Exam Preparation

Discuss Answers to last year’s exam

Sebastian Maneth
NICTA and UNSW

CSE@UNSW -- Semester 1, 2008
(1) For each of the following, explain why it is not well-formed XML (is a WFC or the XML grammar violated?)

a) `<author></author><title></title>`

b) `<author><title></author></title>`

c) `<info temp='25C'>content</info>`

d) `<!DOCTYPE greeting [`  
`     <!ELEMENT greeting ( #PCDATA )>`  
`     <!ENTITY e1 "&e2; e3">`  
`     <!ENTITY e2 "&e3;">`  
`     <!ENTITY e3 "&e2;">`  
` ]>`  
`<greeting> &e1; </greeting>`

e) `<a at1="blah" at&t; 2="foo"> 1 &lt; 5 </a>`

f) `<a b3="a" b2="b" b1="a" b2="5"/>`  

g) `<a>b>c</c/> </c><c/> ab&e; </b></a>`
(1) For each of the following, explain why it is not well-formed XML (is a WFC or the XML grammar violated?)

a) `<author></author><title></title>`  
   → XML grammar (cannot be derived by grammar!)

b) `<author><title></author></title>`

c) `<info temp='25C'>content</info>`

d) `<!DOCTYPE greeting [  
<!ELEMENT greeting ( #PCDATA)>  
<!ENTITY e1 "&e2; e3">  
<!ENTITY e2 "&e3;">  
<!ENTITY e3 "&e2;">  
]><greeting> &e1; </greeting>  
<greeting> &e1; </greeting>`

e) `<a at1="blah" at&lt;2="foo"> 1 &lt; 5 </a>`

f) `<a b3="a" b2="b" b1="a" b2="5"/>`

g) `<a><b><c><c/></c><c/>ab&e;</a>`
(1) For each of the following, explain why it is not well-formed XML (is a WFC or the XML grammar violated?)

a) `<author></author><title></title>` → XML grammar

b) `<author><title></author></title>` → WFC

c) `<info temp='25C'>content</info>`

d) `<!DOCTYPE greeting [`  
   `<!ELEMENT greeting (#PCDATA)>`  
   `<!ENTITY e1 "&e2; e3">`  
   `<!ENTITY e2 "&e3;">`  
   `<!ENTITY e3 "&e2;">`
   `]>`  
   `<greeting> &e1; </greeting>`

e) `<a at1="blah" at2="foo"> 1 &lt; 5 </a>`

f) `<a b3="a" b2="b" b1="a" b2="5"/>`

g) `<a>b>c</c></a>`
For each of the following, explain why it is not well-formed XML (is a WFC or the XML grammar violated?)

a) `<author></author><title></title>` → XML grammar

b) `<author><title></author></title>` → WFC

c) `<info temp='25C'>content</info>` → XML grammar (should be "25c"; -is actually OK..!)

d) `<!DOCTYPE greeting [`

```xml
<!-- ELEMENT greeting ( #PCDATA ) >
<!ENTITY e1 "&e2; e3">
<!ENTITY e2 "&e3;">
<!ENTITY e3 "&e2;">
]>
<greeting> &e1; </greeting>
```

`<greeting> &e1; </greeting>`

e) `<a at1="bl ah" at&l t; 2="foo"> 1 &l t; 5 </a>`

f) `<a b3="a" b2="b" b1="a" b2="5"/>`

g) `<a><b><c>c</c>/><c>c</c>/>ab&e;</a>`
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d) `<!DOCTYPE greeting [`  
    `<!ELEMENT greeting ( #PCDATA)>`  
    `<!ENTITY e1 "&e2; e3">`  
    `<!ENTITY e2 "&e3;">`  
    `<!ENTITY e3 "&e2;">`  
  ]>`
    `<greeting> &e1; </greeting>`  \(\rightarrow\) **WFC**
e) `<a at1="blah" at2="foo"> 1 &lt; 5</a>`
f) `<a b3="a" b2="b" b1="a" b2="5"/>`
g) `<a>b>c</a></c><c/ >ab&<; <b></a>`
(1) For each of the following, explain why it is not well-formed XML (is a WFC or the XML grammar violated?)

a) `<author>` </author> `<title>` </title> ➔ XML grammar

b) `<author>` `<title>` </author> </title> ➔ WFC

c) `<info temp='25C'>content</info>` ➔ XML grammar (should be "25c"; -is actually OK..!)

d) `<!DOCTYPE greeting [ <!ELEMENT greeting ( #PCDATA )> <!ENTITY e1 "&e2; e3"> <!ENTITY e2 "&e3;"> <!ENTITY e3 "&e2;"> ]> <greeting> &e1; </greeting>`

