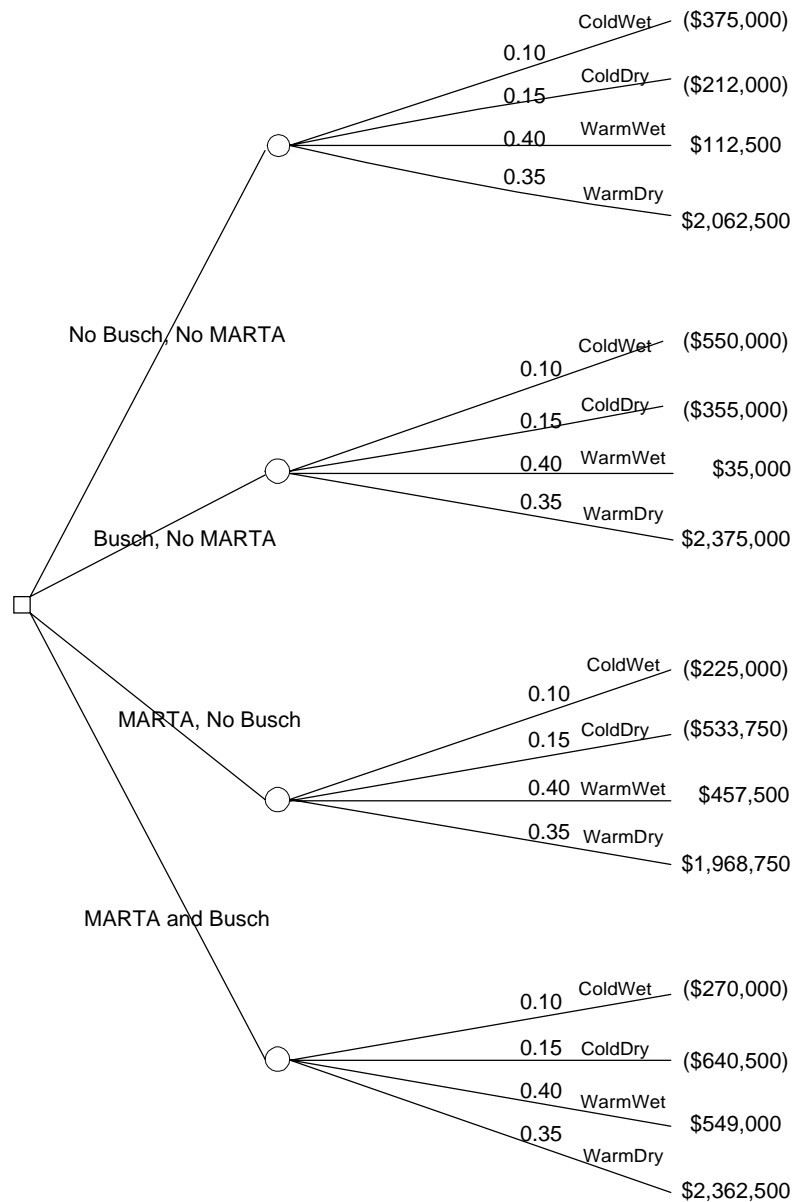


Decision Trees

The Payoff Table and the Opportunity Loss Table are two very similar ways of looking at a Decision Analysis problem. Another way of seeing the structure of the problem is the *Decision Tree*. For a "simple" single stage problem like Roger's problem, it is easy to do without decision trees. When we reach sequential decision problems, they will become virtually indispensable.

decision maker (here it's Roger) makes decisions (chooses alternatives) and has information (here, States of Nature) revealed to him or her. In Roger's case, it is pretty easy to figure that out. First Roger must decide on an alternative (No Busch, no MARTA, *or* Busch, no MARTA, *or* MARTA, no Busch, *or* MARTA and Busch). Then, when the weekend of his IndyCar race arrives, whatever weather happens, happens. It isn't always that simple.



It doesn't matter in what order things happen. A Decision Tree is driven by the order in which the decision maker has information and acts on it!

In Roger's case, the tree represents

1. Roger's decision on how to support his IndyCar race
2. The weather that happens.

Suppose Roger could buy some sort of long range weather forecasting study. In that case the tree would need to represent

1. Roger's decision on whether to buy a long range weather forecast
2. If he buys the forecast, the results of the forecast
3. With or without the forecast, his race support decision
4. The weather that happens.

If you draw the tree in any sequence other than this one, you get stuck. You can't finish it.

