3(1)

x_1	y_1
1	4
1	4
0	0
0	2
−1	6
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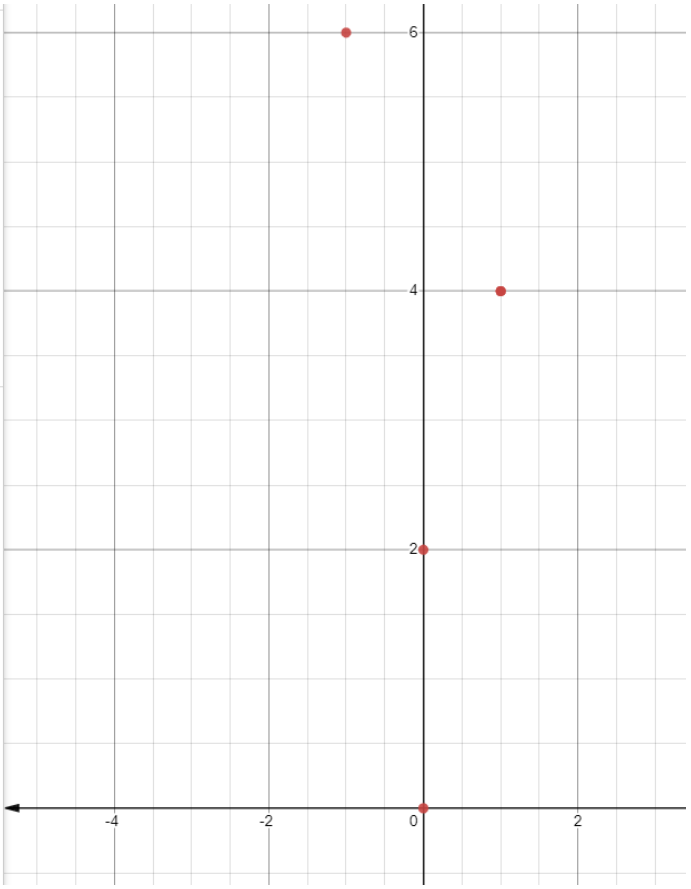


40

$$TPR = \frac{TP}{TP+FN}$$

$$TNR = \frac{TN}{TN+FP}$$

$$PPV = \frac{TP}{TP+FP}$$

$$NPV = \frac{TN}{TN+FN}$$

Если известно TPR и TNR

$$TPR = \frac{TP}{TP+FN} \Rightarrow TP = TPR \cdot (TP + FN)$$

$$TNR = \frac{TN}{TN+FP} \Rightarrow TN = TNR \cdot (TN + FP)$$

$$P = (TP + FN) \Rightarrow FN = P - TPR \cdot P = P(1 - TPR)$$

$$N = (TN + FP) \Rightarrow FP = N - TNR \cdot N = N(1 - TNR)$$

$$PPV = \frac{TP}{TP+FP} \Rightarrow \frac{TPR \cdot P}{TPR \cdot P + N(1-TNR)}$$

$$NPV = \frac{TN}{TN+FN} \Rightarrow \frac{TNR \cdot N}{TNR \cdot N + P(1-TPR)}$$

Если известно TPR и PPV

$$TPR = \frac{TP}{TP+FN} \Rightarrow TP = TPR \cdot (TP + FN)$$

$$PPV = \frac{TP}{TP+FP} \Rightarrow TP = PPV \cdot (TP + FP)$$

$$\Rightarrow TP \cdot PPV + FP \cdot PPV \Rightarrow FP = \frac{(1-PPV) \cdot TP}{PPV} = \frac{(1-PPV) \cdot TPR \cdot P}{PPV}$$

$$TN = N - FP = N - \frac{(1-PPV) \cdot TPR \cdot P}{PPV}$$

$$TNR = \frac{TN}{TN+FP} = 1 - \frac{(1-PPV) \cdot TPR \cdot P}{PPV \cdot N}$$

$$FN = P - TP = P - TPR \cdot P = P(1 - TPR)$$

$$NPV = \frac{TN}{TN+FN} = \frac{N - \frac{(1-PPV) \cdot TPR \cdot P}{PPV}}{N - \frac{(1-PPV) \cdot TPR \cdot P}{PPV} + P(1-TPR)}$$

