Inference for SRL

Armin Halilovic & Thierry Deruyttere (r0660485)

March 24, 2018

Chapter 1

Probabilistic Inference Using Weighted Model Counting

1.1

1.1.1 ENC 1

Indicator clauses:

$$($$

$$\neg\, \lambda_{PollutionLow} \vee \neg\, \lambda_{PollutionHigh}) \wedge (\lambda_{PollutionLow} \vee \lambda_{PollutionHigh}) \wedge (\neg\, \lambda_{SmokerTrue} \vee \neg\, \lambda_{SmokerFalse}) \wedge (\lambda_{SmokerTrue} \vee \lambda_{SmokerFalse}) \wedge (\neg\, \lambda_{CancerTrue} \vee \neg\, \lambda_{CancerFalse}) \wedge (\lambda_{CancerTrue} \vee \lambda_{CancerFalse}) \wedge (\neg\, \lambda_{XrayPositive} \vee \neg\, \lambda_{XrayNegative}) \wedge (\lambda_{XrayPositive} \vee \lambda_{XrayNegative}) \wedge (\neg\, \lambda_{DyspnoeaTrue} \vee \neg\, \lambda_{DyspnoeaFalse}) \wedge (\lambda_{DyspnoeaTrue} \vee \lambda_{DyspnoeaFalse})$$

Parameter clauses:

