SMA 5506
Database Technology

Summer 2005

Session L16

WEB AS A DATABASE: EVOLUTION OF XML

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Traditional Use of the Web: For direct human usage Focus: **Entertainment**

Examples:

Extract just mortgage rate information

Compare mortgage rates offered by multiple sources

Build **cumulative** database of mortgage rates over time

Compare cumulative rates with previously stored, **alert** to new highs and lows

Programs for:

Web Wrapper and Context Mediator Technology

Enhancing

Analyzing

Consolidating

Processing

A

C

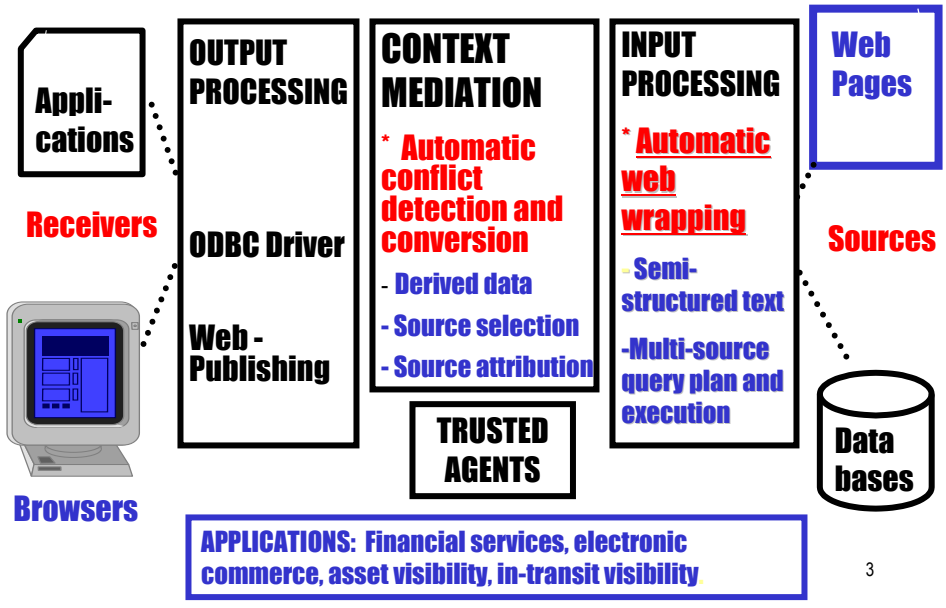
B

Bank Web sites

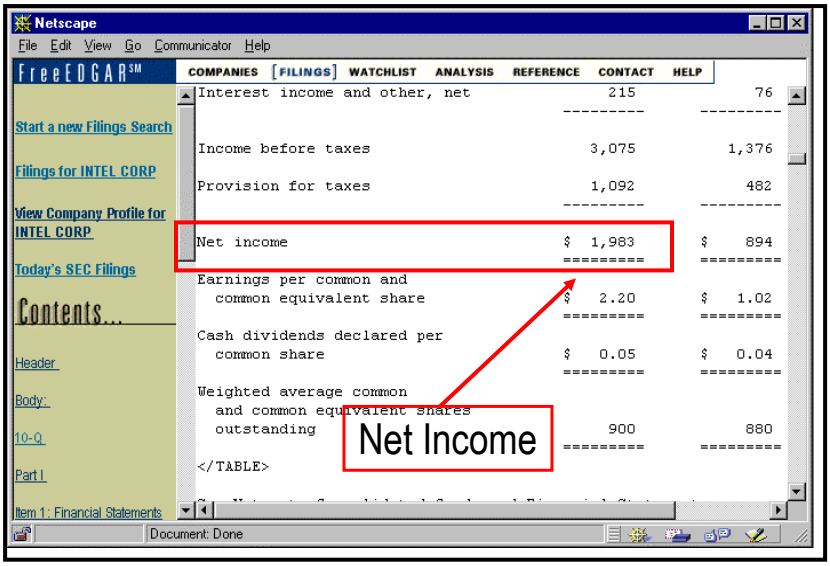
Internal data bases

New Use of the Web: Program intermediaries Focus: **Productivity**

MIT Sloan COntext INterchange (COIN) Project



Example Semi-structured Web data: Intel SEC filing



Sample HTML (excerpt from Edgar web site)

