

Systems Analysis in Construction

CB312

Construction & Building Engineering Department- AASTMT

by

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Decision Analysis

Utility Theory

Payoff Matrix

Decision Tree

What would you do when you face options?

- Which car would you buy, BMW 320i vs. Honda Accord VTI?
- Which elective class would you take, special topics in concrete or construction engineering?

How do you make a choice?

Utility Theory

- Utility is how you measure your preference over different options
 - For cars: Fast, reliable, economic, etc.
- Utility thus enables us to determine the option that maximizes our objectives.
- Utility requires the player (decision maker) to be rational.

Decision Theory

- If we are faced with multiple options, knowing the utility (outcome) of each decision, we can determine the best alternative for ourselves.
- In decision theory, a player (decision maker) faces nature to maximize his/her own outcome.

$$d = d(\max [u])$$

d: decision, u: utility

Example

- Assume you need to determine whether to invest in a bank (A) with interest rate of 12% or bank (B) with interest rate of (15%). Which one will you decide on?
 - This is indeed an easy question, we know our utility (the interest rates) and we will choose the bank with highest rate.

Stochastic Nature

- What if we know only the utility, but with some probability of happening.
- Consider the following example (Payoff table)

decision	State of nature	
	Oil	Dry
<i>Drill for oil</i>	<i>LE700,000</i>	<i>-LE100,000</i>
<i>Sell the land</i>	<i>LE90,000</i>	<i>LE90,000</i>
<i>Chance of state</i>	$\frac{1}{4}$	$\frac{3}{4}$

State of Nature

- Nature is uncontrollable. However, it reacts with some rules, laws, and probabilities.

decision	State of nature	
	Oil	Dry
<i>Drill for oil</i>	<i>LE700,000</i>	<i>-LE100,000</i>
<i>Sell the land</i>	<i>LE90,000</i>	<i>LE90,000</i>
<i>Chance of state</i>	$\frac{1}{4}$	$\frac{3}{4}$

Expected Utility

- Since the utility of each choice is not deterministic, we need to calculate the Expected Utility, $E[u]$.
- Expected utility is the outcome of each decision through the multiplication of the utility (u) by the probability of happening (P)

decision	State of nature	
	Oil	Dry
<i>Drill for oil</i>	<i>LE700,000</i>	<i>-LE100,000</i>
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<i>Chance of state</i>	$\frac{1}{4}$	$\frac{3}{4}$

Expected Utility

- $E[u]_{\text{Drill}} = 0.25 * 700,000 + 0.75 * -100,000 = \text{LE } 100,000$
- $E[u]_{\text{Sell}} = 0.25 * 90,000 + 0.75 * 90,000 = \text{LE } 90,000$

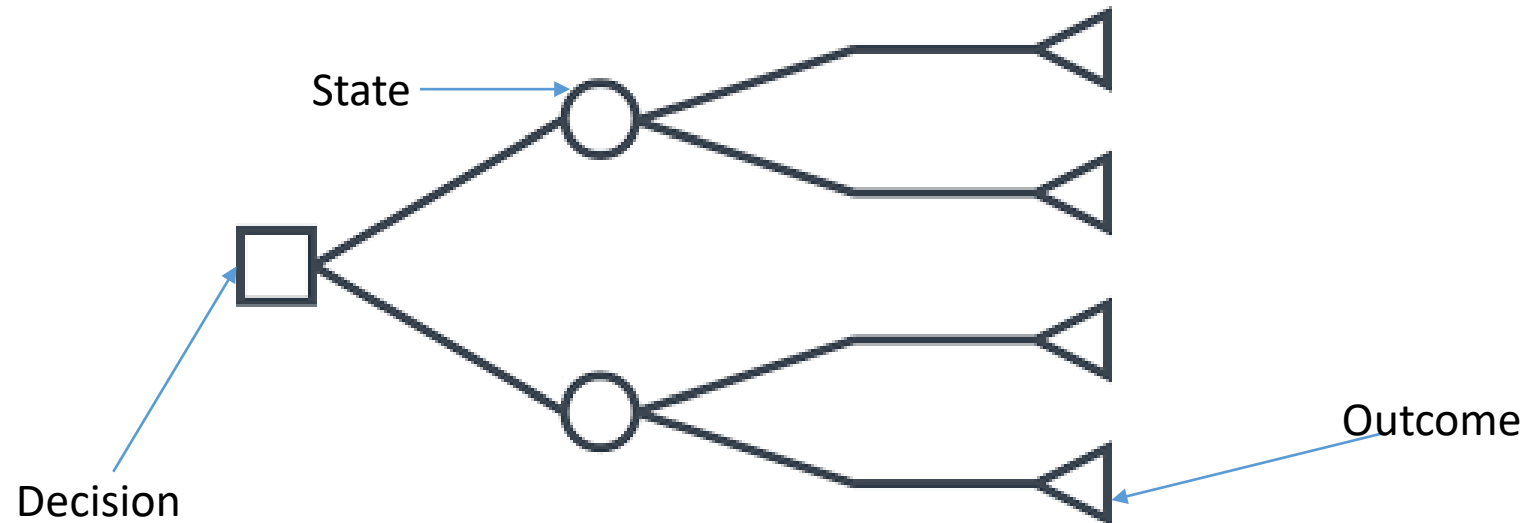
decision	State of nature	
	Oil	Dry
<i>Drill for oil</i>	<i>LE700,000</i>	<i>-LE100,000</i>
<i>Sell the land</i>	<i>LE90,000</i>	<i>LE90,000</i>
<i>Chance of state</i>	<i>1/4</i>	<i>3/4</i>