Weights

$$W($$

$\lambda_{PollutionLow}) = 1.00$
$\mathrm{W}(\neg\lambda_{PollutionLow}) = 1.00$

$\mathrm{W}(\lambda_{PollutionHigh}) = 1.00$
$\mathrm{W}(\neg\lambda_{PollutionHigh}) = 1.00$
$\mathrm{W}(\lambda_{SmokerTrue}) = 1.00$
$\mathrm{W}(\neg\lambda_{SmokerTrue}) = 1.00$
$\mathrm{W}(\lambda_{SmokerFalse}) = 1.00$
$\mathrm{W}(\neg\lambda_{SmokerFalse}) = 1.00$
$\mathrm{W}(\lambda_{CancerTrue}) = 1.00$
$\mathrm{W}(\neg\lambda_{CancerTrue}) = 1.00$
$\mathrm{W}(\lambda_{CancerFalse}) = 1.00$
$\mathrm{W}(\neg\lambda_{CancerFalse}) = 1.00$
$\mathrm{W}(\lambda_{XrayPositive}) = 1.00$
$\mathrm{W}(\neg\lambda_{XrayPositive}) = 1.00$
$\mathrm{W}(\lambda_{XrayNegative}) = 1.00$
$\mathrm{W}(\neg\lambda_{XrayNegative}) = 1.00$
$\mathrm{W}(\lambda_{DyspnoeaTrue}) = 1.00$
$\mathrm{W}(\neg\lambda_{DyspnoeaTrue}) = 1.00$
$\mathrm{W}(\lambda_{DyspnoeaFalse}) = 1.00$
$\mathrm{W}(\neg\lambda_{DyspnoeaFalse}) = 1.00$
$\mathrm{W}(\theta_{PollutionLow}) = 0.90$
$\mathrm{W}(\neg\theta_{PollutionLow}) = 1.00$
$\mathrm{W}(\theta_{PollutionHigh}) = 0.10$
$\mathrm{W}(\neg\theta_{PollutionHigh}) = 1.00$
$\mathrm{W}(\theta_{SmokerTrue}) = 0.30$
$\mathrm{W}(\neg\theta_{SmokerTrue}) = 1.00$
$\mathrm{W}(\theta_{SmokerFalse}) = 0.70$
$\mathrm{W}(\neg\theta_{SmokerFalse}) = 1.00$
$\mathrm{W}(\theta_{CancerTrue|PollutionLow,SmokerTrue}) = 0.03$
$\mathrm{W}(\neg\theta_{CancerTrue|PollutionLow,SmokerTrue}) = 1.00$
$\mathrm{W}(\theta_{CancerFalse|PollutionLow,SmokerTrue}) = 0.97$
$\mathrm{W}(\neg\theta_{CancerFalse|PollutionLow,SmokerTrue}) = 1.00$
$\mathrm{W}(\theta_{CancerTrue|PollutionLow,SmokerFalse}) = 0.00$
$\mathrm{W}(\neg\theta_{CancerTrue|PollutionLow,SmokerFalse}) = 1.00$
$\mathrm{W}(\theta_{CancerFalse|PollutionLow,SmokerFalse}) = 1.00$
$\mathrm{W}(\neg\theta_{CancerFalse|PollutionLow,SmokerFalse}) = 1.00$
$\mathrm{W}(\theta_{CancerTrue|PollutionHigh,SmokerTrue}) = 0.05$
$\mathrm{W}(\neg\theta_{CancerTrue|PollutionHigh,SmokerTrue}) = 1.00$
$\mathrm{W}(\theta_{CancerFalse|PollutionHigh,SmokerTrue}) = 0.95$
$\mathrm{W}(\neg\theta_{CancerFalse|PollutionHigh,SmokerTrue}) = 1.00$
$\mathrm{W}(\theta_{CancerTrue|PollutionHigh,SmokerFalse}) = 0.02$
$\mathrm{W}(\neg\theta_{CancerTrue|PollutionHigh,SmokerFalse}) = 1.00$
$\mathrm{W}(\theta_{CancerFalse|PollutionHigh,SmokerFalse}) = 0.98$
$\mathrm{W}(\neg\theta_{CancerFalse|PollutionHigh,SmokerFalse}) = 1.00$
$\mathrm{W}(\theta_{XrayPositive|CancerTrue}) = 0.90$
$\mathrm{W}(\neg\theta_{XrayPositive|CancerTrue}) = 1.00$
$\mathrm{W}(\theta_{XrayNegative|CancerTrue}) = 0.10$
$\mathrm{W}(\neg\theta_{XrayNegative|CancerTrue}) = 1.00$
$\mathrm{W}(\theta_{XrayPositive|CancerFalse}) = 0.20$
$\mathrm{W}(\neg\theta_{XrayPositive|CancerFalse}) = 1.00$
$\mathrm{W}(\theta_{XrayNegative|CancerFalse}) = 0.80$
$\mathrm{W}(\neg\theta_{XrayNegative|CancerFalse}) = 1.00$

$\mathrm{W}(\theta_{DyspnoeaFalse|CancerFalse}) = 0.70$
$\mathrm{W}(\neg\theta_{DyspnoeaFalse|CancerFalse}) = 1.00$

1.1.2 ENC 2

Indicator clauses

$$(\neg\lambda_{PollutionLow} \vee \neg\lambda_{PollutionHigh}) \wedge (\lambda_{PollutionLow} \vee \lambda_{PollutionHigh}) \wedge$$
$$(\neg\lambda_{SmokerTrue} \vee \neg\lambda_{SmokerFalse}) \wedge (\lambda_{SmokerTrue} \vee \lambda_{SmokerFalse}) \wedge$$
$$(\neg\lambda_{CancerTrue} \vee \neg\lambda_{CancerFalse}) \wedge (\lambda_{CancerTrue} \vee \lambda_{CancerFalse}) \wedge$$
$$(\neg\lambda_{XrayPositive} \vee \neg\lambda_{XrayNegative}) \wedge (\lambda_{XrayPositive} \vee \lambda_{XrayNegative}) \wedge$$
$$(\neg\lambda_{DyspnoeaTrue} \vee \neg\lambda_{DyspnoeaFalse}) \wedge (\lambda_{DyspnoeaTrue} \vee \lambda_{DyspnoeaFalse})$$

