Extracting Ontologies from Terminological Databases

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1. Abstract

- A structural definition-based terminology (SDBT) defines terms on the basis of properties structured by conceptual categories (classes).
- When a SDBT is extracted from a relational database into RDF, inference rules can be generated for use in complex semantic search by SPARQL query.
- Complex SPARQL queries that leverage these rules can yield better results than simple keyword queries, reflecting the logical combination of semantically related terms.
- With their basis in ontologies so generated, SDBT can be used to index databases for retrieval and to mine informal big data through the application of well-defined semantic concepts.

2. Structural Definition-Based Terminology (SDBT)
2.1 What is a SDBT?

- A SDBT defines terms on the basis of properties that are structured by conceptual categories (classes).
  1. Terms are sorted by conceptual categories (classes).
  2. Terms are defined by properties structured by classes.
  3. Relationships among terms and properties are built by vocabularies.

2.2 Requirements of SDBT

1. Taxonomy of conceptual categories
   - Hierarchical classification of conceptual categories (classes) of terms having the same properties.

2. Properties of conceptual categories
   - The conceptual category (class) is structured by properties.
   - Structured properties of a class is a metadata schema of the class.

3. Vocabulary terms (VT) for relationship among terms and properties
   - Relationships among terms and properties are built by vocabulary terms.
2.3 Conceptual Model of SDBT (1/2)

Top Level Class

Mid Level Class

Mid Level Class

Properties

2.3 Conceptual Model of SDBT (2/2)

Term

Properties of Term
- Chinese characters
- Definition
- Annotation
- Synonym

Relation Properties
- BT, NT, RT

Class Properties (ex. Person_Name)
- Period, Birthday, Country, Works, Theory/School

Class
3. How to build a SDBT Database

3.1 Example: STNet Project

- **STNet project**
  - Funded by NRF (National Research Foundation of Korea) for 3 years from Sep. 2012 to Aug. 2015 for constructing STNet database.

- **STNet database**
  - Constructed for keywords from journal articles in the fields of the humanities and social sciences in KCI.
  - There are 55,236 structural definition-based academic terms in the STNet database.

<table>
<thead>
<tr>
<th>Division</th>
<th>Current situation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of terms</td>
<td>50,216</td>
</tr>
<tr>
<td>Number of data in properties</td>
<td>72,459</td>
</tr>
<tr>
<td>Code type</td>
<td>7,221</td>
</tr>
<tr>
<td>Text type</td>
<td>16,733</td>
</tr>
<tr>
<td>Subterm</td>
<td>96,823</td>
</tr>
<tr>
<td>Number of links between terms by relation predicates</td>
<td></td>
</tr>
<tr>
<td>Equivalent relationships</td>
<td>23,062</td>
</tr>
<tr>
<td>Hierarchical relationships</td>
<td>66,905</td>
</tr>
<tr>
<td>Associative relationships</td>
<td>130,724</td>
</tr>
<tr>
<td>Subterm</td>
<td>200,950</td>
</tr>
</tbody>
</table>
3.2 Conceptual Model of STNet

3.3 STNet Taxonomy (1/3)

- STNet taxonomy consists of seven top-level classes, 27 middle level classes and 143 lower level classes.
  - A: Object
  - B: Action/Function
  - C: Property
  - D: Theory/Method
  - E: Format/Framework
  - X: General/Common
  - Y: Instance

  - Lower level classes is subdivided into the first lower level and the second lower level.
  - Each class has a code and a class name.
### 3.3 STNet Taxonomy (2/3)

#### Appendix A. STNet Taxonomy

<table>
<thead>
<tr>
<th>Top level classes</th>
<th>Mid level classes</th>
<th>2nd lower level classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>People</td>
<td>Person</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Member</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Relationship</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Role</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Member</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Relationship</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Role</td>
</tr>
</tbody>
</table>

#### 3.3 STNet Taxonomy (3/3)

[Diagram showing STNet Taxonomy continued]
3.4 STNet Properties

- Each class is structured by (conceptual) properties that represent that class.
- Each property has a value that can be divided into “object type,” “code type,” or “text type.”
- Among them, an object type value represents an input terminology in the STNet database.

3.5 Definition by Properties in STNet
3.6 Conceptual Model of Relationships

- Conceptual properties established in class having similar concepts.

- Relationship properties established between keywords (Hierarchical relationships / Equivalent relationships / Associative relationships etc.)

