COMPUTER PROGRAMMING LABORATORY
Experiment # 3:
Decision Making II

QUESTIONS

1) Fourier series is periodic function composed of harmonically related sinusoids, combined by a weighted summation. First harmonic of a periodic function with period 8 can be calculated as follows:

$$g_1(t) = A_1 * \cos\left(\frac{\pi}{4}t + \theta_1\right)$$

where

$$A_1 = \sqrt{{a_1}^2 + {b_1}^2}$$

and

$$\theta_1 = -\tan^{-1}\frac{b_1}{a_1}$$

Prompt a_1, b_1,and θ_1 values from the keyboard and print them. Then, calculate and print value of $g_1(7)$. Test your program for given a_1=3, b_1=4,and $\theta_1=30^o$.

2) The neurons which are the basic unit of a neural network take inputs and produce one output. The outputs of 2-input neuron is calculated as:

$$y = f(x_1 * w_1 + \ x_2 * w_2 + b)$$

The sigmoid function is selected for the output.

$$f(z) = \frac{1}{(1 + e^{-z})}$$

Prompt x_1, x_2, w_1, w_2, and b from the keyboard and print them. Then, calculate and print y. Test your program for x_1=2, x_2=-1, w_1=0.1,w_2=0.8, and b=1.5.

3) The pose of a 2-wheeled mobile robot with a constant speed ω after t time is given below:

$$x = x_0 - r\sin\theta_0 + \ r\sin(\theta_0 + \omega t)$$
$$y = y_0 + r\cos\theta_0 - \ r\cos(\theta_0 + \omega t)$$
$$\theta = \theta_0 + \omega t$$

Prompt x_0, y_0, θ_0, r, ω and t from the keyboard and print them. Then, calculate and print x, y, and θ. Test your program for x_0=5.25, y_0=5.25, θ_0=0, r=2, ω=10 and t=1.

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4) The inverse kinematics equations of a 2-DOF robot arm are given below:

$$\theta_1 = cos^{-1}\left(\frac{{L_1}^2 + A^2 + Z^2 - {L_2}^2}{2L_1\sqrt{A^2 + Z^2}}\right) + tan^{-1}\left(\frac{Z}{A}\right)$$

$$\theta_2 = cos^{-1}\left(\frac{{L_1}^2 + {L_2}^2 - A^2 - Z^2}{2L_1L_2}\right)$$

