

Wiki Authoring and Semantics of Mathematical Document Structure

The ITP 2011 Workshop on Mathematical Wikis (MathWikis-2011)

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Overview

- Introduction of Matherial
 - Wiki engine of Matherial
 - Authoring Documents on Matherial
 - Publishing Documents on the Web
- Describing structure of a Document
 - Documents consisting of several Resources
 - Revisiting OAI-ORE to describe an Aggregation
 - RDF schema

Document Authoring with *Matherial*

Matherial

is a Contents
Management System for
Mathematics

Features of Matherial

- Authoring a Document
 - on Wiki Engine
 - which aggregates several Documents
- File Storage
- Blog
- Discussion Forum

Wiki engine of Matherial

ファイル(F) 編集(E) 表示(V) 履歴(S) ブックマーク(B) ツール(T) ヘルプ(H)

Matherial

← → http://mw2011.matherial.org/LaurentSeries/en/form ☆ Google

LOGIN

Title:

We begin with Taylor's theorem and its proof.

`[[import TaylorTheorem]]` **importing other page**

`[[import ProofOfTaylorTheorem]]`

For a function $f(x)$, $f(x)$ is Taylor expandable when $\lim_{n \rightarrow \infty} R_n(x) = 0$ where R_n is reminder term of `[[wiki/TaylorTheorem|the theorem]]`, and we have bellow.

`[[import TaylorExpansion]]` **LaTeX expression**

Even if complex function $f(z)$ is not holomorphic at a point c , if $f(z)$ is holomorphic in an annulus around c , we get Laurent series bellow,

$$f(z) = \sum_{n=-\infty}^{\infty} a_n(z-c)^n$$

where

$$a_n = \frac{1}{2\pi i} \oint_{\gamma} \frac{f(z) dz}{(z-c)^{n+1}}$$

and γ is a closed curve in the annulus(fig.`[[ref annulus]]`).

`[[figure file/2011/05/10/0 id=annulus]]`

This is extension of `[[TaylorExpansion]]` for functions which are not holomorphic.

Definition
Theorem
Proof
Expression

type of the page

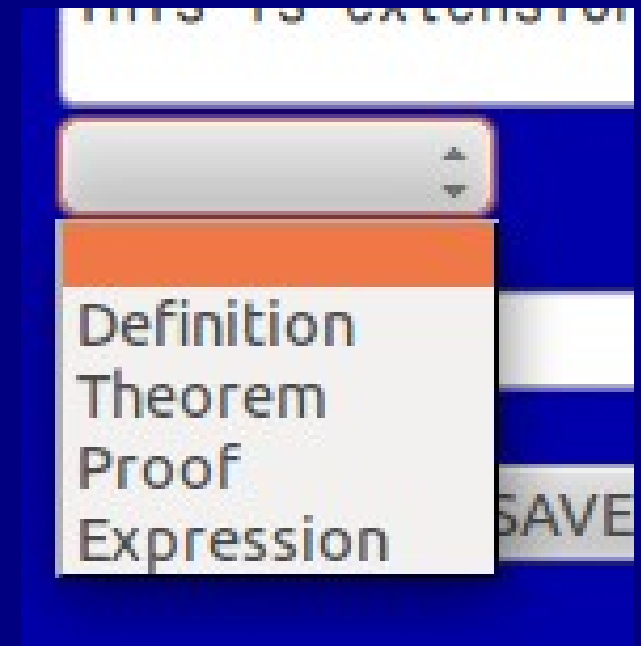
Wiki engine of Matherial

- Mathematical Expressions
 - Input
 - LaTeX notation
 - Output
 - “Presentation” MathML

e when $\lim_{n \rightarrow \infty} R_n(x) = 0$ where R is
ve below.

Wiki engine of Matherial

- Type of Page
 - General Page
 - Mathematical
 - Definition
 - Theorem
 - Proof
 - Expression



Wiki engine of Matherial

- *Importing* (or transcluding)
 - Mathematical Resources
 - Sharing Def., Th., Pr. and Expression
 - Image files
 - Embedding with their description

```
[[import TaylorTheorem]]
```

```
[[import ProofOfTaylorTheorem]]
```

```
[[figure file/2011/05/10/0 id=annulus]]
```

Wiki engine of Matherial

Material

http://mw2011.matherial.org/LaurentSeries

LOGIN

[EDIT DISCUSSION](#) [NEW PAGE](#) [XML\(NLM-DTD\)](#) [SRC](#)

Laurent Series

We begin with Taylor's theorem and its proof.

