$$\overbrace{\underset{\text{input}}{\Sigma}\quad\underset{\text{tape}}{\Gamma}}^{TM}\quad\underset{\text{print}}{P}$$

X

$$\delta_{TM}: Q \times \Gamma \to Q \times \Gamma \times \{L, R\}$$

$E_{CFG} = \{ \langle G \rangle \mid G$ is a cfg and $L(G) = \emptyset \}$

---

construct TM R that decides E_{CFG}.

$R =$ on input $\langle G \rangle$

1. mark all terminal symbols.
2. repeat (3) until no new variables are marked.
3. mark any variable A where G has a rule

$$A \to U_1 U_2 \cdots U_k$$

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.

$S \to Aa$

$A \to S$

$S \to aAb$

$A \to c$

$$EQ_{CFG} = \{\langle G, H\rangle \mid G \text{ and } H \text{ are CFG's and } L(G) = L(H)\}$$

is not decidable

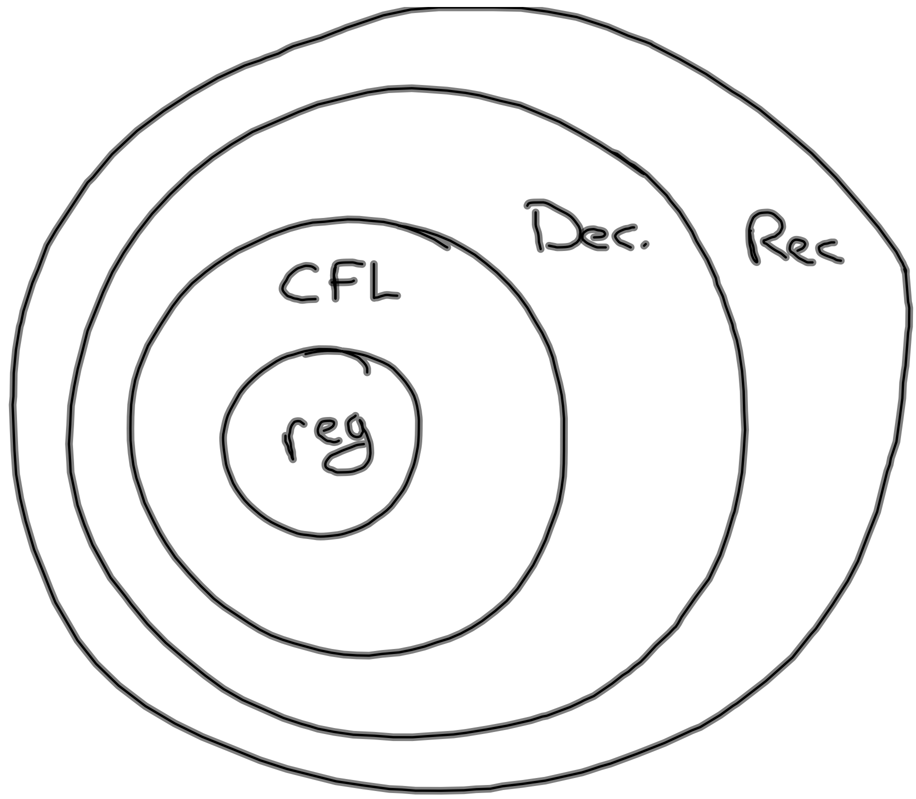
~~Any~~ Every context free language is decidable.

Let G be a CFG for the CFL

Construct a TM that decides the CFL.