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 3.2 Final//EN">
<html>
<head>
<title>Partes&#174; FreeEDGAR: Free Real-Time SEC EDGAR Filings</title>
<BODY topmargin=18 leftmargin=6 bgcolor="#ffffff" link="#0000ee" VLINK="#551A8B" ALINK="#ff0000">
</TABLE>
<pre><font size=2>
                                  1998        1997        1996
                                 -------     -------     -------
NET REVENUES                    $26,273     $25,070     $20,847
                                 -------     -------     -------
Cost of sales                    12,144       9,945       9,164
                                 -------     -------     -------
OPERATING INCOME                  8,379       9,887       7,553
                                 -------     -------     -------
NET INCOME                      $ 6,068     $ 6,945     $ 5,157
</font></pre>
<!-- end company info -->
<!-- begin page footer -->
<table cellpadding=0 cellspacing=0 border=0>
<tr><td align=left valign=middle width=455 nowrap height=20>
<img src="/Global/images/black.gif" height=2 width=455></td></tr>
<tr><td align=left valign=top nowrap width=455>
<font size=1 face="helvetica,arial">
<p>Copyright &#169;1999 Partes Corporation.<br></font></td></tr></table>
<!-- end page footer -->
</td></tr></table>
</BODY>
</HTML>
```

Text

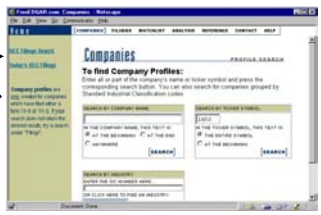
Comments

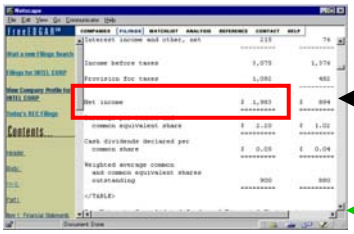
HTML formatting

Home page

Web Navigation

SEC Site

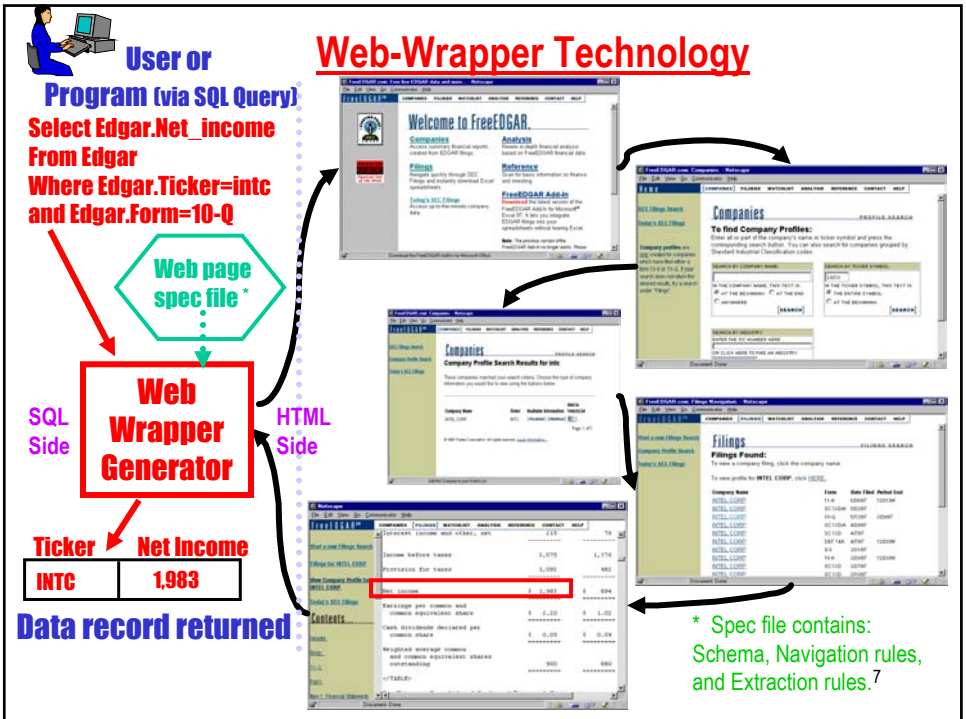




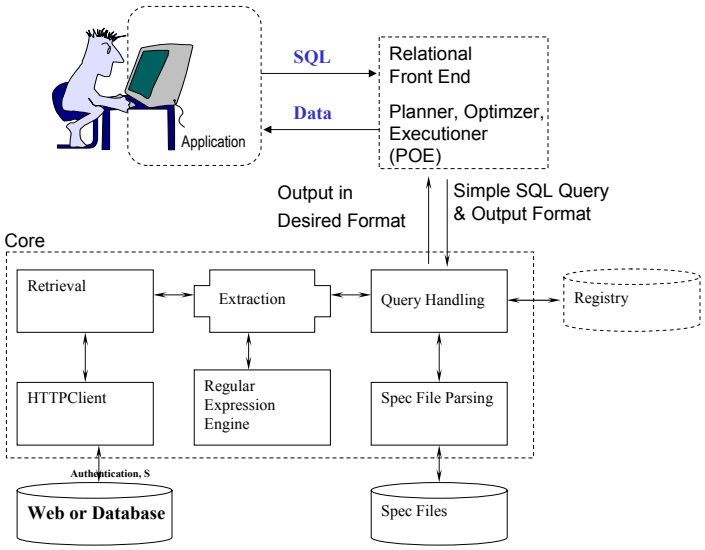
Filing with Intel Net Income

Target page

Web-Wrapper Technology

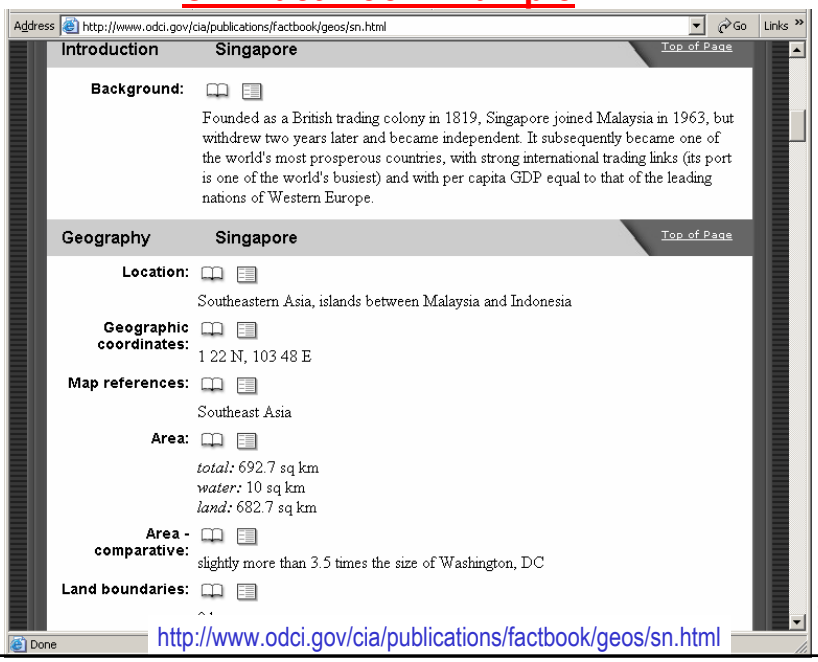


Cameleon Architecture



Demo at context2.mit.edu/coin -> demos -> Cameleon# demo

CIA Fact Book Example



http://www.odci.gov/cia/publications/factbook/geos/sn.html

CAMELEON **QUERY**:

Select capital, location, coordinates, totalarea, climate, population, GDP from cia where Country="Singapore"

CAMELEON **RESULTS**:

