Werkzeuge der Informatik
XML - Extensible Markup Language

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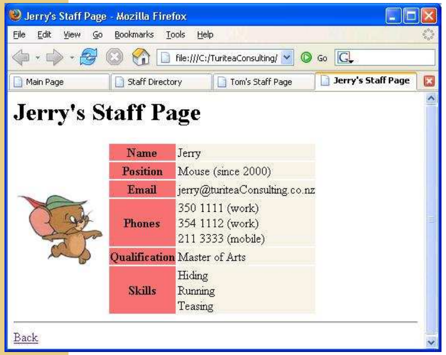
XML Data

- A semi-structured data tuple (and a possible visualisation through a web browser):

```
⟨Employee⟩
  ⟨Name⟩Jerry⟨/Name⟩
  ⟨Position⟩Mouse⟨/Position⟩
  ⟨Email⟩jerry@turiteaConsulting.co.nz⟨/Email⟩
  ⟨Phones⟩
    ⟨Phone⟩350 1111⟨/Phone⟩
    ⟨Phone⟩354 1112⟨/Phone⟩
    ⟨Phone⟩211 3333⟨/Phone⟩
  ⟨/Phones⟩
  ⟨Qualification⟩Master of Arts⟨/Qualification⟩
  ⟨Skills⟩
    ⟨Skill⟩Hiding⟨/Skill⟩
    ⟨Skill⟩Running⟨/Skill⟩
    ⟨Skill⟩Teasing⟨/Skill⟩
  ⟨/Skills⟩
  ⟨Photo⟩figures/jerry.jpg⟨/Photo⟩
⟨/Employee⟩
```



Jerry's Staff Page - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
file:///C:/TuriteaConsulting/
Go
Main Page
Staff Directory
Tom's Staff Page
Jerry's Staff Page

Jerry's Staff Page

Name	Jerry
Position	Mouse (since 2000)
Email	jerry@turiteaConsulting.co.nz
Phones	350 1111 (work) 354 1112 (work) 211 3333 (mobile)
Qualification	Master of Arts
Skills	Hiding Running Teasing

Back

XML Elements

- XML stands for *Extensible Markup Language*,
  describing data with XML is sometimes called *XML-ification*
- We have chosen *markup tags* to specify the logical structure of the data
  - the staff details of an employee consist of a name, a position, etc.
  - hence we have chosen the corresponding tags to markup the respective data items
- The essential information is the text between the tags, while the tags represent *meta-information* that helps to understand the text
- Any piece of XML code is called an *XML fragment*
  - however, there are certain rules for forming XML code
- Markup tags usually come in pairs and markup *XML elements*, such as

```
⟨Skill⟩Hiding⟨/Skill⟩
```

  - herein, ⟨Skill⟩ is the *start tag*, and ⟨/Skill⟩ the *end tag*
  - the text in between is the *content* of the XML element

XML Elements

- The content of an XML element might be
  - pure text
  - a mixture of pure text and markup
  - further XML elements
  - nothing
- XML elements may be *nested* into one another, such as

```
⟨Phones⟩
  ⟨Phone⟩350 1111⟨/Phone⟩
  ⟨Phone⟩354 1112⟨/Phone⟩
  ⟨Phone⟩211 3333⟨/Phone⟩
⟨/Phones⟩
```

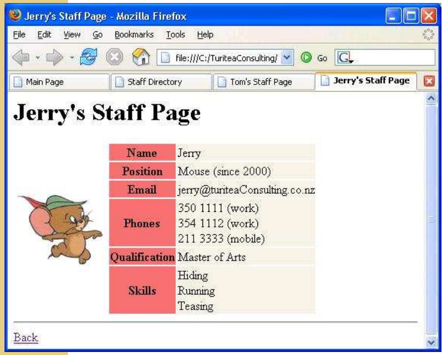
- An XML element without content is called an *empty XML element*
  - in this case, we use only a single markup tag, such as

```
⟨Retired/⟩
```

