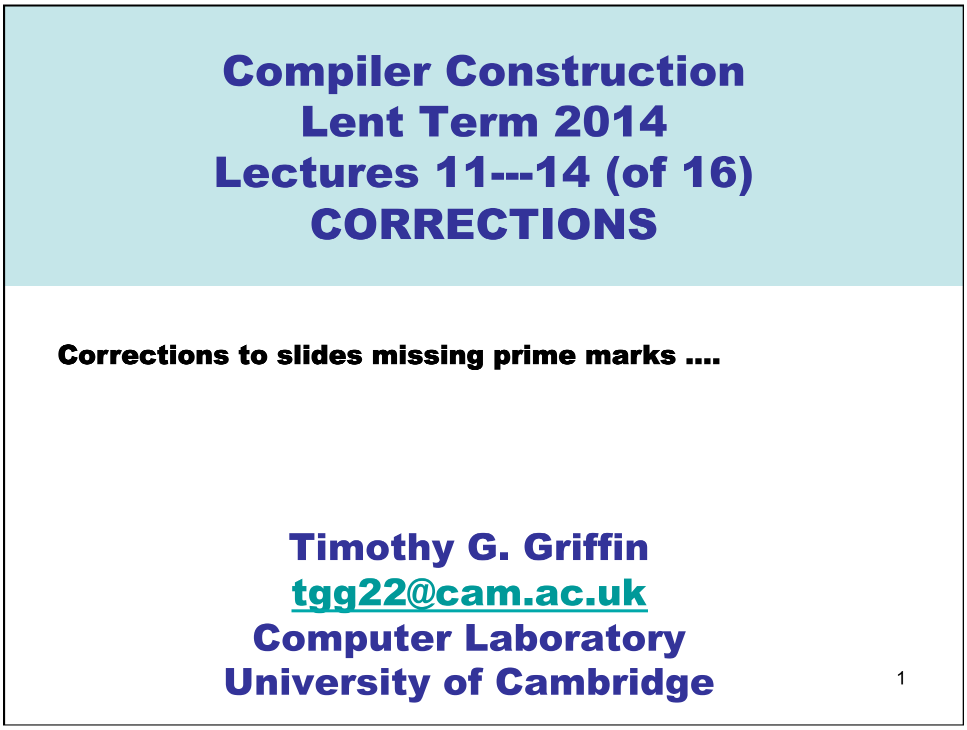

Compiler Construction
Lent Term 2014
Lectures 11---14 (of 16)
CORRECTIONS

Corrections to slides missing prime marks ….

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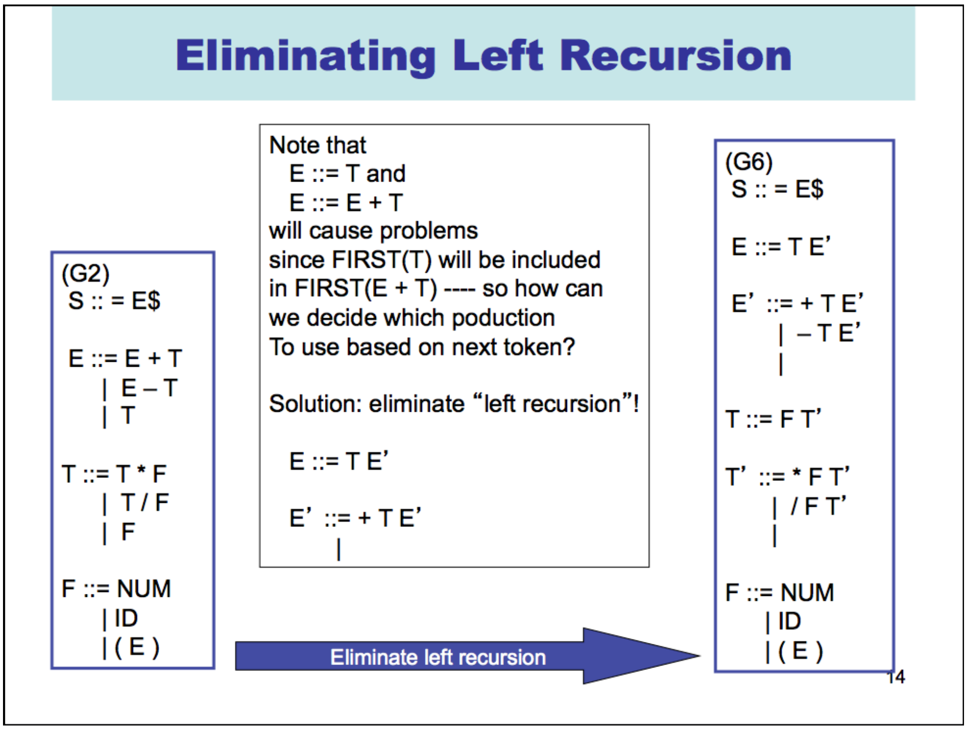

