ex1. 0. Goal → list

1 list → pair list

2 ε

3 pair → (list)

first rhs = first(B1) − {ε}

for (i = 1 to k+1) ..

first rhs

	init	1st	2nd	3rd	4th
Goal	{ }	ϕ	{ε}	{ε, (}	ε (
list	ϕ	ϕ {ε}	{ε, (}	{ε, (}	ε)
pair	ϕ	{ (}	{ (}	{ (}	(
(	(	(	(	(	(
)	)	)	)	)	)
ε	ε	ε	ε	ε	ε
eof	eof	eof	eof	eof	eof

practice 1. List → pair List
pair

pair → (List)
( ) .

practice 2.

A → a A
| B C d

B → b B
| ε

C → e C
| ε

Ex

① $G \rightarrow E$

② $E \rightarrow T E'$

③ $E' \rightarrow + T E'$

④ $\quad - T E'$

⑤ $\quad \varepsilon$

⑥ $T \rightarrow F T'$

⑦ $T' \rightarrow * F T'$

⑧ $\quad / F T'$

⑨ $\quad \varepsilon$

⑩ $F \rightarrow (E)$

⑪ $\quad | \ num$

⑫ $\quad | \ id$

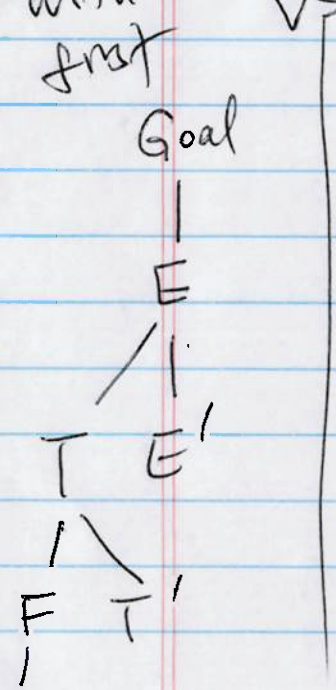
$$first(\alpha) = \begin{cases} \alpha & \alpha \in \{+, -, *, /, (,), num, id, eof, \varepsilon\} \\ G \\ E \\ E' \\ T, \\ F \\ T- \end{cases}$$

first.	G	E	E'	T	T'	F
init.	ϕ	ϕ	ϕ	ϕ	ϕ	ϕ
1st.	ϕ	ϕ	+, -, ε	ϕ	*, /, ε	(, num, id
2nd.	ϕ	ϕ	+, -, ε	(, num, id	*, /, ε	(, num, id
3rd.	ϕ	(, num, id	+, -, ε	(, num, id	*, /, ε	(, num, id
4th.	(, num, id	(, num, id	+, -, ε	(, num, id	*, /, ε	(, num, id
5th.	"	"	"	"	"	"

parsing using first.

