1. ID3 ON contact-lenses SOFT/HARD/NONE

- ATTRIBUTE "AGE"

AGE = YOUNG

$info([2,2,4]) = E\left(\frac{2}{8}, \frac{2}{8}, \frac{4}{8}\right) = -\frac{2}{8}\cdot\log\left(\frac{2}{8}\right) - \frac{2}{8}\cdot\log\left(\frac{2}{8}\right) - \frac{4}{8}\cdot\log\left(\frac{4}{8}\right) = 0.451$ (0.301)

AGE = PRE-PRESBYOPIC

$info([2,1,5]) = E\left(\frac{2}{8}, \frac{1}{8}, \frac{5}{8}\right) = -\frac{2}{8}\cdot\log\left(\frac{2}{8}\right) - \frac{1}{8}\cdot\log\left(\frac{1}{8}\right) - \frac{5}{8}\cdot\log\left(\frac{5}{8}\right) = 0.391$

AGE = PRESBYOPIC

$info([1,1,6]) = E\left(\frac{1}{8}, \frac{1}{8}, \frac{6}{8}\right) = -\frac{1}{8}\cdot\log\left(\frac{1}{8}\right) - \frac{1}{8}\cdot\log\left(\frac{1}{8}\right) - \frac{6}{8}\cdot\log\left(\frac{6}{8}\right) = 0.319$

$info([2,24],[2,1,5],[1,1,6]) = .451\left(\frac{8}{24}\right) + .391\left(\frac{8}{24}\right) + .319\left(\frac{8}{24}\right) = \boxed{0.387}$

ATTRIBUTE "SPECTACLE-PRESCRIP"

= HYPERMETROPE

$info([3,1,8]) = E\left(\frac{3}{12}, \frac{1}{12}, \frac{8}{12}\right) = -\frac{3}{12}\cdot\log\left(\frac{3}{12}\right) - \frac{1}{12}\cdot\log\left(\frac{1}{12}\right) - \frac{8}{12}\cdot\log\left(\frac{8}{12}\right) = 0.358$

= MYOPE

$info([2,3,7]) = E\left(\frac{2}{12}, \frac{3}{12}, \frac{7}{12}\right) = -\frac{2}{12}\log\left(\frac{2}{12}\right) - \frac{3}{12}\cdot\log\left(\frac{3}{12}\right) - \frac{7}{12}\cdot\log\left(\frac{7}{12}\right) = 0.417$

$info([3,1,8],[2,3,7]) = .358\left(\frac{12}{24}\right) + .417\left(\frac{12}{24}\right) = \underline{0.389}$

ATTRIBUTE "ASTIGMATISM"

= YES

$info([0,4,8]) = E\left(\frac{0}{12}, \frac{4}{12}, \frac{8}{12}\right) = 0 - \frac{4}{12}\cdot\log\left(\frac{4}{12}\right) - \frac{8}{12}\cdot\log\left(\frac{8}{12}\right) = 0.276$

= NO

$info([5,0,7]) = E\left(\frac{5}{12}, \frac{0}{12}, \frac{7}{12}\right) = -\frac{5}{12}\cdot\log\left(\frac{5}{12}\right) - 0 - \frac{7}{12}\cdot\log\left(\frac{7}{12}\right) = 0.295$

- $info([0,4,8],[5,0,7]) = .276\left(\frac{12}{24}\right) + .295\left(\frac{12}{24}\right) = \boxed{0.286}$

ATTRIBUTE "TEAR-PROD-RATE"

= NORMAL

$info([5,4,3]) = E\left(\frac{5}{12}, \frac{4}{12}, \frac{3}{12}\right) = -\frac{5}{12}\cdot\log\left(\frac{5}{12}\right) - \frac{4}{12}\cdot\log\left(\frac{4}{12}\right) - \frac{3}{12}\cdot\log\left(\frac{3}{12}\right) = 0.468$

= REDUCED

$info([0,0,12]) = E\left(\frac{0}{12}, \frac{0}{12}, \frac{12}{12}\right) = -0 - 0 - 0 = 0$

$info([5,4,3],[0,0,12]) = .468\left(\frac{12}{24}\right) + 0\left(\frac{12}{24}\right) = \underline{0.234}$ * ROOT NODE

TEAR-PROD-RATE = "NORMAL"

SPECTACLE-PRESCRIP

= HYPERMETROPE

$info([3,1,2]) = E\left(\frac{3}{6}, \frac{1}{6}, \frac{2}{6}\right) = -\frac{3}{6}\cdot\log\left(\frac{3}{6}\right) - \frac{1}{6}\cdot\log\left(\frac{1}{6}\right) - \frac{2}{6}\cdot\log\left(\frac{2}{6}\right) = 0.439$

= MYOPE

$info([2,3,1]) = E\left(\frac{2}{6}, \frac{3}{6}, \frac{1}{6}\right) = 0.439$

$info([3,1,2],[2,3,1]) = .439\left(\frac{6}{12}\right) + .439\left(\frac{6}{12}\right) = \boxed{0.439}$

ASTIGMATISM

= YES

$info([0,4,2]) = E\left(0, \frac{4}{6}, \frac{2}{6}\right) = 0 - \frac{4}{6}\cdot\log\left(\frac{4}{6}\right) - \frac{2}{6}\cdot\log\left(\frac{2}{6}\right) = 0.276$

= no

$info([5,0,1]) = E\left(\frac{5}{6}, 0, \frac{1}{6}\right) = -\frac{5}{6}\cdot\log\left(\frac{5}{6}\right) - 0 - \frac{1}{6}\cdot\log\left(\frac{1}{6}\right) = 0.196$

