Decision Theory

A broad range of concepts which have been developed to both **describe** and **prescribe** the process of decision making, where **a choice is made from a finite set of possible alternatives**. **Normative** decision theory describes how decisions should be made in order to accommodate a set of axioms believed to be desirable; descriptive decision theory deals with how people actually make decisions; and prescriptive decision theory formulates how decisions should be made in realistic settings. Thus, this field of study involves people from various disciplines: behavioral and social scientists and psychologists who generally attempt to discover elaborate descriptive models of the decision process of real humans in real settings; **mathematicians** and **economists** who are concerned with the axiomatic or **normative theory of decisions**; and engineers and managers who may be concerned with sophisticated prescriptive decision-making procedures.

(*http://www.answers.com/topic/decision-theory*)

… Decision Theory

Classification of problems (in *decision theory* may be divided into five *categories*)**:**

1.Decision under certainty issues are those in which each alternative action results in one and only one outcome and where that outcome is sure to occur.
2.Decision under probabilistic uncertainty issues are those in which one of several outcomes can result from a given action depending on the state of nature, and these states occur with known probabilities. There are outcome uncertainties, and the probabilities associated with these are known precisely.
3.Decision under probabilistic imprecision issues are those in which one of several outcomes can result from a given action depending on the **state of nature**, and these states occur with unknown or imprecisely specified probabilities. There are outcome uncertainties, and the probabilities associated with the uncertainty parameters are not all known precisely.
4.Decision under information imperfection issues are those in which one of several outcomes can result from a given action depending on the state of nature, and these states occur with imperfectly specified probabilities. There are outcome uncertainties, and the probabilities associated with these are not all known precisely. **Imperfections in knowledge** of the utility of the various event outcomes may exist as well.
5.Decision under **conflict and cooperation** issues are those in which there is **more than a single decision maker**, and where the objectives and activities of one decision maker are not necessarily known to all decision makers. Also, the objectives of the decision makers may differ.

… Decision Theory

Bases of normative *decision theory*. The general concepts of axiomatic or normative decision theory formalize and rationalize the decision-making process. Normative decision theory depends on the following assumptions:

1. Past preferences are valid indicators of present and future preferences.
2. People correctly perceive the values of the uncertainties that are associated with the outcomes of decision alternatives.
3. People are able to assess decision situations correctly, and the resulting decision situation structural model is well formed and complete.
4. People make decisions that accurately reflect their true preferences over the alternative courses of action, each of which may have uncertain outcomes.
5. People are able to process decision information correctly.
6. Real decision situations provide people with decision alternatives that allow them to express their true preferences.
7. People accept the axioms that are assumed to develop the various normative theories.
8. People make decisions without being so overwhelmed by the complexity of actual decision situations that they would necessarily use suboptimal decision strategies.

Given these necessary assumptions, there will exist departures between normative and descriptive decision theories. A principal task of those aiding others in decision making is to retain those features from the descriptive approach which enable an acceptable transition from normative approaches to prescriptive approaches. The prescriptive features should eliminate potentially undesirable features of descriptive approaches, such as flawed judgment heuristics and information processing biases, while retaining acceptable features of the normative approaches. *See also* Decision analysis; Decision support system.

Determination of utility

When choosing among alternatives, the decision maker must be able to indicate preferences among decisions that may result in diverse outcomes. In simple situations when only money is involved, an expected-value approach might be suggested, in which a larger expected amount of money is preferred to a smaller amount. However, in many situations the utility associated with money is not a linear function of the amount of money involved.

According to expected utility theory, the decision maker should seek to choose the alternative $a_i$which makes the resulting expected utility the largest possible. The utility u_{ij}, of choosing decision a_i and obtaining outcome event e_j, will also depend upon the particular value of the probabilistically uncertain random variable e_j as conditioned on the decision path that is selected. So, the best that the decision maker can do here is to maximize some function, such as the expected value or utility (EU), as shown below, where the maximization is carried out over all alternative decisions, and $P(e_j \mid a_i)$ is the probability that the state of nature is e_j given that alternative a_i is implemented. The notation $\mathrm{EU}\{a_i\}$ is often used to mean the expected utility of taking action a_i. Generally, this is also called the subjective expected utility (SEU). "Subjective" denotes the fact that the probabilities may be based on subjective beliefs and the utilities may reflect personal consequences.

$$\max_i \mathrm{EU}\{a_i\} = \max_i \sum_{j=1}^{n} u_{ij} P(e_i \mid a_i)$$

Systematic approach to making decisions especially under uncertainty. Although statistics such as Expected Value and Standard Deviation are essential for choosing the best course of action, the decision problem can best be approached, using what is referred to as a *payoff table* (or *decision matrix*), which is characterized by: (1) the *row* representing a set of alternative Courses of Action available to the decision maker; (2) the *column* representing the State of Nature or conditions that are likely to occur and over which the decision maker has no control; and (3) the entries in the body of the table representing the outcome of the decision, known as *payoffs*, which may be in the form of costs, revenues, profits, or cash flows. By computing expected value of each action, we will be able to pick the best one.

Example 1: Assume the following probability distribution of daily demand for strawberries:

Daily Demand	0	1	2	3
Probability	0.2	0.3	0.3	0.2

Also assume that unit cost = $3, selling price = $5 (i.e., profit on sold unit = $2), and salvage value on unsold units = $2 (i.e., loss on unsold unit = $1). We can stock either 0, 1, 2, or 3 units. The question is: How many units should be stocked each day? Assume that units from one day cannot be sold the next day. Then the payoff table can be constructed as follows:

	Demand / Stock / Probability	State of Nature				Expected Value
		0	1	2	3	
		0.2	0.3	0.3	0.2	
Actions	0	0	0	0	0	0
	1	-1	2	2	2	1.40
	2	-2	**1***	4	4	**1.90****
	3	-3	0	3	6	1.50

*Profit for (stock 2, demand 1) equals (no. Of units sold) (profit per unit) - (no. Of units unsold)(loss per unit) = (1)($5 - 3) - (1)($3 - 2) = $1

**Expected value for (stock 2) is: -2(.2) + 1(.3) + 4(.3) + 4(.2) = $1.90. The optimal stock action is the one with the highest Expected Monetary Value, i.e., stock 2 units.

