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 derivates)
  - Multiple Inheritance
  - Typed relations between concepts (like: roles in KL-One derivates)
  - 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

Multiple inheritance is also possible:

Multiple inheritance is also possible:

Multiple inheritance is also possible:

Multiple inheritance is also possible:

Multiple inheritance is also possible:

Multiple inheritance is also possible:

Multiple inheritance is also possible:
SHOE: Example of an ontology representing computer science departments

Definition of relationships between typed concepts:

```xml
<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 to 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.SHOEEntity"/>
  <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-INERENCE
   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-INERENCE>
```
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-INERENCE>
  <INF-IF>
    <RELATION NAME="age">
      <ARG POS=1 VALUE="per" USAGE=VAR>
      <ARG POS=2 VALUE="a" USAGE=VAR>
    </RELATION>
    <COMPARISON OP="greaterThanOrEqual">
      <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-INERENCE>
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
<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.</A>
    <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:

```xml
<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 derivates):

```xml
<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:

```xml
<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.

```xml
<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:

```xml
<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:

```xml
<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">
    </ARG>
  </RELATION>
  <RELATION NAME="cs.age">
    <ARG POS=TO VALUE="23">
  </ARG>
</INSTANCE>