Describe deterministic finite-state automata that accept each of the following languages over the alphabet $\Sigma = \{0, 1\}$. Give the states of your DFAs mnemonic names, and describe briefly in English the meaning or purpose of each state.

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 not to use too many states, but don’t try to use as few states as possible. Clarity is more important than brevity.

Yes, these are exactly the same languages that you saw last Friday.

0. All strings.

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 every $1$ appears before every substring $000$.

5. All strings containing at least three $0$s.

6. Every string except $000$. [Hint: Don’t try to be clever.]

More difficult problems to think about 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 every run has odd length. (For example, $0001$ and $10000111$ and the empty string $\epsilon$ are in this language, but $000000$ and $001000$ are not.)

*11. All strings in which the substring $000$ appears an even number of times. (For example, $01100$ and $000000$ and the empty string $\epsilon$ are in this language, but $00000$ and $001000$ are not.)