Type Based XML Projection

VLDB 2006, Seoul, Korea

Véronique Benzaken⋆ Giuseppe Castagna♢
Dario Colazzo⋆ **Kim Nguyễn**⋆

⋆ : Équipe Bases de Données, LRI, Université Paris-Sud 11, Orsay, France
♢ : Équipe Langage, DI, École Normale Supérieure, Paris, France

Outline

1. Introduction
2. Notations
3. Algorithm
4. Formal results
5. Experiments
6. Conclusion

Outline

1. Introduction
2. Notations
3. Algorithm
4. Formal results
5. Experiments
6. Conclusion

Main memory query (XQuery) processing

Main memory query (XQuery) processing

Pros :

- Lightweight system

Main memory query (XQuery) processing

Pros :

- Lightweight system
- Easy to program and integrate into an existing architecture

Main memory query (XQuery) processing

Pros :

- Lightweight system
- Easy to program and integrate into an existing architecture

Cons :

- DOM like data-models are memory killers.

Main memory query (XQuery) processing

Pros :

- Lightweight system
- Easy to program and integrate into an existing architecture

Cons :

- DOM like data-models are memory killers.

We can use **pruning** to reduce the amount of data needed in main memory!

We can use **pruning** to reduce the amount of data needed in main memory !

Exemple :

```
for $x in $doc/descendant-or-self::title/child::text()
return $x
```

We can use **pruning** to reduce the amount of data needed in main memory !

Exemple :

```
for $x in $doc/descendant-or-self::title/child::text()
return $x
```

```
<bib>
  <book year="1994">
   <title>TCP/IP Illustrated</title>
   <author><last>Stevens</last><first>W.</first></author>
   <publisher>Addison-Wesley</publisher>
   <price>65.95</price>
  </book>
  <book year="1992">
   <title>Advanced Programming in the Unix environment</title>
   <author><last>Stevens</last><first>W.</first></author>
   <publisher>Addison-Wesley</publisher>
   <price>65.95</price>
  </book>
  ...
</bib>
```

Projecting XML Documents, Amélie Marian and Jérome Siméon, VLDB 2003.

Queries + document analysis to compute the pruning :

+ Algorithm is formally specified
+ Achieve high precision in pruning
– Does not take into account backward axis.
– Performances degrade in the presence of //

Indeed, for some queries, pruning the document is more expensive than actually executing the query.

Solution : Queries + **type** based optimisations

By using a DTD and a given set of queries, we can statically infer a *projector* for the set of queries and use it to prune the document.
Main advantages :

- Efficient : no additional cost at runtime
- Take into account backward axis
- Soundness : executing the query on the projected document gives the same result as on the original.
- Precision (and even exact for a large class of DTDs and queries).

1 Introduction

2 Notations

3 Algorithm

4 Formal results

5 Experiments

6 Conclusion

Definition (DTD)

A DTD is a pair (X, E) where X is a distinguished name (the root) and E is a set of productions of the form

$$\{X_1 \rightarrow R_1,\ \ldots, X_n \rightarrow R_n\}$$

where each R_i is of the form :

$$a_i[\textit{Regexp}] \text{ or } \textit{String}$$

where a_i is a unique `tag` name and Regexp a regular expression of X_i. Names(E) is the set of names occuring in E.

Definition (Projector)

For a given DTD (X, E) *a type projector for* (X, E) *is a set of names* $\mathcal{P}$ *such that :*

1. $\mathcal{P} \subseteq$ *Names(E)*
2. $\forall X_i \in \mathcal{P}$ *there is at least one derivation from* X *to* X_i *in* E

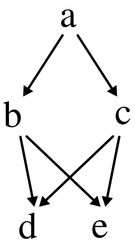
Definition (Pruning)

The pruning (or projection) of a document D *valid w.r.t a DTD* (X, E) *with the projector* $\mathcal{P}$ *is a document* D' *where every node not generated by a name in* $\mathcal{P}$ *is erased (replaced by the empty sequence).*

Definition (Pruning)

The pruning (or projection) of a document D valid w.r.t a DTD (X, E) with the projector $\mathcal{P}$ is a document D' where every node not generated by a name in $\mathcal{P}$ is erased (replaced by the empty sequence).

```
<!ELEMENT a    (b,c)>
<!ELEMENT b    (d,e)>
<!ELEMENT c    (d,e)>
<!ELEMENT d    (#PCDATA)>
<!ELEMENT e    (#PCDATA)>
```



```
for $x in $doc/descendant-or-self::c
return $x
```

```
for $x in $doc/descendant-or-self::c
return $x
```

$X_a \rightarrow \mathsf{a}[X_b, X_c]$

$X_b \rightarrow \mathsf{b}[X_d, X_e]$ $\quad X_c \rightarrow \mathsf{c}[X_d, X_e]$

$X_d \rightarrow \texttt{String}$ $\quad X_e \rightarrow \texttt{String}$

```
<a>
 <b>
  <d>LotsOfData</d>
  <e>SuperLongString<e/>
 </b>
 <c>
  <d>bar</d>
  <e>foo<e/>
 </c>
</a>
```

```
for $x in $doc/descendant-or-self::c
return $x
```

$$X_a \to \mathsf{a}[X_b, X_c]$$

$$X_b \to \mathsf{b}[X_d, X_e] \qquad X_c \to \mathsf{c}[X_d, X_e]$$

$$X_d \to \texttt{String} \qquad X_e \to \texttt{String}$$

$$\mathcal{P} = \{X_a, X_c, X_d, X_e\}$$

```
<a>
 <b>
  <d>LotsOfData</d>
  <e>SuperLongString<e/>
 </b>
 <c>
  <d>bar</d>
  <e>foo<e/>
 </c>
</a>
```

```
<a>
 <b>
  <d>LotsOfData</d>
  <e>Superlongstring<e/>
 </b>
 <c>
  <d>foo</d>
  <e>bar<e/>
 </c>
</a>
```

```
for $x in $doc/descendant-or-self::c
return $x
```

