Optimal decision-making under constraints and uncertainty

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Appendices

A

Pseudocode of partial-sweep algorithm

Because the pseudo code for our partial-sweep SCMD propagation algorithm is too lengthy to include in the main part of this paper, we provide it in this appendix.

Note that OscaR [132] uses *reversible data structures* that provide very convenient support for backtracking. We do not include any 'undo' operations for backtracking in our algorithm, as those mechanisms are already provided by the reversible data structures implemented in OscaR.

A.1 Notation and terminology

We use r to refer to a node in the *ordered binary decision diagram (OBDD)*, and r^- and r^+ to its lo and hi child, respectively. We use $var(r)$ to indicate *variable* that labels a node r, and we use $w(r)$ to indicate its weight in case $var(r)$ is a stochastic variable. The path weight of r is denoted by $\pi(r)$, and its score according to Equation 2.11 by $s(r)$.

We assume that the nodes of the OBDD are indexed in a topological way, such that any path from a root to a leaf corresponds to a series of increasing indices. In most of the top-down and bottom-up sweep algorithms we use queues to limit the number of nodes we visit during the sweep. In our pseudo code, a queue corresponding to a downward sweep is represented by $\mathcal{Q}$ (such that elements in the queue are sorted in increasing order of OBDD node index), while a queue used for an upward sweep is denoted with $\mathcal{U}$ (with elements in the queue sorted in decreasing order of OBDD node index). Note that we treat these queues as sets: they only contain unique elements.

We often iterate over OBDD nodes that are labelled with a particular decision variable D. We denote this set of particular decision nodes with OBDD_D.

For compactness, we refer to a node labelled with a stochastic variable as a *stochastic node*. We use similar shorthands for *free* or *unbound decision nodes*, *bound decision nodes*, *true decision nodes* and *false decision nodes*.

In the case of decision nodes, we define the *active child* of a node as follows. A child of a decision node is active if it is the hi child of a free or true decision node, or if it is the lo child of a false decision node (see Algorithm 9).

We think of propagation as the act of *removing* outgoing arcs of decision nodes when we fix the corresponding decision variable (recall Figure 6.2 in Section 6.4.3). Specifically, we remove an OBDD arc (p, c) from a parent p to child c if we fix $var(p)$ to *true* and c is p's lo child, or if we fix $var(p)$ to *false* and c is p's hi child (see Algorithm 9).

Through this process of removing arcs, we effectively remove *valid paths* (recall the definition of a valid path from Section 6.4.2) from the OBDD. Valid paths from OBDD roots to internal OBDD nodes, or to or from active decision nodes can determine whether or not we consider OBDD nodes to still be *relevant*, given the current partial strategy and corresponding removed arcs.

There are two ways in which a node r can be relevant. In the first case, it is a free decision node *and* it is reachable through a valid path from an OBDD root. In the second case, it is itself not a free decision node, but there is at least one valid path from a free decision node above r in the diagram down to r *and* there is a valid path from r itself down to a free decision node below it (see Algorithm 9).

In order to determine if a node is relevant, and to keep track of the part of the OBDD that is active (see Section 6.4.3), we associate three counters with each node r:

`Reachable[`r`]` Indicates the number of valid paths from the *artificial root* (see below) of the OBDD down to r. The counter for this artificial root itself (and for the actual OBDD roots) is always 1.

`FreeIn[r]` Indicates the number of incoming arcs that are a part of a valid path from free decision nodes above r in the OBDD. This counter can take the values 0–$|parents(r)|$.

`FreeOut[r]` Indicates the number of arcs outgoing of r that are a part of a valid path from r down to free decision nodes below r. For each node of the OBDD, this counter can take the values 0–2. For the leaves, this counter is always equal to 0.

In the general case, an OBDD may have multiple roots, each one corresponding to a query in the original . In order to define the `Reachable` counter in our implementation, we have added an artificial root to the OBDD, with one outgoing arc to each of the original roots.

The intuition behind the `Reachable` counter is the following: during search and propagation, assignments to decision variables may disconnect part of the OBDD from the root, because we remove arcs accordingly (**O6** in Section 6.4.3). This happens for example in Figure 6.2b.

