Ubiquitous Computing Laboratory
Kyung Hee University, Korea

# ACTIVITY RECOGNITION GROUP

Research summary of Students

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Advisors. Prof. Young-Koo Lee, Prof. Tae-Seong Kim and Prof. Sungyoung Lee

# RESEARCH SUMMARY

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Research summary of Uzair Ahmad, Ph.D. Candidate
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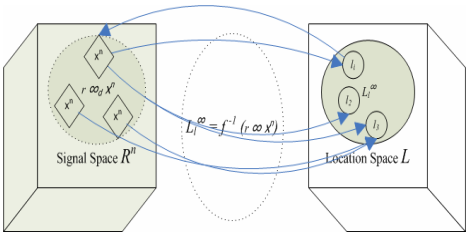
## Basic Concept

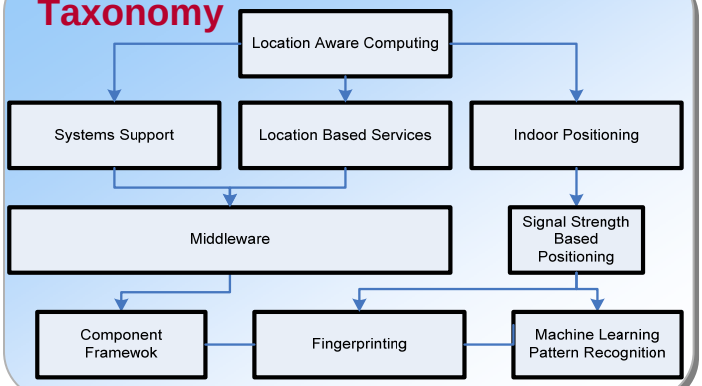
Mapping relationship between the Signal Space and the physical Space

## Problem Statement




Learning the Inverse function $f^{-1}$, with limited number of samples

## Taxonomy




## Applications

- Multimedia Content Adaptation
- Nearest Object Finder, Guide, Escort, Advertising, Games, Messaging…

## Issues

- **Flexibility**
  - Location Resolution
  - PR Model Selection
  - Repair
  - Scalability
- **Time to develop**
  - Tedious Development Life Cycle
- **Integration**
  - Distributed Components
  - Sensor Data Collection & Management, PR Model, Middleware, End User LBS

## Methodology

- Development of Efficient ML Methods
  - To reduce ‘time to develop’
  - To achieve flexibility
- Component Technology based Middleware Support

## Contributions

Integrated Middleware Infrastructure for Rapid development of Custom Resolution Indoor Location Systems and Location Based Services.

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Research summary of **Phan Tran Ho Truc**, Ph.D. Candidate

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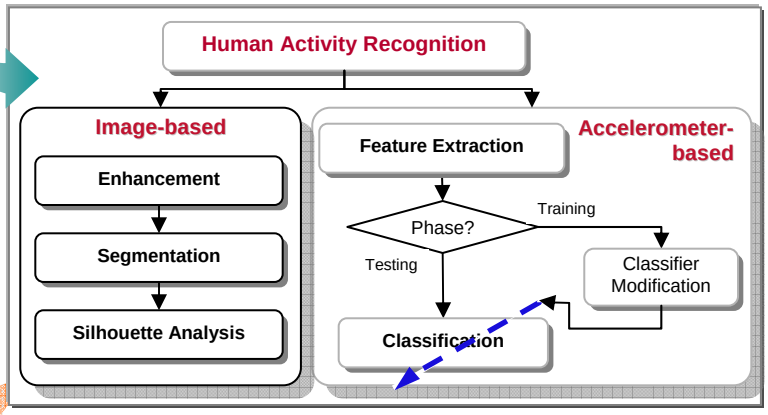
## Goal and Applications

- To accurately provide information about human activities using video and accelerometer data, e.g., walking, playing golf, washing hands.
- Sport analysis, patient monitoring, u-healthcare system, etc.

