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Assignment 5 Written Task

**TASK1**

**Output for Command python3 decision\_tree.py pendigits\_training.txt pendigits\_test.txt optimized 50**

tree= 1, node= 1, feature=16, thr= 21.57, gain=0.621424

tree= 1, node= 2, feature= 5, thr= 41.18, gain=0.587628

tree= 1, node= 3, feature=14, thr= 58.82, gain=0.697235

tree= 1, node= 4, feature=10, thr= 15.69, gain=0.670083

tree= 1, node= 5, feature=11, thr= 39.22, gain=0.629044

tree= 1, node= 6, feature= 1, thr= 35.29, gain=0.712500

tree= 1, node= 7, feature= 9, thr= 56.86, gain=0.814218

tree= 1, node= 8, feature=15, thr= 60.78, gain=0.475710

tree= 1, node= 9, feature= 6, thr= 64.71, gain=0.620325

tree= 1, node= 10, feature=15, thr= 37.25, gain=0.224713

tree= 1, node= 11, feature= 4, thr= 90.20, gain=0.686759

tree= 1, node= 12, feature=15, thr= 37.25, gain=0.281171

tree= 1, node= 13, feature=11, thr= 29.41, gain=0.584898

tree= 1, node= 14, feature=15, thr= 96.08, gain=0.737506

tree= 1, node= 15, feature= 8, thr= 24.33, gain=0.205385

tree= 1, node= 16, feature= 2, thr= 73.53, gain=0.027989

tree= 1, node= 17, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 18, feature=16, thr= 0.41, gain=0.188928

tree= 1, node= 19, feature=10, thr= 60.47, gain=0.530651

tree= 1, node= 20, feature=13, thr= 30.06, gain=0.640257

tree= 1, node= 21, feature= 9, thr= 34.59, gain=0.140904

tree= 1, node= 22, feature= 7, thr= 72.55, gain=0.509615

tree= 1, node= 23, feature= 8, thr= 77.10, gain=0.409412

tree= 1, node= 24, feature= 2, thr= 84.51, gain=0.550957

tree= 1, node= 25, feature=14, thr= 14.78, gain=0.131381

tree= 1, node= 26, feature=16, thr= 31.18, gain=0.222560

tree= 1, node= 27, feature=10, thr= 19.61, gain=0.464511

tree= 1, node= 28, feature=12, thr= 31.67, gain=0.157508

tree= 1, node= 29, feature=14, thr= 71.06, gain=0.344859

tree= 1, node= 30, feature= 3, thr= 54.90, gain=0.092930

tree= 1, node= 31, feature=10, thr= 58.82, gain=0.918296

tree= 1, node= 32, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 33, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 34, feature= 8, thr= 66.47, gain=0.110097

tree= 1, node= 35, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 36, feature=15, thr= 25.49, gain=0.773333

tree= 1, node= 37, feature= 1, thr= 39.22, gain=0.203813

tree= 1, node= 38, feature= 4, thr= 96.71, gain=0.374672

tree= 1, node= 39, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 40, feature=10, thr= 1.43, gain=0.077936

tree= 1, node= 41, feature= 7, thr= 68.14, gain=0.274080

tree= 1, node= 42, feature=15, thr= 96.08, gain=0.341335

tree= 1, node= 43, feature= 2, thr= 82.35, gain=0.324193

tree= 1, node= 44, feature= 3, thr= 88.59, gain=0.253482

tree= 1, node= 45, feature= 6, thr= 89.29, gain=0.811518

tree= 1, node= 46, feature= 9, thr= 76.47, gain=0.650022

tree= 1, node= 47, feature= 7, thr= 50.47, gain=0.757526

tree= 1, node= 48, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 49, feature= 4, thr= 87.45, gain=0.051386

tree= 1, node= 50, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 51, feature= 1, thr= 53.57, gain=0.129949

tree= 1, node= 52, feature=16, thr= 67.29, gain=0.265884

tree= 1, node= 53, feature=11, thr= 67.06, gain=0.773029

tree= 1, node= 54, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 55, feature=13, thr= 21.57, gain=0.159034

tree= 1, node= 56, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 57, feature= 6, thr= 54.41, gain=0.006884

tree= 1, node= 58, feature= 7, thr= 96.08, gain=0.024998

tree= 1, node= 59, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 60, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 61, feature= 2, thr= 3.92, gain=0.998846

tree= 1, node= 62, feature= 6, thr= 13.35, gain=0.035341

tree= 1, node= 63, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 64, feature= 8, thr= 71.86, gain=0.496889

tree= 1, node= 65, feature=11, thr= 60.78, gain=0.864204

tree= 1, node= 66, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 67, feature= 2, thr= 92.47, gain=0.078528

tree= 1, node= 68, feature= 6, thr= 68.63, gain=0.135036

tree= 1, node= 69, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 70, feature= 9, thr= 18.67, gain=0.368566

tree= 1, node= 71, feature= 8, thr= 73.02, gain=0.050120

tree= 1, node= 72, feature=13, thr= 55.47, gain=0.287642

tree= 1, node= 73, feature= 9, thr= 49.82, gain=0.208356

tree= 1, node= 74, feature= 2, thr= 39.18, gain=0.308576

tree= 1, node= 75, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 76, feature= 6, thr= 15.69, gain=0.106446

tree= 1, node= 77, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 78, feature= 1, thr= 78.43, gain=0.174910

tree= 1, node= 79, feature= 6, thr= 84.31, gain=0.901825

tree= 1, node= 80, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 81, feature= 7, thr= 70.59, gain=0.988057

