T'	F T'
T'									
F									
E		T E'						T E'	T E'

$$\text{FIRST}(* F T') = \{ \} \cup \{ * \}$$

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow \text{id}$
 $F \rightarrow \text{num}$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)

	\$	(	)	*	+	-	/	id	num
S		E \$						E \$	E \$
E'	ε		ε		+ T E'	- T E'			
T		F T'						F T'	F T'
T'				* F T'					
F									
E		T E'						T E'	T E'

$T' \rightarrow * F T'$
 $*$

S → E \$
 E → T E'
 E' → + T E'
 E' → - T E'
 E' →
 T → F T'
 T' → * F T'
 T' → / F T'
 T' →
 F → id
 F → num
 F → (E)

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)

	\$	(	)	*	+	-	/	id	num
S		E \$						E \$	E \$
E'	ε		ε		+ T E'	- T E'			
T		F T'						F T'	F T'
T'				* F T'					
F									
E		T E'						T E'	T E'

$$\text{FIRST}(/ F T') = \{ \} \cup \{ / \}$$

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow id$
 $F \rightarrow num$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	x	id num (
E'	x ✓	+ -	\$)
T	x	id num (+ - \$)
T'	x ✓	* /	+ - \$)
F	x	id num (* / + - \$)
E	x	id num (\$)

	\$	(	)	*	+	-	/	id	num
S		E \$						E \$	E \$
E'	€		€		+ T E'	- T E'			
T		F T'						F T'	F T'
T'				* F T'			/ F T'		
F									
E		T E'						T E'	T E'

$T' \rightarrow / F T'$
 $/$

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow \text{id}$
 $F \rightarrow \text{num}$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)

	\$	(	)	*	+	-	/	id	num
S		E \$						E \$	E \$
E'	€		€		+ T E'	- T E'			
T		F T'						F T'	F T'
T'	€		€	* F T'	€	€	/ F T'		
F									
E		T E'						T E'	T E'

$T' \rightarrow$
 $+ - \$)$

S \rightarrow E \$
 E \rightarrow T E'
 E' \rightarrow + T E'
 E' \rightarrow - T E'
 E' \rightarrow
 T \rightarrow F T'
 T' \rightarrow * F T'
 T' \rightarrow / F T'
 T' \rightarrow
 F \rightarrow id
 F \rightarrow num
 F \rightarrow (E)

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)

	\$	(	)	*	+	-	/	id	num
S		E \$						E \$	E \$
E'	ε		ε		+ T E'	- T E'			
T		F T'						F T'	F T'
T'	ε		ε	* F T'	ε	ε	/ F T'		
F									
E		T E'						T E'	T E'

$$\text{FIRST}(\text{id}) = \{ \} \cup \{ \text{id} \}$$

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow \text{id}$
 $F \rightarrow \text{num}$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)

	\$	(	)	*	+	-	/	id	num
S		E \$						E \$	E \$
E'	ε		ε		+ T E'	- T E'			
T		F T'						F T'	F T'
T'	ε		ε	* F T'	ε	ε	/ F T'		
F								id	
E		T E'						T E'	T E'

$F \rightarrow \text{id}$
 id

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow \text{id}$
 $F \rightarrow \text{num}$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	x	id num (
E'	x ✓	+ -	\$)
T	x	id num (+ - \$)
T'	x ✓	* /	+ - \$)
F	x	id num (* / + - \$)
E	x	id num (\$)

	\$	(	)	*	+	-	/	id	num
S		E \$						E \$	E \$
E'	ε		ε		+ T E'	- T E'			
T		F T'						F T'	F T'
T'	ε		ε	* F T'	ε	ε	/ F T'		
F								id	
E		T E'						T E'	T E'

$$\text{FIRST}(\text{num}) = \{ \} \cup \{ \text{num} \}$$

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow \text{id}$
 $F \rightarrow \text{num}$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)

	\$	(	)	*	+	-	/	id	num
S		E \$						E \$	E \$
E'	ε		ε		+ T E'	- T E'			
T		F T'						F T'	F T'
T'	ε		ε	* F T'	ε	ε	/ F T'		
F								id	num
E		T E'						T E'	T E'

$F \rightarrow \text{num}$
 num

S \rightarrow E \$
 E \rightarrow T E'
 E' \rightarrow + T E'
 E' \rightarrow - T E'
 E' \rightarrow
 T \rightarrow F T'
 T' \rightarrow * F T'
 T' \rightarrow / F T'
 T' \rightarrow
 F \rightarrow id
 F \rightarrow num
 F \rightarrow (E)

NT	Nullable	First	Follow
S	x	id num (
E'	x \checkmark	+ -	\$)
T	x	id num (+ - \$)
T'	x \checkmark	* /	+ - \$)
F	x	id num (* / + - \$)
E	x	id num (\$)

	\$	(	)	*	+	-	/	id	num
S		E \$						E \$	E \$
E'	ϵ		ϵ		+ T E'	- T E'			
T		F T'						F T'	F T'
T'	ϵ		ϵ	* F T'	ϵ	ϵ	/ F T'		
F								id	num
E		T E'						T E'	T E'

$$\text{FIRST}((E)) = \{ \} \cup \{ (\}$$

$S \rightarrow E \$$
 $E \rightarrow T E'$
 $E' \rightarrow + T E'$
 $E' \rightarrow - T E'$
 $E' \rightarrow$
 $T \rightarrow F T'$
 $T' \rightarrow * F T'$
 $T' \rightarrow / F T'$
 $T' \rightarrow$
 $F \rightarrow \text{id}$
 $F \rightarrow \text{num}$
 $F \rightarrow (E)$

NT	Nullable	First	Follow
S	×	id num (
E'	× ✓	+ -	\$)
T	×	id num (+ - \$)
T'	× ✓	* /	+ - \$)
F	×	id num (* / + - \$)
E	×	id num (\$)

	\$	(	)	*	+	-	/	id	num
S		E \$						E \$	E \$
E'	ε		ε		+ T E'	- T E'			
T		F T'						F T'	F T'
T'	ε		ε	* F T'	ε	ε	/ F T'		
F		(E)						id	num
E		T E'						T E'	T E'

$F \rightarrow (E)$
 $($