DECISION-MAKING UNDER **UNCERTAINTY** AND **RISK**

Business Decision Making

Nikola Kadoić

FACULTY OF **ORGANIZATION** AND **INFORMATICS**

AGENDA

- 2 groups of decision-making methods
- Matrix of the payment
- Basic methods for decision making under uncertainty and risks

2 GROUPS OF DECISION-MAKING METHODS

Multiple criteria DM methods

Table of decision making

- Alternatives
- Criteria
- Consequences (Values)

An example od DM problem

	Work experience	Education	Interview
P1	3 years	High	5
P2	5 years	Secondary	6
P3	No exp	High	7

Methods:

- Ranking, evenswaps, Electra, Promethee, Topsis, AHP, ANP, SAW (pairwise comparisons), Dex…

DM under uncertanty and risks

Table of payments

- Alternatives
- Events (and probabilities)
- Payments

An example of DM problem

	It's raining	It isn't raining
Take the umbrella	☺	☹
Do not take the umbrella	☹	☺

Methods:

- Laplace, Savage, Expected value, Waldo, Hurvisz, Decision tree…

MATRIX OF PAYMENT

~~MAIN LEVELS OF THINKING~~

RISKS ⇒ prob. are known

UNCERTAINTY ⇒ prob. are NOT known

- A - Alternatives
- V - Payments
- S - Events and probabilities

M_2

	S1	S2	S3	...	Sn
A1	V11	V12	V13	...	V1n
A2	V21	V22	V23	...	V2n
A3	V31	V32	V33	...	V3n
...	...	...	...	...	...
Am	Vm1	Vm2	Vm3	...	Vmn

M1

PROFIT

LOSSES

BASIC METHODS: UNCERTAINTY AND RISKS

- Theoretical methods (uncertainty)
  - Max-max (Optimistic approach, Risking approach)
  - Max-min (Pesimistic approach, Wald criterion, safe-player)
  - Hurwicz criterion of the realism
  - Savage regret criterion
- Practical methods (risk)
  - Laplace criterion
  - Expected value criterion
  - Decision-making tree

BASIC METHODS: UNCERTAINTY AND RISKS

- **EXAMPLE:** Company X considers its expansion. There are several possible ways of the expansion. Also, one of the alternatives is status quo – not to do anything. There are three possible events in terms of the market behaviour: expansion, stagnation and recesion. In the matrix of the payment, there are the payments (profits and losses) that will be achieved if the company selects some option and any of the events appears (in thousands of euros)

	Expansion	Stagnation	Recesion
	0,1	0,5	0,4
Big company	200	50	-120
Medium-sized c.	90	120	-30
Small company	40	30	20
Status quo	0	0	0

$H_i = \alpha \cdot max_i + (1-\alpha) min_i$

$H_B = 0.4 \cdot 200 + 0.6 \cdot (-120) = 8$

BASIC METHODS: UNCERTAINTY AND RISKS

$\alpha = 0.4$

	Expansion	Stagnation	Recesion	min	max	H
Big company	200	50	-120	-120	200	8
Medium-sized c.	90	120	-30	-30	120	30
Small company	40	30	20	20	40	28
Status quo	0	0	0	0	0	0
HP	200	120	20	SC	BC	MSC

Matrix of **regrets**	Expansion	Stagnation	Recesion	MAX
Big company	0	70	140	140
Medium-sized c.	110	0	50	110
Small company	160	90	0	160
Status quo	200	0	20	200
				MSC

1) Maximin
2) maximax
3) Hurwizs Criterion of realism
α = tendency to take risk
$\alpha \in [0, 1]$
4) Savage regret method

BASIC METHODS: UNCERTAINTY AND RISKS

$CEV_{MSC} = 0.1 \cdot 90 + 0.5 \cdot 120 + 0.4 \cdot (-30) =$

	Expansion	Stagnation	Recesion	Laplace	CEV
	1/3	1/3	1/3		
→	0.1	0.5	0.4		
Big company	200	50	-120	43.3	-3
Medium-sized c.	90	120	-30	60	57
Small company	40	30	20	30	27
Status quo	0	0	0	0	0
				MSC	MSC

$$EV_i = \sum p \cdot V_i$$

expected value

1) Laplace criterion

$Laplace_{MSC} = \frac{1}{3} \cdot 200 + \frac{1}{3} \cdot 50 + \frac{1}{3} \cdot (-120) = 43.3$

