Decision Tree

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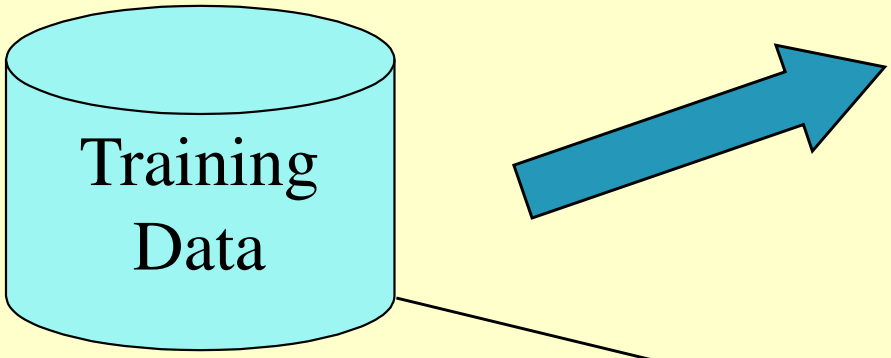
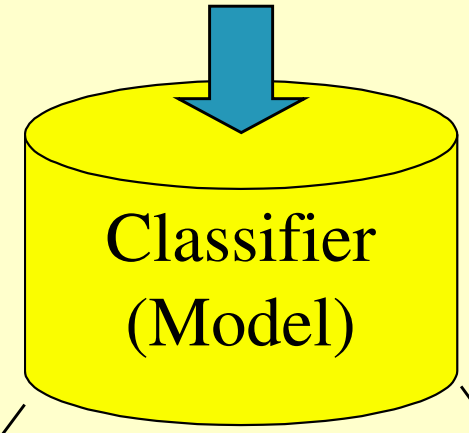
What is a Decision Tree?

- An *inductive learning task*
  - Use particular facts to make more generalized conclusions
- A predictive model based on a branching series of Boolean tests
  - These smaller Boolean tests are less complex than a one-stage classifier

Process (1): Model Construction



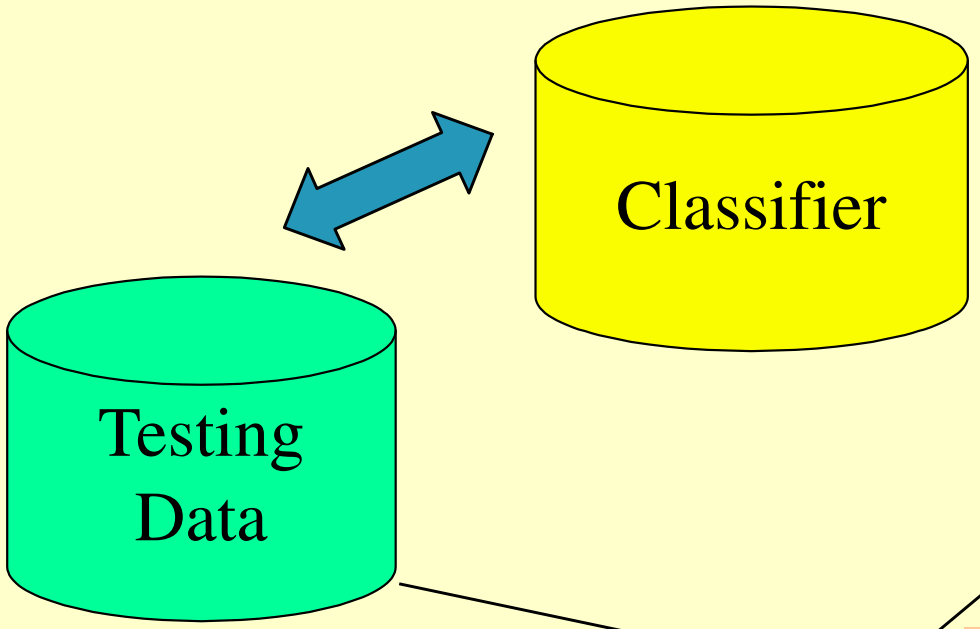
Classification
Algorithms



NAME	RANK	YEARS	TENURED
Mike	Assistant Prof	3	no
Mary	Assistant Prof	7	yes
Bill	Professor	2	yes
Jim	Associate Prof	7	yes
Dave	Assistant Prof	6	no
Anne	Associate Prof	3	no

