Tutorial 3

1.1

A ⊥ C | {B, D} can be modelled with figure 1, because they are d-separated.

B ⊥ D | {A, C} cannot be modelled, because C is a collider and conditioning on C d-connects B and D. They would be independent given only A without C: B ⊥ D | {A}.

1.2

a)

A clique is a fully connected subgraph, i.e. a set of nodes, where every node is connected to every other node.

b)

In G1: {A,C}, {C,B}

In G2: {A,D}, {A,B}, {C,D}, {C,B}, {D,B}, {A,D,B}, {C,D,B}

1.3

a) Independencies in G3 given x4 and x5

{x1, x2, x3} ⊥ {x6, x7, x8} | {x4, x5}

b) Markov Blanket for x2 and x6 in G3

In a MRF the Markov Blanket are the direct neighbours in the graph.

MB for x2: {x1, x3, x5}

MB for x6: {x4, x5, x7, x8}

MB for {x2, x6}: {x1, x3, x5, x4, x5, x7, x8}

1.4

p(a|c) = p(a,c) / p(c)

p(a,c) = Z^-1 ∑b φ(a,b) φ(b,c)

p(c) as in exercise defined.

1.5

a)

p(d|c) = p(d,c) | p(c)

b)

p(a|d) = p(a,d) / p(d)

2.1

2.2

b)

According to MSE I got the best result for

Tau=6.6

Lambda=7

Iterations=20

(Grid search with 0.2 steps for both parameters.)

Worst MSE was at ~0.199, which was basically the noisy image.

Calendar, qr code

Description automatically generated

c)

**Tau** affects the belief how correct the observation is, thus governs the influence strength of the observation on the final reconstruction result.

**Lambda** governs the smoothness of the reconstructed image by determining how strongly the neighbouring nodes affect each other.

A high tau and low lambda value can result in a still noisy image.  
While a low tau and high lambda value results in an oversmoothed / smudged image.  
One has to find a good trade-off.

Remarks:

I would like to know how to come up with the specified factor functions in the denoising example. I feel that I have very theoretical knowledge about the topic and out-in-the-wild adapting these algorithms, designing functions, relationships between variables, entire graphs describing phenomena might be problematic.

I have learned that MRF and BN display different independencies.

I have learned Message passing and Sum Product Algorithm given the problem statement. The image denoising example was interesting.