The `FreeIn` counter of a node r has a value in the same domain as the `Reachable` counter, but represents a different concept. As addressed in **O4** in Section 6.4.3, only score changes in nodes that are descendants of free decision nodes, can influence the scores of those decision nodes. Therefore, during the bottom-up traversal of the OBDD to update the scores (Algorithm 4), we do not always need to propagate all the way to the roots. Once we encounter a node r whose score has changed due to recent value assignment to decision variables, but from which there is no valid path back to the artificial OBDD root that passes through a free decision node, we do not need to enqueue the parents of r for score updates. We keep track of this by counting how many of the incoming arcs of node r are on such a path.

The logic behind the `FreeOut` counter is similar to that of the `FreeIn` counter. However: instead of stopping an upward sweep, it serves to stop the downward sweep for path weight computation, to address **O5** in Section 6.4.3. The value of the `FreeOut` counter for a node r is either 0, 1 or 2, as it represent the number of children of the `FreeOut` counter that are on valid paths down to free decision nodes. Observe that if a node r is a fixed decision node, the value of its `FreeOut` counter can never exceed 1, as one of the outgoing arcs of r is removed by fixing the corresponding decision variable.

A.2 An SCPMD solving algorithm

Algorithm 1 shows the basic steps needed for solving an SCPMD in the *maximise expectation* setting (to which both problems described in Examples 4.2.1 and 4.2.2 belong).

Recall that these problems seek to maximise an expected score. We use the *stochastic constraint on monotonic distributions (SCMD)* for solving these problems by solving the constraint

$$\sum_{r \in \text{roots}} \rho_r \cdot P(r \mid \sigma) > \theta, \tag{A.1}$$

and, as soon as we have found a solution with score s^*, we update θ to take that value, and continue the search until we find a new solution, with a larger score.

A.3 Initialisation

Before the search for a solution to the stochastic constraint of Equation 1.1 begins, we initialise the data structures needed for enforcing the SCMD with the function INITIALISESCMD(OBDD, **D**), as given in Algorithm 2.

A.4 Partial-sweep propagation algorithm

During the search, as more and more decision variables become fixed, we repeatedly call the PROPAGATESCMD function in Algorithm 3 to recompute scores, path weights, partial derivatives and the score of the partial strategy, but also to keep track of the relevant part of the OBDD.

We first update arrays that record the current scores and path weights of the nodes in the OBDD, using the functions in Algorithms 4 and 5. Then, we detect currently free decision variables that must be fixed to *true* in order to obtain a score larger than the current value of θ with the ENFORCEDOMAINCONSISTENCY function in Algorithm 6. This function also fixes these variables accordingly. Finally, we maintain the relevant part of the OBDD by updating the counters presented in Section A.1, using the functions in Algorithms 7 and 8. To increase the readability of our pseudocode, we use the helper functions specified in Algorithm 9.

Algorithm 1 Solving an *stochastic constraint (optimisation) problem on monotonic distributions (SCPMD)*, in the *maximise expectation* setting.

Input: an OBDD, a set of decision variables $\mathbf{D}$, a maximum cardinality k. These are all considered to be global variables.

Output: the optimal strategy σ^* and its corresponding score $s(\sigma^*)$.

procedure BRANCH(σ', D, a)
    $\mathbf{D}_{\text{free}} \leftarrow \mathbf{D}_{\text{free}} \setminus \{D\}$
    $F \leftarrow \{D\}$ ▷ The set of decision variables that are fixed in this call to the BRANCH function.
    $\sigma' \leftarrow \sigma' \cup \{D = a\}$ ▷ Update partial strategy.
    $(\text{conflict}, \sigma', F) \leftarrow$ PROPAGATESCMD(σ', F) ▷ See Algorithm 3.
    if conflict **then return** and BACKTRACK **end if**
    $(\text{conflict}, \sigma', F) \leftarrow$ PROPAGATECARDINALITYCONSTRAINT(σ', F) ▷ Assumed given, outside the scope of this work.
    if conflict **then return** and BACKTRACK **end if**
    SOLVE(σ')

