

Describe deterministic finite-state automata that accept each of the following languages over the alphabet  $\Sigma = \{0, 1\}$ . Describe briefly what each state in your DFAs *means*.

Either drawings or formal descriptions are acceptable, as long as the states  $Q$ , the start state  $s$ , the accept states  $A$ , and the transition function  $\delta$  are all clear. Try to keep the number of states small.

1. All strings containing the substring **000**.
2. All strings *not* containing the substring **000**.
3. All strings in which every run of **0**s has length at least 3.
4. All strings in which no substring **000** appears before a **1**.
5. All strings containing at least three **0**s.
6. Every string except **000**. [*Hint: Don't try to be clever.*]

**Work on these later:**

7. All strings  $w$  such that *in every prefix of  $w$* , the number of **0**s and **1**s differ by at most 1.
8. All strings containing at least two **0**s and at least one **1**.
9. All strings  $w$  such that *in every prefix of  $w$* , the number of **0**s and **1**s differ by at most 2.
- \*10. All strings in which the substring **000** appears an even number of times.  
(For example, **0001000** and **0000** are in this language, but **00000** is not.)