$info([0,4,2],[5,0,1]) = .276\left(\frac{6}{12}\right) + .196\left(\frac{6}{12}\right) = \boxed{0.236}$ * 1ST LEVEL NODE

AGE

= PRE-PRESBYOBIC

$info([2,1,1]) = E\left(\frac{2}{4}, \frac{1}{4}, \frac{1}{4}\right) = -\frac{2}{4}\cdot\log\left(\frac{2}{4}\right) - \frac{1}{4}\cdot\log\left(\frac{1}{4}\right) - \frac{1}{4}\cdot\log\left(\frac{1}{4}\right) = 0.452$

= PRESBYOBIC

$info([1,1,2]) = E\left(\frac{1}{4}, \frac{1}{4}, \frac{2}{4}\right) = 0.452$

= YOUNG

$info([2,2,0]) = E\left(\frac{2}{4}, \frac{2}{4}, 0\right) = -\frac{2}{4}\cdot\log\left(\frac{2}{4}\right) - \frac{2}{4}\cdot\log\left(\frac{2}{4}\right) - 0 = 0.301$

$info(AGE) = .452\left(\frac{4}{12}\right) + .452\left(\frac{4}{12}\right) + .301\left(\frac{4}{12}\right) = \boxed{0.402}$

TEAR-PROD-RATE = "REDUCED"

SPEC-PRESCRIP

= HYPERMETROPE

$info([0,0,6]) = E\left(0, 0, \frac{6}{6}\right) = -0 - 0 - \frac{6}{6}\log\left(\frac{6}{6}\right) = 0$

= MYOPE

$info([0,0,6]) = 0$

$info([0,0,6],[0,0,6]) = 0$

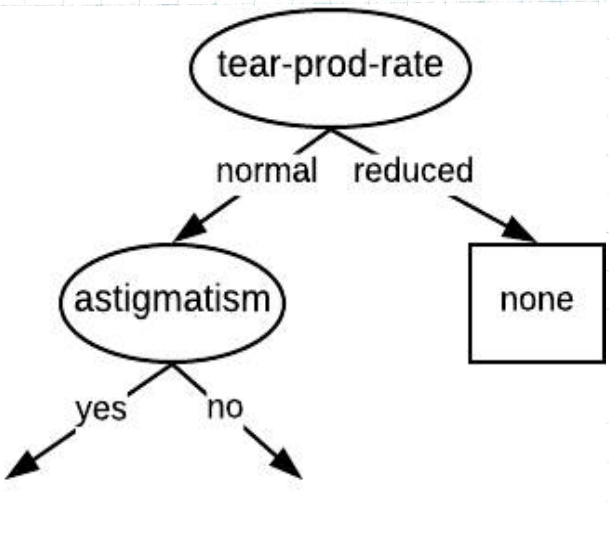
ASTIGMATISM

$info = 0$

AGE

$info = 0$

∴ REDUCED = NONE 1ST LEVEL LEAF



rule #1

if ___ then → yes Current accuracy = 9/14

if (wind = F) then → yes Coverage ⇒ 8/14

accuracy = 6/8

if (windy = F) ∧ (Humidity = normal) → yes Coverage = 4/14

accuracy = 4/4 ⇒ 100%

rule #2

if ___ then → yes current accuracy = 9/14

if (temp = mild) → yes Coverage = 6/14

accuracy = 4/6

if (temp = Mild) ∧ (Humidity = Normal) → yes Coverage = 2/14

accuracy = 2/2 ⇒ 100%

Eng 473 A1

Question 3

Pre-Presbyopic, hypermitrope, yes, reduced

i) $P(CL = None) = 15/24$

$P(CL = Soft) = 5/24$

$P(CL = Hard) = 4/24$

ii) $P(age = PP \mid CL = None) = (5+1)/(15+3)$ $P(age = PP \mid CL = Soft) = (2+1)/(5+3)$ $P(age = PP \mid CL = Hard) = (1+1)/(4+3)$

$P(Pres = hyp \mid CL = None) = (8+1)/(15+2)$ $P(Pres = hyp \mid CL = Soft) = (3+1)/(5+2)$ $P(Pres = hyp \mid CL = hard) = (1+1)/(4+2)$

$P(asti = yes \mid CL = None) = (8+1)/(15+2)$ $P(asti = yes \mid CL = Soft) = (0+1)/(5+2)$ $P(asti = yes \mid CL = hard) = (4+1)/(4+2)$

$P(TPR = redu \mid CL = None) = (11+1)/(15+2)$ $P(TPR = redu \mid CL = Soft) = (0+1)/(5+2)$ $P(TPR = redu \mid CL = hard) = (0+1)/(4+2)$

$P(CL = None \mid E) =$

$= \dfrac{(6/18)(9/17)(9/17)(12/17)(16/27)}{P(E)}$

$\Rightarrow \dfrac{0.03907999}{P(E)}$

$P(CL = Soft \mid E) =$

$= \dfrac{(3/8)(4/7)(1/7)(1/7)(6/27)}{P(E)}$

$\Rightarrow \dfrac{0.00097817}{P(E)}$

$P(CL = hard \mid E) =$

$= \dfrac{(2/7)(2/6)(5/6)(1/6)(5/27)}{P(E)}$

$\Rightarrow \dfrac{0.00244953}{P(E)}$

Normalization Constant $= P(E) = 0.03907999 + 0.00097817 + 0.00244953$

$= 0.04250134$

Therefore, $P(CL = None \mid E) = 0.03907999/0.04250134 = 91.95\% \approx 92\%$

$P(CL = Soft \mid E) = 0.00097817/0.04250134 = 2.287\% \approx 2.3\%$

$P(CL = hard \mid E) = 0.00244953/0.04250134 = 5.763\% \approx 5.8\%$