procedure SOLVE(σ')
    if $\mathbf{D}_{\text{free}} = \varnothing$ **and** $s(\sigma') > s^*$ **then**
        $\sigma^* \leftarrow \sigma'$
        $s^* \leftarrow s(\sigma^*)$ ▷ Score is computed incrementally (see Algorithm 3).
        UPDATESCMDTHRESHOLD(s^*)
        return and BACKTRACK
    for $D \in \mathbf{D}_{\text{free}}$ **do** ▷ There are different selection strategies for determining which D to branch on next.
        $a \leftarrow$ SELECTVALUE($dom(D)$) ▷ And different strategies for determining on which value to branch.
        BRANCH(σ', D, a)
        BRANCH(σ', D, $\overline{a}$)

InitialiseSCMD ▷ See Algorithm 2.
InitialiseCardinalityConstraint($\mathbf{D}$, k) ▷ Assumed given, outside the scope of this work.
$\mathbf{D}_{\text{free}} \leftarrow \mathbf{D}$ ▷ Set of free decision variables, global variable.
$\sigma^* \leftarrow \{D = \bot \mid D \in \mathbf{D}\}, s^* \leftarrow 0$ ▷ Optimal strategy and corresponding score, global variables.
$\sigma' \leftarrow$ EnforceDomainConsistency($\mathbf{D}_{free}$) ▷ Fix those variables that must be *true* to obtain partial strategy (Algorithm 6).
Solve(σ')
return $\sigma^*, s(\sigma^*)$

Algorithm 2 Initialisation of data structures. Note that OBDD and **D** are considered to be global variables.

```
procedure InitialiseFreeIn
    for r ∈ OBDD do FreeIn[r] ← 0 end for
    for r ∈ sorted(OBDD) do                                  ▷ Downward sweep.
        if var(r) is decision OR FreeIn[r] > 0 then
            FreeIn[r⁻] ← FreeIn[r⁻] + 1
            FreeIn[r⁺] ← FreeIn[r⁺] + 1

procedure InitialiseFreeOut
    for r ∈ OBDD do FreeOut[r] ← 0 end for
    for r ∈ reversed(sorted(OBDD)) do                        ▷ Upward sweep.
        if var(r) is decision OR FreeOut[r] > 0 then
            for p ∈ parents(r) do FreeOut[p] ← FreeOut[p] + 1 end for

procedure InitialiseReachable
    for r ∈ OBDD do Reachable[r] ← 0 end for
    Reachable[root] ← 1
    for r ∈ sorted(OBDD) do                                  ▷ Downward sweep.
        Reachable[r⁻] ← FreeIn[r⁻] + 1
        Reachable[r⁺] ← FreeIn[r⁺] + 1

procedure InitialiseScores
    for r ∈ reversed(sorted(OBDD)) do                        ▷ Upward sweep.
        if var(r) is decision then
            s(r) ← s(r⁺)
        else
            s(r) ← w(r) · s(r⁺) + (1 − w(r)) · s(r⁻)
```

procedure INITIALISEPATHWEIGHTS
  for $r \in$ OBDD **do** $\pi(r) \leftarrow 0$ **end for**
  for $r \in$ SORTED(OBDD) **do** ▷ Downward sweep.
    if r is an original root of the OBDD **then**
      $\pi(r) \leftarrow \pi(r) + \rho_r$
    else
      for $p \in$ PARENTS(r) **do**
        if $var(p)$ is decision **then**
          if r is hi child of p **then** $w \leftarrow 1$ **else** $w \leftarrow 0$
        else
          if r is hi child of p **then** $w \leftarrow w(p)$ **else** $w \leftarrow (1 - w(p))$
        $\pi(r) \leftarrow \pi(r) + \pi(p) \cdot w$

procedure INITIALISESCMD
  INITIALISEFREEIN
  INITIALISEFREEOUT
  INITIALISEREACHABLE
  INITIALISESCORES
  INITIALISEPATHWEIGHTS
  $\theta \leftarrow 0$ ▷ The current best score to beat.

