\{a^i b^j c^k \mid \begin{align*} i &= j, & j &= k \text{ or } i &= k \end{align*}\}

\[
S \rightarrow A \mid B \mid C
\]

\[
A \rightarrow DE
\]

\[
D \rightarrow aD_b \mid \varepsilon
\]

\[
E \rightarrow cE \mid \varepsilon
\]

\[
B \rightarrow FG
\]

\[
F = af \mid \varepsilon
\]

\[
G = bGc \mid \varepsilon
\]

\[
C \rightarrow aCc \mid H
\]

\[
H \rightarrow bH \mid \varepsilon
\]
\( n \) the length is odd and its middle symbol is \( \emptyset \)

\[
S \rightarrow 1s7 | 050 | 150 |
\]

\[
051 | \emptyset
\]
Push Down Automata (PDA)

- nfa
- stack - infinite
  - push/pop
  - recognize CFL

In q₁, with input 1 and top of stack a,
pop a, push b,
go to q₂

1, a → ε  
don't push  
1, ε → b  
don't check top and don't pop anything

1, a → a  
want to push b if input is 1 and stack top is a

ε, ε → b
PDA →

\((Q, \Sigma, \Gamma, \delta, q_0, F)\)

\(Q\) : set of states

\(\Sigma\) : input alphabet

\(\Gamma\) : stack alphabet

\(\delta\) : \(Q \times \Sigma \times \Gamma \rightarrow P(Q \times \Gamma)\)

\(q_0\) : start state \(q_0 \in Q\)

\(F\) : set of final states \(F \subseteq Q\)