3.7 STNet vocabulary (1/2)

- STNet vocabulary consists 95 relation predicates (vocabulary terms: vt).
- STNet terms connect to the other terms that are used by property values of that class or that belong to other classes.
- In other words, the term that belongs to the “Title_of_Literature” class has a relationship with the values in properties of that class, such as “hasCreator” or “hasPublicationYear.”
- For example, The Diary of a Young Girl: Anne Frank
  - The term of “Title_of_Literature” class has connections with “Anne Frank” of the “hasCreator” property and “1947” of the “hasPublicationYear” property.
  - Additionally, The Diary of a Young Girl: Anne Frank term can have an interrelationship with the “World War II” term in another “Event Name” class through a relation predicate, such as “isAffectedBy” → “affects.”
3.7 STNet Vocabulary (2/2)

<table>
<thead>
<tr>
<th>Classification</th>
<th>The Name of Relation</th>
<th>The Name of Inverse Relation</th>
</tr>
</thead>
<tbody>
<tr>
<td>inverse relation</td>
<td>Lab &amp; Lab name</td>
<td>Lab &amp; Lab name</td>
</tr>
<tr>
<td>inverse relation</td>
<td>Lab &amp; Lab name</td>
<td>Lab &amp; Lab name</td>
</tr>
</tbody>
</table>

3.8 Relationships by VT in STNet

<table>
<thead>
<tr>
<th>Relationship Name (Eng)</th>
<th>Relationship Name (Kor)</th>
<th>Inverse Relationship Name</th>
<th>Relationship Property</th>
<th>Relationship Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group of Relationships</td>
<td>Relationship Name (Eng)</td>
<td>Relationship Name (Kor)</td>
<td>Inverse Relationship Name</td>
<td>Relationship Property</td>
</tr>
</tbody>
</table>
4. Extracting Ontology from SDBT Database

4.1 Setting up Ontology Classes & OWL Properties

- Ontology classes are composed in the form of OWL-DL based on the conceptual scopes in the STNet.

- “ObjectType Properties” and 40 “DataType Properties” are defined by analyzing the types of relations among input terminologies in STNet.

- In the case of “ObjectType Property,”
  - We set up the “InverseOf” and “Reflexive” relations, and “Domain” and “Range” according to the structure of the properties of classes.
  - We also accorded “Range” such as String, DateTime, and Integer to “DataType Property” by referring values (code or text) to properties in the STNet.
4.2 Construction of Axiom Sets

- Applied ontology schema completed with verification of ontology structure to the STNet instance data.
- After verifying errors about data, constructed axiom sets about all classes in the STNet.
- Examples of connections with “Domain” or “Range”
  - When the “y01-01 Real_Person” class has connections with other related classes having property values such as “Advocate ↝ advocatedBy,” “hasBirthPlace ↝ isBirthPlaceOf,” & “hasEra ↝ isActivityPeriodOf.”

4.3 Converting STNet Data into RDF

- Convert the STNet RDB Data into RDF ontology using the D2R server.
  - At the start of this process, define target data and set up property values about that data.
  - Then, use converted scripts in D2RQ form to convert RDB data into RDF data.
  - Additionally, after creating the D2RQ (2016) mapping languages, check and modify the errors regarding target data through “d2rQuery,” provided by the D2R Server.
4.4 Definition of Inference Rules

- To define generalized inference control rules for the STNet, set up inference control rules based on the types of classes and properties that contained above-average (24 or more) data after calculating the sorts and the numeral values of input data in the form of “Subject(X class) ↔ Predicate(Property) ↔ Object(Y Class)” regarding STNet data imported in the process of ontology conversion.

- The reason is to make efficient rules that could minimize logical errors in the process of terminology searching because one term can belong to the many classes, and the property values in X class can connect with many related Y classes.

- For example, input terms in the “hasWork” property of the “Real_Person” class can belong to “Title_of_Works,” “Title_of_Literature,” “Monument_Name_Cultural_Asset_Name,” “Performing_Arts,” “Title_of_Documents,” and so on.

4.5 SPARQL Queries and Search Results

- Extracted SPARQL query results for the very complicated search scenarios for which it was too difficult to deduce a result value via a simple keyword search.

- Scenario 1:
  - [Real_Person] was born in [Name_Of_State_City_Town / Name_Of_Countries] with the nationality of [Name_Of_Countries] and was active in the period of [Period] as a [Occupation].