Algorithm 3 SCMD propagation algorithm for propagating the consequences of a given partial strategy σ'. Note that the set of currently free decision variables $\mathbf{D}_{free}$ is a global variable.

procedure PROPAGATESCMD(σ', s_{old}, F)
  $s \leftarrow s_{old}$ ▷ Score of previous partial strategy.
  $\delta \leftarrow$ UPDATESCORES(F) ▷ δ is sum of derivatives of decision variables that were recently fixed to *false*, see also Algorithm 4.
  $s \leftarrow s - \delta$ ▷ score of current partial strategy σ'
  if $s \leq \theta$ **then return** $(true, \sigma', F)$ **end if** ▷ If we cannot satisfy the constraint, we must return and backtrack.
  UPDATEPATHWEIGHTS(F) ▷ See Algorithm 5.
  $(\sigma', F) \leftarrow$ ENFORCEDOMAINCONSISTENCY(σ', F, s) ▷ See Algorithm 6.
  UPDATEREACHABLEFREEIN(F) ▷ See Algorithm 7.
  UPDATEFREEOUT(F) ▷ See Algorithm 8.
  return $(false, \sigma', F)$

Algorithm 4 Given a set F of decision variables that were recently fixed (either by branching or by propagation), update the node scores (using Equation 2.11 on page 39) that may have changed due to these new truth assignments. See Algorithm 9 for helper functions.

procedure UPDATESCORES(F) ▷ Upward sweep.
  $\mathcal{U} \leftarrow \{r \mid var(r) \in F \wedge var(r) = \bot \wedge \texttt{Reachable}[r] > 0\}$ ▷ Max heap (treat as set).
  $\delta \leftarrow 0$ ▷ The combined derivative for all variables that are fixed to *false* in this round.
  $s_{old} \leftarrow 0$ ▷ Old score of an OBDD node.
  while $\mathcal{U} \neq \emptyset$ **do**
    $r \leftarrow \mathcal{U}$.DEQUEUE
    $s_{old} \leftarrow s(r)$
    if $var(r) \in \mathbf{D}$ **then** ▷ r is a decision node.
      $s(r) \leftarrow s\,(\text{ACTIVECHILD}(r))$
      if $var(r) \in F$ **and** $var(r)$ is *false* **then**
        $\delta \leftarrow \delta + \pi(r) \cdot (s(r^+) - s(r^-))$
    else ▷ r is a stochastic node.
      $s_{new} \leftarrow w(r) \cdot s(r^+) + (1 - w(r)) \cdot s(r^-)$
    if $s_{new} \neq s_{old}$ **then** ▷ We do not need to continue the propagation if the score for r has not changed.
      $s(r) \leftarrow s_{new}$
      for $p \in$ PARENTS(r) **do**
        if not REMOVED(p, r) **then** ENQUEUERELEVANT($\mathcal{U}$, p) **end if**
  return δ

Algorithm 5 Given a set F of decision variables that were fixed (either by branching or by propagation), update the path weights that may have changed due to this. See Algorithm 9 for helper functions.

procedure UPDATEPATHWEIGHTS(F) ▷ Downward sweep.
    $\mathcal{Q} \leftarrow \varnothing$ ▷ Min heap (treat as set).
    for $r \in \{r \mid var(r) \in F \wedge \texttt{Reachable}[r] > 0\}$ **do**
        if $var(r)$ is *false* **then**
            $\mathcal{Q}$.ENQUEUE(r^-)
            $\mathcal{Q}$.ENQUEUE(r^+)
    while $\mathcal{Q} \neq \varnothing$ **do**
        $r \leftarrow \mathcal{Q}$.DEQUEUE
        $\pi_{old} \leftarrow \pi(r)$
        if r is an original root of the OBDD **then** $\pi_{new} \leftarrow \rho_r$ **else** $\pi_{new} \leftarrow 0$ ▷ Roots have a path weight of ρ_r, which is the utility of the corresponding query.
        for $p \in$ PARENTS(r) **do**
            if $var(p)$ is decision variable **then** ▷ r is a decision node
                if ACTIVECHILD(p) $= r$ **then** $w \leftarrow 1$ **else** $w \leftarrow 0$
            else ▷ r is a stochastic node
                if r is hi child of p **then** $w \leftarrow w(p)$ **else** $w \leftarrow (1 - w(p))$
            $\pi_{new} \leftarrow \pi_{new} + \pi(p) \cdot w$
        if $\pi_{new} \neq \pi_{old}$ **then** ▷ We do not need to continue the propagation if the path weight has not changed.
            $\pi(r) \leftarrow \pi_{new}$
            if $var(r)$ is stochastic variable **then** ▷ r is a stochastic node.
                ENQUEUERELEVANT($\mathcal{Q}$, r^-)
                ENQUEUERELEVANT($\mathcal{Q}$, r^+)
            else ▷ r is a decision node.
                ENQUEUERELEVANT($\mathcal{Q}$, ACTIVECHILD(r))