$X_a \to \mathtt{a}[X_b, X_c]$

$X_b \to \mathtt{b}[X_d, X_e]$ $\quad X_c \to \mathtt{c}[X_d, X_e]$

$X_d \to \mathtt{String}$ $\quad X_e \to \mathtt{String}$

$\mathcal{P} = \{X_a, X_c, X_d, X_e\}$

```
<a>
 <b>
  <d>LotsOfData</d>
  <e>SuperLongString<e/>
 </b>
 <c>
  <d>bar</d>
  <e>foo<e/>
 </c>
</a>
```

```
<a>
 <b>
  <d>LotsOfData</d>
  <e>Superlongstring<e/>
 </b>
 <c>
  <d>foo</d>
  <e>bar<e/>
 </c>
</a>
```

Definition (XPath (1.0))

$$
\begin{array}{lcl}
Q & ::= & \mathit{Axis} :: \mathit{Test} \\
 & | & \mathit{Axis} :: \mathit{Test}[\mathit{Expr}] \\
 & | & Q/Q
\end{array}
\qquad
\begin{array}{lcl}
\mathit{Expr} & := & Q \\
 & | & \mathit{Expr}\ op\ \mathit{Expr} \\
 & | & f(\mathit{Expr}, \ldots, \mathit{Expr}) \\
 & | & Base
\end{array}
$$

$$
\begin{array}{lcl}
\mathit{Axis} & ::= & \texttt{self} \mid \texttt{child} \mid \texttt{descendant} \mid \texttt{parent} \mid \texttt{ancestor} \mid \ldots \\
\mathit{Test} & ::= & tag \mid \texttt{node}() \mid \texttt{text}()
\end{array}
$$

Definition (Simple path)

$$
\begin{array}{lcl}
Q & ::= & \mathit{Axis} :: \mathit{Test} \\
 & | & \mathit{Axis} :: \mathit{Test}[\mathit{Cond}] \\
 & | & Q/Q
\end{array}
\qquad
\begin{array}{lcl}
\mathit{Cond} & := & \mathit{SPath} \\
 & | & \mathit{Cond}\ \mathtt{or}\ \mathit{Cond}
\end{array}
$$

$$
\begin{array}{lcl}
\mathit{SPath} & ::= & \mathit{Axis} :: \mathit{Test} \\
 & | & \mathit{Axis} :: \mathit{Test}/\mathit{SPath}
\end{array}
$$

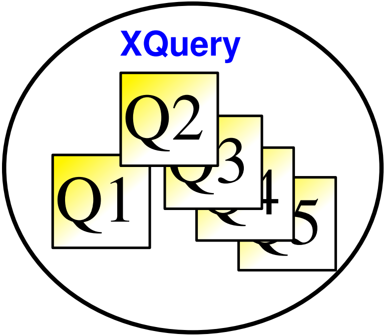
1. Introduction
2. Notations
3. Algorithm
4. Formal results
5. Experiments
6. Conclusion

Overall process

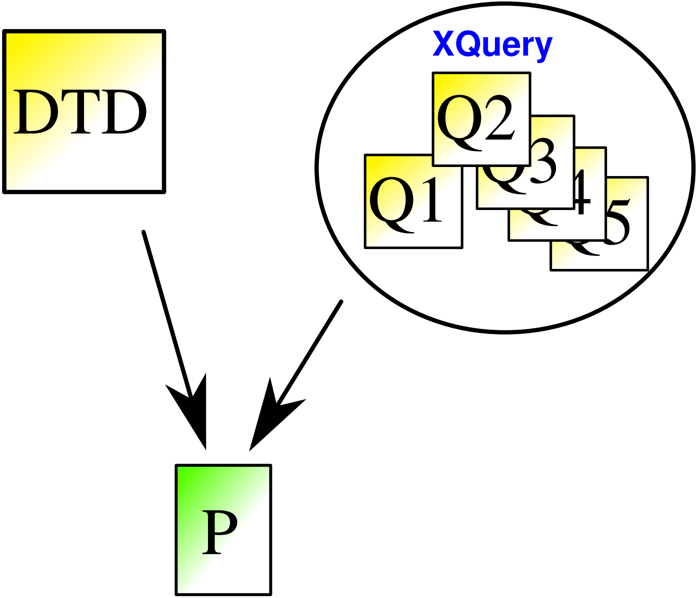
Static inference :

Overall process

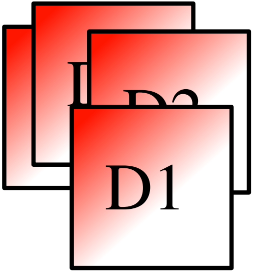
Static inference :



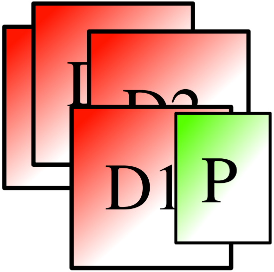
Static inference :



