Inference for SRL Report

Capita Selecta AI (Probabilistic Programming) 2016-2017

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Daniel: Not sure if the 6th clause of the network variable A in IV is correctly substituted due to the property describe in the paper "Consider again Figure 1 and imagine that the parameter $\theta c1|a1$ were 0. Given that this parameter is known to be 0, all models that set this parameter variable to true will have weight 0."

Daniel: For VI, should we also chance the closure that contains a probability of 0, like we did in the ENC1 encoding? Look comment above

I. PROBABILISTIC INFERENCE USING WEIGHTED MODEL COUNTING

A. PGM to CNF

Table I shows the semantics of the domain variables used for those tasks.

Tables II and III show the logical variables used for encoded the Bayesian Network in [1].

Table IV represents the encoded Bayesian Network using ENC1 and table V contains the corresponding weights.

Likewise, table VI represent the encoded Bayesian Network using ENC2 and table VII contains the corresponding weights.

REFERENCES

[1] Bayesian networks.

Table I.   RANDOM VARIABLES AND DOMAINS SEMANTICS

Variable	Domain
B = Burglary	b1 = theres is a burglary b2 = theres is no burglary
E = Earthquake	e1 = there is a heavy earthquake e2 = there is a mild earthquake e3 = there is no earthquake
A = Alarm	a1 = alarm rings a2 = alarm does not ring
J = John	j1 = John calls j2 = John does not call
M = Mary	m1 = Mary calls m2 = Mary does not call

Table II.   LOGICAL VARIABLES USING ENC1

Network variables	Indicator Variable	CTP
B	$\lambda_{b1}, \lambda_{b2}$	θ_{b1}, θ_{b2}
E	$\lambda_{e1}, \lambda_{e2}, \lambda_3$	$\theta_{e1}, \theta_{e2}, \theta_3$
A	$\lambda_{a1}, \lambda_{a2}$	$\theta_{a1|b1,e1}, \theta_{a1|b1,e2}, \theta_{a1|b1,e3}, \\ \theta_{a1|b2,e1}, \theta_{a1|b2,e2}, \theta_{a1|b2,e3}, \\ \theta_{a2|b1,e1}, \theta_{a2|b1,e2}, \theta_{a2|b1,e3}, \\ \theta_{a2|b2,e1}, \theta_{a2|b2,e2}, \theta_{a2|b2,e3}$
J	$\lambda_{j1}, \lambda_{j2}$	$\theta_{j1|a1}, \theta_{j2|a1}, \theta_{j1|a2}, \theta_{j2|a2}$
M	$\lambda_{m1}, \lambda_{m2}$	$\theta_{m1|a1}, \theta_{m2|a1}, \theta_{m1|a2}, \theta_{m2|a2}$

Table III.   LOGICAL VARIABLES USING ENC2

Variables	Indicator Variable	CTP
B	$\lambda_{b1}, \lambda_{b2}$	ρ_{b1}
E	$\lambda_{e1}, \lambda_{e2}, \lambda_3$	ρ_{e1}, ρ_{e2}
A	$\lambda_{a1}, \lambda_{a2}$	$\rho_{a1|b1,e1}, \rho_{a1|b1,e2}, \rho_{a1|b1,e3},$ $\rho_{a1|b2,e1}, \rho_{a1|b2,c2}, \rho_{a1|b2,e3}$
J	$\lambda_{j1}, \lambda_{j2}$	$\rho_{j1|a1}, \rho_{j1|a2}$
M	$\lambda_{m1}, \lambda_{m2}$	$\rho_{m1|a1}, \rho_{m1|a2}$