   ➔ WFC

e) `<a at1="blah" at\&t;2="foo">1 &lt; 5</a>` ➔ XML grammar

f) `<a b3="a" b2="b" b1="a" b2="5"/>`

g) `<a>b>c</c>/</c>` ➔ `</c>`

```
[41] Attribute ::= Name Eq AttValue
[5] Name ::= ( Letter | '.' | ':' ) ( NameChar )* 
[84] Letter ::= [ a-zA-Z ]
```
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d) `<!DOCTYPE greeting [  
<!ELEMENT greeting (#PCDATA)>  
<!ENTITY e1 "&e2; e3">  
<!ENTITY e2 "&e3;">  
<!ENTITY e3 "&e2;">  
]> <greeting> &e1; </greeting>  ➔ `WFC`  

e) `<a at1="blah" at&t;2="foo"> 1 &lt; 5 </a>`  ➔ `XML grammar`  

f) `<a b3="a" b2="b" b1="a" b2="5"/>`  ➔ `WFC`  

g) `<a>b</a>c</c/>`  ➔ `WFC`  

*Well-formedness constraint: Unique Att Spec*

An attribute name **MUST NOT** appear more than once in the same start-tag or empty-element tag.
(1) For each of the following, explain why it is not well-formed XML (is a WFC or the XML grammar violated?)

a) `<author></author><title></title>` → **XML grammar**

b) `<author><title></author></title>` → **WFC**

c) `<info temp='25C'>content</info>` → **XML grammar** (should be "25c"; -is actually OK..!)

d) `<!DOCTYPE greeting [<ENTITY e1 "&e2; e3"> <ENTITY e2 "&e3;"> <ENTITY e3 "&e2;"> ]> <greeting> &e1; </greeting>` → **WFC**

e) `<a at1="blah" at2="foo">1 &lt; 5</a>` → **XML grammar**

f) `<a b3="a" b2="b" b1="a" b2="5"/>` → **WFC**

g) `<a>b>c</c>ab&e;</b>` → **WFC**

---

**Well-formedness constraint: Entity Declared**

...the Name given in the entity reference **MUST** match that in an entity declaration that...
(2) Show sequences of Unicode characters for which
a) UTF-8 needs more space than UTF-16

b) UTF-16 needs more space than UTF-8
together with the corresponding UTF codes and their lengths.

c) Explain how to binary sort a sequence of UTF-8 characters.
   Use pseudo code if appropriate.
(2) Show sequences of Unicode characters for which
   a) UTF-8 needs more space than UTF-16

   b) UTF-16 needs more space than UTF-8
together with the corresponding UTF codes and their lengths.

   c) Explain how to binary sort a sequence of UTF-8 characters.
      Use pseudo code if appropriate.

---

a) \U00010FFFF

| UTF-8: | 11101111 10111111 10111111 | = 24bits |
| UTF-16: | 11111111 11111111 | = 16bits |
(2) Show sequences of Unicode characters for which
a) UTF-8 needs more space than UTF-16
b) UTF-16 needs more space than UTF-8
together with the corresponding UTF codes and their lengths.

c) Explain how to binary sort a sequence of UTF-8 characters.
   Use pseudo code if appropriate.

a) \text{U+FFFF}

\begin{align*}
\text{UTF-8:} & \quad 11101111 \ 10111111 \ 10111111 \quad = \text{24bits} \\
\text{UTF-16:} & \quad 11111111 \ 11111111 \quad = \text{16bits}
\end{align*}

b) \text{U+00}

\begin{align*}
\text{UTF-8:} & \quad 00000000 \quad = \text{8bits} \\
\text{UTF-16:} & \quad 00000000 \ 00000000 \quad = \text{16bits}
\end{align*}
(2) Show sequences of Unicode characters for which
a) UTF-8 needs more space than UTF-16

b) UTF-16 needs more space than UTF-8
together with the corresponding UTF codes and their lengths.

c) Explain how to binary sort a sequence of UTF-8 characters.
   Use pseudo code if appropriate.

---

a) \uFFFD

<table>
<thead>
<tr>
<th>UTF-8:</th>
<th>UTF-16:</th>
</tr>
</thead>
<tbody>
<tr>
<td>11101111 10111111 10111111</td>
<td>11111111 11111111</td>
</tr>
</tbody>
</table>

b) \u0000

<table>
<thead>
<tr>
<th>UTF-8:</th>
<th>UTF-16:</th>
</tr>
</thead>
<tbody>
<tr>
<td>00000000</td>
<td>00000000 00000000</td>
</tr>
</tbody>
</table>

---

to binary compare two characters, simply start from the highest bit!
In this way, for characters with different lengths in UTF-8, after
\leq 4 bits we will be done!

