

Glossary

- Bayesian Classifier** A classifier that assigns probabilities to the different object labels based on Bayes rule.
- Bayesian network** A directed acyclic graph that represents the joint distribution of a set of random variables such that each variable is conditionally independent of its non-descendants given its parents in the graph.
- Causal Bayesian Network** A directed acyclic graph in which the nodes represent random variables and the arcs causal relations.
- Causal reasoning** A procedure for answering causal queries form a causal model.
- Classifier** A method or algorithm that assigns labels to objects.
- Clique** A completely connected subset of nodes in a graph that is maximal.
- Conditional independence** Two variables are conditionally independent given a third variable if they become independent when the third variable is known.
- Conditional Probability** Probability of certain event given that another event has occurred.
- Conditional Random Field** A random field in which all the variables are globally conditioned on the observations.
- Decision Tree** A tree that represents a decision problem and has three types of nodes: decisions, uncertain events and results.
- Directed Acyclic Graph** A directed graph that has no directed circuits (a directed circuit is a circuit in which all edges in the sequence follow the directions of the arrows).
- D-separation** A graphical criteria for determining if two subsets of variables are conditionally independent given a third subset in a Bayesian network.
- Dynamic Bayesian Network** An extension of Bayesian networks to model dynamic processes; it consists of series of time slices, each time slice represents the state of all variables at certain time.
- Expectation-Maximization** An statistical technique used for parameter estimation when there are non-observable variables.
- Graph** A graphical representation of binary relations between a set of objects.

- Hidden Markov Model** A Markov chain in which the states are not directly observable.
- Independent variables** Two random variables are independent if knowing the value of one of them does not affect the probability distribution of the other one.
- Influence Diagram** A graphical model for solving decision problems. It is an extension of Bayesian networks that incorporates decision and utility nodes.
- Junction Tree** A tree in which each node corresponds to a subset of variables of a probabilistic graphical model.
- Limited Memory Influence Diagram** An influence diagram in which the variables known when making a decision are not necessarily remembered for future decisions.
- Markov Blanket** A set of variables that make a variable independent of all other variables in a probabilistic graphical model.
- Markov Chain** A state machine in which the transition between states are non-deterministic and satisfy the Markov property.
- Markov Decision Process** A graphical model for sequential decision making composed of a finite set of states and actions, in which the states follow the Markov property.
- Markov Network** A random field represent as an undirected graph that satisfies the locality property—each variable in the field is independent of all other variables given its neighbors in the graph.
- Markov Property** The probability of the next (future) state is independent of the previous states (past) given the current (present) state.
- Markov Random Field** Markov network.
- Multidimensional classifier** A classifier that can assign more than one label to each object.
- Naive Bayes Classifier** A Bayesian classifier that assumes that all attributes are independent given the class variable.
- Partially Observable Markov Decision Process** A Markov decision process in which the states are not directly observable.
- Policy** A function that maps states to actions.
- Probabilistic Graphical Model** A compact representation of a joint probability distribution of a set of random variables composed by a graph and a set of local probability distributions.
- Probabilistic Inference** A procedure for calculating the posterior probability of the unknown variables in a probabilistic graphical model given certain evidence (a subset of known or instantiated variables).
- Probability** A function that assigns a real number to each event (subset of a sample space) and satisfies certain axioms known as the probability axioms.
- Random Field** A collection of random variables indexed by sites.
- Random Variable** A mapping form a sample space to real numbers.
- Rational Agent** An agent that selects its decisions to maximize its expected utility according to its preferences.

Relational Probabilistic Graphical Models An extension of probabilistic graphical models that are more expressive by incorporating some type of relational representation.

Sample space The set of possible outcomes of an experiment.

Temporal Event Network A Bayesian network for modeling dynamic processes in which each node represents the time of occurrence of an event or state change of certain variable.

Tree A connected graph that does not have simple circuits.

