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"Generation of A Learning Pathway for A Learning Material"

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Abstract
The Metadata for educational resources helps to understand the details of learning object used on a website. From the IEEE Learning Object Metadata there are various metadata which we can extract automatically. Still there are metadata like interactivity type, interactivity level and Learning Path for which automatic extraction is not identified. Our research will also focus on the automatic extraction of the learning path. Learning Path will help Students to know the pre study and post study topics and it will help teachers to explain the topic by going through sequence.
Keywords:- Web-based learning, Learning material, e-Learning, Learning path, Pre study topics, Pre learning topics, Post learning topics, Post study topics, Learning object, Learning Object Metadata

I. INTRODUCTION
Learning path generation is our research area. One topic has many pre learning and post learning topics. That describes a Learning Path of that particular topic. We are generating learning path for topics.
Metadata for educational resources helps to understand the details of learning object used on a website. Each student has different grasping power and has different choices for studying. Same way for teachers, it's difficult to find best suitable material with respect to the students' pre knowledge and interest. By going through learning path it will be easy to understand topics for students. And for teachers it will be easy to explain.

Learning Object
A learning object is "a collection of content items, practice items, and assessment items that are combined based on a single learning objective".
Learning objects go by many names, including content objects, chunks, educational objects, information objects, intelligent objects, and knowledge bits, knowledge objects, learning components, media objects, and reusable curriculum components, reusable information objects, and reusable learning objects, testable reusable units of cognition, training components, and units of learning.

Examples of Learning object
The best way to understand what a learning object is, and why they matter, is to look at examples. Following are some examples of learning objects:
- Electronic calculators
- Animations
- Tutorials
- Text entries
- Bibliographies
- Audio clips
- Video clips
- Quizzes
- Photographs
- Illustrations
- Diagrams
- Graphs and charts
- Maps
- Assessments

Learning Object Metadata
Metadata is data that describes other data. It summarizes basic information about data, which can make finding and working with particular instances of data easier.

Learning Object Metadata (LOM) is a metadata standard to describe educational resources. LOM is a data model, usually encoded in XML, used to describe a learning object and similar digital resources used to support learning. It is nothing but a description of a learning object.

Metadata standards

It is recommended that the learning objects should be associated with some common metadata standard.
Some metadata standards are listed below:

- IEEE LOM, http://ltsc.ieee.org/wg12/index.html
- DCMI, http://dublincore.org/
- IMS, http://www.imsglobal.org/
- SCORM, http://www.adlnet.gov/scorm/index.cfm
- CanCore, http://www.cancore.ca/
- ADL, http://www.adlnet.org

We are going to focus on IEEE LOM.

IEEE Schematic representation of the hierarchy of elements in the LOM data model

The LOM comprises a hierarchy of elements shown in figure. At the first level there are nine categories, each of which contains sub-elements; these sub-elements may be simple elements that hold data, or may themselves be aggregate elements, which contain further sub-elements. The semantics of an element are determined by its context: they are affected by the parent or container element in the hierarchy and by other elements in the same container.

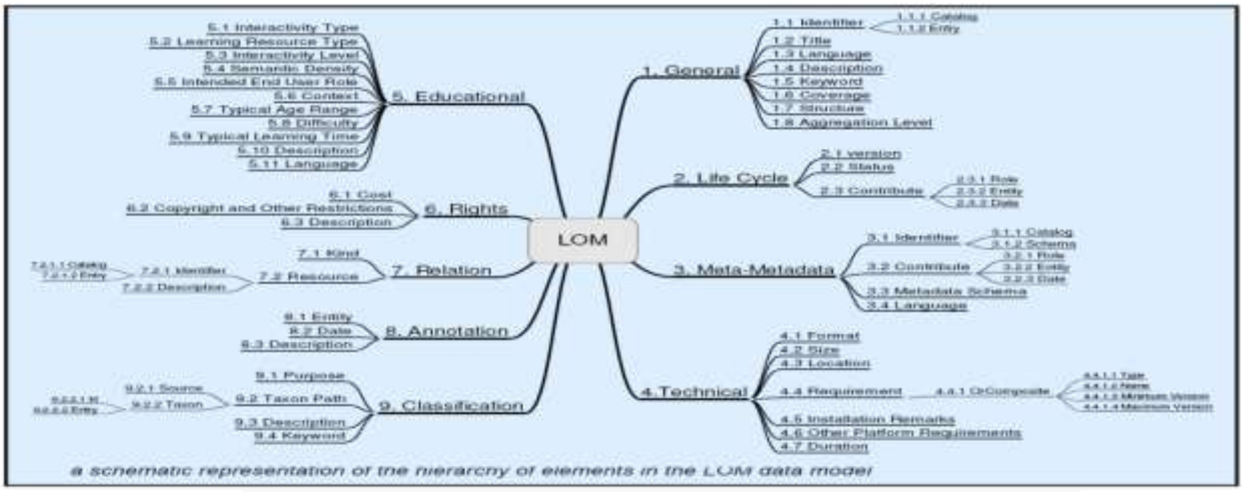

Fig.1: IEEE Schematic representation of the hierarchy of elements in the LOM data model

Categories of metadata

There are nine categories of IEEE LOM. They are described below.