- In case UTF-8 lengths are same \(\rightarrow\) normal binary compare..
(3) Show an element node with mixed content, using the XML Information Set.
Assume that for a node M, Type(M) is its type, i.e.,
is one of DOC, ELEM, ATTR, or CHAR.
Using the Infoset, show pseudo code that, given a node N,

a) returns all ancestors of the node

b) returns the previous sibling of the node.
(3) Show an element node with mixed content, using the XML Information Set.
Assume that for a node \( M \), \( \text{Type}(M) \) is its type, i.e.,
is one of DOC, ELEM, ATTR, or CHAR.
Using the Infoset, show pseudo code that, given a node \( N \),

a) returns all ancestors of the node

b) returns the previous sibling of the node.

```plaintext
localName(e1) = "element"
children(e1) = [e2, c1]
localName(e2) = "element"
children(e2) = []
parent(e2) = e1
code(c1) = U+00
parent(c1) = e1
attributes(e1) = []
attributes(e2) = []
```
(3) Show an element node with mixed content, using the XML Information Set.
Assume that for a node M, \text{Type}(M) is its type, i.e.,
is one of \text{DOC}, \text{ELEM}, \text{ATTR}, or \text{CHAR}.
Using the Infoset, show pseudo code that, given a node N,

a) returns all ancestors of the node

b) returns the previous sibling of the node.

\begin{verbatim}
local name(e1)  = "elem"
children(e1)   = [e2,c1]
local name(e2)  = "elem"
children(e2)   = []
parent(e2)     = e1
code(c1)       = U+00
parent(c1)     = e1
attributes(e1) = []
attributes(e2) = []
\end{verbatim}

a) getAncestors(Node n): NodeSet
\{
    NodeSet result=NULL;

    if(n.type!=DOC) {
        for(; n=n->parent ; n.type!="DOC") Add(n,result);
        Add(n,result);
    }
    return result;
\}
(3) Show an element node with mixed content, using the XML Information Set.
Assume that for a node M, Type(M) is its type, i.e.,
is one of DOC, ELEM, ATTR, or CHAR.
Using the Infoset, show pseudo code that, given a node N,

a) returns all ancestors of the node

b) returns the previous sibling of the node.

```
l = e1
local name(e1) = "elem"
children(e1) = [e2, c1]
local name(e2) = "elem"
children(e2) = []
p = e1
parent(e2) = e1
c = U+00
parent(c) = e1
attribute(e1) = []
attribute(e2) = []

a) getAncestors(Node n): NodeSet
{
    NodeSet result = NULL;
    if(n.type!= DOC) {
        n = n->parent;
        while(n.type!= DOC) Add(n, result);
    }
    Add(n, result);
    return result;
}

b) getPrevSibling(Node n): Node
{
    NodeList l = NULL;
    if(n.type!= "DOC") {
        Node parent = n->parent;
        l = n->children;
        if(l == NULL) return NULL;
        s = first(l);
        if(s == l) return NULL;
        while(s->next != n)
            s = s->next();
        return s;
    }
}
```
(4) Using DOM, give pseudo code that determines the average depth of the XML tree. The average depth of `<a/>` is 1.
(4) Using DOM, give pseudo code that determines the average depth of the XML tree. The average depth of `<a/>` is 1.

```java
int total = 0;
int count = 0;

call calcAverage(root, 1);

return total / count;

void calcAverage(Node n, int depth)
{
    NodeList children = n->childList();
    if (children->isEmpty())
    {
        total += depth;
        count += 1;
        return;
    }
    else for each Node c in children calcAverage(c, depth+1);
}
```
(5) Explain in detail, using an example, why hashing is useful for finding the minimal DAG of a tree. Why are updates more expensive on a DAG than on a tree? Give an example that clearly explains this.
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Why are updates more expensive on a DAG than on a tree? Give an example that clearly explains this.

When computing the minimal DAG, we need to determine whether a given subtree has occurred already. If we keep a table of pointers to the subtrees that have occurred already, then to check for a given subtree whether or not it occurs in the table takes in the worst case

\((\# \text{of trees in the table}) \times (\# \text{nodes in subtree})\)

which, in the worst case, is quadratic to the size of the input tree!

With hashing, we only need

\((\# \text{trees in the hash bucket}) \times (\# \text{nodes in the subtree})\).

Thus, if a bucket has only a constant number of trees, on average, then the complexity goes from quadratic to linear!

Example tree:

```
Assume
hash(“a-tree”) = 1
hash(“b-tree”) = 2
hash(“c-tree”) = 3
hash(“d-tree”) = 4
Then we need no (tree) comparisons whatsoever!
```
(5) Explain in detail, using an example, why hashing is useful for finding the minimal DAG of a tree. Why are updates more expensive on a DAG than on a tree? Give an example that clearly explains this.

Inserting a single new child required adding two rows and changing one existing one.

(The shared 2nd child “b-subtree” of the a-node must be duplicated first, before the c-child can be added.)
(6) Give the PRE/POST table for the tree

```xml
<a><b><c/> >/ b><c><d/> >/d><b/> >/b/> >/d>/ c><d/> >/b><c><b/> >/d/> >/c><d/> 
</b></a>
```

b) Give pseudo code that computes the POST order of a tree in an iterative way, i.e., without any recursive calls(!). You can use `firstChild(n)`, `nextSibling(n)`, and `parent(n)` for a node `n`.