Attributes of XML Elements

- An XML element may have *attributes* to capture further properties
  - they are stored as *attribute-value pairs* in the start tag

```
⟨Employee⟩
  ⟨Name⟩Jerry⟨/Name⟩
  ⟨Position Since="2000"⟩Mouse⟨/Position⟩
  ⟨Email⟩jerry@turiteaConsulting.co.nz⟨/Email⟩
  ⟨Phones⟩
    ⟨Phone Kind="work"⟩350 1111⟨/Phone⟩
    ⟨Phone Kind="work"⟩354 1112⟨/Phone⟩
    ⟨Phone Kind="mobile"⟩211 3333⟨/Phone⟩
  ⟨/Phones⟩
  ⟨Qualification⟩Master of Arts⟨/Qualification⟩
  ⟨Skills⟩
    ⟨Skill⟩Hiding⟨/Skill⟩
    ⟨Skill⟩Running⟨/Skill⟩
    ⟨Skill⟩Teasing⟨/Skill⟩
  ⟨/Skills⟩
  ⟨Photo⟩figures/jerry.jpg⟨/Photo⟩
⟨/Employee⟩
```


Jerry's Staff Page - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
file:///C:/TuriteaConsulting/
Go
Main Page
Staff Directory
Tom's Staff Page
Jerry's Staff Page
Back

Jerry's Staff Page

Name	Jerry
Position	Mouse (since 2000)
Email	jerry@turiteaConsulting.co.nz
Phones	350 1111 (work) 354 1112 (work) 211 3333 (mobile)
Qualification	Master of Arts
Skills	Hiding Running Teasing

XML Documents

- XML code is stored in *XML documents*
- An XML document consists of three parts:
  - its XML declaration
  - its processing instructions
  - its root element
- An XML document must have a root element, while XML declaration and the processing instructions are optional
- Usually, the *XML declaration* looks as follows:

```
⟨?xml version="1.0" encoding="UTF-8"?⟩
```

  - it indicates the version of XML being used, here 1.0
  - and it states in which encoding the document is written
- The *processing instructions* could be declarations of style sheets, etc.
- For the *root element*, just choose a name and form it like any other XML element:

```
⟨DB⟩...⟨/DB⟩
```

XML Documents

- An XML document must be *well-formed*, that is,
  - there is exactly one root element
  - start and end tags must match
  - start and end tags must nest properly

  - The following XML fragments are not well-formed:

```
⟨apple⟩⟨/pear⟩
```

```
⟨apple⟩⟨pear⟩⟨/apple⟩⟨/pear⟩
```

- XML is case-sensitive (this is different from HTML)
  - The following XML fragment is not well-formed:

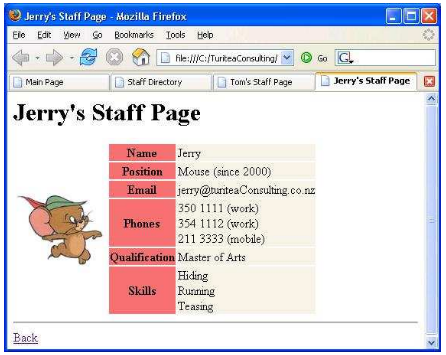
```
⟨Apple⟩⟨/apple⟩
```

- In future, whenever we talk about an XML document, we mean a well-formed one

XML Repositories

```
⟨?xml version="1.0" encoding="UTF-8"?⟩
⟨Employee⟩
  ⟨Name⟩Jerry⟨/Name⟩
  ⟨Position Since="2000"⟩Mouse⟨/Position⟩
  ⟨Email⟩jerry@turiteaConsulting.co.nz⟨/Email⟩
  ⟨Phones⟩
    ⟨Phone Kind="work"⟩350 1111⟨/Phone⟩
    ⟨Phone Kind="work"⟩354 1112⟨/Phone⟩
    ⟨Phone Kind="mobile"⟩211 3333⟨/Phone⟩
  ⟨/Phones⟩
  ⟨Qualification⟩Master of Arts⟨/Qualification⟩
  ⟨Skills⟩
    ⟨Skill⟩Hiding⟨/Skill⟩
    ⟨Skill⟩Running⟨/Skill⟩
    ⟨Skill⟩Teasing⟨/Skill⟩
  ⟨/Skills⟩
  ⟨Photo⟩figures/jerry.jpg⟨/Photo⟩
⟨/Employee⟩
```