Suppose the decision maker can obtain a perfect prediction of which event (state of nature) will occur. The Expected Value With Perfect Information would be the total expected value of actions selected on the assumption of a perfect forecast. Expected value (Expected Value of Perfect Information) with perfect information *minus* the expected value with existing information.

The *p-value* is the probability under the assumption of *null hypothesis*.

Example 2: For two sets (A and B)

Day	1	2	3	4	5	=T.TEST(B3:G3,B4:G4,2,1)
A:	33	35	36	38	39	0.000104521
B:	22	23	22	24	23	

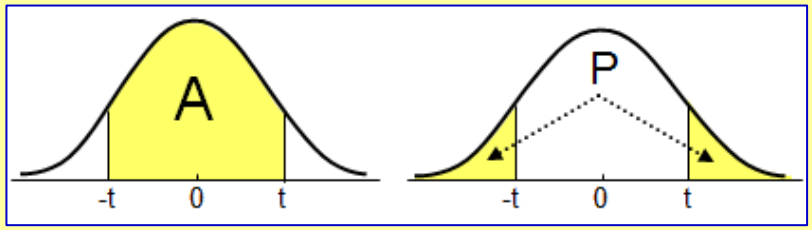
An informal interpretation of a *p*-value, based on a significance level of about 10%, might be:

- $p \leq 0.01$: *very strong presumption* against *null hypothesis*
- $0.01 < p \leq 0.05$: *strong presumption* against *null hypothesis*
- $0.05 < p \leq 0.1$: *low presumption* against *null hypothesis*
- $p > 0.1$: *no presumption* against the *null hypothesis*

t-Test: Paired Two Sample for Means

	A:	*B:*
Mean	36.2	22.8
Variance	5.7	0.7
Observations	5	5
Pearson Correlation	0.650814027	
Hypothesized Mean Difference	0	
df	4	
t Stat	15.37085417	
P(T<=t) one-tail	0.000052260	
t Critical one-tail	2.131846786	
P(T<=t) two-tail	0.000104521	
t Critical two-tail	2.776445105	

Values of the t-distribution (two-tailed):



DF	A	0.8	0.9	0.95	0.98	0.99	0.995	0.998	0.999
	P	0.2	0.1	0.05	0.02	0.01	0.005	0.002	0.001
1		3.078	6.314	12.706	31.82	63.657	127.321	318.309	636.619
2		1.886	2.92	4.303	6.965	9.925	14.089	22.327	31.599
3		1.638	2.353	3.182	4.541	5.841	7.453	10.215	12.924
4		1.533	2.132	2.776	3.747	4.604	5.598	7.173	8.61
5		1.476	2.015	2.571	3.365	4.032	4.773	5.893	6.869
6		1.44	1.943	2.447	3.143	3.707	4.317	5.208	5.959
7		1.415	1.895	2.365	2.998	3.499	4.029	4.785	5.408
8		1.397	1.86	2.306	2.897	3.355	3.833	4.501	5.041
9		1.383	1.833	2.262	2.821	3.25	3.69	4.297	4.781
10		1.372	1.812	2.228	2.764	3.169	3.581	4.144	4.587

t-Test: Paired Two Sample for Means		
	A:	B:
Mean	36.2	22.8
Variance	5.7	0.7
Observations	5	5
Pearson Correlation	0.65081403	
Hypothesized Mean Differe	0	
df	**4**	
t Stat	15.3708542	
P(T<=t) one-tail	5.226E-05	
t Critical one-tail	2.13184679	
P(T<=t) two-tail	0.00010452	
t Critical two-tail	**2.77644511**	

Decision Tree Analysis

(http://www.mindtools.com/dectree.html)

Decision Trees are useful tools for helping you to choose between several courses of action:

- They provide a highly effective structure within which you can explore options, and investigate the possible outcomes of choosing those options.
- They also help you to form a balanced picture of the risks and rewards associated with each possible course of action.
- This makes them particularly useful for choosing between different strategies, projects or investment opportunities, particularly when your resources are limited

… *Decision Tree Analysis*

The ***Decision Tree*** start with the decision that you need to make, drawing a square to represent this on the left hand side.

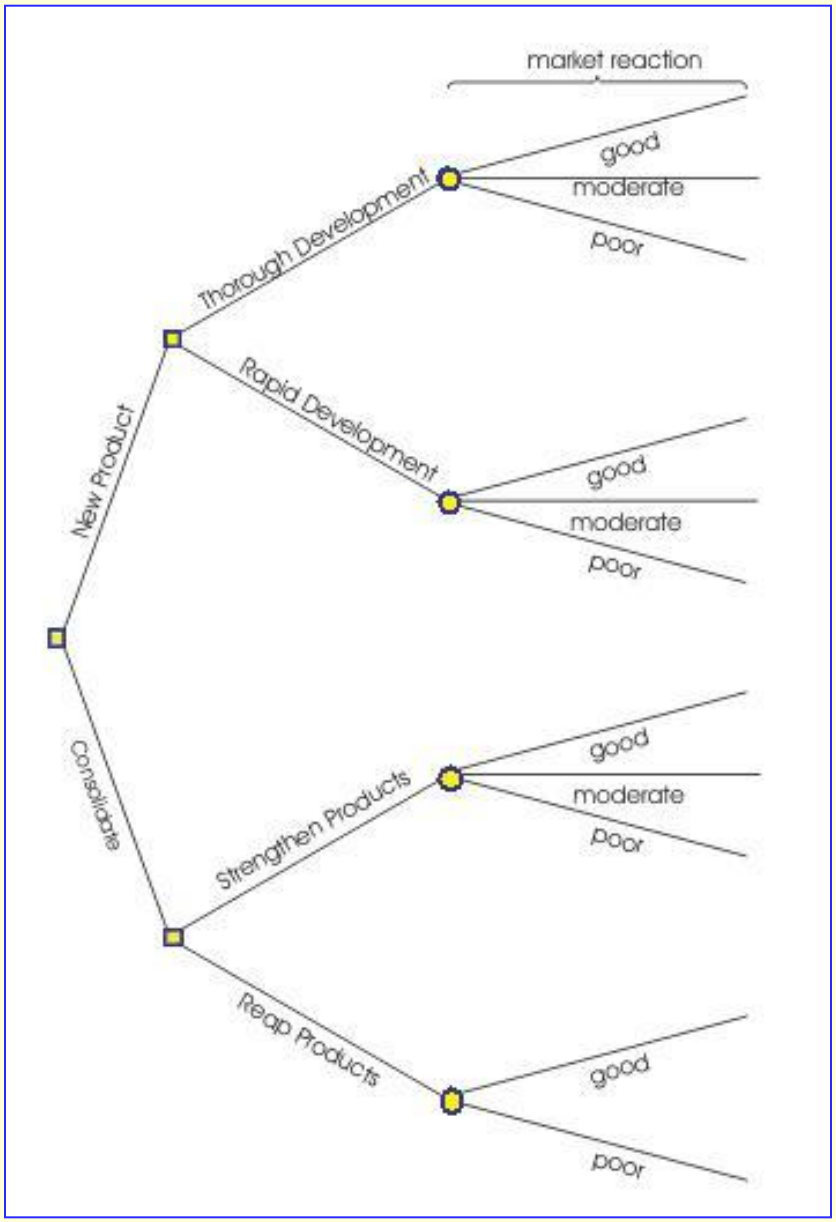
From this box draw out lines towards the right for each possible solution, and write a short description of the solution along the line.

