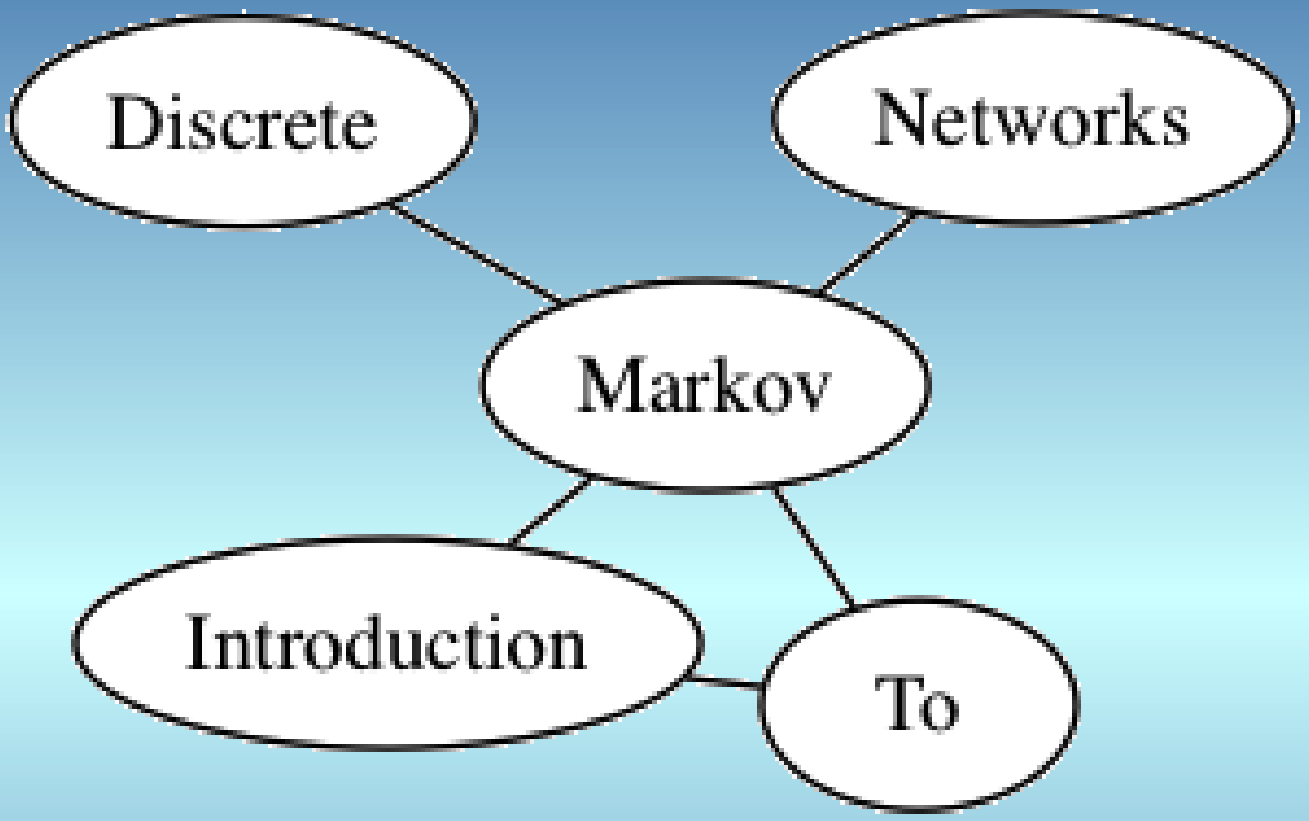


Francisco Mendonça

Motivation ?