- Store the XML element Employee in an XML document (**jerry.xml**)


Jerry's Staff Page - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
file:///C:/TuriteaConsulting/
Go
Main Page
Staff Directory
Tom's Staff Page
Jerry's Staff Page
Back

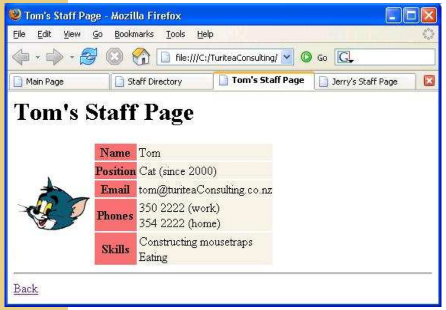
Jerry's Staff Page

Name	Jerry
Position	Mouse (since 2000)
Email	jerry@turiteaConsulting.co.nz
Phones	350 1111 (work) 354 1112 (work) 211 3333 (mobile)
Qualification	Master of Arts
Skills	Hiding Running Teasing

- Similarly, create an XML document for each staff member

XML Repositories

```
⟨?xml version="1.0" encoding="UTF-8"?⟩
⟨Employee⟩
  ⟨Name⟩Tom⟨/Name⟩
  ⟨Position Since="2000"⟩Cat⟨/Position⟩
  ⟨Email⟩tom@turiteaConsulting.co.nz⟨/Email⟩
  ⟨Phones⟩
    ⟨Phone Kind="work"⟩350 2222⟨/Phone⟩
    ⟨Phone Kind="home"⟩354 2222⟨/Phone⟩
  ⟨/Phones⟩
  ⟨Skills⟩
    ⟨Skill⟩Constructing mousetraps⟨/Skill⟩
    ⟨Skill⟩Eating⟨/Skill⟩
  ⟨/Skills⟩
  ⟨Photo⟩figures/tom.gif⟨/Photo⟩
⟨/Employee⟩
```


Tom's Staff Page - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
file:///C:/TuriteaConsulting/
Go
Main Page
Staff Directory
Tom's Staff Page
Jerry's Staff Page

Tom's Staff Page

Name	Tom
Position	Cat (since 2000)
Email	tom@turiteaConsulting.co.nz
Phones	350 2222 (work) 354 2222 (home)
Skills	Constructing mousetraps Eating

Back

- An *XML repository* is a collection of XML documents (that are somehow related)

Describing Data Types

- We observe:
  - there are lots of employees having different staff details, but in all cases the structure of their staff details looks similar
  - classification abstraction means to describe the common structure
  - we aim to describe the common *data type* (as far as possible)
  - then, this data type can serve as a schema for the XML data tuples, which will be *instances* of the data type
- After analysing the structure of the Employee elements, we declare:

  ⟨!ELEMENT Employee (Name, Position, Email, Phones, Qualification, Skills, Photo)⟩

  - this may serve as a common data model for all staff
- We observe:
  - this is a complex data type, so we also need to declare data types for Names, Positions, etc.
  - Qualification is only optional, so we need to indicate this

XML Element Declarations

- An *element declaration* has the general form:

  ⟨!ELEMENT `element-name content-model`⟩

- The *element name* is the name inside the start and end tag
  - it must be a valid XML name, that is,
    - start with an alphabetical character or an underscore _
    - but not with the string "xml"
    - it may contain any alphanumerical character or _ or - or .
    - but no blanks, no reserved symbols such as ⟨ or ⟩ or & or "
- The *content model* specifies what may occur between the start and end tag:
  - pure text
  - anything (any mixture of pure text and markup)
  - further XML elements
  - nothing