Index

A

Algebraic decision diagram, 204
Axioms of utility theory, 183

B

BAN classifier, 46
Baum-Welch algorithm, 74
Bayes ball algorithm, 103
Bayes rule, 17
Bayesian chain classifiers, 52
Bayesian classifier, 42
Bayesian constraint-based causal discovery, 243
Bayesian network, 102
Bellman equation, 202
Beta probability distribution, 138
Binomial probability distribution, 19

C

Canonical models, 107
Causality, 237
Causal prediction, 240
Causal query, 240
Causal sufficiency, 243
Chain classifiers, 52
Chain rule, 17
Circuit, 30
Classification, 41
Classification of PGMs, 9
Classifier evaluation, 42
Clique, 33
Complete graph, 33
Concurrent MDPs, 206

Conditional independence, 17
Conditional random field, 92
Conditioning algorithm, 120
Correlation, 22
Counterfactual, 242

D

Decision diagram, 109
Decision nodes, 187
Decision theory, 182
Decision tree, 109, 185
Directed acyclic graph, 30
Directed graph, 27
Discount factor, 201
Discretization, 142
D-separation, 103
Dynamic Bayesian network, 161
Dynamic Bayesian network classifier, 170
Dynamic decision networks, 192

E

Elimination ordering heuristics, 119
Endogenous variables, 239
Entropy, 24
Equivalent states, 206
Existential quantifier, 222
Exogenous variables, 239
Expectation–Maximization (EM), 140
Expected monetary value, 184
Expected value, 19
Exponential probability distribution, 20

F

Factored MDP, 204
 Faithfulness, 243
 Feature selection, 48
 Finite horizon, 201
 Flat representation, 5
 Forward algorithm, 71

G

Gaussian Bayesian networks, 127
 Gaussian probability distribution, 20
 General schema, 11
 Gibbs random field, 88
 Graph isomorphism, 30

H

Hidden Markov model, 68
 Hierarchical MDPs, 206

I

Independence, 17
 Independence axioms, 105
 Infinite horizon, 201
 Influence diagrams, 187
 Information, 23
 Information validation, 129
 Interaction graph, 119
 Intervention, 239
 Ising model, 83
 Iterative conditional modes (ICM), 90

J

Joint probability, 17
 Junction tree algorithm, 121

L

Laplacian smoothing, 138
 Learning DBNs, 163
 Learning polytree BNs, 146
 Learning TNBNs, 167
 Learning tree BNs, 145
 Likelihood weighting algorithm, 126
 Limited memory influence diagrams, 192
 Logical consequence, 221
 Logic connectives, 221
 Logic sampling algorithm, 124
 Loopy belief propagation, 124
 Lottery, 182

M

Mappings, 105
 Markov blanket, 105
 Markov chain, 64
 Markov decision process, 199
 Markov logic network, 226
 Markov network, 84
 Markov property, 64
 Markov random field, 84
 Maximal ancestral graph, 243
 Maximum a posteriori probability (MAP), 89
 Maximum cardinality search, 35
 Maximum expected utility, 183
 Maximum posterior marginals (MPM), 89
 Metropolis, 90
 Minimum description length, 149
 Missing values, 139
 Most probable explanation, 126
 Multidimensional Bayesian classifier, 50
 Multidimensional BN classifier, 51

N

Naive Bayes classifier, 43
 Neighborhood order in an MRF, 87
 Noisy OR, 108

O

Object-oriented BNs, 223

P

PageRank, 78
 Parameter learning, 137
 Parameter uncertainty, 138
 Parental ancestral graph, 243
 Partially observable MDP, 207
 PC algorithm, 152
 Perfect ordering, 34
 Perron-Frobenius Theorem, 67
 Policy, 201
 Policy iteration algorithm, 203
 Predicates, 222
 Probabilistic graphical model, 8
 Probability definition, 16
 Probability interpretations, 15
 Probability propagation algorithm, 112

R

Random variables, 18
 Regular Markov random fields, 86
 Running intersection property, 35

S

Semi-naive Bayesian classifiers, 48
Simulated annealing, 90
Single query inference, 112
Skeleton, 224
State diagram, 65
Stationary process, 162
Stochastic search algorithm, 89
Structure learning, 143
Symbol-relational grammars, 231

T

TAN classifier, 46
Taxonomy of RPGMs, 219
Temporal event networks, 164
Temporal node, 165
Temporal nodes Bayesian networks, 165
Total Probability, 18
Trajectory, 29
Tree-width, 123

Trees, 31

Triangulated graph, 35

U

Uncertainty effects, 3
Undirected graph, 27
Uniform probability distribution, 18
Universal quantifier, 222
Utility nodes, 187
Utility theory, 182

V

Value iteration algorithm, 203
Variable elimination algorithm, 116
Viterbi algorithm, 73

W

Well formed formula, 221