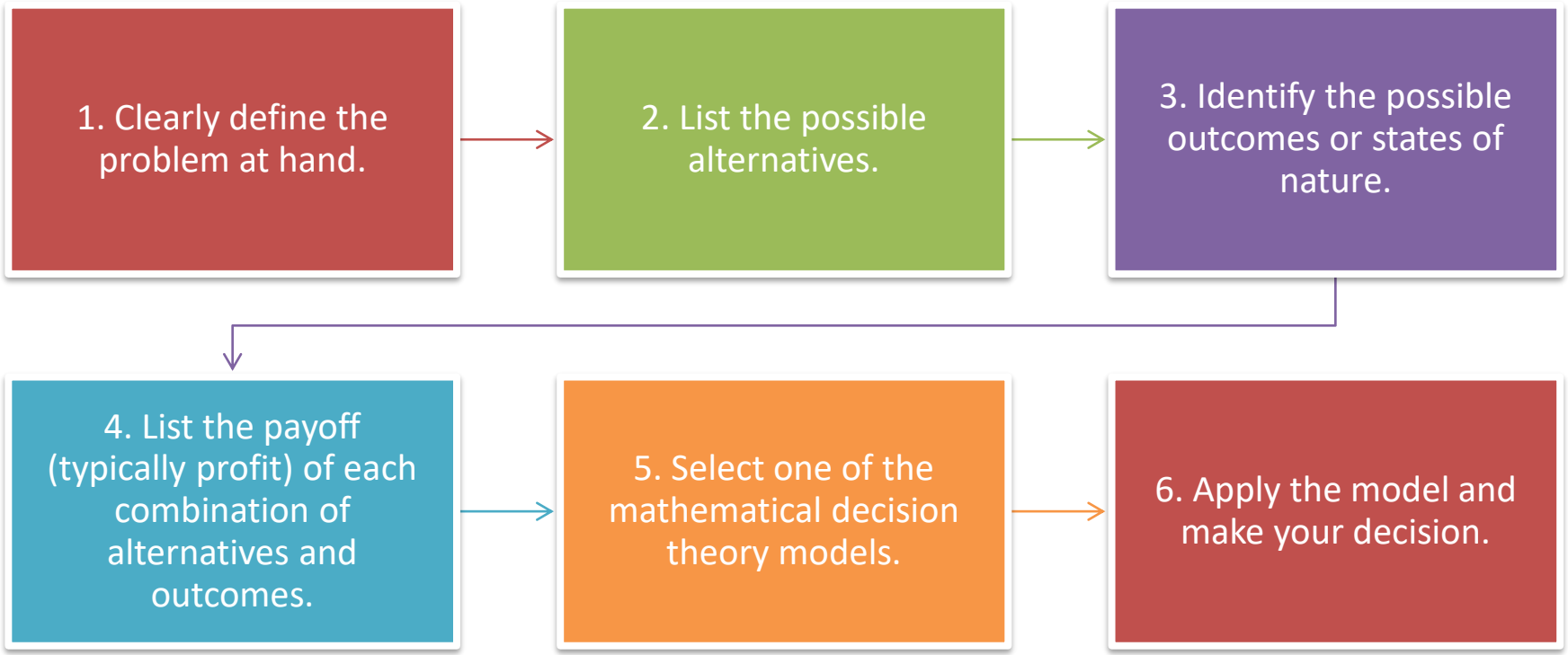
DECISION MAKING THEORY

Week 10

Decision Analysis

Decision Tree

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.