Using the PRE/POST encoding, explain how to obtain

c) the ancestors of a node
d) the last child of a node
e) the maximal depth of the subtree at a node.
(6) Give the PRE/POST table for the tree

\[
\begin{array}{c|c|c}
\text{PRE} & \text{POST} & \text{Label} \\
1 & 14 & a \\
2 & 2 & b \\
3 & 1 & c \\
4 & 7 & c \\
5 & 3 & d \\
6 & 6 & d \\
7 & 4 & b \\
8 & 5 & b \\
9 & 8 & d \\
10 & 13 & b \\
11 & 11 & c \\
12 & 12 & b \\
13 & 10 & d \\
14 & 12 & d \\
\end{array}
\]

b) Give pseudo code that computes the POST order of a tree in an iterative way, i.e., without any recursive calls(!). You can use firstChild(n), nextSibling(n), and parent(n) for a node n.

Using the PRE/POST-encoding, explain how to obtain

c) the ancestors of a node

d) the last child of a node

e) the maximal depth of the subtree at a node.
(6) Give the PRE/POST table for the tree

\[
\langle a \rangle \langle \langle b \rangle \langle c \rangle \langle d \rangle \rangle \langle \langle b \rangle \langle c \rangle \langle d \rangle \rangle \langle \langle b \rangle \langle c \rangle \langle b \rangle \rangle \langle \langle d \rangle \langle \langle c \rangle \langle d \rangle \rangle \rangle \langle \langle b \rangle \langle c \rangle \langle d \rangle \rangle \rangle
\]

b) Give pseudo code that computes the POST order of a tree in an iterative way, i.e., without any recursive calls(!). You can use firstChild(n), nextSibling(n), and parent(n) for a node n.

Using the PRE/POST-encoding, explain how to obtain

c) the ancestors of a node

d) the last child of a node

e) the maximal depth of the subtree at a node.

---

b) int i =1;
    Node n=root;
    repeat{
        while(firstChild(n)!=NULL) n=firstChild(n);
        post(i) =n;
        i++;
        while(nextSibling(n)==NIL){
            n=parent(n);
            if(n==NULL) break;
            post(i) =n;
            i++;
        }
        n=nextSibling(n);
    }
(6) Give the PRE/POST table for the tree

```
< a > b > c / > / c > d / > d > b / > b / > / d > c > d / > b > c > b / > d / > / c > d / >
```

b) Give pseudo code that computes the POST order of a tree in an iterative way, i.e., without any recursive calls(!). You can use firstChild(n), nextSibling(n), and parent(n) for a node n.

Using the PRE/POST-encoding, explain how to obtain

- c) the ancestors of a node
- d) the last child of a node
- e) the maximal depth of the subtree at a node.

c) Given (pre, post) of a node, its ancestors are all nodes with pre-value < pre and post-value > post.
(6) Give the PRE/POST table for the tree

```
<a>b</a><c/ >/ b>c<d/ >d>b/ >/ d</c<d/ >b>c<d/ >d/ >/ c>d/ >
</b></a>
```

b) Give pseudo code that computes the POST order of a tree in an iterative way, i.e., without any recursive calls(!). You can use firstChild(n), nextSibling(n), and parent(n) for a node n.

Using the PRE/POST-encoding, explain how to obtain

c) the ancestors of a node
d) the last child of a node
e) the maximal depth of the subtree at a node.

c) Given (pre, post) of a node, its ancestors are all nodes with pre-value < pre and post-value > post.

d) If there is a node with pre-value > pre and with post-value=post-1, then that is the last child of (pre, post)
(6) Give the PRE/POST table for the tree

\[
\begin{array}{ccccccccc}
\text{a} \rightarrow \text{b} \rightarrow \text{c} \rightarrow \text{d} / \rightarrow \text{d} \rightarrow \text{b} / \rightarrow d / \rightarrow d / \rightarrow c < d / \rightarrow b < c < d / \rightarrow d / \rightarrow c < d / \\
\end{array}
\]

b) Give pseudo code that computes the POST order of a tree in an iterative way, i.e., without any recursive calls(!). You can use firstChild(n), nextSibling(n), and parent(n) for a node n.

Using the PRE/POST-encoding explain how to obtain

- the ancestors of a node
- the last child of a node
- the maximal depth of the subtree at a node.

c) Given (pre, post) of a node, its ancestors are all nodes with pre-value < pre and post-value > post.

d) If there is a node with pre-value > pre and with post-value=post-1, then that is the last child of (pre, post).

e) int maxDepth(int pr){
   size(int p): int{
      int s=0;
      for(int pr2=p+1; post(pr2)<post(p); pr2++) s++;
      return s;
   }
   int D=0; int u, L;
   L=pr+size(pr)-post(pr);
   for(int pr2=pr+1; post(pr2)<post(pr); pr2++){
      u=pr2+size(pr2)-post(pr2)-L;
      if(u>D) D=u;
   }
   return D;
}
(8) Show the Glushkov automaton for the regular expression \( E = (a \mid b)^*a \).
Is this expression 1-unambiguous? Explain!
Give a deterministic automaton for the same expression.
Is \( E_2 = (b^*a(a \mid b))^*a \) equivalent to \( E \)? Is it 1-unambiguous?
Show a 1-unambiguous expression that is equivalent to \( a(a \mid b)^* \).
(8) Show the Glushkov automaton for the regular expression \( E=(a \mid b)^*a \). Is this expression 1-unambiguous? Explain!
Give a deterministic automaton for the same expression. Is \( E_2=(b^*a(a\mid b))^*a \) equivalent to \( E \)? Is it 1-unambiguous?
Show a 1-unambiguous expression that is equivalent to \( a(a \mid b)^* \).
(8) Show the Glushkov automaton for the regular expression \( E = (a \mid b)^*a \). Is this expression 1-unambiguous? Explain!

