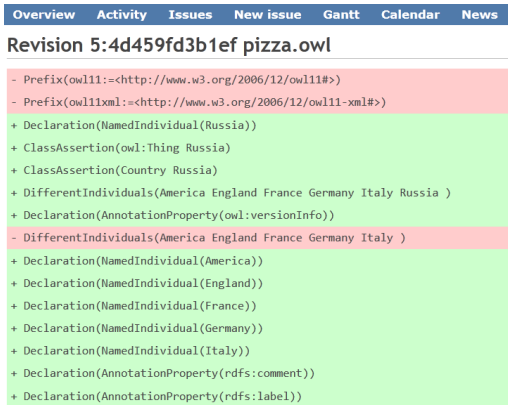
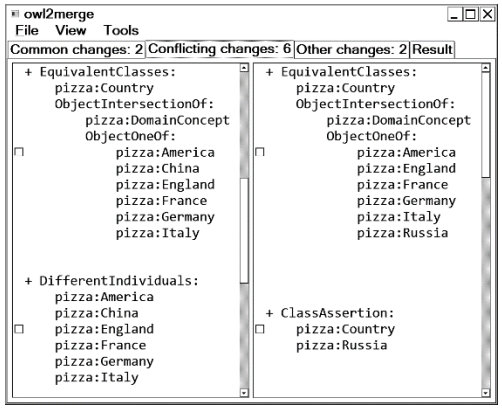
Ontology Diff Web UI



Ontology Three Way Merge UI



Single Entity Change Log

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Toolset for collaborative distributed web ontology development

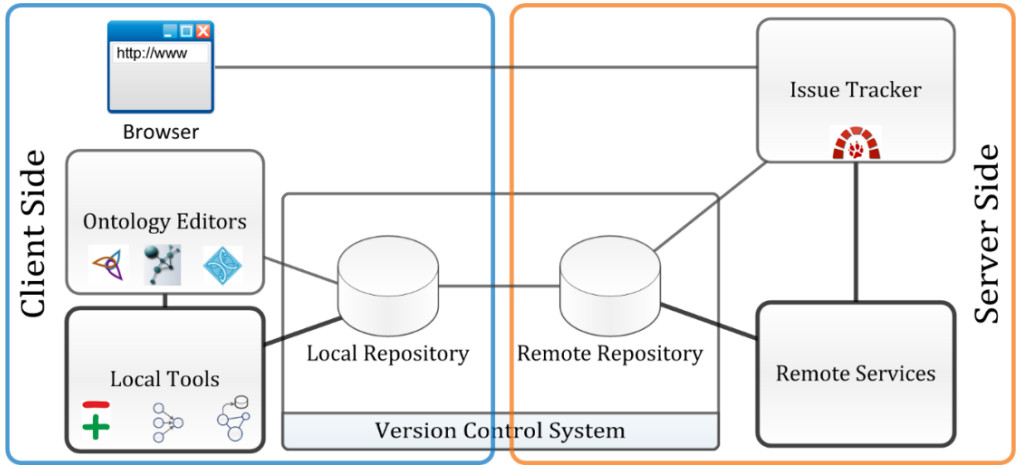
Web ontologies make up the Semantic Web, which allows data to be shared and reused across application, enterprise, and community boundaries. Ontologies have a wide range of applications, including such areas as biology, medicine, genetics, oil production, and information technologies.

This project aims at creating a system to allow performing version control and collaborative distributed development of web ontologies by integrating custom ontology diff and merge tools with existing distributed version control systems and issue trackers.

Advantages of the approach

- Is based on mature systems;
- Does not require persistent network connection;
- Allows developers to use ontology editing software they are accustomed to;
- Does not restrict web ontology language expressiveness.

Components of the System



Algorithms

Ontology = $\langle \mathbf{E}, \mathbf{A}, \mathbf{N}, \mathbf{I}, \mathbf{P}, d, f \rangle$ where

- $\mathbf{E} \subset \mathbf{E}^U$ – entities;
- $\mathbf{A} \subset \mathbf{A}^U$ – axioms;
- $\mathbf{N} \subset \mathbf{N}^U$ – ontology annotations (n_p, n_v), where n_p – annot. property, n_v – annot. value;
- $\mathbf{I} \subset \mathbf{I}^U$ – imports (links to other ontologies);
- $\mathbf{P} \subset \mathbf{P}^U \subset \mathbf{S} \times \mathbf{S}$ – prefixes (p_n, p_i), where p_n – prefix name, p_i – prefix value;
- $d \in \mathbf{D}$ – ontology identifier (r_o, r_v), where r_o – Ontology IRI, r_v – Version IRI;
- $f \in \mathbf{F}$ = { «RDF/XML», «Turtle», «OWL/XML», «OWL Functional Syntax», «OWL Manchester Syntax» } – ontology format

