Influence Diagrams, Decision Trees

Reference: Clemen & Reilly. Making Hard Decisions, 2nd ed. Chapter 3. Duxbury, 2001

NOTE: Some materials for this presentation courtesy of Dr. Dan Maxwell

The Elements of a Decision

- Objectives and means
- Alternatives to choose between
- Uncertainty in Events and Outcomes
- Consequences of the Decision

How do we structure the problem?

Common ways of structuring the decision problem:

- Influence Diagrams
- Decision Trees



Courtesy of Dr. Dan Maxwell

A Simple Influence Diagram





Showing Influence with Arrows



Representing Influence with Arrows Solid arrows into chance nodes represent relevance, and dashed arrows into decision nodes represent information.

Objectives Hierarchy into Influence Diagram





Multiple Objectives



Note: The Oval Shape can be Used as well as the Diamond Shape for the Final Satisfaction Node

Figure 3.7 Using an Influence Diagram: Multiple Objectives in Selecting a Bomb-Detection System

Basic Diagram for Investment









FIGURE 3.11 Influence Diagram for Evacuation Decision

Sequential Decision Problems



FIGURE 3.13 Influence Diagram for Farmer's Sequential Decision Problem

Note: Payoff = Cash Flow; Total Payoff = Net Present Value

A Simple Influence Diagram for New Product



NOTE alternative method of representing payoff (consequence) node

FIGURE 3.14 Simple Influence Diagram for New Product Decision





FIGURE 3.15 New Product Decision with Additional Detail



Another Representation of Deterministic Nodes





Starting an Influence Diagram



FIGURE 3.18 Beginning the Toxic-Chemical Influence Diagram





FIGURE 3.19 Intermediate Influence Diagram for the Toxic-Chemical Decision

A Completed Influence Diagram



FIGURE 3.20 Completed Influence Diagram for the Toxic-Chemical Decision



FIGURE 3.21 Decision-Tree Representation of Venture-Capital Problem

Decision Trees – Dealing with Uncertainty

- Probabilities replace the weights
 - Account for uncertainty
 - Used to evaluate expected values
- Example Venture Capital Problem



Decision Trees (continued)

- Expected return on investment:
 - If investment is made E(I) = pR + (1 p)L
 - If investment not made E(N) = r
- Decision:
 - Invest if pR + (1 p)L > r
 - Don't invest if r > pR + (1 p)L
 - What would you do if r = pR + (1 p)L?
- Decision Trees evaluated left to right



decision must be made before uncertain event takes place



decision is conditional on the known outcome of the uncertain event

Example

Do I take my umbrella or not?

- If I don't and it is sunny, that is best value 1.00
- If I do I won't get wet but it's inconvenient
 - value 0.80
- If I don't and it rains I ruin my suit value 0.00
- Probability of sunshine is p



Payoff Calculation: - Take umbrella 0.8p + 0.8(1-p) = 0.8 - Don't take umbrella 1.0p + 0(1-p) = p Therefore: Take umbrella if p < 0.8





FIGURE 3.25 The Politician's Basic Risky Decision







Sequential Decision Tree



FIGURE 3.30 Skeleton Version of Farmer's Sequential Decision Problem: Decision-Tree Form

Influence Diagram or Decision Tree

Influence Diagram1. Gives basic information2. Less messy

3. Graphically more appealing when presented to upper management

Decision Trees 1.Gives detailed info 2.More messy due to greater details 3.Not so appealing

Must be viewed as complementary techniques. One strategy is to start with influence diagram and fill in the details to develop a decision tree.