1.a) $accuracy = \frac{TP + TN}{TP + TN + FP + FN}$

Age	Spectacle	Astigmatism	Tear	Lenses (ground truth)	
Young	Hypermetrope	Yes	Normal	Yes	✗ FN
Young	Hypermetrope	No	Normal	Yes	✓ TP
Young	Myope	No	Reduced	No	✓ TN
Presbyopic	Hypermetrope	No	Reduced	No	✓ TN
Presbyopic	Myope	No	Normal	No	✗ FP
Presbyopic	Myope	Yes	Reduced	No	✓ TN
Prepresbyopic	Myope	Yes	Normal	Yes	✓ TP
Prepresbyopic	Myope	No	Reduced	No	✓ TN

wrong
correct

$6/8 = 75\%$

TP = 2
TN = 4
FN = 1
FP = 1

$accuracy = \frac{6}{2+4+1+1} = \frac{6}{8} = \boxed{0.75 \Rightarrow 75\%}$

1.b)

$Precision = \frac{TP}{TP + FP} = \frac{2}{2+1} = \boxed{\frac{2}{3} = 0.6\bar{6} \Rightarrow 67\%}$

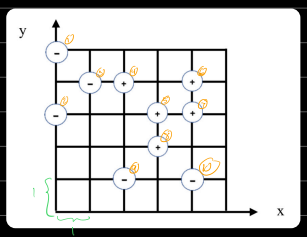
$r = \frac{TP}{TP + FN} = \frac{2}{2+1} = \boxed{\frac{2}{3} = 0.6\bar{6} \Rightarrow 67\%}$

F1 - Meusur?

$F1 - Measare = \frac{2rP}{r + P} = \frac{2\left(\frac{2}{3}\right)\left(\frac{2}{3}\right)}{\frac{4}{3}} = \frac{\frac{8}{9}}{\frac{4}{3}} = \boxed{\frac{2}{3}}$

3.a) Leave-one-out / (LOO-CV) 1 NN

test case	Closest Neighbor	Distance	Prediction	True/False
①	3	$\sqrt{2}$	−	T
②	3	$\sqrt{2}$	−	T
③	4	1	+	F
④	3	1	−	F
⑤	7 or 8	1	+	T
⑥	7	1	+	T
⑦	5 or 6	1	+	T
⑧	5	1	+	T
⑨	8	$\sqrt{2}$	+	F
⑩	8	$\sqrt{2}$	+	F



$$\text{Error} = \frac{\text{number of wrong predictions}}{\text{total number of predictions}} \quad E = \frac{4}{10} = 0.4 = 40\%$$

3.b) LOO-CV for 3NN

test case	Closest Neighbor	Prediction	True/False
①	2, 3, 4	−, −, +	T
②	1, 3, 4	−, −, +	T
③	1, 2, 4	−, −, +	T
④	3, 5, 6	−, +, +	T
⑤	6, 7, 8	+, +, +	T
⑥	4, 5, 7	+, +, +	T
⑦	5, 6, 8	+, +, +	T
⑧	5, 7, 9	+, +, −	T
⑨	5, 8, 10	+, +, −	F
⑩	7, 8, 9	+, +, −	F

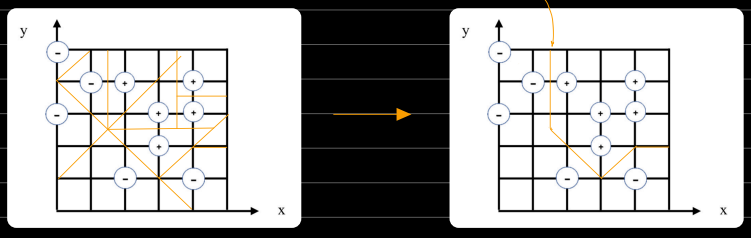
$$\text{Error} = \frac{\text{number of wrong predictions}}{\text{total number of predictions}} = \frac{2}{10} = 0.2 = 20\%$$

3.c) 9NN closest Neighbors are all other points

test case	Prediction	True/False
①	+	F
②	+	F
③	+	F
④	−	F
⑤	−	F
⑥	−	F
⑦	−	F
⑧	−	F
⑨	+	F
⑩	+	F

$$\text{Error} = \frac{\text{number of wrong predictions}}{\text{total number of predictions}} = \frac{10}{10} = 100\%$$

3.d) Decision Boundary 1NN



4) 3NN, find 10?