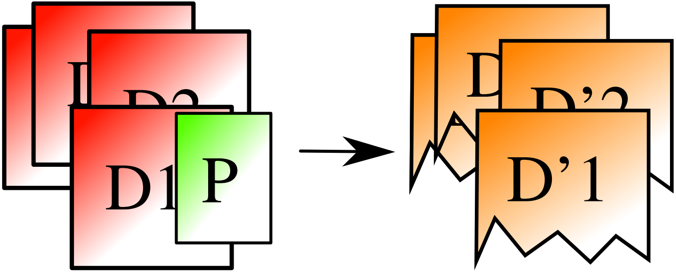
Runtime :



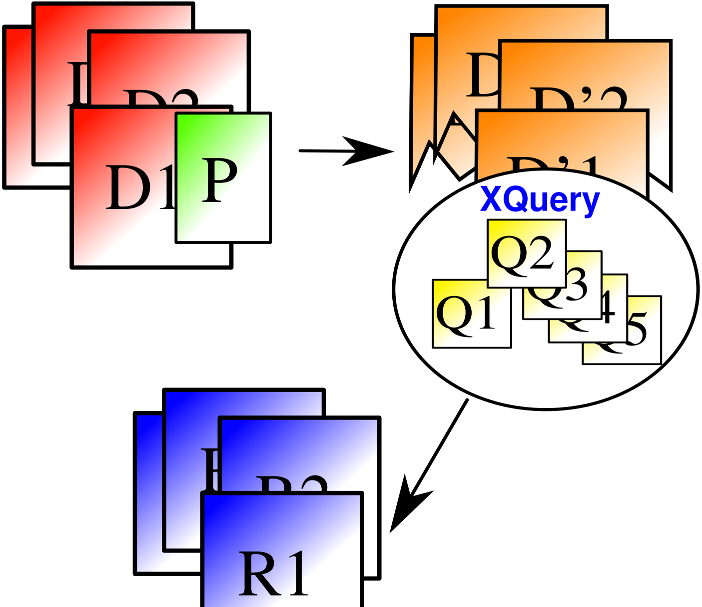
Runtime :

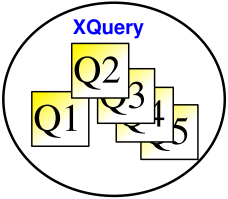


Runtime :

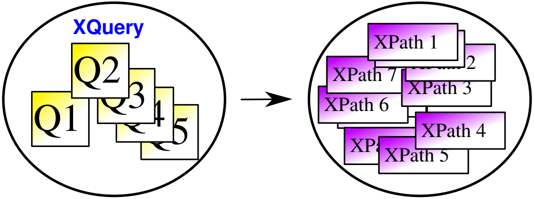


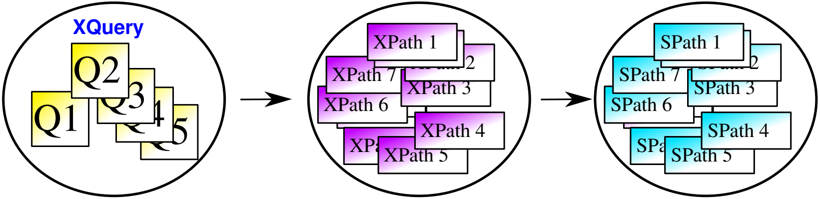
Runtime :

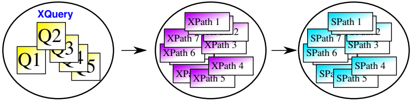



XQuery
Q2
Q3
Q1
Q4
Q5

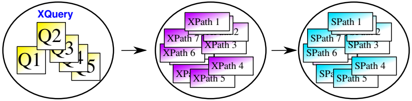
Static inference




XQuery
Q2
Q1
Q3
XPath 1
XPath 7
XPath 3
XPath 6
XPath 4
XPath 5
SPath 1
SPath 7
SPath 3
SPath 6
SPath 4
SPath 5

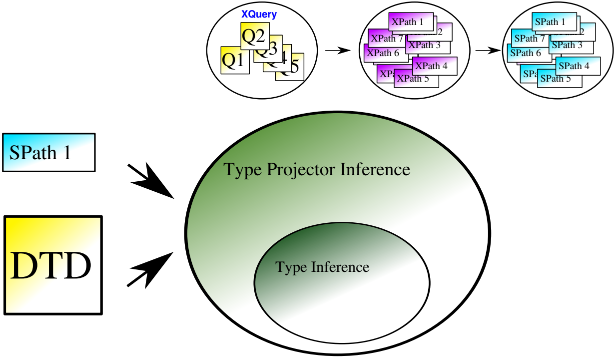

XQuery
Q2
Q1
Q3
XPath 1
XPath 7
XPath 3
XPath 6
XPath 4
XPath 5
SPath 1
SPath 7
SPath 3
SPath 6
SPath 4
SPath 5