Eliminating Left Recursion

```
(G2)
 S :: = E$

 E ::= E + T
      | E – T
      | T

T ::= T * F
      | T / F
      | F

F ::= NUM
      | ID
      | ( E )
```

Note that
  E ::= T and
  E ::= E + T
will cause problems
since FIRST(T) will be included
in FIRST(E + T) ---- so how can
we decide which poduction
To use based on next token?

Solution: eliminate “left recursion”!

```
  E ::= T E’

  E’ ::= + T E’
         |
```

```
(G6)
 S :: = E$

 E ::= T E’

 E’ ::= + T E’
        | – T E’
        |

T ::= F T’

T’ ::= * F T’
       | / F T’
       |

F ::= NUM
      | ID
      | ( E )
```

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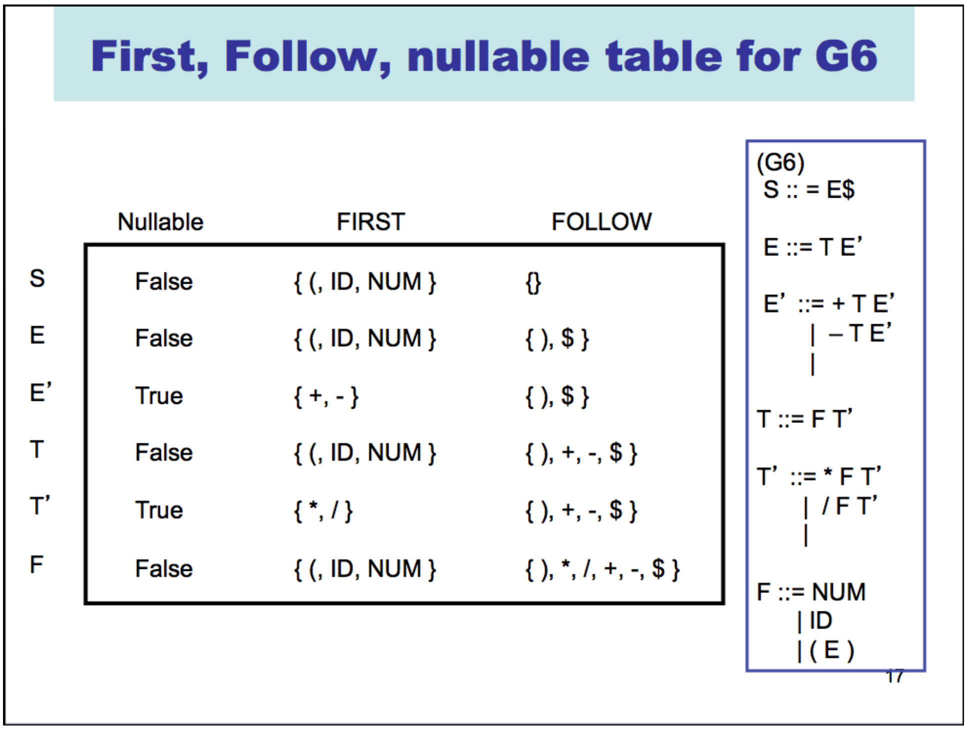