Algorithm 6 Enforce domain consistency by fixing free variables to *true* if we find that fixing them to *false* cannot lead to a solution to the stochastic constraint.

procedure ENFORCEDOMAINCONSISTENCY(σ', F, s)
  for $D \in \mathbf{D}_{free}$ **do**
    $\Delta \leftarrow 0$ ▷ Partial derivative for free decision variable D.
    for $r \in \{r \in \text{OBDD}_D \mid$ `Reachable[`r`]`$\}$ **do**
      $\Delta \leftarrow \Delta + \pi(r) \cdot (s(r^-) - s(r^+))$ ▷ Update the partial derivative for D.
    if $s - \Delta \leq \theta$ **then** ▷ The current partial strategy cannot be extended to a valid solution if we fix D to *false*.
      $\sigma' \leftarrow \sigma' \cup \{d = true\}$ ▷ Infer that D must be *true*.
      $\mathbf{D}_{free} \leftarrow \mathbf{D}_{free} \setminus \{D\}$
      $F \leftarrow F \cup \{D\}$
  return (σ', F)

Algorithm 7 Update the `Reachable` and `FreeIn` counters after fixing decision variables F. See Algorithm 9 for helper functions.

```
procedure UpdateReachableFreeIn(F)                          ▷ Downward sweep.
    Q ← ∅                                                   ▷ Min heap (treat as set).
    procedure EnqueueIfNeedToPropagate(r)
        if FreeOut[r] > 0 and (FreeIn[r] = 0 OR Reachable = 0) then
            Q.enqueue(r)

    S ← {r | var(r) ∈ F and Reachable[r] > 0 and FreeOut[r] > 0}
    for r ∈ S do
        a ← activeChild(r)
        i ← inactiveChild(r)
        if a is not a leaf and FreeIn[r] = 0 then
            FreeIn[a] ← FreeIn[a] − 1
            if a ∉ S then EnqueueIfNeedToPropagate(a) end if
        if i is not a leaf then
            FreeIn[i] ← FreeIn[i] − 1
            Reachable[i] ← Reachable[i] − 1
            if i ∉ S then EnqueueIfNeedToPropagate(i) end if
    while Q ≠ ∅ do
        r ← Q.dequeue
        if Reachable[r] = 0 then
            for c ∈ children(r) do
                if c is not a leaf and removed(r, c) then
                    FreeIn[c] ← FreeIn[c] − 1
                    Reachable[c] ← Reachable[c] − 1
                    EnqueueIfNeedToPropagate(c)
        else
            if FreeIn[r] = 0 and var(r) is decision and var(r) is bound then
                for c ∈ children(r) do
                    if c is not a leaf and not removed(r, c) then
                        FreeIn[c] ← FreeIn[c] − 1
                        EnqueueIfNeedToPropagate(c)
```

Algorithm 8 Update the `FreeOut` counter after fixing decision variables V. See Algorithm 9 for helper functions.

