• **Decidable Languages**: Some TM exists which will accept any string \( w \) that is in \( L \), and reject any string not in \( L \). The TM always halts.

  - (p. 194) \( A_{DFA} = \{<B,w>| B \text{ is a DFA that accepts } w\} \)
  - (p. 195) \( A_{NFA} = \{<B,w>| B \text{ is an NFA that accepts } w\} \)
  - (p. 196) \( A_{REX} = \{<R,w>| R \text{ is a regex that generates } w\} \)
  - (p. 196) \( E_{DFA} = \{<A>| A \text{ is a DFA where } L(A) = \Phi\} \)
  - (p. 197) \( EQ_{DFA} = \{<A,B>| A,B \text{ both DFAs } & L(A) = L(B)\} \)
  - (p. 198) \( A_{CFG} = \{<G,w>| G \text{ is a CFG that generates } w\} \)
  - (p. 199) \( E_{CFG} = \{<G>| G \text{ is a CFG } & L(G) = \Phi\} \)
  - (p. 200) Every CFL is decidable
  - (Prob. 4.3) \( ALL_{DFA} = \{<A>| A \text{ a DFA and } L(A)=\Sigma^*\} \)
  - (Prob. 4.4) \( A_{\epsilon_{CFG}} = \{<G>| G \text{ a CFG that generates } \epsilon\} \)
  - (Prob. 4.10) \( INFINITE_{DFA} = \{<A>| A \text{ a DFA, } L(A) \text{ is infinite}\} \)
  - (Prob. 4.11) \( INFINITE_{PDA} = \{<A>| A \text{ a PDA, } L(A) \text{ is infinite}\} \)
• **Undecidable Languages**: A decider does not exist.
  • (p. 202) $\text{HALT}_{\text{TM}} = \{<M,w>| M \text{ is a TM that halts on } w\}$
  • (p. 207) $A_{\text{TM}} = \{<M,w>| M \text{ accepts } w\}$
  • (p. 217) $E_{\text{TM}} = \{<M>| M \text{ is a TM and } L(M)=\emptyset\}$
  • (p. 218) $\text{REGULAR}_{\text{TM}} = \{<M>| M \text{ a TM & } L(M) \text{ is regular}\}$
  • (p. 219) $L_P = \{<M>| M \text{ a TM such that } L(M) \text{ has property } P\}$
  • (p. 220) $\text{EQ}_{\text{TM}} = \{<M1,M2>| M1, M2 \text{ TMs, } L(M1)=L(M2)\}$
  • (p. 222) $A_{\text{LBA}} = \{<M,w>| M \text{ an LBA that accepts } w\}$
  • (p. 223) $E_{\text{LBA}} = \{<M>| M \text{ an LBA where } L(M) \text{ is empty}\}$
  • (p. 225) $\text{ALL}_{\text{CFG}} = \{<G>| G \text{ is CFG where } L(G)=\Sigma^*\}$
  • (p. 228) $\text{PCP} = \{<P>| P \text{ instance of Post Correspondence Problem}\}$

• **Recognizable Languages**: Some TM exists which can accept any string $w$ that is in $L$, and will not accept any string not in $L$. No guarantees that TM will even halt for $w$ not in $L$.

• **co-Turing Recognizable Languages**: a TM recognizer exists for the complement of the language
  • (Prob. 4.5) $E_{\text{TM}} = \{<M>| M \text{ is a TM and } L(M)=\emptyset\}$
  • If $L$ is both recognizable and co-Turing recognizable then it is decidable
• **Class P**: decidable by a 1-tape TM in poly time
  
  • (p. 287) **PATH** = \{<G,s,t>| G is directed graph (V,E), with path from s to t\}
  
  • (p. 289) **RELPRIME** = \{<x,y>|x,y relatively prime\}
  
  • (Prob. 7.8) **CONNECTED** = \{<G>| G is a connected undirected graph\}
  
  • (Prob. 7.9) **TRIANGLE** = \{<G>|G contains a triangle\}
  
  • (Prob. 7.10) **ALL\textsubscript{DFA}**
  
  • (Prob. 7.13) **MODEEXP** = \{(a,b,c,p)| positive binary integers such that ab = c mod p\}
  
  • (p. 290) Every context-free language is in P

• **Class NP**: Not in P but a poly time NTM exists (* in NP-Complete)
  
  • *HAMPATH = \{(G,s,t)|G is graph with Hamiltonian path from s to t\}
  
  • **COMPOSITES** = \{x|x=pq, for p,q>1\}
  
  • *CLIQUE = \{<G,k>|G undirected graph with k-clique\}
  
  • *SUBSET-SUM = \{<S,t>|S = \{x_1, ...x_k\}\}
  
  • *SAT = \{wff| wff is satisfiable\}
  
  • *VERTEXCOVER = \{<G,k>|G has a k-node vertex cover\}