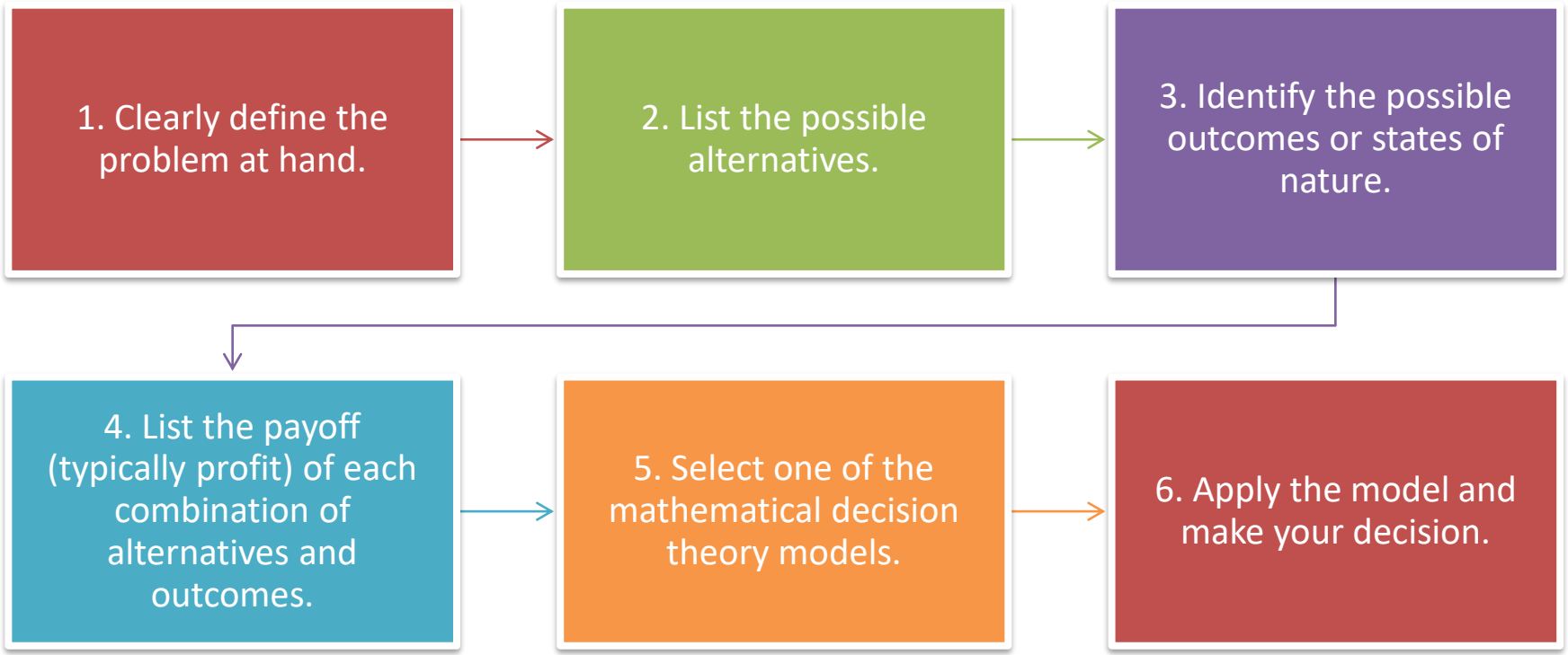
Decision Making Theory

Week 9

Decision Analysis

Decision Table

Six Steps in Decision Making



Thompson Lumber Company

- John Thompson is the founder and president of Thompson Lumber Company, a profitable firm located in Portland, Oregon.

Step 1 - Define the Problem

- **Step 1.** The problem that John Thompson identifies is whether to expand his product line by manufacturing and marketing a new product, backyard storage sheds.

Step 2 – Generate Alternatives

- An **alternative** is defined as a course of action or a strategy that the decision maker can choose.
- **Step 2.** John decides that his alternatives are to construct (1) a large new plant to manufacture the storage sheds, (2) a small plant, or (3) no plant at all (i.e., he has the option of not developing the new product line).
- *One of the biggest mistakes that decision makers make is to leave out some important alternatives*.

Step 3 - Identify states of nature.

