# Decision Tree Tutorial

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## Introduction

We make decisions everyday from getting up in the morning to figuring out what we want to have for dinner. In most cases, we have a good idea of what we like or want based on previous experiences. For example, you might prefer to have ice cream for dinner because you like it. But what if you also believe that having ice cream is not the healthiest option for dinner. Instead, you could have vegetables for dinner because it's healthier (or so you believe).

These decisions are mostly determined by the most current information at our disposal. But in many instances, there is a great amount of uncertainty. Sometimes, this uncertainty can impact the decision we will make. For instance, what if we know with 100% certainty that having ice cream for dinner was going to cause a heart attack afterwards? Would you still want to have the ice cream? What if that certainty was reduced to 1%? Would you change your mind about having the ice cream?

This is a common problem in health care where different treatments have a lot of uncertainty in their effectiveness. When you go see a doctor for an illness, you will usually receive some kind of treatment after the doctor diagnoses your illnes. But what if the doctor misdiagnose your illness? Or what if the doctor correctly diagnoses the illness but the treatment isn't effective? These questions are common in health care and difficult to predict with a high degree of uncertainty.

In the field of pharmacoeconomics, decision trees are used to predict what would happen after a decision has been made about a treatment strategy. Often times, these decisions are driven by the current evidence usually in the form of randomized controlled trials (RCTs). Sometimes the evidence comes from a meta-analysis or a clinician's experience. But what is almost always in a decision tree is the outcomes (or payoffs). Each treatment strategy will involve a series of pathways that will ultimately lead to some kind of outcome. These outcomes can be good or bad. Some examples of outcomes common with decision tree analysis are survival, response, life years, and quality-adjusted life years (QALYs). Another element that is also evaluated is the cost of the treatment strategy. Just like the outcomes, each treatment strategy will have costs associated with each pathway. Summing these up for each pathway, a pharmacoeconomist can determine the total cost of that treatment strategy.

Pharmacoeconomists can use decision trees to evaluate the value of a treatment strategy by measuring the outcomes alongside the costs associated with each treatment pathway and comparing these to other treatment strategies (e.g., usual care or standard care). This is called a cost-effectiveness analysis, which is the systematic evaluation of the value of a treatment strategy compared to an alternative treatment strategy. In this tutorial, I will show you how to create simple decision trees to predict the cost-effectivenss of a treatment strategy compared to an existing strategy such as standard care.

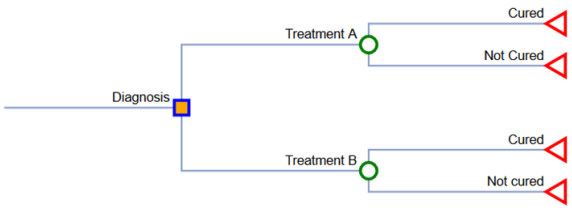
## Objectives

1. Describe the basic elements of a decision tree model
2. Construct a decision tree model using R
3. Evaluate the cost-effectiveness of a treatment compared to standard care

## Elements of a decision tree

A decision tee provides a visial diagram of the possible pathways for a treatment strategy. Usually a decision tree will be illustrated going from left to right and will start with a decision node (square) and end with a terminal node (triangle). Other elements of a decision tree include the chance nodes (circle), which denotes the probability of an event occurring. These symbols are common conventions for decision trees and each intersection is referred to as a node. In Figure 1, a decision is made at the decision node (square) and then there is a probability that it is effective as indicated by the chance node (circle); the decision tree will have to eventually end with an outcome at the terminal node (triangle).

Figure 1. Decision tree model.




## Decision tree example

Now that we know the basic elements of a decision tree, let's take a look at an example.

Suppose that a patient sees their doctor for an acute respiratory infection (ARI). The doctor can treat the patient with two types of antibiotics (Treatment A and Treatment B). The doctor can forgoe treatment with Treatment B and instead recommend that the patient received Treatment A.

The decision tree for an ARI scenario is illustrated in Figure 2. The decision node (square) is to treat with Treatment A or Treatment B. The chance nodes (circle) indicate the part of the decision tree where the patient can have some probability of having an adverse reaction and/or a cure. The terminal node (triangle) captures the outcomes for the decision pathway. (Although unnecessary, it is prudent to have similar decision pathways for the two treatment strategies. This makes it easier to compare the results and reduces potential bias due to the structure of the decision tree.)

Figure 2. Decision tree for acture respiratory infection (ARI) treatment.