Taylor Theorem

Let f be a function which is defined on the interval (a, b) and suppose the n th derivative $f^{(n)}$ exists on (a, b) . Then for all x and x_0 in (a, b) ,

$$R_n(x) = \frac{f^{(n)}(y)}{n!}(x - x_0)^n$$

with y strictly between x and x_0 (y depends on the choice of x). $R_n(x)$ is the n th remainder of the Taylor series for $f(x)$.

(Original text is <http://planetmath.org/encyclopedia/TaylorTheorem.html>, retrieved at 2011.05.08)

Proof of Taylor Theorem

Let $f(x)$, $a < x < b$ be a real-valued, n -times differentiable function, and let $a < x_0 < b$ be a fixed base-point. We will show that for all $x \neq x_0$ in the domain of the function, there exists a ξ , strictly between x_0 and x such that

$$f(x) = \sum_{k=0}^{n-1} f^{(k)}(x_0) \frac{(x - x_0)^k}{k!} + f^{(n)}(\xi) \frac{(x - x_0)^n}{n!}.$$

Fix $x \neq x_0$ and let R be the remainder defined by

$$f(x) = \sum_{k=0}^{n-1} f^{(k)}(x_0) \frac{(x - x_0)^k}{k!} + R \frac{(x - x_0)^n}{n!}.$$

Next, define

For a function $f(x)$, f is Taylor expandable when $\lim_{n \rightarrow \infty} R_n(x) = 0$ where R is reminder term of the theorem, and we have bellow.

Taylor Expansion

$$f(x) = \sum_{n=0}^{\infty} \frac{f^{(n)}(a)}{n!}(x - a)^n$$

Even if complex function $f(z)$ is not holomorphic at a point c , if f is holomorphic in an annulus around c , we get Laurent series bellow,

$$f(z) = \sum_{n=-\infty}^{\infty} a_n(z - c)^n$$

where

$$a_n = \frac{1}{2\pi i} \oint_{\gamma} \frac{f(z) dz}{(z - c)^{n+1}}$$

and γ is a closed curve in the annulus(fig.annulus).



Annulus for Laurent Series

Annulus for Laurent Series is shown.

This is extension of [TaylorExpansion](#) for functions which are not holomorphic.

