

0. $\langle S \rangle ::= \langle E \rangle \$$		First	Follow
1. $\langle E \rangle ::= \langle T \rangle \langle X \rangle$	$\langle E \rangle$	First(T) --> ( id	\$ )
2. $\langle X \rangle ::= + \langle T \rangle \langle X \rangle$	$\langle X \rangle$	+ empty	Follow(E) AND Follow(X) --> )
3. $\langle X \rangle ::= \epsilon$	$\langle T \rangle$	First(F) --> ( id	First(X) AND Follow(E) AND Follow(X) --> + ) empty
4. $\langle T \rangle ::= \langle F \rangle \langle V \rangle$	$\langle V \rangle$	* empty	Follow(T) AND Follow(V) --> + )
5. $\langle V \rangle ::= * \langle F \rangle \langle V \rangle$	$\langle F \rangle$	( id	First(V) AND Follow(T) AND Follow(V) --> * + ) empty
6. $\langle V \rangle ::= \epsilon$			
7. $\langle F \rangle ::= ( \langle E \rangle )$			
8. $\langle F \rangle ::= id$			

First

	+	*	(	)	id	Epsilon
$\langle E \rangle$			x		x	
$\langle X \rangle$	x					x
$\langle T \rangle$			x		x	
$\langle V \rangle$		x				x
$\langle F \rangle$			x		x	

Follow

	+	*	(	)	id	
$\langle E \rangle$				x		
$\langle X \rangle$				x		
$\langle T \rangle$	x			x		x
$\langle V \rangle$	x			x		
$\langle F \rangle$	x	x		x		x

M

1

2 3

4

5 6

7 8

	+	*	(	)	id	\$
$\langle E \rangle$						0
$\langle X \rangle$	x 2					
$\langle T \rangle$	x 4			x 4		
$\langle V \rangle$		x 5				
$\langle F \rangle$	x 7	x 7		x 7		

What is the M set used for?

Check last row of M

0.  $\langle S \rangle ::= \langle \text{Prog} \rangle \$$
1.  $\langle \text{Prog} \rangle ::= \{ \langle \text{Stmts} \rangle \}$
2.  $\langle \text{Stmts} \rangle ::= \langle \text{Stmt} \rangle \langle \text{Stmts} \rangle$
3.  $\langle \text{Stmts} \rangle ::= \epsilon$
4.  $\langle \text{Stmt} \rangle ::= \text{id} = \langle \text{Expr} \rangle ;$
5.  $\langle \text{Stmt} \rangle ::= \text{if} ( \langle \text{Expr} \rangle ) \langle \text{Stmt} \rangle$
6.  $\langle \text{Expr} \rangle ::= \text{id} \langle \text{Etail} \rangle$
7.  $\langle \text{Etail} \rangle ::= + \langle \text{Expr} \rangle$
8.  $\langle \text{Etail} \rangle ::= - \langle \text{Expr} \rangle$
9.  $\langle \text{Etail} \rangle ::= \epsilon$

	First	Follow
$\langle \text{Prog} \rangle$	{	\$
$\langle \text{Stmts} \rangle$	First(Stmt) --> id if      empty	} Follow(Stmts) --> }
$\langle \text{Stmt} \rangle$	id if	First(Stmts) AND Follow(Stmts) --> id if }
$\langle \text{Expr} \rangle$	id	; ) Follow(Etail) --> ; )
$\langle \text{Etail} \rangle$	+ -      empty	Follow(Expr) --> ; )

empty

First

	{	}	id	=	;	if	(	)	+	-	Epsilon
$\langle \text{Prog} \rangle$	x										
$\langle \text{Stmts} \rangle$			x			x					x
$\langle \text{Stmt} \rangle$			x			x					
$\langle \text{Expr} \rangle$			x								
$\langle \text{Etail} \rangle$									x	x	x

Follow

	{	}	id	=	;	if	(	)	+	-
$\langle \text{Prog} \rangle$										
$\langle \text{Stmts} \rangle$		x								
$\langle \text{Stmt} \rangle$		x	x			x				
$\langle \text{Expr} \rangle$					x			x		
$\langle \text{Etail} \rangle$					x			x		

M

	{	}	id	=	;	if	(	)	+	-	\$
1 2 3 4 5 6 7 8 9											0
			x 2			x 2					
		x	x 4			x 5					
									x 7	x 8	

If Stmt was empty and rule 2 was different, would the First(Stmts) --> First(some nonterminal)

Is the grammar guaranteed to be LL1 parsable

Check to understanding of empty symbols - Follow set row of Stmt

0.  $\langle S \rangle ::= \langle A \rangle \$$
1.  $\langle A \rangle ::= \langle R \rangle \langle D \rangle$
2.  $\langle D \rangle ::= + \langle R \rangle \langle D \rangle$
3.  $\langle D \rangle ::= - \langle R \rangle \langle D \rangle$
4.  $\langle D \rangle ::= \epsilon$
5.  $\langle R \rangle ::= \langle C \rangle \langle B \rangle$
6.  $\langle B \rangle ::= * \langle C \rangle \langle B \rangle$
7.  $\langle B \rangle ::= / \langle C \rangle \langle B \rangle$
8.  $\langle B \rangle ::= \epsilon$
9.  $\langle C \rangle ::= ( A )$
10.  $\langle C \rangle ::= \text{int}$

