

**Part 1: Submit via email to TA**

1. Using JFLAP design PDA's for the following languages:
  - (a)  $\{w \in \{a, b\}^* \mid |w| \geq 4 \text{ and is even, and the middle symbol of } w \text{ is not the same as the last symbol of } w\}$ . Save this PDA in file 2hw1a
  - (b)  $\{w \in \{a, b, c\}^* \mid w \text{ has equal } a\text{'s and } c\text{'s or } w \text{ has twice as many } a\text{'s as } b\text{'s}\}$ . Save this PDA in file 2hw1bRun each PDA on JFLAP with at least 3 strings in the language and at least 3 strings not in the language. Turn in the PDAs with the test strings and the verdicts of JFLAP to TA.
2. Design two different PDA's (one direct and one indirect by first constructing a CFG) for each of the following languages:
  - (a)  $\{w \in \{a, b, c\}^* \mid \text{every } c \text{ in } w \text{ is immediately followed by an } a \text{ and the number of } b\text{'s and } c\text{'s in } w \text{ is unequal}\}$ . Save the direct PDA in 2hw2ad and the indirect PDA in 2hw2ai
  - (b)  $\{a^m b^n \mid m > 2n \text{ or } m < n, m, n \geq 0\}$ . Save the direct PDA in 2hw2bd and the indirect PDA in 2hw2biRun each PDA on JFLAP with at least 3 strings in the language and at least 3 strings not in the language. Turn in the design with the test strings and the verdicts of JFLAP to TA.

**Part 2: Turn in at the beginning of class**

3. Use pumping lemma to show that the language  $\{0^n 1^p 2^n \mid 0 \leq n < p\}$  is not a context-free language. You must do the proof in three steps. First, choose an appropriate string. Second, consider all cases satisfying the pumping lemma conditions for the five pieces of the chosen string. Third, derive a contradiction for each case. No partial credit will be given if the first step is wrong.
4. Prove or disprove the following: there are context-free languages  $L$  and  $L'$  such that both  $L$  and  $L'$  are not regular, but  $LL'$  is regular.