Constant-delay Enumeration for Lorem Ipsum

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Abstract

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012 ACM Subject Classification Theory of computation → Database theory

eywords and phrases Streams, query evaluation, enumeration algorithms.

1 Introduction

ola

Cristian: Here a comment from Cristian.

El siguiente paper abordara como se puede relacion el Strahler number con diversas aplicaciones en el undo, tal que, la centralidad planteada en un paper anterior tendra un papel de suma importancia para antear todo.

2 Preliminaries

raphs. A graph is a pair $G = (V, E)$ where V is a finite set and $E \subseteq V \times V$ is a finite relation. Each par of rtex let be (v_1, v_2) , $v_1, v_2 \in V$ this set of vertex its called edges and can be directed or not, so the edges E. A path in a graph is a sequence of non-repeated nodes connected through edges present in a graph, if here exist a path between two vertex, this vertex are called connected. An example, let be $x, y \in V$ a path n be expressed so $\{x, x_1, x_2, \cdots, y_1, y_2, \cdots, y_n\}$ with $x, x_i, y_i, y \in V$

rees. A tree is an undirected graph in which any two vertices are connected by only and only one path. A oted tree is refereed as a tree with a vertex who serves as the "root" of the tree, being a references to the hers vertices in the tree.

plicacions.

3 Main results

e present here the data structure, called Enumerable Compact Sets with Shifts, to compactly store e outputs of evaluating an annotated automaton over a straight-line program. This structure extends numerable Compact Sets (ECS) introduced in [**DurandG07**] (we note that a similar data structure for nstant-delay enumeration was previously proposed in [**BaganDG07**]). Indeed, people have also used CS extensions in [**DurandG07**, **BucchiGQRV22**]. This new version extends ECS by introducing a shift perator, which helps compactly move all outputs' positions with a single call. Although the shift nodes quire a revision of the complete ECS model, it simplifies the evaluation algorithm in Section **??** and achieves tput-linear delay for enumerating all outputs. For completeness of presentation, this section goes through l main details as in [**BaganDG07**].

Lemma 1. *Given an SLP S, we can compute the values of $|\mathsf{str}(A)|$ for all non-terminals A in S in time* $(|S|)$.

From now on, we assume that all SLPs are in Chomsky normal form, due to the following result:

Theorem 2 (SLP Balancing theorem)**.** *There is a $c \in \mathbb{N}$ such that any given SLP S for string w can be ansformed in time $\mathcal{O}(|S|)$ into a SLP S' for w in Chomsky normal form with $|S'| \leq c \cdot |S|$.*

Algorithm 1 The enumeration algorithm of an unambiguous $\mathcal{A} = (Q, \Sigma, \Omega, \Delta, q_0, F)$ over a SLP-compressed ocument $S = (N, \Sigma, R, S_0)$.

procedure EVALUATION($\mathcal{A}, S$)
  Initialize $\mathcal{D}$ as an empty $\perp$.
  NONTERMINAL(S_0)
  $v \leftarrow \perp$
  for each $q \in F$ **do**
    $v \leftarrow$ UNION($v, M_{S_0}[q_0, q]$)
  ENUMERATE($v, \mathcal{D}$)

procedure TERMINAL(a)
  $M_a \leftarrow \{[p,q] \rightarrow \perp \mid p, q \in Q\}$
  for each $(p, a, o, q) \in \Delta$ **do**
    $M_a[p,q] \leftarrow$ UNION($M_a[p,q]$, ADD(o))
  for each $(p, a, q) \in \Delta$ **do**
    $M_a[p,q] \leftarrow$ UNION($M_a[p,q]$, ϵ)

procedure NONTERMINAL(X)
  $M_X \leftarrow \{[p,q] \rightarrow \perp \mid p, q \in Q, p \neq q\} \cup$
    $\{[p,q] \rightarrow \epsilon \mid p, q \in Q, p = q\}$
  $\mathsf{len}_X \leftarrow 0$
  for $i = 1$ **to** $|R(X)|$ **do**
    $Y \leftarrow R(X)[i]$
    if M_Y is not defined **then**
      if $Y \in \Sigma$ **then**
        TERMINAL(Y)
      else
        NONTERMINAL(Y)
    $M_X \leftarrow M_X \otimes$ SHIFT(M_Y, len_X)
    $\mathsf{len}_X \leftarrow \mathsf{len}_X + \mathsf{len}_Y$

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Proposition 3. *Given an SLP S, we can compute the values of $|\mathsf{str}(A)|$ for all non-terminals A in S in me $\mathcal{O}(|S|)$.*

roof Sketch. This is a short paragraph that gives an idea of the full proof to the statement above. ◀

The proposition above is Proposition **??**. The complete proof can be found in the full version of the paper.