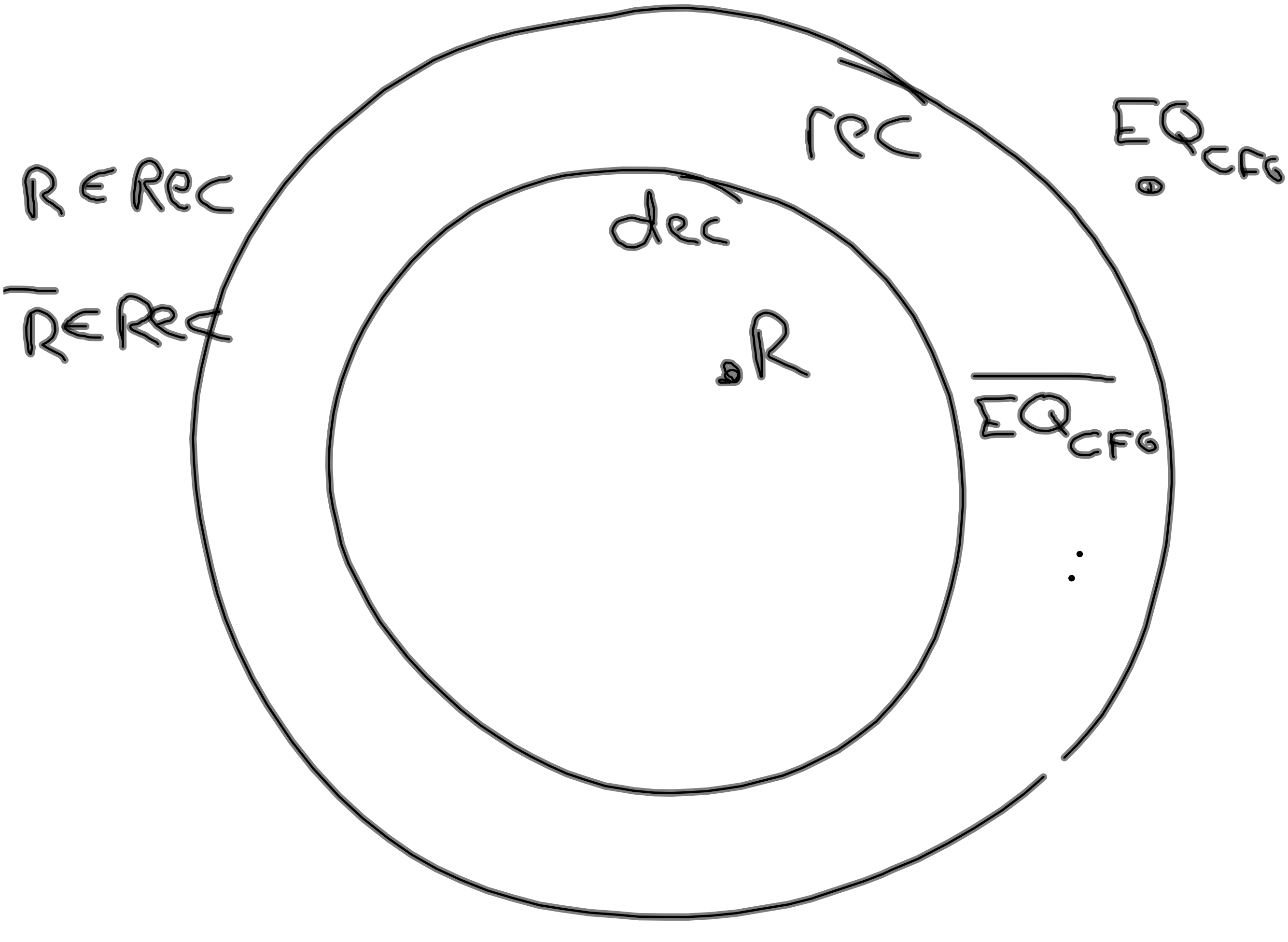
$M =$ on input w, $w \in \Sigma^*$

1. Run TM S (S decides A_{CFG}) on input $\langle G, w \rangle$
2. If S accepts, accept else, reject.


Rec
Dec.
CFL
reg

$$A_{TM} = \{\langle M, w\rangle \mid M \text{ is a T.M. that accepts } w\}$$

The Halting Problem


R ∈ Rec
$\overline{R}$ ∈ Rec
rec
dec
R
EQ_{CFG}
$\overline{EQ_{CFG}}$