```
<?xml version="1.0" encoding="ISO-8859-1" ?>
- <DOCUMENT>
  - <ELEMENT>
      <capital>Singapore</capital>
      <location>Southeastern Asia, islands between Malaysia and
        Indonesia</location>
      <coordinates>1 22 N, 103 48 E</coordinates>
      <totalarea>692.7 sq km</totalarea>
      <climate>tropical; hot, humid, rainy; two distinct monsoon seasons -
        Northeastern monsoon from December to March and Southwestern
        monsoon from June to September; inter-monsoon - frequent afternoon
        and early evening thunderstorms</climate>
      <population>4,452,732 (July 2002 est.)</population>
      <gdp>$106.3 billion (2001 est.)</gdp>
    </ELEMENT>
  </DOCUMENT>
```

Spec file for CIA Fact Book (partial)

```
<?xml version="1.0" encoding="UTF-8" ?>
 <!DOCTYPE RELATION SYSTEM "http://interchange.mit.edu/cameleon_sharp/cameleonspec.dtd">
 <RELATION name="cia">
  <SOURCE URI="http://www.odci.gov/cia/publications/factbook/index.html">
       <ATTRIBUTE name="Link" type="String“ link=“true”>
          <BEGIN> <![CDATA[ <body  ]]>  </BEGIN>
          <PATTERN> <![CDATA[ <option value="([^"]*)"[^>]*>#Country#  ]]>  </PATTERN>
          <END> <![CDATA[ </[Bb][oO][dD][yY]>  ]]>  </END>
       </ATTRIBUTE>
  </SOURCE>
  <SOURCE URI="http://www.odci.gov/cia/publications/factbook/#Link#">
       <ATTRIBUTE name="totalarea" type="String">
          <BEGIN> <![CDATA[ Area:  ]]>  </BEGIN>
          <PATTERN> <![CDATA[ total:.*?</i>\s*([\0-\377]*?)\s*<  ]]>  </PATTERN>
          <END> <![CDATA[ </tr>  ]]>  </END>
        </ATTRIBUTE>
       <ATTRIBUTE name="capital" type="String">
          <BEGIN> <![CDATA[ Capital:  ]]>  </BEGIN>
          <PATTERN> <![CDATA[ <br>\s*([\0-\377]*?)\s*<  ]]>  </PATTERN>
          <END> <![CDATA[ </tr>  ]]>  </END>
       </ATTRIBUTE>
      …
  </SOURCE>
 </RELATION>
```


Regular Expressions Used in Spec Files

- `*` Match 0 or more times (greedy).
- `*?` Match 0 or more times (non-greedy).
- `+` Match 1 or more times (greedy).
- `?` Match 0 or 1 time (greedy).

Greedy quantifiers such as * matches as much as possible, whereas non-greedy quantifiers stop at the minimum match. Example:

 hello lovely   world

(.*) would match ‘hello lovely   world’ whereas

(.*?) would match ‘hello’ and ‘world’

- `.` matches everything except \n
- `[\0-\377]` matches everything
- `^` matches the beginning of a string or line
- `[^ a character]` matches everything except the specified character.
  For instance [^<] matches anything but <
- `$` matches the end of a string or line
- `\s` matches a whitespace character
- `\S` matches a non-whitespace character
- `\d` matches a digit
- Expressions within parentheses are saved.

CIA Example

In source:

```
<br>
        <i>total:</i> 692.7 sq km
<br><i>water:</i> 10 sq km
```

In Spec:

```
<ATTRIBUTE name="totalarea" type="String">
        <BEGIN> <![CDATA[ Area:  ]]>  </BEGIN>
        <PATTERN> <![CDATA[ total:.*?</i>\s*([\0\377]*?)\s*<  ]]> </PATTERN>
        <END> <![CDATA[ </tr>  ]]>  </END>
<ATTRIBUTE>
```

In Result:

```
        <totalarea>692.7 sq km</totalarea>
```

What if we want to get rid of sq km in result?

Instead of matching everything using ([\0-\377]*?), we match digits and dot only like:

```
…
<PATTERN> <![CDATA[total:.*?</i>\s*([\d\.]*?)\s*sq]]> </PATTERN>
…
```


Another Example (from Edgar web site)

<pre>

	1998	1997	1996
NET REVENUES	$26,273	$25,070	$20,847
Cost of sales	12,144	9,945	9,164
OPERATING INCOME	8,379	9,887	7,553
NET INCOME	$ 6,068	$ 6,945	$ 5,157

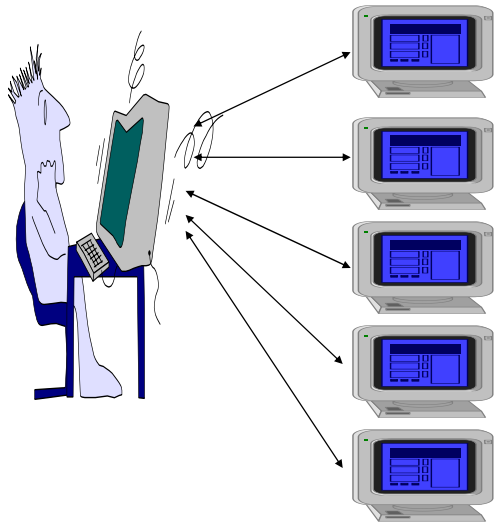
 </pre>

http://soursop.mit.edu/edgar.htm

To extract 1996 Cost of Sales (http://soursop.mit.edu/hzedgar.xml**)**