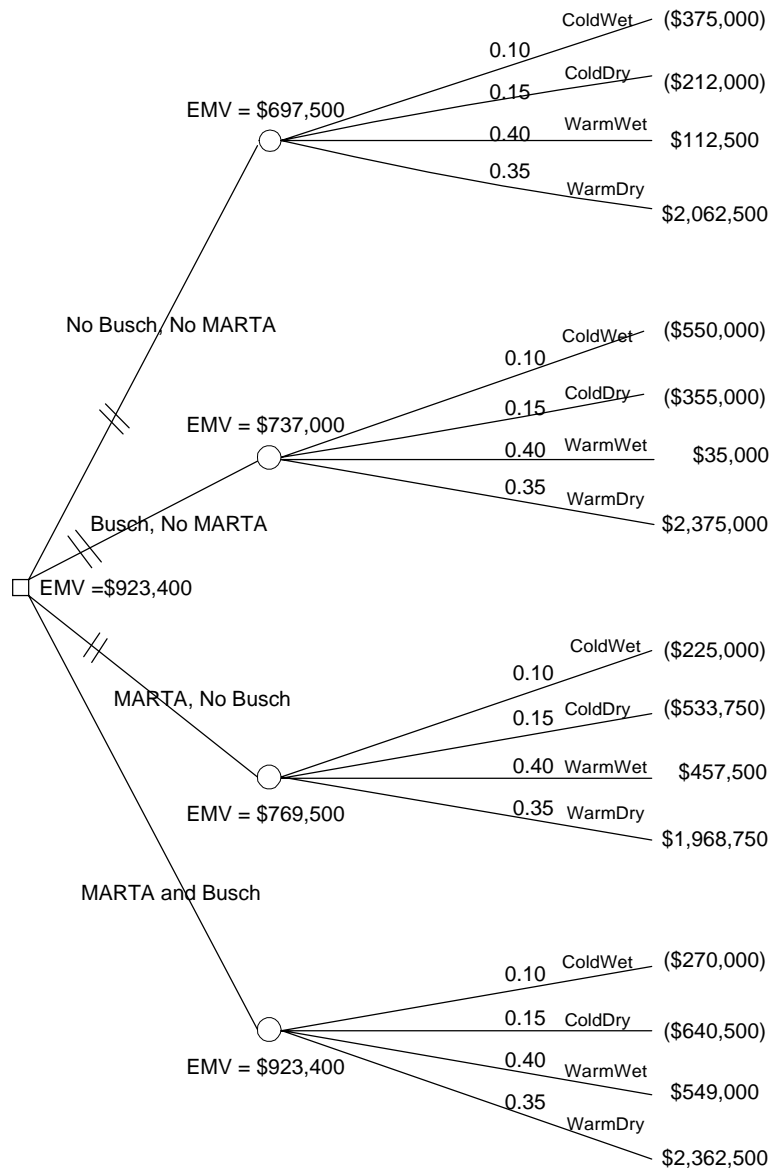
Let's suppose that you do understand the order in which the decision maker has information and acts on it. There are some conventions we follow in constructing a Decision tree.

- 1.The tree begins at a single "node", usually a decision.
2. We show decision nodes as little boxes whose branches represent alternatives.
- 3.We show chance nodes as little circles whose branches represent outcomes or States of Nature.
- 4.The outermost branches end at "terminal points", where we show the payoffs.
- 5.We label chance branches with their probabilities.
- 6.In fact, we label everything as clearly as possible.

The initial tree shows us the structure of Roger's problem, but it doesn't solve it. How do we solve the problem (again)?

First, we go to the outermost chance nodes, and we apply the probabilities to the payoffs to compute the EMV. Now that we have the EMV, we treat the node as a terminal point; we will now act as though the EMV were an actual payoff for reaching that node. We will work our way from the "leaves" of the tree back toward the base until we reach a decision node. At each decision node, we select the one branch leaving that node which has the highest value. That highest value could be a "real" payoff, or it could be an EMV. We leave that branch intact, and "cut off" all other branches leaving that decision node. A pair of hash marks through the branch indicates that we have "cut off" the branch, along with any branches that follow it.

On the next page, you'll see Roger's finished tree. The Expected Monetary Value for the alternative MARTA and Busch is (again) \$923,400, which is higher than for any other alternative. We have "pruned" the branches representing the other alternatives. The \$923,400 EMV for that branch is also the EMV for the tree.



Notice that only *decision branches* get pruned. The only way to lose a chance branch is if it grows from a pruned decision branch. We prune *all* branches following the pruned decision branch with it.

The completed decision tree amounts to a *decision rule*. In this case it is very simple decision rule. The decision rule simply says to support the IndyCar race with a Busch race and give free MARTA rides, then live with whatever weather you get.