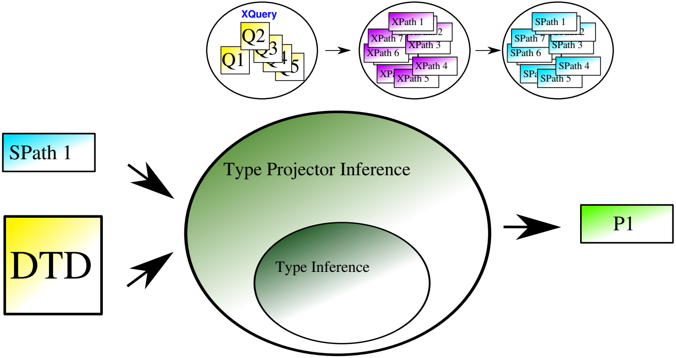

SPath 1

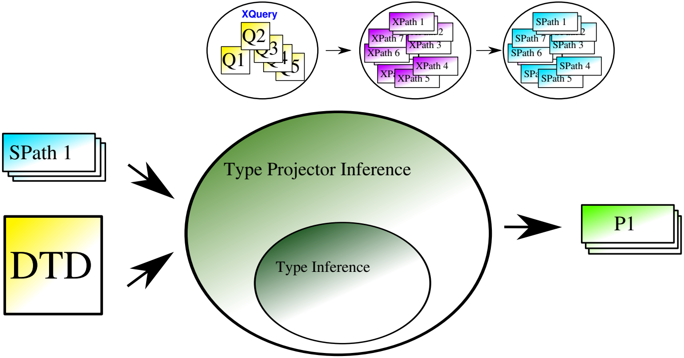

XQuery
Q1
Q2
XPath 1
XPath 3
XPath 4
XPath 5
XPath 6
XPath 7
SPath 1
SPath 3
SPath 4
SPath 5
SPath 6
SPath 7

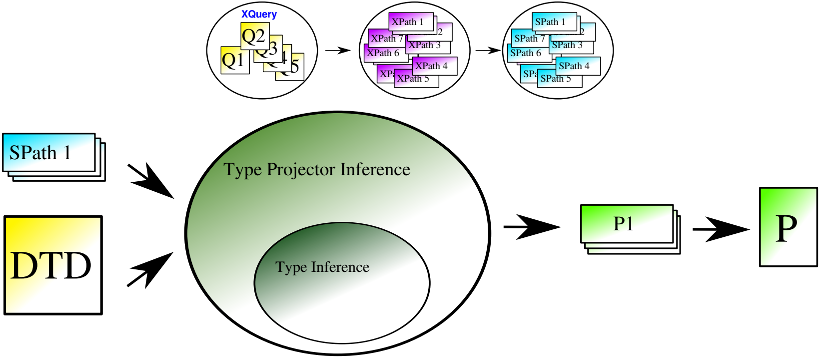

SPath 1


DTD


XQuery
Q2
Q1
Q3
Q4
Q5
XPath 1
XPath 7
XPath 3
XPath 6
XPath 4
XPath 5
SPath 1
SPath 7
SPath 3
SPath 6
SPath 4
SPath 5
SPath 1
DTD
Type Projector Inference
Type Inference


XQuery
Q2
Q1
XPath 1
XPath 7
XPath 3
XPath 6
XPath 4
XPath 5
SPath 1
SPath 7
SPath 3
SPath 6
SPath 4
SPath 5
SPath 1
DTD
Type Projector Inference
Type Inference
P1


XQuery
Q2
Q1
XPath 1
XPath 7
XPath 3
XPath 6
XPath 4
XPath 5
SPath 1
SPath 7
SPath 3
SPath 6
SPath 4
SPath 5
SPath 1
DTD
Type Projector Inference
Type Inference
P1


XQuery
Q2
Q1
XPath 1
XPath 7
XPath 3
XPath 6
XPath 4
XPath 5
SPath 1
SPath 7
SPath 3
SPath 6
SPath 4
SPath 5
SPath 1
DTD
Type Projector Inference
Type Inference
P1
P

$$\texttt{typeinf(}\mathsf{DTD}\texttt{,}\{X\}\texttt{,}path\texttt{)} = T$$

Type T is the set of names of types of nodes in the result.

$$\texttt{typeinf(}\mathsf{DTD}\texttt{,}\{X\}\texttt{,}path\texttt{)} = T$$

Type T is the set of names of types of nodes in the result.

$T = \varnothing \rightarrow$ query gives an empty result on any document.

$$\texttt{typeinf(}\mathsf{DTD}\texttt{,}\{X\}\texttt{,}path\texttt{)} = T$$

Type T is the set of names of types of nodes in the result.

$T = \varnothing \rightarrow$ query gives an empty result on any document.

```
/self::a/child::b/child::d
```

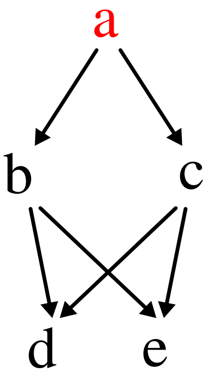
$$\texttt{typeinf(DTD,}\{X\}\texttt{,}path\texttt{)} = T$$

Type T is the set of names of types of nodes in the result.

$T = \varnothing \rightarrow$ query gives an empty result on any document.

`/self::a/child::b/child::d`

1. $\texttt{typeinf(DTD,}\{X_a\}\texttt{,self::a)} = \{X_a\}$



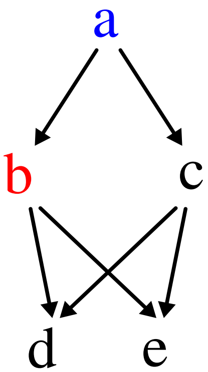
$$\texttt{typeinf(DTD,}\{X\}\texttt{,}path\texttt{)} = T$$

Type T is the set of names of types of nodes in the result.

$T = \varnothing \rightarrow$ query gives an empty result on any document.