At the end of each line, consider the results. If the result of taking that decision is uncertain, draw a circle. If the result is another decision that you need to make, draw another square (**squares** represent ***decisions***, and **circles** represent ***uncertain outcomes***). Write the decision or factor above the square or circle.

Starting from the new decision squares, draw out lines representing the options that you could select, and so on.

Example ***Decision Tree*** :

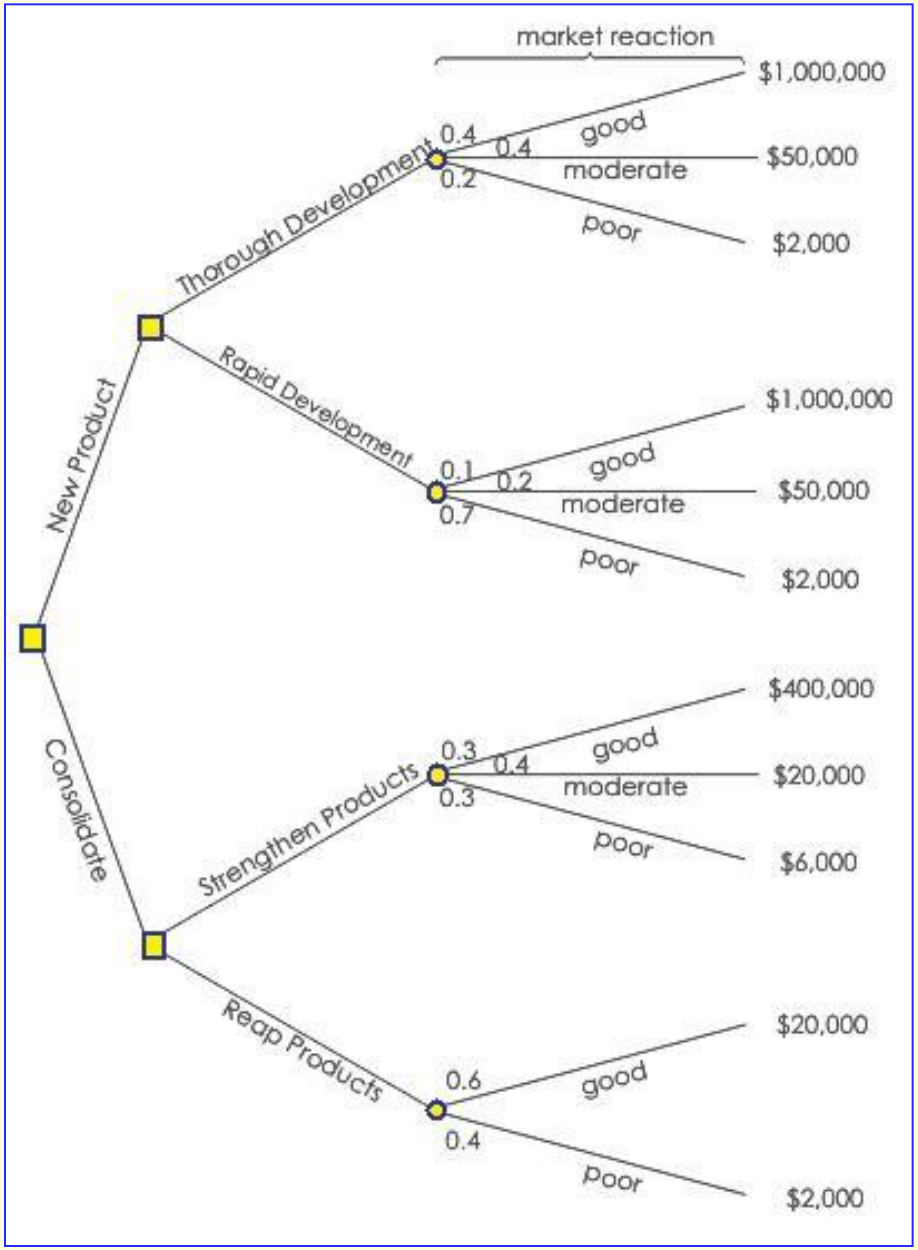
Should we develop a new product or consolidate?



Evaluating the ***Decision Tree***:

- Start by **assigning a *cash value*** or ***score*** to each possible outcome.
- Estimate the probability of each outcome :
  - **percentages** → total = 100% ,
  - **fractions** → total = 1 ,

  at each circle.