Give a deterministic automaton for the same expression. Is \( E_2 = (b^*a(a\mid b))^*a \) equivalent to \( E \)? Is it 1-unambiguous? Show a 1-unambiguous expression that is equivalent to \( a(a \mid b)^* \).

Deterministic??

\[ \rightarrow \text{no!} \]

Thus, \( E \) is not 1-unambiguous.
(8) Show the Glushkov automaton for the regular expression $E=(a \mid b)^*a$.

Is this expression 1-unambiguous? Explain!

Give a deterministic automaton for the same expression.

Is $E_2=(b^*a(a\mid b))^*a$ equivalent to $E$? Is it 1-unambiguous?

Show a 1-unambiguous expression that is equivalent to $a(a \mid b)^*$.
(8) Show the Glushkov automaton for the regular expression \( E = (a \mid b)^*a \).

Is this expression 1-unambiguous? Explain!

Give a deterministic automaton for the same expression.

Is \( E_2 = (b^*a(a\mid b))^*a \) equivalent to \( E \)? Is it 1-unambiguous?

Show a 1-unambiguous expression that is equivalent to \( a(a \mid b)^* \).

NOT equivalent to \( E \! \)! The string “ba” is matched by \( E \), but NOT by \( E_2 \).

\( E_2 \) is NOT 1-unambiguous:
(8) Show the Glushkov automaton for the regular expression \( E=(a \mid b)^*a \). Is this expression 1-unambiguous? Explain!
Give a deterministic automaton for the same expression.
Is \( E_2=(b^*a(a\mid b))^*a \) equivalent to \( E \)? Is it 1-unambiguous?
Show a 1-unambiguous expression that is equivalent to \( a(a \mid b)^* \).

The expression \( b^*a(b^*)^* \) is

\[ \Rightarrow \] equivalent to \( E \)
\[ \Rightarrow \] 1-unambiguous.
(9) For the tree given in 6, write XPath expressions that

a) select all b nodes
b) select all b nodes that have a c-child
c) select all b nodes that have no c-children
d) select the right most c-node
e) select all nodes that have a c-parent

```xml
<a><b><c/></b><c><d/></c><d/></a>
```

Watch out! This is a typo on your Exam printout. Sorry.
(9) For the tree given in 6, write XPath expressions that

a) select all b nodes
b) select all b nodes that have a c-child
c) select all b nodes that have no c-children
d) select the right most c-node
e) select all nodes that have a c-parent

```
<a><b><c/></b><c><d/><d><b/><b/></d></c><d/><b><c><b/><d/></c><d/></b></a>
```

```
1: a
  2: b
  4: c
  9: d
  10: b
  3: c
  5: d
  6: d
  11: c
  14: d
  7: b
  8: b
  12: b
  13: d
```

a) //b
(9) For the tree given in 6, write XPath expressions that

a) select all b nodes  

b) select all b nodes that have a c-child

c) select all b nodes that have no c-children

d) select the right most c-node

e) select all nodes that have a c-parent

```
<a><b><c/></b><c><d/><d><b/><b/></d></c><d/><b><c><b/><d/></c><d/></b></a>
```

![Tree diagram]

1: a

2: b 4: c 9: d 10: b

3: c 5: d 6: d 11: c

7: b 8: b 12: b 13: d

a) //b

b) //b[c]
(9) For the tree given in 6, write XPath expressions that

a) select all b nodes
b) select all b nodes that have a c-child
c) select all b nodes that have no c-children
d) select the right most c-node
e) select all nodes that have a c-parent

```
<a><b><c/></b><c><d/><d><b/><b/></d></c><d/><b><c><b/><d/></c><d/></b></a>
```

```
1: a

2: b
3: c
   5: d
   6: d

4: c

9: d

10: b

11: c

14: d

7: b

8: b

12: b

13: d
```

a) //b
b) //b[c]
c) //b[not(c)]
For the tree given in 6, write XPath expressions that

a) select all b nodes
b) select all b nodes that have a c-child

(c) select all b nodes that have no c-children

d) select the right most c-node (node no 11)

e) select all nodes that have a c-parent

```
<a><b><c/></b><c><d/></c><d/><b/><b/></d></c><d/><b><c><b/><d/></c><d/></b></a>
```

1: a

2: b 4: c 9: d 10: b

3: c 5: d 6: d 11: c 14: d

7: b 8: b 12: b 13: d

a) //b

b) //b[c]

