Inference: Loopy Belief Propagation

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Loopy belief propagation

- In practice exact inference may not be possible
- Approaches in such cases:
  1. Variational methods, which are deterministic
  2. Sampling or Monte Carlo methods

     Based on stochastic numerical sampling from distributions
  3. Loopy belief propagation
     - Apply sum product algorithm even though there is no guaranty of good results
     - Message passing schedule is modified
       - *Flood schedule* simultaneously passes a message across every link in both direction
       - *Serial schedule* pass one message at each time step

7. Learning the graph structure

- We have assumed that the structure of the graph is known and fixed
- It is interesting to go beyond inference and learn the graph structure from data
- Requires defining a set of possible structures and a measure to score each structure

Bayesian Learning of graph

- Compute posterior distribution over graph structures
  - Make prediction by averaging with respect to this distribution
- If we have prior $p(m)$ over graphs indexed by m then posterior is
  - $p(m|D) \propto p(m)p(D|m)$
  - Where D is the data set
- Model evidence $p(D|m)$ provides score for each model
  - Evaluation of evidence involves marginalization over latent variables
  - Computationally challenging for many models
- Exploring space of structures is also problemtic
  - No of different graph structures grows exponentially with no of nodes
  - Necessary to use heuristics to find good candidates