Compilers Problem Set 1.

1. $[1\text{-}9]\Sigma^*$
2. $\left((\Sigma \mid \varepsilon)^* \cdot (\Sigma \mid \varepsilon)^* \cdot (\Sigma \mid \varepsilon)^*\right)^*$
3. $[\hat{}\,]^* (\,[\hat{}\,]^* \,[\hat{}\,]^* \,[\hat{}\,]^*)^*$
4. $0 \mid -[1\text{-}9]\Sigma^*$
5. $[\hat{}\,]^*$
6. $[\hat{}\,]^* \cup \Sigma^* \cdot \Sigma^* \cdot \Sigma^*$
7. (al | pl | thr (c) ough.
8. (alt, pl, thr, c, th) ough | thought.
9. requires a PDA.

   pumping lemma. $xyz$ $|xy| \le p$ $|y| > 0$

   Construct $0^p 1^p$

   $0^p 0^m 1^n 0^m 1^n 1^p$

   breaks
10. not possible

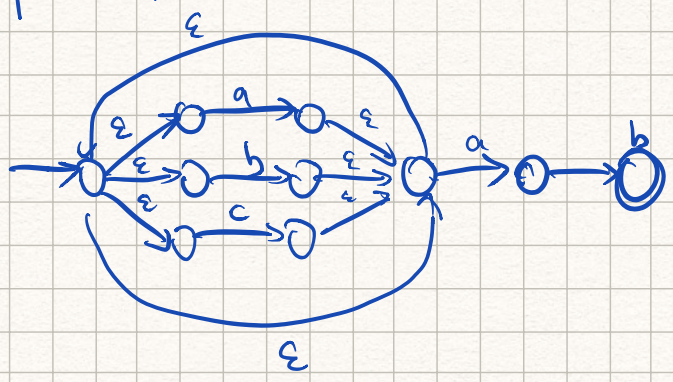
    pumping lemma.

    $1^{p+1} 0^{p+1} 1^{p+1}$

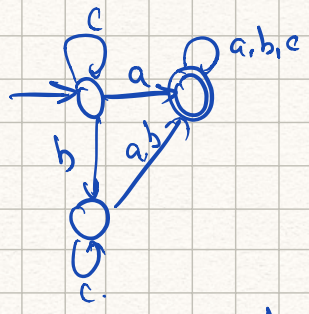
    $|xy| \le p$ breaks

Compilers Problem Set 2.

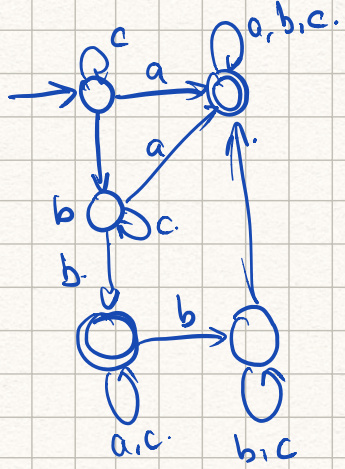
1.



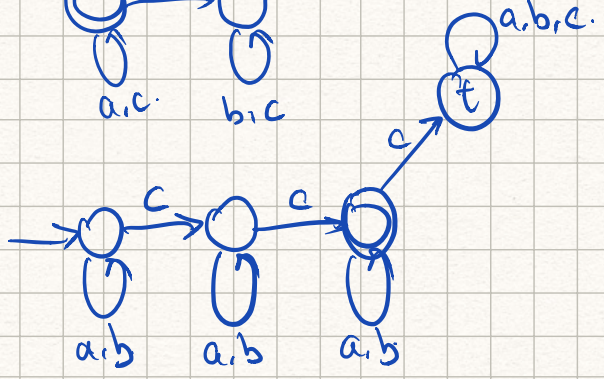

2.



