Age	Comp^n	Type	Profit
old	yes	s/w	Down
old	No	s/w	Down
old	No	h/w	Down
mid	yes	s/w	Down
mid	yes	h/w	Down
mid	No	h/w	up.
mid	No	s/w	up.
new	yes	s/w	up.
new	No	h/w	up.
new	No	s/w	up

① Entropy of class(E) = $-\left[\frac{p}{p+n}\log_2\left[\frac{p}{p+n}\right]+\frac{n}{p+n}\log_2\left[\frac{n}{p+n}\right]\right]$

② Information Gain(pi,ni)= $-\left[\frac{p_i}{p_i+n_i}\log_2\left[\frac{p_i}{p_i+n_i}\right]+\frac{n_i}{p_i+n_i}\log_2\left[\frac{n_i}{p_i+n_i}\right]\right]$

③ Entropy of Attribute = $\sum\frac{p_i+n_i}{p+N}\times IG(p_i,n_i)$

④ Gain of Attribute = Entropy of Class - Entropy of Attribute

①

Age	Comp^n	Type	Profit
old	yes	s/w	Down
old	No	s/w	Down
old	No	h/w	Down
mid	yes	s/w	Down
mid	yes	h/w	Down
mid	No	h/w	up.
mid	No	s/w	up.
new	yes	s/w	up.
new	No	h/w	up.
new	No	s/w	up

P → up = 5
N → Down = 5

Class = Profit

Entropy of class = $-\left[\frac{p}{p+n}\log_2\left[\frac{p}{p+n}\right]+\frac{n}{p+n}\log_2\left[\frac{n}{p+n}\right]\right]$

$=-\left[\frac{5}{5+5}\log_2\left[\frac{5}{5+5}\right]+\frac{5}{5+5}\log_2\left[\frac{5}{5+5}\right]\right]$

$=-\frac{5}{10}\log_2\left[\frac{5}{10}\right]-\frac{5}{10}\log_2\left[\frac{5}{10}\right]=1$

Entropy of class =1

Entropy of Age

	Pi	ni	IG(Pi,ni)
old	0	3	0
mid	2	2	1
new	3	0	0

i) $IG(old) = -\frac{0}{0+3}\log_2\left[\frac{0}{0+3}\right]-\frac{3}{0+3}\log_2\left[\frac{3}{0+3}\right]=0$

$IG(mid) = -\frac{2}{4}\log_2\left[\frac{2}{4}\right]-\frac{2}{4}\log_2\left[\frac{2}{4}\right]=1$

$IG(new) = \frac{3}{3+0}\log_2\left[\frac{3}{3+0}\right]-\frac{0}{3+0}\log_2\left[\frac{0}{3+0}\right]=0$

ii) Entropy of Age = $\sum\frac{p_i+n_i}{p+N}\times IG(p_i,n_i)$

$=\frac{0+3}{5+5}\times 0+\frac{2+2}{5+5}\times 1+\frac{3+0}{5+5}\times 0=\frac{2+2}{5+5}=\frac{4}{10}=0.4$

Entropy of Age =0.4

iii) Gain(Age) = Entropy(Class) - Entropy(Age)
Gain (Age) = 1- 0.4 =0.6

Entropy of Competition

	Pi	ni	IG(Pi,ni)
Yes	1	3	0.81127
NO	4	2	0.918295

i) $IG(Yes) = -\frac{1}{4}\log_2\left[\frac{1}{4}\right]-\frac{3}{4}\log_2\left[\frac{3}{4}\right]=0.81127$

$IG(No) = \frac{4}{6}\log_2\left[\frac{4}{6}\right]-\frac{2}{6}\log_2\left[\frac{2}{6}\right]=0.918295$

ii) Entropy of Competition = $\sum\frac{p_i+n_i}{p+N}\times IG(p_i,n_i)$

Entropy of Competition = 0.8754

$\frac{1+3}{5+5}\times 0.81127+\frac{4+2}{5+5}\times 0.918295$

iii) Gain(Competition)= Entropy(Class)- Entropy(Compe)
Gain(Competition)= 1-0.8754 = 0.1245

Entropy of Type

	Pi	ni	IG(Pi,ni)
s/w	3	3	1
h/w	2	2	1

i) $IG(s/w)=1$
$IG(h/w)=1$

ii) Entropy of Type = $\sum\frac{p_i+n_i}{p+N}\times IG(p_i,n_i)$

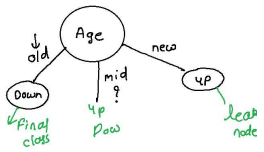
Entropy of Type =1

$=\frac{3+3}{5+5}\times 1+\frac{2+2}{5+5}\times 1=\frac{6}{10}+\frac{4}{10}=\frac{10}{10}=1$

iii) Gain(type)=Entropy(Class)-Entropy(type)
Gain(type)=1-1 =0

Attribute	Gain
① Age	0.6 ← Highest Gain
② Comp^n	0.1245
③ Type	0

old → down
mid → 2 up, 2 down
new → up



Age	Comp^n	Type	Profit
mid	yes	s/w	Down
mid	yes	h/w	Down
mid	No	h/w	up.
mid	No	s/w	up.

P= 2
N =2

Entropy of Class = $-\left[\frac{2}{4}\log_2\left[\frac{2}{4}\right]+\frac{2}{4}\log_2\left[\frac{2}{4}\right]\right]=1$

Entropy of Class = 1

Entropy of Competition

	Pi	ni	IG(Pi,ni)
Yes	0	2	0
NO	2	0	0

Entropy of Competition = $\sum\frac{p_i+n_i}{p+n}\times IG(p_i,n_i)$

$=\frac{0+2}{2+2}\times 0+\frac{2+0}{2+2}\times 0=0$

Entropy of Competition = 0

Gain(Competition)= Entropy(Class)- Entropy(Compe)
Gain(Competition)= $1-0=1$

Entropy of Type

	Pi	ni	IG(Pi,ni)
s/w	1	1	1
h/w	1	1	1

Entropy of Type = $\sum\frac{p_i+n_i}{p+N}\times IG(p_i,n_i)$

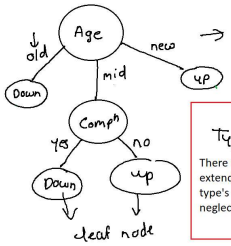
$=\frac{1+1}{2+2}\times 1+\frac{1+1}{2+2}\times 1=\frac{2}{4}+\frac{2}{4}=1$

Entropy of Type =1

Gain(type)=Entropy(Class)-Entropy(type)
Gain(type)=1-1 =0

Attribute	Gain
Comp^n	1 ← Highest Gain
Type	0

Comp^n
yes → Down
no → up



→ Final modal

Type is neglected

There was no need for extending the tree further and type's Gain is always 0 so it is neglected.