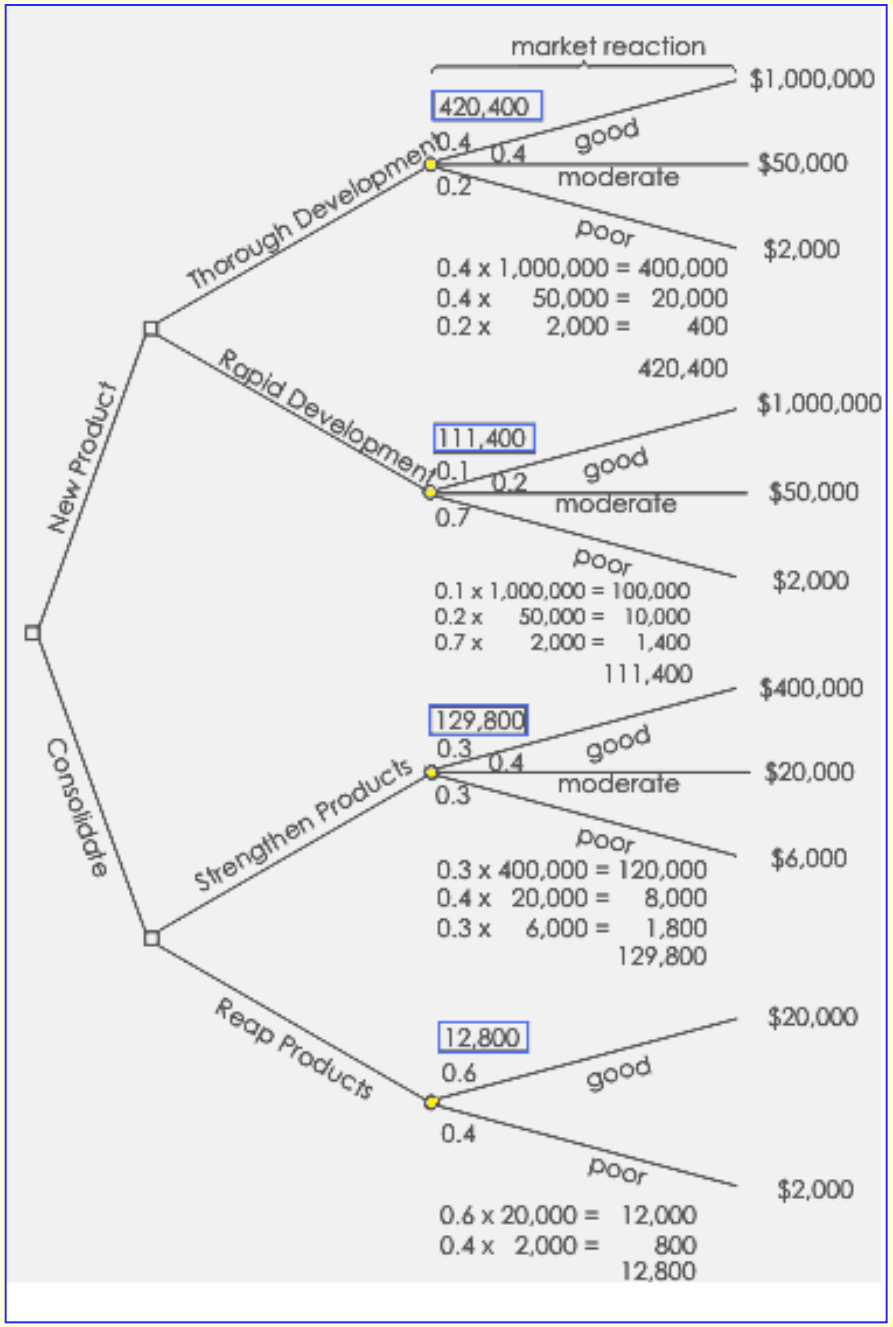
Calculating *Tree Values*:

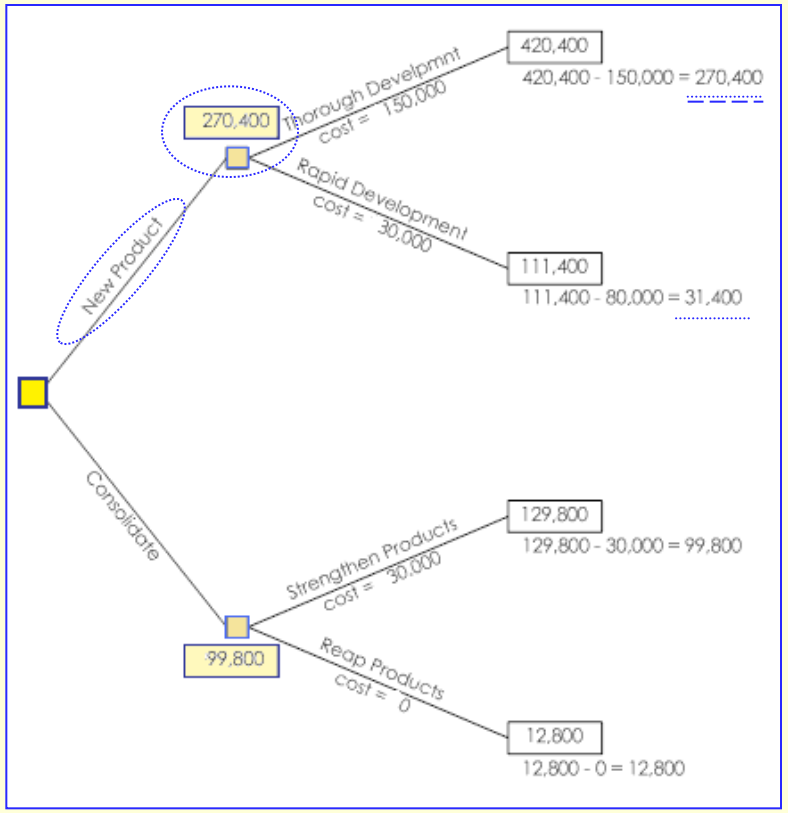
Start on the ***right side*** of the decision tree, and work back towards the ***left***.

As you complete a set of calculations on a node (decision square or uncertainty circle), then record the result.

You can ignore all the calculations that lead to that result from then on.

0.4	1,000,000	400,000
0.4	50,000	20,000
0.2	2,000	400
1	**+**	**420,400**





The benefit calculated for *new product, thorough development* was 420,400. We estimate the future cost of this approach as 150,000. This gives a net benefit of **270,400**. The net benefit of *new product, rapid development* was 31,400. We choose the most valuable option and allocate this value to the decision node.

The best option is to develop ***a new product***. It is worth much more to us to take our time and get the product right, than to rush the product to market. And it's better just to improve our existing products than to botch a new product, even though it costs us less.

Decision trees provide an effective method of decision making because they:

- Clearly lay out the problem so that all options can be challenged.
- Allow us to analyze the possible consequences of a decision fully.
- Provide a framework to quantify the values of outcomes and the probabilities of achieving them.
- Help us to make the best decisions on the basis of existing information and best guesses.

As with all decision making methods, decision tree analysis should be used in conjunction with common sense - decision trees are just one important part of your decision making tool kit.

Teoria Deciziilor

Managerul trebuie sa ia decizii eficiente!