Если известно TPR и NPV

$$TPR = \frac{TP}{TP+FN} \Rightarrow TP = TPR \cdot (TP + FN)$$

$$FN = P - TP = P - TPR \cdot P = P(1 - TPR)$$

$$NPV = \frac{TN}{TN+FN} \Rightarrow (TN + FN) \cdot NPV - TN$$

$$\Rightarrow TN = \frac{FN \cdot NPV}{(1-NPV)} = \frac{P \cdot (1-TPR) \cdot NPV}{(1-NPV)}$$
$$FP = N - TN = N - \frac{P \cdot (1-TPR) \cdot NPV}{(1-NPV)}$$

$$TNR = \frac{TN}{TN+FP} = \frac{P \cdot (1-TPR) \cdot NPV}{(1-NPV) \cdot N}$$
$$PPV = \frac{TP}{TP+FP} = \frac{P \cdot TPR}{P \cdot TPR + N - \frac{P \cdot (1-TPR) \cdot NPV}{(1-NPV)}}$$

Если известно TNR и PPV

$$TNR = \frac{TN}{TN+FP} \Rightarrow TN = TNR \cdot (TN + FP)$$
$$FP = N - TN = N \cdot (1 - TNR)$$
$$PPV = \frac{TP}{TP+FP} \Rightarrow TP = PPV \cdot (TP + FP)$$
$$\Rightarrow TP = \frac{N \cdot (1-TNR)}{(1-PPV)}$$

$$TPR = \frac{TP}{TP+FN} = \frac{N \cdot (1-TNR)}{(1-PPV)}$$
$$FN - P - TP = P - \frac{N(1-TNR)}{(1-PPV)}$$
$$NPV = \frac{TN}{TN+FN} = \frac{TNR \cdot N}{TNR \cdot N + P - \frac{N(1-TNR)}{(1-PPV)}}$$

Если известно TNR и NPV

$$TNR = \frac{TN}{TN+FP} \Rightarrow TN = TNR \cdot (TN + FP)$$
$$FP = N - TN = N \cdot (1 - TNR)$$
$$NPV = \frac{TN}{TN+FN} \Rightarrow (TN + FN) \cdot NPV - TN$$
$$\Rightarrow FN = \frac{TNR \cdot N \cdot (1-NPV)}{NPV}$$
$$TP = P - FN = P - \frac{TNR \cdot N \cdot (1-NPV)}{NPV}$$

$$TPR = \frac{TP}{TP+FN} = 1 - \frac{TNR \cdot N \cdot (1-NPV)}{P \cdot NPV}$$

$$PPV = \frac{TP}{TP+FP} = \frac{P - \frac{TNR \cdot N \cdot (1-NPV)}{NPV}}{P - \frac{TNR \cdot N \cdot (1-NPV)}{NPV} + N \cdot (1-TNR)}$$

Если известно PPV и NPV

$$PPV = \frac{TP}{TP+FP}$$

$$FP = N - TN$$

$$NPV = \frac{TN}{TN+FN}$$

$$FN = P - TP$$

Система

$$1) PPV(TP + N - TN) = TP$$

$$2) NPV(TN + P - TP) = TN$$

$$TP \cdot (1 - PPV) + TN \cdot PPV = N \cdot PPV$$

$$P \cdot (1 - PPV) + \frac{TN \cdot (NPV-1) \cdot (1-PPV)}{NPV} + TN \cdot PPV = N \cdot PPV$$

$$\Rightarrow TN = \frac{N \cdot PPV - P \cdot (1-PPV)}{\frac{(NPV-1) \cdot (1-PPV)}{NPV} + PPV}$$

$$TPR = \frac{TP}{TP+FN} = 1 + \frac{(NPV-1)}{NPV \cdot P} \cdot \frac{N \cdot PPV - P \cdot (1-PPV)}{(\frac{(NPV-1) \cdot (1-PPV)}{NPV} + PPV)}$$

$$TNR = \frac{TN}{TN+FP} = \frac{N \cdot PPV - P \cdot (1-PPV)}{(\frac{(NPV-1) \cdot (1-PPV)}{NPV} + PPV) \cdot N}$$