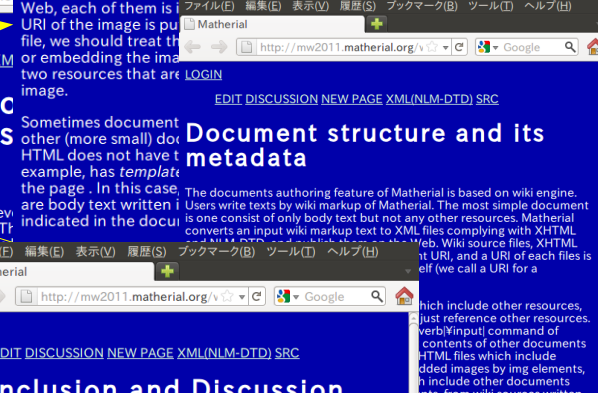
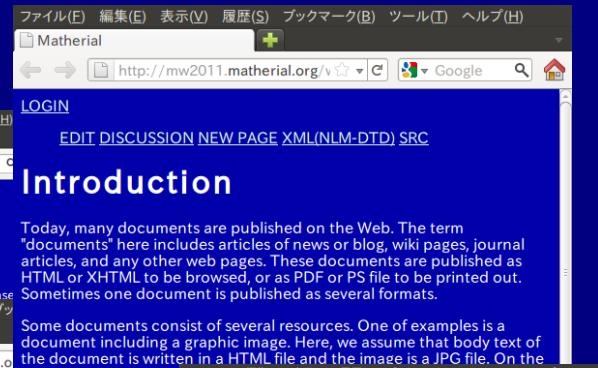
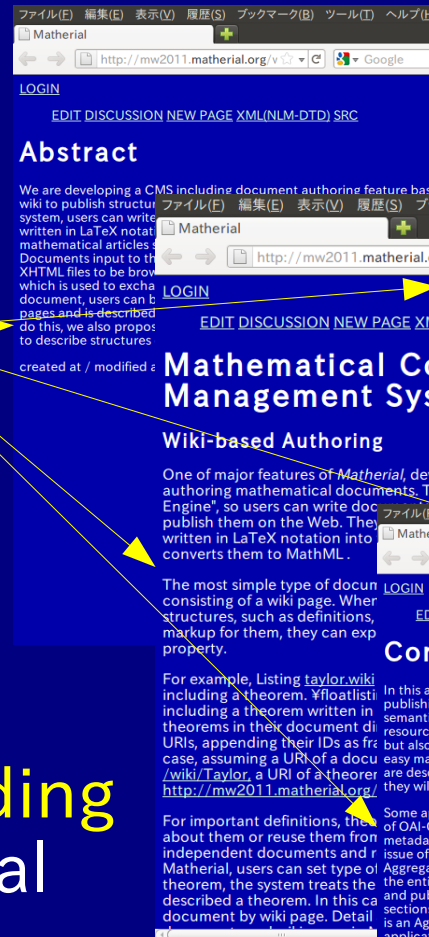
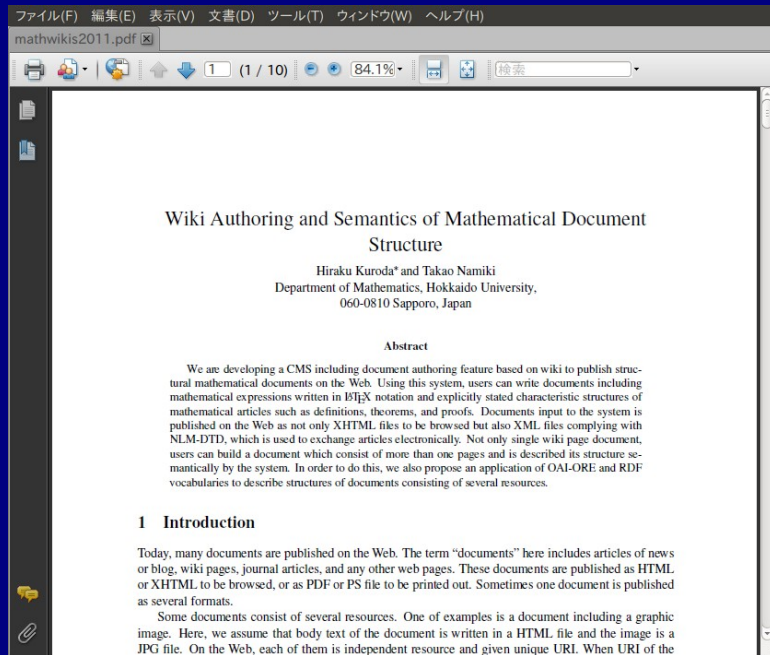
Two types of Documents

- Material covers two types of Documents
 - A Wiki page
 - An Aggregation of Wiki pages

A Wiki page as a Document

- has Body text
 - Wiki notation → HTML and NLM-DTD
 - import other resources
 - other page
 - image
- parts of documents

An Aggregation of Wiki pages



- Publishing document including several sections on Matherial
- split into sections
- write each section as a WikiPage

An Aggregation of Wiki pages

Material

LOGIN

Title: Wiki Authoring and Semant

Authors: hiraku

Contents:

- [[section Introduction]]
- [[section Material]]
- [[section StructureAndMetadata]]
- [[section ConclusionAndDiscussion]]

MSC:

Keywords:

SAVE PREVIEW

Material

LOGIN

EDIT DISCUSSION NEW PAGE XML(NLM-DTD) SRC

Introduction

Today, many documents are published on the Web. The term "documents" here includes articles of news or blog, wiki pages, journal articles, and any other web pages. These documents are published as HTML or XHTML to be browsed, or as PDF or PS file to be printed out. Sometimes one document is published as several formats.

Some documents consist of several resources. One of examples is a document including a graphic image. Here, we assume that body text of the document is written in a HTML file and the image is a JPG file. On the Web, each of them is independent resource and given unique URI. When URI of the image is put on src attribute of an img element in the HTML file, we should treat the document as not just referencing but including or embedding the image. In this case, this document is an aggregation of two resources that are HTML file of body text and JPG file of graphical image.