IF rank = ‘professor’
OR years > 6
THEN tenured = ‘yes’

Process (2): Using the Model in Prediction



NAME	RANK	YEARS	TENURED
Tom	Assistant Prof	2	no
Merlisa	Associate Prof	7	no
George	Professor	5	yes
Joseph	Assistant Prof	7	yes

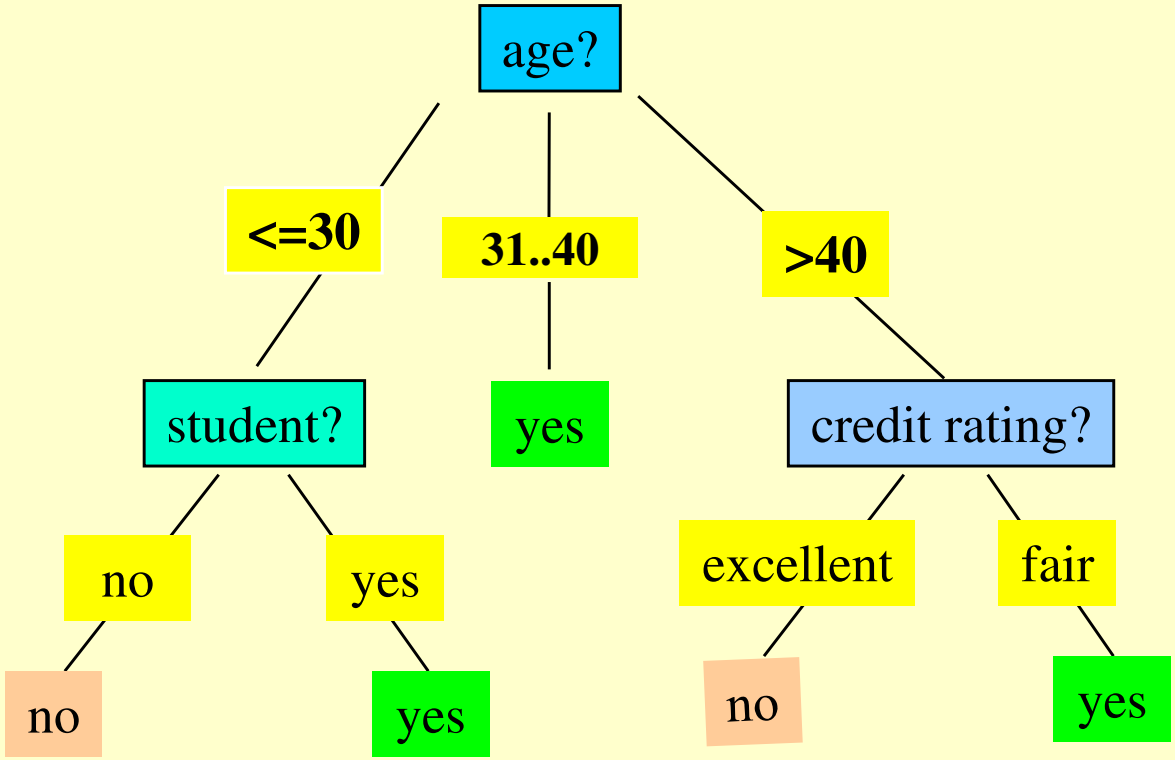
(Jeff, Professor, 4)

Tenured?

