



Sankardham Kelavani Mandal's Jashbhai Maganbhai Patel College of Commerce

Program: F.Y. B. Com.

Semester- I

Course: Mathematical and Statistical Techniques-I

Topic: Decision Theory

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Unit - V : Decision Theory



• Decision making situation,

- Decision maker,
- Courses of Action,
- States of Nature,
- Pay-off and Pay-off matrix;

Decision Making Under Uncertainty:

• Maximin,

- Maximax,
- Minimax regret
- and Laplace criteria;
- simple examples to find optimum decision.
 - Formulation of Payoff Matrix.

Decision Tree

Decision Making Under Certainty:

- Expected Monetary Value (EMV);
- Decision Tree;
- Simple Examples based on EMV.
- Expected Opportunity Loss (EOL),
- simple examples based on EOL.

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- Decision Theory is deals with decision making.
- ▶ It provides a formal analytical frame work for decision under conditions of uncertainty.

Decision may be defines as the selection of the action, by the decision maker, which is considered to be the best according to some predetermined standard from amongst the available options.



There are following steps in decision making:

- 1. Identification of all possible outcomes called states of nature or events.
- 2. Identification of all course of action called Acts.
- 3. Determine of payoff functions
- 4. Choosing from among the alternatives, the best possible action on the basis of some criteria.

We use the following terminology:

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- 1. The decision maker: The decision maker may be an individual or group of individuals who is responsible for making the selection of the course of action from a set of possible course of action.
- 2. State of nature: it is also known as Events. State of nature are various possible outcomes or occurrences which are outside the decision maker's control and they determine the level of success for a given act.
- Act: The act are alternative course of action or strategies that are available to the decision maker.
 The decision maker has control over the choice of these acts.



4. Payoff: it measures the net benefits resulting from each combination of state of nature and course of action. The payoff values are known as conditional profit values or conditional economics consequences.

5. Payoff table: A tabular arrangements of payoff values is known as payoff matrix.

Types of decision making environment:



- In decision making problem the decision maker is concerned with choosing from the **available alternative courses of action**, the one that yields best result.
- If the consequences of each choices are known with **certainty**, the decision maker easily make decision.
- But in most of situations the decision maker has to deal with environment where **uncertainty** of outcomes prevails.



The decision making problem can be discussed under the following heads on the basis of their environment:

- 1. Decision making under certainty
- 2. Decision making under uncertainty
- 3. Decision making under risk
- 4. Decision making under conflict.



• Decision making under certainty:

In this case decision maker has the complete knowledge of the consequences of every alternatives or decision choices.

Decision maker presumes that only one state of nature is relevant for this purpose.

• Decision making under uncertainty:

In this case decision maker faces multiple states of nature but has no means to arrive at the probability values to the likelihood of occurrences of these state of nature.

Such situation is arise when some new product is introduced in the market or a new plant is set up.

• In absence of knowledge about probability of any state of nature, the decision maker can arrive at a decision only on the actual conditional payoff values.



We shall discussed the following criteria that are available for **decision making under uncertainty:**

- 1. Maximax (optimistic) criterion
- 2. Maximin (pessimistic) criterion
- 3. Minimax Regret Criterion
- 4. Laplace criterion (criterion of equally likelihood)

Q.1) the following matrix gives the payoff in rupees of different strategies (acts) A1, A2, A3 against different events S1, S2, S3, S4:

Acts Strategy	State of Nature (Events)							
	S1	S2	S3	S4				
A1	8000	-500	10000	15000				
A2	12000	7000	500	0				
A3	13000	10000	-1000	2000				

What decision can be taken using

- a) Maximax Criterion
- b) Maximin Criterion
- c) Minimax Regret Criterion
- d) Laplace Criterion

a) By Maximax Criterion



Acts	State of	Nature (Ev	vents)		Max	(Max(Max)	Acts
Strategy	S1	S2	S3	S4			
A1	8000	-500	10000	15000	15000	15000	A1
A2	12000	7000	500	0	12000		
A3	13000	10000	-1000	2000	13000		

