NPFL092 Technology for Natural Language Processing

Introduction to XML

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eXtensible Markup Language

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

<my_courses>

    <course id="NPFL092">
      <name>NLP Technology</name>
      <semester>winter</semester><hours_per_week>1/2</hours_per_week>
      <department>Institute of Formal and Applied Linguistics</department>
      <teachers>
        <teacher>Rudolf Rosa</teacher>
        <teacher>Zdeněk Žabokrtský</teacher>
      </teachers>
    </course>

</my_courses>
```

Outline

- basic properties of XML
- syntactic requirements
- well-formedness vs. validity
- pros and cons

Markup languages

- a markup language - a set of rules for annotating a text (=adding information into it)
- marks must be syntactically distinguishable from the text (hence, some kind of escaping is always needed)
- markup can specify a formatting of text segments, or their meaning (semantics), or both
- a markup language can be line oriented or not
- typically at least partially "recursive" (a CFG is needed for parsing it)

History

- markup used since 1960s
  - markup = inserted marks into a plain-text document
  - e.g. for formatting purposes (e.g. TEXin (1977
- 1969 – GML – Generalized Markup Language
  - Goldfarb, Mosher and Lorie, legal texts for IBM
- 1986 – SGML – Standard Generalized Markup Language, ISO 8879
  - too complicated!
- 1992 – HTML (Hypertext Markup Language)
  - only basics from SGML, very simple
- 1996 – W3C new directions for a new markup language specified, major design decisions
- 1998 – XML 1.0
- 2004 – XML 1.1, only tiny changes, XML 2.0 not under serious consideration now

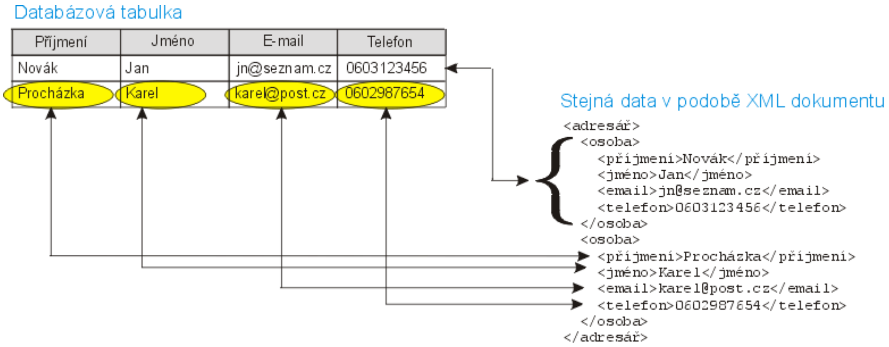
eXtensible Markup Language

- Language – a convention capturing a certain subset of Σ^*; it can be decided whether a string does or doesn't belong to the language,
- Markup – additional information inserted into the text in a form of textual marks, which are, however, distinguishable from the text itself.
- eXtensible – complexity can be scaled up according to your needs (as opposed to, e.g., HTML or markdown, whose mark inventories cannot be changed by users)

Advantages of XML

- open file format, specification for free from W3C (as opposed to some proprietary file formats of database engines or text editors)
- easily understandable, self-documented files
- text-oriented – no specialized tools required, abundance of text editors
- possibly more semantic information content (compared e.g. to formatting markups - e.g. "use a 14pt font for this" vs "this is a subsection heading")
- easily convertible to other formats
- easy and efficient parsing / structure checking
- support for referencing

Relational Databases vs. XML



Databázová tabulka

Příjmení	Jméno	E-mail	Telefon
Novák	Jan	jn@seznam.cz	0603123456
Procházka	Karel	karel@post.cz	0602987654

Stejná data v podobě XML dokumentu