Mathematical Knowledge Management

Wiki-based Authoring

One of major features of the Material system is that it allows users to publish their own documents on the Web. The Material system converts them to XHTML files. The most simple type of document is a wiki page. A wiki page consists of a wiki page structure, such as definition, and a URI for them, they are called a URI.

Conclusion and Discussion

In this article, we introduced a CMS developed for authoring and publishing mathematical documents, and we proposed background semantics to describe structures of documents consisting of several resources. Using the system, we can publish not only small documents but also large documents consisting of several resources by writing in easy mark-up. Structures of documents consisting of several resources are described as RDF graphs based on Resource map of OAI-ORE, and they will be reused by Semantic Web Technologies.

Some applications of OAI-ORE are describe an article as an aggregation of OAI-ORE. The FORESITE project developed a toolkit to describe metadata of articles from JSTOR by using OAI-ORE. In the project, each issue of journals is an Aggregation of articles, and each article is an Aggregation of individual page images and a PDF-formatted version of the entire article. The ICE-TheOREM project provides thesis authoring and publishing systems. In this project, each thesis is an Aggregation of sections and PDF, DOC, and ODT version of the article, and each section is an Aggregation of PDF, DOC, and ODT version of the section. These applications treat each article as an Aggregation of parts of it and its Representations. On the other hand, in this article, we describe a Document as an Aggregation of parts of it, and we use another property for relationships between a Document and its Representations.

The OMDoc format is a content markup scheme for mathematical documents. This format is designed for the Mathematical Knowledge Base. SWIM is a semantic wiki for Mathematical Knowledge Management using OMDoc and OpenMath. While these are aimed at building the Mathematical Knowledge Base, the Material is aimed at publishing mathematical documents by using simple notation for authoring and only presentation markups for outputting. OMDoc also provides a document ontology. RDF classes i.e. Definition, Theorem (and so on), Proof, and Formula and RDF properties i.e. proves and provedBy are defined, but a class for general mathematical expression is not defined. These classes of OMDoc ontology are subclass of MathKnowledgeItem.

Enumerating Wiki pages to aggregate

An Aggregation of Wiki pages

ファイル(E) 編集(E) 表示(V) 履歴(S) ブックマーク(B) ツール(T) ヘルプ(H)

Matherial

http://mw2011.matherial.org/wasmds

LOGIN

[EDIT](#) [DISCUSSION](#) [NEW PAGE](#) [XML\(NLM-DTD\)](#)

Wiki Authoring and Semantics of Mathematical Document Structure

Authors

- Hiraku Kuroda* [Department of Mathematics, Graduate School of Science, Hokkaido University.](#)

Abstract

We are developing a CMS including document authoring feature based on wiki to publish structural mathematical documents on the Web. Using this system, users can write documents including mathematical expressions written in LaTeX notation and explicitly stated characteristic structures of mathematical articles such as definitions, theorems, and proofs. Documents input to the system is published on the Web as not only XHTML files to be browsed but also XML files complying with NLM-DTD, which is used to exchange articles electronically. Not only single wiki page document, users can build a document which consist of more than one pages and is described its structure semantically by the system. In order to do this, we also propose an application of OAI-ORE and RDF vocabularies to describe structures of documents consisting of several resources.

MSC:

Keywords:

- [Introduction](#)
- [Mathematical Contents Management System](#)
- [Document structure and its metadata](#)
- [Conclusion and Discussion](#)

ファイル(E) 編集(E) 表示(V) 履歴(S) ブックマーク(B) ツール(T) ヘルプ(H)

Matherial

http://mw2011.matherial.org/v

LOGIN

[EDIT](#) [DISCUSSION](#) [NEW PAGE](#) [XML\(NLM-DTD\)](#) [SRC](#)

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Mathematical Management System

Wiki-based Authoring

One of major features of *Matherial* is "Wiki-based Authoring". In *Matherial*, "Matherial Engine", so users can write documents on the Web. They can write documents in LaTeX notation and convert them to XHTML.

The most simple type of document is a wiki page. When users write documents, such as definitions, theorems, and proofs, they can express their structures semantically.

For example, Listing [Taylor's theorem](#) in their document directory, assuming a URI of a document [/wiki/Taylor](#), a URI of a theorem [http://mw2011.matherial.org/v/wiki/Taylor/theorem1](#).