Ontology Diff

$v_1 = \langle \mathbf{E}_1, \mathbf{A}_1, \mathbf{N}_1, \mathbf{I}_1, \mathbf{P}_1, d_1, f_1 \rangle$ $\quad$ $v_2 = \langle \mathbf{E}_2, \mathbf{A}_2, \mathbf{N}_2, \mathbf{I}_2, \mathbf{P}_2, d_2, f_2 \rangle$

$\mathbf{C}_A = \delta_A(\mathbf{A}_1, \mathbf{A}_2) = \{ \text{AddAxiom}(a) \mid a \in \mathbf{A}_2 \setminus \mathbf{A}_1 \} \cup \{ \text{RemoveAxiom}(a) \mid a \in \mathbf{A}_1 \setminus \mathbf{A}_2 \}$

$\mathbf{C}_N = \delta_N(\mathbf{N}_1, \mathbf{N}_2) = \{ \text{AddOntologyAnnotation}(n) \mid n \in \mathbf{N}_2 \setminus \mathbf{N}_1 \}$
$\cup \{ \text{RemoveOntologyAnnotation}(n) \mid n \in \mathbf{N}_1 \setminus \mathbf{N}_2 \}$

$\mathbf{C}_I = \delta_I(\mathbf{I}_1, \mathbf{I}_2) = \{ \text{AddImport}(i) \mid i \in \mathbf{I}_2 \setminus \mathbf{I}_1 \} \cup \{ \text{RemoveImport}(i) \mid i \in \mathbf{I}_1 \setminus \mathbf{I}_2 \}$

$\mathbf{C}_d = \delta_d(d_1, d_2) = \{ \text{SetOntologyID}(d_1, d_2) \mid d_1 \neq d_2 \}$

$\mathbf{C}_f = \delta_f(f_1, f_2) = \{ \text{SetOntologyFormat}(f_1, f_2) \mid f_1 \neq f_2 \}$

$\mathbf{C}_P = \delta_P(\mathbf{P}_1, \mathbf{P}_2) = \{ \text{AddPrefix}(p_{n2}, p_{i2}) \mid (p_{n2}, p_{i2}) \in \mathbf{P}_2 \wedge \nexists (p_{n1}, p_{i1}) \in \mathbf{P}_1 : (p_{n1}=p_{n2} \vee p_{i1}=p_{i2}) \}$
$\cup \{ \text{RemovePrefix}(p_{n1}, p_{i1}) \mid (p_{n1}, p_{i1}) \in \mathbf{P}_1 \wedge \nexists (p_{n2}, p_{i2}) \in \mathbf{P}_2 : (p_{n1}=p_{n2} \vee p_{i1}=p_{i2}) \}$
$\cup \{ \text{ModifyPrefix}(p_{n1}, p_{i1}, p_{i2}) \mid (p_{n1}, p_{i1}) \in \mathbf{P}_1 \wedge \exists (p_{n2}, p_{i2}) \in \mathbf{P}_2 : (p_{n1}=p_{n2} \wedge p_{i1} \neq p_{i2}) \}$
$\cup \{ \text{RenamePrefix}(p_{n1}, p_{i1}, p_{n2}) \mid (p_{n1}, p_{i1}) \in \mathbf{P}_1 \wedge \exists (p_{n2}, p_{i2}) \in \mathbf{P}_2 : ((p_{n2}, p_{i2}) \notin \mathbf{P}_1) \wedge p_{n1} \neq p_{n2} \wedge p_{i1} = p_{i2} \}$

Change Analysis

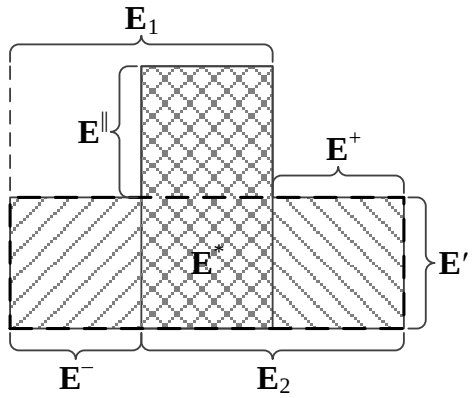
Changed entities: $\mathbf{E}' \subset \mathbf{E}_1 \cup \mathbf{E}_2$

Unchanged entities: $\mathbf{E}^{\|} = \mathbf{E}_1 \cap \mathbf{E}_2 \setminus \mathbf{E}'$

New entities: $\mathbf{E}^{+} = \mathbf{E}' \setminus \mathbf{E}_1 = \mathbf{E}_2 \setminus \mathbf{E}_1$

Removed entities: $\mathbf{E}^{-} = \mathbf{E}' \setminus \mathbf{E}_2 = \mathbf{E}_1 \setminus \mathbf{E}_2$