Table I: Categories of IEEE LOM

1. General	Descriptive information of the learning object as a whole, such as: identifier, title, language, description, keyword, coverage, structure, aggregation level.
2. Life-cycle	Elements related to the creation or revision history of the learning object as well as information about those who have contributed to the development, creation, revision of the learning object.
3. Meta-metadata	Information regarding the creation of the metadata record.
4. Technical	The category consists of elements that describe the technical characteristics of the learning object such as the format, size, location and technical requirements.
5. Educational	The educational category aggregates elements regarding pedagogical and educational information about the use of a learning object. Such elements include: Interactivity type, Learning resource type, Interactivity level, Semantic density, Audience or Intended end user role, Context, Typical age range, Difficulty, Typical learning time, Description, Language.
6. Rights	The rights category includes information regarding the intellectual property rights and conditions of use of the learning object.
7. Relation	The relation category presents information about the relationship of the described learning object with other objects.
8. Annotation	The annotation category provides a comment regarding the use of learning objects.
9. Classification	The classification category classifies the content of the learning object based on an appropriate classification system.

We are going to focus on education category of LOM.

Elements of learning object metadata of education category
There are following elements of learning object metadata of education category.

Table II: Elements of LOM of education category

Interactivity Type (IEEE 1484.12.1-2002)	Active: Active learning (e.g., learning by doing) is supported by content that directly induces productive action by the learner. Expositive: Expositive learning (e.g., passive learning) occurs when the learner's job mainly consists of absorbing the content exposed to them. Mixed: A blend of active and expositive interactivity types.
Learning Resource Type (IEEE best practice)	exercise, simulation, questionnaire, diagram, figure, graph, index, slide, table, narrative text, exam, experiment, problem statement, self assessment, lecture
Interactivity Level (IEEE 1484.12.1-2002 but meaningful only in community practice)	very low, low, medium, high, very high
Semantic Density (IEEE 1484.12.1-2002 but meaningful only in community practice)	very low, low, medium, high, very high
Intended End User Role (IEEE 1484.12.1-2002)	Teacher student author learner Manager
Context (IEEE 1484.12.1-2002)	School higher education training Other
Typical Age Range	(range)
Difficulty (IEEE 1484.12.1-2002 but meaningful only in a context of a community)	very easy easy medium difficult very difficult
Typical learning time	open text element
Description	open text element
Language	standardized def.

II. PROBLEM STATEMENT

One Learning Material covers many topics and concepts. For e-learners, it will be difficult to understand particular topic without properly knowing its prerequisites topics. A Learning Path Way of a topic is needed by going through which learner can easily get solutions for their problems with clear understanding.

III. PROPOSED MODEL

Learning pathway is described as the chosen route, taken by a learner through a range of (commonly) e-learning activities, which allows them to build knowledge progressively. With learning pathways, the control of choice moves away from the tutor to the learner. "The sequence of intermediate steps from preconceptions to target model form what Scott (1991) and Niedderer and Goldberg (1995) have called a learning pathway.
Learning Pathways will give a learner answers for many questions, which are described below.

- When a Lerner studies a topic, they have particular purpose in mind, which means they need to narrow their topic. How might they narrow that topic?
- When a learner studies a topic, they need to research it and need to find sources which will give them great information. What sources could give them great information about that topic?
- When a learner studies a topic, they use key words which are important for understanding that topic. What Keywords they need to understand to talk about that topic in a smart way?

In Short Learning Path is the ideal sequence of learning activities that drives learners to reach proficiency in their result in the shortest possible time. By looking at learning as a complete process rather than a single event, a Learning Path enables learners and teachers to find new ways to drive out time, waste and variability in training which leads to improved results, reduced costs and reduce time.

Proposed Model

Fig.2 shows proposed model for generating learning pathway of a particular topic.

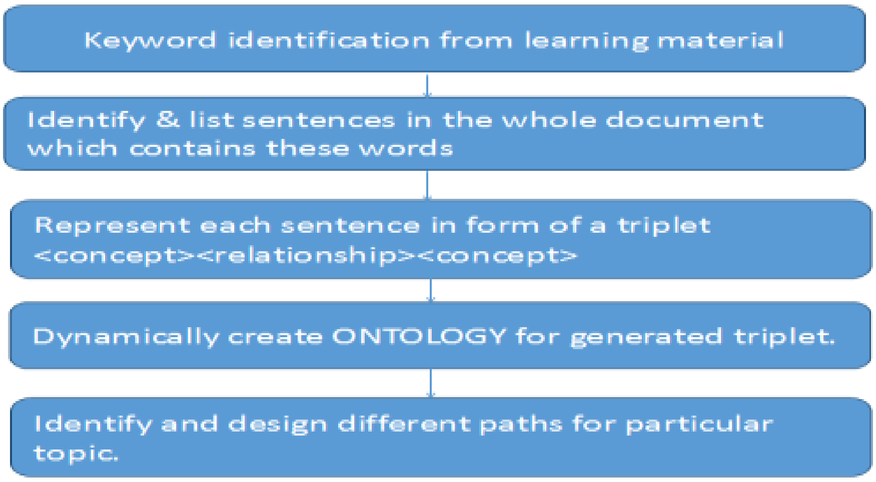

Fig.2: Proposed Model for finding learning pathway generation

Model Description

For generating Learning Path of a particular topic we are basically following three step processes.

1. Triplet Generation
2. Ontology creation.
3. Learning Path Generation

1. Triplet Generation

   Step 1: Identify Keywords available in a document.