Therefore best course of action is A1 on the basis of Maximax criterion

a) By Maximin Criterion



Acts	State of	Nature (I	Events)	Min	(Max(Min)	Acts	
Strat egy	S1	S2	S3	S4			
A1	8000	-500	10000	15000	-500	0	A2
A2	12000	7000	500	0	0		
A3	13000	10000	-1000	2000	-1000		

Therefore best course of action is A2 on the basis of Maximin criterion

a) By Minimax Regret Criterion

Acts	State of	State of Nature (Events)							
Strat egy	S1	S2	S 3	S4					
A1	8000	-500	10000	15000					
A2	12000	7000	500	0					
A3	13000	10000	-1000	2000					

Regret (opportunity loss)Table

Acts Strategy	State of Nature (Event	State of Nature (Events)								
	S1	S2	S3	S4						
A1	13000-8000 = 5000	10000- (-500)= 10500	10000-10000= 0	15000 -15000= 0						
A2	13000-12000= 1000	10000-7000= 3000	10000-500= 9500	15000-0= 15000						
A3	13000-13000= 0	10000-10000= 0	10000(-1000)= 11000	15000-2000 = 13000						



Regret (opportunity loss)Table

Acts	State of Na	ture (Events	5)		Max	Min(Max)	Decision
Strategy	S1	S2	S3	S4			
A1	5000	10500	0	0	10500	10500	A1
A2	1000	3000	9500	15000	15000		
A3	0	100	11000	13000	13000		

Therefore best course of action is A1 on the basis of Minimax Regret criterion

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Laplace Criterion



Acts	State of	Nature (Ev	ents)		Average		Max(Average)
Strategy	S1	S2	S3	S4			
A1	8000	-500	10000	15000	(8000-500+10000+15000)/4 =	8125	8125
A2	12000	7000	500	0	(12000+7000+500+0)/4=	4875	
A3	13000	10000	-1000	2000	(13000+10000-1000+2000)/4=	6000	

Therefore best course of action is A1 on the basis of Laplace criterion



Q.2) A farmer wants to decides which of three crops he should plant on his 100 Acre firm. The profit from each is dependent on the rainfall during the growing season. The farmer has categorized the amount of rainfall as high, medium, low. His estimated profit for each is shows in the table.

Rainfall	СгорА	СгорВ	CropC
Low	8000	3500	5000
Medium	4500	4500	5000
High	2000	5000	4000

If the farmer wishes to plant only one crop, decide which will be his choices using the following criterion

- a) Maximax Criterion
- b) Maximin Criterion
- c) Minimax Regret Criterion
- d) Laplace Criterion



a) Maximax Criterion

	Action \rightarrow	CropA	CropB	CropC
ature	S 1	8000	3500	5000
e of na	S2	4500	4500	5000
State	S 3	2000	5000	4000
	Max	8000	5000	5000
	Max(max)	Max(max) 8000		
	Action	Crop A		

Therefore farmer will plant Crop A on the basis of maximax criterion



b) Maximin Criterion

Rainfall	Low	Medium	High	Min	Max(Min)	Action
Crop A	8000	4500	2000	2000		
Crop B	3500	4500	5000	3500		
Crop C	5000	5000	4000	4000	4000	Crop C

Therefore farmer will plant Crop C on the basis of maximin criterion



c) Minimax Regret Criterion

Acts	State of	Nature (Event	s)
	Low	Medium	High
Crop A	8000	4500	2000
Crop B	3500	4500	5000
Crop C	5000	5000	4000

Acts	State of Nature (Events)								
	Low			Medium		High			
Crop A	8000- 8000=	0		5000 - 4500 =	500	5000 -2000=	3000		
Crop B	8000 -3500 =	4500		5000 - 4500 =	500	5000 - 5000=	0		
Crop C	8000 - 5000 =	3000		5000 -5000 =	0	5000 - 4000 =	1000		

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Acts	State of Nature (Events)		Max	Min(Max)	Decision	
	Low	Medium	High			
Crop A	0	500	3000	3000	3000	Crop A
Crop B	4500	500	0	4500		
Crop C	3000	0	1000	3000	3000	Crop C

Therefore farmer will plant Crop A, or C on the basis of Minimax Regret criterion



Q.3) The following table is payoff of four alternative plans under each of five possible states of nature:

Acts	State of nature				
	S1	S2	S 3	S4	
Р	36	24	15	24	
Q	24	18	10	30	
R	28	19	28	30	
S	20	32	35	40	

Find the best course of action on the following criterion

- a) Maximax Criterion
- b) Maximin Criterion
- c) Minimax Regret Criterion
- d) Laplace Criterion

Expected Monetary Value (EMV)



For the give information find best course of action by using EMV criterion

Acts/ State of nature	S1	S2	S3
А	10	5	-20
В	15	10	5
С	10	20	30
Prob.	0.4	0.3	0.3

EMV(A) = 10*0.4 + 5*0.3 + (-20)*0.3 = -0.5

EMV(B) = 15*0.4 + 10*0.3 + 5*0.3 = 10.5

EMV(C) = 10*0.4 + 20*0.3 + 30*0.3 = 19

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Max(EMV(A), EMV(B), EMV(C) = 19
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Therefore on the basis of EMV criterion the best course of action is Act C



For the give information find best course of action by using EMV criterion

Acts/ State of nature	S1	S2	S3
Р	10	50	-30
Q	-20	10	50
R	40	20	30
Prob.	0.2	0.3	0.5

EMV(P) = 10*0.2 + 50*0.3 + (-30)*0.5 = 2

EMV(Q) = (-20)*0.2 + 10*0.3 + 50*0.5 = 24

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EMV(R) = 40*0.2 + 20*0.3 + 30*0.5 = 29
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Max(EMV(P), EMV(Q), EMV(R) = 29
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Therefore on the basis of EMV criterion the best course of action is Act R

For the give information find best course of action by using EOL criterion

Acts/ State of nature	S1	S2	S3
А	10	5	-20
В	15	10	5
С	10	20	30
Prob.	0.4	0.3	0.3

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Acts/ State of nature	S1	S2	S3
А	10	5	-20
В	15	10	5
С	10	20	30
Prob.	0.4	0.3	0.3

To construct Regret table



To construct Regret table

Acts/ State of nature	S1	S2	S3
А	15-10=5	20-5=15	30-(-20)=50
В	15-15=0	20-10=10	30-5=25
С	15-10=5	20-20=0	30-30=0
Prob.	0.4	0.3	0.3

Regret table (Opportunity Loss Table)

Acts/ State of nature	S1	S2	S3
А	5	15	50
В	0	10	25
С	5	0	0
Prob.	0.4	0.3	0.3

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Regret table (Opportunity Loss Table)						
Acts/ State	S 1	52	53			

of nature	51	52	53
А	5	15	50
В	0	10	25
С	5	0	0
Prob.	0.4	0.3	0.3

EOL(A) = 5*0.4 + 15*0.3 + 50*0.3 = **21.5**

EOL(B) = 0*0.4 + 10*0.3 + 25*0.3 = 10.5

EOL(C) = 5*0.4 + 0*0.3 + 0*0.3 = 2

MIN(EOL(A), EOL(B), EOL(C) = 2

Therefore on the basis of EOL criterion the best course of action is Act C

For the give information find best course of action by using EOL criterion



Alternatives/ Economy	Growing	Stable	Declining
Bonds	35	30	20
Stocks	40	25	10
Mutual Funds	30	30	18
Prob.	0.2	0.5	0.3

Identify the maximum value of state of nature(here economy)

Alternatives/ Economy	Growing	Stable	Declining
Bonds	35	30	20
Stocks	40	25	10
Mutual Funds	30	30	18
Prob.	0.2	0.5	0.3

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Regret Table or Expected Opportunity Loss table (EOL Table))
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Alternatives/ Economy	Growing	Stable	Declining
Bonds	5	0	0
Stocks	0	5	10
Mutual Funds	10	0	2
Prob.	0.2	0.5	0.3

EOL(Bonds) = 5*0.2 + 0*0.5 + 0*0.3 = 1

EOL(Stocks) = 0*0.2 + 5*0.5 + 10*0.3 = 5.5

EOL(Mutual Funds) = 10*0.2 + 0*0.5 + 2*0.3 = 2.6

Min(EOL(Bonds), EOL(Stocks), EOL(Mutual Funds)) = 1

Therefore on the basis of EOL criterion the best course of action is Act Bonds

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