(c) //b[not(c)]

d) //c[b]

or //c[b and d]
For the tree given in 6, write XPath expressions that

a) select all b nodes
b) select all b nodes that have a c-child

c) select all b nodes that have no c-children
d) select the right most c-node (node no 11)
e) select all nodes that have a c-parent

<a><b><c/></b><c><d/><d><b/><b/></d></c><d/><b><c><b/><d/></c><d/></b></a>

1: a
   2: b
   4: c
   9: d
   10: b
   3: c
   5: d
   6: d
   11: c
   14: d
   7: b
   8: b
   12: b
   13: d

   a) //b
   b) //b[c]
   c) //b[not(c)]
   d) //c[b]
   or //c[b and d]
   e) //*[parent::c]
   or //c/*
(10) Below is a tree corresponding to the document in (6).
Show the sequences of node numbers that are selected by the following queries.

a) //c//d  
b) //*[a or b]  
c) //b/ancestor::d/following::d  
d) //*[not(.//b | ./ancestor::c)]  
e) //c//d/preceding::*//d
Below is a tree corresponding to the document in (6).

Show the sequences of node numbers that are selected by the following queries.

a) //c//d
b) //*[a or b]
c) //b/ancestor::d/following::d
d) //*[not(.//b | ./ancestor::c)]
e) //c//d/preceding::*/d

a) 5, 6, 13
Below is a tree corresponding to the document in (6). Show the sequences of node numbers that are selected by the following queries.

a) //c//d
b) //*[a or b]
c) //b/ancestor::d/following::d
d) //*[not(.//b | ./ancestor::c)]
e) //c//d/preceding::*//d

a) 5, 6, 13
b) 1, 6, 11
Below is a tree corresponding to the document in (6).
Show the sequences of node numbers that are selected by the following queries.

a) //c//d
b) //*[a or b]
c) //b/ancestor::d/following::d
d) //*[not(.//b | ./ancestor::c)]
e) //c//d/preceding::*//d

1: a
2: b 4: c 9: d 10: b
3: c 5: d 6: d 11: c 14: d
7: b 8: b 12: b 13: d

a) 5, 6, 13
b) 1, 6, 11
c) 9, 13, 14
(10) This a tree corresponding to the XML in (6).
Show the sequences of node numbers that are selected by the following queries.

a) //c//d
b) //*[a or b]
c) //b/ancestor::d/following::d
d) //*[not(.//b | ./ancestor::c)]
e) //c//d/preceding::*//d
(10) This a tree corresponding to the XML in (6).
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b) //*[a or b]
c) //b/ancestor::d/following::d
d) //*[not(.//b | ./ancestor::c)]
e) //c//d/preceding::*//d

```
1: a
2: b 4: c 9: d 10: b
3: c 5: d 6: d 11: c 14: d
7: b 8: b 12: b 13: d
```

<table>
<thead>
<tr>
<th>Query</th>
<th>Selected Node Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>5, 6, 13</td>
</tr>
<tr>
<td>b)</td>
<td>1, 6, 11</td>
</tr>
<tr>
<td>c)</td>
<td>9, 13, 14</td>
</tr>
<tr>
<td>d)</td>
<td>2, 3, 9, 14</td>
</tr>
<tr>
<td>e)</td>
<td>5, 6</td>
</tr>
</tbody>
</table>
(10) This a tree corresponding to the XML in (6).

c) //b/ancestor::d/following::d
d) //*[not(.//b | ./ancestor::c)]

For query c) show in detail how the Core-XPath evaluation algorithm computes the answer to this query.
Do the same for query d).

lab(a) = \{ 1 \}
lab(b) = \{ 2, 7, 8, 10, 12 \}
lab(c) = \{ 3, 4, 11 \}
lab(d) = \{ 5, 6, 9, 13, 14 \}
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lab(d) = \{5, 6, 9, 13, 14\}
(10) This a tree corresponding to the XML in (6).

c) //b/ancestor::d/following::d
d) //*[not(./b | ./ancestor::c)]

For query c) show in detail how the Core-XPath evaluation algorithm computes the answer to this query. Do the same for query d).

lab(a) = { 1 }
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lab(d) = \{ 5, 6, 9, 13, 14 \}
(10) This a tree corresponding to the XML in (6).

c) //b/ancestor::*/following::*
d) //*[not(.//b | ./ancestor::*c)]

For query c) show in detail how the Core-XPath evaluation algorithm computes the answer to this query. Do the same for query d).

lab(a) = { 1 }
lab(b) = { 2, 7, 8, 10, 12 }
lab(c) = { 3, 4, 11 }
lab(d) = { 5, 6, 9, 13, 14 }
(10) This a tree corresponding to the XML in (6).

c) //b/ancestor::*[following::*

d) //*[not(../../../b | ../../../ancestor::*c)]

For query c) show in detail how the Core-XPath evaluation algorithm computes the answer to this query. Do the same for query d).