   Step 2: List out sentences which contain two keywords in one sentence.

   Step 3: We have List of Patterns Which helps us to know the relationship between keywords or we can say it as concepts.

   Step 4: If we found sentence with two keywords connected with pattern available in our list of pattern. We will take it as a triplet of Concept1<Relationship>Concept2.

2. Ontology creation

Step 1: Create two classes "Keywords" and "Patterns". Keyword class contains all the keywords extracted from document. And pattern class contains list of patterns.

Step 2: Create Object Property "Prerequisites" for Keyword class.

Step 3: For a Generated Triplet create relationship between two concepts.

For Example:

For Triplet: concept1<Prerequisite>concept2. Connection Link between concept1 and concept2 will be created.

Thus whole Onto graph for Document is created.

3. Learning path generation

Once we have Onto graph with us we can suggest learning paths to learners for the topic.

Step 1: Learner will give topic for which they want learning path as an input.

Step 2: By going through all the connected links of that topic in an onto graph we are generating learning path for that topic.

IV. EXPERIMENTS CONDUCTED

For a Learning path generation our first step is to generate ontology for a learning material.

For that we have read different documents and extracted patterns which give us prerequisite for a topic. Using those patterns, we are generating triples of a concept i.e. concept1<prerequisite>concept2. Using that triplet we are generating onto graph for that material.

List of Documents and Patterns Extracted

Table III shows list of patterns we extracted for a document shown in document name column.

Table III: list of documents and patterns extracted

Document Name	Patterns Extracted
Data Structures and Algorithms: Annotated Reference with Examples	can be thought of, is the same as, are very similar to, as simple as, is even simpler than, is exactly the same as, is implemented using, is effectively, can be thought of as, is generally implemented as, is very similar, are most commonly used to implement, can be efficiently implemented using, remains the same as,is to use, uses, can be thought of, uses, being ran on
Introduction to Algorithms, Second Edition by Thomas H. Cormen Charles	Makes can be viewed runs starts by using use as is used to implement can be implemented by using is based on corresponding to the equals is often used as implements implements is determined by with which we are working are represented by call Represent by which is based on represented become an effective alternative to can be computed from can be stored in the are stored in the suffers from a problem known as is one of the best methods available for improves can be used both as can be represented by a are one of many applies to is typically applied to to solve to construct is an algorithm that solves the problem of which have many similarities to do not always yield are a classic example of the obtains Is proof of correctness relies on the yields are similar to generalize is much like searching is a collection of is a set of obeys are organized in a are loosely based on relies on that of are similar to those performed on is a collection of is accessed by is like a

Data Structures	to efficiently process, like, supports, composed of, used to, similar to, is using, uses,
Concurrent Data Structure by Mark Moir and Nir shavit	are among the, provides, are based on, represented as a, provides, implement, is a, are linearizable versions of the,

V. RESULT ANALYSIS

1. Triplet Generation

➢ Statement1: All arrays **consist of** contiguous memory locations.

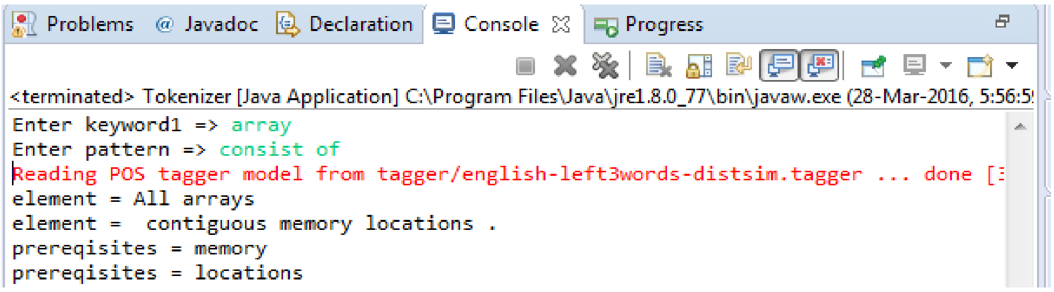

Fig.3: Triplet generation for statement1

➢ Statement2: Array **is used for** different verities of applications.

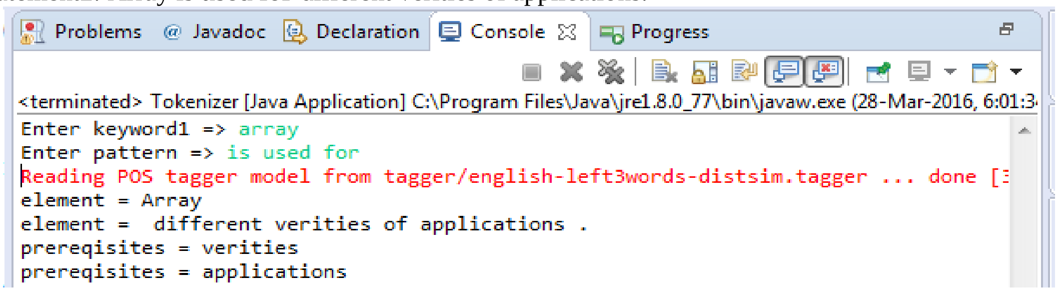

Fig.4: Triplet generation for statement2

➢ Statement3 & Statement4: Array **is used to store** the data or values of same data type.
Above array **is used to store** the integer numbers in an array.