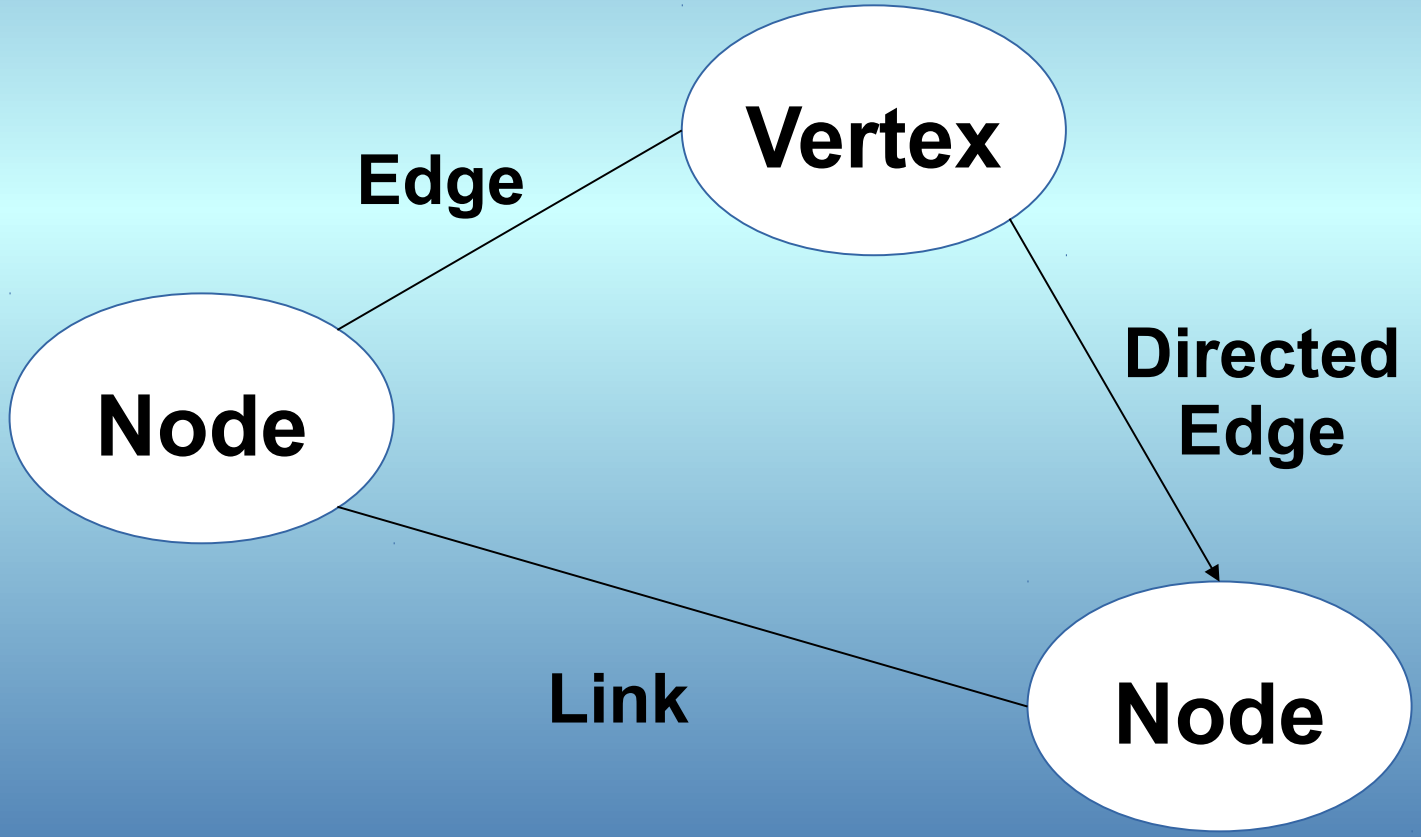
Basis for Markov Logic Networks

Probabilistic Graphical Models

Graph Representation

Probability

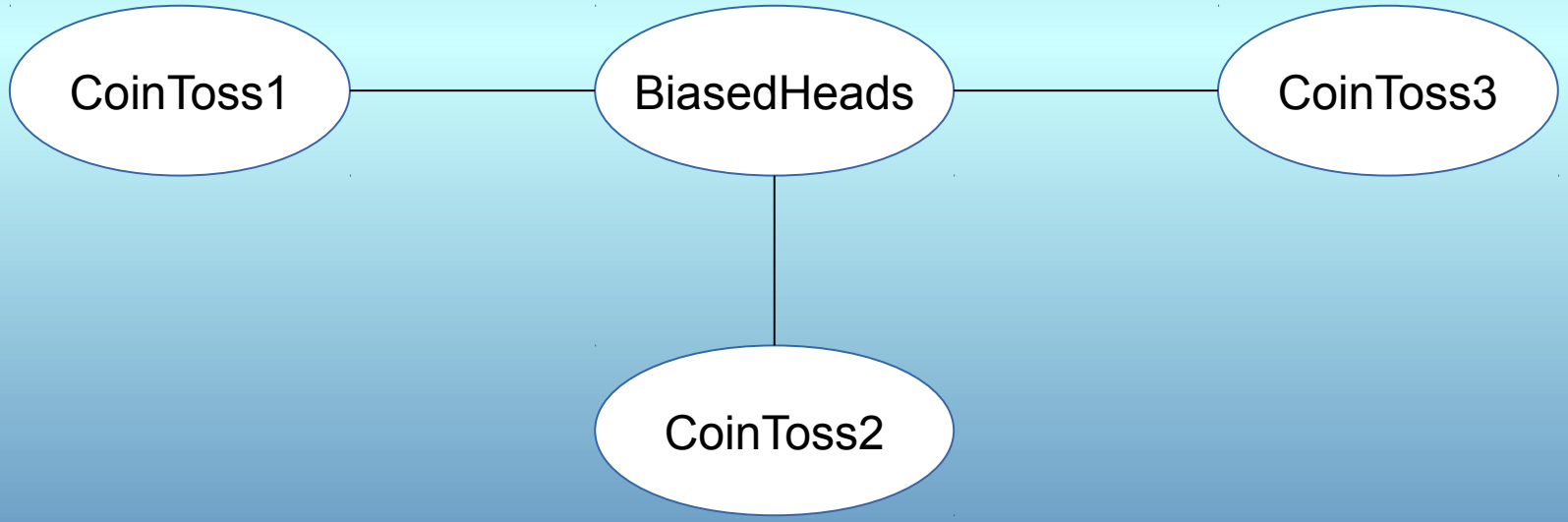
