

SHOE (Simple HTML Ontology Extension)

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 - Superset of HTML
 - To specify ontologies for Internet-agents
 - Annotate web documents semantically with machine-readable knowledge
 - Compatible to SGML and XML
- **The SHOE specification allows the construction of ontologies supporting:**
 - Concept hierarchies as in terminological logics (KL-One derivatives)
 - Multiple Inheritance
 - Typed relations between concepts (like: roles in KL-One derivatives)
 - Inference using Horn-Clauses
 - Inheritance and usage of existing ontologies

SHOE (Simple HTML Ontology Extension)

SHOE uses the following additional tags as an extension to HTML:

For the definition of ontologies:

ONTOLOGY, /ONTOLOGY, USE-ONTOLOGY, DEF-CATEGORY,
DEF-RELATION, /DEF-RELATION, DEF-ARG, DEF-RENAME,
DEF-CONSTANT, DEF-TYPE, DEF-INFERENCE, /DEF-INFERENCE,
INF-IF, /INF-IF, INF-THEN, /INF-THEN, COMPARISON,
/COMPARISON, CATEGORY, RELATION, /RELATION, ARG.

For the annotation of HTML-pages additionally:

INSTANCE, /INSTANCE.

SHOE: Example of an ontology representing computer science departments

<HTML>

<HEAD>

Indication that this document is conformant with SHOE 1.0

```
<META HTTP-EQUIV="SHOE" CONTENT="VERSION=1.0">
```

```
<TITLE> Our CS Ontology </TITLE>
```

```
</HEAD>
```

<BODY>

Declaration of the ontology's name and version

```
<ONTOLOGY ID="cs-dept-ontology" VERSION="1.0">
```

Declaration to use another yet existing ontology

```
<USE-ONTOLOGY ID="base-ontology" VERSION="1.0" PREFIX="base"  
  URL="http://www.cs.umd.edu/projects/plus/SHOE/base.html">
```

The prefix “**base**” is used to indicate explicit references to elements of the imported base ontology.

SHOE: Example of an ontology representing computer science departments

Based on the subsumption-relation „ISA“ an inheritance hierarchy is constructed.

SHOEEntity is the accepted „root“-category for all categories declared in every ontology constructed.

```
<DEF-CATEGORY NAME="Organization" ISA="base.SHOEEntity">
<DEF-CATEGORY NAME="Person" ISA="base.SHOEEntity">
<DEF-CATEGORY NAME="Publication" ISA="base.SHOEEntity">
<DEF-CATEGORY NAME="ResearchGroup" ISA="Organization">
<DEF-CATEGORY NAME="Department" ISA="Organization">
<DEF-CATEGORY NAME="Worker" ISA="Person">
<DEF-CATEGORY NAME="FacultyMember" ISA="Worker">
<DEF-CATEGORY NAME="Assistant" ISA="Worker">
<DEF-CATEGORY NAME="AdministrativeStaff" ISA="Worker">
```

SHOE: Example of an ontology representing computer science departments

```
<DEF-CATEGORY NAME="Student" ISA="Person">
<DEF-CATEGORY NAME="PostDoc" ISA="FacultyMember">
<DEF-CATEGORY NAME="Lecturer" ISA="FacultyMember">
<DEF-CATEGORY NAME="Professor" ISA="FacultyMember">
<DEF-CATEGORY NAME="ResearchAssistant" ISA="Assistant">
<DEF-CATEGORY NAME="TeachingAssistant" ISA="Assistant">
<DEF-CATEGORY NAME="GraduateStudent" ISA="Student">
<DEF-CATEGORY NAME="UndergraduateStudent" ISA="Student">
<DEF-CATEGORY NAME="Secretary" ISA="AdministrativeStaff">
```

Multiple inheritance is also possible:

```
<DEF-CATEGORY NAME="Chair" ISA="AdministrativeStaff
Professor">
```

SHOE: Example of an ontology representing computer science departments

Definition of relationships between typed concepts:

```
<DEF-RELATION NAME="advisor">
  <DEF-ARG POS="1" TYPE="Student">
  <DEF-ARG POS="2" TYPE="Professor">
</DEF-RELATION>
<DEF-RELATION NAME="member">
  <DEF-ARG POS="1" TYPE="Organization">
  <DEF-ARG POS="2" TYPE="Person">
</DEF-RELATION>
<DEF-RELATION NAME="publicationAuthor">
  <DEF-ARG POS="1" TYPE="Publication">
  <DEF-ARG POS="2" TYPE="Person">
</DEF-RELATION>
```