XML Element Declaration

- We use ⟨!ELEMENT `element-name (#PCDATA)`⟩ if the content is pure text
  - `#PCDATA` stands for parsed, or better, parsable character data
- We use ⟨!ELEMENT `element-name ANY`⟩ if the content may be anything
  - this is very convenient, but not very informative . . .
- We use ⟨!ELEMENT `element-name EMPTY`⟩ if there is no content
  - but wait, till we can add attributes . . .
- We use ⟨!ELEMENT `element-name child-elements`⟩ if the content are further XML elements
  - these elements are referred to as *child elements* or *children*
  - as an example, we recall our data type for the staff details:

  ⟨!ELEMENT Employee (Name, Position, Email, Phones, Qualification, Skills, Photo)⟩

Declaring Child Elements

- Recall, that we need to indicate that Qualification is an optional child

- We use regular expressions to describe the permitted combinations of child elements

  ⟨!ELEMENT `element-name reg-expression`⟩

- Regular expressions can be build as follows:
  - start with `#PCDATA`, `EMPTY` or any valid XML names
  - form sequences
  - form alterations
  - indicate optionality
  - indicate iteration
  - indicate non-empty iteration
  - add braces

- In practise, the regular expressions used for XML elements are often rather simple

Declaring Child Elements

- Here are some easy-to-follow rules of thumb:
  - To describe a sequence of elements of types child$_1$,. . . , child$_n$, use

    ⟨!ELEMENT element-name (child$_1$, . . . , child$_n$)⟩

  - To describe the alternative of elements of types child$_1$,. . . , child$_n$, use

    ⟨!ELEMENT element-name (child$_1$ | · · · | child$_n$)⟩

  - To indicate an *option*, attach a **?** to one or more child elements
    - such an element may or may not appear
  - To indicate an *iteration*, attach a ***** to one or more child elements
    - such an element may occur a finite number of times (or not at all)
  - To indicate a *non-empty iteration*, attach a **+** to one or more child elements
    - such an element may occur a non-zero, finite number of times

Our Example

- We indicate that Qualification is only optional:

  ⟨!ELEMENT Employee (Name, Position, Email, Phones, Qualification$^?$, Skills, Photo)⟩

- We declare data types for the child elements Names, Positions, etc.

  ⟨!ELEMENT Name (#PCDATA)⟩

  ⟨!ELEMENT Position (#PCDATA)⟩

  ⟨!ELEMENT Email (#PCDATA)⟩

  ⟨!ELEMENT Phones (Phone*)⟩

  ⟨!ELEMENT Qualification (#PCDATA)⟩

  ⟨!ELEMENT Skills (Skill*)⟩

  ⟨!ELEMENT Photo (#PCDATA)⟩

- We declare data types for the grand child elements Phone and Skill

  ⟨!ELEMENT Phone (#PCDATA)⟩

  ⟨!ELEMENT Skill (#PCDATA)⟩

Our Example

- We check the suitability of the data type:

```
⟨Employee⟩

  ⟨Name⟩Tom⟨/Name⟩
  ⟨Position Since="2000"⟩Cat⟨/Position⟩
  ⟨Email⟩tom@turiteaConsulting.co.nz⟨/Email⟩
  ⟨Phones⟩
    ⟨Phone Kind="work"⟩350 2222⟨/Phone⟩
    ⟨Phone Kind="home"⟩354 2222⟨/Phone⟩
  ⟨/Phones⟩

  ⟨Skills⟩
    ⟨Skill⟩Constructing mousetraps⟨/Skill⟩
    ⟨Skill⟩Eating⟨/Skill⟩
  ⟨/Skills⟩
  ⟨Photo⟩figures/tom.gif⟨/Photo⟩
⟨/Employee⟩
```

```
⟨!ELEMENT Employee (Name, Position, Email,
    Phones, Qualification?, Skills, Photo)⟩
⟨!ELEMENT Name (#PCDATA)⟩
⟨!ELEMENT Position (#PCDATA)⟩
⟨!ELEMENT Email (#PCDATA)⟩
⟨!ELEMENT Phones (Phone*)⟩
⟨!ELEMENT Phone (#PCDATA)⟩


⟨!ELEMENT Qualification (#PCDATA)⟩
⟨!ELEMENT Skills (Skill*)⟩
⟨!ELEMENT Skill (#PCDATA)⟩


⟨!ELEMENT Photo (#PCDATA)⟩
```