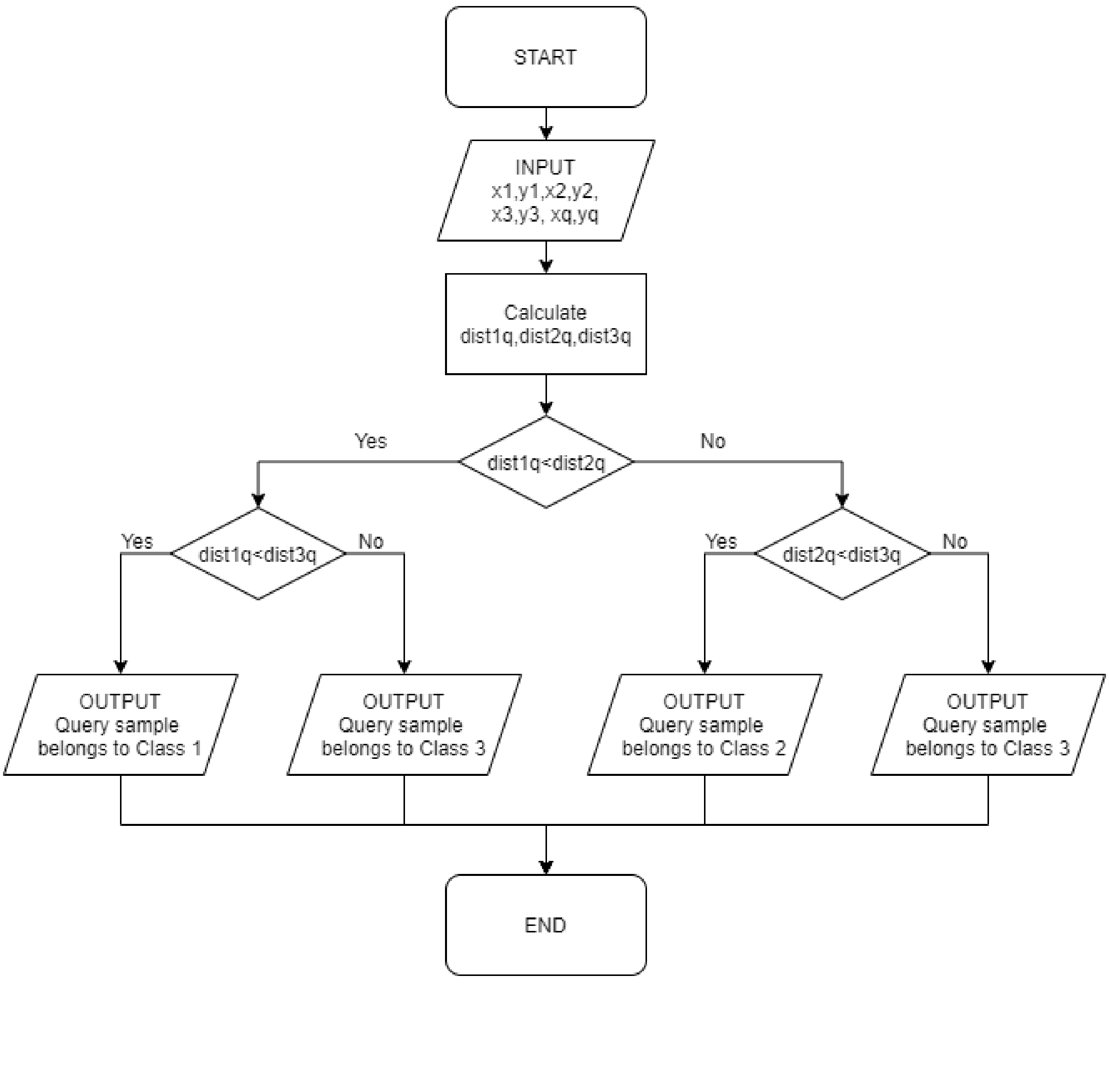
Prompt L_1, L_2, A, and Z from the keyboard and print them. Then, calculate and print θ_1 and θ_2. Test your program for L_1=7, L_2=4.3, A=5.2, and Z=4.

5) There are three classes in 2-dimensional Cartesian coordinates, centers of these classes are (x1,y1), (x2,y2) and (x3,y3), respectively. Main purpose of the program is to detect which class center gives minimum Euclidean Distance with query point at (xq,yq). Euclidean Distance is calculated as following formula:

$$dist\big((xn, yn), (xq, yq)\big) = \sqrt{(xn - xq)^2 + (yn - yq)^2}$$

Use the given flowchart given in figure to develop the program. Test your program with

i) x1=3,y1=4,x2=-1,y2=-3,x3=-7,y3=5,xq=-4,yq=6
ii) x1=3,y1=4,x2=-1,y2=-3,x3=-7,y3=5,xq=1,yq=0

