

B(E)4M36SMU

Bayesian Networks

Wednesday 22nd March, 2023

Organization

- ▶ **2 weeks** of lectures and tutorials
- ▶ a *gentle introduction* to Bayesian Networks
- ▶ theoretical **homework worth 10 points**
 - ▶ assigned at the end of the BN tutorials
 - ▶ due *3 weeks* after being published

What are Bayesian Networks?

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- ▶ **Definition:**

A collection of random variables $\mathbf{X} = (X_1, \dots, X_n)$ is a Bayesian Network w.r.t. a directed acyclic graph (V, E) if its joint probability distribution factorizes over the graph such that

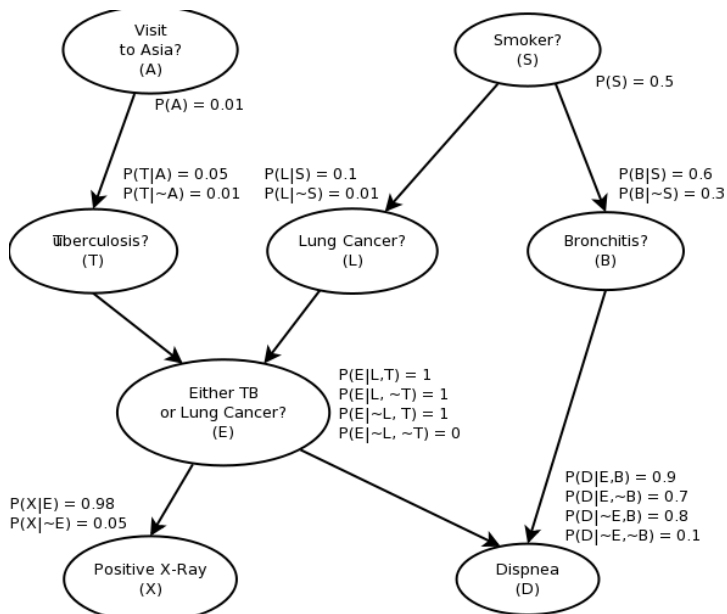
$$P(\mathbf{X}) = \prod_{i=1}^n P(X_i \mid \text{Par}(X_i)),$$

where $\text{Par}(X_i) \subset V$ denotes all parents of node i .

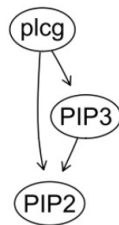
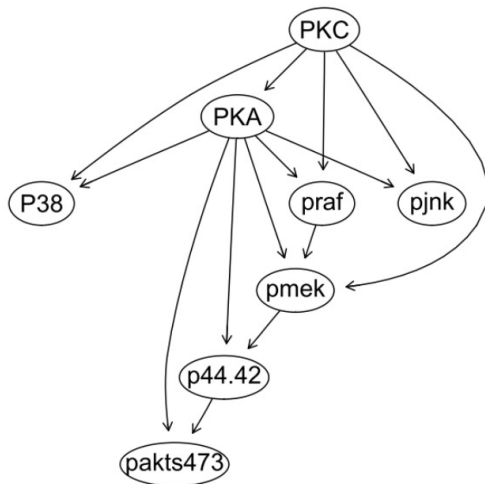
Where are Bayesian Networks used?

- ▶ medical diagnosis
- ▶ bioinformatics & drug discovery
- ▶ credit scoring & fraud detection
- ▶ fault diagnosis
- ▶ ...

ASIA network



SACHS network






(11 nodes, 17 arcs)

INSURANCE network



Literature

-  S. Lauritzen, D. Spiegelhalter.
Local Computation with Probabilities on Graphical Structures and their Application to Expert Systems (with discussion).
Journal of the Royal Statistical Society: Series B (Statistical Methodology), 50(2):157-224, 1988.
-  K. Sachs, O. Perez, D. Pe'er, D. A. Lauffenburger, G. P. Nolan.
Causal Protein-Signaling Networks Derived from Multiparameter Single-Cell Data.
Science, 308:523-529, 2005.
-  J. Binder, D. Koller, S. Russell, K. Kanazawa.
Adaptive Probabilistic Networks with Hidden Variables.
Machine Learning, 29(2-3):213-244, 1997.

Useful Links

- ▶ <https://www.bnlearn.com/bnrepository/>
- ▶ <https://ermongroup.github.io/cs228-notes/>