`/self::a/child::b/child::d`

1. typeinf(DTD,$\{X_a\}$,self::a)$= \{X_a\}$
2. typeinf(DTD,$\{X_a\}$,child::b)$= \{X_b\}$



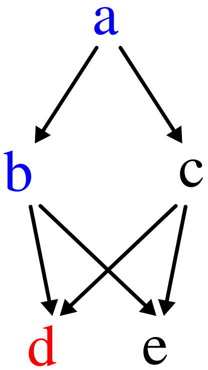
$$\texttt{typeinf}(\mathsf{DTD},\{X\},path) = T$$

Type T is the set of names of types of nodes in the result.

$T = \varnothing \rightarrow$ query gives an empty result on any document.

`/self::a/child::b/child::d`

1. $\texttt{typeinf}(\mathsf{DTD},\{X_a\},\texttt{self::a}) = \{X_a\}$
2. $\texttt{typeinf}(\mathsf{DTD},\{X_a\},\texttt{child::b}) = \{X_b\}$
3. $\texttt{typeinf}(\mathsf{DTD},\{X_b\},\texttt{child::d}) = \{X_d\}$



$$\texttt{typeinf(DTD,}\{X\}\texttt{,}path\texttt{)} = T$$

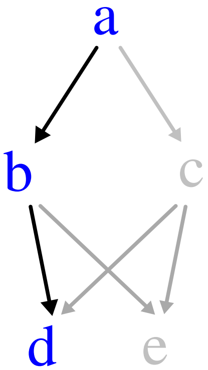
Type T is the set of names of types of nodes in the result.

$T = \varnothing \rightarrow$ query gives an empty result on any document.

`/self::a/child::b/child::d`

1. $\texttt{typeinf(DTD,}\{X_a\}\texttt{,self::a)} = \{X_a\}$
2. $\texttt{typeinf(DTD,}\{X_a\}\texttt{,child::b)} = \{X_b\}$
3. $\texttt{typeinf(DTD,}\{X_b\}\texttt{,child::d)} = \{X_d\}$

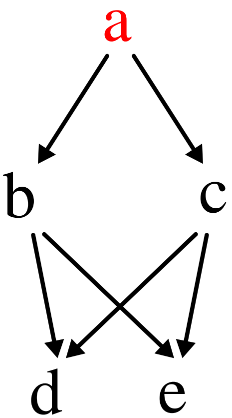
$$\mathcal{P} = \{X_a, X_b, X_d\}$$



```
//*/self::b/child::d
```

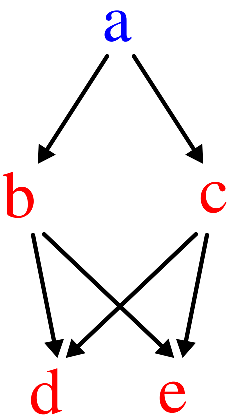
`//*/self::b/child::d`

❶ typeinf(DTD,$\{X_a\}$,//*)



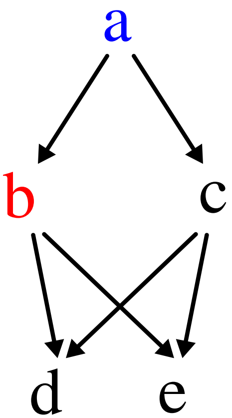
//*/self::b/child::d

1. typeinf(DTD,$\{X_a\}$,//*)



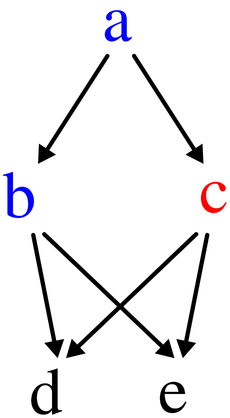
`//*/self::b/child::d`

1. typeinf(DTD, $\{X_a\}$, //*)
   1. typeinf(DTD, $\{X_b\}$, self::b/child::d) $= \{X_d\}$



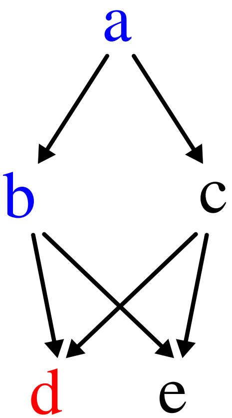
`//*/self::b/child::d`

1. typeinf(DTD,$\{X_a\}$,//*)
   1. typeinf(DTD,$\{X_b\}$,self::b/child::d)$= \{X_d\}$
   2. typeinf(DTD,$\{X_c\}$,self::b/child::d)$= \varnothing$



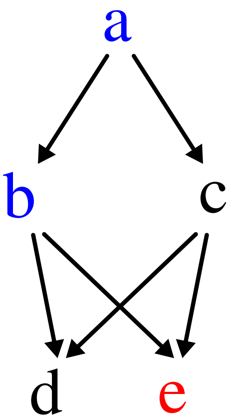
`//*/self::b/child::d`

1. `typeinf(DTD,`$\{X_a\}$`,//*)`
   1. `typeinf(DTD,`$\{X_b\}$`,self::b/child::d)`$= \{X_d\}$
   2. `typeinf(DTD,`$\{X_c\}$`,self::b/child::d)`$= \varnothing$
   3. `typeinf(DTD,`$\{X_d\}$`,self::b/child::d)`$= \varnothing$