Yes

Decision Tree Induction: An Example

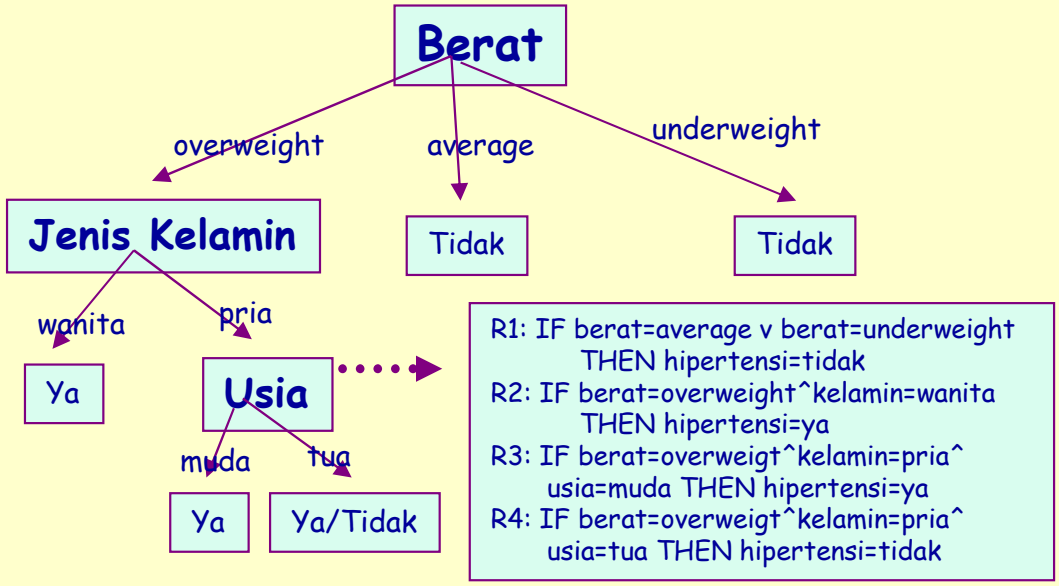
- Training data set: Buys_computer
- The data set follows an example of Quinlan's ID3 (Playing Tennis)
- Resulting tree:



age	income	student	credit_rating	buys_computer
<=30	high	no	fair	no
<=30	high	no	excellent	no
31…40	high	no	fair	yes
>40	medium	no	fair	yes
>40	low	yes	fair	yes
>40	low	yes	excellent	no
31…40	low	yes	excellent	yes
<=30	medium	no	fair	no
<=30	low	yes	fair	yes
>40	medium	yes	fair	yes
<=30	medium	yes	excellent	yes
31…40	medium	no	excellent	yes
31…40	high	yes	fair	yes
>40	medium	no	excellent	no

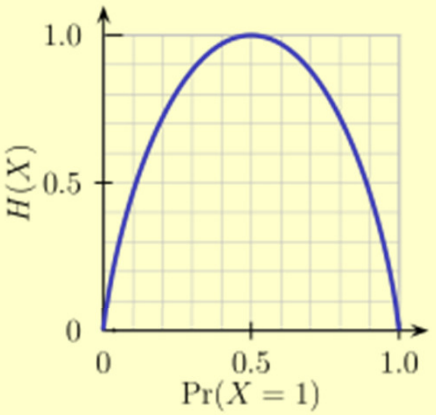
Concept of Decision Tree

Nama	Usia	Berat	Kelamin	Hipertensi
Ali	muda	overweight	pria	ya
Edi	muda	underweight	pria	tidak
Annie	muda	average	wanita	tidak
Budiman	tua	overweight	pria	tidak
Herman	tua	overweight	pria	ya
Didi	muda	underweight	pria	tidak
Rina	tua	overweight	wanita	ya
Gatot	tua	average	pria	tidak



Brief Review of Entropy

- Entropy (Information Theory)
  - A measure of uncertainty associated with a random variable
  - Calculation: For a discrete random variable Y taking m distinct values $\{y_1, \ldots, y_m\}$,
    - $H(Y) = -\sum_{i=1}^{m} p_i \log(p_i)$, where $p_i = P(Y = y_i)$
  - Interpretation:
    - Higher entropy => higher uncertainty
    - Lower entropy => lower uncertainty
- Conditional Entropy
  - $H(Y|X) = \sum_x p(x) H(Y|X = x)$



m = 2

Example: Training Data

Nama	Usia	Berat	Kelamin	Hipertensi
Ali	muda	overweight	pria	ya
Edi	muda	underweight	pria	tidak
Annie	muda	average	wanita	tidak
Budiman	tua	overweight	pria	tidak
Herman	tua	overweight	pria	ya
Didi	muda	underweight	pria	tidak
Rina	tua	overweight	wanita	ya
Gatot	tua	average	pria	tidak

Entropy untuk Usia

Usia	Hipertensi	Jumlah
muda	Ya (+)	1
muda	Tidak (-)	3
tua	ya	2
tua	tidak	2

Usia = muda

$$q_1 = -\frac{1}{4}\log_2\frac{1}{4} - \frac{3}{4}\log_2\frac{3}{4} = 0.81$$

Usia = tua

$$q_2 = -\frac{2}{4}\log_2\frac{2}{4} - \frac{2}{4}\log_2\frac{2}{4} = 1$$

Entropy untuk Usia

$$E = \frac{4}{8}q_1 + \frac{4}{8}q_2 = \frac{4}{8}(0.81) + \frac{4}{8}(1) = 0.91$$