tree= 1, node= 82, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 83, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 84, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 85, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 86, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 87, feature= 9, thr= 1.96, gain=0.027154

tree= 1, node= 88, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 89, feature=15, thr= 1.96, gain=0.057144

tree= 1, node= 90, feature= 5, thr= 62.75, gain=0.149994

tree= 1, node= 91, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 92, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 93, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 94, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 95, feature= 2, thr= 26.47, gain=0.028970

tree= 1, node= 96, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 97, feature= 7, thr= 45.33, gain=0.097300

tree= 1, node= 98, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 99, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=100, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=101, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=102, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=103, feature=14, thr= 6.08, gain=0.024501

tree= 1, node=104, feature=14, thr= 5.10, gain=0.465185

tree= 1, node=105, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=106, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=107, feature= 8, thr= 54.53, gain=0.349184

tree= 1, node=108, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=109, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=110, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=111, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=112, feature= 6, thr= 74.55, gain=0.060896

tree= 1, node=113, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=114, feature=10, thr= 5.61, gain=0.007149

tree= 1, node=115, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=116, feature= 7, thr= 58.29, gain=0.175730

tree= 1, node=117, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=118, feature= 1, thr= 73.33, gain=0.054012

tree= 1, node=119, feature=12, thr= 9.06, gain=0.541116

tree= 1, node=120, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=121, feature= 8, thr= 67.06, gain=0.321696

tree= 1, node=122, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=123, feature= 1, thr= 60.78, gain=0.098830

tree= 1, node=124, feature=10, thr= 18.55, gain=0.134335

tree= 1, node=125, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=126, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=127, feature= 2, thr= 79.29, gain=0.678954

tree= 1, node=128, feature= 5, thr= 48.04, gain=0.291818

tree= 1, node=129, feature=12, thr= 39.69, gain=0.517478

tree= 1, node=130, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=131, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=132, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=133, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=134, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=135, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=136, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=137, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=138, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=139, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=140, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=141, feature=10, thr= 88.47, gain=0.008575

tree= 1, node=142, feature= 7, thr= 67.45, gain=0.250919

tree= 1, node=143, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=144, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=145, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=146, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=147, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=148, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=149, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=150, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=151, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=152, feature= 2, thr= 89.59, gain=0.025926

tree= 1, node=153, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=154, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=155, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=156, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=157, feature= 4, thr= 89.02, gain=0.028237

tree= 1, node=158, feature= 9, thr= 24.51, gain=0.021367

tree= 1, node=159, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=160, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=161, feature=15, thr= 52.94, gain=0.111623

tree= 1, node=162, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=163, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=164, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=165, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=166, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=167, feature= 3, thr= 45.71, gain=0.103275

tree= 1, node=168, feature= 8, thr= 17.69, gain=0.008314

tree= 1, node=169, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=170, feature= 2, thr= 81.37, gain=0.056120

tree= 1, node=171, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=172, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=173, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=174, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=175, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=176, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=177, feature=16, thr= 9.12, gain=0.021405

tree= 1, node=178, feature= 7, thr= 21.57, gain=0.053910

tree= 1, node=179, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=180, feature= 2, thr= 66.67, gain=0.077022

tree= 1, node=181, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=182, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=183, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=184, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=185, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=186, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=187, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=188, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=189, feature= 4, thr= 99.12, gain=0.041635

tree= 1, node=190, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=191, feature= 3, thr= 41.47, gain=0.067329

tree= 1, node=192, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=193, feature= 3, thr= 86.33, gain=0.018695

tree= 1, node=194, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=195, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=196, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=197, feature=-1, thr= -1.00, gain=0.000000

**classification accuracy=0.8382**

**Output for Command python3 decision\_tree.py pendigits\_training.txt pendigits\_test.txt randomized 50**

tree= 1, node= 1, feature=11, thr= 56.86, gain=0.474440

tree= 1, node= 2, feature=14, thr= 27.45, gain=0.676611

tree= 1, node= 3, feature=12, thr= 37.25, gain=0.522972

tree= 1, node= 4, feature= 9, thr= 35.29, gain=0.317141

tree= 1, node= 5, feature=14, thr= 81.65, gain=0.710664

tree= 1, node= 6, feature= 3, thr= 64.71, gain=0.104459

tree= 1, node= 7, feature=14, thr= 60.78, gain=0.879792

tree= 1, node= 8, feature=13, thr= 41.18, gain=0.179793

tree= 1, node= 9, feature=15, thr= 60.78, gain=0.211328

tree= 1, node= 10, feature=10, thr= 54.90, gain=0.334623

tree= 1, node= 11, feature= 3, thr= 61.25, gain=0.026071

tree= 1, node= 12, feature=14, thr= 15.88, gain=0.897130

tree= 1, node= 13, feature= 4, thr= 99.02, gain=0.254690

tree= 1, node= 14, feature= 8, thr= 62.75, gain=0.793630

tree= 1, node= 15, feature= 1, thr= 1.96, gain=0.073895

tree= 1, node= 16, feature= 6, thr= 88.53, gain=0.491755

tree= 1, node= 17, feature=14, thr= 15.35, gain=0.173300

tree= 1, node= 18, feature=10, thr= 58.16, gain=0.282919

tree= 1, node= 19, feature= 1, thr= 6.67, gain=0.129717

tree= 1, node= 20, feature= 9, thr= 11.76, gain=0.114607

tree= 1, node= 21, feature= 9, thr= 45.10, gain=0.300426

tree= 1, node= 22, feature= 9, thr= 50.98, gain=0.066859

tree= 1, node= 23, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 24, feature= 4, thr= 90.47, gain=0.345011