Attribute Declaration

- XML elements can have attributes to capture particular properties of these elements, such as

```
⟨!ATTLIST Position Since CDATA #REQUIRED⟩
```

- An *attribute declaration* has the general form:

```
⟨!ATTLIST element-name attribute-specifications⟩
```

  - the element name specifies the element whose attributes we want to declare
  - the list of attribute specifications contains exactly one for each attribute, each *attribute specification* has the form

```
attribute-name  attribute-type  attribute-constraint
```

  - the *attribute name* is the name chosen for this attribute
    - the attribute name must be a valid XML name (as explained above)
    - naturally, any two attributes of the same element should have distinct names

Attribute Declaration

- There are three kinds of attribute values: strings, enumerated, and tokens

- *Strings:* the attribute's value is a character string
  - we use the simple data type CDATA
  - blanks are allowed
  - any text is allowed except for reserved symbols

- *Enumerated:* the attribute's value must be chosen from a user-specified list

```
⟨!ELEMENT Car EMPTY⟩
⟨!ATTLIST Car Make CDATA #REQUIRED
          Colour CDATA #REQUIRED
          New ( yes | no ) #REQUIRED⟩
```

- *Tokens:* the attribute's value is a special-purpose character string
  - NMTOKEN can be used for a valid XML name
  - ENTITY can be used for a reference to an external file
  - ID, IDREF and IDREFS are explained later on

Attribute Declaration

- The *attribute constraint* is one of
  - #REQUIRED if the attribute must occur in every element
  - #IMPLIED if the attribute is optional
  - a default value for the attribute
  - #FIXED value
  - #CURRENT if the attribute takes the value most recently assigned to this attribute

- For our example
  - we can simply choose:

```
⟨!ATTLIST Position Since CDATA #REQUIRED⟩
⟨!ATTLIST Phone Kind CDATA #IMPLIED⟩
```

  - thus, Since is a compulsory attribute, and Kind is an optional attribute
  - alternatively we could also choose:

```
⟨!ATTLIST Phone Kind (work | home | mobile) #IMPLIED⟩
```

Our Example

- We check the suitability of the data type again:

```
⟨Employee⟩

  ⟨Name⟩Tom⟨/Name⟩
  ⟨Position Since="2000"⟩Cat⟨/Position⟩

  ⟨Email⟩tom@turiteaConsulting.co.nz⟨/Email⟩
  ⟨Phones⟩
    ⟨Phone Kind="work"⟩350 2222⟨/Phone⟩
    ⟨Phone Kind="home"⟩354 2222⟨/Phone⟩
  ⟨/Phones⟩

  ⟨Skills⟩
    ⟨Skill⟩Constructing mousetraps⟨/Skill⟩
    ⟨Skill⟩Eating⟨/Skill⟩
  ⟨/Skills⟩
  ⟨Photo⟩figures/tom.gif⟨/Photo⟩
⟨/Employee⟩
```

```
⟨!ELEMENT Employee (Name, Position, Email,
    Phones, Qualification?, Skills, Photo)⟩
⟨!ELEMENT Name (#PCDATA)⟩
⟨!ELEMENT Position (#PCDATA)⟩
⟨!ATTLIST Position Since CDATA #REQUIRED⟩
⟨!ELEMENT Email (#PCDATA)⟩
⟨!ELEMENT Phones (Phone*)⟩
⟨!ELEMENT Phone (#PCDATA)⟩
⟨!ATTLIST Phone Kind CDATA #IMPLIED⟩

⟨!ELEMENT Qualification (#PCDATA)⟩
⟨!ELEMENT Skills (Skill*)⟩
⟨!ELEMENT Skill (#PCDATA)⟩


⟨!ELEMENT Photo (#PCDATA)⟩
```