Parameter clauses

$$(\neg\rho_{PollutionLow} \vee \lambda_{PollutionLow}) \wedge (\rho_{PollutionLow} \vee \lambda_{PollutionHigh}) \wedge$$
$$(\neg\rho_{SmokerTrue} \vee \lambda_{SmokerTrue}) \wedge (\rho_{SmokerTrue} \vee \lambda_{SmokerFalse}) \wedge (\neg\lambda_{PollutionLow} \vee$$
$$\neg\lambda_{SmokerTrue} \vee \neg\rho_{CancerTrue|PollutionLow,SmokerTrue} \vee \lambda_{CancerTrue}) \wedge$$
$$(\neg\lambda_{PollutionLow} \vee \neg\lambda_{SmokerTrue} \vee \rho_{CancerTrue|PollutionLow,SmokerTrue} \vee$$
$$\lambda_{CancerFalse}) \wedge (\neg\lambda_{PollutionLow} \vee \neg\lambda_{SmokerFalse} \vee$$
$$\neg\rho_{CancerTrue|PollutionLow,SmokerFalse} \vee \lambda_{CancerTrue}) \wedge (\neg\lambda_{PollutionLow} \vee$$
$$\neg\lambda_{SmokerFalse} \vee \rho_{CancerTrue|PollutionLow,SmokerFalse} \vee \lambda_{CancerFalse}) \wedge$$
$$(\neg\lambda_{PollutionHigh} \vee \neg\lambda_{SmokerTrue} \vee \neg\rho_{CancerTrue|PollutionHigh,SmokerTrue} \vee$$
$$\lambda_{CancerTrue}) \wedge (\neg\lambda_{PollutionHigh} \vee \neg\lambda_{SmokerTrue} \vee$$
$$\rho_{CancerTrue|PollutionHigh,SmokerTrue} \vee \lambda_{CancerFalse}) \wedge (\neg\lambda_{PollutionHigh} \vee$$
$$\neg\lambda_{SmokerFalse} \vee \neg\rho_{CancerTrue|PollutionHigh,SmokerFalse} \vee \lambda_{CancerTrue}) \wedge$$
$$(\neg\lambda_{PollutionHigh} \vee \neg\lambda_{SmokerFalse} \vee \rho_{CancerTrue|PollutionHigh,SmokerFalse} \vee$$
$$\lambda_{CancerFalse}) \wedge (\neg\lambda_{CancerTrue} \vee \neg\rho_{XrayPositive|CancerTrue} \vee \lambda_{XrayPositive}) \wedge$$
$$(\neg\lambda_{CancerTrue} \vee \rho_{XrayPositive|CancerTrue} \vee \lambda_{XrayNegative}) \wedge (\neg\lambda_{CancerFalse} \vee$$
$$\neg\rho_{XrayPositive|CancerFalse} \vee \lambda_{XrayPositive}) \wedge (\neg\lambda_{CancerFalse} \vee$$
$$\rho_{XrayPositive|CancerFalse} \vee \lambda_{XrayNegative}) \wedge (\neg\lambda_{CancerTrue} \vee$$
$$\neg\rho_{DyspnoeaTrue|CancerTrue} \vee \lambda_{DyspnoeaTrue}) \wedge (\neg\lambda_{CancerTrue} \vee$$
$$\rho_{DyspnoeaTrue|CancerTrue} \vee \lambda_{DyspnoeaFalse}) \wedge (\neg\lambda_{CancerFalse} \vee$$
$$\neg\rho_{DyspnoeaTrue|CancerFalse} \vee \lambda_{DyspnoeaTrue}) \wedge (\neg\lambda_{CancerFalse} \vee$$
$$\rho_{DyspnoeaTrue|CancerFalse} \vee \lambda_{DyspnoeaFalse})$$

Weights

$\mathrm{W}(\lambda_{PollutionLow}) = 1.00$
$\mathrm{W}(\neg\lambda_{PollutionLow}) = 1.00$
$\mathrm{W}(\lambda_{PollutionHigh}) = 1.00$