procedure UPDATEFREEOUT(V) ▷ Upward sweep.
  $\mathcal{U} \leftarrow \{r \mid var(r) \in V \wedge \texttt{Reachable}[r] > 0 \wedge \texttt{FreeIn}[r] > 0\}$ ▷ Max heap (treat as set).
  while $\mathcal{U} \neq \varnothing$ **do**
    $r \leftarrow \mathcal{U}$.DEQUEUE
    if $var(r) \in V$ **then**
      if $\texttt{FreeOut}[\text{ACTIVECHILD}(r)] > 0$ **then** $\texttt{FreeOut}[r] \leftarrow 1$ **else** $\texttt{FreeOut}[r] \leftarrow 0$
    if $\texttt{FreeOut}[r] = 0$ **and** ($var(r)$ is stochastic variable OR $var(r)$ is bound) **then**
      for $p \in$ PARENTS(r) **do**
        if not REMOVED(p, r) **and** RELEVANT(p) **then**
          $\texttt{FreeOut}[p] \leftarrow \texttt{FreeOut}[p] - 1$
          $\mathcal{U}$.ENQUEUE(p)

Algorithm 9 Helper functions for the update algorithms.

Upon finding a solution with score s, update the threshold θ, which is the next score to beat.

procedure UPDATESCMDTHRESHOLD(s)
    $\theta \leftarrow s$

For free and *true* variables, the hi child is active. For *false* variables the lo child is active. This function returns the active child of node r.

procedure ACTIVECHILD(r)
    switch $var(r)$ **do**
        case $var(r)$ is `free`
            return r^+
        case $var(r)$ is `true`
            return r^+
        case $var(r)$ is `false`
            return r^-

Fixing variables to values corresponds to removing their other outgoing arc (corresponding to the opposite value) from the diagram. This function checks if an arc is removed.

procedure REMOVED(p, r)
    if $var(p)$ is not `free` **and** ACTIVECHILD(p) $\neq r$ **then**
        return `true`
    return `false`

A node is relevant if it corresponds to a free decision variable that has a connection to the root, or if the node corresponds to a stochastic variable and is on a path from one free decision node to another.

procedure RELEVANT(r)
    if $var(r)$ is `free` **and** `Reachable`$[r] > 0$ **then**
        return `true`
    else if `FreeIn`$[r] > 0$ **and** `FreeOut`$[r] > 0$ **then**
        return `true`
    else
        return `false`

procedure ENQUEUERELEVANT($\mathcal{Q}$, r)
    if RELEVANT(r) **then** $\mathcal{Q}$.ENQUEUE(r) **end if**

B

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C

Curriculum Vitae

Anna Latour was born in Leiden to parents who fully expected her to study arts or literature. Instead, after completing her high school education at the Haags Montessori Lyceum, she obtained a Bachelor's degree in Physics and Astrophysics from the University of Amsterdam. She then worked at the IT department of a pharmaceutical company before starting a pre-Master program at Leiden University to prepare herself for a Master in Artificial Intelligence at that same university.

Anna did the research for her Master thesis at Declarative Languages and Artificial Intelligence (DTAI) group of KU Leuven in Belgium, under the supervision of Dr. Siegfried Nijssen and the DTAI team. She graduated from the Master's program cum laude in 2016 and was awarded with the thesis award from the Koninklijke Nederlandse Vereniging voor Informatieprofessionals (KNVI) and the Koninklijke Hollandsche Maatschappij der Wetenschappen (KHMW) for her Master thesis: *Incremental algorithms for solving stochastic constraint optimisation problems with probabilistic logic programming*.

In 2017, Anna started as a PhD student of Leiden University, under the supervision of Prof. Dr. Joost N. Kok and Dr. Siegfried Nijssen. Her research was funded by an NWO TOP grant awarded to Dr. Nijssen for his PRObabilistic Features for Intelligent Declarative Data Science (PROFIDDS) project. Anna spent the first year of her PhD with the Artificial Intelligence & Algorithms (AIA) group at the Institute of Information and Communication Technologies, Electronics and Applied Mathematics (ICTEAM) at Université catholique de Louvain in Louvain-la-Neuve, Belgium. After moving back to The Netherlands in 2018, she joined Prof. Dr. Holger H. Hoos's Automated Design of Algorithms (ADA) group at Leiden University. In 2019, Anna visited Prof. Dr. Fahiem Bacchus's group at the University of Toronto to work on weighted model counting techniques.