Table IV.   BAYESIAN NETWORK ENCODED USING ENC1

Network variable	Indicator Clauses	ENC1 Parameter Clauses
B	$\lambda_{b1} \vee \lambda_{b2},$ $\neg\lambda_{b1} \vee \neg\lambda_{b2}$	$\lambda_{b1} \Rightarrow \theta_{b1}, \theta_{b1} \Rightarrow \lambda_{b1}$ $\lambda_{b2} \Rightarrow \theta_{b2}, \theta_{b2} \Rightarrow \lambda_{b2}$
E	$\lambda_{e1} \vee \lambda_{e2} \vee \lambda_{e3},$ $\neg\lambda_{e1} \vee \neg\lambda_{e2},$ $\neg\lambda_{e1} \vee \neg\lambda_{e3},$ $\neg\lambda_{e2} \vee \neg\lambda_{e3}$	$\lambda_{e1} \Rightarrow \theta_{e1}, \theta_{e1} \Rightarrow \lambda_{e1}$ $\lambda_{e2} \Rightarrow \theta_{e2}, \theta_{e2} \Rightarrow \lambda_{e2}$ $\lambda_{e3} \Rightarrow \theta_{e3}, \theta_{e3} \Rightarrow \lambda_{e3}$
A	$\lambda_{a1} \vee \lambda_{a2},$ $\neg\lambda_{a1} \vee \neg\lambda_{a2}$	$\lambda_{a1} \wedge \lambda_{b1} \wedge \lambda_{e1} \Rightarrow \theta_{a1|b1,e1}, \theta_{a1|b1,e1} \Rightarrow \lambda_{a1}, \theta_{a1|b1,e1} \Rightarrow \lambda_{b1}, \theta_{a1|b1,e1} \Rightarrow \lambda_{e1}$ $\lambda_{a1} \wedge \lambda_{b1} \wedge \lambda_{e2} \Rightarrow \theta_{a1|b1,e2}, \theta_{a1|b1,e2} \Rightarrow \lambda_{a1}, \theta_{a1|b1,e2} \Rightarrow \lambda_{b1}, \theta_{a1|b1,e2} \Rightarrow \lambda_{e2}$ $\lambda_{a1} \wedge \lambda_{b1} \wedge \lambda_{e3} \Rightarrow \theta_{a1|b1,e3}, \theta_{a1|b1,e3} \Rightarrow \lambda_{a1}, \theta_{a1|b1,e3} \Rightarrow \lambda_{b1}, \theta_{a1|b1,e3} \Rightarrow \lambda_{e3}$ $\lambda_{a1} \wedge \lambda_{b2} \wedge \lambda_{e1} \Rightarrow \theta_{a1|b2,e1}, \theta_{a1|b2,e1} \Rightarrow \lambda_{a1}, \theta_{a1|b2,e1} \Rightarrow \lambda_{b2}, \theta_{a1|b2,e1} \Rightarrow \lambda_{e1}$ $\lambda_{a1} \wedge \lambda_{b2} \wedge \lambda_{e2} \Rightarrow \theta_{a1|b2,e2}, \theta_{a1|b2,e2} \Rightarrow \lambda_{a1}, \theta_{a1|b2,e2} \Rightarrow \lambda_{b2}, \theta_{a1|b2,e2} \Rightarrow \lambda_{e2}$ $\neg\lambda_{a1} \vee \neg\lambda_{b2} \vee \neg\lambda_{c3}$ $\lambda_{a2} \wedge \lambda_{b1} \wedge \lambda_{e1} \Rightarrow \theta_{a2|b1,e1}, \theta_{a2|b1,e1} \Rightarrow \lambda_{a2}, \theta_{a2|b1,e1} \Rightarrow \lambda_{b1}, \theta_{a2|b1,e1} \Rightarrow \lambda_{e1}$ $\lambda_{a2} \wedge \lambda_{b1} \wedge \lambda_{e2} \Rightarrow \theta_{a2|b1,e2}, \theta_{a2|b1,e2} \Rightarrow \lambda_{a2}, \theta_{a2|b1,e2} \Rightarrow \lambda_{b1}, \theta_{a2|b1,e2} \Rightarrow \lambda_{e2}$ $\lambda_{a2} \wedge \lambda_{b1} \wedge \lambda_{e3} \Rightarrow \theta_{a2|b1,e3}, \theta_{a2|b1,e3} \Rightarrow \lambda_{a2}, \theta_{a2|b1,e3} \Rightarrow \lambda_{b1}, \theta_{a2|b1,e3} \Rightarrow \lambda_{e3}$ $\lambda_{a2} \wedge \lambda_{b2} \wedge \lambda_{e1} \Rightarrow \theta_{a2|b2,e1}, \theta_{a2|b2,e1} \Rightarrow \lambda_{a2}, \theta_{a2|b2,e1} \Rightarrow \lambda_{b2}, \theta_{a2|b2,e1} \Rightarrow \lambda_{e1}$ $\lambda_{a2} \wedge \lambda_{b2} \wedge \lambda_{e2} \Rightarrow \theta_{a2|b2,e2}, \theta_{a2|b2,e2} \Rightarrow \lambda_{a2}, \theta_{a2|b2,e2} \Rightarrow \lambda_{b2}, \theta_{a2|b2,e2} \Rightarrow \lambda_{e2}$ $\lambda_{a2} \wedge \lambda_{b2} \wedge \lambda_{e3} \Rightarrow \theta_{a2|b2,e3}, \theta_{a2|b2,e3} \Rightarrow \lambda_{a2}, \theta_{a2|b2,e3} \Rightarrow \lambda_{b2}, \theta_{a2|b2,e3} \Rightarrow \lambda_{e3}$
J	$\lambda_{j1} \vee \lambda_{j2},$ $\neg\lambda_{j1} \vee \neg\lambda_{j2}$	$\lambda_{j1} \wedge \lambda_{a1} \Rightarrow \theta_{j1|a1}, \theta_{j1|a1} \Rightarrow \lambda_{j1}, \theta_{j1|a1} \Rightarrow \lambda_{a1}$ $\lambda_{j1} \wedge \lambda_{a2} \Rightarrow \theta_{j1|a2}, \theta_{j1|a2} \Rightarrow \lambda_{j1}, \theta_{j1|a2} \Rightarrow \lambda_{a2}$ $\lambda_{j2} \wedge \lambda_{a1} \Rightarrow \theta_{j2|a1}, \theta_{j2|a1} \Rightarrow \lambda_{j2}, \theta_{j2|a1} \Rightarrow \lambda_{a1}$ $\lambda_{j2} \wedge \lambda_{a2} \Rightarrow \theta_{j2|a2}, \theta_{j2|a2} \Rightarrow \lambda_{j2}, \theta_{j2|a2} \Rightarrow \lambda_{a2}$
M	$\lambda_{m1} \vee \lambda_{m2},$ $\neg\lambda_{m1} \vee \neg\lambda_{m2}$	$\lambda_{m1} \wedge \lambda_{a1} \Rightarrow \theta_{m1|a1}, \theta_{m1|a1} \Rightarrow \lambda_{m1}, \theta_{m1|a1} \Rightarrow \lambda_{a1}$ $\lambda_{m1} \wedge \lambda_{a2} \Rightarrow \theta_{m1|a2}, \theta_{m1|a2} \Rightarrow \lambda_{m1}, \theta_{m1|a2} \Rightarrow \lambda_{a2}$ $\lambda_{m2} \wedge \lambda_{a1} \Rightarrow \theta_{m2|a1}, \theta_{m2|a1} \Rightarrow \lambda_{m2}, \theta_{m2|a1} \Rightarrow \lambda_{a1}$ $\lambda_{m2} \wedge \lambda_{a2} \Rightarrow \theta_{m2|a2}, \theta_{m2|a2} \Rightarrow \lambda_{m2}, \theta_{m2|a2} \Rightarrow \lambda_{a2}$