41(1)

$$PPV_1 = PPV_2 \qquad\qquad TPR_1 = TPR_2$$

$$\frac{TP_1}{TP_1+FP_1} = \frac{TP_2}{TP_2+FP_2} \Rightarrow \qquad\qquad \frac{TP_1}{P_1} = \frac{TP_2}{P_2} \Rightarrow$$

$$TP_1 = TP_2 \Rightarrow \qquad TP_1 = TP_2 \Rightarrow$$

$$FP_1 = FP_2 \Rightarrow \qquad TP_1 = P_1 - FN_1 =$$

$$FP_1 = N_1 - TN_1 = FP_2 = \qquad TP_2 = P_2 - FN_2 \Rightarrow$$

$$N_2 - TN_2 \Rightarrow TN_1 = TN_2 \qquad TN_2 = TN_2$$

$$TNR_1 = \frac{TN_1}{TN_1 + FP_1} = \frac{TN_2}{TN_2 + FP_2} = TNR_2$$

$$NPV_1 = \frac{TN_1}{TN_1 + FN_1} = \frac{TN_2}{TN_2 + FN_2} = NPV_2$$

Верно

41(2)

$$TNR_1 = \frac{TN_1}{N_1} = \frac{TN_2}{N_2} = TNR_2 \Rightarrow N_1 = N_2 \Rightarrow$$

$$TN_1 = TN_2 \Rightarrow TN_1 = TN_1 - N_1 - FP_1$$

$$TN_2 = TN_2 - N_2 - FP_2 \Rightarrow FP_1 = FP_2$$

$$NPV_1 = \frac{TN_1}{TN_1 + FN_1} = \frac{TN_2}{TN_2 + FN_2} = NPV_2 \Rightarrow TN_1 = TN_2 \Rightarrow$$

$$FN_1 = FN_2 \Rightarrow FN_1 = P_1 - TP_1$$

$$FN_2 = P_2 - TP_2 \Rightarrow TP_1 = TP_2$$

$$PPV_1 = \frac{TP_1}{TP_1 + FP_1} = \frac{TP_2}{TP_2 + FP_2} = PPV_2$$

$$TPR_1 = \frac{TP_1}{TP_1 + FN_1} = \frac{TP_2}{TP_2 + FN_2} = TPR_2$$

Верно

41(3)

$$TPR_1 = \frac{TP_1}{P_1} = \frac{TP_2}{P_2} = TPR_2 \Rightarrow P_1 = P_2 \Rightarrow$$
$$TP_1 = TP_2 \Rightarrow P_1 = TP_1 + FN_1 = P_2 = TP_2 + FN_2 \Rightarrow$$
$$FN_1 = FN_2$$