$W(\neg\lambda_{PollutionHigh}) = 1.00$
$W(\lambda_{SmokerTrue}) = 1.00$
$W(\neg\lambda_{SmokerTrue}) = 1.00$
$W(\lambda_{SmokerFalse}) = 1.00$
$W(\neg\lambda_{SmokerFalse}) = 1.00$
$W(\lambda_{CancerTrue}) = 1.00$
$W(\neg\lambda_{CancerTrue}) = 1.00$
$W(\lambda_{CancerFalse}) = 1.00$
$W(\neg\lambda_{CancerFalse}) = 1.00$
$W(\lambda_{XrayPositive}) = 1.00$
$W(\neg\lambda_{XrayPositive}) = 1.00$
$W(\lambda_{XrayNegative}) = 1.00$
$W(\neg\lambda_{XrayNegative}) = 1.00$
$W(\lambda_{DyspnoeaTrue}) = 1.00$
$W(\neg\lambda_{DyspnoeaTrue}) = 1.00$
$W(\lambda_{DyspnoeaFalse}) = 1.00$
$W(\neg\lambda_{DyspnoeaFalse}) = 1.00$
$W(\rho_{PollutionLow}) = 0.90$
$W(\neg\rho_{PollutionLow}) = 0.10$
$W(\rho_{SmokerTrue}) = 0.30$
$W(\neg\rho_{SmokerTrue}) = 0.70$
$W(\rho_{CancerTrue|PollutionLow,SmokerTrue}) = 0.03$
$W(\neg\rho_{CancerTrue|PollutionLow,SmokerTrue}) = 0.97$
$W(\rho_{CancerTrue|PollutionLow,SmokerFalse}) = 0.00$
$W(\neg\rho_{CancerTrue|PollutionLow,SmokerFalse}) = 1.00$
$W(\rho_{CancerTrue|PollutionHigh,SmokerTrue}) = 0.05$
$W(\neg\rho_{CancerTrue|PollutionHigh,SmokerTrue}) = 0.95$
$W(\rho_{CancerTrue|PollutionHigh,SmokerFalse}) = 0.02$
$W(\neg\rho_{CancerTrue|PollutionHigh,SmokerFalse}) = 0.98$
$W(\rho_{XrayPositive|CancerTrue}) = 0.90$
$W(\neg\rho_{XrayPositive|CancerTrue}) = 0.10$
$W(\rho_{XrayPositive|CancerFalse}) = 0.20$
$W(\neg\rho_{XrayPositive|CancerFalse}) = 0.80$
$W(\rho_{DyspnoeaTrue|CancerTrue}) = 0.65$
$W(\neg\rho_{DyspnoeaTrue|CancerTrue}) = 0.35$
$W(\rho_{DyspnoeaTrue|CancerFalse}) = 0.30$
$W(\neg\rho_{DyspnoeaTrue|CancerFalse}) = 0.70$

1.2

The CNF of the monty hall problem is given in image 1 TODO WEIGHTS

1.3

1.3.1

We will use mini2CD and Cachet as WMC counters.

```
CNF:
select_door(1)
∧ win_keep ∨ -prize(1)
∧ -win_keep ∨ prize(1)
∧ open_door(2) ∨ prize(2) ∨ -prize(3)
∧ -open_door(2) ∨ -prize(2)
∧ -open_door(2) ∨ prize(3)
∧ open_door(3) ∨ prize(3) ∨ -prize(2)
∧ -open_door(3) ∨ -prize(3)
∧ -open_door(3) ∨ prize(2)
∧ win_switch ∨ -prize(2) ∨ open_door(2)
∧ win_switch ∨ -prize(3) ∨ open_door(3)
∧ -win_switch ∨ prize(2) ∨ prize(3)
∧ -win_switch ∨ prize(2) ∨ -open_door(3)
∧ -win_switch ∨ -open_door(2) ∨ prize(3)
∧ -win_switch ∨ -open_door(2) ∨ -open_door(3)
Queries:
query(prize(1))
query(prize(2))
query(prize(3))
query(select_door(1))
query(win_keep)
query(win_switch)
```