ID	Red	Green	Blue	Class
#1	220	20	60	1
#2	255	99	21	1
#3	250	128	14	1
#4	144	238	144	2
#5	107	142	35	2
#6	46	139	87	2
#7	64	224	208	3
#8	176	224	23	3
#9	100	149	237	3
#10	154	205	50	?

$$\sqrt{(x-x)^2+(y-y)^2+(z-z)^2}$$

① $\sqrt{(220-154)^2+(20-205)^2+(60-50)^2} = \sqrt{(66)^2+(-185)^2+(10)^2} = 196.675$

4356 + 34225 100

② $\sqrt{(255-154)^2+(99-205)^2+(21-50)^2} = 149.26$

③ $\sqrt{(250-154)^2+(128-205)^2+(14-50)^2} = 128.22$

④ $\sqrt{(144-154)^2+(238-205)^2+(144-50)^2} = 100.125$

⑤ $\sqrt{(107-154)^2+(142-205)^2+(35-50)^2} = 80.02$

⑥ $\sqrt{(46-154)^2+(139-205)^2+(87-50)^2} = 131.87$

⑦ $\sqrt{(64-154)^2+(224-205)^2+(208-50)^2} = 182.83$

⑧ $\sqrt{(176-154)^2+(224-205)^2+(23-50)^2} = 39.673$

⑨ $\sqrt{(100-154)^2+(149-205)^2+(237-50)^2} = 202.54$

3 closest Neighbors are 4, 5, 8

ID	Class
4	2
5	2
8	3

→ majority = 2

Node 10's class is 2

5) $h_{MAP} = argmax_{h \in H} p(D|h)\, P(h)$

Day	Outlook	Temperature	Humidity	Wind	PlayTennis
D1	Sunny	Hot	High	Weak	No
D2	Sunny	Hot	High	Strong	No
D3	Overcast	Hot	High	Weak	Yes
D4	Rain	Mild	High	Weak	Yes
D5	Rain	Cool	Normal	Weak	Yes
D6	Rain	Cool	Normal	Strong	No
D7	Overcast	Cool	Normal	Strong	Yes
D8	Sunny	Mild	High	Weak	No
D9	Sunny	Cool	Normal	Weak	Yes
D10	Rain	Mild	Normal	Weak	Yes
D11	Sunny	Mild	Normal	Strong	Yes
D12	Overcast	Mild	High	Strong	Yes
D13	Overcast	Hot	Normal	Weak	Yes
D14	Rain	Mild	High	Strong	No

h = yes =>
- $P(Sunny|h) = \frac{2}{9} = 0.22$
- $P(Mild|h) = \frac{4}{9} = 0.44$
- $P(Normal|h) = \frac{6}{9} = 0.66$
- $P(weak|h) = \frac{6}{9} = 0.66$
- $P(yes) = \frac{9}{14} = 0.64$

Multiply => $0.028 = h_{MAP_{yes}}$

↑ Maximum a Posteriori hypothesis

h = No =>
- $P(Sunny|h) = \frac{3}{5} = 0.6$
- $P(Mild|h) = \frac{2}{5} = 0.4$
- $P(Normal|h) = \frac{1}{5} = 0.2$
- $P(weak|h) = \frac{2}{5} = 0.4$
- $P(h) = \frac{5}{14} = 0.36$

Multiply => $0.0069 = h_{MAP_{NO}}$

<D15, Sunny, Mild, Normal, weak>
will be classified as "yes"

$\frac{0.028}{0.028+0.0069} = 0.802$

$\frac{0.0069}{0.0069+0.028} = 0.198$