lab(a) = { 1 }
lab(b) = { 2, 7, 8, 10, 12 }
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(10) This a tree corresponding to the XML in (6).

c) //b/ancestor::*//d/following::d

d) //*[not(.//b | ./ancestor::*c)]

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lab(a) = { 1 }
lab(b) = { 2, 7, 8, 10, 12 }
lab(c) = { 3, 4, 11 }
lab(d) = { 5, 6, 9, 13, 14 }
(11) Show an example of XPath queries q1, q2 such that they are not equivalent, but q1 is included in q2. Show that q1 is included in q2 using one of the methods discussed. Use the homomorphism technique to test whether

\[ p = a[./b[c/*/d]/b[c//d]/b[c/d]] \]

is included in

\[ q = a[./b[c///d]/*[c/d]] \]
(11) Show an example of XPath queries q1, q2 such that they are not equivalent, but q1 is included in q2. Show that q1 is included in q2 using one of the methods discussed. Use the homomorphism technique to test whether

\[ p = a[.//b[c/*//d]]/b[c/d]/b[c/d] \]

is included in

\[ q = a[.//b[c///d]]/*[c/d] \]

or

\[ q_1 = //b \]
\[ q_2 = //b \]

or

\[ q_1 = //b \]
\[ q_2 = //* \]
(11) Show an example of XPath queries q1, q2 such that they are not equivalent, but q1 is included in q2.
Show that q1 is included in q2 using one of the methods discussed.
Use the homomorphism technique to test whether
\[ p = a[.//b[c//d]/b[c/d]/b[c//d]] \]
is included in
\[ q = a[.//b[c//*d]/*[c//d]] \]

Canonical model:

\[
\begin{align*}
q_1 &= /b//b \\
q_2 &= //b
\end{align*}
\]

Replace in q1 // by
\[ \leq N+1 \text{ many } /z/ \]

0, here

\[
\begin{align*}
\text{Do they match q2? } &\rightarrow \text{ yes!!}
\end{align*}
\]

or

\[
\begin{align*}
q_1 &= //b \\
q_2 &= //*
\end{align*}
\]
Show an example of XPath queries \(q_1,q_2\) such that they are not equivalent, but \(q_1\) is included in \(q_2\).

Show that \(q_1\) is included in \(q_2\) using one of the methods discussed.

Use the homomorphism technique to test whether

\[
p = a[.//b[\text{c}/*//\text{d}]//b[\text{c}]/\text{d}] 
\]

is included in

\[
q = a[.//b[\text{c}///\text{d}]/*[\text{c}///\text{d}]]
\]
(11) Show an example of XPath queries q1, q2 such that they are not equivalent, but q1 is included in q2. Show that q1 is included in q2 using one of the methods discussed. Use the homomorphism technique to test whether

\[ p = a[.//b[c//d]/b[//d]/b[c/d]] \]

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\[ q = a[.//b[c//d]/*[c/d]] \]
(11) Show an example of XPath queries q1, q2 such that they are not equivalent, but q1 is included in q2. Show that q1 is included in q2 using one of the methods discussed.

Use the homomorphism technique to test whether

\[ p = a[.//b[c/*/d]/b[c//d]/b[c/d]] \]
\[ q = a[.//b[c/*/*/d]/*[c/d]] \]
(11) Show an example of XPath queries q1, q2 such that they are not equivalent, but q1 is included in q2. Show that q1 is included in q2 using one of the methods discussed.

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\[ p = a[.//b[c//d]]/b[c//d]/b[c/d] \]

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Show that q1 is included in q2 using one of the methods discussed.

Use the homomorphism technique to test whether

\[ p = a[.//b[c/*//d]/b[c//d]/b[c/d]] \] is included in

\[ q = a[.//b[c///*//d]/*[c/d]] \]
(11) Show an example of XPath queries q1, q2 such that they are not equivalent, but q1 is included in q2. Show that q1 is included in q2 using one of the methods discussed. Use the homomorphism technique to test whether

\[ p = a[.//b[c/*//d]/b[c//d]/b[c/d]] \]

is included in

\[ q = a[.//b[c/*//d]/*[c/d]] \]

Can not be mapped.
(11) Show an example of XPath queries q1, q2 such that they are not equivalent, but q1 is included in q2.

Show that q1 is included in q2 using one of the methods discussed.

Use the homomorphism technique to test whether

\[ p = a[.//b[c/*//d]//b[c//d]/b[c/d]] \]

is included in

\[ q = a[.//b[c//*/d]/*[c/d]] \]

\[ \text{Can not be mapped.} \]

\[ \text{Note: p is included in q!!} \]
(11) Show an example of XPath queries q₁, q₂ such that they are not equivalent, but q₁ is included in q₂.
Show that q₁ is included in q₂ using one of the methods discussed.
Use the homomorphism technique to test whether

\[ p = a[.//b[c/*//d]/b[c//d]/b[c/d]] \]

is included in

\[ q = a[.//b[c/*//d]/*[c/d]] \]

**Case 1:** c has d-child

**Case 2:** c has no d-child

*Note: p is included in q!!*
(11) Show an example of XPath queries q1, q2 such that they are not equivalent, but q1 is included in q2. Show that q1 is included in q2 using one of the methods discussed.