tree= 1, node= 25, feature= 3, thr= 30.12, gain=0.088896

tree= 1, node= 26, feature= 8, thr= 46.67, gain=0.866824

tree= 1, node= 27, feature=16, thr= 28.55, gain=0.242354

tree= 1, node= 28, feature=16, thr= 1.02, gain=0.054422

tree= 1, node= 29, feature= 8, thr= 96.37, gain=0.200378

tree= 1, node= 30, feature=10, thr= 70.59, gain=0.584395

tree= 1, node= 31, feature=13, thr= 92.39, gain=0.222068

tree= 1, node= 32, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 33, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 34, feature=13, thr= 56.02, gain=0.066311

tree= 1, node= 35, feature= 5, thr= 52.35, gain=0.657353

tree= 1, node= 36, feature= 1, thr= 25.49, gain=0.643920

tree= 1, node= 37, feature= 5, thr= 86.27, gain=0.186259

tree= 1, node= 38, feature= 2, thr= 71.53, gain=0.447659

tree= 1, node= 39, feature= 8, thr= 54.06, gain=0.043532

tree= 1, node= 40, feature= 1, thr= 39.22, gain=0.342787

tree= 1, node= 41, feature= 8, thr= 31.37, gain=0.025451

tree= 1, node= 42, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 43, feature= 4, thr= 58.82, gain=0.547448

tree= 1, node= 44, feature=10, thr= 42.71, gain=0.015853

tree= 1, node= 45, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 46, feature= 7, thr= 54.90, gain=0.375446

tree= 1, node= 47, feature= 1, thr= 60.78, gain=0.586413

tree= 1, node= 48, feature= 5, thr= 21.57, gain=0.291818

tree= 1, node= 49, feature=12, thr= 28.29, gain=0.135687

tree= 1, node= 50, feature=11, thr= 92.41, gain=0.165928

tree= 1, node= 51, feature=16, thr= 26.47, gain=0.444196

tree= 1, node= 52, feature= 6, thr= 88.75, gain=0.436390

tree= 1, node= 53, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 54, feature= 4, thr= 98.04, gain=0.215096

tree= 1, node= 55, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 56, feature=13, thr= 60.29, gain=0.100184

tree= 1, node= 57, feature= 3, thr= 43.14, gain=0.093934

tree= 1, node= 58, feature= 1, thr= 0.02, gain=0.078982

tree= 1, node= 59, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 60, feature=14, thr= 99.24, gain=0.056230

tree= 1, node= 61, feature=15, thr= 38.59, gain=0.307649

tree= 1, node= 62, feature=10, thr= 5.49, gain=0.117222

tree= 1, node= 63, feature= 9, thr= 9.61, gain=0.076209

tree= 1, node= 64, feature=12, thr= 6.25, gain=0.479832

tree= 1, node= 65, feature= 4, thr= 75.55, gain=0.450067

tree= 1, node= 66, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 67, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 68, feature=15, thr= 24.29, gain=0.216122

tree= 1, node= 69, feature=11, thr= 43.06, gain=0.055492

tree= 1, node= 70, feature=16, thr= 11.18, gain=0.061566

tree= 1, node= 71, feature= 5, thr= 90.20, gain=0.170525

tree= 1, node= 72, feature=16, thr= 23.73, gain=0.315997

tree= 1, node= 73, feature=11, thr= 12.08, gain=0.175703

tree= 1, node= 74, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 75, feature= 9, thr= 4.10, gain=0.030987

tree= 1, node= 76, feature=15, thr= 89.41, gain=0.355969

tree= 1, node= 77, feature= 8, thr= 70.67, gain=0.020784

tree= 1, node= 78, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 79, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 80, feature= 7, thr= 76.47, gain=0.050717

tree= 1, node= 81, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 82, feature=12, thr= 11.61, gain=0.392147

tree= 1, node= 83, feature= 1, thr= 29.41, gain=0.788985

tree= 1, node= 84, feature= 6, thr= 82.35, gain=0.084236

tree= 1, node= 85, feature= 4, thr= 93.12, gain=0.028253

tree= 1, node= 86, feature= 4, thr= 68.65, gain=0.059114

tree= 1, node= 87, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 88, feature=12, thr= 0.55, gain=0.107887

tree= 1, node= 89, feature= 3, thr= 52.35, gain=0.255466

tree= 1, node= 90, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 91, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 92, feature=13, thr= 16.47, gain=0.200665

tree= 1, node= 93, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 94, feature=12, thr= 21.04, gain=0.180254

tree= 1, node= 95, feature= 2, thr= 74.76, gain=0.427659

tree= 1, node= 96, feature=16, thr= 0.00, gain=0.000000

tree= 1, node= 97, feature=15, thr= 23.53, gain=0.235221

tree= 1, node= 98, feature= 6, thr= 88.78, gain=0.403229

tree= 1, node= 99, feature=16, thr= 1.35, gain=0.009978

tree= 1, node=100, feature= 5, thr= 92.16, gain=0.237181

tree= 1, node=101, feature= 4, thr= 42.20, gain=0.044037

tree= 1, node=102, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=103, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=104, feature=14, thr= 81.12, gain=0.005803

tree= 1, node=105, feature= 9, thr= 66.67, gain=0.588622

tree= 1, node=106, feature= 5, thr= 33.33, gain=0.102899

tree= 1, node=107, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=108, feature=16, thr= 1.06, gain=0.167358

tree= 1, node=109, feature=11, thr= 18.71, gain=0.130995

tree= 1, node=110, feature= 4, thr= 96.16, gain=0.147861

tree= 1, node=111, feature=11, thr= 0.88, gain=0.483031

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tree= 1, node=113, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=114, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=115, feature= 9, thr= 6.47, gain=0.089767

tree= 1, node=116, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=117, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=118, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=119, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=120, feature=15, thr= 65.73, gain=0.067619

tree= 1, node=121, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=122, feature= 7, thr= 49.18, gain=0.247201

tree= 1, node=123, feature=12, thr= 0.65, gain=0.649625

tree= 1, node=124, feature= 6, thr= 85.33, gain=0.085817

tree= 1, node=125, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=126, feature=10, thr= 30.86, gain=0.487847

