

Convert Context-Free Grammar to Nondeterministic Pushdown Automata - Exercise

Problem:

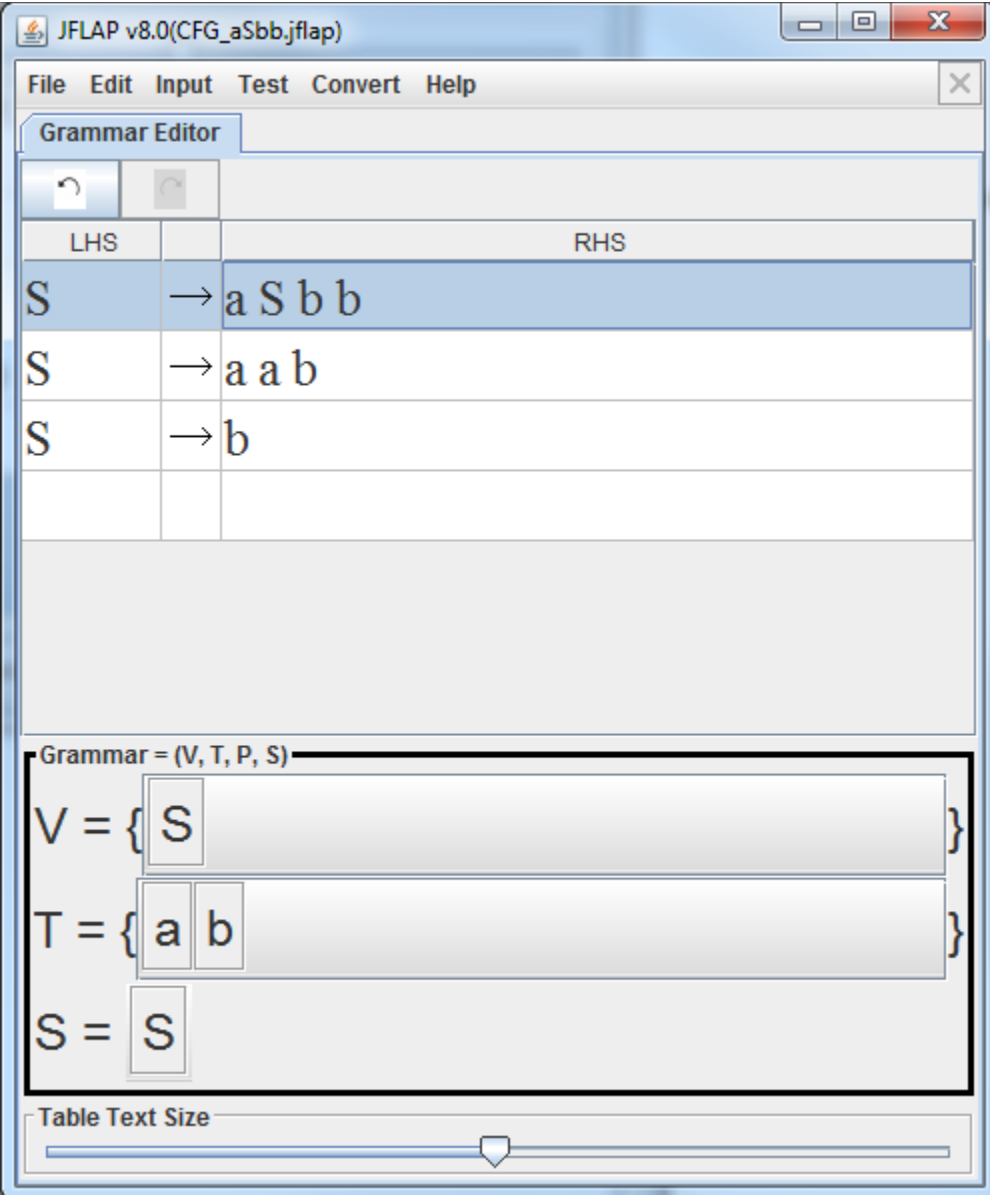
Given the context-free grammar

$$S \rightarrow aSbb \mid aab \mid b,$$

build its equivalent nondeterministic pushdown automata using the LL parsing method.

Solution:

To start, we create a JFLAP file for the given grammar.



The screenshot shows the JFLAP v8.0 interface. The main window is titled "JFLAP v8.0(CFG_aSbb.jflap)". The menu bar includes "File", "Edit", "Input", "Test", "Convert", and "Help". The "Grammar Editor" tab is active, displaying a table with the following rules:

LHS		RHS
S	→	a S b b
S	→	a a b
S	→	b

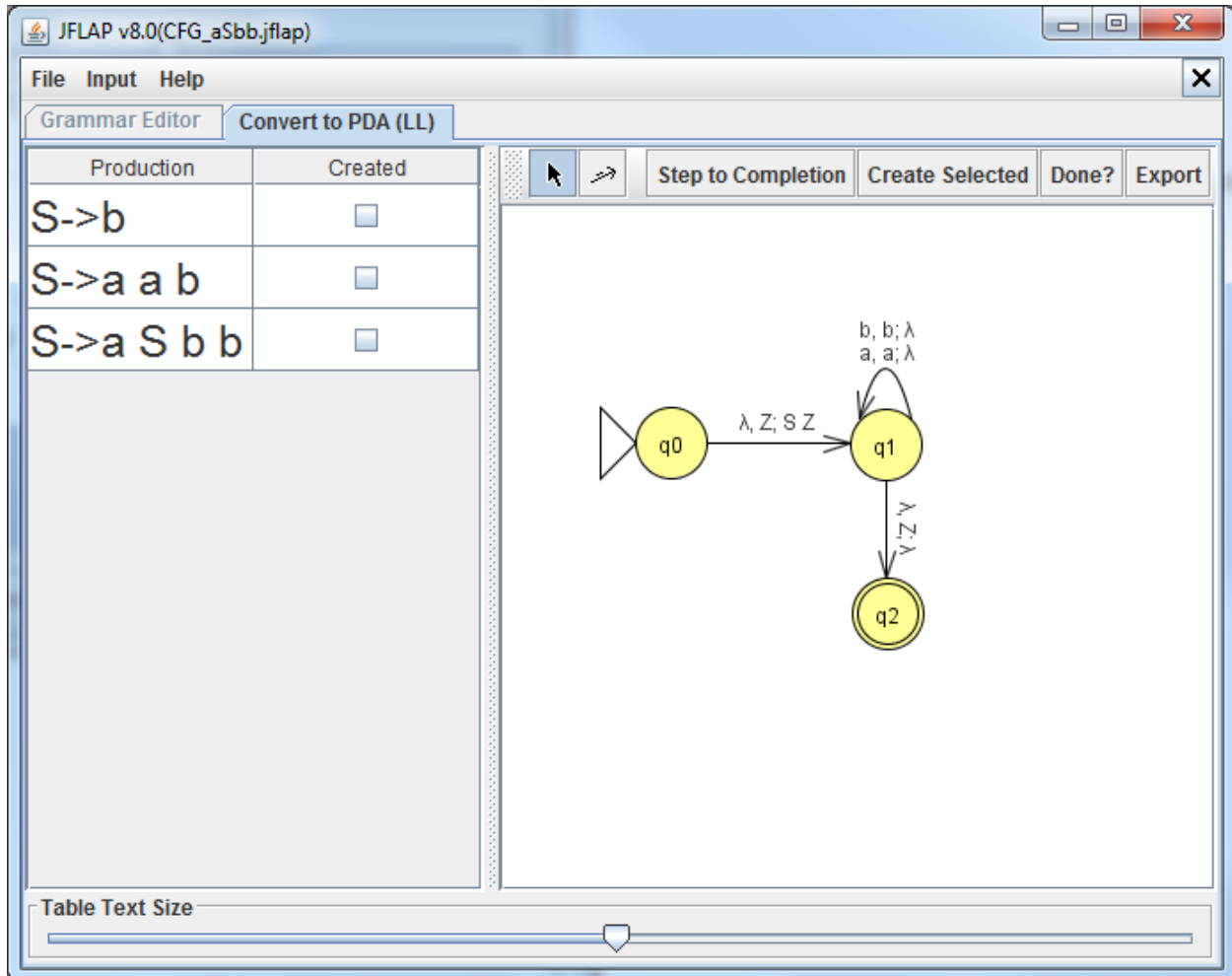
Below the table, the grammar is defined as $\text{Grammar} = (V, T, P, S)$. The components are:

- $V = \{ S \}$
- $T = \{ a, b \}$
- $S = S$

At the bottom, there is a "Table Text Size" slider.

Once that is created, click *Convert > Convert CFG to PDA (LL)* on JFLAP.

This generates a partially completed pushdown automaton on the right side of the window. Rearrange the states so that it is visually easier to follow.



All production rules have been included in the partially complete automaton except for the rules that appear on the left side. For each of these rules (three in the example above), we will create loop transitions around state q_1 .

1. For $S \rightarrow b$, add the transition using " $\lambda, S; b$ ".

JFLAP v8.0(CFG_aSbbjflap)

File Input Help

Grammar Editor Convert to PDA (LL)

Production	Created
$S \rightarrow b$	<input checked="" type="checkbox"/>
$S \rightarrow a a b$	<input type="checkbox"/>
$S \rightarrow a S b b$	<input type="checkbox"/>

Step to Completion Create Selected Done? Export

Table Text Size

Note how the $S \rightarrow b$ rule on the left pane is checked automatically by JFLAP.