example input | + num id EOF

without first

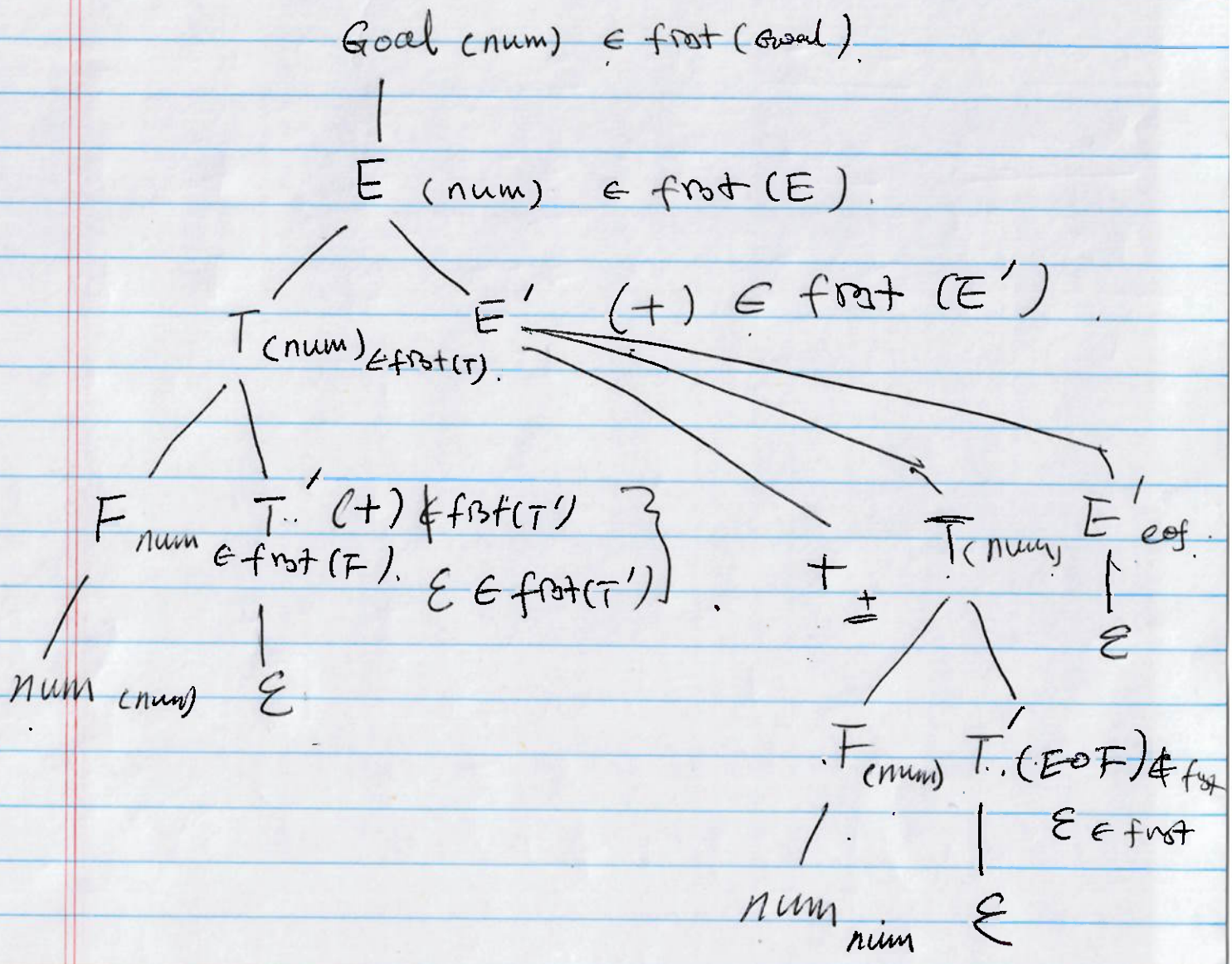


with first

Goal + $\notin$ first(Goal) = {(, num, id)

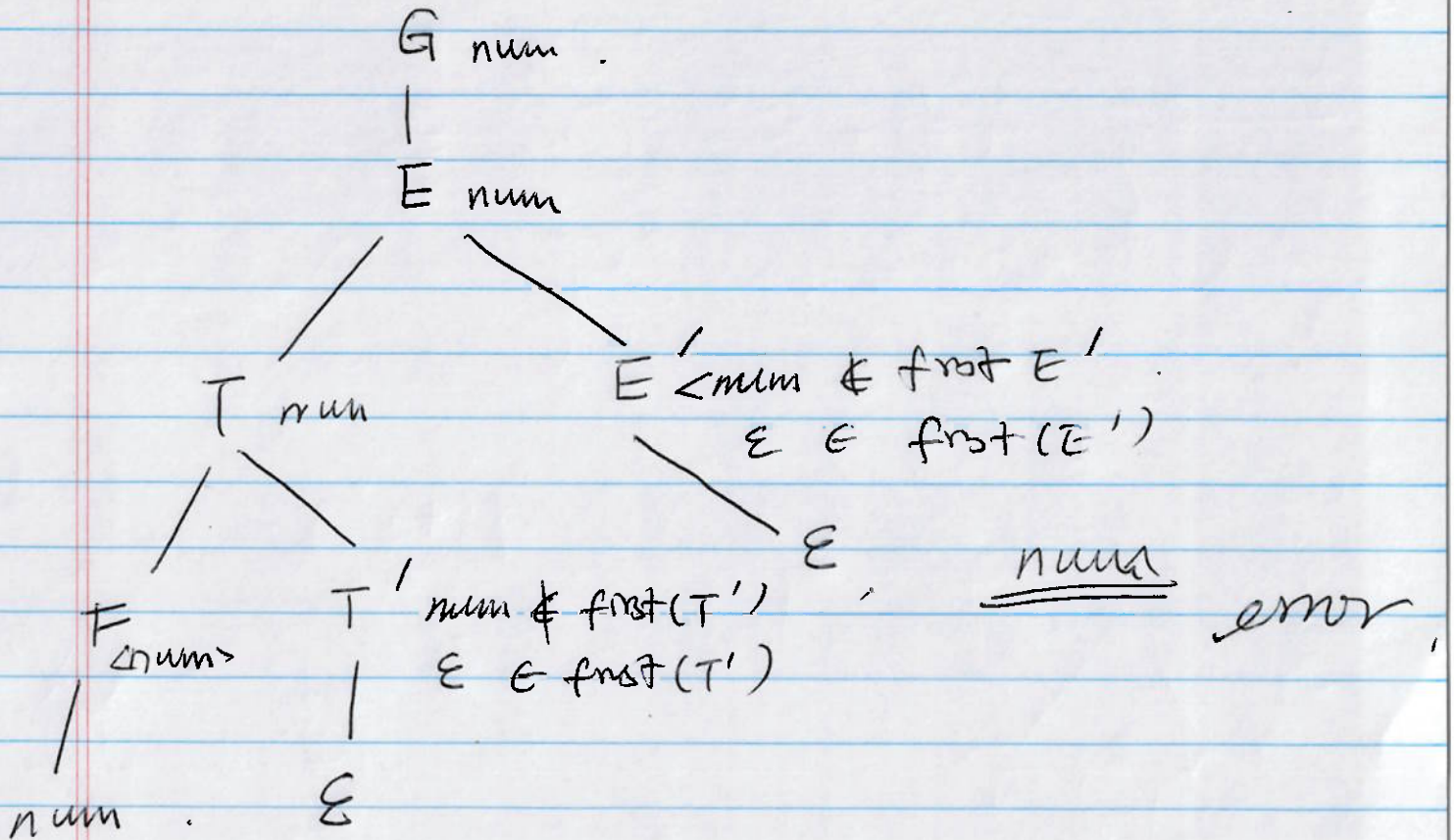
error.

