Introduction to XML & MusicXML

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XML Development

- **eXtensible Markup Language**
  - Version 0 :: 1996
  - Version 1.0 :: 1998
  - Version 1.1 :: 2004
  - Version 1.1.5 :: 2008

- Predecessor: SGML (*Standardized Generalized Markup Language*)
  - 1970’s – 1980’s

- Predecessor: GML (*Generalize Markup Language*)
  - 1960’s

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HTML

- 1.0 1991
- 2.0 1995
- 4.0 1997
- 5.0 2008
XML data structure

- XML describes a tree structure:

```
• XML describes a tree structure:

A
 /|
/ \
B C
 /|
/ \
E F
 /|
/ \
G H
```

- Serialization:

```
</A>
</D>
</G>
</H/>
</G>
</D>
</A>

• Equivalent serialization:

```
<A><B/</C><E/>F/</C><D><G><H/></G></D></A>
```
XML data structure

- XML describes a tree structure:

- Same data structure as directories/folders on a hard disk

- Same conceptualization as LISP code:

```
(A B (C E F) (D (G (H))))
```

Only one “root node” allowed in document
XML Terminology

- `<C>...<C>` is an *element* (tree node)
- C is the element’s *name*
- `<C>` is a *start tag*
- `</C>` is an end tag
- `<E/>` and `<F/>` are *element content* of `<C>`
- Plain text inside of an element is *text content*

- `<H/>` is an element without contents (terminal node)
- `<H/>` is equivalent to `<H></H>`
- Start tags must be followed by matching end tag, or the shorthand `<xxx/>` must be used.
Element Attributes

- Elements can contain a list of attributes within the start tag

\[<\text{A} a=\text{“1”} \ b=\text{“two”} \ c=\text{“1 and 2”}>\]

- Element A has three attributes: a, b, and c.
- A is the name of the attribute, 1 is its value.
- Attributes must have values. \(c=\text{“”}\) represents an attribute without a value.
- Attributes are optional (similar to key values in LISP).
- The value of a is 1, the value of b is two and the value of c is 1 and 2.
- XML Attribute values must be enclosed in double or single quotes.
- Only one attribute of a given name allowed. Bad example: \(<\text{A} a=\text{“1”} \ a=\text{“2”}>\)
- Attributes are considered unordered:
  \[<\text{A} a=\text{“1”} \ b=\text{“two”}>\] is identical to \[<\text{A} b=\text{“two”} \ a=\text{“1”}>\]

HTML attributes do not need to be enclosed in quotes:
\[<\text{table cellpadding}=10>\] is equivalent to \[<\text{table cellpadding}=\text{“10”}>\]
XHTML is does not allow the first case since quotes are always needed.
Elements vs. Attributes

- Elements can contain subelements
- Attributes cannot contain subattributes

- Two similar (but not identical) ways of expressing the same data:

```xml
<A a="1" b="two" c="1 and 2"/>

<A>
<a>1</a>
<b>two</b>
<c>1 and 2</c>
</A>
```

Informal shorthand for attribute a of element A (but not in data):

```
A@a
```

- Attribute a in the first example cannot be expanded later into subattributes
- Element a in the second example can be expanded later to include element contents
XML for non-tree structured data

- non-tree data can be shoe-horned into XML data structure

Tree-like portions encoded as XML elements
- Non-tree connections handled by specialized id/idref/idrefs attributes.

DTD:
```xml
<!ATTLIST
B
  id   ID      #IMPLIED
  idref IDREF  #IMPLIED>
```

- Similar to pointers in C.
XML declaration

- Used to indicate that the following data is XML data
- First characters in file must be “<?xml” (see UTF-16 below).

<?xml version="1.0" encoding="UTF-8" standalone="yes"?>

Three attributes which *must* be in this order (but optional):

@version  = version of XML being used (1.0 or 1.1).
@encoding = character set being used in data. (also UTF-16 which requires two endian bytes before opening <?)
  * UTF-8 is backwards compatible with 7-bit ASCII
  * UTF-16 is not.
@standalone = “yes” if no external definition file, “no” if DTD (Document Type Definition).
XML complete data file

<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<A>
  <B idref="e"/>
  <C>
    <E id="e"/>
    <F idref="d"/>
  </C>
  <D id="d">
    <G>
      <H/>
    </G>
  </D>
</A>
Even more complete data file