## Selected Publications

1. P. T. H. Truc et al., "*Vessel Enhancement using Decimation-free Directional Filter Bank*", US Patent (application number: 11/892,030).
2. P. T. H. Truc et al., "*Vessel Enhancement Filter using Directional Filter Bank*", Elsevier CVIU (accepted with revision).
3. P. T. H. Truc et al., "*Vessel Enhancement in Angiography Images using Decimation-free DFB*", IPCV'07, 2007.
4. P. T. H. Truc et al., "*Automatic Bone Segmentation from CT Images using Chan-Vese Multiphase Active Contour*", J. Biomed. Eng. Res., vol. 28, 2007.
5. P. T. H. Truc et al., "*A Density Distance Augmented Chan-Vese AC for CT Bone Segmentation*", IEEE EMBC 2008 (to be appeared).




| Block | Description | Our Contributions |
|---|---|---|
| Enhancement | To enhance the accessibility of the objects of interest. (This step is optional for the above-mentioned applications.) | We proposed a novel directional image-based filter for applications of line-like object enhancement, e.g., blood vessels [1-3]. |
| Segmentation | To extract the objects of interest by identifying their silhouettes. (This is our main research area.) | We utilized active contour (AC) approaches such as geometric, geodesic, or Chan-Vese ACs, etc. [4].<br>Also, we proposed a novel model of image homogeneity- and density distance-driven AC for better performance [5]. |
| Silhouette Analysis | A series of objects' silhouettes obtained by segmenting sequential video frames are compared with different activities' models to find the best match. | Matching techniques based on LMS errors. (Future work.) |
| Feature Extraction | To extract from acceleration data the most distinguishable features that best differentiate distinct activities. | We proposed to use a general feature vector consisting of statistical features, autoregressive model's coefficients, and wavelet coefficients. |
| Classification | To classify activities based on the extracted features. | We proposed to use neural networks for its simplicity. |

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Research summary of **Donghai Guan**, Ph.D. Candidate

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## Basic Concept

*Semisupervised Learning: Learning with both labeled and unlabeled data.*
*Active Learning: Selecting informative/valuable data for learning.*

## Motivation

• Learning with less training data, as well as less human's labeling effort

## Methodology

Ensemble Learning + Co Training - > Ensemble Based Co Training (ENCOTR)

Advantage: Co-training has intrinsic limitation for the data to learn. The data has to be represented by two different and independent views. That means the features of data have to include two different subsets and each subset must be enough for learning. Through combined with Ensemble learning, this limitation is overcome.

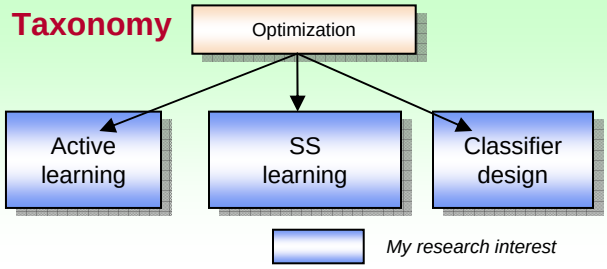
Committee-based Active Learning + Probability Theory
> Probability Based Committee-based Active Learning.

Advantage: Committee-based active learning is lack of mathematical proof. It is heuristic. Through combine with probability theory, the performance is expected to be improved.

## Problem Statement and Related Work

In Many applications, data annotation is very expensive and time-consuming. Therefore, how to get good recognition/learning performance with less labeled data (less labeling effort) is a hot topic. Related work mainly includes semisupervised learning and active learning.

## Taxonomy




## Publication

Donghai Guan et al. IJCNN 2008
Donghai Guan et al. FUZZ-IEEE 2008
Donghai Guan et al. RTCSA 2007

## Contributions

Developing new semi-supervised learning method.
Utilizing semi-supervised learning for activity recognition system.
Data Editing using semi-supervised learning.

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Research summary of **Jehad Sarkar**, Ph.D. Candidate

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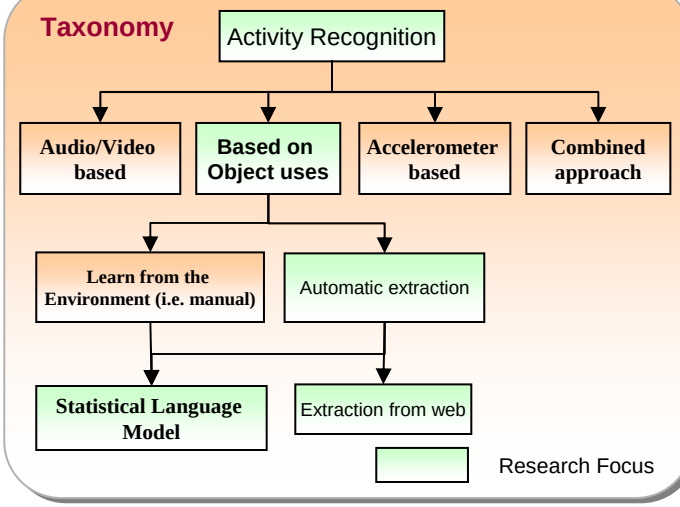
## Motivation

