\[
\begin{align*}
\Sigma &\quad \Gamma &\quad \mathcal{P} \\
\text{input} &\quad \text{tape} &\quad \text{print} \\
\times &\quad &\quad \\
\delta_{TM}: Q \times \Gamma &\to Q \times \Gamma \times \{L, R\}
\end{align*}
\]
\[ E_{CFG} = \{ <G> | \text{G is a cfg and } L(G) = \emptyset \} \]

construct TM R that decides \( E_{CFG} \).

\[ R = \text{on input } <G> \]

1. mark all terminal symbols.

2. repeat until no new variables are marked.

3. mark any variable \( A \) where \( G \) has a rule \( A \rightarrow U_1 U_2 \cdots U_k \) where \( U_i \) is a variable or terminal, for which all \( U_i \) are marked.

4. if start variable is not marked, accept.
else reject.
$EQ_{CFG} = \{ \langle G, H \rangle \mid \text{G and H are CFG's and } L(G) = L(H) \}$

is not decidable
Every context free language is decidable.

Let $G$ be a CFG for the CFL.

Construct a TM that decides the CFL.

$M = \text{on input } w, w \in \Sigma^*$

1. Run TM $S$ ($S$ decides $\text{Acfg}$) on input $\langle G, w \rangle$
2. If $S$ accepts, accept else, reject.
$A_{TM} = \{ <M, w> | M \text{ is a T.M. that accepts } w \}$

The Halting Problem