**5. Build an Artificial Neural Network by implementing the Back propagation Algorithm and Test the same using Appropriate Data Sets.**

**import** numpy **as** np

inputNeurons**=**2

hiddenlayerNeurons**=**4

outputNeurons**=**2

iteration**=**6000

input **=** np**.**random**.**randint(1,5,inputNeurons)

output **=** np**.**array([1.0,0.0])

hidden\_layer**=**np**.**random**.**rand(1,hiddenlayerNeurons)

hidden\_biass**=**np**.**random**.**rand(1,hiddenlayerNeurons)

output\_bias**=**np**.**random**.**rand(1,outputNeurons)

hidden\_weights**=**np**.**random**.**rand(inputNeurons,hiddenlayerNeurons)

output\_weights**=**np**.**random**.**rand(hiddenlayerNeurons,outputNeurons)

**def** sigmoid (layer):

**return** 1**/**(1 **+** np**.**exp(**-**layer))

**def** gradient(layer):

**return** layer**\***(1**-**layer)

**for** i **in** range(iteration):

hidden\_layer**=**np**.**dot(input,hidden\_weights)

hidden\_layer**=**sigmoid(hidden\_layer**+**hidden\_biass)

output\_layer**=**np**.**dot(hidden\_layer,output\_weights)

output\_layer**=**sigmoid(output\_layer**+**output\_bias)

error **=** (output**-**output\_layer)

gradient\_outputLayer**=**gradient(output\_layer)

error\_terms\_output**=**gradient\_outputLayer **\*** error

error\_terms\_hidden**=**gradient(hidden\_layer)**\***np**.**dot(error\_terms\_output,output\_weights**.**T)

gradient\_hidden\_weights **=** np**.**dot(input**.**reshape(inputNeurons,1),error\_terms\_hidden**.**reshape(1,hiddenlayerNeurons))

gradient\_ouput\_weights **=** np**.**dot(hidden\_layer**.**reshape(hiddenlayerNeurons,1),error\_terms\_output**.**reshape(1,outputNeurons))

hidden\_weights **=** hidden\_weights **+** 0.05**\***gradient\_hidden\_weights

output\_weights **=** output\_weights **+** 0.05**\***gradient\_ouput\_weights

**if** i**<**50 **or** i**>**iteration**-**50:

print("\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*")

print("iteration:",i,"::::",error)

print("###output########",output\_layer)

**Output:**

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 0 :::: [[ 0.0720921 -0.94906383]]

###output######## [[0.9279079 0.94906383]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 1 :::: [[ 0.07203592 -0.94865304]]

###output######## [[0.92796408 0.94865304]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 2 :::: [[ 0.07197988 -0.94823618]]

###output######## [[0.92802012 0.94823618]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 3 :::: [[ 0.07192399 -0.94781309]]

###output######## [[0.92807601 0.94781309]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 4 :::: [[ 0.07186825 -0.94738367]]

###output######## [[0.92813175 0.94738367]]

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iteration: 5 :::: [[ 0.07181265 -0.94694777]]

###output######## [[0.92818735 0.94694777]]

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iteration: 6 :::: [[ 0.07175721 -0.94650525]]

###output######## [[0.92824279 0.94650525]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 7 :::: [[ 0.0717019 -0.94605598]]

###output######## [[0.9282981 0.94605598]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 8 :::: [[ 0.07164675 -0.9455998 ]]

###output######## [[0.92835325 0.9455998 ]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 9 :::: [[ 0.07159173 -0.94513658]]

###output######## [[0.92840827 0.94513658]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 10 :::: [[ 0.07153687 -0.94466616]]

###output######## [[0.92846313 0.94466616]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 11 :::: [[ 0.07148214 -0.94418838]]

###output######## [[0.92851786 0.94418838]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 12 :::: [[ 0.07142756 -0.94370307]]

###output######## [[0.92857244 0.94370307]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 13 :::: [[ 0.07137313 -0.94321009]]

###output######## [[0.92862687 0.94321009]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 14 :::: [[ 0.07131884 -0.94270924]]

###output######## [[0.92868116 0.94270924]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 15 :::: [[ 0.07126469 -0.94220037]]

###output######## [[0.92873531 0.94220037]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 16 :::: [[ 0.07121068 -0.94168329]]

###output######## [[0.92878932 0.94168329]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 17 :::: [[ 0.07115681 -0.94115781]]