During her PhD, Anna was a member of the Klankbordgroep Diversiteitsbeleid, the diversity policy feedback group of Leiden University. Additionally, she was a member of Leiden University's Studium Generale programme committee.

In 2018, Anna was awarded Google's Women Techmakers Scholarship for having demonstrated 'outstanding academic achievement, leadership and community involvement', in part for her efforts to increase the diversity, equity and inclusion in STEM (science, technology, engineering and mathematics). Anna's other awards include a research pitch prize for presenting her research 'with great clarity, content and charisma' (ranking highest in the jury report and receiving three times as many audience votes as the runner-up) and the AAAI 2021 outstanding reviewer award, for the 'exceptional care, thoroughness, and thoughtfulness' with which she approached the reviews and discussions of the papers assigned to her.

Anna started the next chapter of her scientific career in February 2022, as a Research Fellow in Prof. Dr. Kuldeep Meel's research group at the School of Computing (SoC) of the National University of Singapore (NUS). She is working on topics related to Boolean satisfiability and the field of *Beyond* $\mathcal{NP}$, and aims to pursue a career in academia.

There are few things that make Anna happier than the opportunity to search for geocaches and Annunciations while travelling for work.

D

List of Publications

Conference papers

- Anna L.D. Latour, Behrouz Babaki, Anton Dries, Angelika Kimmig, Guy Van den Broeck, and Siegfried Nijssen. 'Combining Stochastic Constraint Optimization and Probabilistic Programming: From Knowledge Compilation to Constraint Solving'. In: *Principles and Practice of Constraint Programming: 23rd International Conference (CP 2017)*. 2017, pp. 495–511.

- Anna Louise D. Latour, Behrouz Babaki, Siegfried Nijssen. 'Stochastic Constraint Propagation for Mining Probabilistic Networks'. In: *Proceedings of the Twenty-Eighth International Joint Conference on Artificial Intelligence (IJCAI 2019)*. 2019, pp. 1137–1145.

Journal papers

- Anna L.D. Latour, Behrouz Babaki, Daniël Fokkinga, Marie Anastacio, Holger H. Hoos, and Siegfried Nijssen. 'Exact Stochastic Constraint Optimisation with Applications in Network Analysis'. In: *Artificial Intelligence, vol 304, 2022.*

Workshop papers

- Anna L.D. Latour, Behrouz Babaki, and Siegfried Nijssen. 'Stochastic Constraint Optimization using Propagation on Ordered Binary Decision Diagrams'. In: *Eighth International Workshop on Statistical Relational AI (StarAI 2018), colocated with IJCAI 2018, Stockholm, Sweden, 2018*.
- Daniël Fokkinga, Anna Louise D. Latour, Marie Anastacio, Siegfried Nijssen, and Holger Hoos. 'Programming a Stochastic Constraint Optimisation Algorithm, by Optimisation'. In: *Data Science meets Optimization workshop 2019 (DSO 2019), colocated with IJCAI 2019, Macao, 2019*.

Extended abstracts

- Anna Louise D. Latour, Behrouz Babaki, and Siegfried Nijssen. 'Stochastic Constraint Propagation for Mining Probabilistic Networks'. In: *Proceedings of the Reference AI & ML Conference for Belgium, Netherlands & Luxembourg, BNAIC/BENELEARN 2019, Brussels, 2019*.
- Anna L.D. Latour, Behrouz Babaki, Daniël Fokkinga, Marie Anastacio, Holger H. Hoos, and Siegfried Nijssen. 'Stochastic Constraint Optimisation with Applications in Network Analysis'. In: *International Workshop on Model Counting (MCW), colocated with SAT 2020.*
- Jeroen G. Rook, Anna L.D. Latour, Siegfried Nijssen, and Holger H. Hoos. 'Better Caching for Better Model Counting'. In: *International Workshop on Model Counting (MCW), colocated with SAT 2020.*
- Jeroen G. Rook, Anna L.D. Latour, Siegfried Nijssen, and Holger H. Hoos. 'Caching in Model Counters: A Journey through Space and Time'. In: *International Workshop on Counting and Sampling, colocated with SAT 2021*.