Graph Representation



Joint Probability

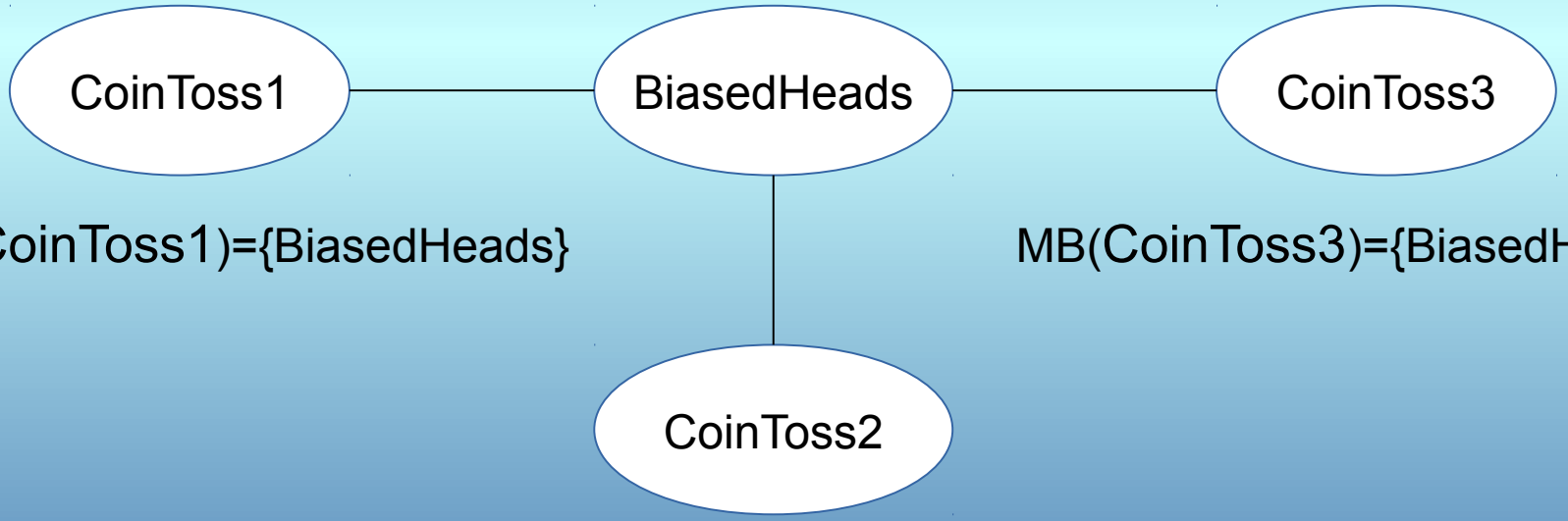
BiasedHeads	CoinToss	P(BiasedHeads, CoinSide)
False	Heads	0.3
False	Tails	0.3
True	Heads	0.3
True	Tails	0.1