Payoff Table

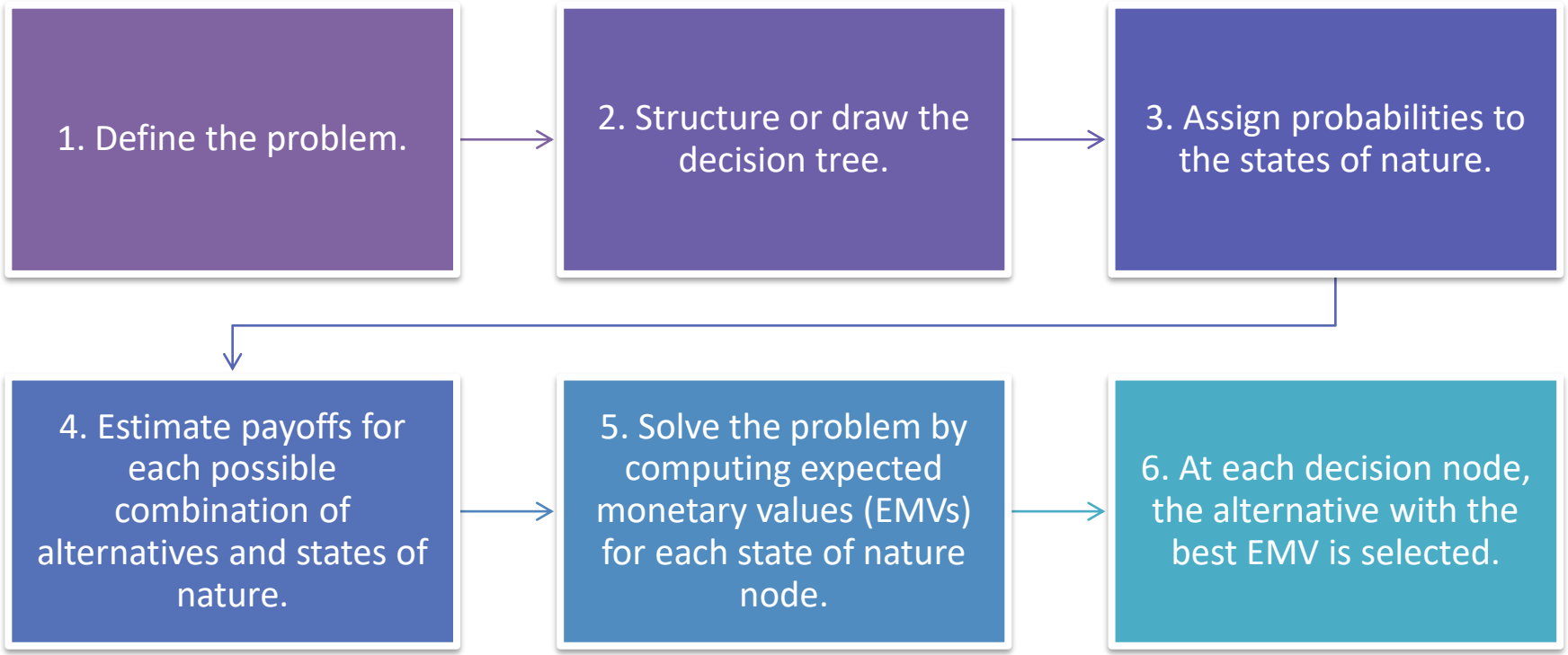
	STATE OF NATURE	
ALTERNATIVE	**FAVORABLE MARKET ($)**	**UNFAVORABLE MARKET ($)**
Construct a large plant	200,000	-180,000
Construct a small plant	100,000	-20,000
Do nothing	0	0
Probabilities	0.50	0.50

Next Steps

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

Decision Table
or
Decision Tree?