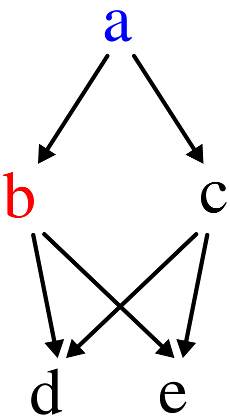
`//*/self::b/child::d`

1. `typeinf(DTD,`$\{X_a\}$`,//*)`
   1. `typeinf(DTD,`$\{X_b\}$`,self::b/child::d)`$= \{X_d\}$
   2. `typeinf(DTD,`$\{X_c\}$`,self::b/child::d)`$= \varnothing$
   3. `typeinf(DTD,`$\{X_d\}$`,self::b/child::d)`$= \varnothing$
   4. `typeinf(DTD,`$\{X_e\}$`,self::b/child::d)`$= \varnothing$



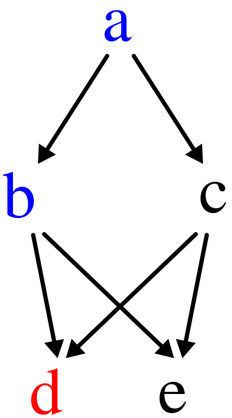
//*/self::b/child::d

1. typeinf(DTD, $\{X_a\}$, //*)
2. typeinf(DTD, $\{X_b\}$, self::b) $= \{X_b\}$



//*/self::b/child::d

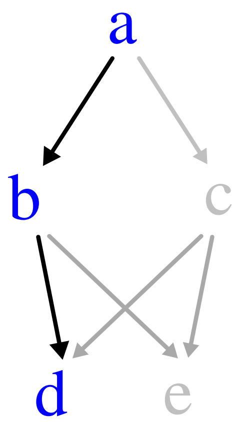
1. typeinf(DTD,$\{X_a\}$,//*)
2. typeinf(DTD,$\{X_b\}$,self::b)$= \{X_b\}$
3. typeinf(DTD,$\{X_b\}$,child::d)$= \{X_d\}$



`//*/self::b/child::d`

1. `typeinf(DTD,`$\{X_a\}$`,//*)`
2. `typeinf(DTD,`$\{X_b\}$`,self::b)`$= \{X_b\}$
3. `typeinf(DTD,`$\{X_b\}$`,child::d)`$= \{X_d\}$

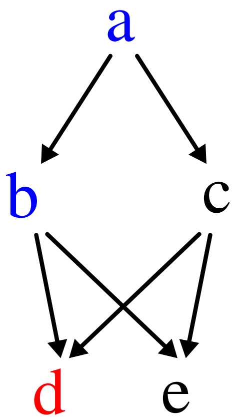
$$\mathcal{P} = \{X_a, X_b, X_d\}$$



```
/self::a/child::b/child::d/parent::node()/child::d
```

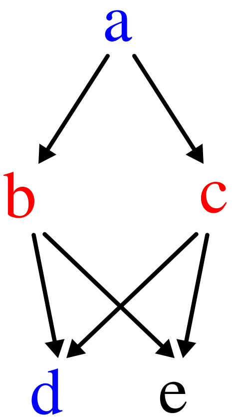
`/self::a/child::b/child::d/parent::node()/child::d`

1. `typeinf(DTD,`$\{X_a\}$`,self::a)`$= \{X_a\}$
2. `typeinf(DTD,`$\{X_a\}$`,child::b)`$= \{X_b\}$
3. `typeinf(DTD,`$\{X_b\}$`,child::d)`$= \{X_d\}$



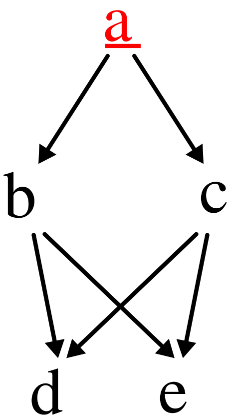
/self::a/child::b/child::d/parent::node()/child::d

1. typeinf(DTD, $\{X_a\}$, self::a) $= \{X_a\}$
2. typeinf(DTD, $\{X_a\}$, child::b) $= \{X_b\}$
3. typeinf(DTD, $\{X_b\}$, child::d) $= \{X_d\}$
4. typeinf(DTD, $\{X_d\}$, parent::node()) $= \{X_b, X_c\}$



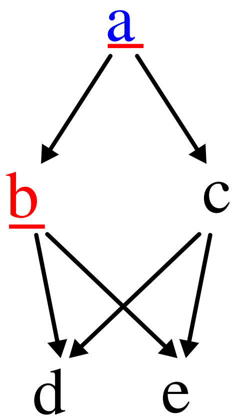
/self::a/child::b/child::d/parent::node()/child::d

1. typeinf(DTD,$\{X_a\}$,$\{X_a\}$,self::a)= $\{X_a\}$



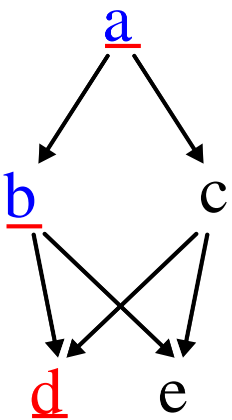
`/self::a/child::b/child::d/parent::node()/child::d`

1. `typeinf(DTD,`$\{X_a\}$`,`$\{X_a\}$`,self::a)`$= \{X_a\}$
2. `typeinf(DTD,`$\{X_a\}$`,`$\{X_a\}$`,child::b)`$= \{X_b\}$



