- **You shall receive feedback on the problems *only if***:
  1. You submit **to Ekanshdeep** by **2359 hrs on Thursday, October 3**, 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.

"I thought it best, finally, to start seeing where I've been rather than where I'm going." – David Ohle

1. Let $L = \{ww^R \mid w \in \Sigma^*\}$. Construct a push-down automata accepting L.
2. Let $\#_a(w)$ denote the number of a's in $w \in \{a, b\}^*$. Let $L = \{w \mid \#_a(w) = \#_b(w)\}$. Can you construct a push-down automata having the stack alphabet $\{\alpha, \perp\}$ which recognises L? ($\perp$ is a special symbol which only appears at the bottom of the stack to denote that the stack is empty.)
3. Let $bin(x)$ denote the binary representation of the number x. Can the following languages be accepted by a push down automaton:
   (a) $L_1 = \{bin(n)\$bin(n+1) \mid n \in \mathbb{N}\}$
   (b) $L_2 = \{bin(n)\$(bin(n+1))^R \mid n \in \mathbb{N}\}$
4. For $L_1, L_2 \subseteq \{a, b\}^*$ let $L_1 ._{\#a} L_2 = \{uv \mid u \in L_1, v \in L_2, \#_a(u) = \#_a(v)\}$. Show that if L_1 and L_2 are regular, then $L_1 ._{\#a} L_2$ is context-free.