Funcţiile manageriale - *planificarea, organizarea, leadership-ul şi controlul* - implică luarea unor **decizii eficiente**.

- ***La decizii strategice*** se preferă să se recurgă la experienţă şi intuiţie (deciziile executive nu se pretează la abordări *cantitative* deoarece ele sunt caracterizate de aspecte *calitative).*
- ***La decizii tactice*** (***operative***) deciziile se pot programa, cuantificarea fiind posibilă / utilă.

Modelarea matematică permite folosirea *analizei deciziilor* în *procesul decizional* - permite rezolvarea de probleme complexe, în care factorii de incertitudine şi risc sunt luaţi în considerare.

Elementele Teoriei Deciziilor

Decizia ::= acţiunea sau procesul de alegere sau selectare a unei alternative din mai multe posibile.

Rolul *deciziei* ::= rezolvarea unei probleme (de conducere, coordonare, reglare, control sau previziune a activităţilor din aria de competenţă a managerului), prin alegerea (de catre manager) o unei soluţii dintre mai multe variante posibile (de rezolvare a problemei date).

Sistemul decizional este constituit din ansamblul deciziilor de conducere elaborate, adoptate şi aplicate în cadrul instituţii. Activitatea managerilor este o înlănţuire de decizii interdependente.

Componentele unei decizii: decidentul, obiectivele, mulţimea alternativelor decizionale (variantele sau soluţiile posibile), mulţimea criteriilor de decizie şi mulţimea consecinţelor.

… Elementele Teoriei Deciziilor

Variantele decizionale ::= alternativele posibile.

Criteriile stabilesc obiectivele de atins (*profitul* - maxim, *costul* - minim, *cheltuielile* - minime, …

Clasificări ale deciziilor:

- *strategice, tactice şi curente* - timpul pentru care se adoptă;
- *în condiţii de certitudine, de risc şi de incertitudine* - gradul de cunoaştere a datelor de intrare şi consecinţelor;
- *individuale* sau *de grup* – numărul de persoane care participă la luarea deciziei;
- *structurate, semistructurate şi nestructurate* - structura problemei de decizie;
- *unicriteriale şi multicriteriale* - numărul criteriilor de decizie.

Etapele procesului decizional tradiţional:

- *identificarea şi definirea problemei* de rezolvat (deciziei) - *Ce trebuie făcut pentru a rezolva problema?* ;
- *stabilirea obiectivelor* şi *criteriilor decizionale* - Obiectivul sau scopul unui proces decizional este analizat în funcţie de criteriul ales;
- *culegerea informaţiilor* - are ca scop certificarea faptelor relevante şi se poate reduce la o problemă de căutare - informaţiile trebuie să fie exacte, operative şi prezentate sugestiv;
- *construirea variantelor (soluţiilor) posibile* - generarea de alternative realiste posibile ;
- *evaluarea variantelor* şi *alegerea variantei optime* – se compară avantajele şi dezavantajele fiecărei alternative, rezultând variante posibile dintre care se alege varianta optima - cea care satisface cel mai bine criteriile alese;
- *comunicarea* şi *aplicarea (implementarea) deciziei*;
- *controlul* (*urmărirea, monitorizarea*) *aplicării deciziei* şi *evaluarea rezultatelor*.

Analiza deciziilor

Analiza deciziilor ::= o abordare raţională a procesului decizional, foloseşte un **model formal** pentru reprezentarea *alternativelor* şi *criteriilor decizionale* în scopul luării unei decizii optime - când riscul este semnificativ.

Analiza deciziilor permite decidentului să abordeze probleme de decizie caracterizate de incertitudine. Ea construieşte un model normativ pentru reprezentarea problemei de decizie, care uşurează analiza ulterioară a sa şi produce o decizie bazată pe considerente de ordin obiectiv. **Modelul formal** obţinut este capabil să genereze strategii optimale pentru probleme de decizie în mai multe etape.

Analiza deciziilor se bazează pe separarea elementelor controlabile de cele necontrolabile - face distincţie între acţiunile pe care decidentul le poate lua şi circumstanţele care sunt în afara controlului acestuia.

… Analiza deciziilor

Etapele analizei deciziilor:

- *Recunoaşterea problemei* - Problemă **aparentă** (manifestată prin simptome) sau problemă **reală** ? Problemă **pozitivă** sau **negativă**?
- *Definirea problemei* - *elemente **generale** (decidentul, scopul deciziei, restricţiile), elemente **specifice*** (alternativele decizionale, stările naturii, consecinţele, probabilităţile)*
- *Construirea modelului – **prototip** (matricea de decizie / arborele de decizie)* *
- *Culegerea datelor necesare* - constante, parametri şi variabile
- *Execuţia modelului* – efectuare calcule – *reguli de decizie*
- *Analiza rezultatelor obţinute* - stabilirea deciziei (acţiunii prescrise), *analiza sensibilităţii* (de *senzitivitate*)
- *Interpretarea rezultatelor* - determină maxime sau minime bazate pe structura modelului şi ipotezele de lucru
- *Recomandarea căii de urmat* - prezentarea rezultatelor de către analist.

Elementele specifice problemei → structurarea modelului :

- **Alternativele decizionale** (variantele de acţiune: *exclusive* şi *exhaustive*):

$$A = \{A_1, A_2, ..., A_m\}.$$

- **Stările naturii** (situaţii în funcţie de care se analizează fiecare alternativă, *ex.* şi *ex.*) :

$$S = \{S_1, S_2, ..., S_n\}.$$

- **Consecinţele** - măsuri cantitative (numerice) ale alegerii unei alternative A_i combinată cu apariţia unei stări S_j :

$$R = \{r_{ij},\ 1 \le i \le m;\ 1 \le j \le n\}.$$

unde: r_{ij} reprezintă *câştigul net* ($r_{ij} > 0$) sau *pierderea netă* ($r_{ij} < 0$).