- Scenario 2:
  - [Theory_Thought] advocated by [Real_Person] is opposed to [Theory_Thought 2] advocated by [Real_Person 2], and [Theory_Thought] is also related to [Theory_Thought 3] and [Concept_Definition]. [Concept_Definition] advocated by [Real_Person 3] is related to [Period] and [Name_Of_Countries].

- Scenario 3:
- Scenario 4:
- Scenario 5:
- Scenario 6:
- Scenario 7:
4.5.1 Search Result of Scenario 1

Scenario 1 - Ontology Structure

Scenario 1: [Real_Person] was born in [Name_Of_State_City_Town / Name_Of_Countries] with the nationality of [Name_Of_Countries] and was active in the period of [Period] as a [Occupation].

- **Ontology Structure:**

Scenario 1 – SPARQL Query

Scenario 1: [Real_Person] was born in [Name_Of_State_City_Town / Name_Of_Countries] with the nationality of [Name_Of_Countries] and was active in the period of [Period] as a [Occupation].

SPARQL Query:

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/02/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX: <http://www.stnet.re.kr/ontology#>
WHERE {
  ?Location1 rdf:type :x01-03_Name_of_State_City_Town_Street_Avenue.
  ?Nationality ref:type :x01-02_Name_of_Countries.
  ?Era ref:type :x02-01_Period.
  ?Person ref:type :y01-01_Real_Person.
  ?Person :hasBirthPlace ?Location1.
  ?Person :hasNationality ?Nationality.
}
```

Scenario 1 – Query Results

Scenario 1: [Real_Person] was born in [Name_Of_State_City_Town / Name_Of_Countries] with the nationality of [Name_Of_Countries] and was active in the period of [Period] as a [Occupation].

<table>
<thead>
<tr>
<th>Name_Of_State_City_Town</th>
<th>Name_Of_Countries</th>
<th>Period</th>
<th>Occupation</th>
<th>Person</th>
</tr>
</thead>
<tbody>
<tr>
<td>경기도</td>
<td>대한민국</td>
<td>일제강점기</td>
<td>교수</td>
<td>이선근 (Lee, Seongeun)</td>
</tr>
<tr>
<td>강원도</td>
<td>대한민국</td>
<td>일제강점기</td>
<td>정치인</td>
<td>조일명 (Cho, Ilmyeong)</td>
</tr>
<tr>
<td>원산</td>
<td>북한</td>
<td>일제강점기</td>
<td>극작가</td>
<td>박영호 (Park, Yeongho)</td>
</tr>
<tr>
<td>성주군</td>
<td>대한민국</td>
<td>일제강점기</td>
<td>정치인</td>
<td>김창숙 (Kim, Changsuk)</td>
</tr>
<tr>
<td>청양</td>
<td>북한</td>
<td>일제강점기</td>
<td>연극배우</td>
<td>황철 (Hwang, Chul)</td>
</tr>
</tbody>
</table>

※ Korean word translated into English in brackets.

※ 461 search results for scenario 1: just 5 results tabulated.
### 4.5.2 Search Result of Scenario 2

Scenario 2 – Query Results

<table>
<thead>
<tr>
<th>[Real_Person]</th>
<th>[Theory_Thought]</th>
<th>[Real_Person 2]</th>
<th>[Theory_Thought 2]</th>
<th>[Concept_Definition]</th>
<th>[Real_Person 3]</th>
<th>[Period]</th>
<th>[Name_Of_Countries]</th>
</tr>
</thead>
<tbody>
<tr>
<td>후설 (Husserl, Edmund)</td>
<td>形態心學 (Esthetic Psychology)</td>
<td>布拉特諾 (Brentano, Franz)</td>
<td>地方自然 (Regional Natural Tendency)</td>
<td>地方自然 (Regional Natural Tendency)</td>
<td>王陽明 (Wang Shouren)</td>
<td>明時代 (Ming Dynasty)</td>
<td>中國 (China)</td>
</tr>
<tr>
<td>주자 (Zhuxi)</td>
<td>性理學的世界觀 (World View of Neo-Confucianism)</td>
<td>周敦頤 (Zhuangzi)</td>
<td>地方自然 (Regional Natural Tendency)</td>
<td>地方自然 (Regional Natural Tendency)</td>
<td>王陽明 (Wang Shouren)</td>
<td>明時代 (Ming Dynasty)</td>