Table V.   WEIGHTS ASSOCIATION USING ENC1 WHERE MISSING WEIGHTS ARE SET TO ONE

Weights	Value
$W(\theta_{b1})$	0.7
$W(\theta_{b2})$	0.3
$W(\theta_{e1})$	0.01
$W(\theta_{e2})$	0.19
$W(\theta_{e3})$	0.80
$W(\theta_{a1|b1,e1})$	0.90
$W(\theta_{a1|b1,e2})$	0.85
$W(\theta_{a1|b1,e3})$	0.80
$W(\theta_{a1|b2,e1})$	0.30
$W(\theta_{a1|b2,e2})$	0.10
$W(\theta_{a1|b2,e3})$	0.00
$W(\theta_{a2|b1,e1})$	0.10
$W(\theta_{a2|b1,e2})$	0.15
$W(\theta_{a2|b1,e3})$	0.20
$W(\theta_{a2|b2,e1})$	0.70
$W(\theta_{a2|b2,e2})$	0.90
$W(\theta_{a2|b2,e3})$	1.00
$W(\theta_{j1|a1})$	0.80
$W(\theta_{j1|a2})$	0.10
$W(\theta_{j2|a1})$	0.20
$W(\theta_{j2|a2})$	0.90
$W(\theta_{m1|a1})$	0.80
$W(\theta_{m1|a2})$	0.10
$W(\theta_{m2|a1})$	0.20
$W(\theta_{m2|a2})$	0.90