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tree= 1, node=128, feature=-1, thr= -1.00, gain=0.000000

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tree= 1, node=131, feature=13, thr= 69.75, gain=0.063123

tree= 1, node=132, feature= 4, thr= 89.55, gain=0.029271

tree= 1, node=133, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=134, feature= 9, thr= 8.82, gain=0.023720

tree= 1, node=135, feature=15, thr= 52.94, gain=0.996792

tree= 1, node=136, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=137, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=138, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=139, feature=10, thr= 55.47, gain=0.064498

tree= 1, node=140, feature= 4, thr= 98.06, gain=0.212697

tree= 1, node=141, feature= 3, thr= 40.90, gain=0.040243

tree= 1, node=142, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=143, feature= 7, thr= 41.18, gain=0.745313

tree= 1, node=144, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=145, feature= 9, thr= 57.82, gain=0.120466

tree= 1, node=146, feature=12, thr= 0.00, gain=0.000000

tree= 1, node=147, feature=15, thr= 39.22, gain=0.255116

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tree= 1, node=149, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=150, feature=-1, thr= -1.00, gain=0.000000

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tree= 1, node=160, feature= 2, thr= 29.22, gain=0.252531

tree= 1, node=161, feature= 1, thr= 23.53, gain=0.751202

tree= 1, node=162, feature=11, thr= 92.41, gain=0.114698

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tree= 1, node=164, feature=10, thr= 79.41, gain=0.033411

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tree= 1, node=166, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=167, feature=13, thr= 90.94, gain=0.094910

tree= 1, node=168, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=169, feature= 8, thr= 29.51, gain=0.029899

tree= 1, node=170, feature=14, thr=100.00, gain=0.000000

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tree= 1, node=199, feature= 3, thr= 44.71, gain=0.038005

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tree= 1, node=206, feature= 9, thr= 75.67, gain=0.075046

tree= 1, node=207, feature= 1, thr= 1.16, gain=0.060435

tree= 1, node=208, feature= 5, thr= 18.53, gain=0.022141

tree= 1, node=209, feature= 6, thr= 89.47, gain=0.090544

tree= 1, node=210, feature=16, thr= 56.86, gain=0.410838

tree= 1, node=211, feature=12, thr= 32.25, gain=0.170341

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tree= 1, node=227, feature=11, thr= 79.76, gain=0.083537

tree= 1, node=228, feature=13, thr= 43.53, gain=0.078558

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tree= 1, node=231, feature= 4, thr= 98.08, gain=0.354216

tree= 1, node=232, feature= 2, thr= 67.08, gain=0.388018

tree= 1, node=233, feature=14, thr= 24.67, gain=0.147706

tree= 1, node=234, feature= 4, thr= 82.12, gain=0.024492

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tree= 1, node=421, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=422, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=423, feature= 3, thr= 25.71, gain=0.462506

tree= 1, node=424, feature=10, thr= 12.08, gain=0.172037

tree= 1, node=425, feature= 5, thr= 39.22, gain=0.086343

tree= 1, node=426, feature= 7, thr= 67.06, gain=0.174455

tree= 1, node=427, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=428, feature= 7, thr= 0.24, gain=0.053347

tree= 1, node=429, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=430, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=431, feature= 9, thr= 79.14, gain=0.044085

tree= 1, node=432, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=433, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=434, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=435, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=436, feature= 9, thr= 91.57, gain=0.127651

tree= 1, node=437, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=438, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=439, feature= 6, thr= 94.18, gain=0.088254

tree= 1, node=440, feature= 7, thr= 25.41, gain=0.096945

tree= 1, node=441, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=442, feature=15, thr= 87.37, gain=0.035323

tree= 1, node=443, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=444, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=445, feature= 3, thr= 46.35, gain=0.021991

tree= 1, node=446, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=447, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=448, feature=-1, thr= -1.00, gain=0.000000

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tree= 1, node=453, feature=-1, thr= -1.00, gain=0.000000

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tree= 1, node=456, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=457, feature= 1, thr= 15.53, gain=0.228538

tree= 1, node=458, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=459, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=460, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=461, feature=11, thr= 1.10, gain=0.038574

tree= 1, node=462, feature= 7, thr= 98.27, gain=0.075603

tree= 1, node=463, feature=14, thr= 32.12, gain=0.104559

tree= 1, node=464, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=465, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=466, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=467, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=468, feature=-1, thr= -1.00, gain=0.000000

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tree= 1, node=471, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=472, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=473, feature=-1, thr= -1.00, gain=0.000000