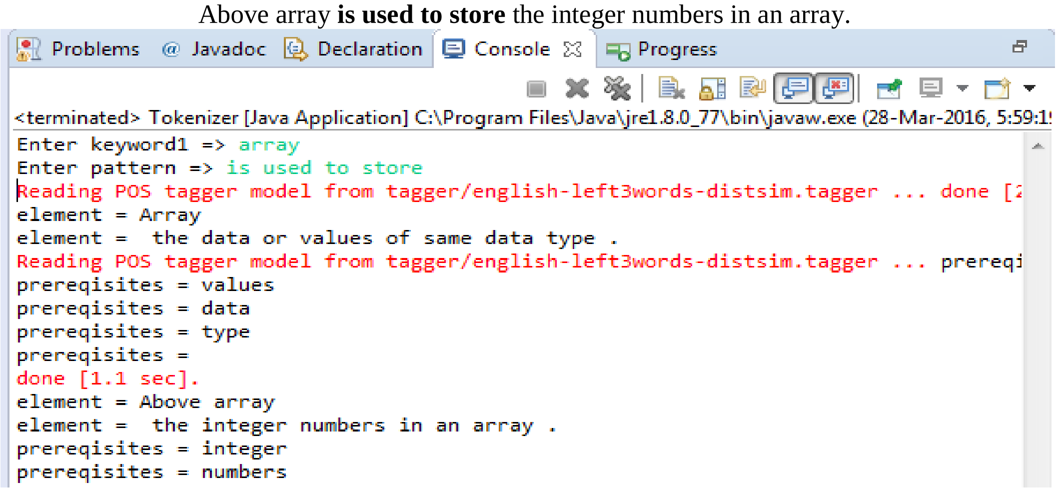

Fig.5: Triplet generation for statement3&4

- Statement5-1: So in short character array **can store** character variables

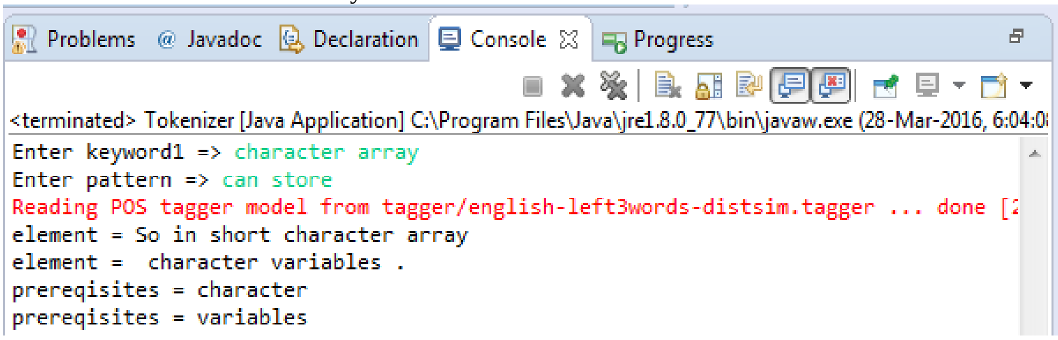

Fig.6: Triplet generation for statement5-1

- Statement5-2: while floating array **stores only** floating numbers.

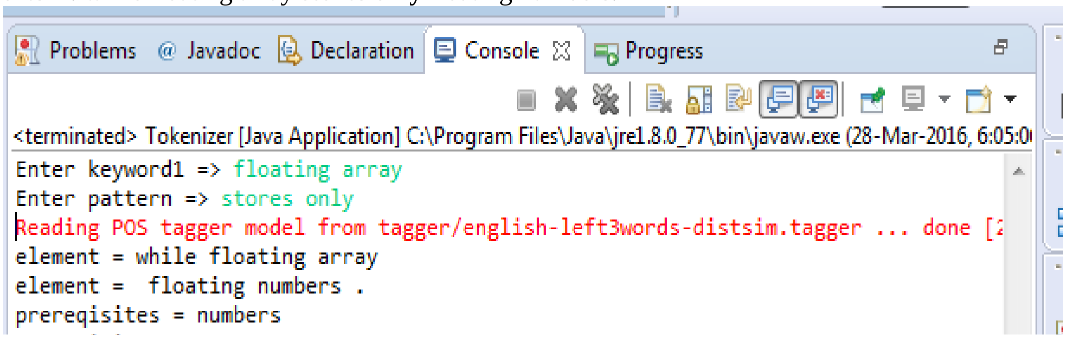

Fig.7: Triplet generation for statement5-2

- Statement6: Array **can be used for** Sorting Elements.

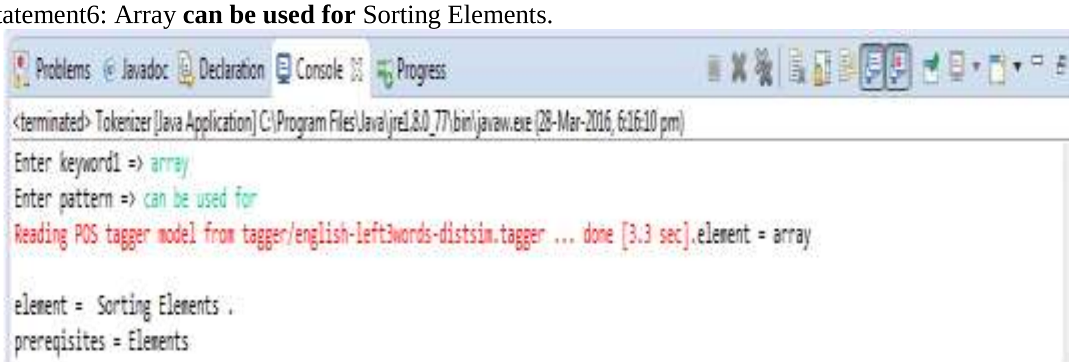

Fig.8: Triplet generation for statement6

- Statement7: Array Can **Perform** Matrix Operation.