```xml
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<!DOCTYPE A [  
  <!ELEMENT A (B,C,D)>  
  <!ELEMENT C (E,F)>  
  <!ELEMENT D (G)>  
  <!ELEMENT G (H)>  
  <!ATTLIST B idref IDREF #IMPLIED>  
  <!ATTLIST E id ID #IMPLIED>  
  <!ATTLIST D id ID #IMPLIED>  
]>  
<A>  
  <B idref="e"/>  
  <C>  
    <E id="e"/>  
    <F idref="d"/>  
  </C>  
  <D id="d">  
    <G>  
      <H/>  
    </G>  
  </D>  
</A>
```

Element A can have subelements B, C & D.

Element B can have an attribute named idref which can be set to a value which is the type IDREF.
Data/Structure definition separation

<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<!DOCTYPE A SYSTEM "tree.dtd">
or
<!DOCTYPE A SYSTEM "http://somewhere.com/tree.dtd">
or
<!DOCTYPE A PUBLIC "-//Owner/Class Description//Language//Version" "tree.dtd">

<!ELEMENT A (B,C,D)>  
<!ELEMENT C (E,F)>  
<!ELEMENT D (G)>  
<!ELEMENT G (H)>  

<!ATTLIST B idref IDREF #IMPLIED>  
<!ATTLIST E id ID #IMPLIED>  
<!ATTLIST D id ID #IMPLIED>
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<!DOCTYPE score-partwise PUBLIC "-//Recordare//DTD MusicXML 1.0 Partwise//EN" "http://www.musicxml.org/dtds/1.0/partwise.dtd">
<score-partwise>
  <identification>
    <encoding>
      <software>Finale 2012 for Mac</software>
      <software>Dolet Light for Finale 2012</software>
      <encoding-date>2013-01-21</encoding-date>
    </encoding>
  </identification>
  <part-list>
    <score-part id="P1">
      <part-name>MusicXML Part</part-name>
      <score-instrument id="P1-I1">
        <instrument-name>Garritan: ARIA Player</instrument-name>
      </score-instrument>
      <midi-instrument id="P1-I1">
        <midi-channel>1</midi-channel>
        <midi-bank>15489</midi-bank>
        <midi-program>1</midi-program>
      </midi-instrument>
    </score-part>
  </part-list>
  <![CDATA[ ... ]]>
</score-partwise>
<part id="P1">
  <measure number="1">
    <print/>
    <attributes>
      <divisions>2</divisions>
      <key>
        <fifths>0</fifths>
        <mode>major</mode>
      </key>
      <time>
        <beats>4</beats>
        <beat-type>4</beat-type>
      </time>
      <clef>
        <sign>G</sign>
        <line>2</line>
      </clef>
    </attributes>
    <sound tempo="120"/>
    <note default-x="86">
      <pitch>
        <step>C</step>
        <octave>4</octave>
      </pitch>
      <duration>8</duration>
      <voice>1</voice>
      <type>whole</type>
    </note>
    <barline location="right">
      <style>light-heavy</style>
    </barline>
  </measure>
</part>

Compare to GUIDO:
[c/1]

(GUIDO content not separable from structure)

4 quarter notes
looks like a whole note
Data Interchange

Lamb
MusicXML Note parameters

<note default-x="165.98" default-y="-25.00">
  <pitch>
    <step>A</step>
    <alter>2</alter>
    <octave>4</octave>
  </pitch>
  <duration>1</duration>
  <voice>1</voice>
  <type>16th</type>
  <accidental>double-sharp</accidental>
  <stem>up</stem>
  <beam number="1">end</beam>
  <beam number="2">end</beam>
  <notations>
    <articulations>
      <detached-legato/>
    </articulations>
  </notations>
  <lyric number="1">
    <syllabic>single</syllabic>
    <text>Lamb</text>
  </lyric>
</note>
<note default-x="165.98" default-y="-25.00">
  <pitch>
    <step>A</step>
    <alter>2</alter>
    <octave>4</octave>
  </pitch>
  <duration>1</duration>
  <voice>1</voice>
  <type>16th</type>
  <accidental>double-sharp</accidental>
  <stem>up</stem>
  <beam number="1">end</beam>
  <beam number="2">end</beam>
  <notations>
    <articulations>
      <detached-legato/>
    </articulations>
  </notations>
  <lyric number="1">
    <syllabic>single</syllabic>
    <text>Lamb</text>
  </lyric>
</note>

<note default-x="180">
  <pitch>
    <step>A</step>
    <alter>2</alter>
    <octave>4</octave>
  </pitch>
  <duration>1</duration>
  <voice>1</voice>
  <type>16th</type>
  <accidental>double-sharp</accidental>
  <stem>up</stem>
  <beam number="1">end</beam>
  <beam number="2">end</beam>
  <notations>
    <articulations>
      <detached-legato default-x="1" default-y="-44" placement="below"/>
    </articulations>
  </notations>
  <lyric default-y="-80" number="1">
    <syllabic>single</syllabic>
    <text font-family="FreeSerif" font-size="10.8">Lamb</text>
  </lyric>
</note>