Semantic Web

Generating Semantic Annotations

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Agenda

• Motivation
• Technical solution, illustrations, and extensions
  – Semantic annotation of text
  – Semantic annotation of multimedia
• Large example
• Summary
• References
MOTIVATION
Semantic Annotation

• Creating semantic labels within documents for the Semantic Web.

• Used to support:
  – Advanced searching (e.g. concept)
  – Information Visualization (using ontology)
  – Reasoning about Web resources

• Converting syntactic structures into knowledge structures
BORN in Philadelphia in 1844, Thomas Eakins is one of America’s few indisputably great painters.
• Manual annotation is the transformation of existing syntactic resources into interlinked knowledge structures that represent relevant underlying information.

• Manual annotation is an expensive process, and often does not consider that multiple perspectives of a data source, requiring multiple ontologies, can be beneficial to support the needs of different users.

• Manual annotation is more easily accomplished today, using authoring tools such as Semantic Word:
Bagram, Afghanistan (CNN) -- British commandos have unearthed a large weapons cache inside a "significant" al Qaeda cave complex in Afghanistan.

UK military officials say...

The cave system is still being searched but anti-aircraft, anti-tank and other heavy munitions have already been found.
Semi-automatic semantic annotation

- Semi-automatic annotation systems rely on human intervention at some point in the annotation process.

- The platforms vary in their architecture, information extraction tools and methods, initial ontology, amount of manual work required to perform annotation, performance and other features, such as storage management.

- Example: GATE (see in section 2.1 and 3).
Automatic semantic annotation

- Automatic semantic annotation is based on the automatic annotating algorithms: e.g., PANKOW (Pattern-based Annotation through Knowledge On the Web), C-PANKOW (Context-driven and Pattern-based Annotation through Knowledge on the Web) for texts; statistical algorithms for image and video annotations.

- However, annotations based on automatic algorithms mostly need to be proved and corrected after implementation of these algorithms.

- EXAMPLE of tools: OntoMat can provide fully automated annotation and interactive semi-automatic annotation of texts.
  - M-OntoMat is an automatic multimedia annotation tool (see 2.2 Multimedia Annotation).
  - ALIPR is a real-time automatic image tagging engine.
Automatic semantic annotation: OntoMat

- OntoMat-Annotizer was created by S. Handshuh, M. Braun, K. Kuehn, L. Meyer within OntoAgent project.

- OntoMat supports two modes of interaction with PANKOW-algorithm: (1) fully automatic annotation, and (2) interactive semi-automatic annotation.

- In the fully automatic mode, all categorizations with strength above a user-defined are used to annotate the Web content.

- In the interactive mode, the system proposes the top five concepts to the user for each instance candidate. Then, the user can disambiguate and resolve ambiguities (see the illustration below).
Automatic semantic annotation: OntoMat
• ALIPR stands for „Automatic Linguistic Indexing of Pictures—Real Time”

• It is an Automatic Photo Tagging and Visual Image Search

• ALIPR was developed in 2005 at Pennsylvania State University by Professors Jia Li and James Z. Wang and was published and made public in October 2006.

• ALIPR version 1.0 is designed only for color photographic images.

• After writing in the URL or after image upload, the tool automatically offers the tags for the image annotation (see illustration with a flower in the next slide)
Automatic semantic annotation: ALIPR

Top 15 Computer-Predicted Tags
ALIPR is like a child trying to learn about the world. Please help us to teach ALIPR. Check those correctly annotated words.

- food
- texture
- candies
- tissue
- pathology
- flower
- indoor
- dessert
- natural
- yellow
- micro_image
- rock
- man-made
- space
- orbit

Thought of other terms missed by ALIPR? Please add here, separated by commas ",,"

Optional information:
Picture title
URL to see related pictures
Copyright (hypertext ok)
ALIPR annotates images based on content.

First, it learnt to recognize the meaning of the tags before suggesting the correct labels. As part of the learning process, the researchers fed ALIPR hundreds of images of the same topic, for example “flower”. ALIPR analyzed the pixels and extracted information related to color and texture. It then stored a mathematical model for “flower" based on the cumulative data.