	First	Follow
$\langle A \rangle$	First(R) $\rightarrow ( \text{int}$	$\$ )$
$\langle D \rangle$	$+ -$ empty	Follow(A) $\rightarrow )$
$\langle R \rangle$	First(C) $\rightarrow ( \text{int}$	First(D) AND Follow(A) AND Follow(D) $\rightarrow + - )$ empty
$\langle B \rangle$	$* /$ empty	Follow(R) $\rightarrow + - )$ empty
$\langle C \rangle$	$( \text{int}$	First(B) AND Follow(R) AND Follow(B) $\rightarrow * / + - )$ empty

First

	+	-	*	/	(	)	int	Epsilon
$\langle A \rangle$					x		x	
$\langle D \rangle$	x	x						x
$\langle R \rangle$					x		x	
$\langle B \rangle$			x	x				x
$\langle C \rangle$					x		x	

Follow

	+	-	*	/	(	)	int	
$\langle A \rangle$						x		
$\langle D \rangle$						x		
$\langle R \rangle$	x	x				x		x
$\langle B \rangle$	x	x				x		x
$\langle C \rangle$	x	x	x	x		x		x

M

	+	-	*	/	(	)	int	\$
1 $\langle A \rangle$								0
2 3 4 $\langle D \rangle$	x 2	x 3						
5 $\langle R \rangle$	x	x				x 5		
6 7 8 $\langle B \rangle$	x 8	x 8	x 6	x 7		x 8		
9 10 $\langle C \rangle$	x	x	x	x		x		

Empties wrong? I think the Follow empties might be. Row R and B and C of M set

What happens if there are none checked in a row?

0.  $\langle S \rangle ::= \langle A \rangle \$$
1.  $\langle E \rangle ::= \langle M \rangle \langle O \rangle$
2.  $\langle E \rangle ::= \text{👉} \langle I \rangle \text{😊}$
3.  $\langle M \rangle ::= \text{😊} \text{😞}$
4.  $\langle M \rangle ::= \text{👁👁}$
5.  $\langle O \rangle ::= \text{👁} \langle J \rangle$
6.  $\langle J \rangle ::= \text{👉} \langle J \rangle$
7.  $\langle J \rangle ::= \epsilon$
8.  $\langle I \rangle ::= \text{👋} \langle I \rangle$
9.  $\langle I \rangle ::= \epsilon$

	First	Follow
$\langle E \rangle$		
$\langle M \rangle$		
$\langle O \rangle$		
$\langle J \rangle$		
$\langle I \rangle$		

First

	👉	😊	😞	👁👁	👁	👋	Epsilon
$\langle E \rangle$							
$\langle M \rangle$							
$\langle O \rangle$							
$\langle J \rangle$							
$\langle I \rangle$							

Follow

	👉	😊	😞	👁👁	👁	👋
$\langle E \rangle$						
$\langle M \rangle$						
$\langle O \rangle$						
$\langle J \rangle$						
$\langle I \rangle$						

M

	👉	😊	😞	👁👁	👁	👋	\$
$\langle E \rangle$							
$\langle M \rangle$							
$\langle O \rangle$							
$\langle J \rangle$							
$\langle I \rangle$							

0.  $\langle S \rangle ::= \langle A \rangle \$$
1.  $\langle A \rangle ::= \langle R \rangle \langle D \rangle$
2.  $\langle D \rangle ::= + \langle R \rangle \langle D \rangle$
3.  $\langle D \rangle ::= \langle R \rangle \langle D \rangle$
4.  $\langle D \rangle ::= \epsilon$
5.  $\langle R \rangle ::= \langle C \rangle \langle B \rangle$
6.  $\langle B \rangle ::= * \langle C \rangle \langle B \rangle$
7.  $\langle B \rangle ::= / \langle C \rangle \langle B \rangle$
8.  $\langle B \rangle ::= \epsilon$
9.  $\langle C \rangle ::= \text{num}$
10.  $\langle C \rangle ::= ( \langle A \rangle )$

	First	Follow
$\langle A \rangle$		
$\langle D \rangle$		
$\langle R \rangle$		
$\langle B \rangle$		
$\langle C \rangle$		

First

	+	*	/	num	(	)	Epsilon
$\langle A \rangle$							
$\langle D \rangle$							
$\langle R \rangle$							
$\langle B \rangle$							
$\langle C \rangle$							

Follow

	+	*	/	num	(	)
$\langle A \rangle$						
$\langle D \rangle$						
$\langle R \rangle$						
$\langle B \rangle$						
$\langle C \rangle$						

M

	+	*	/	num	(	)	\$
$\langle A \rangle$							
$\langle D \rangle$							
$\langle R \rangle$							
$\langle B \rangle$							
$\langle C \rangle$							