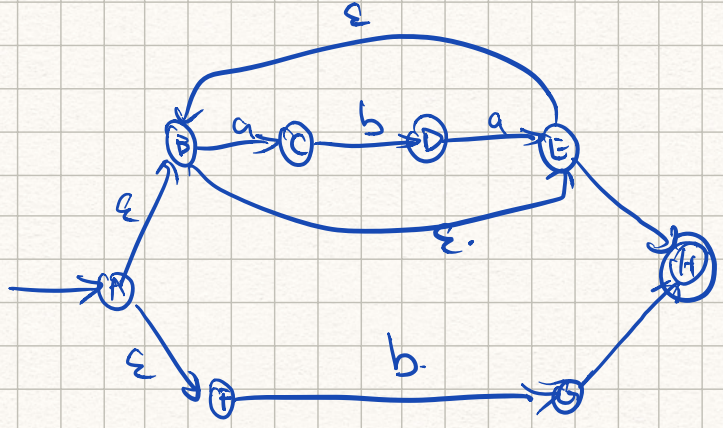

3.

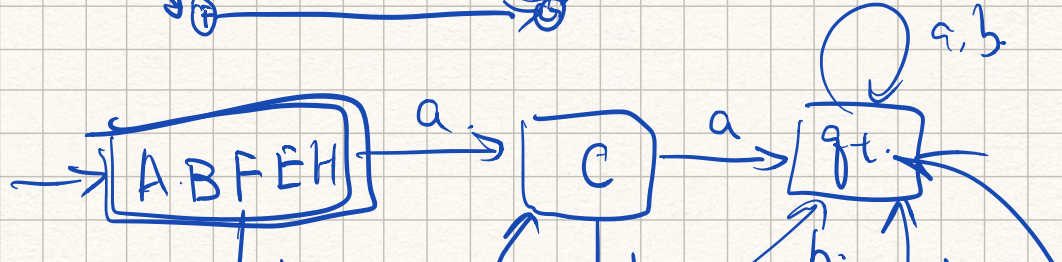


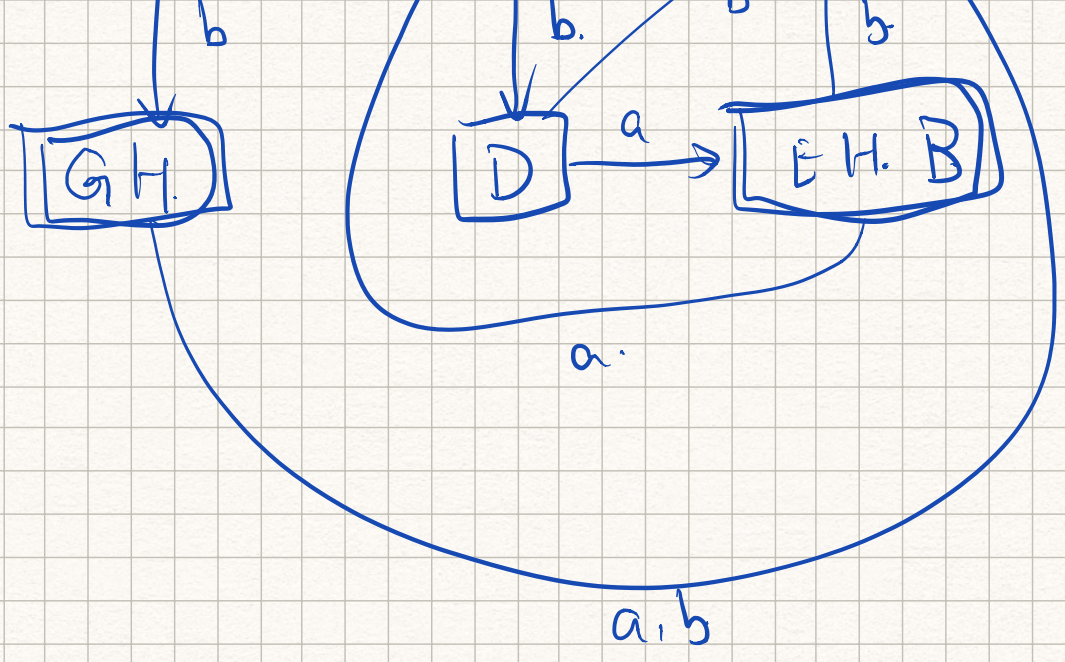

4.