Later, when a user uploads a new picture of a flower, ALIPR compares the pixel information from the pre-computed models in its knowledge base and suggests a list of 15 possible tags.
Semantic Annotation Concerns

– Scale, Volume
  • Existing & new documents on the Web
  • Manual annotation
    – Expensive – economic, time
    – Subject to personal motivation
    – Schema Complexity

– Storage
  • support for multiple ontologies
  • within or external to source document?
  • Knowledge base refinement

– Access - How are annotations accessed?
  • API, custom UI, plug-ins
Technical solution

2.1 Annotation of text
   • Semi-automatic text annotation
   • GATE
   • KIM

2.2 Multimedia annotation
   • Levels of multimedia annotation
   • Tools for multimedia annotation
   • Multimedia ontologies
   • „Games with a purpose“
ANNOTATION OF TEXT
Annotation of text

• Many systems apply rules or wrappers that were manually created that try to recognize patterns for the annotations.
• Some systems learn how to annotate with the help of the user.
• Supervised systems learn how to annotate from a training set that was manually created beforehand.
• Semi-automatic approaches often apply information extraction technology, which analyzes natural language for pulling out information the user is interested in.
A Walk-Through Example: GATE

GATE is a leading NLP and IE platform developed in the University of Sheffield, consists of different modules:

- Tokeniser
- Gazetteer
- Sentence Splitter
- Part-of-Speech Tagger (POS-Tagger)
- Named Entity Recogniser (NE-Recognizer)
- OrthoMatcher (Orthographic Matcher)
- Coreference Resolution
The tokeniser splits the text into very simple tokens such as numbers, punctuation and words of different types:

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Semantic Gazetteer Lookup

The gazetteer lists used are plain text files, with one entry per line. Each list represents a set of names, such as names of cities, organizations, days of the week, etc.

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Sentence Splitter

The sentence splitter is a cascade of finite-state transducers which segments the text into sentences. This module is required for the tagger. The splitter uses a gazetteer list of abbreviations to help distinguish sentence-marking full stops from other kinds.

December gold was up $1.30 to $1,066.30 an ounce, after climbing overnight to another trading high of $1,072.00 an ounce.

Gold, which has gained more than 20% this year, was driven higher as the dollar fell to a 14-month low on speculation that U.S. interest rates will remain low for a longer-than-anticipated period of time.

The dollar index, which gauges the greenback's value against a basket of rival currencies, slid to a low of 75.45, marking its weakest level since August 2008.

The weak dollar also boosted oil prices, which rose above $75 a barrel for the first time this year.

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Part-of-Speech Tagger (POS-Tagger)

- POS-Tagger produces a part-of-speech tag as an annotation on each word or symbol.
- Neither the splitter nor the tagger are a mandatory part of the IE system, but the extra linguistic information they produce increases the power and accuracy of the IE tools.

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</table>
Ontology-aware NER (Named Entity Recogniser)

pattern-matching Grammars

The named entity recogniser consists of pattern-action rules, executed by the finite-state transduction mechanism. It recognizes entities like person names, organizations, locations, money amounts, dates, percentages, and some types of addresses.
OrthoMatcher = Orthographic Coreference

• The OrthoMatcher module adds identity relations between named entities found by the semantic tagger, in order to perform co-reference.

• The matching rules are only invoked if the names being compared are both of the same type, i.e. both already tagged as (say) organizations, or if one of them is classified as `unknown'. This prevents a previously classified name from being re-categorized.
Pronominal Coreference Resolution

- quoted text submodule
- pleonastic it submodule
- pronominal resolution submodule
Quoted Text Submodule

The quoted speech submodule identifies quoted fragments in the text being analyzed. The identified fragments are used by the pronominal coreference submodule for the proper resolution of pronouns such as I, me, my, etc. which appear in quoted speech fragments.

"They're like olives in a bottle," Fitzgibbon said of the IPOs. "It's always difficult to get the first one out but then the rest come easily."

Besides the expected stock offerings, Schwarzman said Blackstone in recent months has agreed to sell four additional companies in its portfolio, and is finalizing the sale of a fifth.

Unloading all five companies would pump $2.9 billion into Blackstone's investment funds, he said.

Blackstone is also scouring new investment opportunities after the dry spell wrought by the credit crisis. Schwarzman said lenders are again starting to provide loans for new deals — if not at the levels they did before the market soured.

"I think there are signs of life in the bank market," he said. "We can certainly do transactions in the $3 to $4 billion range."

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The pleonastic *it* submodule matches pleonastic occurrences of "*it*". Similar to the quoted speech submodule, it is a transducer operating with a grammar containing patterns that match the most commonly observed pleonastic *it* constructs.
The main functionality of the coreference resolution module is in the pronominal resolution submodule. This module finds the antecedents for pronouns and creates the coreference chains from the individual anaphor/antecedent pairs and the coreference information supplied by the OrthoMatcher.
• KIM = Knowledge and Information Management
• developed by semantic technology lab „Ontotext“
• based on GATE
• KIM performs IE based on an ontology and a massive knowledge base.
• KIM KB consists of above 80,000 entities (50,000 locations, 8,400 organization instances, etc.)