- **Probabilităţile** - asociate stărilor S_j ($1 \le j \le n$) caracterizează incertitudinea apariţiei acestora:

$$P = \{p_1, p_2, ..., p_n\}.$$

Construirea modelului → Matricea de decizie :

- **modalitate tabelară** de reprezentare a elementelor problemei de decizie. **Liniile** sale reprezintă alternativele, iar **coloanele** stările:

$$D = \{A, S, R, P\}.$$

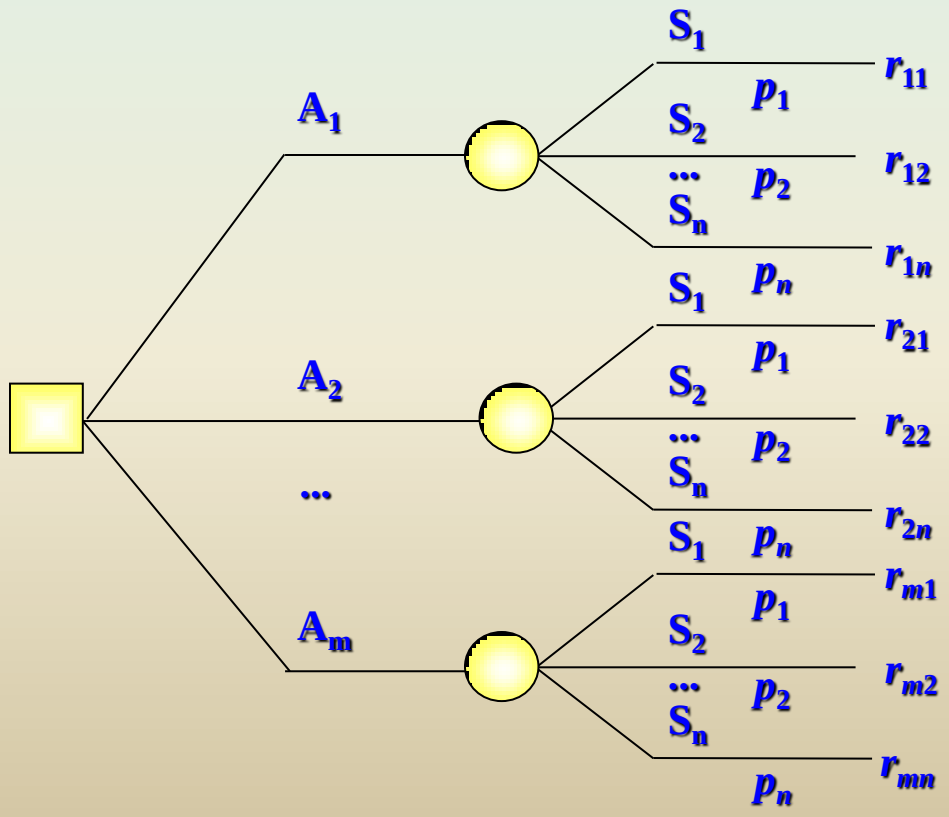
Matricea de decizie				
Alternativele decizionale	Stările naturii			
	p_1	p_2	…	p_n
	S_1	S_2	…	S_n
A_1	r_{11}	r_{12}	…	r_{1n}
A_2	r_{21}	r_{22}	…	r_{2n}
…	…	…	…	…
A_m	r_{m1}	r_{m2}	…	r_{mn}

Construirea modelului → Arborele de decizie :

- **modalitate grafică** de reprezentare a elementelor problemei de decizie.

  Nodurile pot fi de **decizie** (□) sau de **stare** (○) :

$$D = \{A, S, R, P\}.$$



Metode monocriteriale de analiză a deciziilor

1. ***Metode elementare*** (**fără probabilităţi**)
2. ***Metode bazate pe valoarea medie***

O alternativă A_i se numeşte ***dominantă*** pentru A_k dacă $r_{ij} \geq r_{kj}$ pentru toate coloanele j ($1 \leq j \leq n$) - consecinţele pentru alternativa A_i sunt întotdeauna mai bune decât cele pentru A_k, indiferent de starea naturii S_j ($1 \leq j \leq n$).

Reciproc, spunem că alternativa A_k este ***dominată*** de alternativa A_i.

Alternative	Stări – *profituri*		
	S_1	S_2	S_3
A_1	**15**	**3**	**-6**
A_2	**9**	**4**	**-2**
A_3	**3**	**2**	**1**
A_4	**0**	**0**	**0**

Alternativele **dominate** trebuie eliminate din model.

Alternative	Stări – *profituri*		
	S_1	S_2	S_3
A_1	**15**	**3**	**-6**
A_2	**9**	**4**	**-2**
A_3	**3**	**2**	**1**

… Metode elementare (nu folosesc probabilităţile P)

Criteriul optimist - descrie comportamentul decizional al unui optimist atras de câştigurile mai mari, dispus să rişte oricât pentru a le obţine.

Se poate modela cu regula:

- **MAXIMAX** (consecinţele referă ceva pozitiv, iar scopul este **maximizarea**), **MINIMIN** (consecinţele reprezintă ceva negativ, iar scopul este **minimizarea**).

Regula MAXIMAX :

Determină consecinţa maximă $maxiMAX_i$ pentru fiecare alternativă A_i:

$$maxiMAX_i = \mathbf{max}\ \{r_{i1}, r_{i2}, ..., r_{in}\}\ (1 \le i \le m).$$

Dintre consecinţele $maxiMAX=\{maxiMAX_1, maxiMAX_2, ..., maxiMAX_m\}$ se selectează cea mai mare:

$$MAXIMAX_k = \mathbf{max}\ \{maxiMAX_1, maxiMAX_2, ..., maxiMAX_m\}.$$

Alternative	Stări – *profituri*			*maxiMAX*	*MAXIMAX*	*Decizia*
	S_1	S_2	S_3			
A_1	15	3	-6	15	15 [-6]	A_1
A_2	9	4	-2	9		
A_3	3	2	1	3		

… Metode elementare (nu folosesc probabilităţile P)

Criteriul pesimist - descrie comportamentul decizional al unui pesimist speriat de pierderile mari, care ignoră câştigurile atractive cu riscuri mari. Se poate modela cu regula:

- **MAXIMIN** (consecinţele referă ceva pozitiv),
- **MINIMAX** (consecinţele reprezintă ceva negativ).