Memilih Node Awal

Usia	Hipertensi	Jumlah
muda	ya	1
muda	tidak	3
tua	ya	2
tua	tidak	2

Entropy = 0.91

Berat	Hipertensi	Jumlah
overweight	ya	3
overweight	tidak	1
average	ya	0
average	tidak	2
underweight	ya	0
underweight	tidak	2

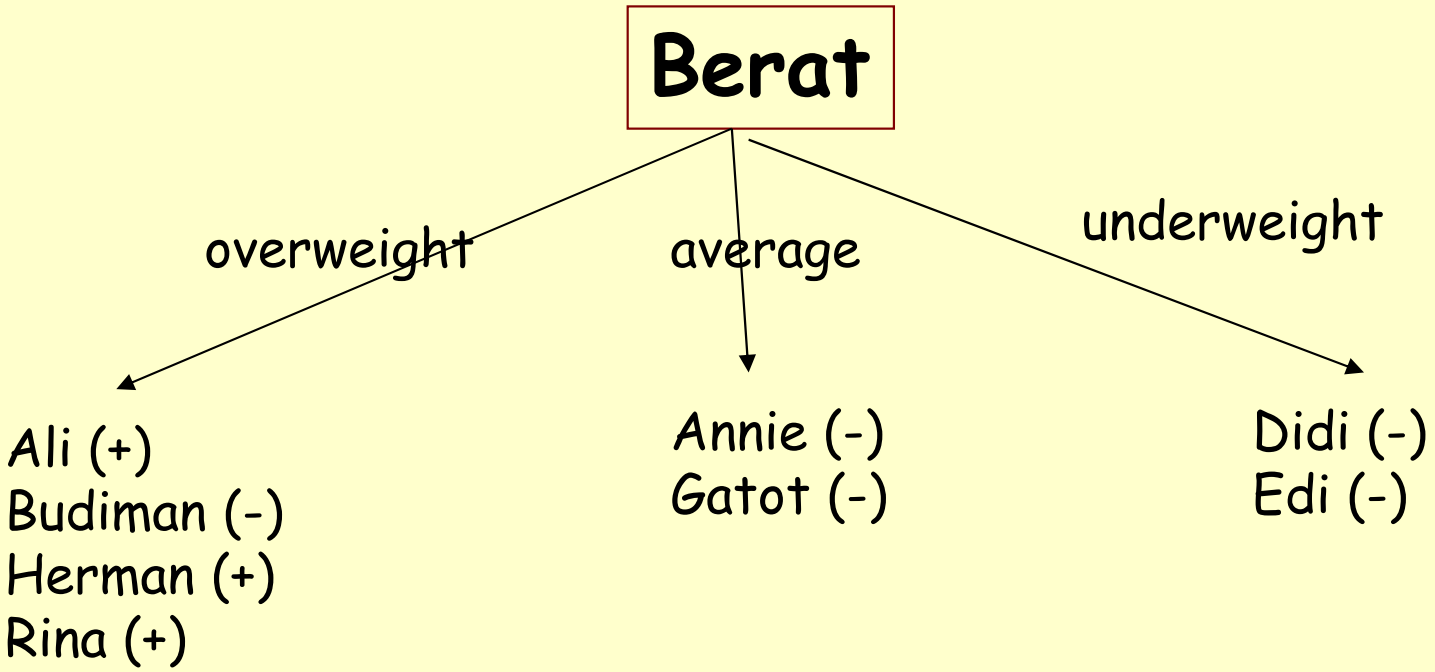
Entropy = 0.41

Kelamin	Hipertensi	Jumlah
pria	ya	2
pria	tidak	4
wanita	ya	1
wanita	tidak	1

Entropy = 0.94