• Each location has geographic coordinates and several aliases (usually including English, French, Spanish, and sometimes the local transcription of the location name) as well as co-positioning relations (e.g. `subRegionOf`).

• The organizations have `locatedIn` relations to the corresponding Country instances. The additionally imported information about the companies consists of short description, URL, reference to an industry sector, reported sales, net income, and number of employees.
The KIM platform provides a novel infrastructure and services for:

- automatic semantic annotation,
- indexing,
- retrieval of unstructured and semi-structured content.
The most direct applications of KIM are:

- Generation of meta-data for the Semantic Web, which allows hyper-linking and advanced visualization and navigation;
- Knowledge Management, enhancing the efficiency of the existing indexing, retrieval, classification and filtering applications.
• The automatic semantic annotation is seen as a named-entity recognition (NER) and annotation process.
• The traditional flat NE type sets consist of several general types (such as Organization, Person, Date, Location, Percent, Money). In KIM the NE type is specified by reference to an ontology.
• The semantic descriptions of entities and relations between them are kept in a knowledge base (KB) encoded in the KIM ontology and residing in the same semantic repository. Thus KIM provides for each entity reference in the text (i) a link (URI) to the most specific class in the ontology and (ii) a link to the specific instance in the KB. Each extracted NE is linked to its specific type information (thus Arabian Sea would be identified as Sea, instead of the traditional – Location).
KIM plug-in for the Internet Explorer browser
MULTIMEDIA ANNOTATION
Multimedia Annotation

- Different levels of annotations
  - Metadata
    - Often technical metadata
    - EXIF, Dublin Core, access rights
  - Content level
    - Semantic annotations
    - Keywords, domain ontologies, free-text
  - Multimedia level
    - Low-level annotations
    - Visual descriptors, such as dominant color
Metadata

• refers to information about technical details
• creation details
  – creator, creationDate, …
  – Dublin Core
• camera details
  – settings
  – resolution
  – format
  – EXIF
• access rights
  – administrated by the OS
  – owner, access rights, …
Content Level

• Describes what is depicted and directly perceivable by a human
• usually provided manually
  – keywords/tags
  – classification of content
• seldom generated automatically
  – scene classification
  – object detection
• different types of annotations
  – global vs. local
  – different semantic levels
Global vs. Local Annotations

- Global annotations most widely used
  - flickr: tagging is only global
  - organization within categories
  - free-text annotations
  - provide information about the content as a whole
  - no detailed information

- Local annotations are less supported
  - e.g. flickr, PhotoStuff allow to provide annotations of regions
  - especially important for semantic image understanding
    - allow to extract relations
    - provide a more complete view of the scene
  - provide information about different regions
  - and about the depicted relations and arrangements of objects
Semantic Levels

• Free-Text annotations cover large aspects, but less appropriate for sharing, organization and retrieval
  – Free-Text Annotations probably most natural for the human, but provide least formal semantics

• Tagging provides light-weight semantics
  – Only useful if a fixed vocabulary is used
  – Allows some simple inference of related concepts by tag analysis (clustering)
  – No formal semantics, but provides benefits due to fixed vocabulary
  – Requires more effort from the user

• Ontologies
  – Provide syntax and semantic to define complex domain vocabularies
  – Allow for the inference of additional knowledge
  – Leverage interoperability
  – Powerful way of semantic annotation, but hardly comprehensible by “normal users”
Tools

• Web-based Tools
  – flickr
  – riya

• Stand-Alone Tools
  – PhotoStuff
  – AktiveMedia

• Annotation for Feature Extraction
  – M-OntoMat-Annotizer
flickr

- Web2.0 application
- tagging photos globally
- add comments to image regions marked by bounding box
- large user community and tagging allows for easy sharing of images
- partly fixed vocabularies evolved
  - e.g. Geo-Tagging
• Similar to flickr in functionality
• Adds automatic annotation features
  – Face Recognition
    • Mark faces in photos
    • associate name
    • train system
    • automatic recognition of the person in the future
PhotoStuff

• Java application for the annotation of images and image regions with domain ontologies
• Used during ESWC2006 for annotating images and sharing metadata
• Developed within Mindswap
AktiveMedia