Fig.9: Triplet generation for statement7

- Statement8: Array **can be used in** CPU Scheduling.

Fig.10: Triplet generation for statement8

2. Dynamic creation of ontology

- classes and individuals:

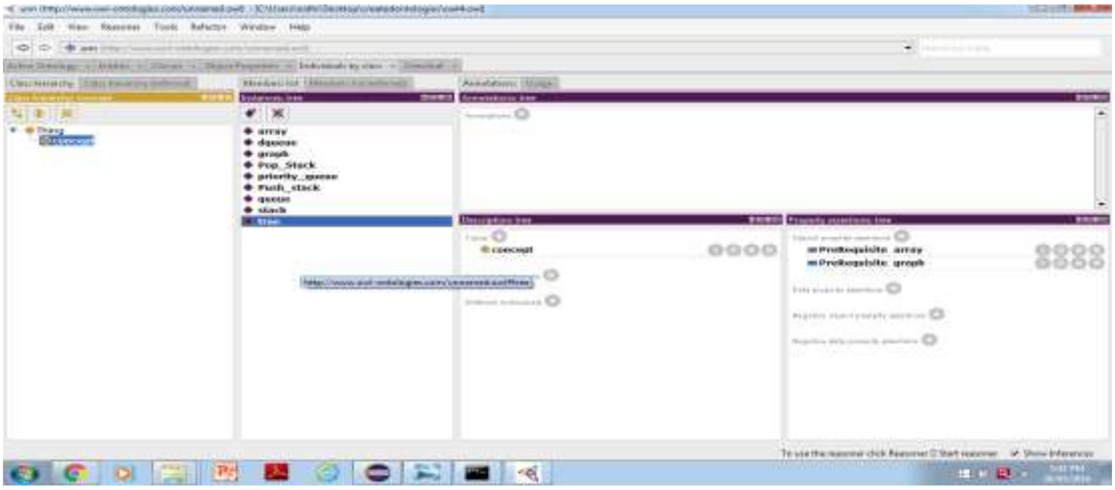

Fig.11: Classes and individual of ontology

- Ontology
- Push stack has a prerequisite Stack

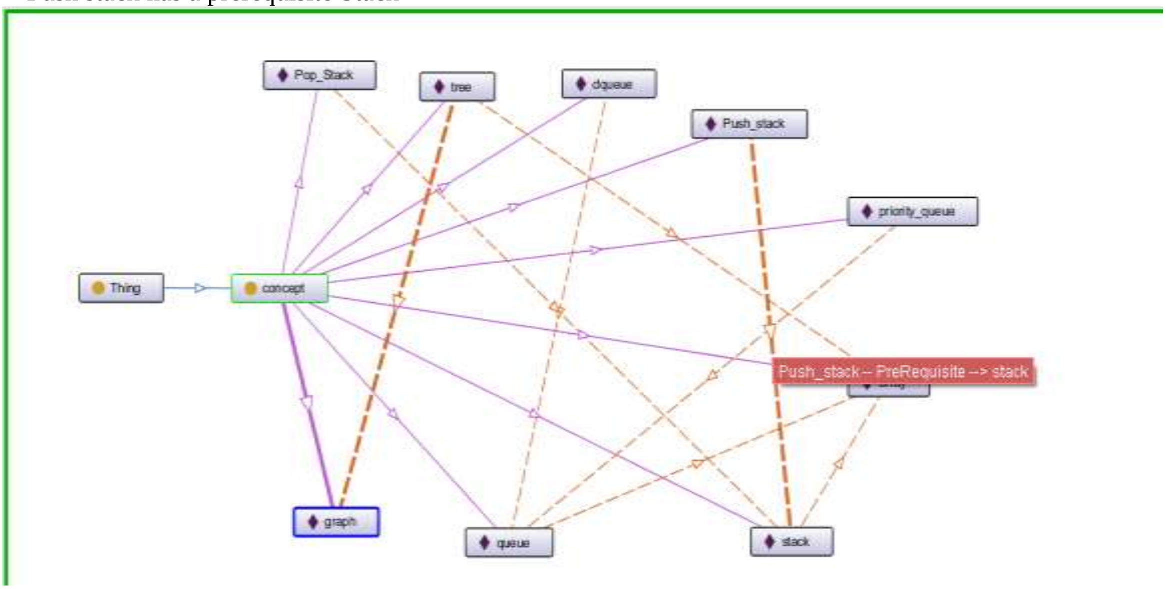

Fig.12: Example1 of ontology

- Stack has a prerequisite Array

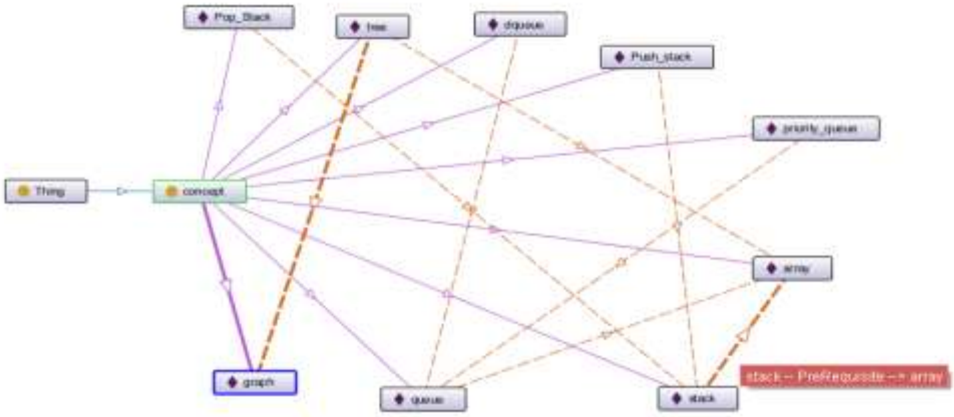