###output######## [[0.92884319 0.94115781]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 18 :::: [[ 0.07110309 -0.94062375]]

###output######## [[0.92889691 0.94062375]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 19 :::: [[ 0.0710495 -0.94008092]]

###output######## [[0.9289505 0.94008092]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 20 :::: [[ 0.07099606 -0.9395291 ]]

###output######## [[0.92900394 0.9395291 ]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 21 :::: [[ 0.07094276 -0.93896809]]

###output######## [[0.92905724 0.93896809]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 22 :::: [[ 0.0708896 -0.93839769]]

###output######## [[0.9291104 0.93839769]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 23 :::: [[ 0.07083657 -0.93781767]]

###output######## [[0.92916343 0.93781767]]

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iteration: 24 :::: [[ 0.07078369 -0.93722781]]

###output######## [[0.92921631 0.93722781]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 25 :::: [[ 0.07073094 -0.93662788]]

###output######## [[0.92926906 0.93662788]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 26 :::: [[ 0.07067833 -0.93601765]]

###output######## [[0.92932167 0.93601765]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 27 :::: [[ 0.07062586 -0.93539685]]

###output######## [[0.92937414 0.93539685]]

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iteration: 28 :::: [[ 0.07057353 -0.93476526]]

###output######## [[0.92942647 0.93476526]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 29 :::: [[ 0.07052133 -0.93412259]]

###output######## [[0.92947867 0.93412259]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 30 :::: [[ 0.07046927 -0.9334686 ]]

###output######## [[0.92953073 0.9334686 ]]

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iteration: 31 :::: [[ 0.07041735 -0.932803 ]]

###output######## [[0.92958265 0.932803 ]]

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iteration: 32 :::: [[ 0.07036556 -0.93212552]]

###output######## [[0.92963444 0.93212552]]

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iteration: 33 :::: [[ 0.0703139 -0.93143586]]

###output######## [[0.9296861 0.93143586]]

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iteration: 34 :::: [[ 0.07026238 -0.93073371]]

###output######## [[0.92973762 0.93073371]]

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iteration: 35 :::: [[ 0.070211 -0.93001879]]

###output######## [[0.929789 0.93001879]]

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iteration: 36 :::: [[ 0.07015975 -0.92929075]]

###output######## [[0.92984025 0.92929075]]

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iteration: 37 :::: [[ 0.07010863 -0.92854929]]

###output######## [[0.92989137 0.92854929]]

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iteration: 38 :::: [[ 0.07005764 -0.92779406]]

###output######## [[0.92994236 0.92779406]]

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iteration: 39 :::: [[ 0.07000679 -0.92702471]]

###output######## [[0.92999321 0.92702471]]

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iteration: 40 :::: [[ 0.06995607 -0.92624088]]

###output######## [[0.93004393 0.92624088]]

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iteration: 41 :::: [[ 0.06990548 -0.92544221]]

###output######## [[0.93009452 0.92544221]]

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iteration: 42 :::: [[ 0.06985502 -0.92462832]]

###output######## [[0.93014498 0.92462832]]

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iteration: 43 :::: [[ 0.0698047 -0.92379882]]

###output######## [[0.9301953 0.92379882]]

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iteration: 44 :::: [[ 0.0697545 -0.92295329]]

###output######## [[0.9302455 0.92295329]]

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iteration: 45 :::: [[ 0.06970443 -0.92209133]]

###output######## [[0.93029557 0.92209133]]

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iteration: 46 :::: [[ 0.06965449 -0.9212125 ]]

###output######## [[0.93034551 0.9212125 ]]

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iteration: 47 :::: [[ 0.06960468 -0.92031637]]

###output######## [[0.93039532 0.92031637]]

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iteration: 48 :::: [[ 0.069555 -0.91940247]]

###output######## [[0.930445 0.91940247]]

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iteration: 49 :::: [[ 0.06950544 -0.91847034]]

###output######## [[0.93049456 0.91847034]]

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iteration: 5951 :::: [[ 0.02082056 -0.02234698]]

###output######## [[0.97917944 0.02234698]]

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iteration: 5952 :::: [[ 0.02081891 -0.02234494]]

###output######## [[0.97918109 0.02234494]]

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iteration: 5953 :::: [[ 0.02081726 -0.0223429 ]]