Markov Networks as Independence Maps



Markov Blankets

MB(BiasedHeads)={CoinToss1,CoinToss2,CoinToss3}



MB(CoinToss1)={BiasedHeads}

MB(CoinToss3)={BiasedHeads}

MB(CoinToss2)={BiasedHeads}

Gibbs Distributions

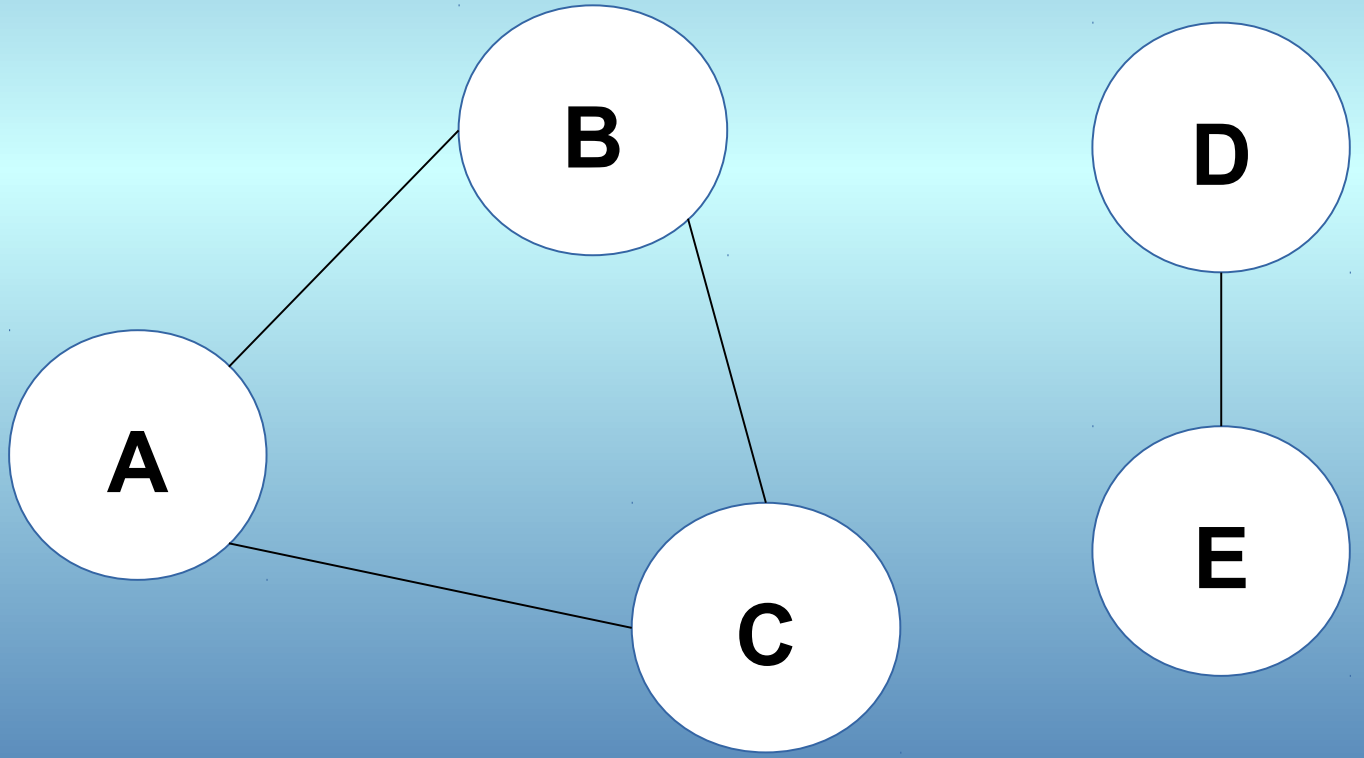
$$P_{\Phi}(X_1, \ldots, X_n) = (1/Z)\, \tilde{P}_{\Phi}(X_1, \ldots, X_n)$$