Fig.13: Example2 of ontology

3. Generated Ontograph

➢ Learning Material: Concurrent Data Structure by Mark Moir and Nirshavit

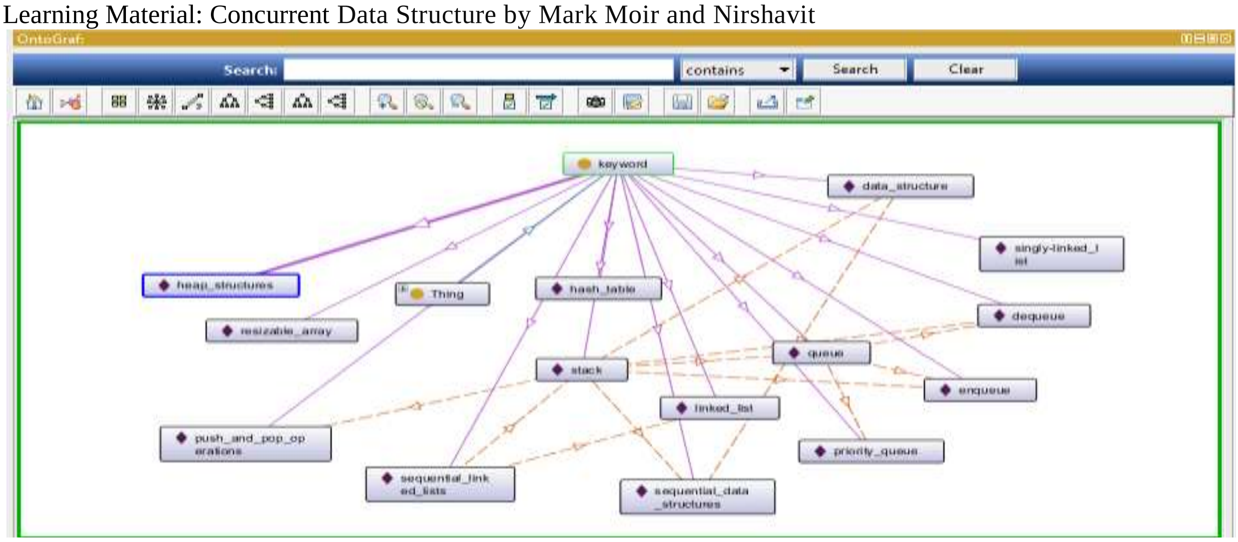

Fig.14: OntoGraph of Concurrent Data Structure by Mark Moir and Nirshavit

➢ Learning Material: Data Structures and Algorithms: Annotated Reference with Examples

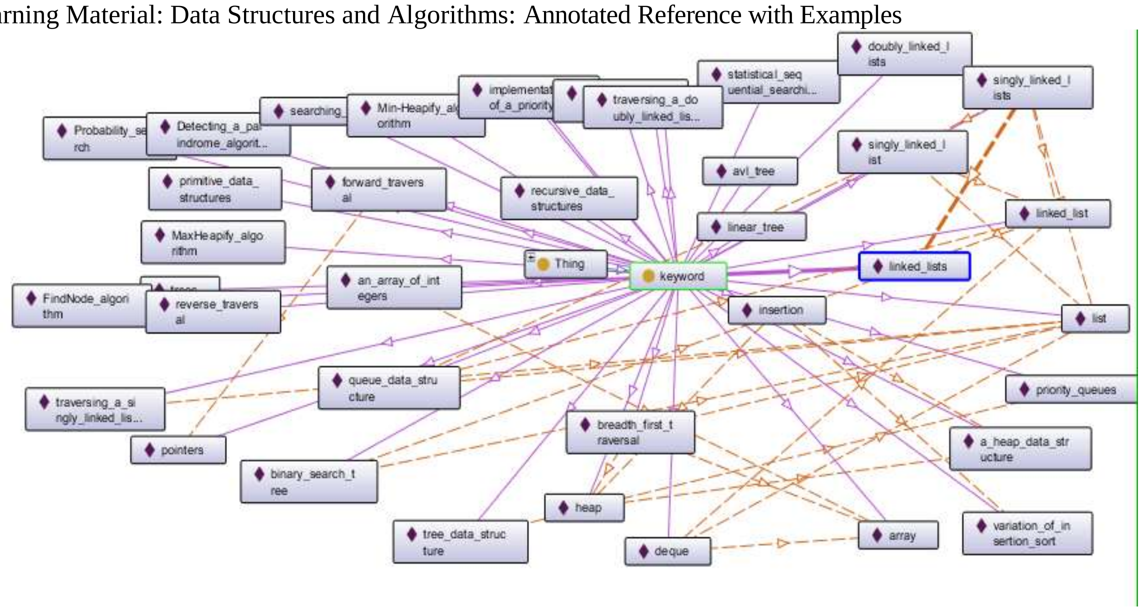

Fig.15: OntoGraph of Data Structures and Algorithms: Annotated Reference with Examples