Modified entities: $\mathbf{E}^{*} = \mathbf{E}' \cap \mathbf{E}_1 \cap \mathbf{E}_2$



Three-Way Merge

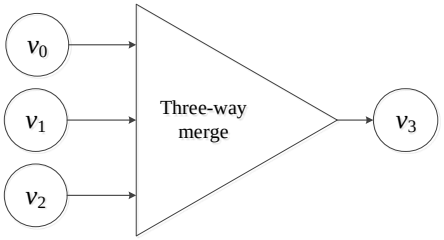
Initial version: $v_0 = \langle \mathbf{E}_0, \mathbf{A}_0, \mathbf{N}_0, \mathbf{I}_0, \mathbf{P}_0, d_0, f_0 \rangle$

Version of user 1: $v_1 = \langle \mathbf{E}_1, \mathbf{A}_1, \mathbf{N}_1, \mathbf{I}_1, \mathbf{P}_1, d_1, f_1 \rangle$

Version of user 2: $v_2 = \langle \mathbf{E}_2, \mathbf{A}_2, \mathbf{N}_2, \mathbf{I}_2, \mathbf{P}_2, d_2, f_2 \rangle$

$\mathbf{C}_1 = \delta(v_0, v_1) = \mathbf{C}_{1A} \cup \mathbf{C}_{1N} \cup \mathbf{C}_{1I} \cup \mathbf{C}_{1P} \cup \mathbf{C}_{1d} \cup \mathbf{C}_{1f}$

$\mathbf{C}_2 = \delta(v_0, v_2) = \mathbf{C}_{2A} \cup \mathbf{C}_{2N} \cup \mathbf{C}_{2I} \cup \mathbf{C}_{2P} \cup \mathbf{C}_{2d} \cup \mathbf{C}_{2f}$



Changes $\mathbf{C}_1 \cup \mathbf{C}_2$ can be divided into:

Matching changes $\mathbf{C}_m = \mathbf{C}_1 \cap \mathbf{C}_2$;

Conflicting changes of user 1: $\mathbf{C}'_1$;

Conflicting changes of user 2: $\mathbf{C}'_2$;

Other changes of user 1: $\mathbf{C}^{\|}_1 = (\mathbf{C}_1 \setminus \mathbf{C}_m) \setminus \mathbf{C}'_1$;

Other changes of user 2: $\mathbf{C}^{\|}_2 = (\mathbf{C}_1 \setminus \mathbf{C}_m) \setminus \mathbf{C}'_2$.

Conflict Detection

Axioms: $\mathbf{C}'_{1A} = \{ c \in \mathbf{C}_{1A} \mid \sigma(c) \cap \sigma(\mathbf{C}_{2A} \setminus \mathbf{C}_m) \neq \emptyset \}$; $\mathbf{C}'_{2A} = \{ c \in \mathbf{C}_{2A} \mid \sigma(c) \cap \sigma(\mathbf{C}_{1A} \setminus \mathbf{C}_m) \neq \emptyset \}$

Prefixes: $\mathbf{C}'_{1P} = \{ c \in \mathbf{C}_{1P} \mid \sigma_P(c) \cap \sigma_P(\mathbf{C}_{2P} \setminus \mathbf{C}_m) \neq \emptyset \}$; $\mathbf{C}'_{2P} = \{ c \in \mathbf{C}_{2P} \mid \sigma_P(c) \cap \sigma_P(\mathbf{C}_{1P} \setminus \mathbf{C}_m) \neq \emptyset \}$

Identifier: $\mathbf{C}'_{1d} = \{ c \in \mathbf{C}_{1d} \setminus \mathbf{C}_{2d} \}$; $\mathbf{C}'_{2d} = \{ c \in \mathbf{C}_{2d} \setminus \mathbf{C}_{1d} \}$

Format: $\mathbf{C}'_{1f} = \{ c \in \mathbf{C}_{1f} \setminus \mathbf{C}_{2f} \}$; $\mathbf{C}'_{2f} = \{ c \in \mathbf{C}_{2f} \setminus \mathbf{C}_{1f} \}$

Project Proposals

- Collaborative ontology development tools
- Security of ontological knowledge bases
- Information systems based on Semantic Web technologies
  - Decision support system
  - E-library system

Publications

- Zaikin, I. An Ontology Development and Maintenance System. Proceedings of the 7th International Forum on Strategic Technology IFOST2012, September 17-21, 2012, Vol. 1. National Research Tomsk Polytechnic University, Tomsk. – pp. 515–518
- Zaikin, I., Tuzovsky A. Owl2vcs: Tools for Distributed Ontology Development, http://webont.org/owled/2013/papers/owled2013_2.pdf