For important definitions, theorems, and proofs, users can build independent documents and publish them on the Web. In the project, each issue of journals is an Aggregation of articles, and each article is an Aggregation of individual page images and a PDF-formatted version of the entire article. The ICE-TheOREM project provides thesis authoring and publishing systems. In this project, each thesis is an Aggregation of sections and PDF, DOC, and ODT version of the article, and each section is an Aggregation of PDF, DOC, and ODT version of the section. These applications treat each article as an Aggregation of parts of it and its Representations. On the other hand, in this article, we describe a Document as an Aggregation of parts of it, and we use another property for relationships between a Document and its Representations.

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In this article, we introduced a CMS developed for authoring and publishing mathematical documents, and we proposed background semantics to describe structures of documents consisting of several resources. Using the system, we can publish not only small documents but also large documents consisting of several resources by writing in easy mark-up. Structures of documents consisting of several resources are described as RDF graphs based on Resource map of OAI-ORE, and they will be reused by Semantic Web Technologies.

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The OMDoc format is a content markup scheme for mathematical documents. This format is designed for the Mathematical Knowledge Base. SWIM is a semantic wiki for Mathematical Knowledge Management using OMDoc and OpenMath. While these are aimed at building the Mathematical Knowledge Base, the Matherial is aimed at publishing mathematical documents by using simple notation for authoring and only presentation markups for outputting. OMDoc also provides a document ontology, RDF classes i.e. Definition, Theorem (and so on), Proof, and Formula and RDF properties i.e. proves and provedBy are defined, but a class for general mathematical expression is not defined. These classes of OMDoc ontology are subclass of MathKnowledgeItem.

.. to build a Document which is an aggregation of Wiki Pages

Authoring Mathematical Document

File (F) 編集 (E) 表示 (V) 履歴 (S) ブックマーク (B) ツール (T) ヘルプ (H)

Matherial

http://mw2011.matherial.org/wasmsd

LOGIN

EDIT DISCUSSION NEW PAGE XML(NLM-DTD)

Wiki Authoring and Semantics of Mathematical Document Structure

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Introduction

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Document structure and its metadata

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User can author **full-text** mathematical document using by easy **Wiki notaion** with structure of **Mathematical Documents**

Representations of a document in Matherial

- XHTML with MathML, RDFa for
 - browsed by human
 - describing metadata by RDFa
 - Structure between Resources
 - General Information
- NLM-DTD
 - using Archiving and Interchange Tag Set
 - XML will be transcluded from other systems

Representations of a document in Matherial

The screenshot shows a web browser window with the URL <http://mw2011.matherial.org/wasmds>. The page title is "Wiki Authoring and Semantics of Mathematical Document Structure". The page content includes a navigation menu with "LOGIN", "EDIT", "DISCUSSION", "NEW PAGE", and "XML(NLM-DTD)". Below the navigation menu, there is a section for "Authors" listing "Hirak Hokk". The main content area starts with an "Abstract" section, followed by a paragraph of text. A diagram is overlaid on the page, showing a central "Document" node in an oval, with arrows pointing to five rectangular boxes: "Abstract", "Introduction", "Contents Manag", "lusion and Disc", and "structure and its". The diagram is set against a black background.

XHTML+MathML+RDFa

RDF-Graph is embedded by using RDFa

Representations of a document in Matherial

```
<!DOCTYPE article PUBLIC "-//NLM//DTD Journal Archiving and Interchange DTD v3.0 20080202//EN" "http://mw2011.matherial.org/wasmds/document/nlm">
<article>
  <front>
    <article-meta>
      <title-group>
        <article-title>Wiki Authoring and Semantics of Mathematical Document Structure</article-title>
      </title-group>
      <contrib-group>
        <contrib>
          <name>
            <!-- Author Name -->
          </contrib>
        </contrib-group>
        <pub-date>
          <self-uri xmlns:xlink="http://www.w3.org/1999/xlink" xlink:href="http://mw2011.matherial.org/wasmds/document/nlm"></self-uri>
        </pub-date>
      </article-meta>
      <abstract>
        <p>We are developing a CMS including document authoring feature based on wiki to publish structural mathematical documents on the Web. Using this system, users can write documents including mathematical expressions written in LaTeX notation and explicitly stated characteristic structures of mathematical articles such as definitions, theorems, and proofs. Documents input to the system is published on the Web as not only XHTML files to be browsed but also XML files complying with NLM-DTD, which is used to exchange articles electronically. Not only single wiki page document, users can build a document which consist of more than one pages and is described its structure semantically by the system. In order to do this, we also propose an application of OAI-ORE and RDF vocabularies to describe structures of documents consisting of several resources. </p>
      </abstract>
    </front>
    <body>
      <sec>
        <title>
          <p>Today, many documents are published on the Web. The term "documents" here includes articles of news or blog, wiki pages, journal articles, and any other web pages. These documents are published as HTML or XHTML to be browsed, or as PDF or PS file to be printed out. Sometimes one document is published as several formats. </p>
          <p>Some documents consist of several resources. One of examples is a document including a graphic image. Here, we assume that body text of the document is written in a HTML file and the image is a JPG file. On the Web, each of them is independent resource and given unique URI. When URI of the image is put on src attribute of an img element in the HTML file, we should treat the document as not just referencing but including or embedding the image. In this case, this document is an aggregation of several resources. </p>
        </title>
      </sec>
    </body>
  </article>
```