Regula MAXIMIN :

Determină consecinţa minimă $maxiMIN_i$ pentru fiecare alternativă A_i:

$$maxiMIN_i = \mathbf{min}\ \{r_{i1}, r_{i2}, ..., r_{in}\}\ (1 \le i \le m).$$

Dintre consecinţele $maxiMIN=\{maxiMIN_1, maxiMIN_2, ..., maxiMIN_m\}$ se selectează cea mai mare:

$$MAXIMIN_k = \mathbf{max}\ \{maxiMIN_1, maxiMIN_2, ..., maxiMIN_m\}.$$

Alternative	Stări – *profituri*			*maxiMIN* *miniMAX*	*MAXIMIN* *MINIMAX*	*Decizia*
	S_1	S_2	S_3			
A_1	15	3	-6	-6 [15]		
A_2	9	4	-2	-2 [9]		
A_3	3	2	1	1 [3]	1 [3]	A_3

… Metode elementare (*nu folosesc probabilităţile P*)

Criteriul lui Hurwicz - descrie un comportament aflat între *optimist* şi *pesimist* printr-o combinaţie ponderată a acestora. Pentru fiecare alternativă se se va calcula o combinaţie cu un *coeficient* $0 \le a \le 1$ *de realism* (a=*optimism*, 1-a=*pesimism*) :

$$H(A_i) = \begin{cases} a \cdot maxiMax_i + (1-a) \cdot maxiMin_i & \text{pentru fluxuri pozitive} \\ a \cdot miniMin_i + (1-a) \cdot miniMax_i & \text{pentru fluxuri negative} \end{cases}$$

Regula *Hurwicz* :

- Alege un coeficient de optimism a ;
- Determină consecinţa ponderată $H(A_i)$ pentru fiecare alternativă A_i ;

Dintre consecinţele $H=\{H(A_1), H(A_2), ..., H(A_m)\}$ se selectează cea mai bună astfel:

$$\begin{cases} \textbf{\textit{max}}\ (H) & \text{pentru fluxuri pozitive} \\ \textbf{\textit{min}}\ (H) & \text{pentru fluxuri negative} \end{cases}$$

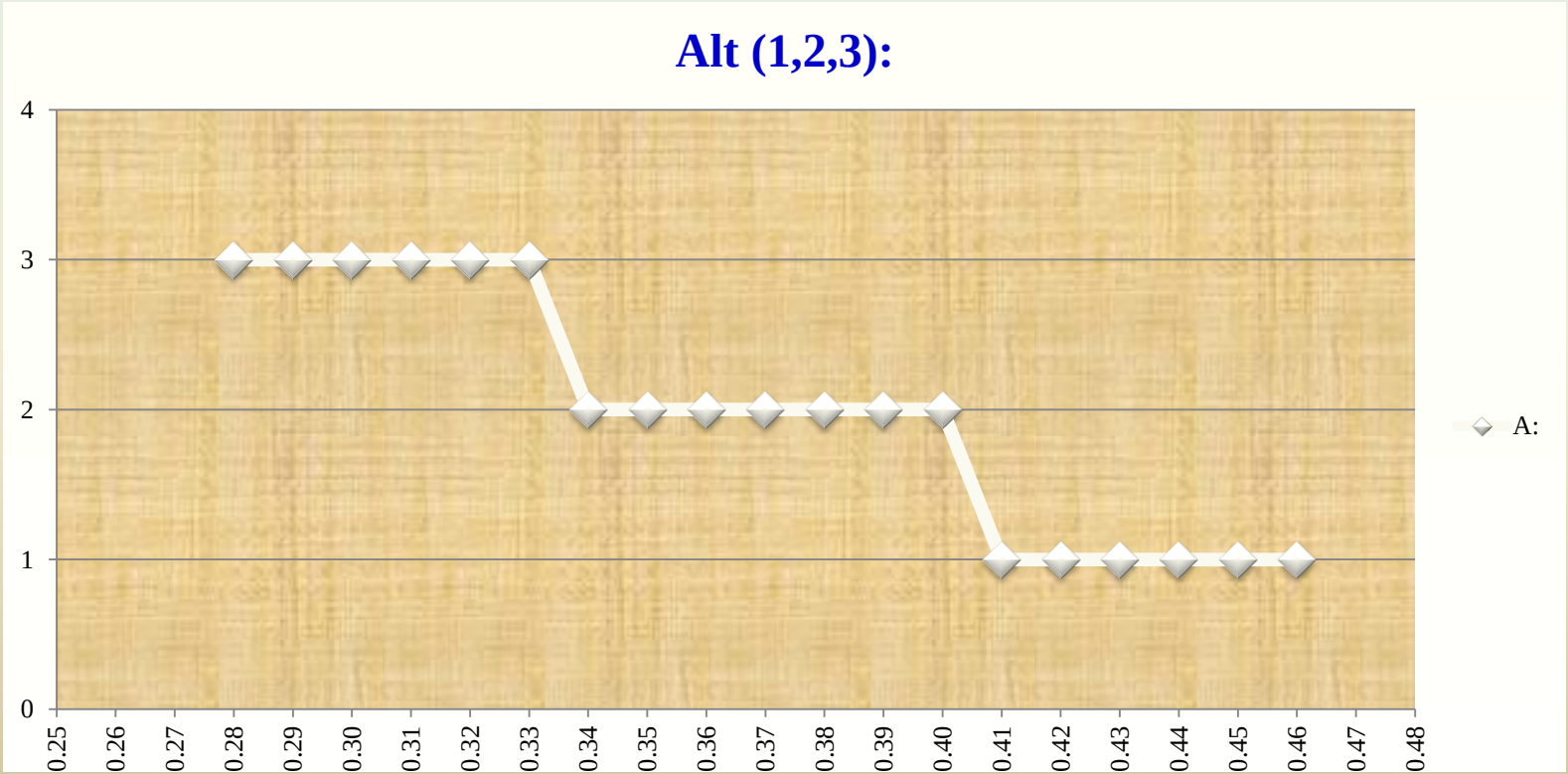
a=0.39 Alternative	Stări – *profituri*			*maxi-MAX*	*maxi-MIN*	*H*	*Decizia*
	S_1	S_2	S_3				
A_1	**15**	**3**	**-6**	15	-6	2.19	
A_2	**9**	**4**	**-2**	9	-2	**2.29**	A_2
A_3	**3**	**2**	**1**	**3**	**1**	1.78	

a=0.33 Alternative	Stări – *profituri*			*maxi-MAX*	*maxi-MIN*	*H*	*Decizia*
	S_1	S_2	S_3				
A_1	**15**	**3**	**-6**	15	-6	0.93	
A_2	**9**	**4**	**-2**	9	-2	1.63	
A_3	**3**	**2**	**1**	**3**	**1**	**1.66**	A_3

a=0.41 Alternative	...	*Decizia*
A_1	...	A_1
A_2	...	
A_3	...	