4 Conclusions

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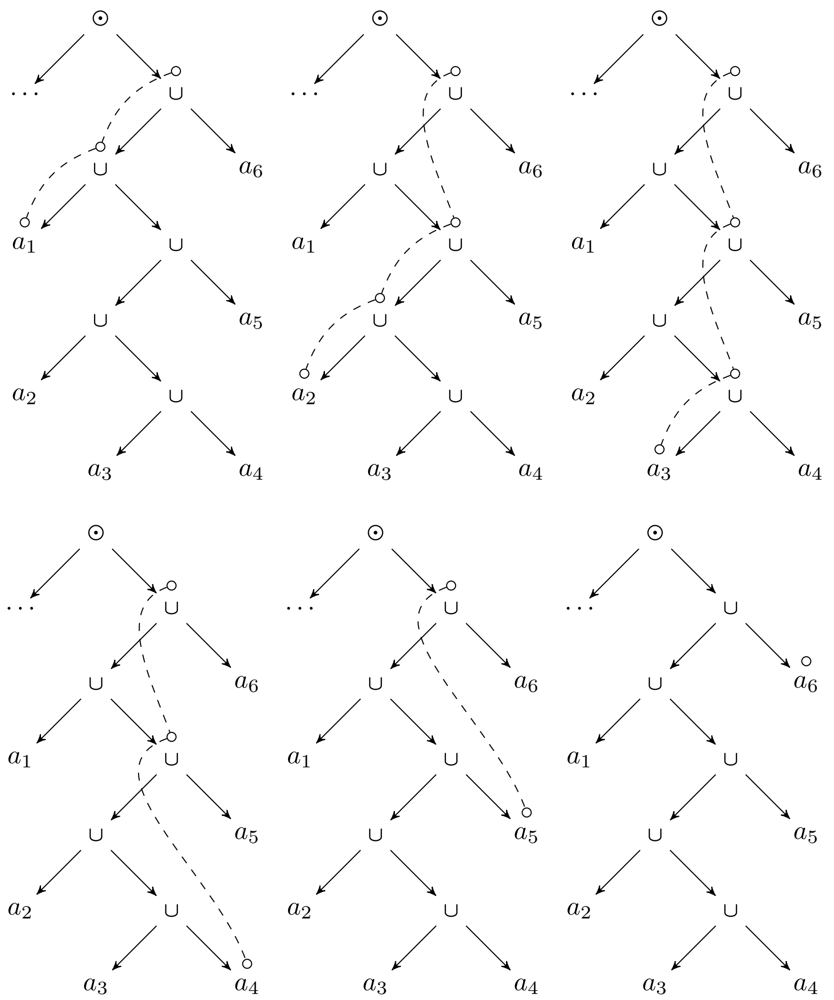

Figure 1 An example iteration of `trav` and `move`. The sequences of nodes joined by dashed lines represent a stack , where the first one was obtained after calling `trav` over the topmost union node, and the following five are obtained repeated applications of `move(St)`.

A Proofs from Section ??

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B Proofs of Section ??

.1 Proof of Lemma ??

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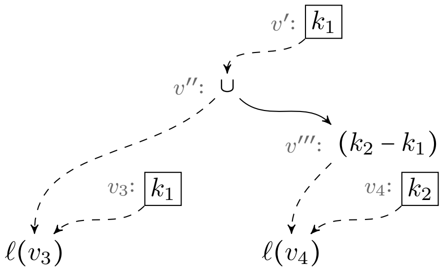

Figure 2 Gadget used in Theorem **??**.

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.2 Proof of Theorem ??

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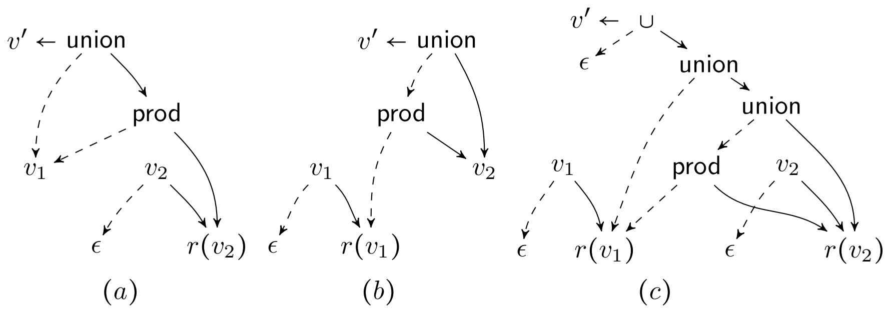

Figure 3 Gadgets for product as defined for an $\mathcal{D}$ with the ϵ-node.

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.3 Proof of Proposition ??

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Claim 4. Fix $k \in \mathbb{N}$. Let $\mathcal{C}_k$ be the class of all duplicate-free and k-bounded D that satisfy the ϵ condition. hen one can solve the problem $\texttt{Enum}[\mathcal{C}_k]$ with output-linear delay and without preprocessing (i.e. constant eprocessing time).

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