Steps of Decision Tree Analysis



Decision Tree

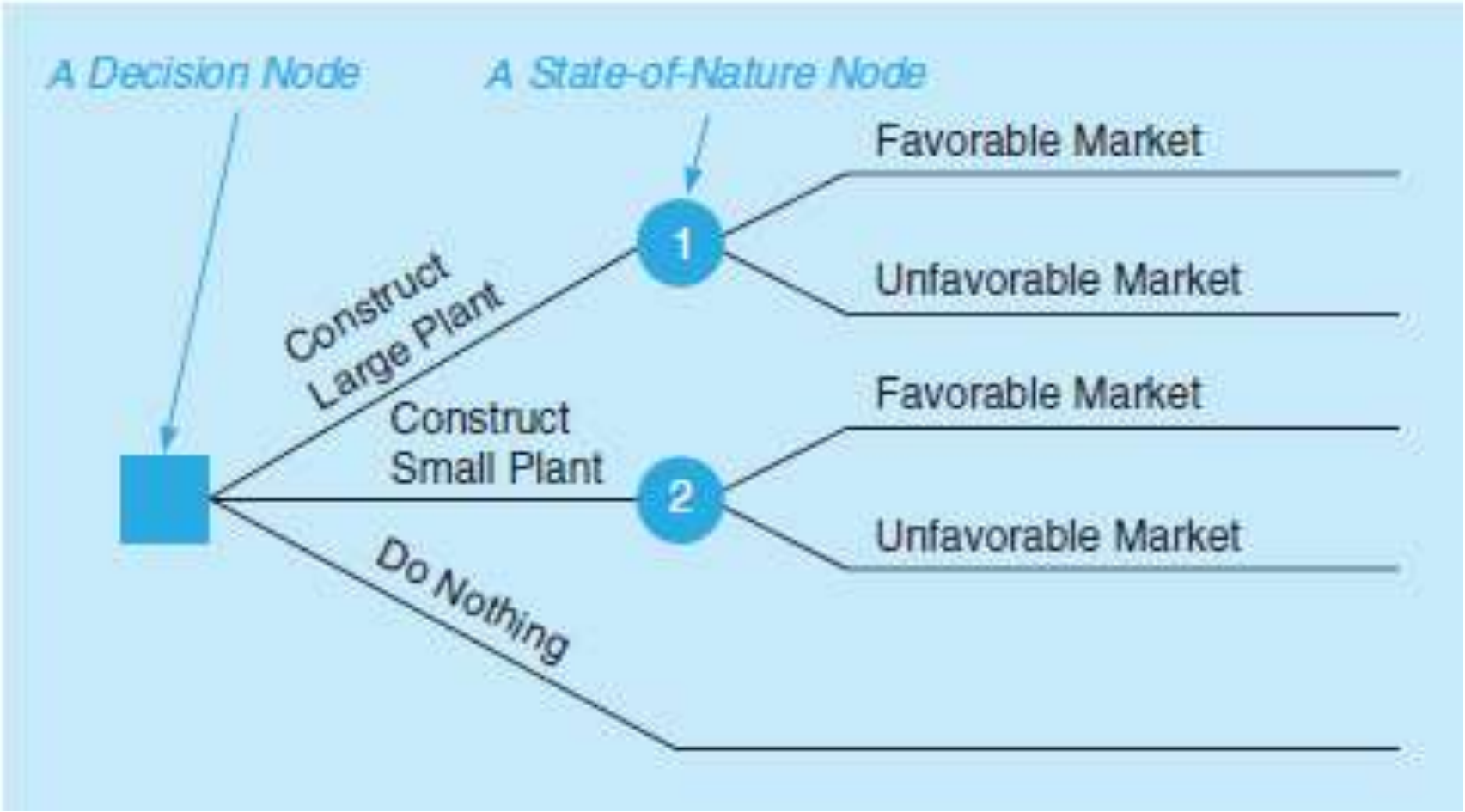
- Decision Node

  → When decision need to be made

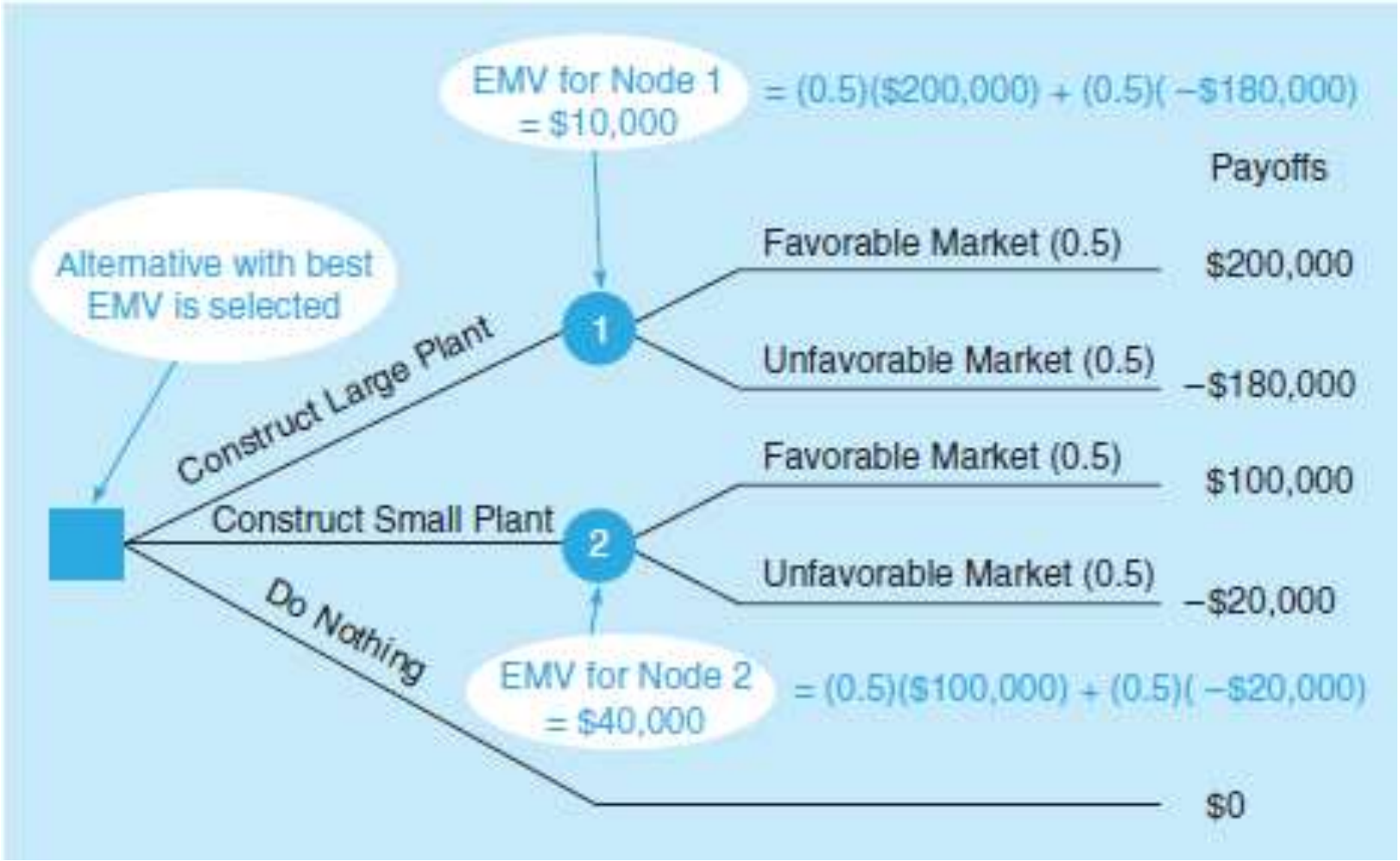
- State-of-Nature Node

  → Uncontrollable condition that can happen

The Decision Tree

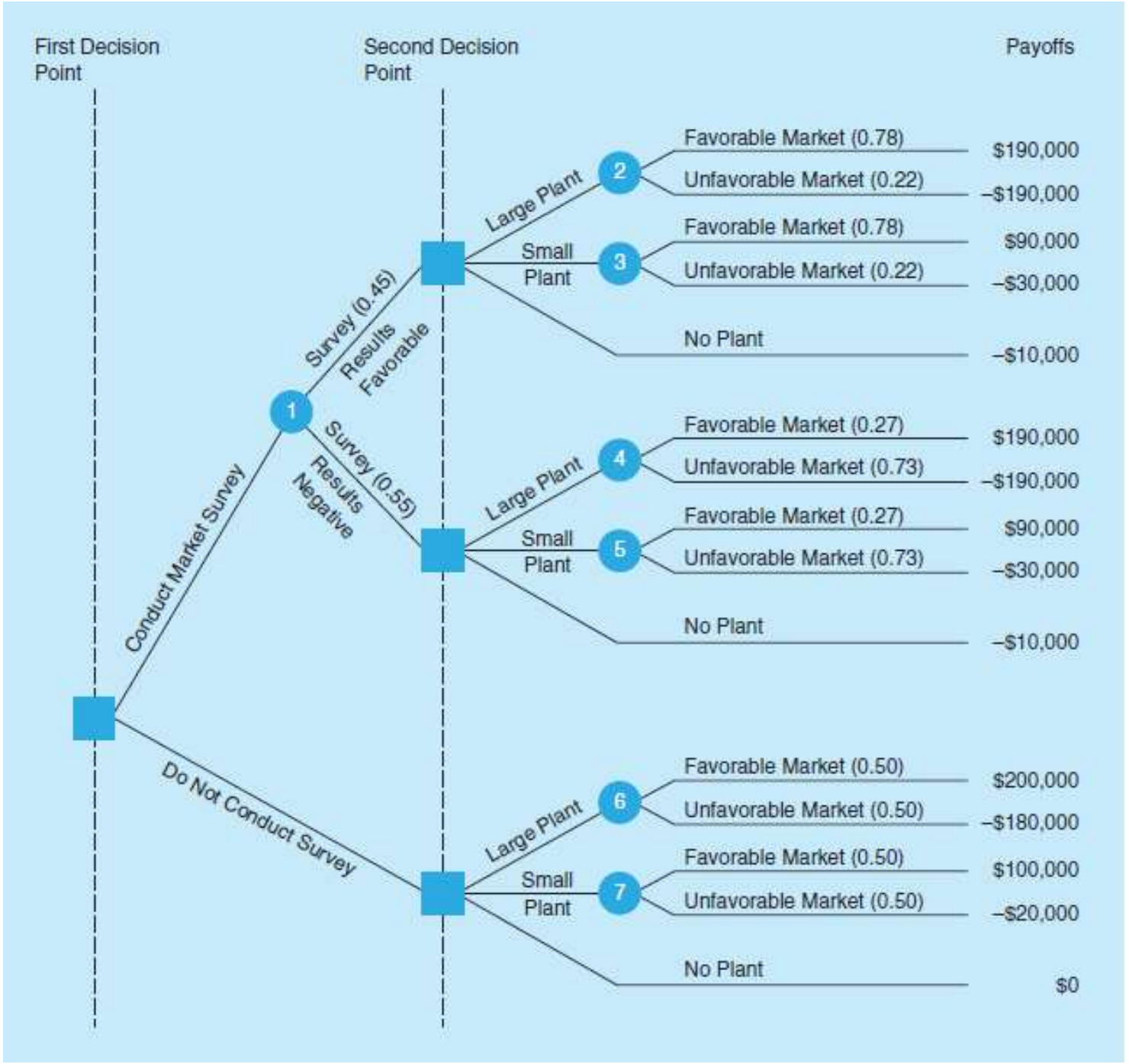


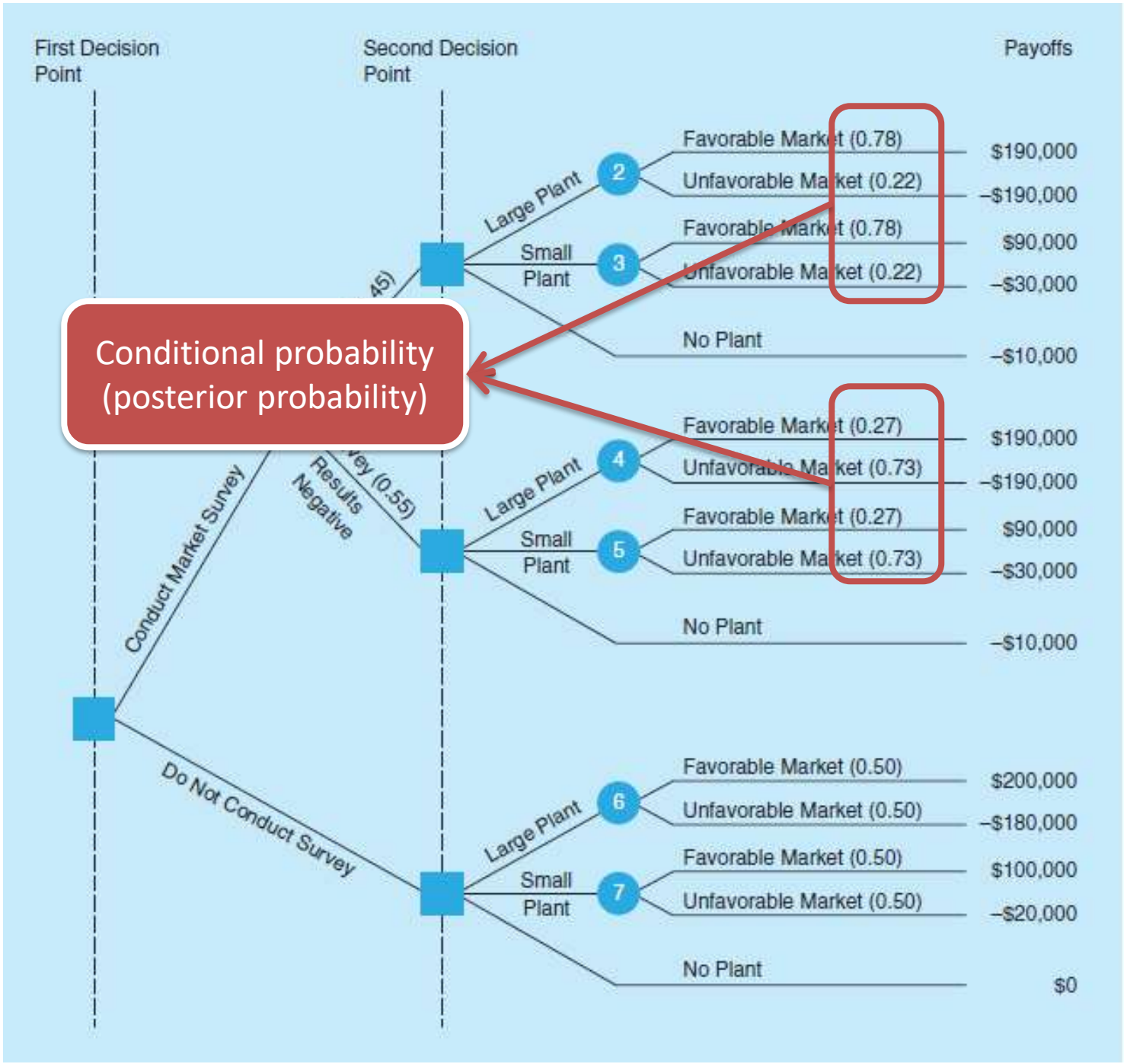
Computing EMV



Sequential Decisions

- When **sequential decisions** need to be made, decision trees are much more powerful tools than decision tables.