Terpilih atribut BERAT BADAN sebagai node awal karena memiliki entropy terkecil

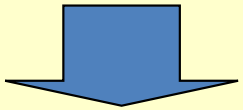
Penyusunan Tree Awal



Penentuan Leaf Node Untuk
Berat=Overweight

Data Training untuk berat=overweight

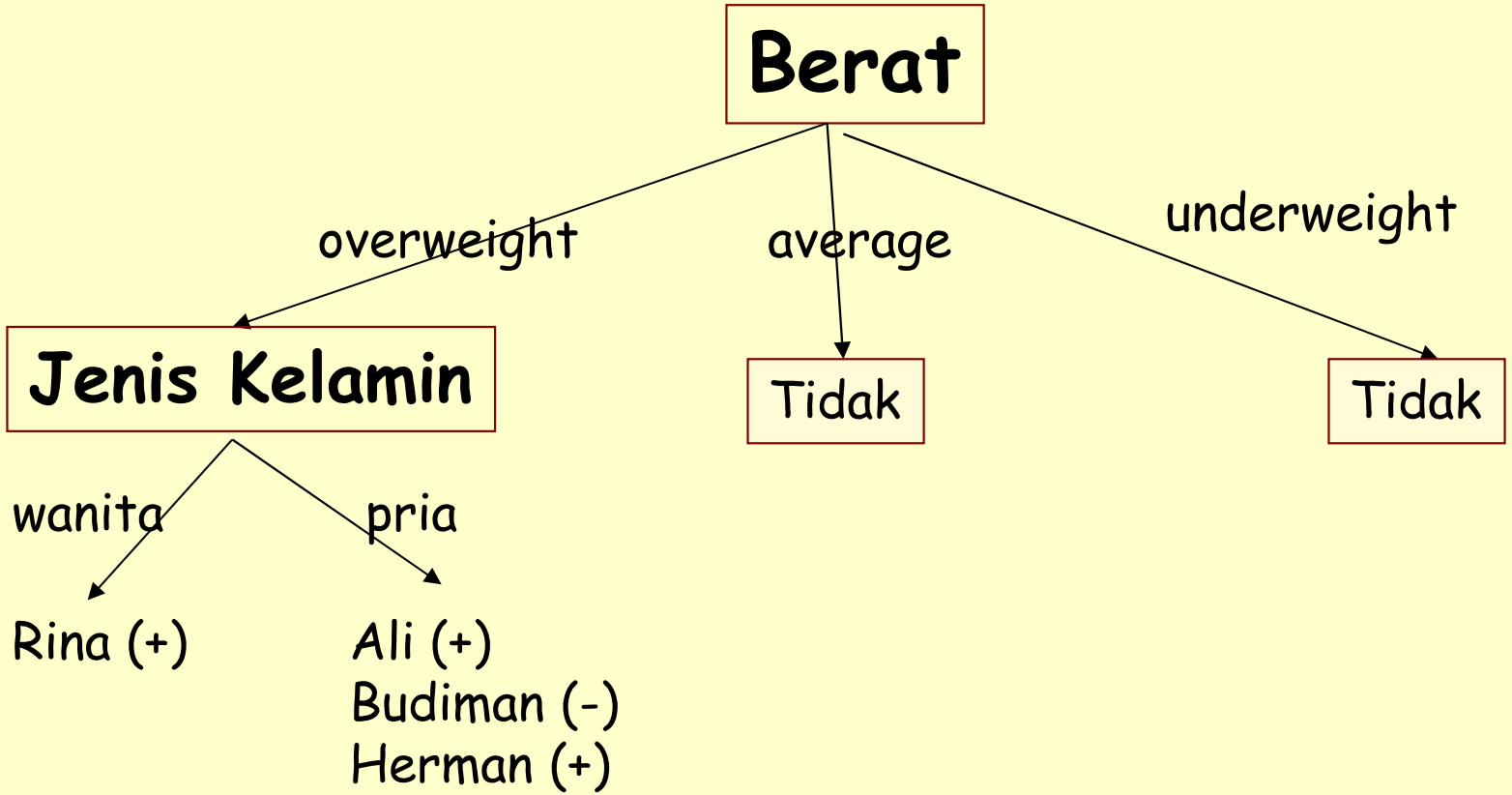
Nama	Usia	Kelamin	Hipertensi
Ali	muda	pria	ya
Budiman	tua	pria	tidak
Herman	tua	pria	ya
Rina	tua	wanita	ya