2. Add the transition " $\lambda, S; aab$ " for $S \rightarrow aab$.

JFLAP v8.0(CFG_aSbb,jflap)

File Input Help

Grammar Editor Convert to PDA (LL)

Production	Created
$S \rightarrow b$	<input checked="" type="checkbox"/>
$S \rightarrow a a b$	<input checked="" type="checkbox"/>
$S \rightarrow a S b b$	<input type="checkbox"/>

Step to Completion Create Selected Done? Export

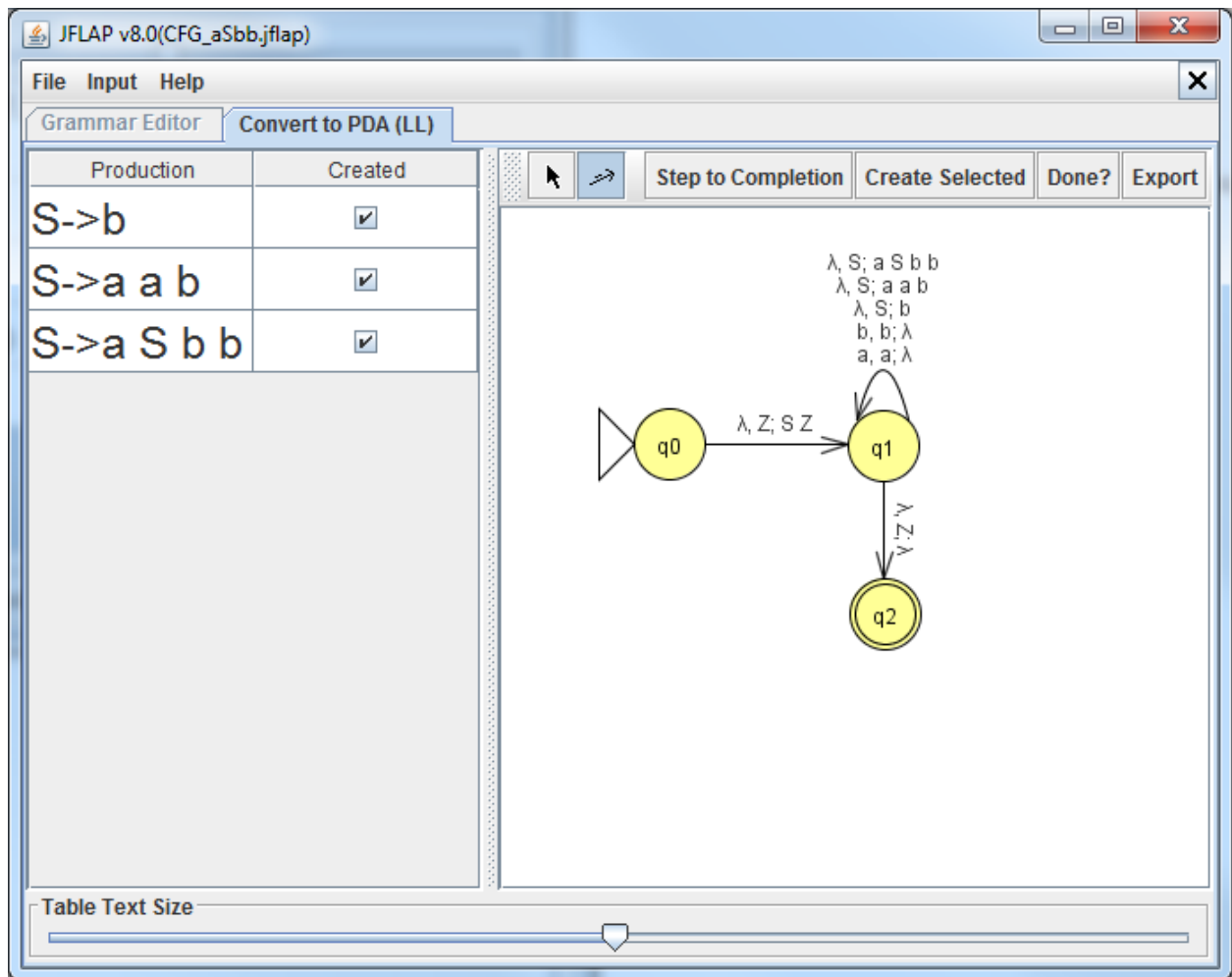
$\lambda, S; a a b$
 $\lambda, S; b$
 $b, b; \lambda$
 $a, a; \lambda$

```

graph LR
    q0((q0)) -- "λ, Z; S Z" --> q1((q1))
    q1 -- "λ, S; a a b" --> q1
    q1 -- "λ, Z; Y" --> q2(((q2)))
  
```

Table Text Size

3. Add the transition " $\lambda, S; aSBB$ " for $S \rightarrow aSBB$.



We have now transformed the context-free grammar to a pushdown automaton. Export the automaton to its own JFLAP file by clicking *Export*. Run some test strings using *Test > Multiple Run*. Verify the results against expected answers.

JFLAP v8.0(PDA_aSbb.jflap)

File Input Help

Automaton Editor Multiple Run

```

    graph LR
      q0((q0)) -- "λ, Z; S Z" --> q1((q1))
      q1 -- "b, b; λ" --> q1
      q1 -- "a, a; λ" --> q1
      q1 -- "λ, S; b" --> q1
      q1 -- "λ, S; a a b" --> q1
      q1 -- "λ, S; a S b b" --> q1
      q1 -- "V, Z V" --> q2(((q2)))
  
```

Table Text Size

Input	Result
b	Accept
a a b	Accept
a b b b	Accept
a a a b b b	Accept
a	Reject
a b a	Reject

Load Inputs Run Inputs Clear Enter λ View Trace