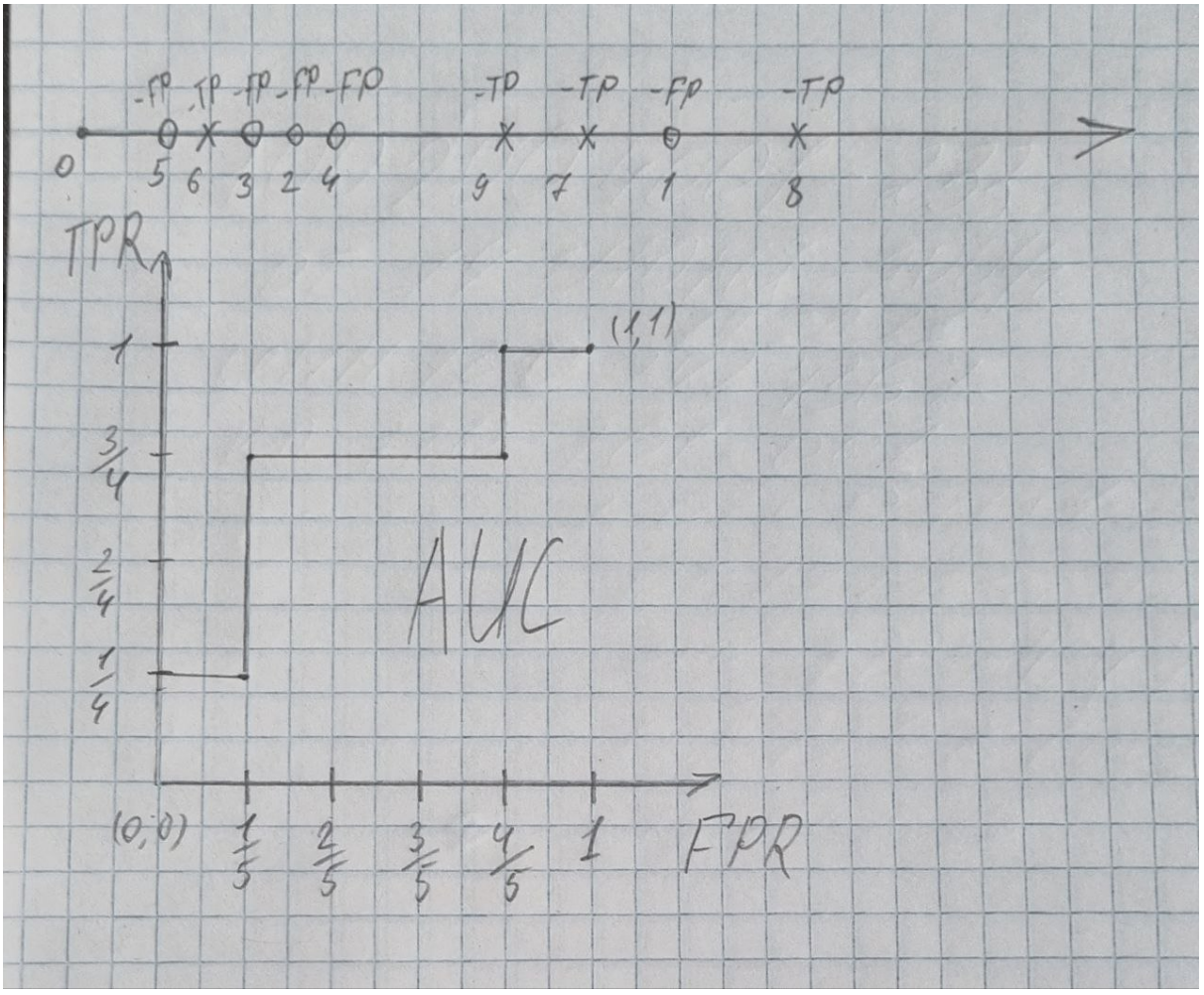
$$FPR_1 = \frac{FP_1}{N_1} = \frac{FP_2}{N_2} = FPR_2 \Rightarrow N_1 = N_2 \Rightarrow$$
$$FP_1 = FP_2 \Rightarrow N_1 = TN_1 + FP_1 = N_2 = TN_2 + FP_2 \Rightarrow$$
$$TN_1 = TN_2$$
$$\Downarrow$$
$$PPV_1 = \frac{TP_1}{TP_1 + FP_1} = \frac{TP_2}{TP_2 + FP_2} = PPV_2$$

$$\Downarrow$$
$$FP_1 = FP_2$$
$$TPR_1 = \frac{TP_1}{P_1} = \frac{TP_2}{P_2} = TPR_2 \Rightarrow P_1 = P_2 \Rightarrow TP_1 = TP_2$$
$$\Downarrow$$
$$FPR_1 = \frac{FP_1}{N_1} = \frac{FP_2}{N_2} = FPR_2$$

Утверждение верно в обе стороны

42

i	1	2	3	4	5	6	7	8	9
$y^{(i)}$	0	0	0	0	0	1	1	1	1
$g(x^{(i)})$	0.75	0.15	0.11	0.8	0.09	0.1	0.66	0.82	0.5



TN 4	FP 1
FN 1	TP 1

$$FPR = \frac{FP}{N} = \frac{1}{5}$$
$$TPR = \frac{TP}{P} = \frac{3}{4}$$
$$TNR = \frac{TN}{N} = \frac{4}{5}$$
$$FNR = \frac{FN}{P} = \frac{1}{4}$$

$$PPV = \frac{TP}{TP+FP} = \frac{3}{4}$$
$$AUC = \frac{1}{5} \cdot \frac{1}{4} + \frac{3}{5} \cdot \frac{3}{4} + \frac{1}{5} \cdot 1 = \frac{14}{20} = \frac{7}{10}$$
$$accuracy = \frac{FP+TN}{TP+TN+FN+FP} = \frac{7}{9}$$
$$error = 1 - accuracy = 1 - \frac{FP+TN}{TP+TN+FN+FP} = \frac{2}{9}$$
$$F_1 = \frac{2 \cdot PPV \cdot TPR}{PPV+TPR} = \frac{2 \cdot \frac{3}{4} \cdot \frac{3}{4}}{\frac{3}{4}+\frac{3}{4}} = \frac{9 \cdot 4}{8 \cdot 6} = \frac{3}{4}$$