Figure 1.1: Grounder problog cnf

mini2CD

- ENC1:

```
Constructing CNF... DONE
CNF stats:
  Vars=30 / Clauses=74
  CNF Time      0.000s
Constructing vtree (from primal graph)... DONE
Vtree stats:
  Vtree widths: con<=5, c_con=40 v_con=5
  Vtree Time    0.003s
Counting... DONE
  Learned clauses       0
Cache stats:
  hit rate      16.7%
  lookups       12
  ent count     10
  ent memory    0.5 KB
  ht  memory    152.6 MB
  clists        1.0 ave, 1 max
  keys          4.2b ave, 6.0b max, 3.0b min
Count stats:
  Count Time    0.000s
  Count/Probability     1.00000
Total Time: 0.128s
```

Figure 1.2: Grounder problog cnf

- ENC2:
- Prolog first:

Cachet

- ENC1:

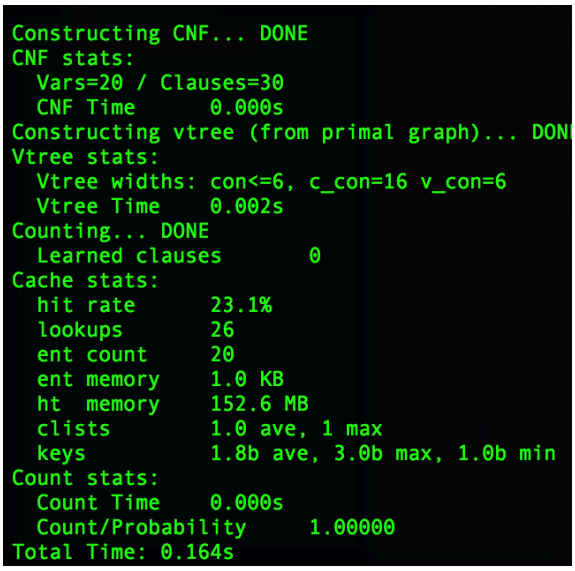

Figure 1.3: Grounder problog cnf

- ENC2:
- Prolog first:

2. Difference between WMC's

The three WMC we will compare are C2D, Cachet and SharpSAT.

C2D Vs Cachet

The biggest difference between C2D and Cachet is that C2D keeps a track of the operation it has performed. This means that Cachet is not a compiler but C2D is. In [1] they note that Cachet could easily be transformed into a compiler. There are some other minor differences like they have a different way to implement decompositions but they also do variable splitting and caching in a different way.

SharpSAT vs Cachet

SharpSAT has an efficient way to cache components. This cache has a limited size and removes old entries using an utility function. It also uses implicit boolean constraint propagation (BCP). This results in a smaller search space and reduces the cache size further. SharpSAT also inherits different techniques from conventional SAT solvers. It inherits a clause learning and a fast BCP algorithm. It also has some things in common with Cachet: For selecting the branch variables, SharpSAT applies the VSADS algorithm from Cachet. Cachet uses a string representation for components while SharpSAT uses a smart coding to store its components in a cache. [2].

C2D vs SharpSAT

The biggest difference between these two is that C2D is a compiler. A point they have in common is that they both use things from the literature. C2D creates a tree while SharpSAT doesn't.

3 Overview of computational requirements

NOG DOEN.

Bibliography

[1] Mark Chavira and Adnan Darwiche. On probabilistic inference by weighted model counting. *Artificial Intelligence*, 172(6):772 – 799, 2008.

[2] Marc Thurley. sharpsat - counting models with advanced component caching and implicit bcp. *Proceedings of the 9th International Conference on Theory and Applications of Satisfiability Testing (SAT 2006)*, pages 424–429, 2006.