- Text and image annotation tool
- Region-based annotation
- Uses ontologies
  - suggests concepts during annotation
  - providing a simpler interface for the user
- Provides semi-automatic annotation of content, using
  - Context
  - Simple image understanding techniques
  - flickr tagging data
M-OntoMat-Annotizer

- Extracts knowledge from image regions for automatic annotation of images
- Extracting features:
  - User can mark image regions manually or using an automatic segmentation tool
  - MPEG-7 descriptors are extracted
  - Stored within domain ontologies as prototypical, visual knowledge
- Developed within aceMedia
- Currently Version 2 is under development, incorporating
  - true image annotation
  - central storage
  - extended knowledge extraction
  - extensible architecture using a high-level multimedia ontology
Multimedia Ontologies

• Semantic annotation of images requires multimedia ontologies
  – several vocabularies exist (Dublin Core, FOAF)
  – they don’t provide appropriate models to describe multimedia content sufficiently for sophisticated applications
• MPEG-7 provides an extensive standard, but especially semantic annotations are insufficiently supported
• Several mappings of MPEG-7 into RDF or OWL exist
  – now: VDO and MSO developed within aceMedia
  – later: Engineering a multimedia upper ontology
aceMedia Ontology Infrastructure

- aceMedia Multimedia Ontology Infrastructure
  - DOLCE as core ontology
  - Multimedia Ontologies
    - Visual Descriptors Ontology (VDO)
    - Multimedia Structures Ontology (MSO)
    - Annotation and Spatio-Temporal Ontology augmenting VDO and MSO
  - Domain Ontologies
    - capture domain specific knowledge
Visual Descriptors Ontology

• Representation of MPEG-7 Visual Descriptors in RDF
  – Visual Descriptors represent low-level features of multimedia content
  – e.g. dominant color, shape or texture
• Mapping to RDF allows for
  – linking of domain ontology concepts with visual features
  – better integration with semantic annotations
  – a common underlying model for visual and semantic features
Visual Knowledge

• Used for automatic annotation of images
• Idea:
  – Describe the visual appearance of domain concepts by providing examples
  – User annotates instances of concepts and extracts features
  – features are represented with the VDO
  – the examples are then stored in the domain ontology as prototype instances of the domain concepts
• Thus the names: prototype and prototypical knowledge
Extraction of Prototype

```xml
<?xml version='1.0' encoding='ISO-8859-1' ?>
<Mpeg7 xmlns...>
  <DescriptionUnit xsi:type = "DescriptorCollectionType">
    <Descriptor xsi:type = "DominantColorType">
      <SpatialCoherency>31</SpatialCoherency>
      <Value>
        <Percentage>31</Percentage>
        <Index>19  23  29 </Index>
        <ColorVariance>0  0  0 </ColorVariance>
      </Value>
    </Descriptor>
  </DescriptionUnit>
</Mpeg7>
```
Transformation to VDO

<?xml version='1.0' encoding='ISO-8859-1' ?>
<Mpeg7 xmlns:...>
<DescriptionUnit xsi:type = "DescriptorCollectionType">
<Descriptor xsi:type = "DominantColorType">
<SpatialCoherency>31</SpatialCoherency>
<Value>
<Percentage>31</Percentage>
<Index>19  23  29 </Index>
<ColorVariance>0  0  0 </ColorVariance>
</Value>
</Descriptor>
</DescriptionUnit>
</Mpeg7>

<vdo:ScalableColorDescriptor rdf:ID="vde-inst1">
<vdo:coefficients> 0 [... ] 1 </vdo:coefficients>
<vdo:numberOfBitPlanesDiscarded> 6 </vdo:numberOfBitPlanesDiscarded>
<vdo:numberOfCoefficients> 0 </vdo:numberOfCoefficients>
</vdo:ScalableColorDescriptor>

<vdoext:Prototype rdf:ID="Sky_Prototype_1">
<rdf:type rdf:resource="#Sky"/>
<vdoext:hasDescriptor
     rdf:resource="#vde-inst1"/>
</vdoext:Prototype>
Using Prototypes for Automatic Labelling

Knowledge Assisted Analysis
Multimedia Structure Ontology

- RDF representation of the MPEG-7 Multimedia Description Schemes
- Contains only classes and relations relevant for representing a decomposition of images or videos
- Contains Classes for different types of segments
  - temporal and spatial segments
- Contains relations to describe different decompositions
- Augmented by annotation ontology and spatio-temporal ontology, allowing to describe
  - regions of an image or video
  - the spatial and temporal arrangement of the regions
  - what is depicted in a region
Games with a purpose

Are proposed to masquerade the core tasks of weaving the Semantic Web behind online, multi-player game scenarios, in order to create proper incentives for human users to get involved.