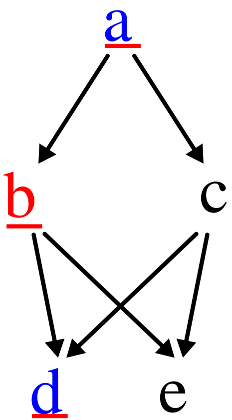
/self::a/child::b/child::d/parent::node()/child::d

1. typeinf(DTD, $\{X_a\}$, $\{X_a\}$, self::a) $= \{X_a\}$
2. typeinf(DTD, $\{X_a\}$, $\{X_a\}$, child::b) $= \{X_b\}$
3. typeinf(DTD, $\{X_b\}$, $\{X_a, X_b\}$, child::d) $= \{X_d\}$



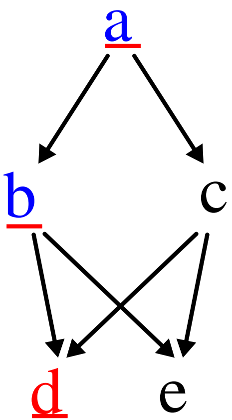
`/self::a/child::b/child::d/parent::node()/child::d`

1. `typeinf(DTD,`$\{X_a\}$`,`$\{X_a\}$`,self::a)`$= \{X_a\}$
2. `typeinf(DTD,`$\{X_a\}$`,`$\{X_a\}$`,child::b)`$= \{X_b\}$
3. `typeinf(DTD,`$\{X_b\}$`,`$\{X_a, X_b\}$`,child::d)`$= \{X_d\}$
4. `typeinf(DTD,`$\{X_d\}$`,`$\{X_a, X_b, X_d\}$`,parent::node())`$= \{X_b\}$



`/self::a/child::b/child::d/parent::node()/child::d`

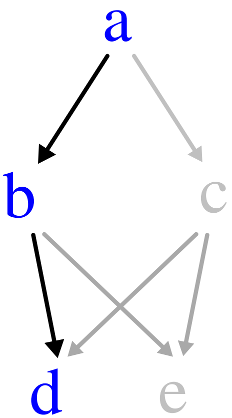
1. typeinf(DTD, $\{X_a\}$, $\{X_a\}$, self::a) = $\{X_a\}$
2. typeinf(DTD, $\{X_a\}$, $\{X_a\}$, child::b) = $\{X_b\}$
3. typeinf(DTD, $\{X_b\}$, $\{X_a, X_b\}$, child::d) = $\{X_d\}$
4. typeinf(DTD, $\{X_d\}$, $\{X_a, X_b, X_d\}$, parent::node()) = $\{X_b\}$
5. typeinf(DTD, $\{X_b\}$, $\{X_a, X_b, X_d\}$, child::d) = $\{X_d\}$



`/self::a/child::b/child::d/parent::node()/child::d`

1. `typeinf(DTD,`$\{X_a\}$`,`$\{X_a\}$`,self::a)`$= \{X_a\}$
2. `typeinf(DTD,`$\{X_a\}$`,`$\{X_a\}$`,child::b)`$= \{X_b\}$
3. `typeinf(DTD,`$\{X_b\}$`,`$\{X_a, X_b\}$`,child::d)`$= \{X_d\}$
4. `typeinf(DTD,`$\{X_d\}$`,`$\{X_a, X_b, X_d\}$`,parent::node())`$= \{X_b\}$
5. `typeinf(DTD,`$\{X_b\}$`,`$\{X_a, X_b, X_d\}$`,child::d)`$= \{X_d\}$

$$\mathcal{P} = \{X_a, X_b, X_d\}$$



1. Introduction
2. Notations
3. Algorithm
4. Formal results
5. Experiments
6. Conclusion

Theorem (Soundness)

Let D be a document valid w.r.t a DTD (X, E) and p a path. Let $\mathcal{P}$ the type projector deduced from p. Let D' be the projection of D with $\mathcal{P}$.

$$\texttt{eval}(p, D) = \texttt{eval}(p, D')$$

Pruning is precise . . .

Pruning is precise . . .

Theorem (Completeness)

$\mathcal{P} = \{X_1, \ldots, X_n\}$ the type projector associated with a path p and a DTD (X, E). Let $\mathcal{P}' = \mathcal{P} \backslash \{X_i\}$. There exists D a document and it's projection D' such that :

$$\texttt{eval}(p, D) \neq \texttt{eval}(p, D')$$

Completeness holds with :

- some restrictions on the DTD (*star-guarded*, non-recursive,. . .)

Pruning is precise ...

Theorem (Completeness)

$\mathcal{P} = \{X_1, \ldots, X_n\}$ the type projector associated with a path p and a DTD (X, E). Let $\mathcal{P}' = \mathcal{P} \backslash \{X_i\}$. There exists D a document and it's projection D' such that :

$$\texttt{eval}(p, D) \neq \texttt{eval}(p, D')$$

Completeness holds with :

- some restrictions on the DTD (*star-guarded*, non-recursive,...)
- some restrictions on the path (no upward axis in predicates, ...)

Pruning is precise . . .

Theorem (Completeness)

$\mathcal{P} = \{X_1, \ldots, X_n\}$ the type projector associated with a path p and a DTD (X, E). Let $\mathcal{P}' = \mathcal{P} \setminus \{X_i\}$. There exists D a document and it's projection D' such that :

$$\texttt{eval}(p, D) \neq \texttt{eval}(p, D')$$

Completeness holds with :

- some restrictions on the DTD (*star-guarded*, non-recursive,. . .)
- some restrictions on the path (no upward axis in predicates, . . .)