POS is used define the position of the arguments: 1...n

SHOE: Example of an ontology representing computer science departments

The dot “.” is used as an abbreviation for accessing elements of the SHOE base ontology.

```
<DEF-RELATION NAME="publicationDate">
  <DEF-ARG POS="1" TYPE="Publication">
    <DEF-ARG POS="2" TYPE=".DATE">
  </DEF-RELATION>
<DEF-RELATION NAME="age">
  <DEF-ARG POS="1" TYPE="Person">
    <DEF-ARG POS="2" TYPE=".NUMBER">
  </DEF-RELATION>
```

SHOE: Example of an ontology representing computer science departments

```
<DEF-RELATION NAME="name">
  <DEF-ARG POS="1" TYPE="base.SHOEntity">
    <DEF-ARG POS="2" TYPE=".STRING">
</DEF-RELATION>
<DEF-RELATION NAME="tenured">
  <DEF-ARG POS="1" TYPE="Professor">
    <DEF-ARG POS="2" TYPE=".TRUTH">
</DEF-RELATION>
```

Finishing/Closing Ontology-Definitions:

```
</ONTOLOGY>
</BODY>
</HTML>
```

SHOE: Inference-rules in ontologies

Horn-Clauses are used to specify inference-rules in SHOE.

By the use of inference rules it is possible to automatically determine additional classifications while annotating web-pages; this means saving work, time, and money.

Example:

If someone claims to be a member of an organization which itself is a suborganization of second organization, then person is also member of the second organization (e.g., Professor of a Department → Faculty → University)

In Prolog notation:

```
member(?org2, ?person) :- member(?org1, ?person) ^  
subOrganization(?org1, ?org2)
```

SHOE: Inference-rules in ontologies

```
<DEF-INFERENCE DESCRIPTION="member (?org2 , ?person)
if member (?org1 , ?person) and subOrganization (?org1 , ?org2) ">
  <INF-IF>
    <RELATION NAME="member">
      <ARG POS=1 VALUE="org1" USAGE=VAR>
      <ARG POS=2 VALUE="person" USAGE=VAR>
    </RELATION>
    <RELATION NAME="subOrganization">
      <ARG POS=1 VALUE="org1" USAGE=VAR>
      <ARG POS=2 VALUE="org2" USAGE=VAR>
    </RELATION>
  </INF-IF>
  <INF-THEN>
    <RELATION NAME="member">
      <ARG POS=1 VALUE="org2" USAGE=VAR>
      <ARG POS=2 VALUE="person" USAGE=VAR>
    </RELATION>
  </INF-THEN>
</DEF-INFERENCE>
```

SHOE: Inference-rules in ontologies

Inference-rules in SHOE may contain constants.

Example: Every undergraduate computer science student at the University of Maryland has Professor John Doe as advisor.

```
<DEF-INFERENCE
DESCRIPTION="advisor (?per,http://www.cs.umd.edu/users/johndoe.html)
  if member(http://www.cs.umd.edu,?person)
  and UnderGraduateStudent(?person) ">
<INF-IF>
  <RELATION NAME="member">
    <ARG POS=1 VALUE="http://www.cs.umd.edu/">
    <ARG POS=2 VALUE="person" USAGE=VAR>
  </RELATION>
  <CATEGORY="UndergraduateStudent" FOR="person" USAGE=VAR>
</INF-IF>
<INF-THEN>
  <RELATION NAME="advisor">
    <ARG POS=1 VALUE="person" USAGE=VAR>
    <ARG POS=2 VALUE="http://www.cs.umd.edu/users/johndoe.html">
  </RELATION>
</INF-THEN>
</DEF-INFERENCE>
```

SHOE: Inference-rules in ontologies

Inference-rules may contain a set of „special“ comparisons.