- Recognition of Activities of Daily Living (ADL) through a stream of sensor data in an unsupervised environment.
- Mine activity model from the web.

## Methodology

- Statistical Language Model (SLM) of Information Retrieval
- The purpose of statistical language modeling (SLM) is to improve the performance of various Natural Language (NL) applications by capturing regularities of NL. It estimates the probability distribution over a various linguistic units, such as words, sentences and whole documents.
- Our focus is to retrieve web pages from WWW, describe how to perform an activity and transform these into SLM. This model will serve as Activity model.
- In addition to this we also intend to use SLM for ranking the activities based on the environmental sensor (sensors attached with daily appliances) such that improved accuracy can be achieved.

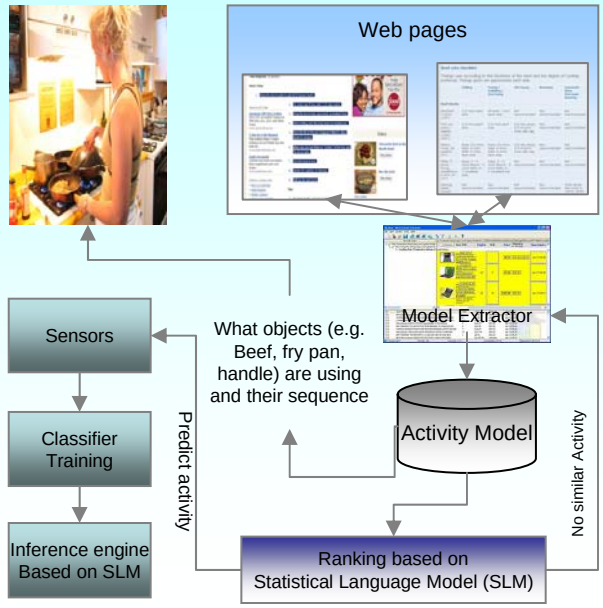
## Taxonomy




## Problem Statement and Related Work

- There are thousands of ADLs. The system that uses supervised learning (human labeling) is not sufficient. We need activity model for this purpose. By activity model we mean the association between low level and high level activity and association between object uses and activity.
- A lot of web pages exists in WWW describe how to perform an activity, what object to use and how to use them. My main research focus is to extract these directions in a meaningful way such that we can use these information for detection of ADL.
- Intel Research unit has published few papers on Activity Modeling.

## Expected model




## Contributions

•Activity Modeling

•Utilization of Statistical Language model of Information Retrieval in activity recognition area.

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Research summary of **Thang Nguyen Duc**, Ph.D. Candidate

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## 1. Motivation

Develop and Implement an efficient system that can perform Human Activity Recognition using stereo data rather than using binary 2D silhouettes as ordinary ways.

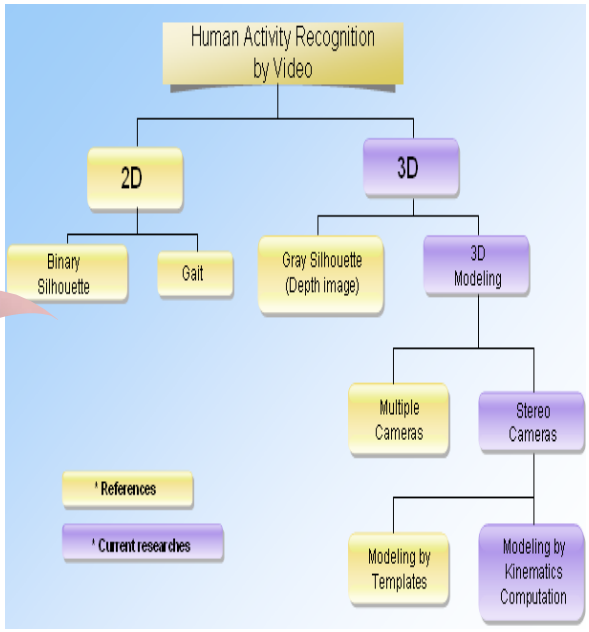
## 2. Problem Statement and Related Work

Nowadays, most of video-based methods for activity recognition focus on 2D binary silhouettes using only one cameras. These techniques face a lot of difficulty, especially for different view recognition.