```
…
<SOURCE URI="http://soursop.mit.edu/edgar.htm">
<ATTRIBUTE name="cost_of_sales_96" type="String">
   <BEGIN> <![CDATA[Cost\s*of\s*sales ]]>  </BEGIN>
   <PATTERN> <![CDATA[\s*[\d,]*?\s+[\d,]*?\s+([\d,]*)\s+]]> </PATTERN>
   <END><![CDATA[OPERATING\s*INCOME]]></END>
</ATTRIBUTE>
…
```

Sample Application:
Providing Integrated Data and Analysis



Equity prices - TIBCO
Real-time feed

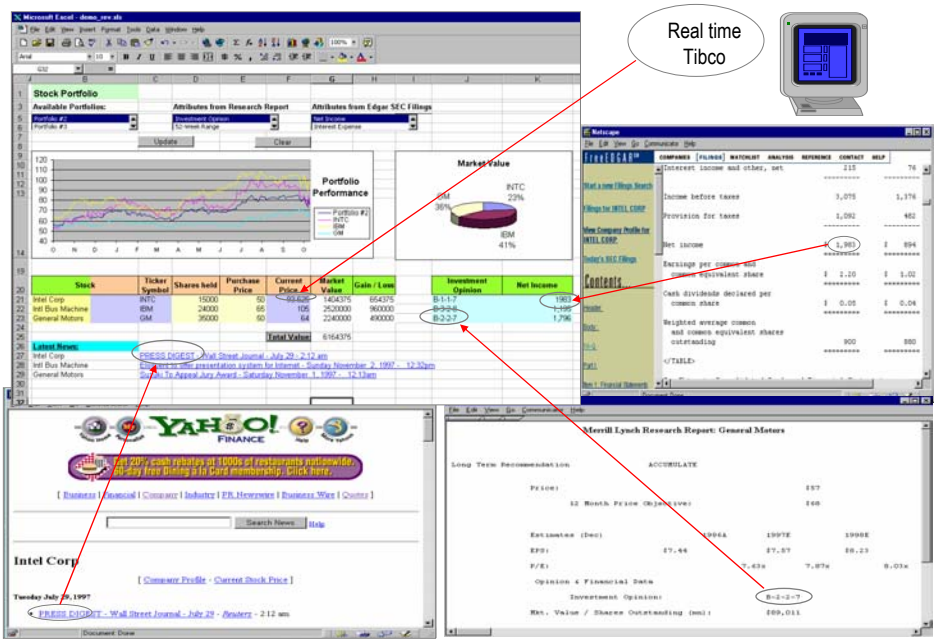
SEC Filings - EDGAR
Web based - Internet

News - Reuters, Newswire and Businesswire
Web based - Internet

Merrill Research Reports
Text based - Merrill Intranet

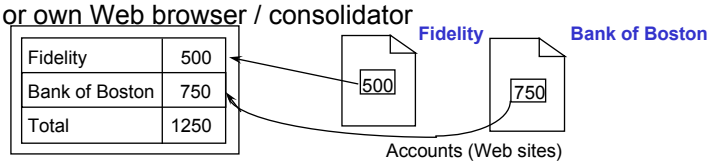
Market updates - Merrill Lynch home page
Web based - Internet

Spreadsheet Interface

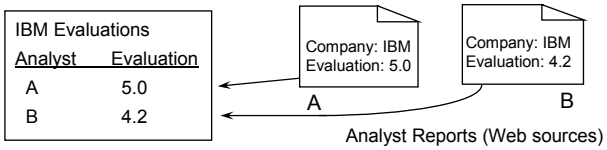


Sample Applications of Semi-Structured Web Data

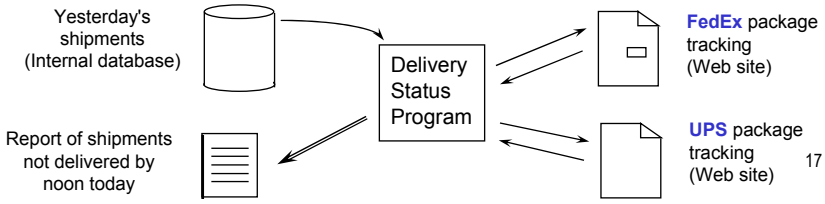
• Automate Extraction of data from specific Web sites into user tool, like Excel, or own Web browser / consolidator



• Automatically Select and Consolidate information across Web sites



• Integrate Internet / Intranet / Client Server networks for internal operations



XML – The Silver Bullet ?

- XML is (according to press reports …)
  - "HTML on steroids" ?
  - "a Rosetta Stone" ?
  - "a universal way to translate data" ?
  - "a miraculous way to" … information integration ?
  - "a silver bullet" ?

XML What is it … really?

- XML - EXtensible Markup Language
- Meta language for defining a markup language
- Based on SGML - Standard Generalized Markup Language
- Data model for syntax for structuring data
- Can define tags at will
- Can nest document structures to arbitrary levels of complexity
- Can use Document Type Definition (DTD)
- Some background sources: w3c.org/XML and XML.org

- Many other members of "family":
  - XSL, XSLT, XLL, XML-Schema, XQuery, etc.

XML Does help create structured Web pages

Feature	HTML	XML
Extensibility	Fixed set of tags	Extensible set of tags
Tag purpose	Presentation	Content
Views	Single	Multiple (XSL)
Orientation	Documents	Documents + semi-structured data
Search	Keyword	Keyword plus Field-sensitive queries

Example: HTML Compared with XML

HTML *

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 3.2 Final//EN">
<html>
<head> . . .
<BODY topmargin=18 leftmargin=6 bgcolor="#ffffff" link="#0000ee" VLINK="#551A8B" ALINK="#ff0000">
<pre><font size=2>
                    Regular   Our
                    Price     Price
      Palm Pilot V  329.00    236.00    In stock
</font></pre>
<table cellpadding=0 cellspacing=0 border=0>
<tr><td align=left valign=middle width=455 nowrap height=20>
<tr><td align=left valign=top nowrap width=455>
<font size=1 face="helvetica,arial"> . . .
</BODY>
</HTML>
```

