Inference for SRL Report

Capita Selecta AI (Probabilistic Programming) 2016-2017

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Alex: proposal: change all e1,e2,e3 to eh,em,en - D: I'd say let it like that to be consistence with the number indices of the other variables. I just add a small description about what is the meaning of each variable to be more precise

Alex: table IV: is this needed? The A ¡=¿ B implicitly means A =¿ B and B =¿ A. D: I made this according to the ENC1 description of the paper, Since table cnfRepresentationEnc1 is in essence the same as enc1Encoding, I took off cnfRepresentationEnc1 from the table list

Alex: table V: maybe add W(theta a2—b2,e3) = 1 just to cover everything? - I guess it's not need it, otherwise we need also to add $\lambda_{b1} = 1, \lambda_{b1} = 2, \lambda_{a1} = 1, \lambda_{a2} = 1, etc.$

Alex: table VII: what's the difference with table VI? D: Actually they are the same, I wanted to explicitly note the CNF representation and the actual encoding but I ended up with the same tables. I took off table cnfRepresentationEnc1

Alex: table VIII: I'm not sure if W(ro e2) = 0.19/(1-0.01) ; is it not just 0.19? Because it's a parent node and does not have any conditionals. I may be very wrong on this; I'm not sure about this. - D: You are right, Earthquake is marginal independent of the others (there is no conditional dependency such that P(E—SomeNodes)), I just wanted to be explicit according with the method described in the paper, we can always get rid of the "unseless" operation

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 I. Random variables and domains semantics

Variable	Domain
B = Burglary	b1 = theres is burglary b2 = theres is no burglary
E = Earthquake	a1 = there is heavyearthquake a2 = there is mild earthquake a3 = 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	λ_{b1}, λ_{b2}	θ_{b1}, θ_{b2}
E	λ_{e1}, λ_{e2}, λ_{3}	θ_{e1}, θ_{e2}, θ_{3}
A	λ_{a1}, λ_{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	λ_{j1}, λ_{j2}	$\theta_{j1\|a1}$, $\theta_{j2\|a1}$, $\theta_{j1\|a2}$, $\theta_{j2\|a2}$
M	λ_{m1}, λ_{m2}	$\theta_{m1\|a1}$, $\theta_{m2\|a1}$,$\theta_{m1\|a2}$, $\theta_{m2\|a2}$

Table III. LOGICAL VARIABLES USING ENC2

Variables	Indicator Variable	CTP
B	λ_{b1}, λ_{b2}	ρ_{b1}
E	λ_{e1}, λ_{e2}, λ_{3}	ρ_{e1}, ρ_{e2}
A	λ_{a1}, λ_{a2}	$\rho_{a1\|b1,c1}$, $\rho_{a1\|b1,c2}$, $\rho_{a1\|b1,c3}$, $\rho_{a1\|b2,c1}$, $\rho_{a1\|b2,c2}$, $\rho_{a1\|b2,c3}$
J	λ_{j1}, λ_{j2}	$\rho_{j1\|a1}$, $\rho_{j1\|a2}$
M	λ_{m1}, λ_{m2}	$\rho_{m1\|a1}$, $\rho_{m1\|a2}$

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 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(θ_{b1})	0.7
W(θ_{b2})	0.3
W(θ_{e1})	0.01
W(θ_{e2})	0.19
W(θ_{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
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($\theta_{j1\|a1}$)	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(ρ_{b1})	0.7
W($\neg\rho_{b1}$)	0.3
W(ρ_{e1})	0.01
W(ρ_{e2})	0.19/(1-0.01) = 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