Table VI.   BAYESIAN NETWORK ENCODED USING ENC2

Network variable	Indicator Clauses	ENC1 Parameter Clauses
B	$\lambda_{b1} \vee \lambda_{b2}$, $\neg\lambda_{b1} \vee \neg\lambda_{b2}$	$\rho_{b1} \Rightarrow \lambda_{b1}$ $\neg\rho_{b1} \Rightarrow \lambda_{b2}$
E	$\lambda_{e1} \vee \lambda_{e2} \vee \lambda_{e3}$, $\neg\lambda_{e1} \vee \neg\lambda_{e2}$, $\neg\lambda_{e1} \vee \neg\lambda_{e3}$, $\neg\lambda_{e2} \vee \neg\lambda_{e3}$	$\rho_{e1} \Rightarrow \lambda_{e1}$ $\neg\rho_{e1} \wedge \rho_{e2} \Rightarrow \lambda_{e2}$ $\neg\rho_{e1} \wedge \neg\rho_{e2} \Rightarrow \lambda_{e3}$
A	$\lambda_{a1} \vee \lambda_{a2}$, $\neg\lambda_{a1} \vee \neg\lambda_{a2}$	$\lambda_{b1} \wedge \lambda_{e1} \wedge \rho_{a1|b1,e1} \Rightarrow \lambda_{a1}$ $\lambda_{b1} \wedge \lambda_{e2} \wedge \rho_{a1|b1,e2} \Rightarrow \lambda_{a1}$ $\lambda_{b1} \wedge \lambda_{e3} \wedge \rho_{a1|b1,e3} \Rightarrow \lambda_{a1}$ $\lambda_{b2} \wedge \lambda_{e1} \wedge \rho_{a1|b2,e1} \Rightarrow \lambda_{a1}$ $\lambda_{b2} \wedge \lambda_{e2} \wedge \rho_{a1|b2,e2} \Rightarrow \lambda_{a1}$ $\lambda_{b2} \wedge \lambda_{e3} \wedge \rho_{a1|b2,e3} \Rightarrow \lambda_{a1}$ $\lambda_{b1} \wedge \lambda_{e1} \wedge \neg\rho_{a1|b1,e1} \Rightarrow \lambda_{a2}$ $\lambda_{b1} \wedge \lambda_{e2} \wedge \neg\rho_{a1|b1,e2} \Rightarrow \lambda_{a2}$ $\lambda_{b1} \wedge \lambda_{e3} \wedge \neg\rho_{a1|b1,e3} \Rightarrow \lambda_{a2}$ $\lambda_{b2} \wedge \lambda_{e1} \wedge \neg\rho_{a1|b2,e1} \Rightarrow \lambda_{a2}$ $\lambda_{b2} \wedge \lambda_{e2} \wedge \neg\rho_{a1|b2,e2} \Rightarrow \lambda_{a2}$ $\lambda_{b2} \wedge \lambda_{e3} \wedge \neg\rho_{a1|b2,e3} \Rightarrow \lambda_{a2}$
J	$\lambda_{j1} \vee \lambda_{j2}$, $\neg\lambda_{j1} \vee \neg\lambda_{j2}$	$\lambda_{a1} \wedge \rho_{j1|a1} \Rightarrow \lambda_{j1}$ $\lambda_{a2} \wedge \rho_{j1|a2} \Rightarrow \lambda_{j1}$ $\lambda_{a1} \wedge \neg\rho_{j1|a1} \Rightarrow \lambda_{j2}$ $\lambda_{a2} \wedge \neg\rho_{j1|a2} \Rightarrow \lambda_{j2}$
M	$\lambda_{m1} \vee \lambda_{m2}$, $\neg\lambda_{m1} \vee \neg\lambda_{m2}$	$\lambda_{a1} \wedge \rho_{m1|a1} \Rightarrow \lambda_{m1}$ $\lambda_{a2} \wedge \rho_{m1|a2} \Rightarrow \lambda_{m1}$ $\lambda_{a1} \wedge \neg\rho_{m1|a1} \Rightarrow \lambda_{m2}$ $\lambda_{a2} \wedge \neg\rho_{m1|a2} \Rightarrow \lambda_{m2}$

Table VII.   WEIGHTS ASSOCIATION USING ENC2 WHERE MISSING WEIGHTS ARE SET TO ONE

Weights	Value
$W(\rho_{b1})$	0.7
$W(\neg\rho_{b1})$	0.3
$W(\rho_{e1})$	0.01
$W(\rho_{e2})$	0.19
$W(\neg\rho_{e1})$	1-0.01 = 0.99
$W(\neg\rho_{e2})$	1-0.19 = 0.81
$W(\rho_{a1|b1,e1})$	0.90
$W(\neg\rho_{a1|b1,e1})$	1-0.90=0.10
$W(\rho_{a1|b1,e2})$	0.85
$W(\neg\rho_{a1|b1,e2})$	1-0.85=0.15
$W(\rho_{a1|b1,e3})$	0.80
$W(\neg\rho_{a1|b1,e3})$	1-0.80=0.20
$W(\rho_{a1|b2,e1})$	0.30
$W(\neg\rho_{a1|b2,e1})$	1-0.30=0.70
$W(\rho_{a1|b2,e2})$	0.10
$W(\neg\rho_{a1|b2,e2})$	1-0-10=0.90
$W(\rho_{a1|b2,e3})$	0
$W(\neg\rho_{a1|b2,e3})$	1-0=1
$W(\rho_{j1|a1})$	0.80
$W(\neg\rho_{j1|a1})$	1-0.80=0.20
$W(\rho_{j1|a2})$	0.10
$W(\neg\rho_{j1|a2})$	1-0.10=0.90