###output######## [[0.97918274 0.0223429 ]]

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iteration: 5954 :::: [[ 0.02081561 -0.02234086]]

###output######## [[0.97918439 0.02234086]]

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iteration: 5955 :::: [[ 0.02081396 -0.02233882]]

###output######## [[0.97918604 0.02233882]]

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iteration: 5956 :::: [[ 0.02081231 -0.02233678]]

###output######## [[0.97918769 0.02233678]]

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iteration: 5957 :::: [[ 0.02081067 -0.02233475]]

###output######## [[0.97918933 0.02233475]]

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iteration: 5958 :::: [[ 0.02080902 -0.02233271]]

###output######## [[0.97919098 0.02233271]]

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iteration: 5959 :::: [[ 0.02080737 -0.02233067]]

###output######## [[0.97919263 0.02233067]]

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iteration: 5960 :::: [[ 0.02080572 -0.02232864]]

###output######## [[0.97919428 0.02232864]]

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iteration: 5961 :::: [[ 0.02080408 -0.0223266 ]]

###output######## [[0.97919592 0.0223266 ]]

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iteration: 5962 :::: [[ 0.02080243 -0.02232457]]

###output######## [[0.97919757 0.02232457]]

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iteration: 5963 :::: [[ 0.02080079 -0.02232253]]

###output######## [[0.97919921 0.02232253]]

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iteration: 5964 :::: [[ 0.02079914 -0.0223205 ]]

###output######## [[0.97920086 0.0223205 ]]

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iteration: 5965 :::: [[ 0.0207975 -0.02231846]]

###output######## [[0.9792025 0.02231846]]

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iteration: 5966 :::: [[ 0.02079585 -0.02231643]]

###output######## [[0.97920415 0.02231643]]

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iteration: 5967 :::: [[ 0.02079421 -0.0223144 ]]

###output######## [[0.97920579 0.0223144 ]]

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iteration: 5968 :::: [[ 0.02079256 -0.02231237]]

###output######## [[0.97920744 0.02231237]]

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iteration: 5969 :::: [[ 0.02079092 -0.02231034]]

###output######## [[0.97920908 0.02231034]]

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iteration: 5970 :::: [[ 0.02078928 -0.02230831]]

###output######## [[0.97921072 0.02230831]]

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iteration: 5971 :::: [[ 0.02078763 -0.02230628]]

###output######## [[0.97921237 0.02230628]]

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iteration: 5972 :::: [[ 0.02078599 -0.02230425]]

###output######## [[0.97921401 0.02230425]]

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iteration: 5973 :::: [[ 0.02078435 -0.02230222]]

###output######## [[0.97921565 0.02230222]]

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iteration: 5974 :::: [[ 0.02078271 -0.02230019]]

###output######## [[0.97921729 0.02230019]]

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iteration: 5975 :::: [[ 0.02078107 -0.02229816]]

###output######## [[0.97921893 0.02229816]]

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iteration: 5976 :::: [[ 0.02077943 -0.02229613]]

###output######## [[0.97922057 0.02229613]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 5977 :::: [[ 0.02077779 -0.02229411]]

###output######## [[0.97922221 0.02229411]]

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iteration: 5978 :::: [[ 0.02077615 -0.02229208]]

###output######## [[0.97922385 0.02229208]]

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iteration: 5979 :::: [[ 0.02077451 -0.02229005]]

###output######## [[0.97922549 0.02229005]]

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iteration: 5980 :::: [[ 0.02077287 -0.02228803]]

###output######## [[0.97922713 0.02228803]]

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iteration: 5981 :::: [[ 0.02077123 -0.022286 ]]

###output######## [[0.97922877 0.022286 ]]

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iteration: 5982 :::: [[ 0.02076959 -0.02228398]]

###output######## [[0.97923041 0.02228398]]

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iteration: 5983 :::: [[ 0.02076795 -0.02228196]]

###output######## [[0.97923205 0.02228196]]

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iteration: 5984 :::: [[ 0.02076631 -0.02227993]]

###output######## [[0.97923369 0.02227993]]

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iteration: 5985 :::: [[ 0.02076468 -0.02227791]]

###output######## [[0.97923532 0.02227791]]

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iteration: 5986 :::: [[ 0.02076304 -0.02227589]]

###output######## [[0.97923696 0.02227589]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 5987 :::: [[ 0.0207614 -0.02227387]]