**classification accuracy=0.7140**

**Output for Command python3 decision\_tree.py pendigits\_training.txt pendigits\_test.txt forest3 50**

tree= 1, node= 1, feature=12, thr= 35.29, gain=0.466267

tree= 1, node= 2, feature= 4, thr= 96.53, gain=0.349658

tree= 1, node= 3, feature= 2, thr= 98.04, gain=0.408999

tree= 1, node= 4, feature= 6, thr= 71.06, gain=0.597131

tree= 1, node= 5, feature=10, thr= 33.35, gain=0.662826

tree= 1, node= 6, feature=15, thr= 98.04, gain=0.399265

tree= 1, node= 7, feature=14, thr= 60.78, gain=0.819294

tree= 1, node= 8, feature=15, thr= 47.06, gain=0.469430

tree= 1, node= 9, feature=10, thr= 37.43, gain=0.234399

tree= 1, node= 10, feature=11, thr= 35.29, gain=0.307247

tree= 1, node= 11, feature=16, thr= 6.43, gain=0.089299

tree= 1, node= 12, feature= 8, thr= 47.06, gain=0.881814

tree= 1, node= 13, feature= 2, thr= 67.25, gain=0.292814

tree= 1, node= 14, feature= 5, thr= 35.29, gain=0.306374

tree= 1, node= 15, feature= 6, thr= 34.82, gain=0.299387

tree= 1, node= 16, feature= 6, thr= 61.31, gain=0.111700

tree= 1, node= 17, feature= 3, thr= 52.94, gain=0.456562

tree= 1, node= 18, feature= 4, thr= 87.53, gain=0.260793

tree= 1, node= 19, feature= 5, thr= 45.10, gain=0.249250

tree= 1, node= 20, feature= 1, thr= 54.90, gain=0.409945

tree= 1, node= 21, feature= 1, thr= 11.76, gain=0.702803

tree= 1, node= 22, feature= 3, thr= 86.41, gain=0.157356

tree= 1, node= 23, feature= 2, thr= 88.39, gain=0.250532

tree= 1, node= 24, feature=12, thr= 78.67, gain=0.191063

tree= 1, node= 25, feature= 5, thr= 35.29, gain=0.274616

tree= 1, node= 26, feature=16, thr= 1.96, gain=0.892121

tree= 1, node= 27, feature= 8, thr= 15.69, gain=0.316062

tree= 1, node= 28, feature=14, thr= 49.41, gain=0.031802

tree= 1, node= 29, feature=14, thr= 22.35, gain=0.374261

tree= 1, node= 30, feature=12, thr= 67.37, gain=0.059879

tree= 1, node= 31, feature= 1, thr= 54.90, gain=0.371625

tree= 1, node= 32, feature= 6, thr= 49.47, gain=0.033296

tree= 1, node= 33, feature= 5, thr= 47.06, gain=0.530224

tree= 1, node= 34, feature= 7, thr= 33.33, gain=0.876716

tree= 1, node= 35, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 36, feature=10, thr= 26.12, gain=0.143741

tree= 1, node= 37, feature= 8, thr= 51.04, gain=0.269175

tree= 1, node= 38, feature=10, thr= 53.22, gain=0.426593

tree= 1, node= 39, feature=16, thr= 12.94, gain=0.666706

tree= 1, node= 40, feature= 3, thr= 33.33, gain=0.045760

tree= 1, node= 41, feature=13, thr= 45.10, gain=0.069191

tree= 1, node= 42, feature= 3, thr= 27.24, gain=0.129612

tree= 1, node= 43, feature= 7, thr= 34.59, gain=0.862068

tree= 1, node= 44, feature= 6, thr= 86.24, gain=0.120379

tree= 1, node= 45, feature= 3, thr= 96.18, gain=0.089385

tree= 1, node= 46, feature=15, thr= 25.67, gain=0.134332

tree= 1, node= 47, feature=16, thr= 21.67, gain=0.128405

tree= 1, node= 48, feature=16, thr= 52.94, gain=0.220336

tree= 1, node= 49, feature=11, thr= 97.57, gain=0.136396

tree= 1, node= 50, feature=13, thr= 45.10, gain=0.025842

tree= 1, node= 51, feature=13, thr= 68.63, gain=0.075565

tree= 1, node= 52, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 53, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 54, feature= 1, thr= 12.35, gain=0.026465

tree= 1, node= 55, feature=15, thr=100.00, gain=0.000000

tree= 1, node= 56, feature=16, thr= 0.31, gain=0.021387

tree= 1, node= 57, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 58, feature= 8, thr= 96.29, gain=0.101924

tree= 1, node= 59, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 60, feature= 6, thr= 31.33, gain=0.044779

tree= 1, node= 61, feature= 5, thr= 34.08, gain=0.611061

tree= 1, node= 62, feature= 6, thr= 47.24, gain=0.111414

tree= 1, node= 63, feature=10, thr= 1.33, gain=0.129253

tree= 1, node= 64, feature= 6, thr= 44.29, gain=0.041608

tree= 1, node= 65, feature= 8, thr= 35.76, gain=0.162108

tree= 1, node= 66, feature=11, thr= 84.78, gain=0.139964

tree= 1, node= 67, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 68, feature= 8, thr= 21.96, gain=0.777544

tree= 1, node= 69, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 70, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 71, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 72, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 73, feature=12, thr= 0.41, gain=0.253448

tree= 1, node= 74, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 75, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 76, feature= 8, thr= 85.33, gain=0.189002

tree= 1, node= 77, feature= 7, thr= 54.90, gain=0.296641

tree= 1, node= 78, feature=15, thr= 98.73, gain=0.095431

tree= 1, node= 79, feature=11, thr= 0.69, gain=0.157091

tree= 1, node= 80, feature= 6, thr= 72.82, gain=0.137060

tree= 1, node= 81, feature= 3, thr= 56.86, gain=0.572581

tree= 1, node= 82, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 83, feature= 2, thr= 82.59, gain=0.294691