For newest researches on 3D-video based activity recognition, they work with multiple cameras system, it 's so complicated and not scalable.

Our developed system will solve these disadvantages with stereo camera approach.

## 3. Taxonomy




## 4. Methodology

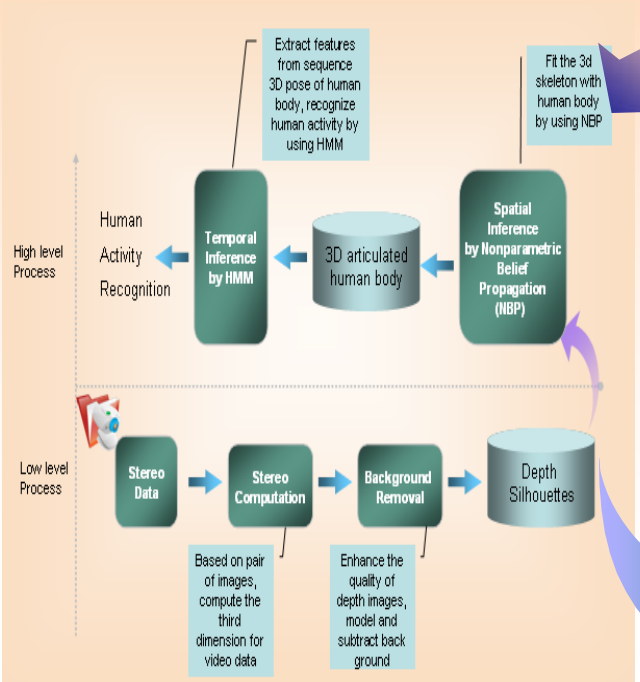
**Stereo Computation:-**From pair of pictures of left a right cameras, compute the disparity between pixels pixels, and then estimate distance between cameras and objects, present depth on gray scale images.

**Background Removal:-** Model and Remove background

**Estimate Depth Silhouettes :-** Extract interesting depth silhouettes, normalize the size and then rectify with binary silhouettes.

**Spatial Inference: -** Fit the 3D articulated skeleton with human body by NBP

**Temporal Inference: -** From a sequence of 3D skeleton of human body, use HMM to learn and then retrieve activity




## 5.Expected Contributions

Activity recognition Engine based on Stereo cameras, that can be used in case lack of sensor devices attached to human body or environment, but still recognize activity well. Main target is to support U-Health Care Disco Project, or Robotic Development

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Research summary of **Roshan Maharjan**, MS Student

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## 1. Basic Concept

• *Ontology Repositories* key technologies:- Ontology storage, reasoning mechanism and query for data..

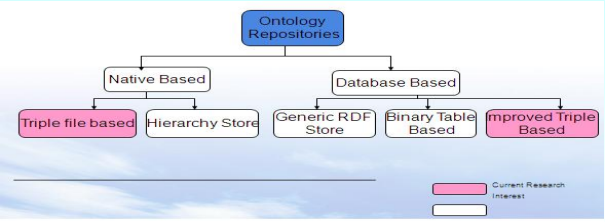
## 2. Problem Statement and Related Work

Current native based stores does not support most OWL features. Current stores degrades significantly for Flash memories since specific characteristics like fast read speed, no in place update.

## 3. Motivation

With the advent of OWL language, most of the RDF storage are being extended to support OWL storage.
Since OWL adds more vocabularies for describing properties and classes, increases reasoning complexity.
Furthermore, emerging database technologies like flash memory disks need different storage structure to exploit its characteristics like fast read speed etc.