- Before deciding about building a new plant, John has the option of conducting his own marketing research survey, at a cost of $10,000.
- The information from his survey could help him decide whether to construct a large plant, a small plant, or not to build at all.
- John recognizes that such a market survey will not provide him with *perfect information,* but it may help quite a bit nevertheless.


First Decision Point
Second Decision Point
Payoffs
Conduct Market Survey
Do Not Conduct Survey
Survey (0.45) Results Favorable
Survey (0.55) Results Negative
1
2
3
4
5
6
7
Large Plant
Small Plant
No Plant
Favorable Market (0.78)
Unfavorable Market (0.22)
Favorable Market (0.27)
Unfavorable Market (0.73)
Favorable Market (0.50)
Unfavorable Market (0.50)
$190,000
–$190,000
$90,000
–$30,000
–$10,000
$200,000
–$180,000
$100,000
–$20,000
$0


First Decision Point
Second Decision Point
Payoffs
Conditional probability (posterior probability)
Conduct Market Survey
Do Not Conduct Survey
Results Negative
Large Plant
Small Plant
No Plant
2
3
4
5
6
7
Favorable Market (0.78)
Unfavorable Market (0.22)
Favorable Market (0.27)
Unfavorable Market (0.73)
Favorable Market (0.50)
Unfavorable Market (0.50)
$190,000
–$190,000
$90,000
–$30,000
–$10,000
$200,000
–$180,000
$100,000
–$20,000
$0

Conditional Probabilities

RESULT OF SURVEY	STATE OF NATURE: FAVORABLE MARKET (FM)	STATE OF NATURE: UNFAVORABLE MARKET (UM)
Positive (predicts favorable market for product)	$P(\text{survey positive} \mid \text{FM}) = 0.70$	$P(\text{survey positive} \mid \text{UM}) = 0.20$
Negative (predicts unfavorable market for product)	$P(\text{survey negative} \mid \text{FM}) = 0.30$	$P(\text{survey negative} \mid \text{UM}) = 0.80$

Conditional Probability:

P(A|B) = P(A and B) / P(B)