2) Criterion of ex. value

$EV_{BC} = 0.1 \cdot 200 + 0.4 \cdot 50 + 0.5 \cdot -120 = (-3$

BASIC METHODS: UNCERTAINTY AND RISKS

	Expansion	Stagnation	Recesion
→	0.1	0.5	0.4
Big company	200	50	-120
Medium-sized c.	90	120	-30
Small company	40	30	20
Status quo	0	0	0

Decision tree - elements

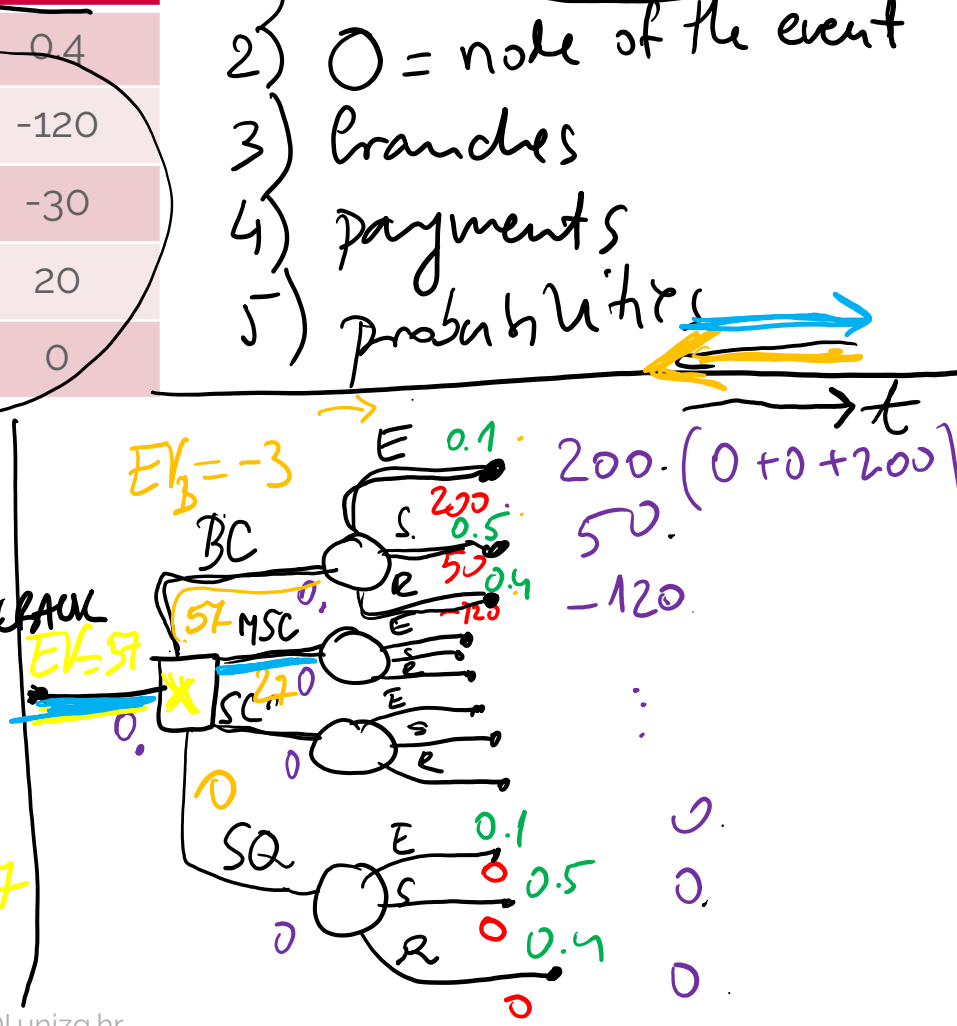
1) □ = node of the decision
2) ○ = node of the event
3) branches
4) payments
5) probabilities

Algorithm: DT

1) Make a tree + calculate the values of the final nodes ← ROLLBACK
2) Calculate EV for each branch
   - final branch ✓
   - the branch that leaves ○ ✓ → EV
   - the branch that leaves □ ✓

$EV = \max\{-3, 57, 27, 0\} = 57$

3) optimal path →



BASIC METHODS: UNCERTAINTY AND RISKS

- **EXAMPLE 2:** Game! Somebody offers you:
  - A: earn 100€ for not to do anything
  - B: you trow the a dice:
    - if you get numbers 1, 2 or 3, you will earn 240 €
    - If you get numbers 4, 5 or 6, you have to pay 3€