$E_{DFA}$ is decidable (emptiness)

$EQ_{DFA} = \{ \langle A, B \rangle \mid A$ and $B$
are DFA's and $L(A) = L(B) \}$

$L(C) = \emptyset$ iff $L(A) = L(B)$

$F$: on input $\langle A, B \rangle$

1. construct DFA $C$ for $L(C)$
2. Run TMT from $E_{DFA}$ on $\langle C \rangle$.
3. If $T$ accepts, accept otherwise reject.
\[ A_{CFG} = \{ \langle G, w \rangle \mid G \text{ is a CFG that generates } w \} \]

\[ A_{CFG} \text{ is decidable.} \]

if \( G \) is in CNF

then any derivation has at most \( 2n-1 \) steps \((n = |w|)\).

\[ s \rightarrow s \alpha \]

1. convert \( G \) to CNF.
2. List all derivations \( w/2n-1 \) steps (unless \( n=0 \), only list 1 step derivations)
3. If any derivation is \( w \), accept. Otherwise, reject.

\[ s \rightarrow a \alpha a \mid b \alpha b \mid a \mid b \mid \epsilon \]

\[ s \Rightarrow a \alpha a \Rightarrow ab \alpha \Rightarrow ababa \]
\[ E_{CFG} = \{ <G> \mid G \text{ is a CFG and } L(G) = \emptyset \} \]

\[ E_{CFG} \text{ is decidable} \]

\[
\begin{align*}
S & \rightarrow S \\
A & \rightarrow \alpha \\
B & \rightarrow B \alpha \\
C & \rightarrow B \gamma \\
D & \rightarrow A \gamma \\
\end{align*}
\]

1. Mark all terminal symbols in the rules of \( G \).
2. Repeat 3 until no new symbols are marked.
3. Mark any variable \( A \) where \( G \) has the rule \( A \rightarrow U_1U_2U_3\ldots U_k \) and all \( U_1\ldots U_k \) are marked.
4. If the start variable is not marked, accept; otherwise reject.
\[ EQ_{\text{CFG}} = \{ (G, H) \mid G, H \text{ are CFG and} \newline L(G) = L(H) \} \]

\[ EQ_{\text{CFG}} \text{ is not decidable.} \]