Example: Only persons over 18 may matriculate at the university.

```
<DEF-INFERENCE>
  <INF-IF>
    <RELATION NAME="age">
      <ARG POS=1 VALUE="per" USAGE=VAR>
      <ARG POS=2 VALUE="a" USAGE=VAR>
    </RELATION>
    <COMPARISON OP="greaterThanOrEqualTo">
      <ARG POS=1 VALUE="a" USAGE=VAR>
      <ARG POS=2 VALUE="18">
    </COMPARISON>
  </INF-IF>
  <INF-THEN>
    <RELATION NAME="canEnter">
      <ARG POS=1 VALUE="per" USAGE=VAR>
      <ARG POS=2 VALUE="YES">
    </RELATION>
  </INF-THEN>
</DEF-INFERENCE>
```

SHOE: Annotation of a web-page

The following sample web-page should be annotated using the defined CS-ontology to allow Internet-agents to extract the information easily.

```
<HTML>
<HEAD>
<TITLE> My Page </TITLE>
</HEAD>
<BODY>
<P> Hi, this is my web page. I am a graduate student and a
    research assistant.
<P> Also, I'm 52 years old.
<P> My name is George Stephanopolous.
<P> Here is a pointer to my
    <A HREF="http://www.cs.umd.edu/smith"> graduate advisor.</A>
<P> And <A HREF="http://www.cs.umd.edu/papers/paper.ps">
    is a paper I recently wrote.
    <h3> Brun Hilda </h3>
    Brun Hilda is a visiting lecturer here from Germany who
    doesn't have her own web page. However, because I am such a
    nice person, I have agreed to let part of my web page space
    belong to her. She is 23.
</BODY>
</HTML>
```

SHOE: Annotation of a web-page

First of all, a new prefix for the cs-dept-ontology is defined:

```
<USE-ONTOLOGY  
  ID="cs-dept-ontology"  
  URL="http://www.cs.umd.edu/projects/plus/SHOE/cs.html"  
  VERSION="1.0"  
  PREFIX="cs">
```

The instances are classified and thereby assigned to concepts of the ontology (comparable to the realization process to connect T-Box and A-Box in KL-One derivatives):

```
<CATEGORY NAME="cs.GraduateStudent">  
<CATEGORY NAME="cs.ResearchAssistant">
```

SHOE: Annotation of a web-page

It is possible and common to declare relationships with other instances or simple data. If John Smith has a homepage which has been annotated with SHOE, we can use this information to declare the fact that John Smith is an advisor, as follows:

```
<RELATION NAME="cs.advisor">  
  <ARG POS=TO VALUE="http://www.cs.umd.edu/users/smith">  
</RELATION>
```

This assumes that John Smith has declared himself to be a professor.

Postscript files do not contain SHOE-Annotations. The only way to express that it is written by George is to use the FROM-Construct.

```
<RELATION NAME="publicationAuthor">  
  <ARG POS=FROM VALUE="http://www.cs.umd.edu/  
  papers/paper.ps">  
</RELATION>
```

SHOE: Annotation of a web-page

Declaring relationships for instances of a web-page:

```
<RELATION NAME="cs.name">  
  <ARG POS=1 VALUE="http://www.cs.umd.edu/users/george/">  
  <ARG POS=2 VALUE="George Stephanopolous">  
</RELATION>  
<RELATION NAME="cs.age">  
  <ARG POS=1 VALUE="http://www.cs.umd.edu/users/george/">  
  <ARG POS=2 VALUE="52">  
</RELATION>
```

For binary relations, there exists the FROM-TO construct. SHOE permits to omit either the „FROM“ or the „TO“ argument, if its value is the instance making the claim:

```
<RELATION NAME="cs.name">  
  <ARG POS=TO VALUE="George Stephanopolous">  
</RELATION>  
<RELATION NAME="cs.age">  
  <ARG POS=TO VALUE="52">  
</RELATION>
```

SHOE: Annotation of a web-page

Nested instances in a web-page are declared using the hash-mark operator „#“.

By the use of this operator, the same URL can be partitioned into multiple Instances.

```
<INSTANCE KEY="http://www.cs.umd.edu/users/george/  
#BRUNHILDA">
```

```
<CATEGORY NAME="cs.Lecturer">
```

```
<RELATION NAME="cs.name">
```

```
  <ARG POS=TO VALUE="Brun Hilda">
```

```
</RELATION>
```

```
<RELATION NAME="cs.age">
```

```
  <ARG POS=TO VALUE="23">
```

```
</RELATION>
```

```
</INSTANCE>
```