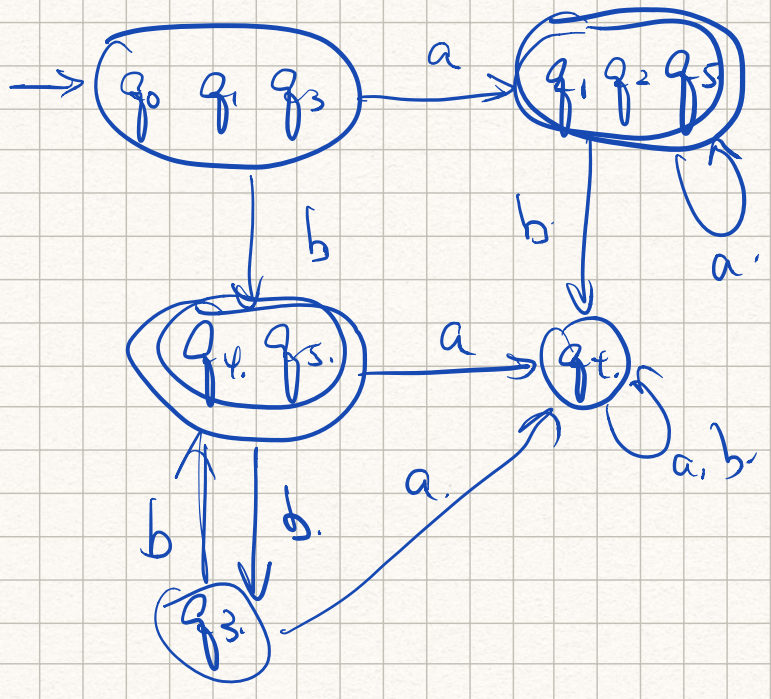

5.






6.




7. $a^p b^p$ $|xy| \leq p$ $|y| > 0$

xy only take a.

8. same as 1. (10%)

Compilers Problem Set 3

1. $S \to aB \mid aC \mid dAc \mid dD \mid e$.

$S \to aS' \mid dS'' \mid e$.  $S' \to B \mid C$.  $S'' \to Ac \mid B$.

$A \to Cbb \mid CbS$

$A \to CbA'$  $A' \to b \mid S$.

$B \to \varepsilon$.

$B \to \varepsilon$

$C \to a$.

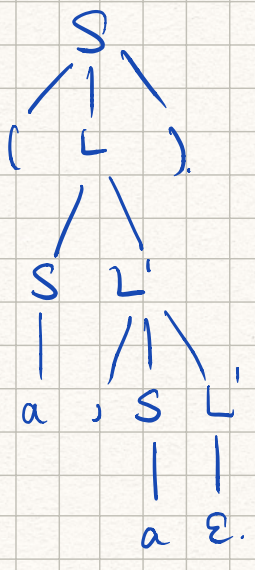
$C \to a$.

2. $L \to L,S \mid S$

$L \to SL'$

$L' \to ,SL' \mid \varepsilon$.

$S \to (L) \mid a$.




$S \to (L) \to (SL') \to (aL')$

$\to (a,SL')$

$\to (a,aL')$

$\to (a,a\varepsilon)$

$\to (a,a)$

$S \to (L) \to (SL') \to (S,SL')$

$\to (S,a)$

$\to (a,a)$

$S \to (L) \mid a$

$L \to SL'$

$L' \to ,SL' \mid \varepsilon$.

| | ( | ) | a | , | $ |
|---|---|---|---|---|---|
| S | (L) | | a | | |
| L | SL' | | SL' | | |

First(S) = {(, a}.

First(L) = First(S) = {(, a}.

| | | |
|---|---|---|
| $L'$ | $\varepsilon$ | $,SL'$ |

First $(L') = \{,\ \varepsilon\}$

Follow(S) = First $(L') - \varepsilon$

$= \{,\ \$\}$.