Document Type Definitions

- We store all the XML element declarations and their attribute declarations in a separate document (**staff.dtd**)

```
⟨!ELEMENT Employee (Name, Position, Email, Phones, Qualification?, Skills, Photo)⟩
⟨!ELEMENT Name (#PCDATA)⟩
⟨!ELEMENT Position (#PCDATA)⟩
⟨!ELEMENT Email (#PCDATA)⟩
⟨!ELEMENT Phones (Phone*)⟩
⟨!ELEMENT Phone (#PCDATA)⟩
⟨!ELEMENT Qualification (#PCDATA)⟩
⟨!ELEMENT Skills (Skill*)⟩
⟨!ELEMENT Skill (#PCDATA)⟩
⟨!ELEMENT Photo (#PCDATA)⟩
⟨!ATTLIST Position Since CDATA #REQUIRED⟩
⟨!ATTLIST Phone Kind CDATA #IMPLIED⟩
```

- We observe:
  - this document is called a *Document Type Definition* or *DTD*, for short
  - this is not XML code, hence a DTD is not an XML document
  - we used the DTD language as a separate language for describing data types

Document Type Definitions

- Finally, we need to link the DTD and the respective XML documents together
  - an DTD contains a data type
  - an XML document contains an instance of the data type
  - usually, there are many XML documents that correspond to a single DTD
- Add an document type declaration after the XML declaration in an XML document

```
⟨!DOCTYPE Employee SYSTEM "staff.dtd"⟩
```

- In general, the *document type declaration* has the form

```
⟨!DOCTYPE root-name SYSTEM uri⟩
```

  - the root name is the name of the root element in the XML documents
  - the URI is the uniform resource identifier of the DTD (usually the file name)
- Alternatively, one can include the entire DTD into the XML document

```
⟨!DOCTYPE root-name [. . . here goes the DTD . . .]⟩
```

  - but this is not recommended for an XML repository where several XML documents share a DTD

Validation of XML Documents

- An XML document is said to be
  - be *well-formed* if has a unique, well-formed root element
  - *conforms* to a DTD if the DTD adequately describes its root element
  - be *valid* if it is linked to DTD and conforms to this DTD
- An XML document is a text file, so any text editor can be used for editing it . . .
- However, to validate it, we can use an *XML parser*:
  - ensure that all required XML elements are present
  - prevent undefined XML elements from being used
  - specify the use of attributes of XML elements and define their permitted values
- To create XML documents and data models for them (such as DTDs) we run through a data modelling process:
  - layout analysis and data access, knowledge integration, and content extraction,
  - structure analysis (recognition, visualisation, representation) of all elements,
  - testing an XML document whether it is well-formed and valid

XML Data Modelling

- Some features of XML are especially attractive for data modelling:
  - an XML document (considered as a complex data tuple) does not necessarily have a data model (such as a DTD)
  - in case it has one, we can prescribe/control the structure to exactly the extent we want to
  - but still, its structure may depart form that specified in that data model
  - the element names used for XML elements make XML documents self-explanatory
- In addition to the DTD language there are exist several popular languages for describing XML data types
  - examples are XML Schema, Relax NG, DSD2, tree grammars
  - overcome some known limitations of the DTD language
  - provide more data modelling features than the DTD language
  - comparing their expressiveness is an important topic in research
  - graphical languages like the XML tree model are popular, too

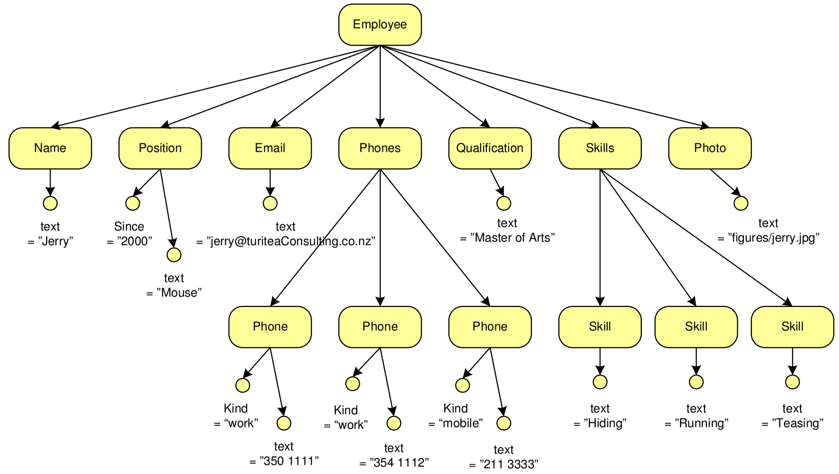
Who owns XML?