- Learning Material: Introduction to Algorithms, Second Edition by Thomas H. CormenCharles

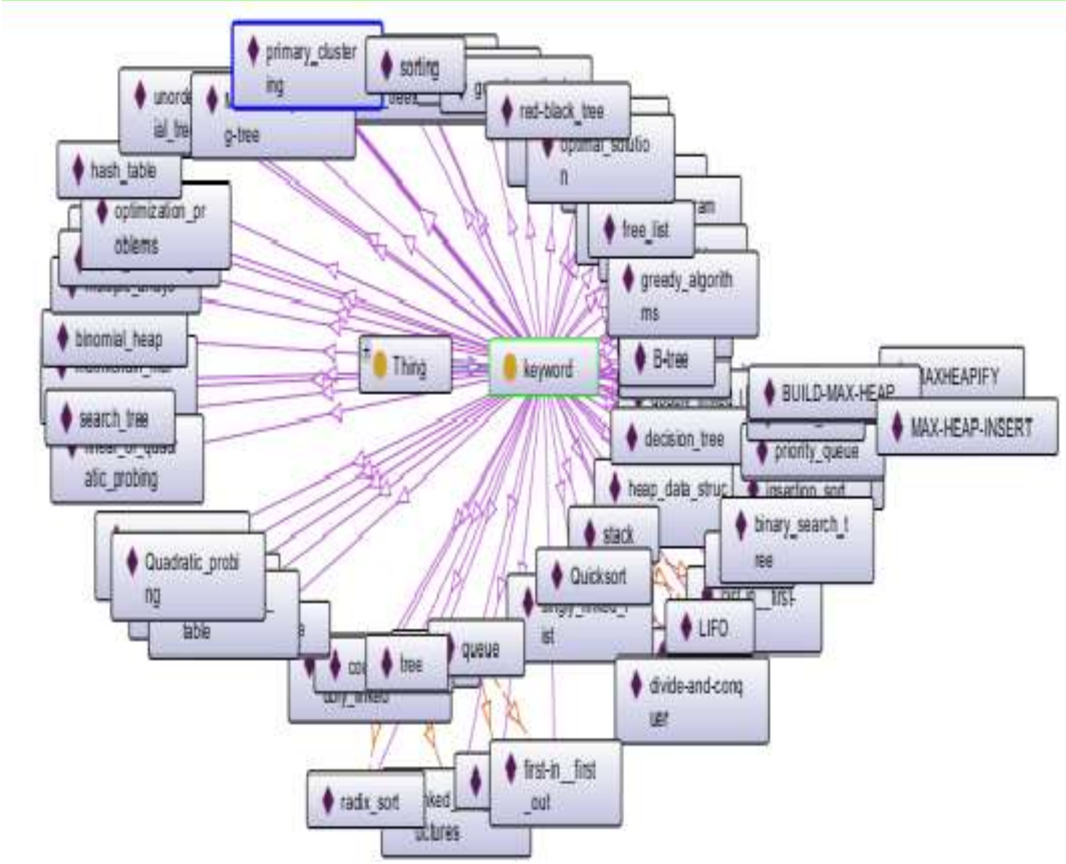

Fig.16: OntoGraph of Introduction to Algorithms, Second Edition by Thomas H. CormenCharles