First, Follow, nullable table for G6

	Nullable	FIRST	FOLLOW
S	False	{ (, ID, NUM }	{}
E	False	{ (, ID, NUM }	{), $ }
E’	True	{ +, - }	{), $ }
T	False	{ (, ID, NUM }	{), +, -, $ }
T’	True	{ *, / }	{), +, -, $ }
F	False	{ (, ID, NUM }	{), *, /, +, -, $ }

(G6)
S :: = E$

E ::= T E’

E’ ::= + T E’
| – T E’
|

T ::= F T’

T’ ::= * F T’
| / F T’
|

F ::= NUM
| ID
| (E)

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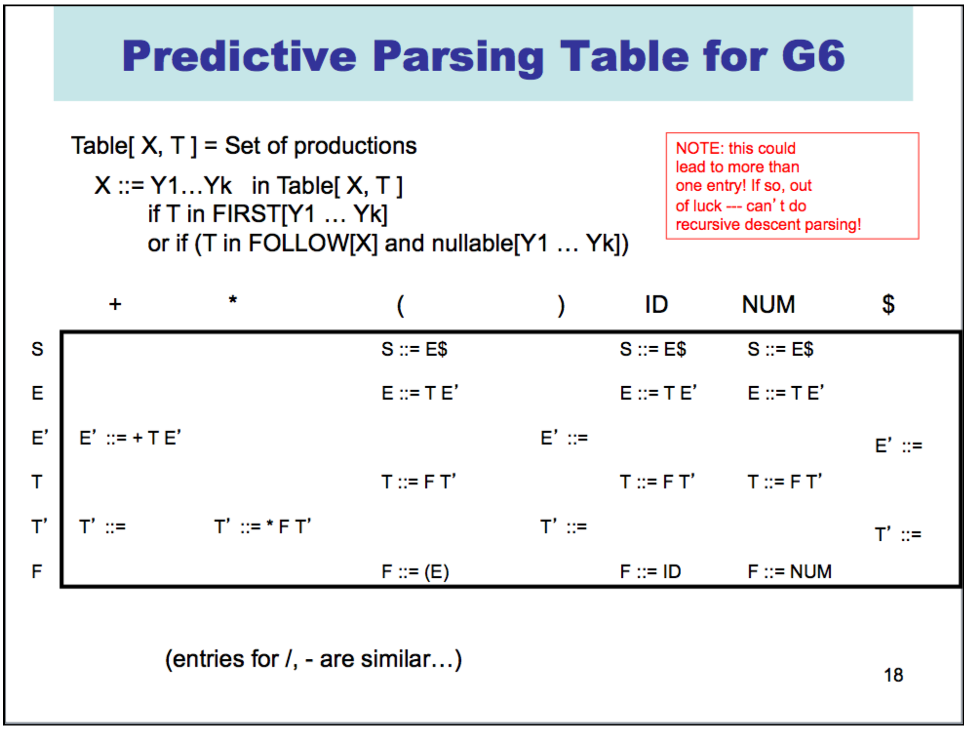

Predictive Parsing Table for G6

Table[X, T] = Set of productions
X ::= Y1…Yk in Table[X, T]
if T in FIRST[Y1 … Yk]
or if (T in FOLLOW[X] and nullable[Y1 … Yk])

NOTE: this could lead to more than one entry! If so, out of luck --- can’ t do recursive descent parsing!