$\cup$ Follow(L)

$= \{,\ \$\ )\}$.

Follow $(L) = \{)\}$

Follow $(L') =$ follow $(L)$

$= \{)\}$

| Stack | Input | Actin. |
|---|---|---|
| $S\$$ | $(a, a)\$$ | $S \to (L)$. |
| $(L)\$$ | $(a, a)\$$ | terminal |
| $L)\$$ | $a, a)\$$ | $L \to SL'$ |
| $SL')\$$ | $a, a)\$$ | $S \to a$. |
| $aL')\$$ | $a, a)\$$ | terminal |
| $L')\$$ | $, a)\$$ | $L' \to ,SL'$ |
| $,SL')\$$ | $, a)\$$ | terminal |
| $SL')\$$ | $a)\$$ | $S \to a$. |
| $aL')\$$ | $a)\$$ | terminal |
| $L')\$$ | $)\$$ | $L' \to \varepsilon$. |
| $)\$$ | $)\$$ | terminal. |
| $\$$ | $\$$ | ACCEPT. |

3.

$L \to C$.
$\quad | C ; L$.

$C \to id := G$.
$\quad |$ if G C
$\quad |$ begin L end.

$G \to id > id$
$\quad | id < id$
$\quad |$ G and id.

$L \to CL'$
$L' \to ; L \mid \varepsilon$.

$C \to id := G$
$\quad |$ if G C.
$\quad |$ begin L end

$G \to id > id G'$
$\quad | id < id G'$
$G' \to$ and $id G' \mid \varepsilon$.

$G \to id G'$
$G' \to > id G''$
$\quad | < id G''$

$G'' \to$ and $id G'' \mid \varepsilon$.

| | Nullable. | First (A) | Follow(A). |
|---|---|---|---|
| L | | = Fst(C) = {id, if, begin} | = {end, $} |
| L' | ✓ | = {;, ε}. | = {end, #} |

| | Nullable | First | Follow |
|---|---|---|---|
| L | | {id, if, begin} | {end, $, ;} |
| L' | ε | {;} | {end, $, ;} |
| C | | {id, if, begin} | {end, $, ;} |
| G | | {id} | {>, <} |
| G' | ε | {>, <} | {end, $, ;} |
| G'' | ε | {end, ε} | {end, $, ;} |

C: = {id, if, begin}.

G: = {id}.

G': = {>, <}.

G'': = {end, ε}.

Follow(L') = Follow(L) = {end, $, ;}.

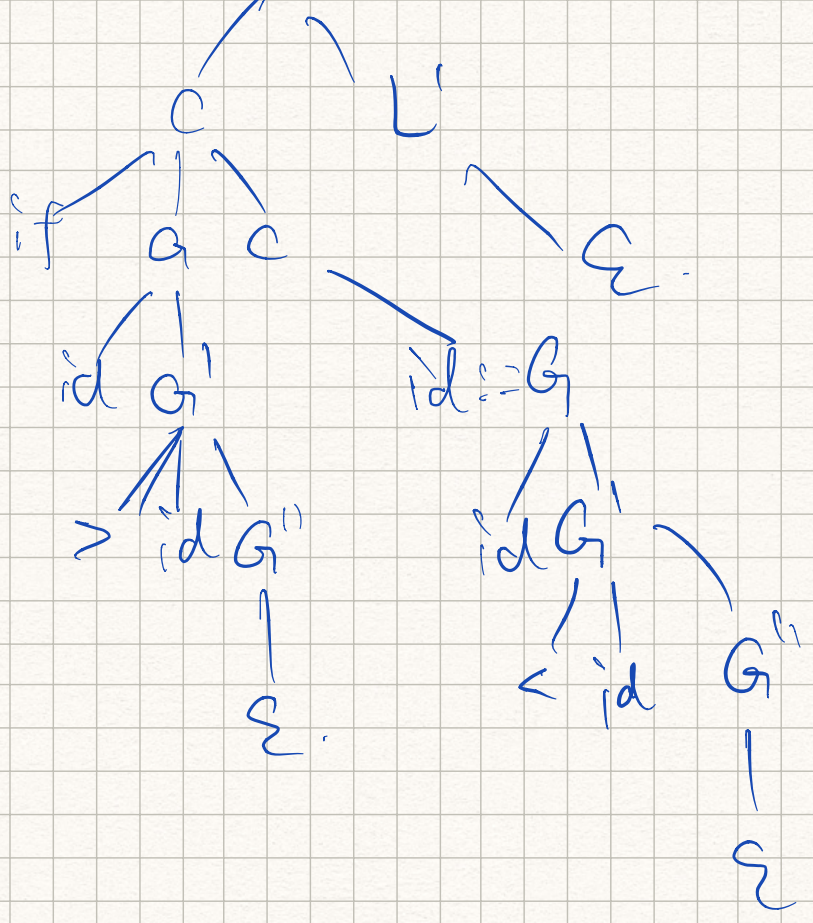
Follow(G) = First(C) ∪ Follow(C) = {id, if, begin, end, $, ;}