Use the homomorphism technique to test whether

\[ p = a[.//b[c/*/d]/b[c//d]/b[c/d]] \] is included in 
\[ q = a[.//b[c//*/d]/*[c/d]] \]

Case 1: c has d-child

\[ \Rightarrow \text{OK!!} \]

\[ p \text{ included in } q, \text{ for Case 1!} \]

Case 2: c has no d-child

**Why?**

**Note:** p is included in q!!
(11) Show an example of XPath queries q1, q2 such that they are not equivalent, but q1 is included in q2. Show that q1 is included in q2 using one of the methods discussed. Use the homomorphism technique to test whether

\[ p = a[.//b[c/*//d]/b[c//d]/b[c/d]] \]

is included in

\[ q = a[.//b[c///d]/*[c/d]] \]

Note: \( p \) is included in \( q \)!!

Why?

Case 2: \( c \) has no \( d \)-child

Also OK!!

\( p \) included in \( q \), for Case 2!

Note: \( p \) is included in \( q \)!!
(12) Construct a DTD such that 10a) is included in 10e), and another DTD such that 10e) is included in 10a).

[Very easy!!]

10a) //c//d
10e) //c//d/ preceding::*//d
(12) Construct a DTD such that 10a) is included in 10e), and another DTD such that 10e) is included in 10a). [Very easy!!]

\[
\begin{align*}
10a) & \quad //c//d \\
10e) & \quad //c//d/\text{preceding:}*://d
\end{align*}
\]

---

For the first part:

*Any DTD* so that c-nodes do NOT have d-descendants! 😊

For the second part:

Any DTD, so that all d-nodes are c-descendants.
(14) Given a PRE/POST/SIZE table, show SQL queries for the XPath queries

a) /*
b) /a/b/*
c) //a/*/b
d) //a/following-sibling::b
(14) Given a PRE/POST/SIZE table, show SQL queries for the XPath queries

a) /*
b) /a/b/*
c) //a/*//b
d) //a/following-sibling::b

SELECT DISTINCT r1.pre FROM doc_tbl r1
WHERE r1.pre=1
ORDERED BY r1.pr
(14) Given a PRE/POST/SIZE table, show SQL queries for the XPath queries

a) /*
b) /a/b/*
c) //a/*//b
d) //a/following-sibling::*

```
SELECT DISTINCT r4.pre FROM doc_tbl r1, r2, r3, r4
    WHERE r1.pre=0
        AND r2.pre>r1.pre
        AND r2.post<r1.post
        AND (r2.pre-r2.post+r2.size)=(r1.pre-r1.post+r1.size)+1
        AND r2.tag="a"
        AND r3.pre>r2.pre
        AND r3.post<r2.post
        AND (r3.pre-r3.post+r3.size)=(r2.pre-r2.post+r2.size)+1
        AND r3.tag="b"
        AND r4.pre>r3.pre
        AND r4.post<r3.post
        AND (r4.pre-r4.post+r4.size)=(r3.pre-r3.post+r3.size)+1
    ORDERED BY r4.pre
```

Recall:  level(n) = pre(n)–post(n)+size(n)
Given a PRE/POST/SIZE table, show SQL queries for the XPath queries

a) /*
b) /a/b/*
c) //a/*/b

d) //a/following-sibling::b

SELECT DISTINCT r4.pre FROM doc_tbl r1, r2, r3, r4
WHERE r1.pre=0
  AND r2.pre>r1.pre
  AND r2.post<r1.post
  AND r2.tag="a"
  AND r3.pre>r2.pre
  AND r3.post<r2.post
  AND (r3.pre-r3.post+r3.size)=(r2.pre-r2.post+r2.size)+1
  AND r4.pre>r3.pre
  AND r4.post<r3.post
  AND r4.tag="b"
ORDERED BY r4.pre

Recall:  level(n) = pre(n) - post(n) + size(n)
Given a PRE/POST/SIZE table, show SQL queries for the XPath queries

a) /*

b) /a/b/*

c) //a/*/b

d) //a/following-sibling::b

```
SELECT DISTINCT r4.pre FROM doc_tbl r1, r2, r3, r4
    WHERE r1.pre=0
    AND r2.pre>r1.pre
    AND r2.post<r1.post
    AND r2.tag="a"
    AND r3.pre<r2.pre
    AND r3.post>r2.post
    AND (r3.pre-r3.post+r3.size)=(r2.pre-r2.post+r2.size)-1
    AND r4.pre>r2.pre
    AND r4.post<r3.post
    AND (r4.pre-r4.post+r4.size)=(r2.pre-r2.post+r2.size)
    AND r4.tag="b"
ORDERED BY r4.pre
```

Recall:  \[\text{level}(n) = \text{pre}(n) - \text{post}(n) + \text{size}(n)\]