<td>中國 (China)</td>
</tr>
<tr>
<td>周敦頤 (Zhuangzi)</td>
<td>性理學的世界觀 (World View of Neo-Confucianism)</td>
<td>周敦頤 (Zhuangzi)</td>
<td>地方自然 (Regional Natural Tendency)</td>
<td>地方自然 (Regional Natural Tendency)</td>
<td>王陽明 (Wang Shouren)</td>
<td>明時代 (Ming Dynasty)</td>
<td>中國 (China)</td>
</tr>
<tr>
<td>主張 (Main)</td>
<td>性理學的世界觀 (World View of Neo-Confucianism)</td>
<td>朱子 (Zhu Xi)</td>
<td>地方自然 (Regional Natural Tendency)</td>
<td>地方自然 (Regional Natural Tendency)</td>
<td>王陽明 (Wang Shouren)</td>
<td>明時代 (Ming Dynasty)</td>
<td>中國 (China)</td>
</tr>
</tbody>
</table>

※ Korean word translated into English in brackets.

※ 340 search results for scenario 2: just 5 results tabulated.
### 4.5.3 Search Result of Scenario 3

#### Scenario 3 – Query Results

※ Scenario 3: [Real Person] was affiliated with the [Organization_Name_Group_Name], which was founded by [Real Person 2] from [Name_Of_State_City_Town], and [Real Person] was highly active in the period of [Period].

<table>
<thead>
<tr>
<th>[Real Person]</th>
<th>[Organization_Name_Group_Name]</th>
<th>[Real Person 2]</th>
<th>[Name_Of_State_City_Town]</th>
<th>[Period]</th>
</tr>
</thead>
<tbody>
<tr>
<td>최재형</td>
<td>국민회 (National Society)</td>
<td>이승만</td>
<td>미국 (United States of America)</td>
<td>조선 후기 (Late Chosun Dynasty)</td>
</tr>
<tr>
<td>허익</td>
<td>국민회 (National Society)</td>
<td>이승만</td>
<td>미국 (United States of America)</td>
<td>조선 후기 (Late Chosun Dynasty)</td>
</tr>
<tr>
<td>알베르투스 마그누스 (Magnus, Albertus)</td>
<td>도미니크 수도회 (Dominican Order)</td>
<td>도미니쿠스 (Dominicus)</td>
<td>프랑스 (France)</td>
<td>서양 중세 (Western Middle Age)</td>
</tr>
<tr>
<td>도미니쿠스 (Dominicus)</td>
<td>도미니크 수도회 (Dominican Order)</td>
<td>도미니쿠스 (Dominicus)</td>
<td>프랑스 (France)</td>
<td>서양 중세 (Western Middle Age)</td>
</tr>
<tr>
<td>지롤라모 사보나롤라 (Savonarola, Girolamo)</td>
<td>도미니크 수도회 (Dominican Order)</td>
<td>도미니쿠스 (Dominicus)</td>
<td>프랑스 (France)</td>
<td>서양 중세 (Western Middle Age)</td>
</tr>
</tbody>
</table>

※ Korean word translated into English in brackets.
※ 142 search results for scenario 3; just 5 results tabulated.
### 4.5.4 Search Result of Scenario 4

#### Scenario 4 – Query Results

*Scenario 4: [Title Of Literature], which was written by [Real Person] in the [Period], reflects the [Theory Thought].*

<table>
<thead>
<tr>
<th>Title Of Literature</th>
<th>Real Person</th>
<th>Period</th>
<th>Theory Thought</th>
</tr>
</thead>
<tbody>
<tr>
<td>주자대전차의집보 (Jujadaejeonchauijipbo)</td>
<td>이향로 (Lee, Hangro)</td>
<td>조선 후기 (Late Chosun Dynasty)</td>
<td>조선 성리학 (Noe-Confucianism of Chosun Era)</td>
</tr>
<tr>
<td>이륜행실도 (Iryunhaengsildo)</td>
<td>이병모 (Lee, Byungmo)</td>
<td>조선 후기 (Late Chosun Dynasty)</td>
<td>유교 (Confucianism)</td>
</tr>
<tr>
<td>경세제민 (Governing a Nation and Providing Relief to People)</td>
<td>우정규 (Woo, Jungkyu)</td>
<td>조선 후기 (Late Chosun Dynasty)</td>
<td>유교 (Confucianism)</td>
</tr>
<tr>
<td>경세제민 (Governing a Nation and Providing Relief to People)</td>
<td>하정유 (Ha, Jeonyou)</td>
<td>조선 후기 (Late Chosun Dynasty)</td>
<td>유교 (Confucianism)</td>
</tr>
<tr>
<td>사의 (Rites of Classical Scholars (Sa Yui))</td>