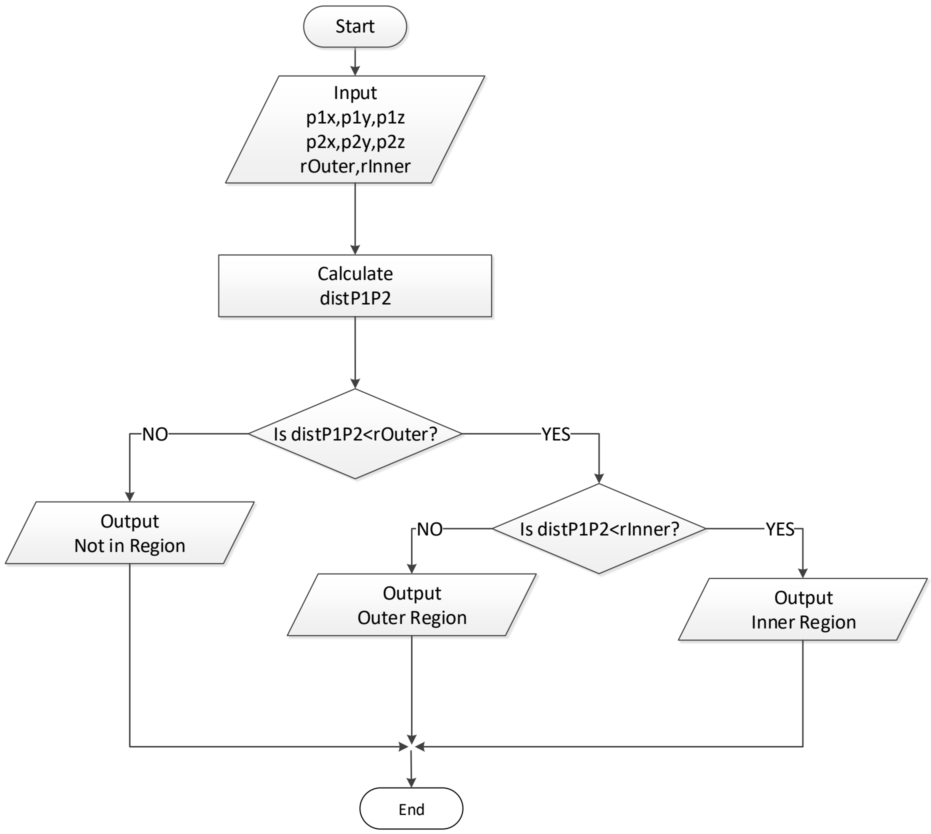


6) There are two points P1 and P2 in 3D dimension (x, y and z axis) and two regions defined with R1 and R2 radius balls centered at P1 point. Distance between two points is calculated as:

$$distP1P2 = \sqrt{(p1x - p2x)^2 + (p1y - p2y)^2 + (p1z - p2z)^2}$$

Use the given flowchart given in figure to develop the program. Test your program with

i) ***p1x*** = 3, ***p1y*** = -2, ***p1z*** = 2, ***p2x*** = 10, ***p2y*** =-5, ***p2z*** =3, ***rOuter* =** 2**, *rInner* =** 4
ii) ***p1x*** = 1, ***p1y*** = 1, ***p1z*** =2, ***p2x*** = 1, ***p2y*** = 1, ***p2z*** = 0, ***rOuter* =** 0.8**, *rInner* =**1.6

