- **You shall receive feedback on the problems *only if***:
  1. You submit **to Ankita** by **2359 hrs on Thursday, October 17**, 2019, and
  2. **Submit each problem in a separate sheet** with your name on each sheet. This is essential because the TAs divide correction duties by problem.
- This problem set should take you approximately an hour to solve. This is the pace that will be expected in the quizzes.

"You only grow by coming to the end of something
and by beginning something else." – John Irving

1. Let G be a CFG in Chomsky normal form.
   (a) Show that for any string $w \in L(G)$ of length $n > 1$, exactly $2n - 1$ steps are required for any derivation of w.
   (b) Let G contain b non-terminals. Show that, if G generates some string with a derivation having at least $2b$ steps, then $L(G)$ is infinite.
2. Recall the *shuffle* operator from Problem Set 3. Prove or disprove:
   (a) Given L context-free and R regular, shuffle(L, R) is context-free.
   (b) Given L_1, L_2 context-free, shuffle(L_1, L_2) is context-free.
3. Given a CFL L in the form of a CFG or a PDA, how would you check if L is finite?
4. Say that a language is prefix-closed if the prefix of any string in the language is also in the language. Let L be an infinite, prefix-closed, context-free language. Show that L contains an infinite regular subset.
