- Description of a "standard" Turing machine
- \( \langle M, w \rangle \) plus an input to \( M \)

- There are unrecognizable languages

Ch. 4:

\[- A_{TM} = \{ \langle M, w \rangle \mid M \text{ is a Turing machine that accepts } w \} \]

is undecidable

- \( A_{TM} \) is recognizable (by a universal Turing machine)

- Complement (\( A_{TM} \)) is not recognizable
Breakout Room Problems

① Give a more detailed description of a universal TM, i.e., that given \( \langle M, w \rangle \) can "simulate" M's computation on input w.

② Given that \( A_{TM} \) is undecidable, show that

\[
\text{HALT}_{TM} = \left\{ \langle M, w \rangle \mid M \text{ halts on input } w \right\}
\]

is undecidable

(halt means reaches either \( q_{\text{accept}} \) or \( q_{\text{reject}} \)).

③ If \( L \) is undecidable and recognizable show that \( L_{\text{comp}} = \Sigma^* \setminus L \) is unrecognizable