1. We will use Maple to study the effects of harvesting cost on the fish harvesting optimization problem. Input the updating function

\[
g := F \rightarrow r*F*(1-F)-h*F;
\]

where \( h \) represents the harvesting effort and \( r \) is the maximum population growth rate. The fish population is measured in millions. Use solve to find the equilibria. Define a function of \( h \) called \( P_{\text{star}} \) which has as its value the positive equilibrium. The equilibrium profit as a function of \( h \) can be given as

\[
P_{\text{star}} := h \rightarrow h*p*F_{\text{star}}(h)-c*h;
\]

The first term is the total harvest times the price per fish \( p \). Assume \( p = 1 \), meaning here 1 million dollars for 1 million fish. The second term is the cost of harvesting, with \( c \) equal to the cost per unit effort of harvesting (again measured in millions of dollars).

(a) Set \( r = 2.5 \), and \( c = 0 \). Find the value of \( h \) that maximizes \( P_{\text{star}} \) by using the derivative. First, find the derivative of \( P_{\text{star}} \) with the command

\[
> \text{dPstar} := \text{diff}(P_{\text{star}}(h),h);
\]

Then use the solve command to find where this is equal to 0,

\[
> \text{hstar} := \text{solve}(%=0,h);
\]

Find \( F_{\text{star}}(\text{hstar}) \) and \( P_{\text{star}}(\text{hstar}) \). Set \( h \) equal to \( \text{hstar} \) (this is necessary to get the cobweb to work), and cobweb the function \( g \) for 10 steps starting from 0.01 with the command

\[
> \text{cobweb}(g,10,0.01,0..1);
\]

Write on your diagram the number of fish at equilibrium, the number of fish harvested, and the profit.

(b) Set \( c := 0.2 \); and \( h := 'h' \); to reinitialize. Repeat a. Why are there more fish and lower profits? Make sure to write the number of fish harvested at equilibrium, the revenue from those fish, and the cost of harvesting those fish. For an extra challenge, how many years would it be (starting from 0.01 fish) before a profit was made?

(c) Repeat b with \( c := 0.7 \). Does your answer make sense? What is the optimal harvesting effort? Why?