Pioneer work: Luis von Ahn „Games with a purpose“

Games for semantic annotations:
ESP Game: Annotating Images

What do you see?

taboo words
net
nert
tree

Matched on: leaf

guesses
leaves
leaf
OntoTube: Annotating YouTube

OntoTube: Annotating YouTube videos

Tim Berners Lee on the Semantic Web

Director, World Wide Web Consortium

Is this video fiction or non-fiction?

YOUR AGREED ON - NON FICTION

SKIP OK
OntoPronto: Annotating Wikipedia

Boston Grammar School
Boston Grammar School is a selective school for boys aged 11 to 18, recently admitting girls aged 16 to 18, in Boston, Lincolnshire. The school was founded by charter of Philip and Mary in 1555. The oldest part of the school was, built in 1567 and formerly referred to as the "big school", is now used as the school library. Boston Grammar School was the model for Boston Latin School, the first ...

Is this Wikipedia page about a:

- single object or happening
- instance

or rather describing a:

- set/type of objects
- class

hint

"Dog" is a class (as several entities of this class exist)
"Lassie" is an instance

Starting Singleplayer mode ...
ILLUSTRATION BY A LARGE EXAMPLE
Step 1: Opening the document

Open the document or write in the URL:
Step 2: Creating the Pipeline

Create pipeline for NLP processing by choosing the NLP applications, giving in the resources you want to process and appropriate parameters for them, then run this application:
Step 3: Proving the automatic annotations

Prove the annotations made automatically and add your changes:

The Semantic Technology Institute (STI) Innsbruck, formerly known as CERI Innsbruck, was founded by Univ-Fr. Dr. Dieter Fensel in 2002 and has developed into a challenging and dynamic research institute of approximately 60 people. STI Innsbruck collaborates with an international network of institutes in Asia, Europe, and the USA, as well as with global industrial partners.

STI Innsbruck is actively involved in multiple national and EU funded projects, with these projects enabling us to meet society’s demand for innovative technological developments and to contribute back scientifically to supporters, sponsors and society. STI Innsbruck has three overlapping streams, namely Research, Teaching, and Business Development, providing a well balanced infrastructure in order to successfully utilize and pass on scientific achievement.
Step 4: Correcting the automated annotations:

Click on the items you want to change with the right mouse button and then change the annotation, add new annotation, or remove the existing annotation:
Annotation window

Choose from the tags offered or write in your annotation

Remove annotation

Change the length of annotation

Search for the entries of the expression in the whole text and annotate them

STI Innsbruck

First Prev. Next Annotate Undo
Step 5: Done!

Annotation after implementation of NLP techniques:

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Final, manually-proved annotation:

The Semantic Technology Institute (STI) Innsbruck, formerly known as DERI Innsbruck, was founded by Univ.-Prof. Dr. Dieter Fensel in 2002 and has developed into a challenging and dynamic research institute of approximately 60 people. STI Innsbruck collaborates with an international network of institutes in Asia, Europe and the USA, as well as with global industrial partners.
SUMMARY
Summary

- The population of ontologies is a task within the semantic content creation process as it links abstract knowledge to concrete knowledge.
- This knowledge acquisition can be done manually, semi-automatically, or fully automatically.
- There is a wide range of approaches that carry out semi-automatic annotation of text: most of the approaches make use of natural language processing and information extraction technology.
- In the annotation of multimedia aim at closing the so-called semantic gap, i.e. the discrepancy between low-level technical features which can be automatically processed to a large extent, and the high-level meaning-bearing features a user is typically interested in.
- Low level semantics can be extracted automatically, while high level semantics are still a challenge (and require human input to a large extent).
REFERENCES
• **Mandatory Reading:**

• **Further Reading:**
  – GATE: [http://gate.ac.uk/overview.html](http://gate.ac.uk/overview.html)
  – M-OntoMat-Annotizer: [http://www.acemedia.org/aceMedia/results/software/m-ontomat-annotizer.html](http://www.acemedia.org/aceMedia/results/software/m-ontomat-annotizer.html)
  – ALIPR: [http://www.alipr.com](http://www.alipr.com)
References


– Games with a purpose: http://www.gwap.com
– OntoGame: http://ontogame.sti2.at/
References

• Wikipedia links:
  – http://en.wikipedia.org/wiki/Games_with_a_purpose
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Questions?