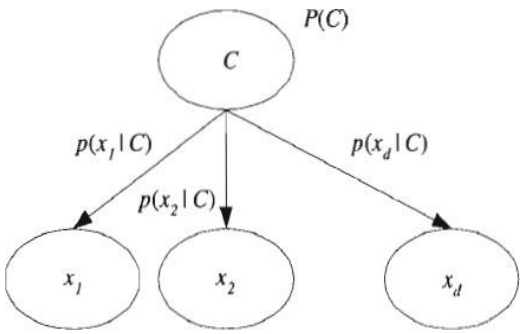
Bayesian Network

Naïve Bayes



Bayes Classifiers

- Bayesian classifiers use **Bayes theorem**, which says

$$p(c_j \mid d) = \frac{p(d \mid c_j)\, p(c_j)}{p(d)}$$

- $p(c_j \mid d)$ = probability of instance d being in class c_j,
  This is what we are trying to compute
- $p(d \mid c_j)$ = probability of generating instance d given class c_j,
  We can imagine that being in class c_j, causes you to have feature d with some probability
- $p(c_j)$ = probability of occurrence of class c_j,
  This is just how frequent the class c_j, is in our database
- $p(d)$ = probability of instance d occurring

  This can actually be ignored, since it is the same for all classes

- To simplify the task, **naïve Bayesian classifiers** assume attributes have independent distributions, and thereby estimate

$$p(d|c_j) = p(d_1|c_j) * p(d_2|c_j) * \ldots * p(d_n|c_j)$$

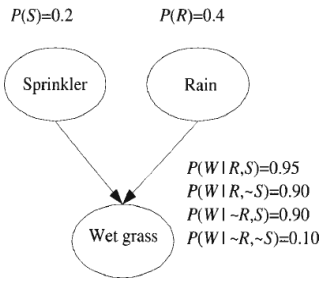
The probability of class c_j generating instance d, equals….

The probability of class c_j generating the observed value for feature 1, multiplied by..

The probability of class c_j generating the observed value for feature 2, multiplied by..

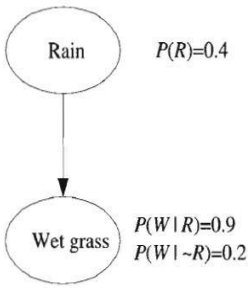
Naïve Bayes vs Bayesian Network

- Pada Naïve Bayes, mengabaikan korelasi antar variabel.
- Sedangkan pada Bayesian Network, variabel input bisa saling dependent.

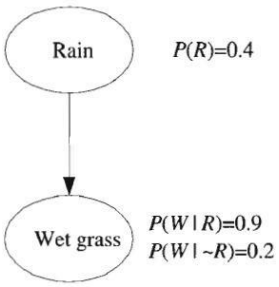


Bayesian Network

- **Bayesian Network** atau **Belief Network** atau **Probabilistik Network** adalah model grafik untuk merepresentasikan interaksi antar variabel.
- Bayesian Network digambarkan seperti graf yang terdiri dari simpul (node) dan busur (arc). Simpul menunjukkan variabel misal Xbeserta nilai probabilitasnya P(X) dan busur menunjukkan hubungan antar simpul.
- Jika ada hubungan dari simpul Xke simpul Y,ini mengindikasikan bahwa variabel X ada pengaruh terhadap variabel Y. Pengaruh ini dinyatakan dengan peluang bersyarat P(Y|X).

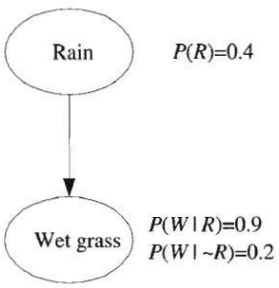


Bayesian Network



- Dari gambar tersebut dapat diketahui peluang gabungan dari P(R,W). Jika P(R) = 0.4, maka P(~R) = 0.6 dan jika P(~W|~R) = 0.8.
- Kaidah Bayes dapat digunakan untuk membuat diagnosa.

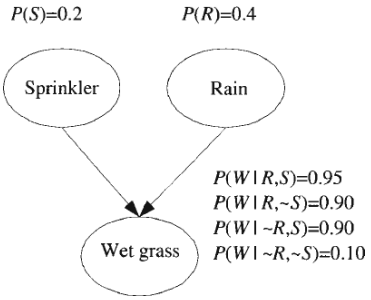
Bayesian Network



Sebagai contoh jika diketahui bahwa rumput basah, maka peluang hujan dapat dihitung sebagai berikut :

$$P(R|W) = \frac{P(W|R)P(R)}{P(W)} = \frac{P(W|R)P(R)}{P(W|R)P(R) + P(W|\sim R)P(\sim R)} = \frac{0.9 \times 0.4}{0.9 \times 0.4 + 0.2 \times 0.6} = 0.75$$

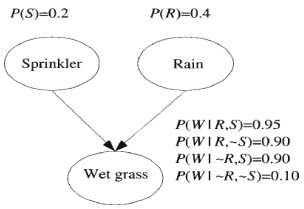
Bayesian Network



- Berapa peluang rumput basah jika Springkler menyala (tidak diketahui hujan atau tidak)

$$
\begin{aligned}
P(W|S) &= P(W|R,S)P(R|S) + P(W|\sim R,S)P(\sim R|S) \\
&= P(W|R,S)P(R) + P(W|\sim R,S)P(\sim R) \\
&= 0.95 \times 0.4 + 0.9 \times 0.6 = 0.92
\end{aligned}
$$