- The next step involves identifying the possible outcomes of the various alternatives
- In decision theory, those outcomes over which the decision maker has little or no control are called **states of nature**
- **Step 3.** Thompson determines that there are only two possible outcomes: the market for the storage sheds could be favorable, meaning that there is a high demand for the product, or it could be unfavorable, meaning that there is a low demand for the sheds.

Step 4 - List the payoff

- The next step is to express the payoff resulting from each possible combination of alternatives and outcomes.
- In decision theory, we call such payoffs or profits **conditional values.**
- **Step 4.** Because Thompson wants to maximize his profits, he can use profit to evaluate each consequence.

Next Steps

- Step 5 and 6 – Select and apply one of the mathematical decision theory

Decision Table
or
Decision Tree?

Types of Decision-Making Environments

Decision making under certainty

Decision making under uncertainty

Decision making under risk

DECISION MAKING UNDER UNCERTAINTY

Decision Making Under Uncertainty

1. Optimistic (maximax)
2. Pessimistic (maximin)
3. Criterion of realism (Hurwicz)
4. Equally likely (Laplace)
5. Minimax regret

Optimistic (maximax)

ALTERNATIVE	STATE OF NATURE		MAXIMUM IN A ROW ($)
	FAVORABLE MARKET ($)	UNFAVORABLE MARKET ($)	
Construct a large plant	200,000	-180,000	200,000
Construct a small plant	100,000	-20,000	100,000
Do nothing	0	0	0

The best (maximum) payoff for each alternative is considered and the alternative with the best (maximum) of these is selected

Pessimistic (maximin)

ALTERNATIVE	STATE OF NATURE		MINIMUM IN A ROW ($)
	FAVORABLE MARKET ($)	UNFAVORABLE MARKET ($)	
Construct a large plant	200,000	-180,000	-180,000
Construct a small plant	100,000	-20,000	-20,000
Do nothing	0	0	0

The worst (minimum) payoff for each alternative is considered and the alternative with the best (maximum) of these is selected

Criterion of Realism (Hurwicz)

- Select a coefficient of realism, α:
  - **1** when the decision maker is 100% **OPTIMISTIC** about the future
  - **0** when the decision maker is 100% **PESSIMISTIC** about the future
- Compute the weighted average:

Weighted average
= α(best in row)+(1-α)(worst in row)

Criterion of Realism (Hurwicz)

ALTERNATIVE	STATE OF NATURE: FAVORABLE MARKET ($)	STATE OF NATURE: UNFAVORABLE MARKET ($)	CRITERION OF REALISM OR WEIGHTED AVERAGE (α=0.8) $
Construct a large plant	200,000	-180,000	124,000
Construct a small plant	100,000	-20,000	76,000
Do nothing	0	0	0

the alternative with the highest weighted average is then chosen

Equally likely (Laplace)

ALTERNATIVE	STATE OF NATURE: FAVORABLE MARKET ($)	STATE OF NATURE: UNFAVORABLE MARKET ($)	ROW AVERAGE ($)
Construct a large plant	200,000	-180,000	10,000
Construct a small plant	100,000	-20,000	40,000
Do nothing	0	0	0

Find the average payoff for each alternative, and selecting the alternative with the best or highest average.

Minimax Regret

Opportunity loss is the amount lost by not picking the best alternative in a given state of nature

	STATE OF NATURE	
ALTERNATIVE	**FAVORABLE MARKET ($)**	**UNFAVORABLE MARKET ($)**
Construct a large plant	200,000 – 200,000 = **0**	0 – (-180,000) = **180,000**
Construct a small plant	200,000 – 100,000 = **100,000**	0 – (-20,000) = **20,000**
Do nothing	200,000 – 0 = **200,000**	0 – 0 = **0**

Minimax regret

ALTERNATIVE	STATE OF NATURE: FAVORABLE MARKET ($)	STATE OF NATURE: UNFAVORABLE MARKET ($)	MAXIMUM IN A ROW ($)
Construct a large plant	0	180,000	180,000
Construct a small plant	100,000	20,000	100,000
Do nothing	200,000	0	200,000

finds the alternative that *min*imizes the *max*imum opportunity loss within each alternative

DECISION MAKING UNDER RISK

Decision Making Under Risk

1

- Expected Monetary Value (EMV)
  - Expected Value of Perfect Information (EVPI)

2

- Expected Opportunity Loss (EOL)

Expected Monetary Value (EMV)

$$EMV(\text{alternative}) = \Sigma X_i.P(X_i)$$

Xi = payoff for the alternative in state of nature i

P(Xi) = probability of achieving payoff Xi

Expected Monetary Value (EMV)