- Well, the *World Wide Web Consortium (W3C)* . . . (though not really)
- W3C develops Web standards and guidelines (*W3C Recommendations*)
  - publishes open (non-proprietary) standards for Web languages
  - more than 90 standards since 1994
  - its mission is to lead the Web to its full potential by developing protocols and guidelines that ensure long-term growth for the Web
  - provides an open forum for discussion about the Web
- The goal is *Web interoperability*:
  - the most fundamental Web technologies must be compatible with one another and allow any hardware and software used to access the Web to work together
  - avoid market fragmentation and thus Web fragmentation
- W3C operations are
  - supported by more than 400 members worldwide (vendors, universities, etc.)
  - financed by member fees, research grants, public and private funding
  - run by about 70 full-time staff
  - administered by the MIT CS&AI Lab (CSAIL), the European Research Consortium for Informatics and Mathematics (ERCIM), and Keio University

W3C Activities

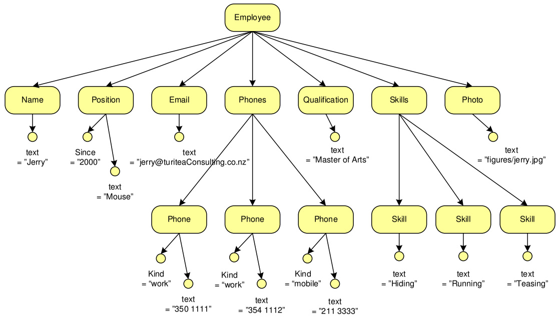
- Researchers can participate in the W3C activities
- W3C currently hosts 23 registered activities on:
  - web architecture: DOM, XML, Internationalisation, URI, Web Services
  - interaction: Graphics, HTML, Math, Rich Web Client, Style, XForms, Sync Multimedia
  - quality assurance: Quality Assurance, Incubator
  - technology and society: Patent Policy, Privacy, Semantic Web
  - ubiquitous web: Device Independence, Mobile Web, Multi-modal Interaction, Voice Browser
  - web accessibility: International Program Office, Technical Issues
- Activities are organised into groups:
  - Working Groups (WG) for technical developments
  - Interest Groups (IG) for strategy discussions
  - Coordination Groups (CG) for communication among related groups
- For the XML activity there are currently 9 groups:
  - XML Core WG, XML Processing WG, XML Query WG, XML Schema WG, XSL WG, Efficient XML Interchange WG, XML Plenary IG, XML Schema IG, XML CG

XML Trees



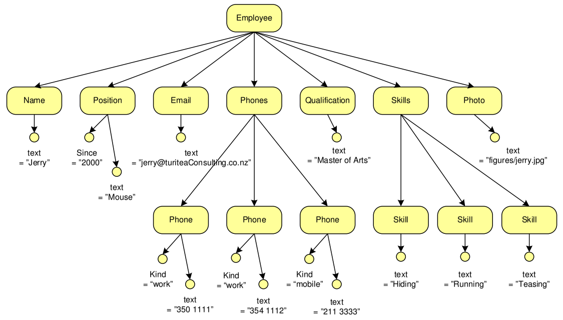
- XML elements may be visualised as XML trees
- This helps to imagine the hierarchical structure of XML elements

Nodes of XML Trees



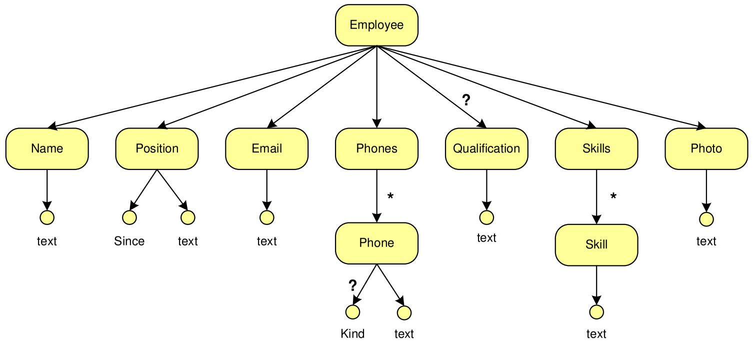
- *Element nodes* are visualised as boxes
  - they represent XML elements
- *Attribute nodes* are visualised as circles
  - they represent attributes of XML elements
- *Text nodes* are visualised as circles, too
  - they represent pure text content of XML elements