	+	*	(	)	ID	NUM	$
S			S ::= E$		S ::= E$	S ::= E$	
E			E ::= T E’		E ::= T E’	E ::= T E’	
E’	E’ ::= + T E’			E’ ::=			E’ ::=
T			T ::= F T’		T ::= F T’	T ::= F T’	
T’	T’ ::=	T’ ::= * F T’		T’ ::=			T’ ::=
F			F ::= (E)		F ::= ID	F ::= NUM	

(entries for /, - are similar…)

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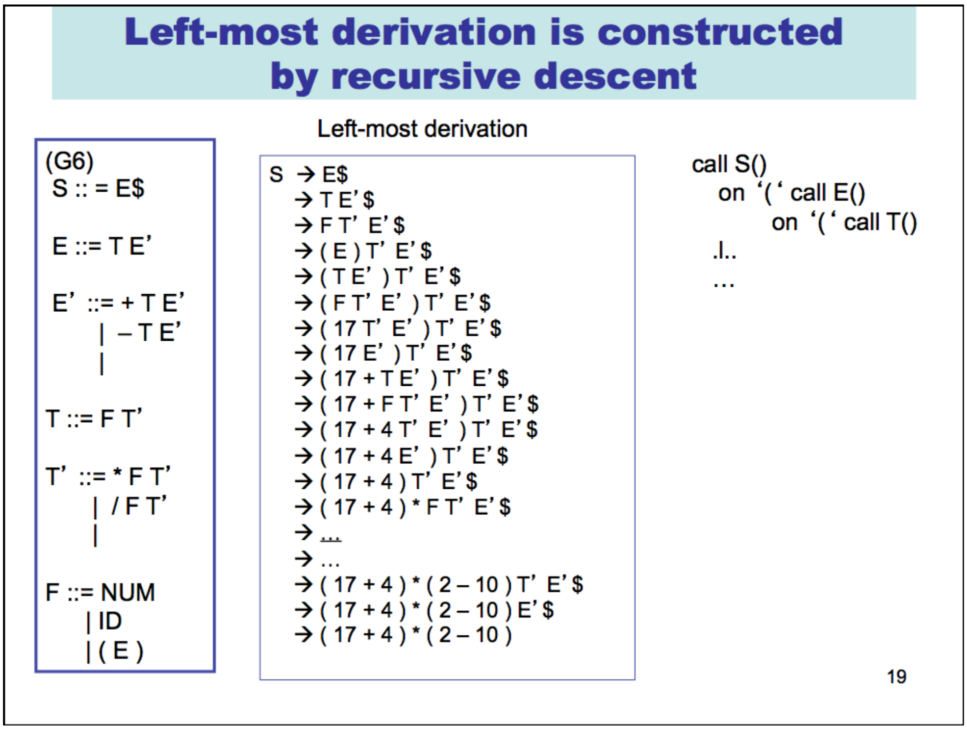


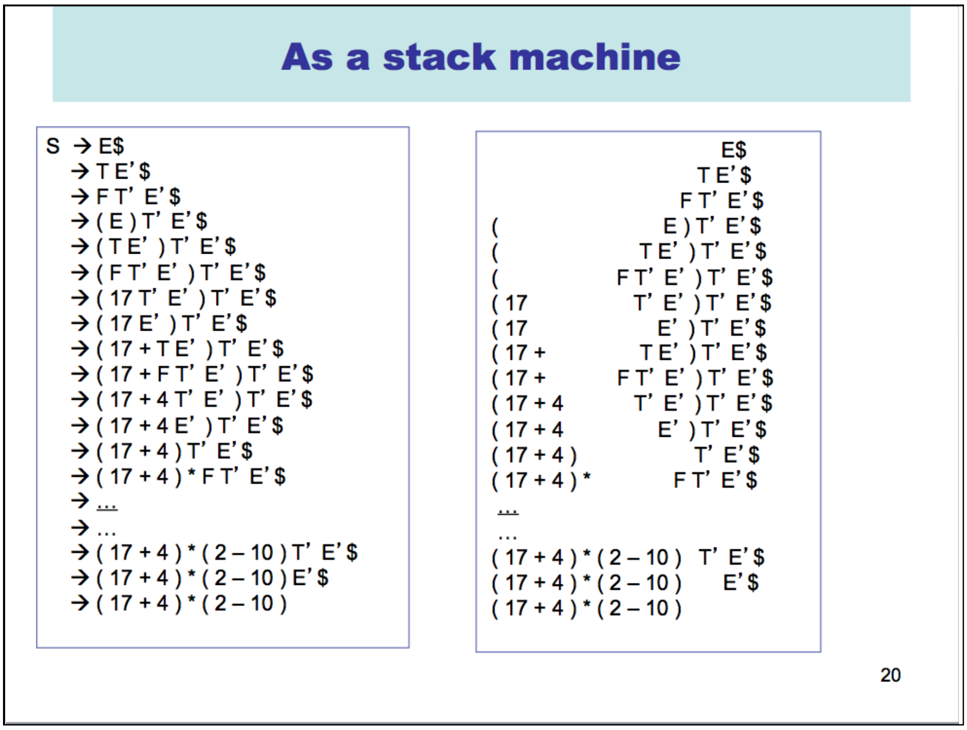
Left-most derivation is constructed by recursive descent

```
(G6)
 S :: = E$

 E ::= T E'

 E'  ::= + T E'
       | – T E'
       |

T ::= F T'

T'  ::= * F T'
      | / F T'
      |

F ::= NUM
    | ID
    | ( E )
```