###output######## [[0.9792386 0.02227387]]

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iteration: 5988 :::: [[ 0.02075977 -0.02227185]]

###output######## [[0.97924023 0.02227185]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 5989 :::: [[ 0.02075813 -0.02226983]]

###output######## [[0.97924187 0.02226983]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 5990 :::: [[ 0.0207565 -0.02226781]]

###output######## [[0.9792435 0.02226781]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 5991 :::: [[ 0.02075486 -0.02226579]]

###output######## [[0.97924514 0.02226579]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 5992 :::: [[ 0.02075323 -0.02226377]]

###output######## [[0.97924677 0.02226377]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 5993 :::: [[ 0.02075159 -0.02226175]]

###output######## [[0.97924841 0.02226175]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 5994 :::: [[ 0.02074996 -0.02225973]]

###output######## [[0.97925004 0.02225973]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 5995 :::: [[ 0.02074833 -0.02225772]]

###output######## [[0.97925167 0.02225772]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 5996 :::: [[ 0.02074669 -0.0222557 ]]

###output######## [[0.97925331 0.0222557 ]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 5997 :::: [[ 0.02074506 -0.02225368]]

###output######## [[0.97925494 0.02225368]]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

iteration: 5998 :::: [[ 0.02074343 -0.02225167]]

###output######## [[0.97925657 0.02225167]]

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iteration: 5999 :::: [[ 0.0207418 -0.02224965]]

###output######## [[0.9792582 0.02224965]]

**6. Write a program to Implement the Navie Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.**

*# import necessary libraries*

**import** pandas **as** pd

**from** sklearn **import** tree

**from** sklearn.preprocessing **import** LabelEncoder

**from** sklearn.naive\_bayes **import** GaussianNB

*# Load Data from CSV*

data **=** pd**.**read\_csv('p-tennis.csv')

print("The first 5 Values of data is :\n", data**.**head())

*# obtain train data and train output*

X **=** data**.**iloc[:, :**-**1]

print("\nThe First 5 values of the train data is\n", X**.**head())

y **=** data**.**iloc[:, **-**1]

print("\nThe First 5 values of train output is\n", y**.**head())

*# convert them in numbers*

le\_outlook **=** LabelEncoder()

X**.**Outlook **=** le\_outlook**.**fit\_transform(X**.**Outlook)

le\_Temperature **=** LabelEncoder()

X**.**Temperature **=** le\_Temperature**.**fit\_transform(X**.**Temperature)

le\_Humidity **=** LabelEncoder()

X**.**Humidity **=** le\_Humidity**.**fit\_transform(X**.**Humidity)

le\_Windy **=** LabelEncoder()

X**.**Windy **=** le\_Windy**.**fit\_transform(X**.**Windy)

print("\nNow the Train output is\n", X**.**head())

le\_PlayTennis **=** LabelEncoder()

y **=** le\_PlayTennis**.**fit\_transform(y)

print("\nNow the Train output is\n",y)

**from** sklearn.model\_selection **import** train\_test\_split

X\_train, X\_test, y\_train, y\_test **=** train\_test\_split(X,y, test\_size **=** 0.20)

classifier **=** GaussianNB()

classifier**.**fit(X\_train, y\_train)

**from** sklearn.metrics **import** accuracy\_score

print("Accuracy is:", accuracy\_score(classifier**.**predict(X\_test), y\_test))

**Output:**

The first 5 Values of data is :

Outlook Temperature Humidity Windy PlayTennis

0 Sunny Hot High False No

1 Sunny Hot High True No

2 Overcast Hot High False Yes

3 Rainy Mild High False Yes

4 Rainy Cool Normal False Yes

The First 5 values of the train data is

Outlook Temperature Humidity Windy

0 Sunny Hot High False

1 Sunny Hot High True

2 Overcast Hot High False

3 Rainy Mild High False

4 Rainy Cool Normal False

The First 5 values of train output is

0 No

1 No

2 Yes

3 Yes

4 Yes

Name: PlayTennis, dtype: object

Now the Train output is

Outlook Temperature Humidity Windy

0 2 1 0 0

1 2 1 0 1

2 0 1 0 0

3 1 2 0 0

4 1 0 1 0

Now the Train output is

[0 0 1 1 1 0 1 0 1 1 1 1 1 0]

Accuracy is: 0.6666666666666666