XSL

XML

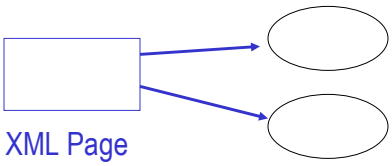
```
<ProductInfo>
   <Product> Palm Pilot V </Product>
   <RegularPrice> 329.00 </RegularPrice>
   <OurPrice> 236.00 </OurPrice>
   <InStock> yes </InStock>
</ProductInfo>
```

* The HTML is normally much messier, with lots more formatting details and <tr> and <td> tags for defining tables and tab positions.

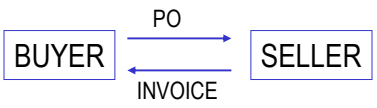
Example: **CIA Factbook in XML at**
http://www.cs.washington.edu/research/xmldatasets/data/mondial/mondial-3.0.xml

XML Why do we need it?

- W3C wanted to get out of the tag creation business
- Separate data from presentation
  - Use of a style sheet instead of "hardcoded" HTML formatting
  - Flexibility / scalability / extensibility



- Also important for Wireless Applications (WML/ XHTML)
- Human readability
- Computer processable
- Information interchange (EDI)



XML . . . Multiple Standards

- What is so great about XML standards – is that there are so many . . .
- Should tag for catalog be called "price" or "cost" ?

"The director of electronic trading at Credit Suisse First Boston and chairman of financial services XML working group is struggling with more than a dozen XML protocols … for financial trading applications." (*ComputerWorld*)

- XML is helpful for integration, but not quite a "silver bullet"
- Much more is needed for information integration
  - ➢ Context Interchange and Semantic Web research are promising areas . . .