Left-most derivation

```
S  → E$
   → T E' $
   → F T'  E' $
   → ( E ) T'  E' $
   → ( T E'  ) T'  E' $
   → ( F T'  E'  ) T'  E' $
   → ( 17 T'  E'  ) T'  E' $
   → ( 17 E'  ) T'  E' $
   → ( 17 + T E'  ) T'  E' $
   → ( 17 + F T'  E'  ) T'  E' $
   → ( 17 + 4 T'  E'  ) T'  E' $
   → ( 17 + 4 E'  ) T'  E' $
   → ( 17 + 4 ) T'  E' $
   → ( 17 + 4 ) * F T'  E' $
   → ...
   → ...
   → ( 17 + 4 ) * ( 2 – 10 ) T'  E' $
   → ( 17 + 4 ) * ( 2 – 10 ) E' $
   → ( 17 + 4 ) * ( 2 – 10 )
```

```
call S()
   on '(' call E()
          on '(' call T()
  .l..
  …
```



As a stack machine

```
S  → E$
   → T E' $
   → F T'  E' $
   → ( E ) T'  E' $
   → ( T E'  ) T'  E' $
   → ( F T'  E'  ) T'  E' $
   → ( 17 T'  E'  ) T'  E' $
   → ( 17 E'  ) T'  E' $
   → ( 17 + T E'  ) T'  E' $
   → ( 17 + F T'  E'  ) T'  E' $
   → ( 17 + 4 T'  E'  ) T'  E' $
   → ( 17 + 4 E'  ) T'  E' $
   → ( 17 + 4 ) T'  E' $
   → ( 17 + 4 ) * F T'  E' $
   → ...
   → ...
   → ( 17 + 4 ) * ( 2 – 10 ) T'  E' $
   → ( 17 + 4 ) * ( 2 – 10 ) E' $
   → ( 17 + 4 ) * ( 2 – 10 )
```

```
                              E$
                           T E' $
                        F T'  E' $
(                     E ) T'  E' $
(                 T E'  ) T'  E' $
(             F T'  E'  ) T'  E' $
( 17             T'  E'  ) T'  E' $
( 17                E'  ) T'  E' $
( 17 +          T E'  ) T'  E' $
( 17 +       F T'  E'  ) T'  E' $
( 17 + 4        T'  E'  ) T'  E' $
( 17 + 4           E'  ) T'  E' $
( 17 + 4 )               T'  E' $
( 17 + 4 ) *         F T'  E' $
...
...
( 17 + 4 ) * ( 2 – 10 )   T'  E' $
( 17 + 4 ) * ( 2 – 10 )       E' $
( 17 + 4 ) * ( 2 – 10 )
```