Edges of XML Trees



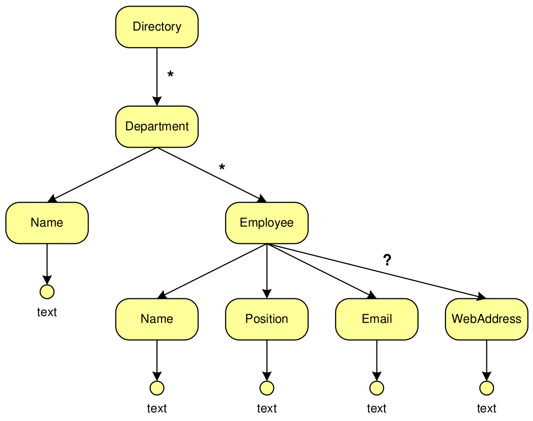
- *Edges* connect the node for an XML element to the nodes for its attributes, its child elements and its pure text content
- The top-most element node is the node of the root element or *root node*, for short
- Nodes without outgoing edges (attribute nodes, text nodes, empty element nodes) are *leaves*
  - well, yes, XML trees stand upside-down

XML Trees and Data Types



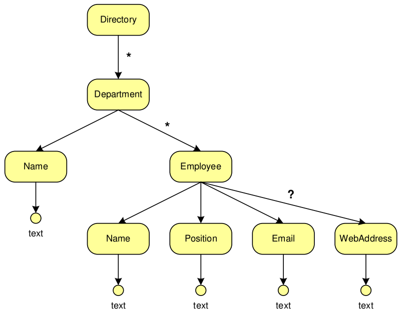
- XML trees can also be used to visualise data types
  - edges can be marked with ?, $*$ or $+$ to visualise optionality, iteration or non-empty iteration
- It is often convenient to draw an XML tree first before writing down a DTD
  - XML trees provide a rather intuitive way towards data modelling for XML

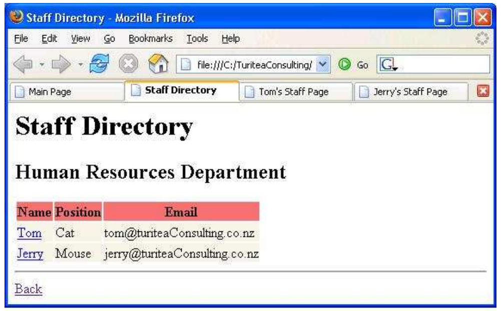
An Example



- We create a data type for a staff directory
  - we chose element types Directory, Department, Employee and a few others
  - this time we assemble less staff details in the Employee type
  - however, we include a new (optional) child WebAddress

Translating XML Trees into DTDs




Staff Directory - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
file:///C:/TuriteaConsulting/
Go
Main Page
Staff Directory
Tom's Staff Page
Jerry's Staff Page

Staff Directory

Human Resources Department

Name	Position	Email
Tom	Cat	tom@turiteaConsulting.co.nz
Jerry	Mouse	jerry@turiteaConsulting.co.nz

Back

- Now we translate the XML tree for the Directory type to the DTD language:

⟨!ELEMENT Directory (Department*)⟩
⟨!ELEMENT Department (Name, Employee*)⟩
⟨!ELEMENT Employee (Name, Position, Email, WebAddress$^?$)⟩
⟨!ELEMENT Name (#PCDATA)⟩
⟨!ELEMENT Position (#PCDATA)⟩
⟨!ELEMENT Email (#PCDATA)⟩
⟨!ELEMENT WebAddress (#PCDATA)⟩