Analiza Senzitivitate (Sensibilitate)	
a	*Decizia*
0.33	A_3
0.39	A_2
0.41	A_1

α:	0.28	0.29	0.30	0.31	0.32	0.33	0.34	0.35	0.36	0.37	0.38	0.39	0.40	0.41	0.42	0.43	0.44	0.45	0.46
	-0.12	0.09	0.30	0.51	0.72	0.93	1.14	1.35	1.56	1.77	1.98	2.19	2.40	2.61	2.82	3.03	3.24	3.45	3.66
	1.08	1.19	1.30	1.41	1.52	1.63	1.74	1.85	1.96	2.07	2.18	2.29	2.40	2.51	2.62	2.73	2.84	2.95	3.06
	1.56	1.58	1.60	1.62	1.64	1.66	1.68	1.70	1.72	1.74	1.76	1.78	1.80	1.82	1.84	1.86	1.88	1.90	1.92
	1.56	1.58	1.60	1.62	1.64	1.66	1.74	1.85	1.96	2.07	2.18	2.29	2.40	2.61	2.82	3.03	3.24	3.45	3.66
A:	3	3	3	3	3	3	2	2	2	2	2	2	2	1	1	1	1	1	1



… Metode elementare (*nu folosesc probabilităţile P*)

Criteriul de regret MiniMax al lui (Leonard Jimmie) Savage – **minimizarea *regretelor*** reultate dintr-o alegere nepotrivită. *Regretul* ol_{ij} se defineşte ca pierderea de avantaje suferită prin alegerea alternativei A_i şi apariţia stării S_j (diferenţa dintre cel mai bun câştig posibil din starea S_j şi cel obţinut prin alegerea alternativei A_i):

$$ol_{ij} = \begin{cases} Max(S_j) - r_{ij} & \text{pentru fluxuri pozitive} \\ r_{ij} - Min(S_j) & \text{pentru fluxuri negative} \end{cases}$$

Regula *Savage* :

- Se construieşte matricea regretelor *OL* din matricea consecinţelor *R*.
- Se aplică regula MINIMAX la matricea *OL*.

Alterna-tive	Stări – *profituri*		
	S_1	S_2	S_3
A_1	15	3	-6
A_2	9	4	-2
A_3	3	2	1

Alterna-tive	Stări – *profituri*			*maxi-MAX*	*MAXI-MAX*	*Deci-zia*
	S_1	S_2	S_3			
A_1	0	1	7	7		
A_2	6	0	3	6	6	A_2
A_3	12	2	0	12		

… Metode elementare (*foloseşte probabilităţile P*)

Criteriul *motivaţiei insuficiente* - Laplace – *Principiul motivaţiei insuficiente*: dacă decidentul n-a atribuit stărilor probabilităţi de apariţie, atunci se consideră că toate stările naturii S_j $(1 \le j \le n)$ sunt egal probabile, ceea ce înseamnă că $p_j = 1/n$, $(1 \le j \le n)$.

Criteriul lui Laplace foloseşte valoarea medie $E(A_i) = \sum_{j=1}^{n} p_j \cdot r_{ij}$, $1 \le i \le m$.

Regula *Laplace* :

- Se atribuie probabilităţile $p_j = 1/n$ la stările naturii S_j $(1 \le j \le n)$.
- Se calculează valoarea aşteptată $E(A_i)$ pentru fiecare alternativă $(1 \le i \le m)$.
- Se alege alternativa cu cea mai bună valoare aşteptată:

  max / ***min*** $\{E(A_1), E(A_2), ..., E(A_m)\}$ pentru fluxuri ***pozitive*** / ***negative***

Alternative	Stări – *profituri*			$E(A_i)$	*Decizia*
	1/3	1/3	1/3		
A_1	**15**	**3**	**-6**	**4**	A_1
A_2	**9**	**4**	**-2**	**3.67**	
A_3	**3**	**2**	**1**	**2**	

… Metode elementare (*foloseşte probabilităţile P*)

Criteriul *modal* (al *verosimilităţii maximale*) – ia în considerare doar starea cu şansă maximă de realizare (***Verosimilitatea Maximală* - *modal*** ← de la modul distribuţiei statistice).

Regula *verosimilităţii maximale (modală)* :

- Se selectează starea S_j $(1 \le j \le n)$ cu şansa maximă.
- Coloanele stărilor S_k $(1 \le k \le n, k \ne j)$ se exclud din matricea de decizie.
- Se alege alternativa cu cea mai bună consecinţă din coloana S_j:

max / min $\{r_{1j}, r_{2j}, ..., r_{mj}\}$ pentru fluxuri ***pozitive / negative***

Alterna-tive	Stări – *profituri*		
	1/4	**1/2**	1/4
A_1	**15**	**3**	**-6**
A_2	**9**	**4**	**-2**
A_3	**3**	**2**	**1**

Alternative	Stare	*Decizia*
	1/2	
A_1	**3**	
A_2	**4**	**A_2**
A_3	**2**	

- ***Metode bazate pe valoarea medie***
  (expected value)

  …

- ***Metode multicriteriale de analiză a deciziilor***
  Electre

  …

Resources and Links:

- DTREG Software For Predictive Modeling and Forecasting (http://www.dtreg.com/index.htm)
  - Decision Tree Forests (http://www.dtreg.com/treeforest.htm?gclid=CIi7sdWI1Z0CFU1_3godpHJysA)
- Bayes Decision Theory: Discrete Features (http://www.cim.mcgill.ca/~friggi/bayes/)
- Measurement Decision Theory (http://www.sciencecentral.com/site/494630)
- Decision Theory (http://www.ierd.duth.gr/english/courses/syllabus_decision_makinglecture_e.htm)
- Decision Theory (http://www.ierd.duth.gr/english/courses/syllabus_decision_makinglecture_e.htm)
- Decision Theory Free Download - windows software (http://www.ierd.duth.gr/english/courses/syllabus_decision_makinglecture_e.htm)
- Elementary Decision Theory (http://www.ebookee.com/Elementary-Decision-Theory_201022.html)
- Planning Algorithms, **Steven M. LaValle**Cambridge University Press, , 2006 (http://planning.cs.uiuc.edu/)
- Pdf & Doc book … decision theory pdf (http://pdfdatabase.com/index.php?q=decision+theory+pdf)