ALTERNATIVE	STATE OF NATURE		ROW AVERAGE ($)
	FAVORABLE MARKET ($)	UNFAVORABLE MARKET ($)	
Construct a large plant	200,000	-180,000	10,000
Construct a small plant	100,000	-20,000	40,000
Do nothing	0	0	0
Probabilities	0.50	0.50	

The alternative with the maximum EMV is then chosen

Expected Value of Perfect Information (EVPI)

1. Choose the best alternative for each state of nature
2. Multiply its payoff times the probability of occurrence of that state of nature, or expected value with perfect information (EVwPI)

$$EVwPI = \Sigma(\text{best payoff in state of nature } i). (\text{probability of state of nature } i)$$

Expected Value of Perfect Information (EVPI)

3. The EVPI is the improvement in EMV that results from having perfect information

EVPI = EVwPI - Best EMV

Expected Value of Perfect Information (EVPI)

ALTERNATIVE	STATE OF NATURE: FAVORABLE MARKET ($)	STATE OF NATURE: UNFAVORABLE MARKET ($)	ROW AVERAGE ($)
Construct a large plant	200,000	-180,000	10,000
Construct a small plant	100,000	-20,000	40,000
Do nothing	0	0	0
With perfect information	200,000	0	100,000
Probabilities	0.50	0.50	

Expected Opportunity Loss (EOL)

1. Construct an opportunity loss table
2. Compute the EOL for each alternative by multiplying the probability of each state of nature times the appropriate opportunity loss value and adding these together

Expected Opportunity Loss (EOL)

ALTERNATIVE	STATE OF NATURE: FAVORABLE MARKET ($)	STATE OF NATURE: UNFAVORABLE MARKET ($)	EOL
Construct a large plant	0	180,000	90,000
Construct a small plant	100,000	20,000	60,000
Do nothing	200,000	0	100,000
Probabilities	0.50	0.50	

Using minimum EOL as the decision criterion

SENSITIVITY ANALYSIS

Sensitivity analysis

- *Sensitivity analysis* investigates how our decision might change given a change in the problem data.

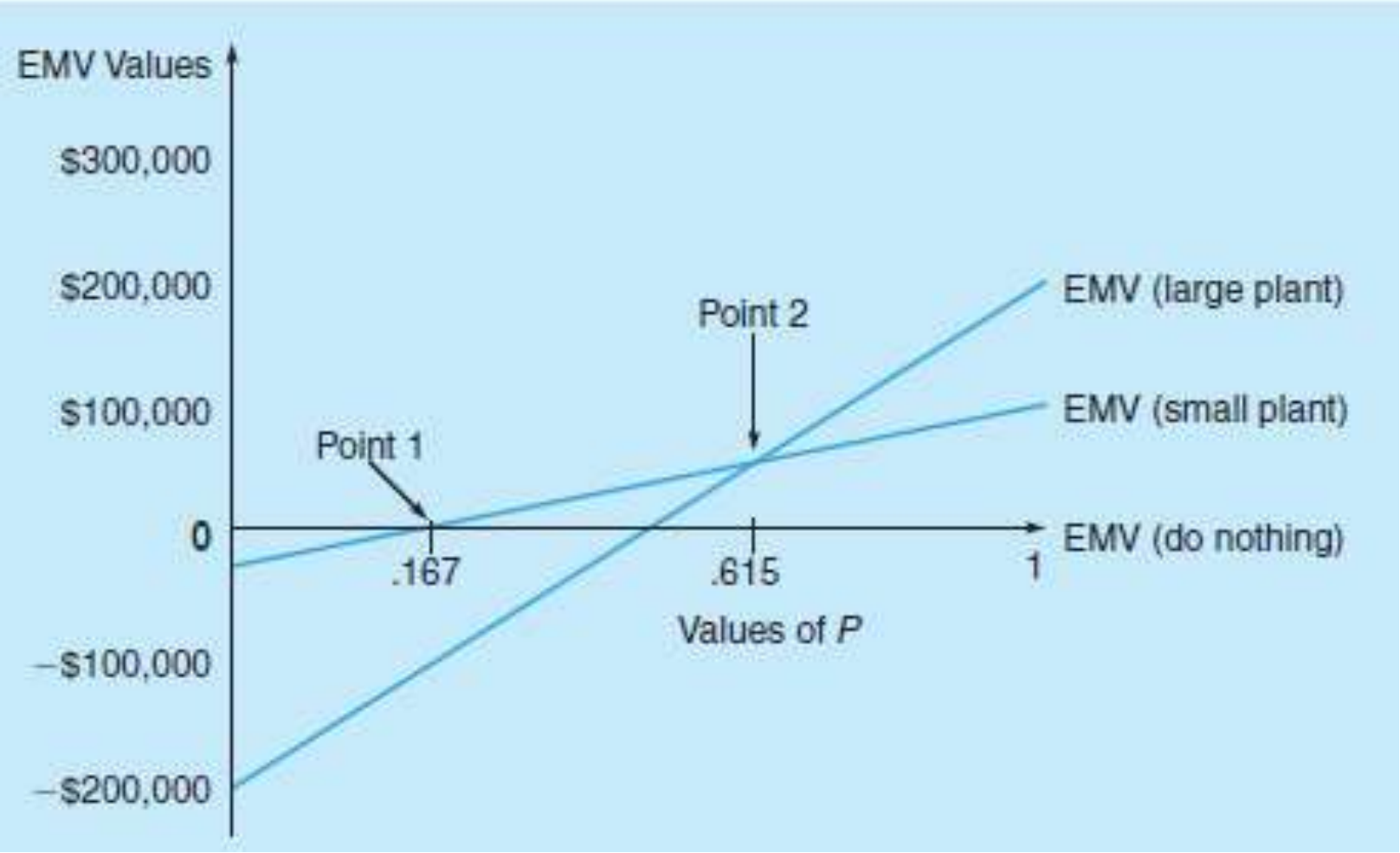
- Example:

  To know the effect of probabilities (P) on decision

Sensitivity analysis

- EMV(large plant)
  = $200,000P - $180,000(1 – P)
  = $200,000P - $180,000 + 180,000P
  = $380,000P - $180,000
- EMV(small plant)
  = $100,000P - $20,000(1 – P)
  = $100,000P - $20,000 + 20,000P
  = $120,000P - $20,000
- EMV(do nothing) = $0P + $0(1 – P) = $0

Sensitivity analysis



EXERCISE

3-20 (1)

Mickey Lawson is considering investing some money that he inherited. The following payoff table gives the profits that would be realized during the next year for each of three investment alternatives Mickey is considering:

DECISION ALTERNATIVE	***STATE OF NATURE***	
	GOOD ECONOMY	**POOR ECONOMY**
Stock market	80.000	-20.000
Bonds	30.000	20.000
CDs	23.000	23.000
Probability	0,5	0,5

3-20 (2)

- a) What decision would maximize expected profits?
- (b) What is the maximum amount that should bepaid for a perfect forecast of the economy?

3-28 (1)

Even though independent gasoline stations have been having a difficult time, Susan Solomon has been thinking about starting her own independent gasoline station. Susan's problem is to decide how large her station should be. The annual returns will depend on both the size of her station and a number of marketing factors related to the oil industry and demand for gasoline. After a careful analysis, Susan developed the following table:

SIZE OF FIRST STATION	***STATE OF NATURE***		
	GOOD MARKET ($)	**FAIR MARKET ($)**	**POOR MARKET ($)**
Small	50.000	20.000	-10.000
Medium	80.000	30.000	-20.000
Large	100.000	30.000	-40.000
Very Large	300.000	25.OO0	-160.000

3-28 (1)

For example, if Susan constructs a small station and the market is good, she will realize a profit of $50,000.

a. Develop a decision table for this decision.
b. What is the maximax decision?
c. What is the maximin decision?
d. What is the equally likely decision?
e. What is the criterion of realism decision? Use an α value of 0.8.
f. Develop an opportunity loss table.
g. What is the minimax regret decision?

3-26

Megley Cheese Company is a small manufacturer of several different cheese products. One of the products is a cheese spread that is sold to retail outlets. Jason Megley must decide how many cases of cheese spread to manufacture each month. The probability that the demand will be six cases is 0.1, for 7 cases is 0.3, for 8 cases is 0.5, and for 9 cases is 0.1. The cost of every case is $45, and the price that Jason gets for each case is $95. Unfortunately, any cases not sold by the end of the month are of no value, due to spoilage. How many cases of cheese should Jason manufacture each month?

THANK YOU