Heuristic Rule 2: *Let $A \to A\alpha_1, \ldots, A \to A\alpha_n$ and $A \to \beta_1, \ldots, A \to \beta_m$ be all rules with A on the left-hand side, where the β_i's do not start with an A and $n > 0$ (that is, there is at least one left-recursive rule). Then replace these rules by $A \to \beta_1 A', \ldots, A \to \beta_m A'$ and $A' \to \alpha_1 A', \ldots, A' \to \alpha_n A'$, and $A' \to e$, where A' is a new nonterminal.*

E → T
E → E+T
T → T*F
T → F
F → (E)
F → id
F → id(E)

E → TE'
E' → +TE' | e
T → FT'
T' → *FT' T' → e
F → (E)
F → idA
A → e
A → (E)

	first	follows
E	(, id	*,), $
E'	+, e	), $
T	(, id	~~e~~ *, +,), $

S → bBA
A → ab
B → b

(p, e, e) (q, S)
(q, e, S) (q, bBA)
(q, e, A) (q, ab)
(q, e, B) (q, b)
(q, a, a) (q, e)
(q, b, b) (q, e)

S → AX | XB
X → axb | e
A → aA | e
B → bB | e

(p, e, e) (q, S)
(q, e, S) (q, AX)
(q, e, S) (q, XB)
(q, e, A) (q, aA)

$\omega c \omega^r$

q_0

$a^m b^n$

$m \le n \le 2m$

aaaaa

$(b, e, e), (q_0, a)$

$(q_0, a, e)(q_0, a)$

$(q_0, a, a)(q_0, a)$

$(q_0, b, a)(q_1, ba)$

$(q_1, b, ba)(q_1, e)$

$(q_1, e,$

aa(abb)b

aaebb b

$S \to aSb \mid aSbb \mid e$

aa(ab)bbb

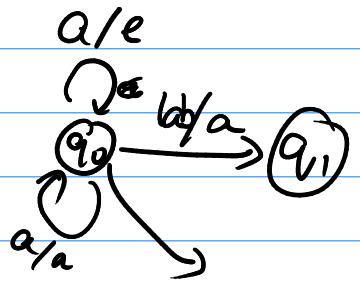
aaabbb

aaabb

a=b

aab

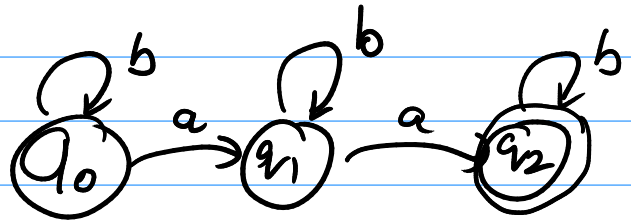
aaabb



$(b, e, e)(q, S)$

q

a



$b^* a b^* a b^*$

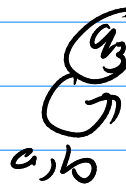
$(q_0, b, e)(q_0, e)$

$(q_0, a, e)(q_1, e)$

$(q_1, b, e)(q_1, e)$

$(q_1, a, e)(q_2, e)$

$(q_2, b, e)(q_2, e)$



$S \to BaBaB$

$B \to bB \mid e$

S → aA
S → bC
A → aC
A → bB
B → aC
B → bC
C → aC
C → bC

} useless nonterminal strip

a & b $ a b

ab

(a+b)*(a+b)

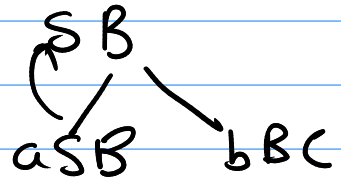
S → aC | SB
A → bSCa | ad ;
~~B → aSB | bBC ;~~
C → ~~aBC~~ | ad ;

~~aBC~~ | ad

aC aCB aCBB

S → aC
~~A → bSCa | ad~~
C → ad
S → aad

ac



$a^n b^{2n} a^m$

ab

$S \to aBa$

$B \to aBa \mid abba$

$(q_1, e, e)\ (q_2, S)$

$(q_2, e, A)\ (q_2, a)$

$(q_2, b, a)\ (q_2, e)$

$(q_2, b, A)\ (q_2, b)$

$(q_2, a, b)\ (q_2, e)$

$S \to aAbbB$

$A \to aAbb \mid e$

$B \to aBa \mid e$

abba

$S \to aAa$

$S \to aAbbB$

$A \to aAbb \mid e$

$B \to aBa \mid e$

p, e, e	q, S	
(q, e, S)	q $aAbbB$	
$q\ e\ A$	q $aAbb$	
$q\ e\ B$	q aBa	
$q\ e\ B$	$q\ e$	
$q\ a\ a$	$q\ e$	
$q\ b\ b$	$q\ e$	
$q\ e\ A$	$q\ e$	

State	Input	stack	Transition
p	abba	e	
q	abba	S	1
q	abba	$aAbbB$	2
q	bba	$AbbB$	6
q	bba	bbB	8
q	ba	bB	5 7
q	a	B	5 7
q	a	aB	4
q	e	B	5 6
q	e	e	3

11th Nov

$S \to AB$
$A \to aA \mid b$
$B \to cA$
$C \to cC \mid \epsilon$

	first	follow
S	a, b	c, a
A	a, b	c, a, b
B	c, b, a	$
C	c, ε	a, b

bεε qS

$q,a,\epsilon \; q_a \epsilon$
$q,b,\epsilon \; q_b \epsilon$
$q,c,\epsilon \; q_c \epsilon$
$q,\$,\epsilon \; q_\$ \epsilon$

$(q_a, e, S), (q, AB)$
$(q_b, e, S), (q, AB)$
$(q_a, e, A), (q, aA)$
$(q_b, e, A), (q, b)$
(

(q, e, e)	(q, S)
(q, e, S)	(q, AB)
(q, e, A)	(q, aA)
(q, e, A)	(q, ε)
~~(q, e, B)~~	~~(q, ε)~~
(q, e, B)	(q, cA)
(q, e, C)	(q, cC)
(q, e, C)	(q, ε)
(q, a, a)	(q, ε)
(q, b, b)	
(q, c, c)	

b c c a a b

q_b S

q_b B

q_b

Deterministic Look-ahead PDA transitions:

1. ((p ,e ,e), (q, S))
2. ((q ,a, e), (q_a, e))
3. ((q ,b, e), (q_b, e))
4. ((q ,c, e), (q_c, e))
5. ((q ,$, e), ($q_\$$, e))
6. ((q_a ,e, S), (q_a, AB)) // since a is in FIRST of S
7. ((q_b ,e, S), (q_b, AB)) // since b is in FIRST of S
8. ((q_a ,e, A), (q_a, aA)) // since a is in FIRST of A
9. ((q_b ,e, A), (q_b, b)) // since b is in FIRST of A
10. ((q_b ,e, B), (q_b,CA)) // since b is in FRIST of B
11. ((q_a ,e, B), (q_a, CA)) // since a is in FRIST of B
12. ((q_c ,e, B), (q_c, CA)) // since c is in FIRST of B
13. ((q_a ,e, C), (q_a, e)) // since a is in FOLOWS of C and C→e
14. ((q_b ,e, C), (q_b, e)) // since b is in FOLOWS of C and C→e
15. ((q_c ,e, C), (q_c, cC)) // since c is in FIRST of C
16. ((q_x ,e,x), (q,e)) //for each x in ∑