$$\tilde{P}_{\Phi}(X_1, \ldots, X_n) = \phi_1 x \ldots x \phi_m$$

$$Z = \sum \tilde{P}_{\Phi}(X_1, \ldots, X_n) = \phi_1 x \ldots x \phi_m$$

ϕ_1(BiasedHeads,CoinToss i) = P(BiasedHeads, CoinToss i)

Graph Cliques



Log-Linear Models

$\phi(D) = \exp(-\epsilon(D))$

$P_\Phi(X_1, \ldots, X_n) \alpha \exp(-\sum \epsilon(D_i))$

features $F = \{f_1(D_1), \ldots, f_k(D_k)\}$
weights $w_1, \ldots, w_k$

$P_\Phi(X_1, \ldots, X_n) \alpha \exp(\sum w_i f_i(D_i))$

Inference: Probability Query Types

Probability Query

MAP Query

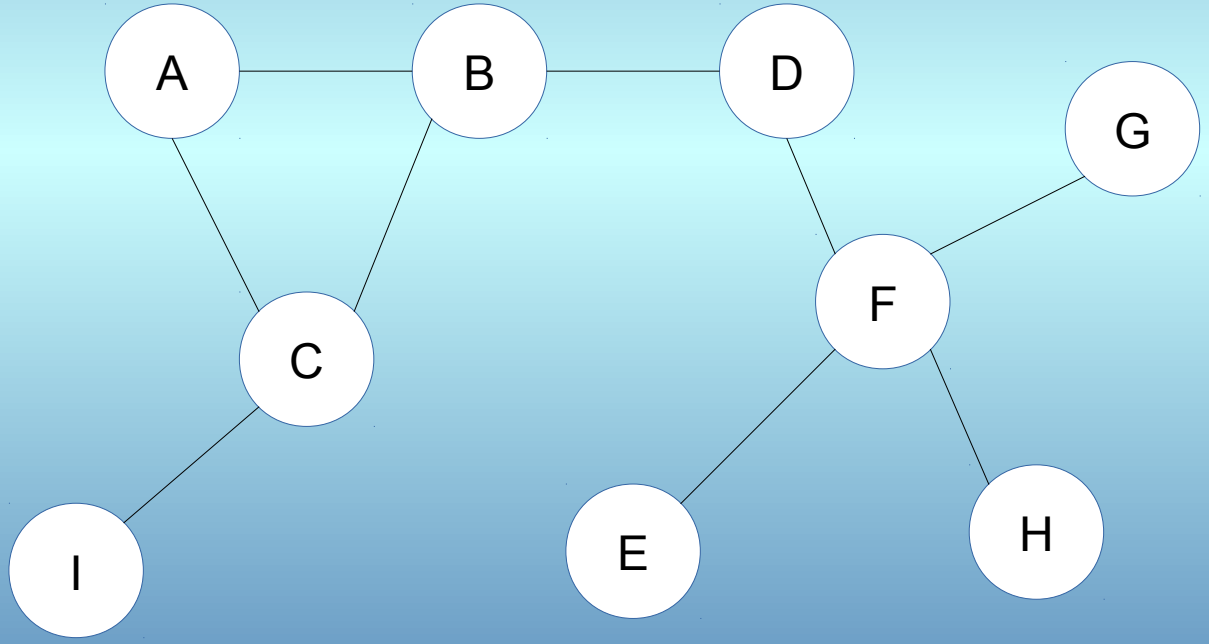
Variable Elimination

Factor Reduction: $\phi[E=e1](X) = \phi(X,e1)$

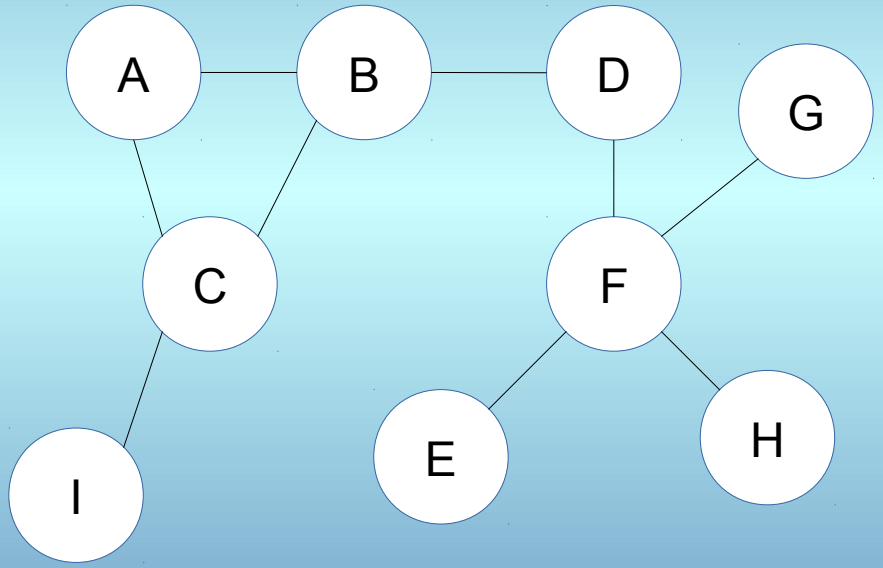
Sum-Product Elimination: $\psi(A,C) = \phi(A,C) \times \Sigma\, \phi(A,B)$

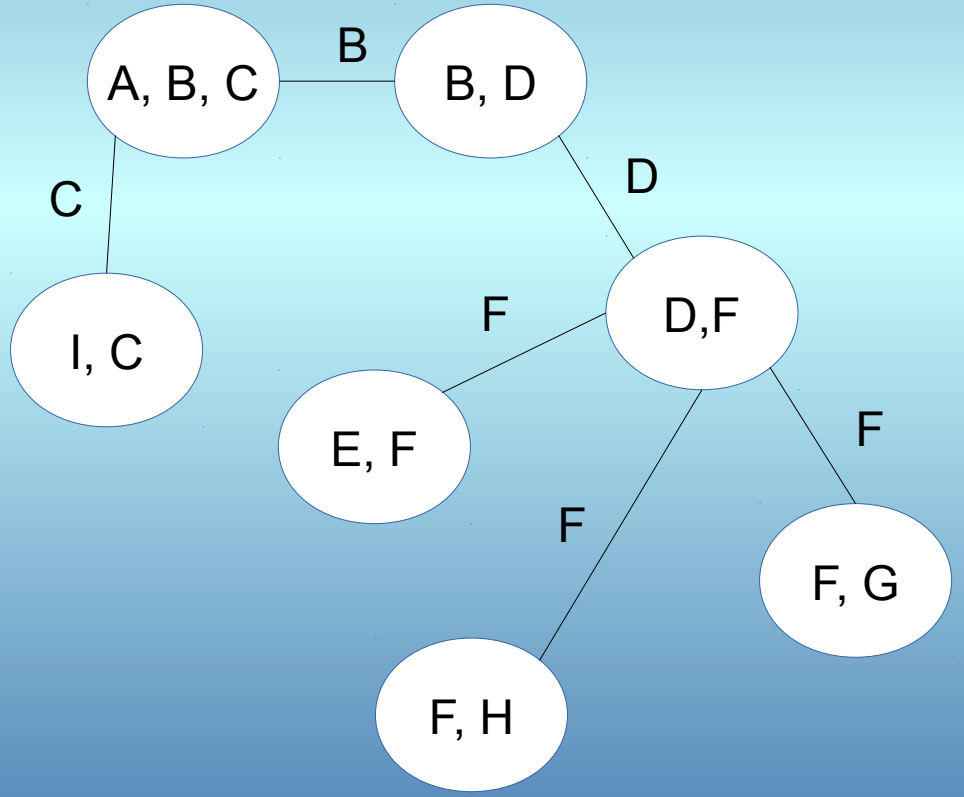
Max-Product Elimination: $\psi(A,C) = \phi(A,C) \times \max \phi(A,B)$

