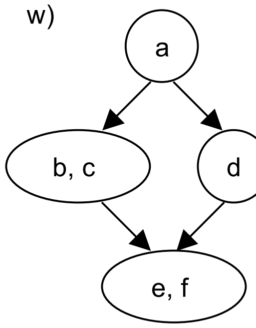
INTELLIGENT DECISION SUPPORT SYSTEMS – EXERCISES I – INTRODUCTION AND PROMETHEE

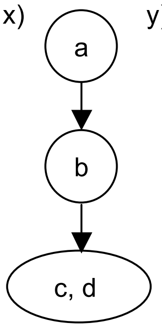
I. Indicate the truth (T) or falsity (F) for the below statements.

a) in multiple criteria choice, one aims at selecting the most preferred subset of alternatives ☐
b) in classification problems, classes (categories) need to be preference-ordered and pre-defined ☐
c) the ranking presented in figure w) is complete ☐
d) the ranking presented in figure x) is complete ☐
e) non-dominated alternatives are also weakly non-dominated ☐
f) the preference plot presented in figure y) corresponds to a gain-type criterion ☐
g) the preference plot presented in figure z) corresponds to a cost-type criterion ☐
h) one can model incomparability using a preference model in the form of a value function ☐
i) among the three families of preference models, decision rules are the most general one ☐

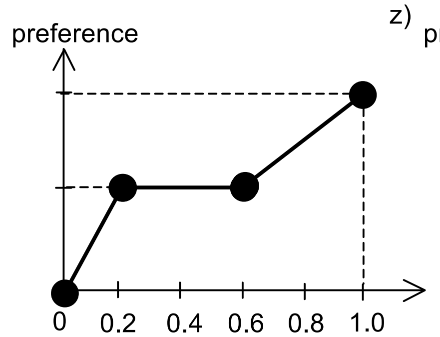
w)



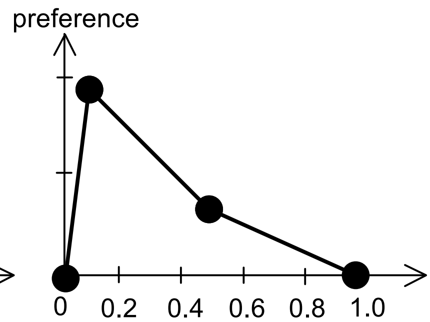
x)



y)



z)



Assume that $g_j(a)$ is the performance of alternative a on criterion g_j, I denotes indifference, and P denotes preference.

II. Which of the below conditions corresponds to the monotonicity of a consistent family of k criteria of gain-type?

a) if $g_j(a) \geq g_j(b)$, $j=1,\ldots,k$ then aPb

b) if aPb, then $\forall c$: $g_j(c) \geq g_j(a)$, $j=1,\ldots,k \Rightarrow$ cPb

c) if aPb and bPc, then aPc

d) if aPb, then $\forall c$: $g_j(c) \geq g_j(a)$, $j=1,\ldots,k \Rightarrow$ cPa

What would change in the correct answer if we considered a family of k criteria of cost-type?

III. Which of the below conditions corresponds to the completeness of a consistent family of k criteria?

a) $\forall a,b$: $g_j(a) = g_j(b)$, $j=1,\ldots,k \Rightarrow$ aPb

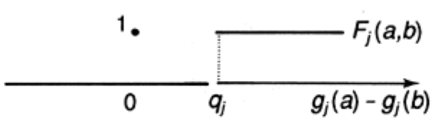
b) if aIb and aIc then bIc

c) if aIb, then $\forall c$: $g_j(c) = g_j(a)$, $j=1,\ldots,k \Rightarrow$ aIc

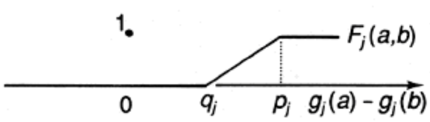
d) $\forall a,b$: $g_j(a) = g_j(b)$, $j=1,\ldots,k \Rightarrow$ aIb

IV. Consider the marginal preference functions for the three criteria: g_1, g_2, and g_3 of gain type. Each criterion's intra- and inter-criteria preference information is provided above the respective plots (q_i – indifference threshold, p_i – preference threshold, w_i – weight). First, compute the marginal preference indices π_j for two pairs of alternatives: A and B as well as C and D. Then, compute the comprehensive preference indices π.