Follow(G') = Follow(G).

| | ; | id | if | begin | end | > | < | end | $ |
|---|---|---|---|---|---|---|---|---|---|
| L | | CL' | CL' | CL' | | | | | |
| L' | ;L | | | | ε | | | | ε |
| C | | id:=G | if GC | begin L end | | | | | |
| G | | idG' | | | | | | | |
| G' | | | | | | >idG'' | <idG'' | | |
| G'' | ε | ε | ε | ε | ε | | | end idG'' | ε |

| Stack | Input | Action |
|---|---|---|
| L$ | if id > id id := id < id $ | L → CL' |
| CL'$ | if id > id id := id < id $ | C → if G C |
| if GC L'$ | if id > id id := id < id $ | termind if |
| GC L'$ | id > id id := id < id $ | G → idG' |
| idG'C L'$ | id > id id := id < id $ | termind id |
| G'C L'$ | > id id := id < id $ | >idG'' |
| >idG''C L'$ | > id id := id < id $ | termind > id |
| G''C L'$ | id := id < id $ | G' → ε |
| C L'$ | id := id < id $ | C → id := G |
| id := G L'$ | id := id < id $ | termind id := |
| G L'$ | id < id $ | idG' |
| idG'L'$ | id < id $ | termind id |
| G'L'$ | < id $ | G' → <idG'' |
| <idG''L'$ | < id $ | termind < id |
| G''L'$ | $ | G'' → ε |
| L'$ | $ | L' → ε |
| $ | $ | ACCEPT |

L




if id > id id := id < id.

Compiler Problem Set 4.