Variable Elimination Ordering

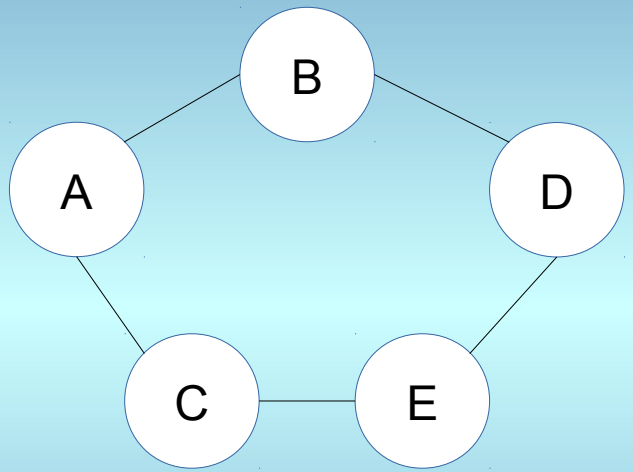


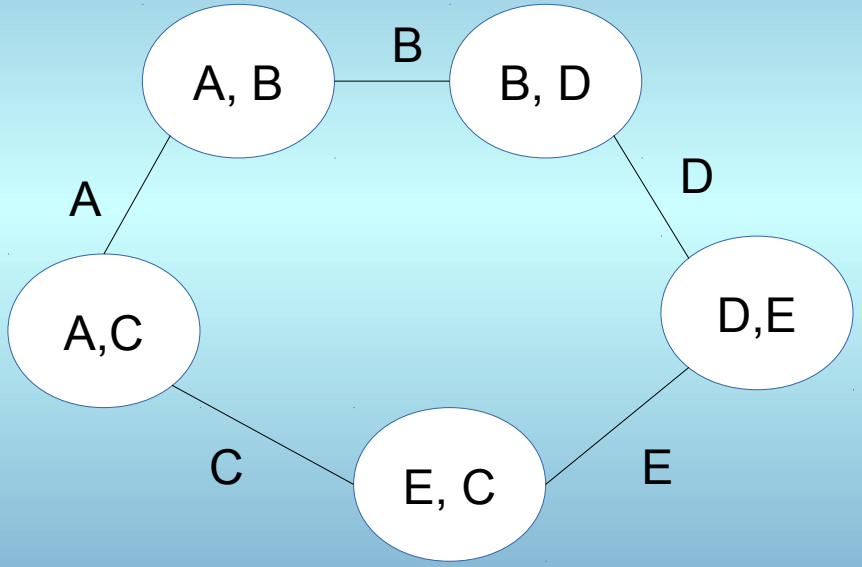
Click Trees

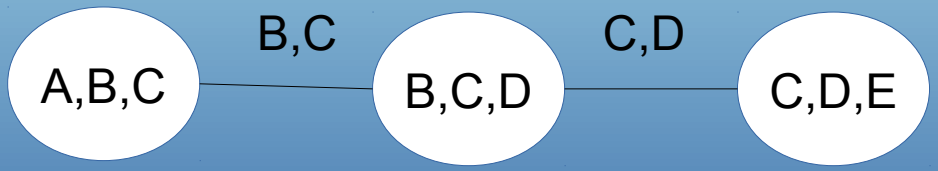




Click/Cluster Graphs







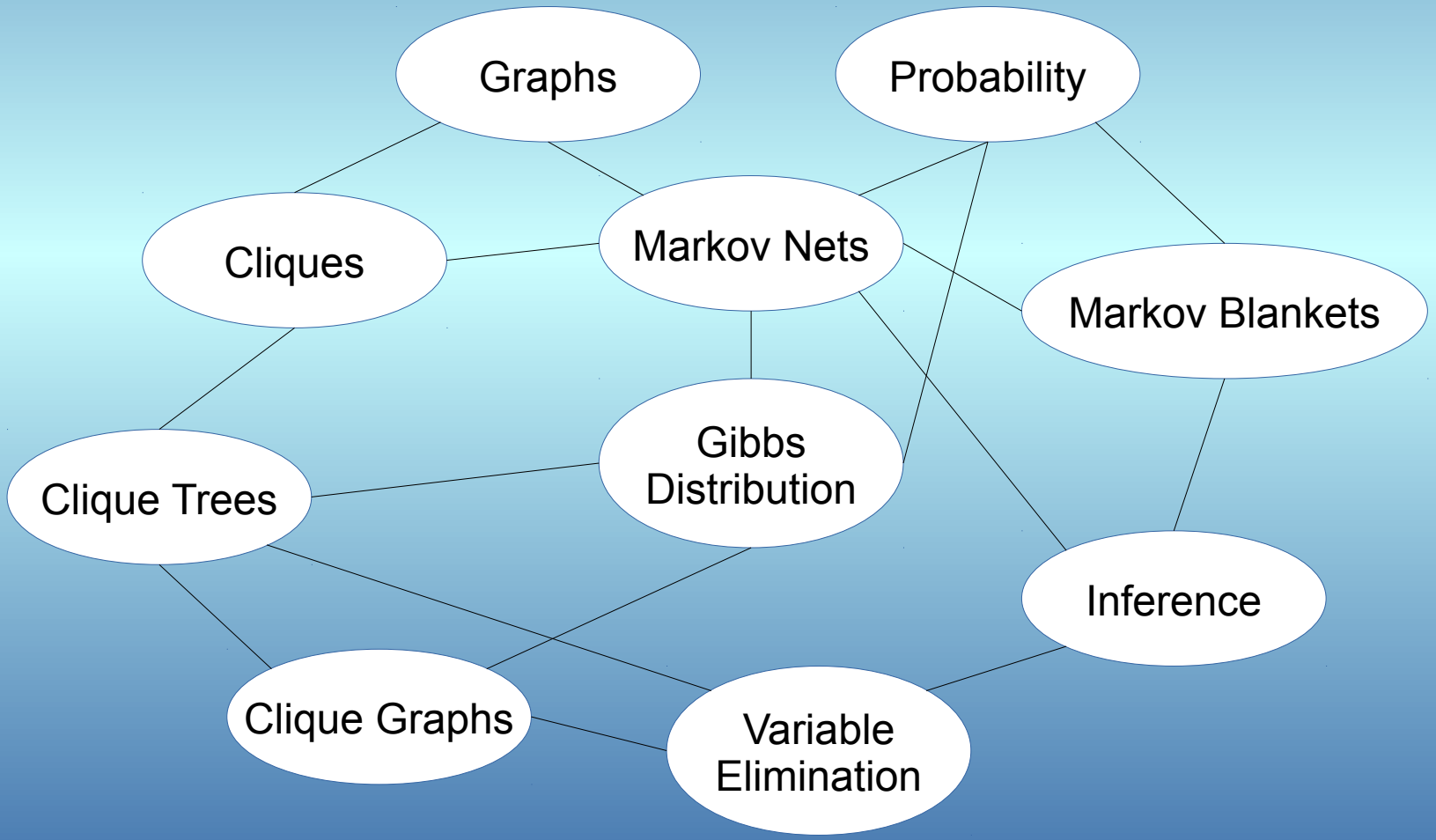
Interesting Applications

Vision (Markov Random Fields)

Text Analysis (Conditional Random Fields)

Markov Logic Networks

Questions?


Graphs
Probability
Cliques
Markov Nets
Markov Blankets
Clique Trees
Gibbs Distribution
Inference
Clique Graphs
Variable Elimination