Bayesian Network



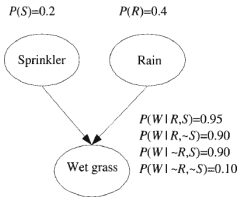
- Berapa peluang Springkler menyala setelah diketahui rumput basah (P|W)?

$$P(S|W) = \frac{P(W|S)P(S)}{P(W)} = \frac{0.92 \times 0.2}{0.52} = 0.35$$

where

$$
\begin{aligned}
P(W) &= P(W|R,S)P(R,S) + P(W|\sim R,S)P(\sim R,S) \\
&\quad + P(W|R,\sim S)P(R,\sim S) + P(W|\sim R,\sim S)P(\sim R,\sim S) \\
&= P(W|R,S)P(R)P(S) + P(W|\sim R,S)P(\sim R)P(S) \\
&\quad + P(W|R,\sim S)P(R)P(\sim S) + P(W|\sim R,\sim S)P(\sim R)P(\sim S) \\
&= 0.95 \times 0.4 \times 0.2 + 0.9 \times 0.6 \times 0.2 + 0.9 \times 0.4 \times 0.8 \\
&\quad + 0.1 \times 0.6 \times 0.8 \\
&= 0.52
\end{aligned}
$$

Bayesian Network

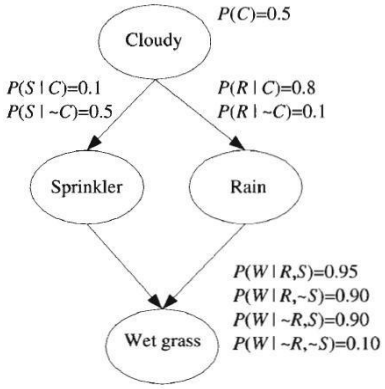


- Jika diketahui hujan, berapa peluang Springkler menyala?

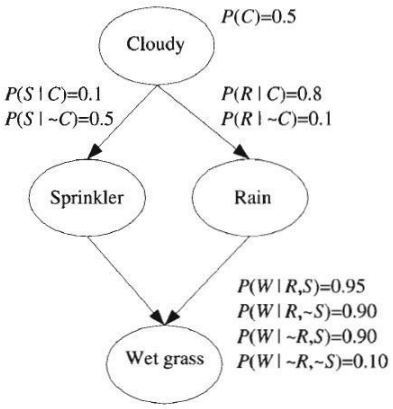
$$P(S|R,W) = \frac{P(W|R,S)P(S|R)}{P(W|R)} = \frac{P(W|R,S)P(S)}{P(W|R)}$$
$$= 0.21$$

Bayesian Network

- Bagaimana jika ada asumsi : Jika cuacanya mendung (cloudy), maka Springkler kemungkinan besar tidak menyala.

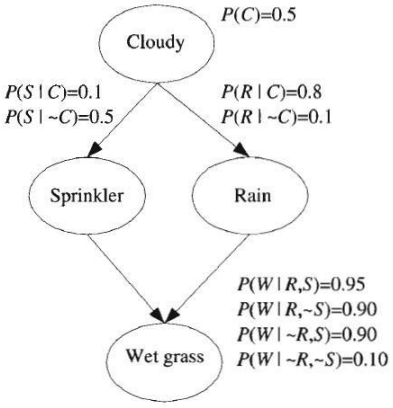


Bayesian Network



- Berapa peluang rumput basah jika diketahui cloudy?

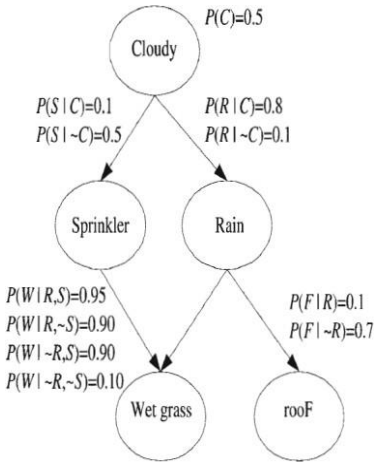
Bayesian Network



- Berapa peluang rumput basah jika diketahui cloudy?

$$
\begin{aligned}
P(W|C) &= P(W|R,S,C)P(R,S|C) \\
&\quad +P(W|\sim R,S,C)P(\sim R,S|C) \\
&\quad +P(W|R,\sim S,C)P(R,\sim S|C) \\
&\quad +P(W|\sim R,\sim S,C)P(\sim R,\sim S|C) \\
&= P(W|R,S)P(R|C)P(S|C) \\
&\quad +P(W|\sim R,S)P(\sim R|C)P(S|C) \\
&\quad +P(W|R,\sim S)P(R|C)P(\sim S|C) \\
&\quad +P(W|\sim R,\sim S)P(\sim R|C)P(\sim S|C)
\end{aligned}
$$

Latihan



- Jika ada seekor kucing yang suka berjalan di atap dan membuat keributan. Jika hujan, kucing tidak keluar.
- Berapa peluang kita akan mendengar kucing diatap jika cuaca Cloudy? P(F|C)