1 Outline

1. Probability
   (a) Basic notions of probability: event, random variable, probability, conditional probability
   (b) Inference by enumeration
   (c) Independence, conditional independence
   (d) Bayes Rule

2. Bayesian Networks
   (a) Definition, Global and Local semantics, Markov Blanket
   (b) Construction of BN
   (c) Inference task
      i. Inference by enumeration
      ii. Approximate inference by Rejection sampling
      iii. Approximate inference by Likelihood-weighting
      iv. Approximate inference by Gibbs MCMC

3. Reasoning over Time
   (a) Modeling systems using temporal models: transition model, sensor model, Markov property
   (b) Inference
      i. Filtering
      ii. Evidence sequence likelihood
      iii. Prediction
      iv. Smoothing
      v. Most likely explanations (Viterbi algorithm)
   (c) Hidden Markov Models, matrix representation of the inference algorithms
   (d) Dynamic Bayesian Networks, construction and properties
2 Sample Problems

The exam will have 4 parts (total 100 points): short-answer questions or true/false (cca 20 points), and for each of the outline sections one larger question with subparts (cca 20-40 points each).

Short answers:

- In any BN $A \rightarrow B \leftarrow C \leftarrow D$, it must be true that $P(C = c|D = d, A = a) = P(C = c|D = d)$. True or False?

Probability:

- Problems 13.6 and (13.7 xor 13.13) together

Bayesian Networks:

- Problem 14.2
- Problem 14.11 (except for e), which seems to be too open-ended for an exam

Reasoning over Time:

- Problem 1 of HW3
- Problem 4 of HW3, but shorter evidence sequence (length 2).

Notes:

- Most problems will be only using discrete variables, but there might be some simple question regarding continuous probabilities, e.g. how do CPTs in BNs look like if there is a continuous variable involved.

- Grading will be not be done on correctness of numerical results (where appropriate), but on showing how the results are computed from the given information. But a calculator might be useful.