tree= 1, node= 84, feature=14, thr= 50.00, gain=0.539206

tree= 1, node= 85, feature= 6, thr= 69.53, gain=0.247877

tree= 1, node= 86, feature=15, thr= 45.10, gain=0.309079

tree= 1, node= 87, feature= 4, thr= 99.06, gain=0.026882

tree= 1, node= 88, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 89, feature=12, thr= 21.24, gain=0.467433

tree= 1, node= 90, feature=16, thr= 21.24, gain=0.022961

tree= 1, node= 91, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 92, feature=16, thr= 10.02, gain=0.038323

tree= 1, node= 93, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 94, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 95, feature=11, thr= 84.31, gain=0.568158

tree= 1, node= 96, feature= 6, thr= 21.33, gain=0.199773

tree= 1, node= 97, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 98, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node= 99, feature=14, thr= 39.24, gain=0.185455

tree= 1, node=100, feature=16, thr= 2.90, gain=0.165064

tree= 1, node=101, feature=16, thr= 10.16, gain=0.088880

tree= 1, node=102, feature= 5, thr= 57.04, gain=0.047836

tree= 1, node=103, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=104, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=105, feature=14, thr= 72.33, gain=0.927159

tree= 1, node=106, feature=10, thr= 83.24, gain=0.072938

tree= 1, node=107, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=108, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=109, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=110, feature=13, thr= 94.90, gain=0.280857

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tree= 1, node=114, feature= 7, thr= 84.78, gain=0.382720

tree= 1, node=115, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=116, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=117, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=118, feature= 7, thr= 55.02, gain=0.137099

tree= 1, node=119, feature=10, thr= 2.90, gain=0.087281

tree= 1, node=120, feature= 2, thr=100.00, gain=0.000000

tree= 1, node=121, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=122, feature= 1, thr= 62.75, gain=0.100001

tree= 1, node=123, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=124, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=125, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=126, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=127, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=128, feature=11, thr= 72.55, gain=0.483229

tree= 1, node=129, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=130, feature= 9, thr= 67.47, gain=0.434973

tree= 1, node=131, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=132, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=133, feature= 4, thr= 98.06, gain=0.006335

tree= 1, node=134, feature=15, thr= 96.24, gain=0.093740

tree= 1, node=135, feature=11, thr= 29.67, gain=0.017949

tree= 1, node=136, feature=14, thr= 31.22, gain=0.090052

tree= 1, node=137, feature= 4, thr= 99.02, gain=0.056744

tree= 1, node=138, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=139, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=140, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=141, feature=13, thr= 50.98, gain=0.038785

tree= 1, node=142, feature= 9, thr= 28.47, gain=0.040679

tree= 1, node=143, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=144, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=145, feature= 4, thr=100.00, gain=0.000000

tree= 1, node=146, feature= 1, thr= 64.71, gain=0.722309

tree= 1, node=147, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=148, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=149, feature=16, thr= 0.12, gain=0.033597

tree= 1, node=150, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=151, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=152, feature=13, thr= 44.24, gain=0.033464

tree= 1, node=153, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=154, feature= 5, thr= 64.71, gain=0.629593

tree= 1, node=155, feature= 9, thr= 70.24, gain=0.489541

tree= 1, node=156, feature=12, thr= 52.08, gain=0.050727

tree= 1, node=157, feature=13, thr= 67.37, gain=0.096976

tree= 1, node=158, feature=10, thr= 70.16, gain=0.013460

tree= 1, node=159, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=160, feature= 2, thr= 79.61, gain=0.086306

tree= 1, node=161, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=162, feature= 7, thr= 70.59, gain=0.543266

tree= 1, node=163, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=164, feature= 7, thr= 72.55, gain=0.815355

tree= 1, node=165, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=166, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=167, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=168, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=169, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=170, feature= 9, thr= 83.39, gain=0.016009

tree= 1, node=171, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=172, feature=11, thr= 68.63, gain=0.086162

tree= 1, node=173, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=174, feature= 1, thr= 18.90, gain=0.111396

tree= 1, node=175, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=176, feature= 4, thr= 78.06, gain=0.288593

tree= 1, node=177, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=178, feature= 3, thr= 25.88, gain=0.013729

tree= 1, node=179, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=180, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=181, feature= 1, thr= 30.12, gain=0.042402

tree= 1, node=182, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=183, feature= 7, thr= 28.24, gain=0.101067

tree= 1, node=184, feature=16, thr= 0.22, gain=0.057226

tree= 1, node=185, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=186, feature= 9, thr= 53.86, gain=0.089832

tree= 1, node=187, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=188, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=189, feature= 3, thr= 19.41, gain=0.044997

tree= 1, node=190, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=191, feature=12, thr= 22.65, gain=0.209128

tree= 1, node=192, feature= 2, thr= 79.73, gain=0.245806

tree= 1, node=193, feature=11, thr= 34.02, gain=0.021159

tree= 1, node=194, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=195, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=196, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=197, feature=12, thr= 3.43, gain=0.163482

tree= 1, node=198, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=199, feature=10, thr= 23.22, gain=0.218441

tree= 1, node=200, feature= 6, thr= 62.45, gain=0.117595

tree= 1, node=201, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=202, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=203, feature= 1, thr= 93.10, gain=0.264460

tree= 1, node=204, feature=14, thr= 14.12, gain=0.045036

tree= 1, node=205, feature=11, thr= 20.75, gain=0.230710

tree= 1, node=206, feature= 7, thr= 23.53, gain=0.192869

tree= 1, node=207, feature= 1, thr= 58.82, gain=0.554901

tree= 1, node=208, feature=11, thr= 87.14, gain=0.067249

tree= 1, node=209, feature=15, thr= 6.37, gain=0.042542

tree= 1, node=210, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=211, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=212, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=213, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=214, feature= 4, thr= 65.69, gain=0.371384