## 4. Taxonomy




## 5. Methodology

***Requirements:***

Query language support:- SPARQL, a w3c recommendation as a standard language to query RDF data.
Choose native database based store in stead of in-memory/RDBMS keeping scalability in mind.
Support basic features of OWL i.e OWL Lite like cardinality, subclassof, subproperty of etc.

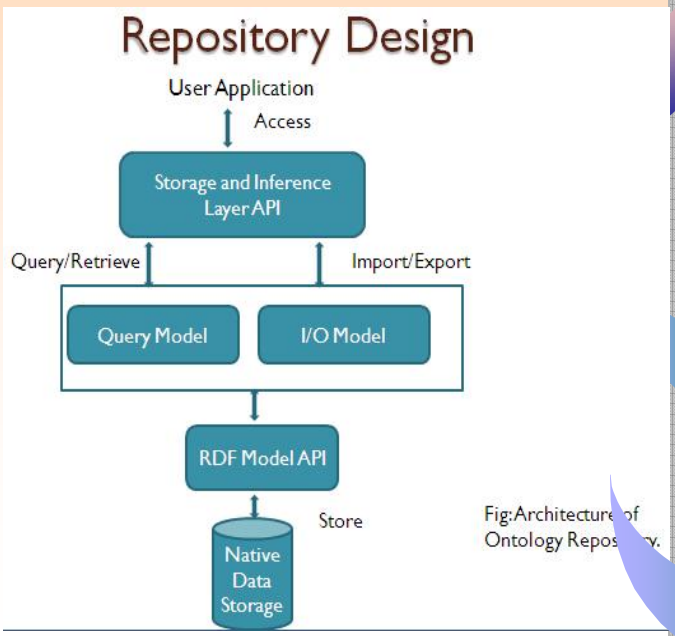



Fig:Architecture of Ontology Repos y.

## 6. Applications

- Large business applications.
- Semantic web applications

## 7.Expected Contributions

**Improve existing repositories for more efficient storage and reasoning.**
**Propose repositories for emerging database technologies like flash memory based systems.**

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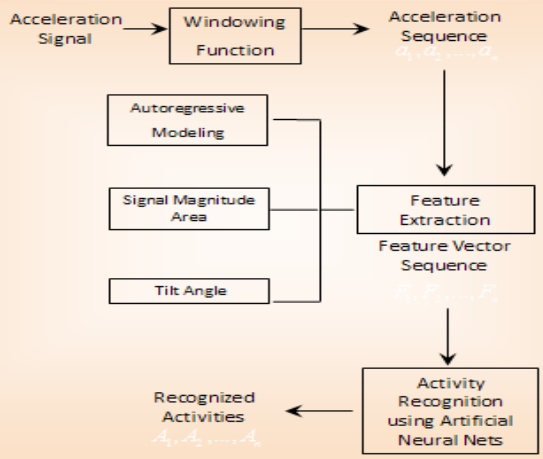
## Basic Concept

Human Activity Recognition using 3-D body worn accelerometers

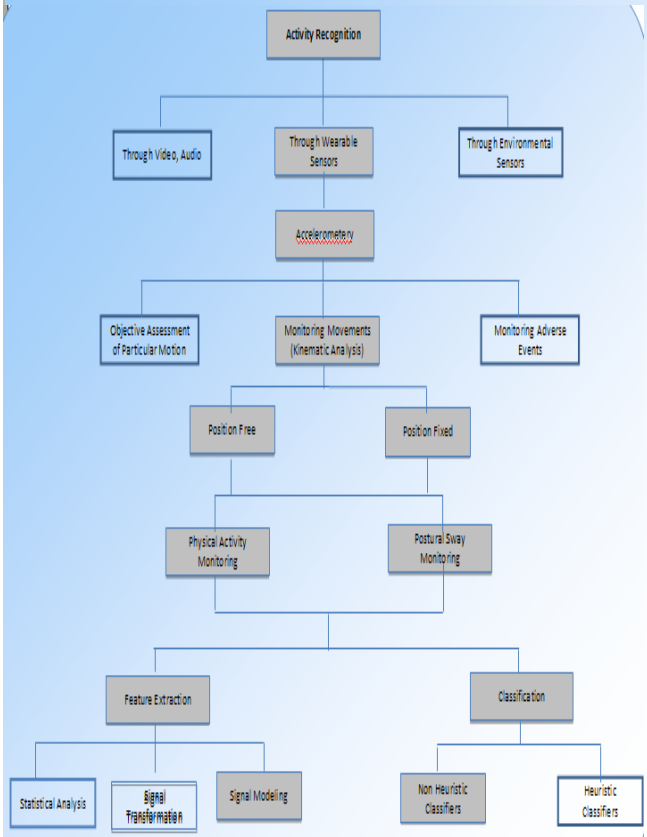
## Problem Statement

- Model the acceleration signal and use The model coefficients as features for Classification
- Achieving acceptable recognition rate Independent of the sensor's position on User's body.