Bayes Theorem

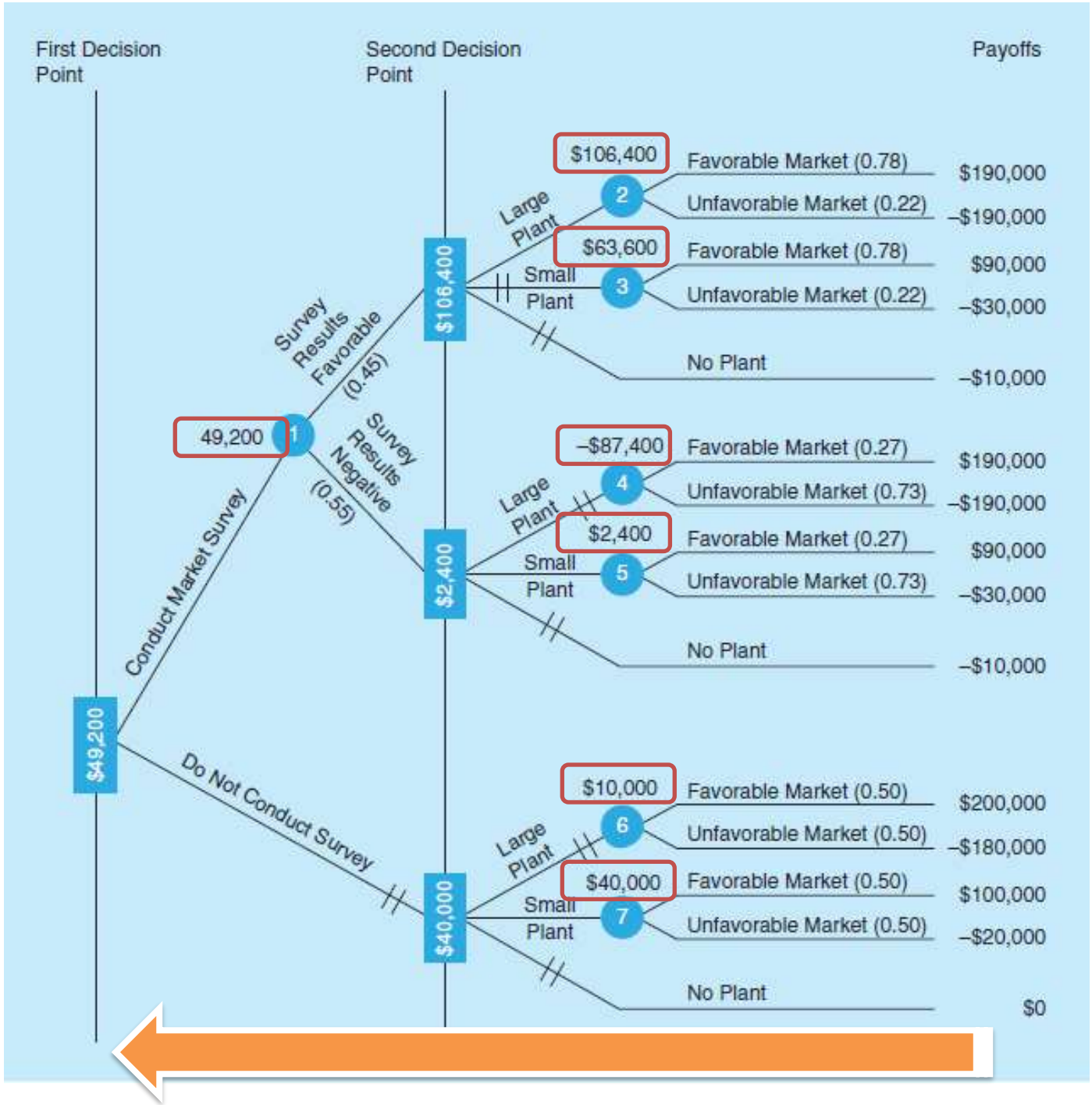
$$P(A|B) = \frac{P(B|A)P(A)}{P(B|A)P(A) + P(B|A')P(A')}$$

- P(FM) = 0.5
- P(UM) = 0.5

Bayes Theorem

STATE OF NATURE	CONDITIONAL PROBABILITY *P*(SURVEY POSITIVE | STATE OF NATURE)	PRIOR PROBABILITY	POSTERIOR PROBABILITY: JOINT PROBABILITY	POSTERIOR PROBABILITY: P(STATE OF NATURE | SURVEY POSITIVE)
FM	0.70	×0.50	= 0.35	0.35/0.45 = 0.78
UM	0.20	×0.50	= 0.10	0.10/0.45 = 0.22
			P(survey results positive) = 0.45	1.00