tree= 1, node=215, feature= 9, thr= 54.90, gain=0.057144

tree= 1, node=216, feature= 8, thr= 1.06, gain=0.158112

tree= 1, node=217, feature=16, thr= 95.20, gain=0.339637

tree= 1, node=218, feature=12, thr= 83.12, gain=0.024407

tree= 1, node=219, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=220, feature= 7, thr= 11.18, gain=0.023877

tree= 1, node=221, feature= 5, thr= 21.04, gain=0.206970

tree= 1, node=222, feature=12, thr= 48.47, gain=0.575890

tree= 1, node=223, feature=15, thr= 1.90, gain=0.157910

tree= 1, node=224, feature= 5, thr= 68.63, gain=0.059359

tree= 1, node=225, feature=13, thr= 78.12, gain=0.044261

tree= 1, node=226, feature=13, thr= 54.47, gain=0.191134

tree= 1, node=227, feature=14, thr= 17.63, gain=0.017728

tree= 1, node=228, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=229, feature= 2, thr= 99.02, gain=0.001495

tree= 1, node=230, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=231, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=232, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=233, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=234, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=235, feature= 3, thr= 26.76, gain=0.044224

tree= 1, node=236, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=237, feature=12, thr= 28.67, gain=0.039352

tree= 1, node=238, feature=-1, thr= -1.00, gain=0.000000

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tree= 1, node=240, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=241, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=242, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=243, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=244, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=245, feature= 6, thr= 60.61, gain=0.066573

tree= 1, node=246, feature= 5, thr= 53.41, gain=0.211981

tree= 1, node=247, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=248, feature= 2, thr= 73.39, gain=0.161903

tree= 1, node=249, feature=15, thr= 98.94, gain=0.133193

tree= 1, node=250, feature=15, thr= 98.90, gain=0.166896

tree= 1, node=251, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=252, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=253, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=254, feature= 5, thr= 97.33, gain=0.038772

tree= 1, node=255, feature=-1, thr= -1.00, gain=0.000000

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tree= 1, node=258, feature= 5, thr= 96.08, gain=0.176123

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tree= 1, node=263, feature= 8, thr= 58.59, gain=0.587897

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tree= 1, node=279, feature= 7, thr= 14.71, gain=0.098235

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tree= 2, node=112, feature=14, thr= 49.02, gain=0.457432

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tree= 2, node=118, feature= 3, thr= 4.08, gain=0.013647

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tree= 3, node= 7, feature=14, thr= 54.90, gain=0.558482

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tree= 3, node= 9, feature=15, thr= 0.04, gain=0.007485

tree= 3, node= 10, feature= 9, thr= 74.51, gain=0.495481

tree= 3, node= 11, feature= 1, thr= 1.96, gain=0.318191

tree= 3, node= 12, feature= 9, thr= 43.14, gain=0.398278

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tree= 3, node= 14, feature= 2, thr= 99.02, gain=0.071317

tree= 3, node= 15, feature= 9, thr= 45.10, gain=0.603513

tree= 3, node= 16, feature=14, thr= 48.33, gain=0.321420

tree= 3, node= 17, feature= 8, thr= 76.94, gain=0.388308

tree= 3, node= 18, feature= 1, thr= 68.63, gain=0.347977

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tree= 3, node= 21, feature= 8, thr= 25.49, gain=0.859781

tree= 3, node= 22, feature=14, thr= 15.69, gain=0.732662

tree= 3, node= 23, feature= 1, thr= 73.10, gain=0.225293

tree= 3, node= 24, feature= 4, thr= 86.86, gain=0.549481

tree= 3, node= 25, feature=10, thr= 56.86, gain=0.469684

tree= 3, node= 26, feature=12, thr= 40.35, gain=0.757484

tree= 3, node= 27, feature= 3, thr= 20.59, gain=0.155142

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tree= 3, node= 37, feature=10, thr= 6.75, gain=0.638629

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tree= 3, node= 39, feature= 4, thr= 98.61, gain=0.224103

tree= 3, node= 40, feature=13, thr= 41.41, gain=0.056003

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tree= 3, node= 42, feature= 3, thr= 52.10, gain=0.333954

tree= 3, node= 43, feature= 7, thr= 59.24, gain=0.381236

tree= 3, node= 44, feature= 1, thr= 45.16, gain=0.085708

tree= 3, node= 45, feature=12, thr= 18.43, gain=0.864440

tree= 3, node= 46, feature=10, thr= 45.37, gain=0.794839

tree= 3, node= 47, feature= 8, thr= 38.65, gain=0.029576

tree= 3, node= 48, feature= 1, thr= 37.25, gain=0.450264

tree= 3, node= 49, feature= 6, thr= 43.73, gain=0.210315

tree= 3, node= 50, feature=11, thr= 23.88, gain=0.242999

tree= 3, node= 51, feature=14, thr= 65.49, gain=0.280894

tree= 3, node= 52, feature= 6, thr= 64.61, gain=0.667166

tree= 3, node= 53, feature= 4, thr= 88.82, gain=0.353083

tree= 3, node= 54, feature= 3, thr= 25.49, gain=0.585433

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tree= 3, node=268, feature=12, thr= 47.12, gain=0.437251

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tree= 3, node=280, feature= 1, thr= 19.22, gain=0.134657

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tree= 3, node=297, feature= 6, thr= 88.63, gain=0.068420