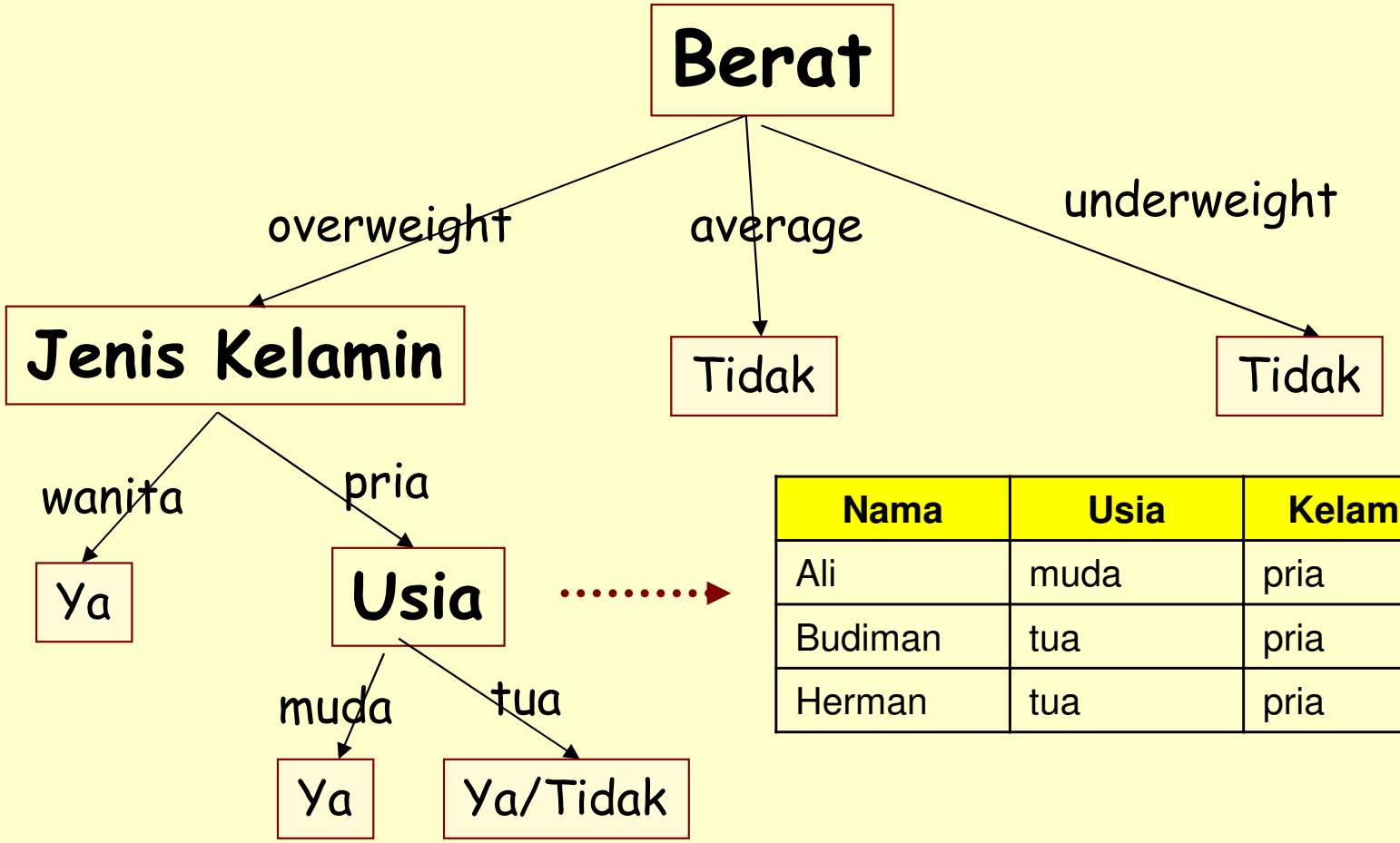
Usia	Hipertensi	Jumlah
muda	ya	1
	tidak	0
tua	ya	2
	tidak	1
Entropy =		0,69

Kelamin	Hipertensi	Jumlah
pria	ya	2
	tidak	1
wanita	ya	1
	tidak	0
Entropy =		0,69

