

# Problem Language

grammar Problem

nonterminal S(0), A(2), B(2);  
 terminal a(2), b(2), c(2), d(2), e(2);  
 start S;

S() ::= A(b,c) b(c,d) B(d,e) e(e,f) [s]  
 A(a,c) ::= /\* eps \*/ [a1]  
           | B(a,b) c(b,c) [a2]  
 B(a,b) ::= /\* eps \*/ [b1]  
           | d(a,b) [b2]

end

State  $q_0(a, b, c, d, e)$

S()	→ .A(a,b) b(b,c) B(c,d) e(d,e)	
A(a,b)	→ .	[a1]
A(a,b)	→ .B(a,n <sub>1</sub> ) c(n <sub>1</sub> ,b)	
B(a,n <sub>2</sub> )	→ .	[b1]
B(a,n <sub>3</sub> )	→ .d(a,n <sub>3</sub> )	

$$\frac{A(n_0, n_1)}{n_0 = a, n_1 = b} \rightarrow q_4(n_0, n_1, c, d, e)$$

$$\frac{B(n_0, n_1)}{n_0 = a, n_1 = ?} \rightarrow q_2(n_0, b)$$

$$\frac{B(n_0, n_1)}{n_0 = a, n_1 \uparrow} \rightarrow q_3(n_0, b, n_1)$$

$$\frac{d(n_0, n_1)}{n_0 = a, n_1 \uparrow} \rightarrow q_1(n_0, n_1)$$

State  $q_1(a, b)$

B(a,b)	→ d(a,b) .	[b2]
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State  $q_2(a, b)$

A(a,b)	→ B(a,n <sub>1</sub> ) . c(n <sub>1</sub> ,b)
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$$\frac{c(n_0, n_1)}{n_0 \uparrow, n_1 = b} \rightarrow q_5(a, n_1, n_0)$$

State  $q_3(a, b, c)$

A(a,b)	→ B(a,c) . c(c,b)
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$$\frac{c(n_0, n_1)}{n_0 = c, n_1 = b} \rightarrow q_5(a, n_1, n_0)$$

State  $q_4(a, b, c, d, e)$

S()	→ A(a,b) . b(b,c) B(c,d) e(d,e)
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$$\frac{b(n_0, n_1)}{n_0 = b, n_1 = c} \rightarrow q_6(a, n_0, n_1, d, e)$$

State  $q_5(a, b, c)$

A(a,b)	→ B(a,c) c(c,b) .	[a2]
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State  $q_6(a, b, c, d, e)$

S()	→ A(a,b) b(b,c) . B(c,d) e(d,e)	
B(c,d)	→ .	[b1]
B(c,d)	→ .d(c,d)	

$$\frac{B(n_0, n_1)}{n_0 = c, n_1 = d} \rightarrow q_7(a, b, n_0, n_1, e)$$

$$\frac{d(n_0, n_1)}{n_0 = c, n_1 = d} \rightarrow q_1(n_0, n_1)$$

State  $q_7(a, b, c, d, e)$

S()	→ A(a,b) b(b,c) B(c,d) . e(d,e)
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$$\frac{e(n_0, n_1)}{n_0 = \mathbf{d}, n_1 = \mathbf{e}} \rightarrow q_8(\mathbf{a}, \mathbf{b}, \mathbf{c}, n_0, n_1)$$

**State**  $q_8(\mathbf{a}, \mathbf{b}, \mathbf{c}, \mathbf{d}, \mathbf{e})$

$S() \rightarrow A(\mathbf{a}, \mathbf{b}) b(\mathbf{b}, \mathbf{c}) B(\mathbf{c}, \mathbf{d}) e(\mathbf{d}, \mathbf{e}) \cdot$  [s]

# Super-clean Problem Language

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grammar Problem_superclean
  nonterminal Z(0), S(5), A(2), B(2);
  terminal a(2), b(2), c(2), d(2), e(2);
  start Z;

  Z() ::= S(b,c,d,e,f) [z]
  S(b,c,d,e,f) ::= A(b,c) b(c,d) B(d,e) e(e,f) [s1]
                  | A(b,c) b(c,d) e(e,f) [s2]
                  | b(c,d) B(d,e) e(e,f) [s3]
                  | b(c,d) e(e,f) [s4]
  A(a,c) ::= B(a,b) c(b,c) [a1]
           | c(b,c) [a2]
  B(a,b) ::= d(a,b) [b]
end

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## State $q_0(a, b, c, d, e)$

$Z()$	$\rightarrow \cdot S(a, b, c, d, e)$
$A(a, b)$	$\rightarrow \cdot B(a, n_1) c(n_1, b)$
$A(a, b)$	$\rightarrow \cdot c(n_2, b)$
$B(a, n_3)$	$\rightarrow \cdot d(a, n_3)$
$S(a, b, c, d, e)$	$\rightarrow \cdot A(a, b) b(b, c) B(c, d) e(d, e)$
$S(a, b, c, d, e)$	$\rightarrow \cdot A(a, b) b(b, c) e(d, e)$
$S(a, b, c, d, e)$	$\rightarrow \cdot b(b, c) B(c, d) e(d, e)$
$S(a, b, c, d, e)$	$\rightarrow \cdot b(b, c) e(d, e)$