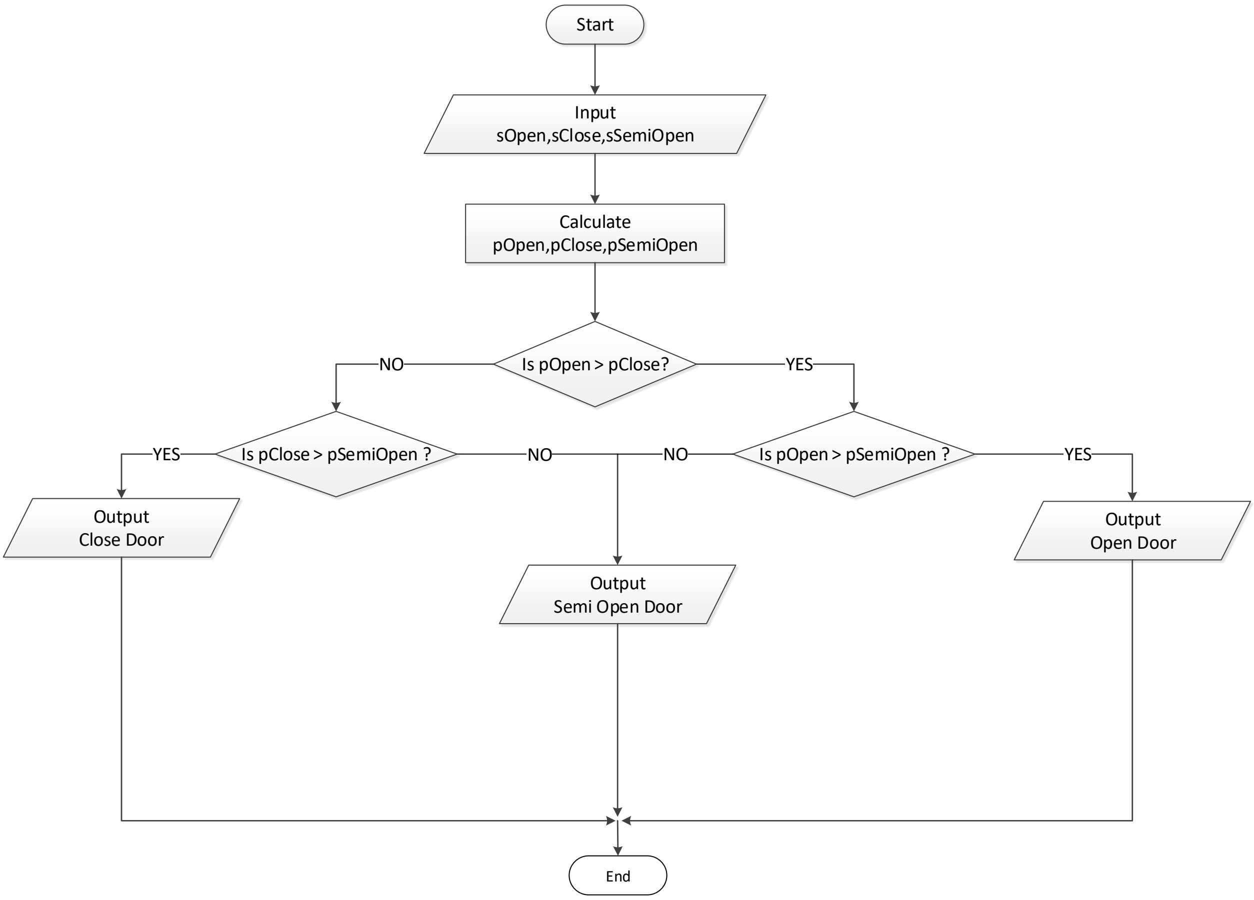


7) Consider we have a classification problem which categorizes the door as open, close and semi-open. After the class score values of one sample are prompted, the probability of each class calculated. Then the category is determined according to the probability values which are calculated as:

$$pOpen = \frac{e^{sOpen}}{e^{sOpen} + e^{sClosed} + e^{sSemiOpen}}$$
$$pClose = \frac{e^{sClose}}{e^{sOpen} + e^{sClosed} + e^{sSemiOpen}}$$
$$pSemiOpen = \frac{e^{sSemiOpen}}{e^{sOpen} + e^{sClosed} + e^{sSemiOpen}}$$

Use the given flowchart given in figure to develop the program. Test your program with

i) ***sOpen*** = 1.8, ***sClose*** = 8.6, ***sSemiOpen*** = 2.4
ii) ***sOpen*** = 12.3, ***sClose*** = 2.4, ***sSemiOpen*** = 3.8



8) Use the given flowchart given in figure to develop the program. Test your program with
i) ***goal***=0, ***dist***=5
ii) ***goal***=1, ***dist***=20.25
iii) ***goal***=1, ***dist***=7.8
iv) ***goal***=1, ***dist***=1.2