STATE OF NATURE	CONDITIONAL PROBABILITY *P*(SURVEY NEGATIVE | STATE OF NATURE)	PRIOR PROBABILITY	POSTERIOR PROBABILITY: JOINT PROBABILITY	POSTERIOR PROBABILITY: *P*(STATE OF NATURE | SURVEY NEGATIVE)
FM	0.30	×0.50	= 0.15	0.15/0.55 = 0.27
UM	0.80	×0.50	= 0.40	0.40/0.55 = 0.73
			P(survey results negative) = 0.55	1.00


First Decision Point
Second Decision Point
Payoffs
$49,200
Conduct Market Survey
Do Not Conduct Survey
49,200
1
Survey Results Favorable (0.45)
Survey Results Negative (0.55)
$106,400
$2,400
$40,000
Large Plant
Small Plant
No Plant
$106,400
2
Favorable Market (0.78)
$190,000
Unfavorable Market (0.22)
–$190,000
$63,600
3
Favorable Market (0.78)
$90,000
Unfavorable Market (0.22)
–$30,000
–$10,000
–$87,400
4
Favorable Market (0.27)
$190,000
Unfavorable Market (0.73)
–$190,000
$2,400
5
Favorable Market (0.27)
$90,000
Unfavorable Market (0.73)
–$30,000
–$10,000
$10,000
6
Favorable Market (0.50)
$200,000
Unfavorable Market (0.50)
–$180,000
$40,000
7
Favorable Market (0.50)
$100,000
Unfavorable Market (0.50)
–$20,000
$0

Expected Value Of Sample Information

EVSI = (EV with SI + cost) – (EV without SI)

- **EVSI** = expected value of sample information
- **EV with SI** = expected value with sample information
- **EV without SI** = expected value without sample information

Expected Value Of Sample Information

- **EV with SI** (conduct market survey)
  = $49,200
- **EV without SI** (do not conduct survey)
  = $40,000
- **Cost = $10,000**
- **EVSI** **=** ($49,200 + $10,000) - $40,000
  = $59,200 - $40,000
  = $19,200

Efficiency of Sample Information

Efficiency of sample information =
(EVSI / EVPI) 100%

- Efficiency of sample information

  = (19,200 / 60,000) 100%

  = 32%

EXERCISE

3-41

A financial advisor has recommended two possible mutual funds for investment: Fund A and Fund B. The return that will be achieved by each of these depends on whether the economy is good, fair, or poor. A payoff table has been constructed to illustrate this situation:

3-41

	STATE OF NATURE		
INVESTATION	**GOOD ECONOMY**	**FAIR ECONOMY**	**POOR ECONOMY**
Fund A	$10.000	$2.000	-$5.000
Fund B	$6.000	$4.000	0
Probability	0,2	0,3	0,5

a) Draw the decision tree to represent this situation.
b) Perform the necessary calculations to determine which of the two mutual funds is better. Which one should you choose to maximize the expected value?

3.34

A group of medical professionals is considering the construction of a private clinic. If the medical demand is high (i.e., there is a favorable market for the clinic), the physicians could realize a net profit of $100,000. If the market is not favorable, they could lose $40,000. Of course, they don't have to proceed at all, in which case there is no cost. In the absence of any market data, the best the physicians can guess is that there is a 50–50 chance the clinic will be successful. Construct a decision tree to help analyze this problem. What should the medical professionals do?

3.35

The physicians in Problem 3-34 have been approached by a market research firm that offers to perform a study of the market at a fee of $5,000. The market researchers claim their experience enables them to use Bayes' theorem to make the following statements of probability:

3.35

- probability of a favorable market given a favorable study = 0.82
- probability of an unfavorable market given a favorable study = 0.18
- probability of a favorable market given an unfavorable study = 0.11
- probability of an unfavorable market given an unfavorable study = 0.89
- probability of a favorable research study = 0.55
- probability of an unfavorable research study = 0.45

3.35

a. Develop a new decision tree for the medical professionals to reflect the options now open with the market study.
b. Use the EMV approach to recommend a strategy

THANK YOU