# Lab5 - Probabilistic Inference

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## 1 Probabilistic Inference using Bayesian Networks

This project implements two techniques for drawing inference from a Bayesian Network.

- Exact inference using variable elimination
- Approximate inference using rejection sampling

### 1.1 Statistics

Sample test 1

| **Inference Technique** | **Query 1** | **Query 2** | **Query 3** | **Query 4** | **Query 5** | **Query 6** |
|---|---|---|---|---|---|---|
| *Variable Elimination* | 0.25 | 0.5 | 0.5 | 0.5 | 0.03125 | 0.0625 |
| *Rejection Sampling 100 Samples* | 0.4 | 0.5454 | 0.5918 | 0.5471 | 0.03 | 0.08 |
| *Rejection Sampling 1000 Samples* | 0.2166 | 0.4785 | 0.4949 | 0.4990 | 0.034 | 0.064 |
| *Rejection Sampling 10000 Samples* | 0.2532 | 0.4901 | 0.4936 | 0.5028 | 0.0302 | 0.0596 |
| *Rejection Sampling 100000 Samples* | 0.2515 | 0.4999 | 0.4983 | 0.4982 | 0.03158 | 0.06191 |

Sample test 2

| **Inference Technique** | **Query 1** | **Query 2** | **Query 3** | **Query 4** | **Query 5** | **Query 6** |
|---|---|---|---|---|---|---|
| *Variable Elimination* | 0.16 | 0.2 | 0.32 | 0.64 | 0.00512 | 0.01728 |
| *Rejection Sampling 100 Samples* | 0 | 0.3333 | 0.2857 | 0.6842 | 0 | 0.02 |
| *Rejection Sampling 1000 Samples* | 0.1666 | 0.1555 | 0.3018 | 0.6363 | 0.003 | 0.014 |
| *Rejection Sampling 10000 Samples* | 0.1494 | 0.2048 | 0.3204 | 0.6334 | 0.0055 | 0.0168 |
| *Rejection Sampling 100000 Samples* | 0.1829 | 0.2030 | 0.3184 | 0.6377 | 0.00519 | 0.01658 |

Sample test 3

| **Inference Technique** | **Query 1** | **Query 2** | **Query 3** | **Query 4** | **Query 5** | **Query 6** |
|---|---|---|---|---|---|---|
| *Variable Elimination* | 0 | 0.3 | 0.500025 | 0.9 | 0.440559 | 0.0005 |
| *Rejection Sampling 100 Samples* | 0 | 0.3333 | 0.5463 | 0.9 | 0.46 | 0 |
| *Rejection Sampling 1000 Samples* | 0 | 0.3 | 0.5060 | 0.9103 | 0.465 | 0 |
| *Rejection Sampling 10000 Samples* | 0 | 0.3316 | 0.4982 | 0.8997 | 0.4324 | 0.0001 |
| *Rejection Sampling 100000 Samples* | 0 | 0.3195 | 0.5000 | 0.8981 | 0.44273 | 0.00049 |

**Analysis** As number of samples increase; inference via rejection sampling approach the exact inference by variable elimination.