- Learning Material: Data Structures

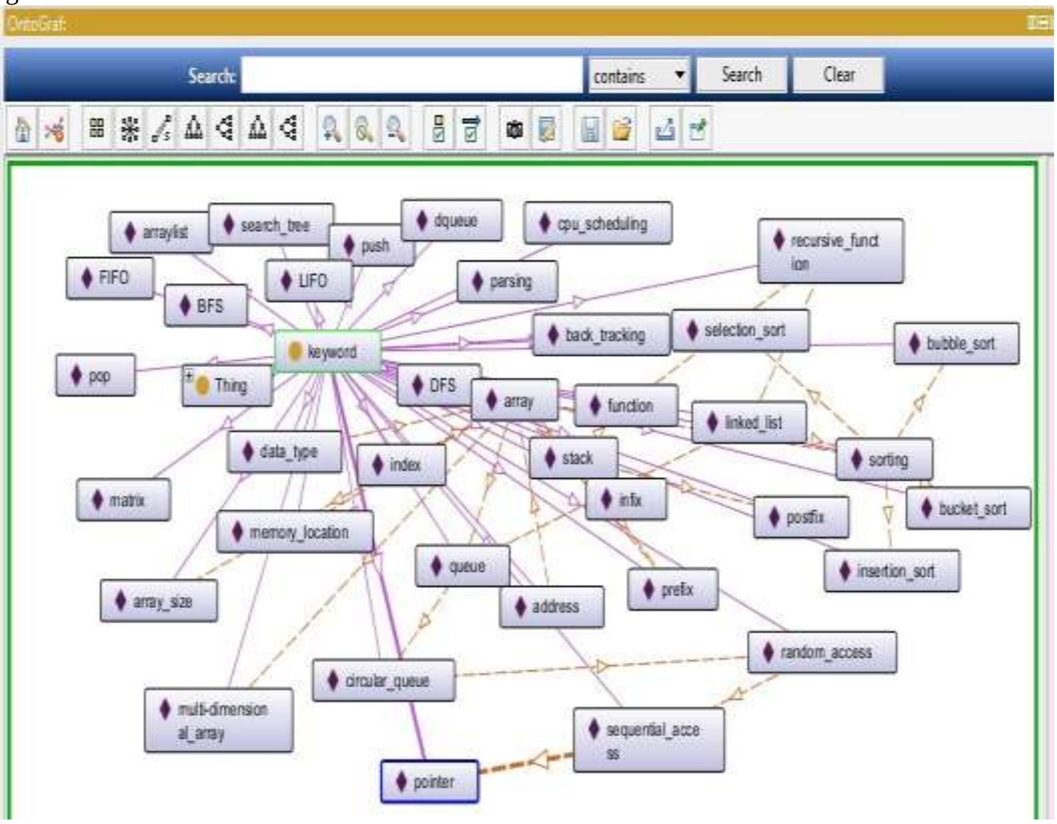

Fig.17: OntoGraph of Data Structures

4. Learning Pathway Generation

➢ Learning path of Array:

```
Problems  Javadoc  Declaration  Console  Debug
<terminated> path [Java Application] C:\Program Files\Java\jre1.8.0_77\bin\javaw.exe (01-May-2016, 10:12:01 pm)
Path for Topic => array


PostPath for  array
[array, multi-dimensional_array]
[array, sorting, bubble_sort]
[array, sorting, bucket_sort, random_access, sequential_access, pointer]
[array, bucket_sort, sequential_access, pointer]
[array, sorting, insertion_sort]
[array, sorting, selection_sort, back_tracking]
[array, infix]
[array, prefix]
[array, stack, function, recursive_function, linked_list, sorting, bubble_sort]
[array, sorting, bucket_sort, random_access, sequential_access, pointer]
[array, bucket_sort, sequential_access, pointer]
[array, sorting, insertion_sort]
[array, sorting, selection_sort, back_tracking]
[array, stack, postfix]
[array, stack, prefix]
[array, stack, infix]
[array, queue, circular_queue, random_access, sequential_access, pointer]
[array, queue, linked_list, sorting, bubble_sort]
[array, sorting, bucket_sort, random_access, sequential_access, pointer]
[array, bucket_sort, sequential_access, pointer]
[array, sorting, insertion_sort]
[array, sorting, selection_sort, back_tracking]
[array, array_size]


PrePath for Topic array
For array prerequisites: [memory_location, address, data_type, index]
```

Fig.18: Generated Learning path for Array

➢ Learning path of stack:

```
<terminated> path [Java Application] C:\Program Files\Java\jre1.8.0_77\bin\javaw.exe (01-May-2016, 10:15:45 pm)
Path for Topic => stack


PostPath for  stack
[stack, function, recursive_function, linked_list, sorting, bubble_sort]
[stack, sorting, bucket_sort, random_access, sequential_access, pointer]
[stack, bucket_sort, sequential_access, pointer]
[stack, sorting, insertion_sort]
[stack, sorting, selection_sort, back_tracking]
[stack, postfix]
[stack, prefix]
[stack, infix]


PrePath for Topic stack
For stack prerequisites: [array]
For array prerequisites: [memory_location, address, data_type, index]
```

Fig.19: Generated Learning path for Stack

➢ Learning path of queue:

```
Path for Topic => queue


PostPath for  queue
[queue, circular_queue]
[queue, dqueue]
[queue, linked_list]


PrePath for Topic queue
For queue prerequisites: [FIFO, array]
For array prerequisites: [memory_location, address, data_type, index]
```

Fig.20: Generated Learning path for Queue

- Learning path of liked list:

```
<terminated> path [Java Application] C:\Program Files\Java\jre1.8.0_77\bin\javaw.exe (02-May-2016, 10:59:51 am)
Path for Topic => linked list


PostPath for  linked list
[linked list, singly_linked_list]
[linked list, circular_linked_list]
[linked list, doubly_linked_list]


PrePath for Topic linked list
For linked list prerequisites: [node, array, addressing, queue]
For array prerequisites: [memory_location, data_type, addressing, index]
For queue prerequisites: [FIFO, array]
For array prerequisites: [memory_location, data_type, addressing, index]
```

Fig.21: Generated Learning path for Liked list

VI. CONCLUSION

In this research, we have created triplets. Using triplets, we have created onto graph. And using onto graph, we have generated learning path for a particular concept of a Learning material.

VII. FUTURE SCOPE

In learning pathway generation, we have identified some patterns suitable for establishing prerequisite relationship between two topics. And we have analysed it with five documents. This can be done with some more and large documents and more patterns can be added in a patterns list. Furthermore, we have generated the possible learning path for a topic. That learning path can be personalised and using learners profile optimum path can be suggested to the learner.

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