<td>허전 (Heo, Jeon)</td>
<td>조선 후기 (Late Chosun Dynasty)</td>
<td>유가사상 (Confucian Thoughts)</td>
</tr>
</tbody>
</table>

* Korean word translated into English in brackets. * 49 search results for scenario 4: just 5 results tabulated.
### 4.5.5 Search Result of Scenario 5

#### Scenario 5 – Query Results

※ Scenario 5: (Real_Person), who founded [Organization_Name_Group_Name], is a leader for [Event_Name_Title_Of_Agreement] which occurred in [Name_Of_Countries] in the period of [Period], and the [Event_Name_Title_Of_Agreement] is also related to [Real_Person 2].

<table>
<thead>
<tr>
<th>(Real_Person)</th>
<th>(Organization_Name_Group_Name)</th>
<th>(Event_Name_Title_Of_Agreement)</th>
<th>(Name_Of_Countries)</th>
<th>(Period)</th>
<th>(Real_Person 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>최남선 (Choi, Namsun)</td>
<td>조선광문회 (Chosun Gwangmunhoe)</td>
<td>시조 부흥 운동 (Sijo Renaissance Campaign)</td>
<td>대한민국 (Republic of Korea)</td>
<td>일제강점기 (Japanese Colonized period)</td>
<td>이병기 (Lee, Byungki)</td>
</tr>
<tr>
<td>이병기 (Lee, Byungki)</td>
<td>한국전쟁 (Korean War)</td>
<td>문화 대혁명 (The Cultural Revolution)</td>
<td>중국 (China)</td>
<td></td>
<td>최남선 (Choi, Namsun)</td>
</tr>
<tr>
<td>마오쩌둥 (Mao Zedong)</td>
<td>홍위병 (Red Guards)</td>
<td>문화 대혁명 (The Cultural Revolution)</td>
<td>중국 (China)</td>
<td>중구 현대 (Contemporary China)</td>
<td>레이펑 (Lei Feng)</td>
</tr>
<tr>
<td>리안시스템 (Li Yan)</td>
<td>당기 (The Cultural Revolution)</td>
<td>문화 대혁명 (The Cultural Revolution)</td>
<td>중국 (China)</td>
<td>경극 현대 (Contemporary China)</td>
<td>니콜라이 부하린 (Bukharin, Nikolai Ivanovich)</td>
</tr>
<tr>
<td>브루스 (Bruce)</td>
<td>세계경제세계정치 연구소 (The Institute of World Economics and World Political)</td>
<td>대숙청 (Great Purge)</td>
<td>소련 (Soviet Union)</td>
<td>서양 현대 (Contemporary Western)</td>
<td>니콜라이 부하린 (Bukharin, Nikolai Ivanovich)</td>
</tr>
<tr>
<td>문무 (Sun Wen)</td>
<td>중국 국민당 (Guomindang)</td>
<td>신해 혁명 (Xinhai Revolution)</td>
<td>중국 (China)</td>
<td>중국 근대 (Modern Times of China)</td>
<td>위안스카이 (Yuan Shikai)</td>
</tr>
</tbody>
</table>

※ Korean words translated into English in brackets.
※ 12 search results for scenario 5; just 5 results tabulated.
### 4.5.6 Search Result of Scenario 6

#### Scenario 6 – Query Results

<table>
<thead>
<tr>
<th>[Name_Of_Countries]</th>
<th>[Event_Name_Title_Of_Agreement]</th>
<th>[Name_Of_Continent_Peninsula]</th>
<th>[Name_Of_Countries2]</th>
<th>[Name_Of_State_City_Town]</th>
<th>[Languages_By_Countries]</th>
</tr>
</thead>
<tbody>
<tr>
<td>이집트 (Egypt)</td>
<td>출애굽 (Exodus)</td>
<td>북아프리카 (North Africa)</td>
<td>리비아 (Libya)</td>
<td>카이로 (Cairo)</td>
<td>아랍어 (Arabic)</td>
</tr>
<tr>
<td>프랑스 (France)</td>
<td>테르미도르 반동 (Thermidor coup d'État)</td>
<td>서유럽 (Western Europe)</td>
<td>영국 (United Kingdom)</td>
<td>파리 (Paris)</td>
<td>프랑스어 (French)</td>
</tr>
<tr>
<td>프랑스 (France)</td>
<td>68 학생 혁명 (68 Revolution)</td>
<td>서유럽 (Western Europe)</td>
<td>영국 (United Kingdom)</td>
<td>파리 (Paris)</td>
<td>프랑스어 (French)</td>
</tr>
<tr>
<td>프랑스 (France)</td>
<td>앵포르멜 (Informel)</td>
<td>서유럽 (Western Europe)</td>
<td>영국 (United Kingdom)</td>
<td>파리 (Paris)</td>