Database as XML

RELATIONAL

```
<dataroot>
 <Census>
   <State>Alabama</State>
  <Abbr>AL</Abbr>
  <Year>1999</Year>
  <Population>4370</Population>
  <Cars>3957</Cars>
  <Drivers>3521</Drivers>
 </Census>
 <Census>
  <State>Alabama</State>
  <Abbr>AL</Abbr>
  <Year>2000</Year>
  <Population>4447</Population>
  <Cars>3960</Cars>
  <Drivers>3521</Drivers>
 </Census>
…
</dataroot>
```

NESTED/HIERARCHICAL

```
<dataroot>
 <Census>
  <State>Alabama</State>
  <Abbr>AL</Abbr>
  <Year val="1999">
    <Population>4370</Population>
    <Cars>3957</Cars>
    <Drivers>3521</Drivers>
  </Year>
  <Year val="2000">
    <Population>4447</Population>
    <Cars>3960</Cars>
    <Drivers>3521</Drivers>
  </Year>
 </Census>
 <Census>
  <State>Alaska</State>
  <Abbr>AK</Abbr>
  <Year val="1999">
. . .
</dataroot>
```

NESTED/HIERARCHICAL

```
<dataroot>
 <Census>
   <State>Alabama</State>
   <Abbr>AL</Abbr>
   <Yearrec>
   <Year>1999</Year>
     <Population>4370</Population>
     <Cars>3957</Cars>
     <Drivers>3521</Drivers>
    </Yearrec>
  <Yearrec>
   <Year>2000</Year>
     <Population>4447</Population>
     <Cars>3960</Cars>
     <Drivers>3521</Drivers>
  </Yearrec>
 </Census>
 <Census>
  <State>Alaska</State>
  <Abbr>AK</Abbr>
  <Yearrec>
    <Year>1999</Year>
. . .
</dataroot>
```

SQL vs. XQuery

- **Q: How can you query an XMLdocument database? A: XQuery**

Feature	SQL	XQuery
Language	Declarative	Functional / Procedural
Data model	Relational	XML document: Sequence based, can be relational with arbitrary nesting, hierarchical, etc.
Functions	Built-ins only	Built-ins & user defined
Optimization	Established	Still being researched

Syntax: F-L-W-O-R: For, Let, Where, Order by, Return

XML Primer at http://www.softwareag.com/xml/tools/xquery_primer.pdf

Tutorial slides at http://www.brics.dk/~amoeller/XML/querying/index.html

XQuery by Example (Q1)

Census (relational)

State	Abbr	Year	Population	Cars	Drivers
Alabama	AL	1999	4370	3957	3446
Alabama	AL	2000	4447	3960	3521
…					
Wyoming	WY	2000	494	586	371

Census.xml

```
<?xml version="1.0"
encoding="UTF-8"?>
<dataroot>
  <Census>
    <State>Alabama</State>
    <Abbr>AL</Abbr>
    <Year>1999</Year>
    <Population>4370</Population>
    <Cars>3957</Cars>
    <Drivers>3521</Drivers>
  </Census>
 <Census>
    <State>Alabama</State>
    <Abbr>AL</Abbr>
    <Year>2000</Year>
    <Population>4447</Population>
    <Cars>3960</Cars>
    <Drivers>3521</Drivers>
  </Census>
…
<dataroot>
```

- Q1: population of Massachusetts
  - In SQL:

```
Select Year, Population
From Census
Where State="Massachusetts";
```

  - In XQuery

```
for $s in doc("census.xml")
//Census[State = "Massachusetts"]
return <Mass_pop> {$s/Year, $s/Population} </Mass_pop>
```

XQuery by Example (Q6)

- **Q6: Names of all students from states with more than 9 million people in 2000**
  - In SQL:

```
select student.name
from  student, census
where student.home = census.state
          and  census.year = 2000
          and  census.population > 9000
```

  - In XQuery

```
for $s in doc("census.xml")//Census[Year=2000 and
Population>9000]
let $t := doc("student.xml")/*/Student[Home=$s/State]
return $t/Name
```


XQuery by Example (Q7)