```
<adresář>
  <osoba>
    <příjmení>Novák</příjmení>
    <jméno>Jan</jméno>
    <email>jn@seznam.cz</email>
    <telefon>0603123456</telefon>
  </osoba>
  <osoba>
    <příjmení>Procházka</příjmení>
    <jméno>Karel</jméno>
    <email>karel@post.cz</email>
    <telefon>0602987654</telefon>
  </osoba>
</adresář>
```

Credit: kosek.cz

Relational Databases vs. XML

Relational databases

- basic data unit – a table consisting of tuples of values for pre-defined “fields”
- tables could be interlinked
- binary file format highly dependent on particular software
- emphasis on computational efficiency (indexing)

XML

- hierarchical (tree-shaped) data structure
- inherent linear ordering
- self-documented file format independent of implementation of software
- no big concerns with efficiency (however, given the tree-shaped prior, some solutions are better than others)

XML: quick syntax tour

Basic notions:

- **XML document** is a text file in the XML format.
- Documents consists of nested **elements**.
- Boundaries of an element given by a **start tag** and an **end tags**.
- Another information associated with an element can be stored in **element attributes**.

```
<?xml version="1.0" encoding="UTF-8"?>
<my_courses>
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      <name>NLP Technology</name>
      <semester>winter</semester><hours_per_week>1/2</hours_per_week>
      <department>Institute of Formal and Applied Linguistics</department>
      <teachers>
        <teacher>Rudolf Rosa</teacher>
        <teacher>Zdeněk Žabokrtský</teacher>
      </teachers>
    </course>
</my_courses>
```

XML: quick syntax tour (2)

- Tags:
  - Start tag `<element_name>`
  - End tag `</element_name>`
  - Empty `element <element_name/>`
- Elements can be embedded, but they cannot cross $\rightarrow$ XML document $=$ tree of elements
- There must be exactly one root element.
- Special symbols $<$ and $>$ must be encoded using entities (“escape sequences”) &lt; and &gt; , & $\rightarrow$ &amp;
- Attribute values must be enclosed in quotes or apostrophes; (another needed entities: &quot; and &apos;)

Time for a question

- What is the shortest length of an XML file?

XML: quick syntax tour (3)

- XML document can contain instructions for xml processor
- the most frequent instruction – a declaration header:

```
<?xml version="1.0" encoding="utf-8" ?>
```

- document type declaration:

```
<!DOCTYPE MojeKniha SYSTEM "MojeKniha.DTD">
```

- Comments (not allowed inside tags, cannot contain –)

```
<!-- bla bla bla -->
```

- If the document conforms to all syntactic requirements: a **well-formed** XML document
- Well-formedness does not say anything about the content (element and attribute names, the way how elements are embedded...)
- Checking the well-formedness using the Unix command line:

```
> xmllint --noout my-xml-file.xml
```

Time for an exercise

- Use a text editor for creating an XML file, then check whether it is well formed.

Need to describe the content formally too?

- well-formedness – only conforming the basic XML syntactic rules, nothing about the content structure
- but what if you need to specify the structure
- several solutions available
    - DTD – Document Type Definition
    - other XML schema languages such as RELAX NG (REgular LAnguage for XML Next Generation) or XSD (XML Schema Definition)

DTD – Document Type Definition

DTD

- Came from SGML
- Formal set of rules for describing document structure
- Declares element names, their embeding, attribute names and values...
- example: a document consisting of a sequence of chapters, each chapter contains a title and a sequence of sections, sections contain paragraphs...

DTD location

- external DTD – a stand-off file
- internal DTD – inside the XML document

DTD Validation

- the process of checking whether a document fulfills the DTD requirements
- if OK: the document is **valid with respect to the given DTD**
- of course, only a well-formed document can be valid
- checking the validity from the command line:

```
> xmllint --noout --dtdvalid my-dtd-file.dtd  my-xml-file.xml
```

- an unfortunate terminological confusion: you can often see the term ‘validation’ or ‘validator’ used in the sense of well-formedness checking/checker

DTD structure

- Four types of declarations
- Declaration of elements <!ELEMENT ...>
- Declaration of attributes <!ATTLIST ...>
- Declaration of entities
- Declaration of notations

Declaration of elements

- Syntax: <!ELEMENT name content>
- A name must start with a letter, can contain numbers and some special symbols .-_:
- Empty element: <!ELEMENT název EMPTY>
- Element without content limitations: <!ELEMENT název ANY>

Declaration of elements (2)

- Text containing elements
  - Reserved name PCDATA (Parseable Character DATA)
  - Example: <!ELEMENT title (#PCDATA)>
- Element content description – regular expressions
- Sequence connector ,
- Alternative connector |
- Quantity ? + *
- Mixed content example: <!ELEMENT emph (#PCDATA|sub|super)* >

Declaration of attributes

- Syntax: <!ATTLIST element_name declaration_of_attributes>
- declaration of an attribute
    - attribute name
    - attribute type
    - default value (optional)
- example: <!ATTLIST author firstname CDATA surname CDATA>

Declaration of attributes (2)

- Selected types of attribute content:
  - CDATA – the value is character data
  - ID – the value is a unique id
  - IDREF – the value is the id of another element
  - IDREFS – the value is a list of other ids
  - NMTOKEN – the value is a valid XML name
  - ...
- Some optional information can be given after the type:
  - #REQUIRED – the attribute is required
  - ...

A DTD example (credit: w3schools.com)

```
<!DOCTYPE TVSCHEDULE [

<!ELEMENT TVSCHEDULE (CHANNEL+)>
<!ELEMENT CHANNEL (BANNER,DAY+)>
<!ELEMENT BANNER (#PCDATA)>
<!ELEMENT DAY (DATE,(HOLIDAY|PROGRAMSLOT+)+)>
<!ELEMENT HOLIDAY (#PCDATA)>
<!ELEMENT DATE (#PCDATA)>
<!ELEMENT PROGRAMSLOT (TIME,TITLE,DESCRIPTION?)>
<!ELEMENT TIME (#PCDATA)>
<!ELEMENT TITLE (#PCDATA)>
<!ELEMENT DESCRIPTION (#PCDATA)>

<!ATTLIST TVSCHEDULE NAME CDATA #REQUIRED>
<!ATTLIST CHANNEL CHAN CDATA #REQUIRED>
<!ATTLIST PROGRAMSLOT VTR CDATA #IMPLIED>
<!ATTLIST TITLE RATING CDATA #IMPLIED>
<!ATTLIST TITLE LANGUAGE CDATA #IMPLIED>
]>
```

An external DTD

- a separate file,
- could be referred from an XML file using a processing instruction:

```
<!DOCTYPE nameofmyrootelement SYSTEM "mydtdfile.dtd">
```

- DTD example (credit: w3schools.com):

```
<!ELEMENT note (to,from,heading,body)>
<!ELEMENT to (#PCDATA)>
<!ELEMENT from (#PCDATA)>
<!ELEMENT heading (#PCDATA)>
<!ELEMENT body (#PCDATA)>
```

An internal DTD included inside XML file (credit: w3schools.com)

- included into an XML file
- Example (credit: w3schools.com):

```
 <?xml version="1.0"?>
<!DOCTYPE note [
<!ELEMENT note (to,from,heading,body)>
<!ELEMENT to (#PCDATA)>
<!ELEMENT from (#PCDATA)>
<!ELEMENT heading (#PCDATA)>
<!ELEMENT body (#PCDATA)>
]>
<note><to>Tove</to><from>Jani</from>
<heading>Reminder</heading>
<body>Don't forget me this weekend</body>
</note>
```

Time for a question

- When would you prefer to store DTD internally and when externally?

DTD pros and cons

- positive: very simple, concise syntax
- negative: a DTD itself is not an XML file
- negative: DTD much less expressive compared to e.g. to XML Schema

Time for an exercise

- What can go wrong with an XML file if you check its well-formedness and validity. How would you check whether the requirements are fulfilled?

Criticism of XML

- quite verbose (well, you can always compress your XML files, but still)
- computationally demanding when it comes to huge data and/or limited hardware capacity
- relatively complex
- redundant
- simpler and less lengthy alternatives are popular now now such as
    - JSON – suitable for interchange of structure data
    - markdown – for textual documents with simple structure

Summary

1. XML = an easy-to-process file format
2. platform-independent
3. self-documented structure (if properly-designed)
4. thus excellent for data exchange
5. createable using any text editor, readable by naked eye
6. tree-shaped logical skeleton
7. open specification, no specialized software needed
8. a bit too verbose, not optimal if speed is an issue
9. standard libraries existing in most programming languages (next week)

https://ufal.cz/courses/npfl092