Example - Gambling

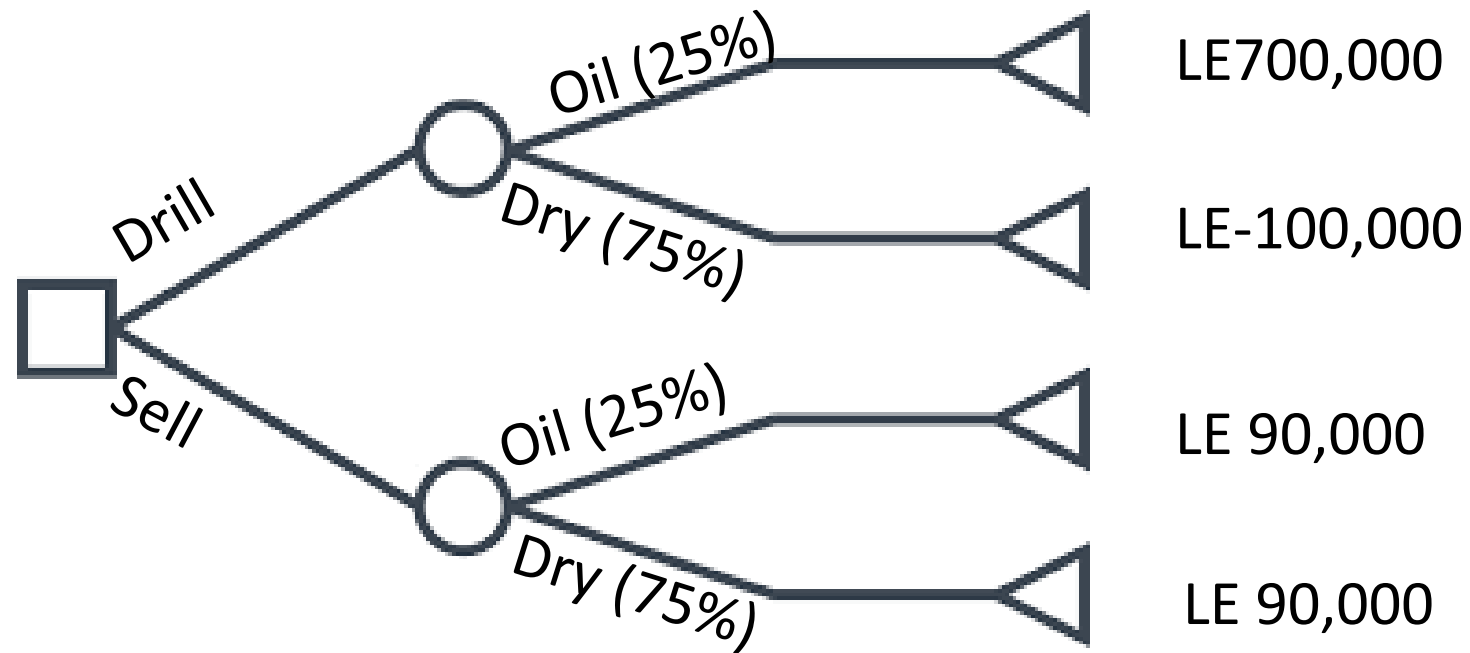
decision	State of nature	
	Win	Loose
<i>Play</i>	<i>LE6</i>	<i>-LE9</i>
<i>Do not play</i>	<i>LE0</i>	<i>LE0</i>
<i>Chance of state</i>	<i>2/3</i>	<i>1/3</i>

Decision Tree

- When facing multiple options, decision tree can be very useful.
- Decision tree is even better in extensive decision (decisions within decisions).



Decision Tree for Oil example



Backward induction: solving from right to left

