Problem 1 (Automatic scheduler for WiFi and mobile data):

Many a times we have to switch between WiFi and mobile data based on availability. This problem is motivated by this broad idea. Whenever we are using WiFi or mobile data, we are selecting a wireless channel to transmit on. Let's say that WiFi and mobile data are associated with channels 1 and 2 respectively.

Let $i \in \{1, 2\}$ denote the channel index. Channel i is either available for not available in a time slot. Let $s_{i,t} \in \{0, 1\}$ denote whether channel i is available ($s_{i,t} = 1$) or not available ($s_{i,t} = 0$) in time slot t. If channel i is not available in time slot t, then the probability that it is not available in next time slot $t + 1$ is α_i. If channel i is available in time slot t, then the probability that it is available in next time slot $t + 1$ is θ_i. If a channel is not available, the number of data packets that we can send through it is obviously zero. If channel i is available, we can set $d \in \{0, 1, 2, \ldots, D\}$ packets through it where the probability of sending d packets is $p_{i,d}$.

If we switch to channel i, we can't start to use it even if it is available. We have to wait for τ_i time slots for the device to establish connection with the channel. For this τ_i time slots, the number of data packets that we can send is zero. The objective is to maximize the total number of data packets transmitted over an infinite horizon. Formulate this problem as a Markov decision process.

Problem 2 (Investing in a stock market):

Formulate this as an MDP. A very crude objective is to maximize the bank balance.

There is a critical difference between the first and the second problem. In the first problem, the concrete problem statement is given. In the second problem, there is no concrete problem statement. In a "researcher's terminology", the first problem has the system model while the second one does not. However, in both cases, you have to formulate the problem as an MDP. Problem 2 is more challenging because:

1. We don't have a clear cut idea of the associated variables.
2. We have to make assumptions that are practical enough but not so practical that renders the problem unsolvable (computationally).