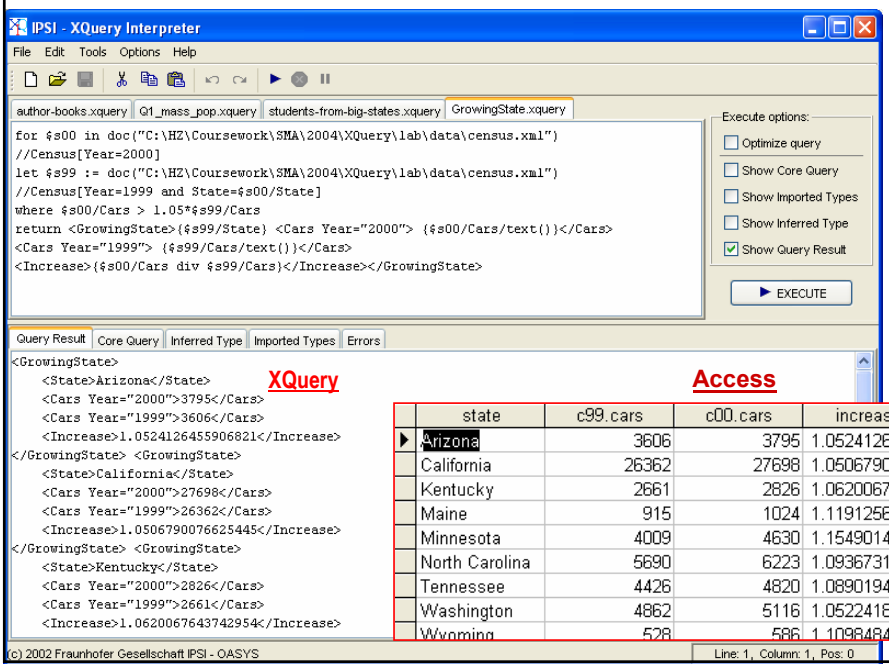
- **Q7. Names of all states where number of cars increased by over 5% between 1999 and 2000**
  - In SQL:

```
Select c00.state, c99.cars, c00.cars, c00.cars/c99.cars as
increase
From census c00, census c99
Where c00.year=2000 and c99.year=1999
And c00.cars > 1.05 * c99.cars
And c00.state = c99.state;
```

  - In XQuery

```
for $s00 in doc("census.xml")//Census[Year=2000]
let $s99 := doc("census.xml")//Census[Year=1999 and
State=$s00/State]
where $s00/Cars > 1.05*$s99/Cars
return <GrowingState>{$s99/State} <Cars Year="2000">
{$s00/Cars/text()}</Cars>
<Cars Year="1999"> {$s99/Cars/text()}</Cars>
<Increase>{$s00/Cars div $s99/Cars}</Increase></GrowingState>
```

Results of Q7



Matching (Regular Expressions) in XQuery

```
let $ss := doc("C:\HZ\Coursework\SMA\2004\XQuery\lab\data\census.xml")
//Census[matches(./State/text(), ".*ss.*")]
for $state in distinct-values($ss/State)
return <State name="{$state}">
{for $y in $ss/Year[../State=$state]
  order by $y descending  return <Year
val="{$y}">
{$ss/Population[(../State=$state and ../Year=$y)]}</Year>}
</State>
```

- Finds all states that have "ss" anywhere in their name …

Resutls:

```
<State name="Massachusetts">
  <Year val="2000">
    <Population>6349</Population>
  </Year>
  <Year val="1999">
    <Population>6175</Population>
  </Year>
  <Year val="1998">
    <Population>6144</Population>
  </Year>
</State> <State name="Mississippi">
  <Year val="2000">
    <Population>2845</Population>
  </Year>
  <Year val="1999">
    <Population>2769</Population>
  </Year>
  <Year val="1998">
    <Population>2751</Population>
  </Year>
  . . .
```

Cameleon and XQuery

- Can use Cameleon web wrapping to dynamically convert HTML web site to appear to be an XMLdocument, then use XQuery to query that document
- Benefits can perform "Joins" between XML and HTML documents.
- Example: Query exchange rate between USD and EUR on 7/4/04:

```
let $d :=
doc("http://interchange.mit.edu/cameleon_sharp/camserv.aspx?query=Select+exchanged%2C+expr
essed%2C+date%2C+rate+From+hzoanda+where+date%3D%2207%2F04%2F2004%22+and+exc
hanged%3D%22USD%22+and+expressed%3D%22EUR%22&amp;format=xml")
return $d//ELEMENT/*
```

Results:

```
<exchanged>USD</exchanged> <expressed>EUR</expressed> <date>07/04/2004</date>
<rate>0.81261</rate>
```

- Of course, this can also be done using Cameleon directly using SQL. (which allows joins among HTML, XML, and relation databases)

Summary

- **Tim Berners-Lee**, W3C Director:
  - "The Web is quickly becoming the world's fastest growing repository of data"
- In past: Primarily processed by humans.
- In future, must be processible by programs (agents for humans)
- Tools, such as MIT's Automatic Web Wrapper and W3C's XML and XQuery, are providing these capabilities.

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