Exercise 30

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The context free grammar

$$S = aSb \mid S'$$
$$S' = bS'a \mid \epsilon$$

generates the language

$$\{a^m b^n a^n b^m \mid m, n \geq 0\}.$$

This language is recognized by the pushdown automaton

$$(\{S, A_1, B_1, A_2, B_2, F\},\ \{a, b\},\ \{\$, E, I\},\ \delta,\ S,\ \{F\})$$

where δ maps everything to $\emptyset$ except for
$(S, \epsilon, \epsilon) \to \{(A_1, \$)\}$,
$(A_1, a, \epsilon) \to \{(A_1, E), (B_1, E)\}$,
$(B_1, b, \epsilon) \to \{(B_1, I), (A_2, I)\}$,
$(A_2, a, I) \to \{(A_2, \epsilon), (B_2, \epsilon)\}$,
$(B_2, b, E) \to \{(B_2, \epsilon)\}$, and
$(B_2, \epsilon, \$) \to \{(F, \epsilon)\}$.