example input 2. num + num EOF



example Mpt 3

num num EOF .



Goal: to detect error as early as possible

If the tree node we are working on is A,

and nexttoken / lookahead symbol ∉ first(A)

but ε ∈ first(A)

we want to differentiat 2 cases

(1) syntax error

(2) apply A → ε If the

next token can follow A.

2.2. Follow(A)

A ∈ N

follow(A): all words/terminals/tokens. (T or EoF) that can occur to the immediat right of a strng derived from A.

example1

	first	follow
S → A B C | a	first(S) = {a}	EoF. follow(C) = EoF
B → b B | b	first(B) = {b}	follow(B) = {C} follow(A) = {b}
C → c	first(C) = {c}	
A → a A | a	first(A) = {a}	

$A \longrightarrow B_1 B_2 \cdots B_i B_{i+1} B_{i+2} B_k$

$follow(A) \subseteq follow(B_k)$

$follow(B_i) \supseteq first(B_{i+1})$ * (not complete)

$S \longrightarrow aA$ $\quad EOF \in follow(S)$

$\Downarrow$

$EOF \in follow(A)$

$\vdash \longrightarrow Ab$ $\quad b \in follow(A)$

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quiz

example:

$S \to E\ a\ A\ B\ D$

$A \to aA \mid \varepsilon$

$B \to bB \mid \varepsilon$

$D \to d \mid \varepsilon$

$E \to e$

follow(A) $\supseteq$ first(B) $- \{\varepsilon\}$

first(D) $- \{\varepsilon\}$

$\cup$ follow(D)

)

	S	A	B	D	E
first	e	a, ε	b, ε	d, ε	e
follow:	EOF	b, d, EOF	d, EOF	EOF	

$A \to B_1\ B_2 \cdots B_i\ B_{i+1} \cdots B_k$

follow(B_i) $\supseteq$ first B_{i+1} $\quad \varepsilon \notin$ first(B_{i+1})

$\supseteq$ first(B_{i+1}) $- \{\varepsilon\}$. $\quad \varepsilon \in$ first(B_{i+1})

$\cup$ follow(B_{i+1}).

// init.

for each $A \in N$

follow $(A) = \phi$

follow $(S) = \{EOF\}$.

// iterate.

while follow sets change ←

for each rule $A \longrightarrow B_1 B_2 \cdots B_i B_{i+1} \cdots B_k$

trailer = follow(A)

for $i = k$ to 1

if $B_i \in N$

follow (B_i) = follow(B_i) ∪ trailer

if $\varepsilon \in$ first (B_i)

trailer = tailer ∪ first(B_i) $-\{\varepsilon\}$

else // $\varepsilon \notin$ first (B_i)

trailer = first (B_i)

else // $B_i \notin N$, i.e. $B_i \in T$

trailer = B_i

// end of for.

example:

① $G \rightarrow E$

② $E \rightarrow T\ E'$

③ $E' \rightarrow +\ T\ E'$
$\quad\quad - \ T\ E'$
$\quad\quad \varepsilon$

⑥ $T \rightarrow F\ T'$

⑦ $T' \rightarrow *\ F\ T'$

⑧ $\quad\quad / \ F\ T'$

⑨ $\quad\quad \varepsilon$

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

First:	G	E	E'	T	T'	F
	(, num, id	(, num, id	ε, +, −	(, num, id	*, /, ε	(, num, id

follow:

init	EOF	ϕ	ϕ	ϕ	ϕ	ϕ
1st.	EOF	EOF	EOF	+, −, EOF		