Penyusunan Tree

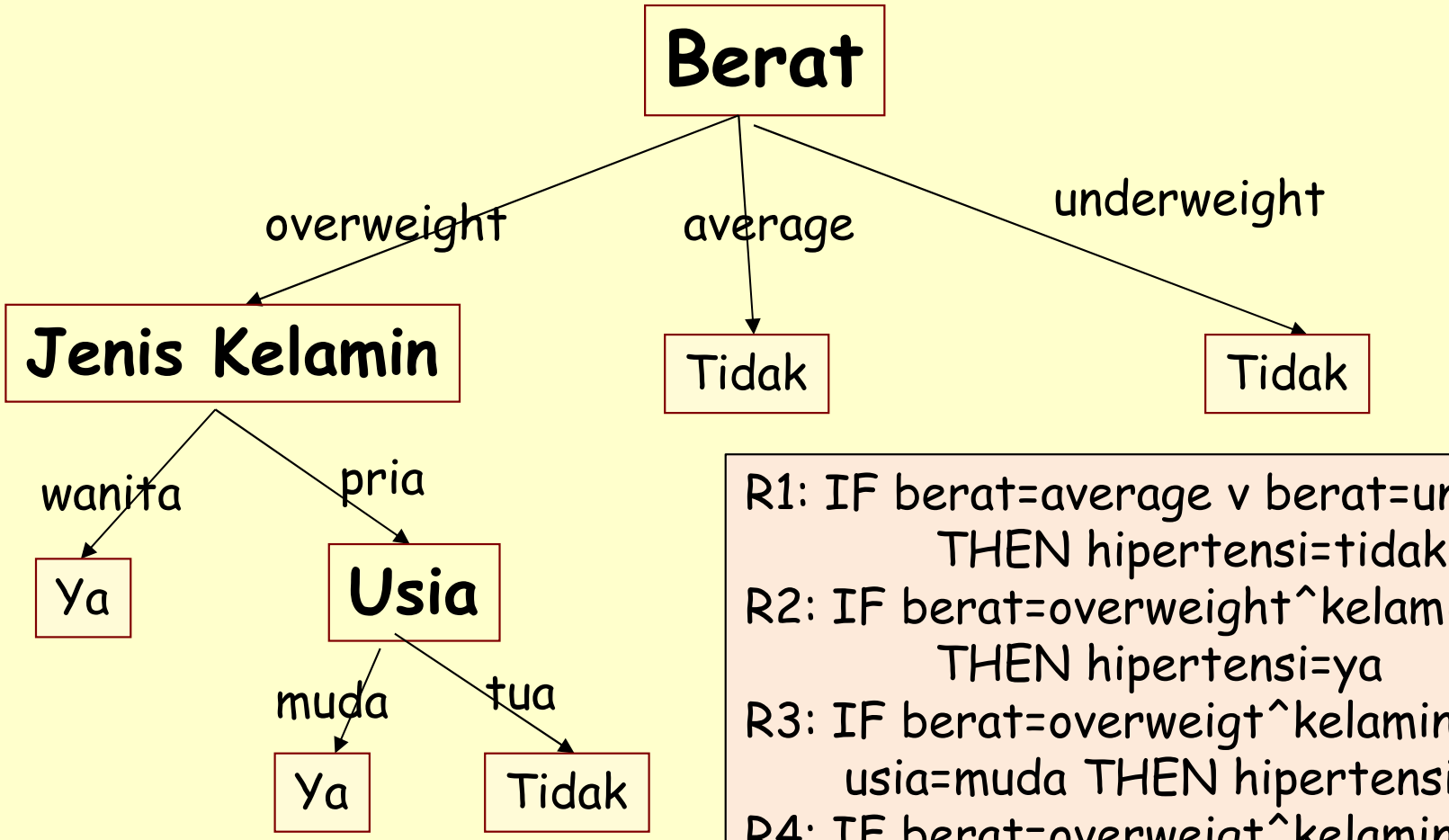


Hasil Tree



Nama	Usia	Kelamin	Hipertensi
Ali	muda	pria	ya
Budiman	tua	pria	tidak
Herman	tua	pria	ya

Mengubah Tree Menjadi Rule



R1: IF berat=average v berat=underweight
THEN hipertensi=tidak
R2: IF berat=overweight^kelamin=wanita
THEN hipertensi=ya
R3: IF berat=overweigt^kelamin=pria^
usia=muda THEN hipertensi=ya
R4: IF berat=overweigt^kelamin=pria^
usia=tua THEN hipertensi=tidak

Hasil Prediksi Pada Data Training

Nama	Usia	Berat	Kelamin	Hipertensi	Klasifikasi
Ali	muda	overweight	pria	ya	ya
Edi	muda	underweight	pria	tidak	tidak
Annie	muda	average	wanita	tidak	tidak
Budiman	tua	overweight	pria	tidak	tidak
Herman	tua	overweight	pria	ya	tidak
Didi	muda	underweight	pria	tidak	tidak
Rina	tua	overweight	wanita	ya	ya
Gatot	tua	average	pria	tidak	tidak

Error ratio = 12.5 %
(1 dari 8 data)