$\frac{A(n_0, n_1)}{n_0 = a, n_1 = b}$	$\rightarrow q_7(n_0, n_1, c, d, e, c, d, e)$
$\frac{B(n_0, n_1)}{n_0 = a, n_1 \uparrow}$	$\rightarrow q_6(n_0, b, n_1)$
$\frac{S(n_0, n_1, n_2, n_3, n_4)}{n_0 = a, n_1 = b, n_2 = c, n_3 = d, n_4 = e}$	$\rightarrow q_5(n_0, n_1, n_2, n_3, n_4)$
$\frac{b(n_0, n_1)}{n_0 = b, n_1 = c}$	$\rightarrow q_1(a, n_0, n_1, d, e, a, d, e)$
$\frac{c(n_0, n_1)}{n_0 \uparrow, n_1 = b}$	$\rightarrow q_3(a, n_1, n_0)$
$\frac{d(n_0, n_1)}{n_0 = a, n_1 \uparrow}$	$\rightarrow q_2(n_0, n_1)$

## State $q_1(a, b, c, d, e, a, d, e)$

$S(a, b, c, d, e) \rightarrow b(b, c) \cdot e(d, e)$
$S(a, b, c, d, e) \rightarrow b(b, c) \cdot B(c, d) e(d, e)$
$B(c, d) \rightarrow \cdot d(c, d)$

$\frac{B(n_0, n_1)}{n_0 = c, n_1 = d}$	$\rightarrow q_8(a, b, n_0, n_1, e)$
$\frac{d(n_0, n_1)}{n_0 = c, n_1 = d}$	$\rightarrow q_2(n_0, n_1)$
$\frac{e(n_0, n_1)}{n_0 = d, n_1 = e}$	$\rightarrow q_4(a, b, c, n_0, n_1)$

## State $q_2(a, b)$

$B(a, b) \rightarrow d(a, b) \cdot [b]$
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## State $q_3(a, b, c)$

$A(a, b) \rightarrow c(c, b) \cdot [a2]$
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## State $q_4(a, b, c, d, e)$

$S(a, b, c, d, e) \rightarrow b(b, c) e(d, e) \cdot [s4]$
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## State $q_5(a, b, c, d, e)$

$Z() \rightarrow S(a, b, c, d, e) \cdot [z]$
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## State $q_6(a, b, c)$

$A(a, b) \rightarrow B(a, c) \cdot c(c, b)$
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$$\frac{c(n_0, n_1)}{n_0 = c, n_1 = b} \rightarrow q_9(a, n_1, n_0)$$

State  $q_7(a, b, c, d, e, c, d, e)$

$S(a, b, c, d, e) \rightarrow A(a, b) \cdot b(b, c) B(c, d) e(d, e)$
$S(a, b, c, d, e) \rightarrow A(a, b) \cdot b(b, c) e(d, e)$

$$\frac{b(n_0, n_1)}{n_0 = b, n_1 = c} \rightarrow q_{10}(a, n_0, n_1, d, e, d, e)$$

State  $q_8(a, b, c, d, e)$

$S(a, b, c, d, e) \rightarrow b(b, c) B(c, d) \cdot e(d, e)$
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$$\frac{e(n_0, n_1)}{n_0 = d, n_1 = e} \rightarrow q_{11}(a, b, c, n_0, n_1)$$

State  $q_9(a, b, c)$

$A(a, b) \rightarrow B(a, c) c(c, b) \cdot [a1]$
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State  $q_{10}(a, b, c, d, e, f, g)$

$S(a, b, c, d, e) \rightarrow A(a, b) b(b, c) \cdot e(d, e)$
$S(a, b, c, f, g) \rightarrow A(a, b) b(b, c) \cdot B(c, f) e(f, g)$
$B(c, f) \rightarrow \cdot d(c, f)$

$$\frac{B(n_0, n_1)}{n_0 = c, n_1 = f} \rightarrow q_{12}(a, b, n_0, n_1, g)$$

$$\frac{d(n_0, n_1)}{n_0 = c, n_1 = f} \rightarrow q_2(n_0, n_1)$$

$$\frac{e(n_0, n_1)}{n_0 = d, n_1 = e} \rightarrow q_{13}(a, b, c, n_0, n_1)$$

State  $q_{11}(a, b, c, d, e)$

$S(a, b, c, d, e) \rightarrow b(b, c) B(c, d) e(d, e) \cdot [s3]$
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State  $q_{12}(a, b, c, d, e)$

$S(a, b, c, d, e) \rightarrow A(a, b) b(b, c) B(c, d) \cdot e(d, e)$
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$$\frac{e(n_0, n_1)}{n_0 = d, n_1 = e} \rightarrow q_{14}(a, b, c, n_0, n_1)$$

State  $q_{13}(a, b, c, d, e)$

$S(a, b, c, d, e) \rightarrow A(a, b) b(b, c) e(d, e) \cdot [s2]$
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State  $q_{14}(a, b, c, d, e)$

$S(a, b, c, d, e) \rightarrow A(a, b) b(b, c) B(c, d) e(d, e) \cdot [s1]$
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