Pruning is precise . . .

Theorem (Completeness)

$\mathcal{P} = \{X_1, \ldots, X_n\}$ the type projector associated with a path p and a DTD (X, E). Let $\mathcal{P}' = \mathcal{P} \backslash \{X_i\}$. There exists D a document and it's projection D' such that :

$$\texttt{eval}(p, D) \neq \texttt{eval}(p, D')$$

Completeness holds with :

- some restrictions on the DTD (*star-guarded*, non-recursive,. . .)
- some restrictions on the path (no upward axis in predicates, . . .)

1. Introduction
2. Notations
3. Algorithm
4. Formal results
5. Experiments
6. Conclusion

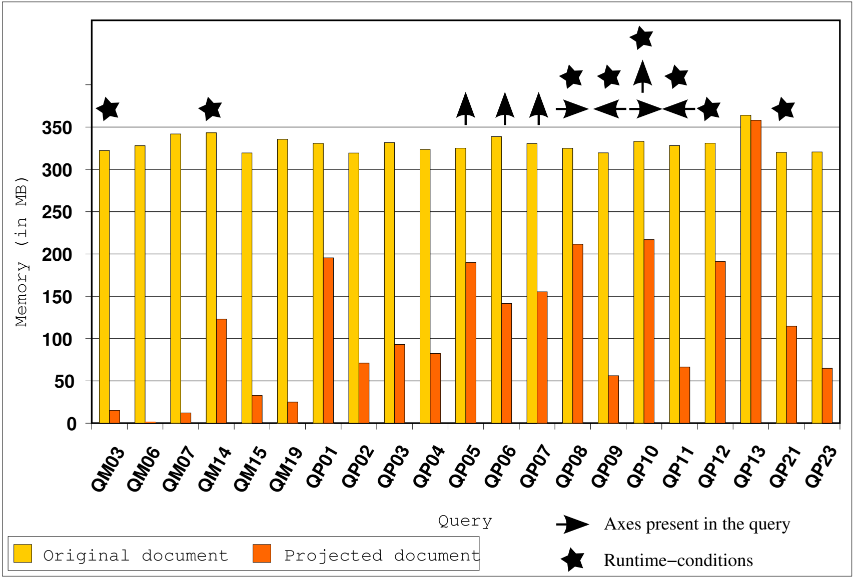
Protocol :

- Linux desktop, 512MB Ram, 3Ghz x86 CPU (and no swap).
- Implementation in OCaml.
- Validity of the result checked with the Galax query engine.
- Pruning tested on XMark and XPathMark benchmarks.

Protocol :

- Linux desktop, 512MB Ram, 3Ghz x86 CPU (and no swap).
- Implementation in OCaml.
- Validity of the result checked with the Galax query engine.
- Pruning tested on XMark and XPathMark benchmarks.

- Prunning is one pass bufferless traversal of the document.
- In practice, computing the type projector is fast.



Memory used to process a 56 MB document with Galax.

	QM03	QM06	QM07	QM14	QM15	QM19
	★			★		
Original Size (MB)	930	2048	1100	202	2048	964
Pruned Size(MB)	25	5,3	42	139	24	24
Memory Usage (MB)	374	90	380	512	245	512
% of original size	2.5	0.3	3.4	69.6	1.15	2.5
Gain in Speed ($\times$ faster)	17.8	110.1	28.2	3.9	62.6	7.5

Qualitative : type projectors are always comparable and serval times more precise.

Comparison with previous work

Qualitative : type projectors are always comparable and serval times more precise.

Performances : pruning is linear in time (in the size of the document) and constant in memory. *It can be done while validating the document.*

Qualitative : type projectors are always comparable and serval times more precise.

Performances : pruning is linear in time (in the size of the document) and constant in memory. *It can be done while validating the document.*

Features : handles backward as well as following/preceding axes.

1. Introduction
2. Notations
3. Algorithm
4. Formal results
5. Experiments
6. Conclusion

- Formal foundations ensure validity of the pruning and it's efficiency.

- Formal foundations ensure validity of the pruning and it's efficiency.
- Handle any XQuery query, either directly or by approximating it.

Conclusion

- Formal foundations ensure validity of the pruning and it's efficiency.
- Handle any XQuery query, either directly or by approximating it.
- Whereas approximations are made for runtime conditions, the technique still preserve a *high degree of precision*.

- Formal foundations ensure validity of the pruning and it's efficiency.
- Handle any XQuery query, either directly or by approximating it.
- Whereas approximations are made for runtime conditions, the technique still preserve a *high degree of precision*.
- *No additional cost at runtime*.

Future work

Many directions :

- Adapt our approach to work on *untyped* documents by using data-guides or path summaries.

Future work

Many directions :

- Adapt our approach to work on *untyped* documents by using data-guides or path summaries.
- Extend the formalism to handle XML-Schema rather than DTDs.

Future work

Many directions :

- Adapt our approach to work on *untyped* documents by using data-guides or path summaries.
- Extend the formalism to handle XML-Schema rather than DTDs.
- Integration with classical databases techniques.

Future work

Many directions :

- Adapt our approach to work on *untyped* documents by using data-guides or path summaries.
- Extend the formalism to handle XML-Schema rather than DTDs.
- Integration with classical databases techniques.
- Integration with a query engine.