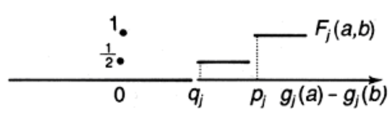
g_1 : $q_1 = 10$, $w_1 = 3$



g_2 : $q_2 = 10$, $p_2 = 20$, $w_2 = 5$



g_3 : $q_3 = 2$, $p_3 = 5$, $w_3 = 2$



	$g_1\uparrow$	$g_2\uparrow$	$g_3\uparrow$
A	10	18	10
B	15	0	20

	g_1	g_2	g_3
$\pi_j(A,B)$	0	0.8	0
$\pi_j(B,A)$	0	0	1

$\pi(A,B)$	$(3\cdot0 + 5\cdot0.8 + 2\cdot0)/10 = 0.4$
$\pi(B,A)$	$(3\cdot0 + 5\cdot0 + 2\cdot1)/10 = 0.2$

	$g_1\uparrow$	$g_2\uparrow$	$g_3\uparrow$
C	20	10	17
D	0	25	20

	g_1	g_2	g_3
$\pi_j(C,D)$			
$\pi_j(D,C)$			

$\pi(C,D)$	
$\pi(D,C)$	

Repeat the computations for pair (A,B), while assuming that all criteria are of cost-type.

V. Indicate the truth (T) or falsity (F) for the below statements.

a) the PROMETHEE methods use an outranking-based preference model	
b) PROMETHEE I provides a partial ranking of alternatives	
c) the sum of comprehensive flows of all alternatives in PROMTEHEE II is equal to zero	
d) for alternatives a and b, the sum of marginal preference indices $\pi_j(a,b)$ and $\pi_j(b,a)$ can be equal to zero	
e) for alternatives a and b, the sum of comprehensive preference indices $\pi(a,b)$ and $\pi(b,a)$ is never greater than one	
f) to select the most preferred subset of alternatives, PROMETHEE V requires pre-computed comprehensive flows	

VI. Using the PROMETHEE method, one derived a matrix of comprehensive preference indices $\pi(a,b)$ for all pairs of alternatives. Compute the positive $\Phi^+(a)$, negative $\Phi^-(a)$, and comprehensive flows $\Phi(a)$ for all alternatives. Draw the rankings obtained with PROMETHEE II and PROMETHEE I. Recall that PROMETHEE I admits incomparability.

$\pi(a,b)$	W	X	Y	Z	$\Phi^+(a)$	$\Phi^-(a)$	$\Phi(a)$
W	0	0	0	0.3	0.3	0.9	-0.6
X	0	0	0.2	0.7	0.9	0.1	0.8
Y	0.9	0	0	0.7			
Z	0	0.1	0.1	0			

VII. Consider six alternatives (S, V, W, X, Y, Z) with the following comprehensive flows: $\Phi(S) = 0.9$, $\Phi(V) = -0.9$, $\Phi(W) = -0.6$, $\Phi(X) = 0.8$, $\Phi(Y) = 1.3$, and $\Phi(Z) = -1.5$. Formulate the binary linear program according to the assumptions of PROMETHEE V that would allow selecting a subset of two alternatives that respect the constraints on the maximal budget of 100 and the minimal projected gain of 300. The budgets and gains for all alternatives are provided in the below table. Use the following binary variables: x_S, x_V, x_W, x_X, x_Y, and x_Z, corresponding to the six alternatives.

	S	V	W	X	Y	Z
budget	40	30	60	50	70	20
projected gain	140	100	150	170	200	120

What would be the optimal subset of alternatives selected by PROMETHEE V?