<td>프랑스어 (French)</td>
</tr>
<tr>
<td>프랑스 (France)</td>
<td>프로이센 프랑스 전쟁 (Franco-Prussian War)</td>
<td>서유럽 (Western Europe)</td>
<td>영국 (United Kingdom)</td>
<td>파리 (Paris)</td>
<td>프랑스어 (French)</td>
</tr>
</tbody>
</table>

※ Scenario 6: [Name_Of_Countries] at which [Event_Name_Title_Of_Agreement] occurred is located in the [Name_Of_Continent_Peninsula], which is adjacent to [Name_Of_Countries2]; its capital is [Name_Of_State_City_Town], [Languages_By_Countries] was used.

※ 264 search results for scenario 6; just 5 results tabulated.
### Scenario 7 – Query Results

*Scenario 7: The most famous thing in the [Name_Of_State_City_Town] is the [Monument_Name_Cultural_Asset_Name] that represents the genre of [Buildings_Facilities], which was produced in the period of [Period].

<table>
<thead>
<tr>
<th>Name_Of_State_City_Town</th>
<th>Monument_Name_Cultural_Asset_Name</th>
<th>Buildings_Facilities</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goyang-si</td>
<td>서삼릉 (Seosamneung Royal Tombs)</td>
<td>Royal Tomb</td>
<td>조선시대 (Period of Chosun Dynasty)</td>
</tr>
<tr>
<td>Guri-si</td>
<td>동구릉 (Donggureung Royal Tombs)</td>
<td>Royal Tomb</td>
<td>조선시대 (Period of Chosun Dynasty)</td>
</tr>
<tr>
<td>Gongju-si</td>
<td>무령왕릉 석수 (Stone Image of an Animal in the Royal Tomb of King Muryeong)</td>
<td>Stone Image of an Animal</td>
<td>백제시대 (Period of Baekje Kingdom)</td>
</tr>
<tr>
<td>Chungcheongnam-do</td>
<td>정림사지오층석탑 (Five storied Stone Pagoda of Jeongnimsa Temple Site)</td>
<td>Stone Pagoda</td>
<td>백제시대 (Period of Baekje Kingdom)</td>
</tr>
<tr>
<td>Iksan-si</td>
<td>미륵사지 석탑 (Stone Pagoda of Mireuksa Temple Site)</td>
<td>Stone Pagoda</td>
<td>백제시대 (Period of Baekje Kingdom)</td>
</tr>
</tbody>
</table>

※ Korean word translated into English in brackets.
※ 84 search results for scenario 7: just 5 results tabulated.
5. Resume

5.1 Resume (1/2): SDBT

1) A SDBT defines terms on the basis of properties structured by conceptual categories (classes).
   ① The property structure of a conceptual category (class) is the metadata schema of the terms which fall into the class.
   ② Thus all terms are defined according to the metadata schema of the class a term belongs.

2) SDBT employs taxonomy of the conceptual categories (classes) of terms having the same properties.

3) SDBT employs vocabulary term (vt) to establish relations between term and properties, among properties, and among terms.
5.2 Resume (2/2): SDBT Database & Ontology

1) For Semantic Search
   ① A semantic search is possible by converting SDBT data into RDF ontology and definition of inference rules.
   ② The SDBT-based ontology can be efficiently utilized for semantic retrieval.
   ③ The SDBT-based ontology is a new methodology for supporting information retrieval within a specific domain using expanded queries.

2) For Text Analysis
   ① SDBT can be used to mine topics from text or informal big data through applying well-defined semantic concepts to SDBT ontologies.
   ② Using SDBT ontologies, the relationships among topics or core words could be presented.

Thank you for your attention!!