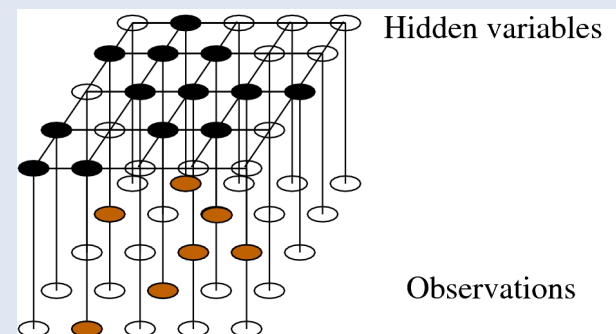
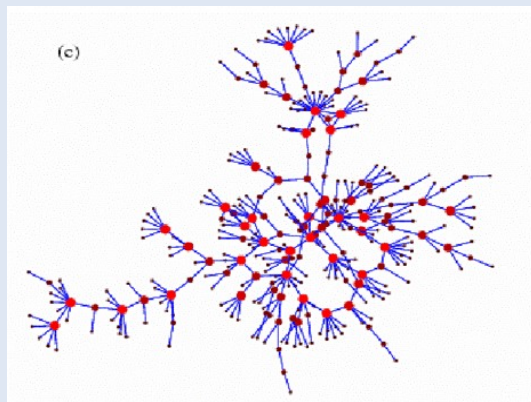


# Graphical models for reasoning on biological systems: computational challenges

*How reasoning on or controlling biological systems using graphical models raise new computational issues?*

*What are the current research trends to solve these issues?*

- *Which types of graphical models do we use?*

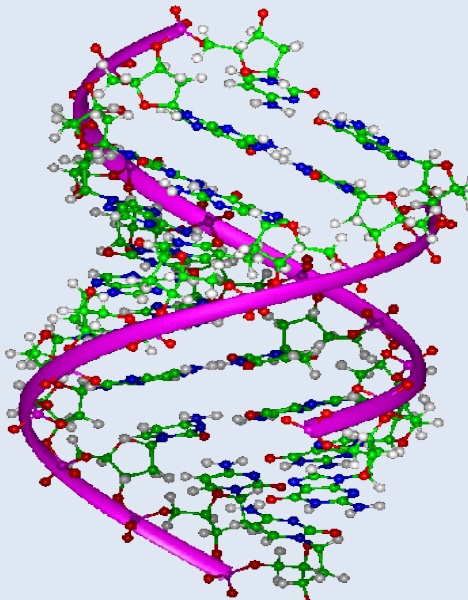


# Graphical models for reasoning on biological systems: computational challenges

*How reasoning on or controlling biological systems using graphical models raise new computational issues?*

*What are the current research trends to solve these issues?*

- *Which biological systems do we study?*



# Stochastic and deterministic graphical models : A brief overview

*A graphical model:*

*Agregation of local functions over state (and decision) variables*

- Constraint Satisfaction Problems (and their weighted extensions)
  - Discrete decision variables, local specification of integer-valued cost functions
  - Admissible decision values / minimum cost decision values
- Stochastic graphical models (Bayesian Nets, Gaussian random fields...)
  - Discrete or continuous state variables, local specifications of probability distributions
  - Marginal probabilities, "most-likely" tuples
- Influence Diagrams
  - Discrete state *and* decision variables, local specifications of probability distributions and utility functions
  - Expected utility maximisation

# Stochastic and deterministic graphical models : Questions

- Modeling
  - Providing / extending new mathematical models
  - Modeling new problems (about biological systems, here)
- Learning
  - Model parameter estimation, structure learning...
- Reasoning
  - Finding most probable states, solution counting, marginal computation...
- Optimising
  - Exact or approximate optimisation of decisions...
- *Etc.*

# Biological systems applications

- Molecular biology
  - Protein interactions
  - Regulation networks
- C. Barnes "Approximate Bayesian Computation (ABC) to Learn the Structure and Dynamics of Complex Systems"
- Daudin et al. "Properties of variational estimates of a mixture model for random graphs"
- Vandiel et al. "Extended Bayesian scores for reconstructing gene regulatory networks"
- Gay et al. "A Graphical Method for Reducing and Relating Models in Systems Biology"

# Ecological systems applications

- Ecological systems
  - Understanding of spatial patterns in ecological systems
  - Epidemics dynamics modeling
  - Sampling for ecological systems map reconstruction
- J. Illian "Ecological applications of spatial point process theory - examples of spatial complexity"
- Bonneau et al. "Solving adaptive sampling problems in graphical models using Markov Decision Processes"
- Crété et al. "Spatiotemporal Modeling of a Spread of Apple Scab"