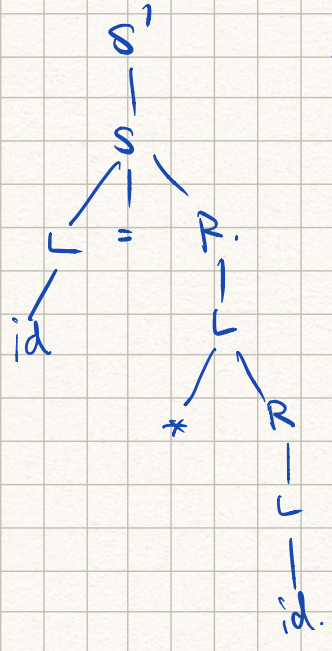
$S' \to S$

$S \to L = R.$
$\quad | \; R.$

$L \to *R$
$\quad | \; id.$

$R \to L.$

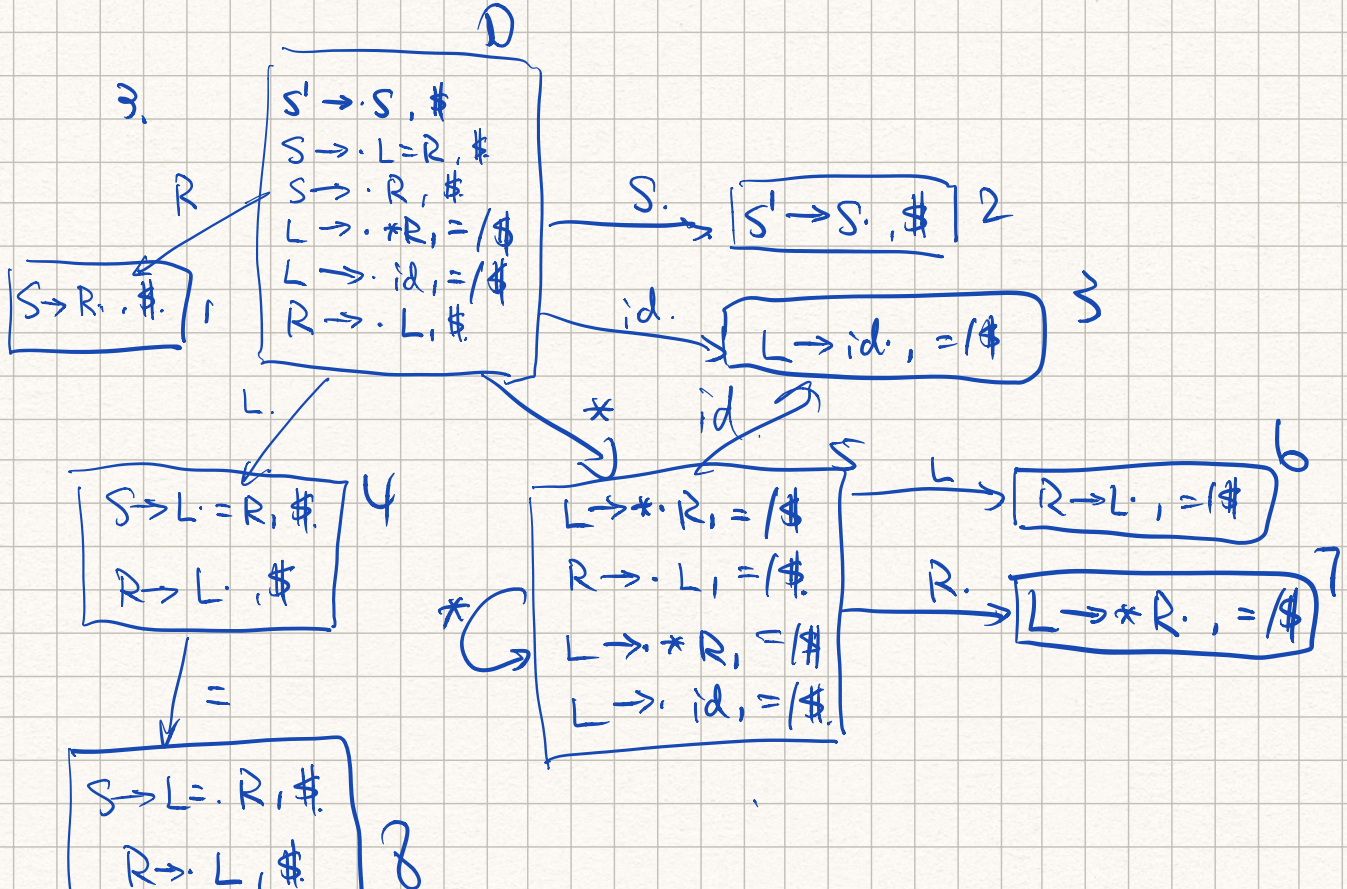
1.