## Methodology




## Taxonomy




## Contributions

Human Activity Recognition Using 3-D accelerometers Through Augmented AR Coefficients and Artificial Neural Nets

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Research summary of Pham Thi Thu Thuy, MS Student
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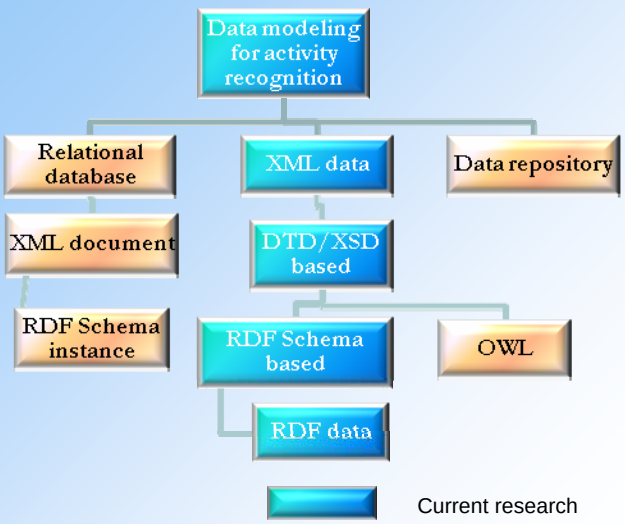
## 1. Motivation

Adding machine-understandable metadata to web resources. These metadata, when handled by intelligent agents or applications, enable automatic information processing and improve information retrieval, sharing, aggregation, or management.

## 2. Problem Statement and Related Work

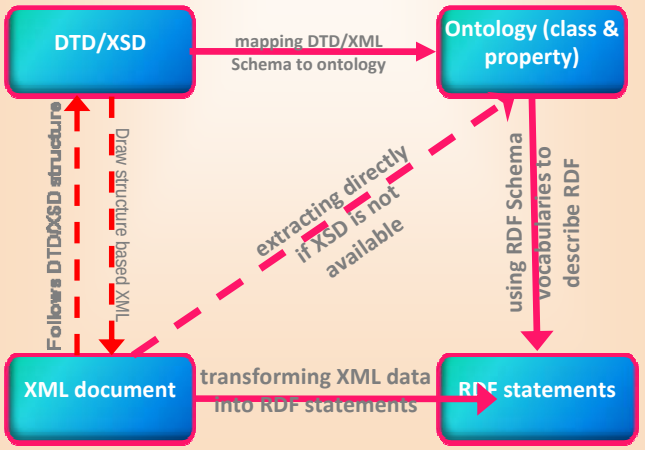
- Most of data on the current web are stored in XML which cannot be understood by the machines. Moreover, there are small ontologies in the current web in RDF or OWL.
- Most existing approaches provide new RDF/OWL syntaxes for XML which require human intervention and bear little meaning.
- Our proposed procedure automatically transforms XML data into existing RDF while keeping XML structure and adding more semantics about data.

## 3. Taxonomy




## 4. Methodology

**DTD/XSD mapping to RDF Schema:** Map element definitions to class, property, data-type and their relationships in RDF Schema.
**XML transforming:** Transform XML data into existing RDF statements based RDF Schema vocabulary
**Implementing results:** RDF triples, RDF graph and RDF file.
**Validate RDF result:** Use W3C validate services to validate RDF file to ensure the validation of result so that it can be used directly by applications without changes and human interaction.




## 5.Expected Contributions

- Automatically extract data on the current web to ontology based RDF data and OWL.
- Provide common ontology for the repository of activity recognition.
- Data will be retrieved by high-level query languages (RQL, SPARQL) and reused by other machines.

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