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tree= 3, node=303, feature= 9, thr= 47.04, gain=0.009558

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tree= 3, node=305, feature= 2, thr= 81.14, gain=0.043412

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tree= 3, node=329, feature=-1, thr= -1.00, gain=0.000000

tree= 3, node=330, feature=15, thr= 99.04, gain=0.007645

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tree= 3, node=334, feature=-1, thr= -1.00, gain=0.000000

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tree= 3, node=336, feature= 7, thr= 62.59, gain=0.089703

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tree= 3, node=343, feature= 2, thr= 92.24, gain=0.050364

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tree= 3, node=345, feature=-1, thr= -1.00, gain=0.000000

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tree= 3, node=348, feature=-1, thr= -1.00, gain=0.000000

tree= 3, node=349, feature=-1, thr= -1.00, gain=0.000000

tree= 3, node=350, feature=-1, thr= -1.00, gain=0.000000

tree= 3, node=351, feature=10, thr= 22.10, gain=0.285575

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tree= 3, node=353, feature= 3, thr= 21.65, gain=0.031511

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tree= 3, node=356, feature=-1, thr= -1.00, gain=0.000000

tree= 3, node=357, feature=11, thr= 1.35, gain=0.087918

tree= 3, node=358, feature= 3, thr= 31.00, gain=0.017287

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tree= 3, node=362, feature=-1, thr= -1.00, gain=0.000000

tree= 3, node=363, feature=-1, thr= -1.00, gain=0.000000

tree= 3, node=364, feature= 5, thr= 99.29, gain=0.082732

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tree= 3, node=370, feature=-1, thr= -1.00, gain=0.000000

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tree= 3, node=372, feature=13, thr= 47.22, gain=0.198445

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tree= 3, node=376, feature=13, thr= 39.24, gain=0.130171

tree= 3, node=377, feature=-1, thr= -1.00, gain=0.000000

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tree= 3, node=379, feature=-1, thr= -1.00, gain=0.000000

tree= 3, node=380, feature=-1, thr= -1.00, gain=0.000000

tree= 3, node=381, feature= 8, thr= 35.84, gain=0.199473

tree= 3, node=382, feature=15, thr=100.00, gain=0.000000

tree= 3, node=383, feature= 6, thr= 94.29, gain=0.057435

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tree= 3, node=387, feature= 8, thr= 44.47, gain=0.012249

tree= 3, node=388, feature=-1, thr= -1.00, gain=0.000000

tree= 3, node=389, feature=13, thr= 45.88, gain=0.557855

tree= 3, node=390, feature=10, thr= 0.84, gain=0.518508

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tree= 3, node=395, feature=-1, thr= -1.00, gain=0.000000

tree= 3, node=396, feature=10, thr= 0.00, gain=0.000000

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tree= 3, node=399, feature=11, thr= 3.24, gain=0.051801

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tree= 3, node=401, feature=16, thr= 21.88, gain=0.244765

tree= 3, node=402, feature=-1, thr= -1.00, gain=0.000000

tree= 3, node=403, feature=-1, thr= -1.00, gain=0.000000

**classification accuracy=0.8557**

**TASK 2**

**Part a):**

Given,80 people decided to wait, and 20 people decided not to wait. Entropy of parent node A is given by,

(

**Part b):**

On the child cases

Fore Node B, 20 waited and 15 didn’t if it was weekend.

Fore Node C, 60 waited and 5 didn’t if it was not weekend.

Entropy at node B= (

Entropy at node C= (

Information gain=H(A) – (H(B) + H(C)) **= 0.1228**

*Information gain for the weekend test at Node A is 0.1228.*

**Part c):**

**Information gain at Node E is 0.**

**Part d):**

The test case hungry patron who came in a rainy Tuesday end up in **Node F.** The decision tree output for that case is “**will wait”.**

**Part e)**

The test case not hungry patron who came in a sunny Saturday end up in **Node H.** The decision tree output for that case is “**will not wait”.**

**TASK3**

For parent class there are 5 X’s and 5 Y’s

(

There are three attributes A,B and C.

So for A, when A=1 🡪X=3, Y=0

For A, when A=2 🡪X=1,Y=3

For A, when A=3 🡪X=1,Y=2

*Information gain using A = [ = 0.4*

FOR B

when B=1 🡪X=1, Y=3

For B, when B=2 🡪X=3,Y=1

For A, when B=3 🡪X=1,Y=1

*Information gain using B=* 1 – [ =0.1510

FOR C

when C=1 🡪X=1, Y=4

For C, when C=2 🡪X=3,Y=1

For C, when C=3 🡪X=1,Y=0

*Information gain using C =* 1 – [ =0.3145

***Therefore, comparing the information gain of A, B and C:***

***A>C>B 🡪 0.4>0.3145>0.1510***

***Here, Attribute A achieves the highest information gain at the root.***

**TASK4**

**Part a):**

*Highest possible entropy value at Node N with 4 class labels =**log2N =* ***log24 = 2***

*Lowest possible entropy value at Node N=* ***0***

**Part b):**

*Highest possible information gain at Node N when chosen attribute K is the* ***entropy at node N*** *when sum of all the child node results to 0 as information gain equals entropy of parent subtracting sum of weighted entropy of all the child Node.*

***Lowest possible information gain at Node N is 0*** *when entropy at node N is equal to weighted sum of entropy of all the child Node.*

**TASK 5**

As the given classifier is binary, classifier gives 28% accuracy meaning it gives wrong answer

72%. So, we can achieve the accuracy better than 60% by flipping the answer of the classifier. By this, classifier can give guaranteed accuracy of 72% which is better than 60% accuracy.