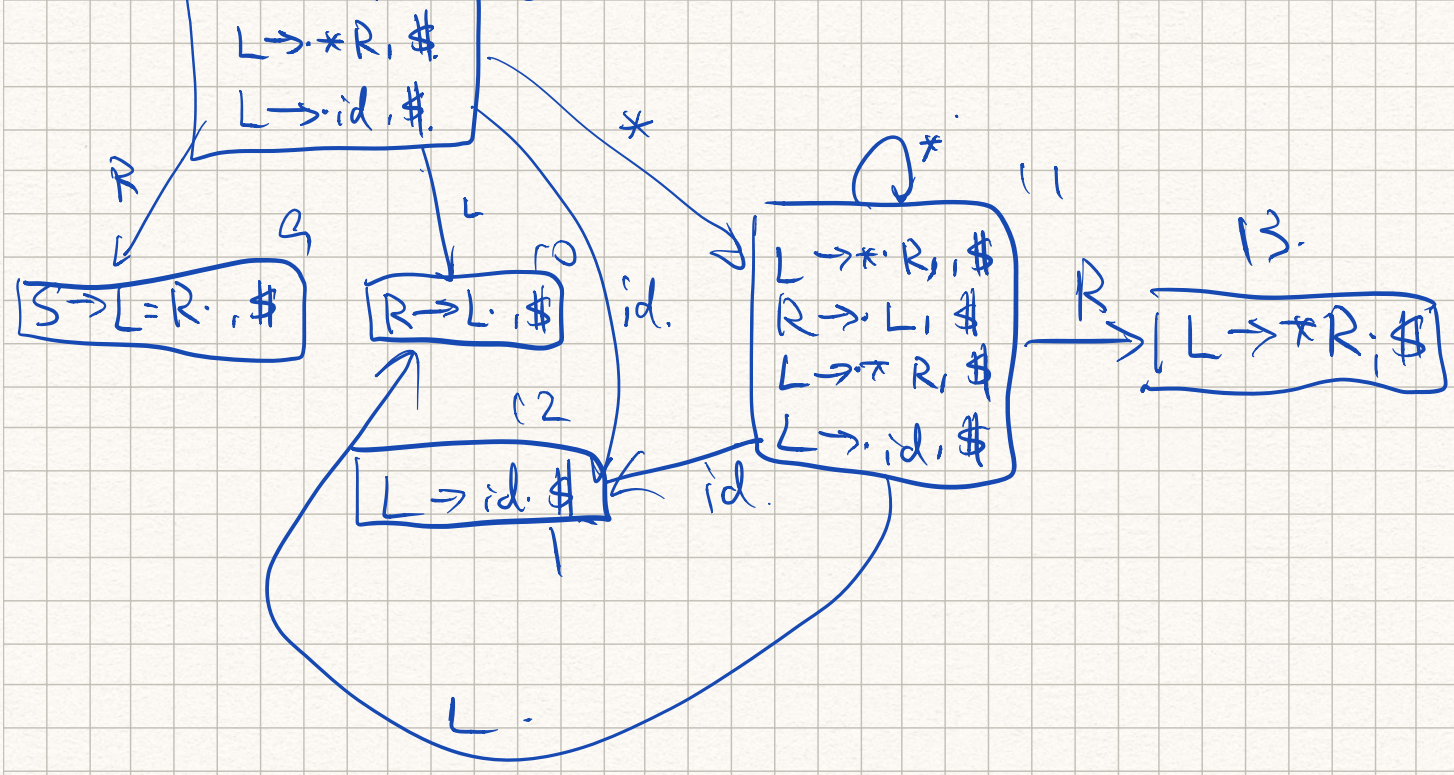



2. $id = * id$

$S' \to S \to L = R \to L = *R \to L = *L \to L = *id. \to id = *id.$

3.






| States | = | * | id. | $. | S | L | R. |
|---|---|---|---|---|---|---|---|
| 0 | | s5. | s3. | | g2 | g4 | g1. |
| 1 | | | | Acc. | | | |
| 2 | | | | red. | | | |
| 3 | red. | | | red. | | | |
| 4 | s8. | | | red. | | | |
| 5 | | s5. | s3. | | | g6 | g7. |
| 6 | red | | | red. | | | |
| 7 | red. | | | red. | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |
| 13 | | | | | | | |
| 14. | | | | | | | |