- NLM-DTD
- Journal Archiving and Interchange Tag Suite
- by National Library for Medicine
- 3 Tag Set
 - Archiving and Interchange
 - Journal Publishing
 - Article Authoring
- Matherial outputs **Archiving and Interchange**
 - including all text of the document
 - transcluded from other systems

Describing Structure of a Document

Two types of Document

- A Wiki (or Web) page type of Document
- Aggregation of pages

Wiki Page as Aggregation

For a function $f(x)$, f is Taylor expandable when $\lim_{n \rightarrow \infty} R_n(x) = 0$ where R is remainder term of the theorem, and we have below.

$$f(x) = \sum_{n=0}^{\infty} \frac{f^{(n)}(a)}{n!} (x-a)^n$$

Even if complex function $f(z)$ is not holomorphic at a point c , if f is holomorphic in an annulus around c , we get Laurent series below,

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and γ is a closed curve in the annulus (fig.annulus).

Annulus for Laurent Series
Annulus for Laurent Series is shown.
This is extension of [TaylorExpansion](#) for functions which are not holomorphic.

```

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```

source
text



image files

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with y strictly between x and x_0 (y depends on the choice of x), $R_n(x)$ is the n th remainder of the Taylor series for $f(x)$.

$$f(x) = \sum_{k=0}^{n-1} \frac{f^{(k)}(x_0)}{k!} (x-x_0)^k + R$$

where $R = \frac{(x-x_0)^n}{n!}$.

Next, define

$$F(\xi) = \sum_{k=0}^{n-1} \frac{f^{(k)}(\xi)}{k!} (x-\xi)^k + R \frac{(x-\xi)^n}{n!}, \quad a < \xi < b.$$

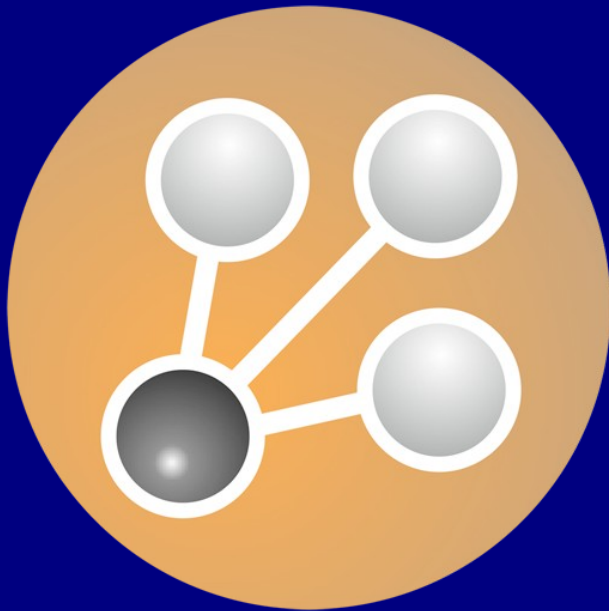
imported
pages

Open Archives Initiative Object Reuse and Exchange

or

OAI-ORE

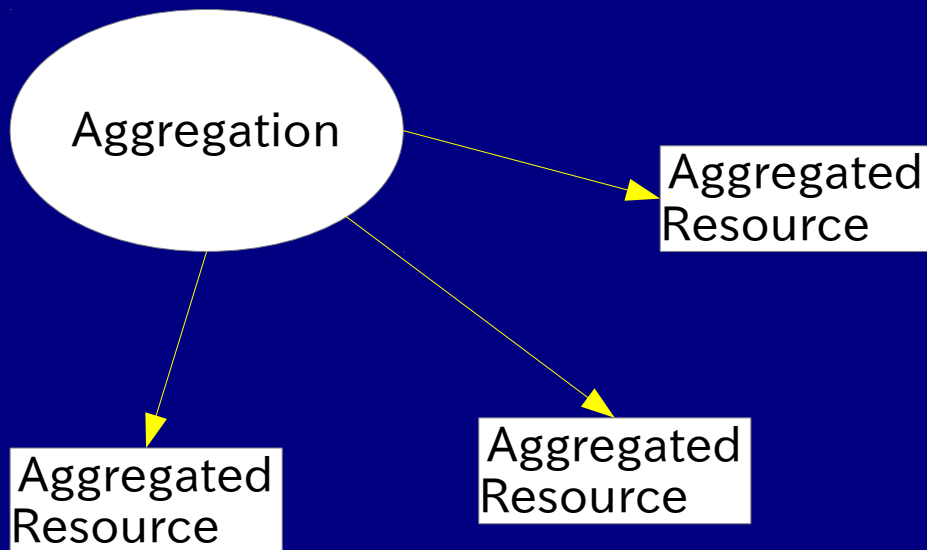
(<http://www.openarchives.org/ore/>)



(<http://www.openarchives.org/ore/logos/logos>)

Aggregation of OAI-ORE

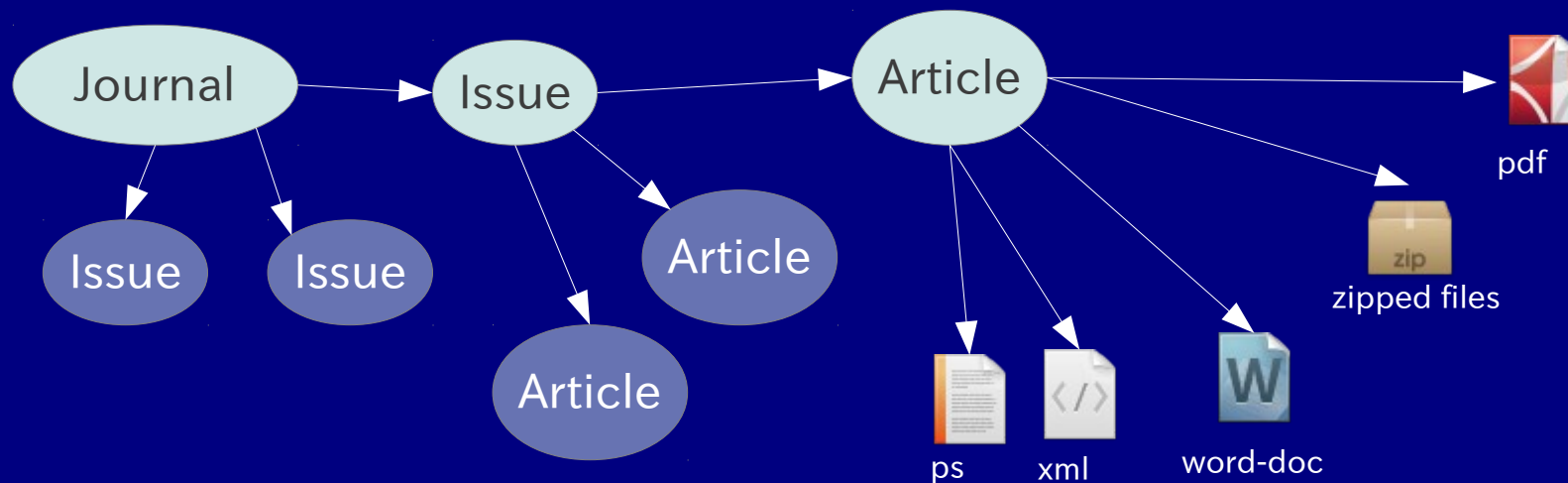
ore:aggregates $\xrightarrow{\text{Rdfs:subPropertyOf}}$ dcterms:hasPart



- OAI-ORE provides a mechanism for describing an Aggregation as **RDF graph**.

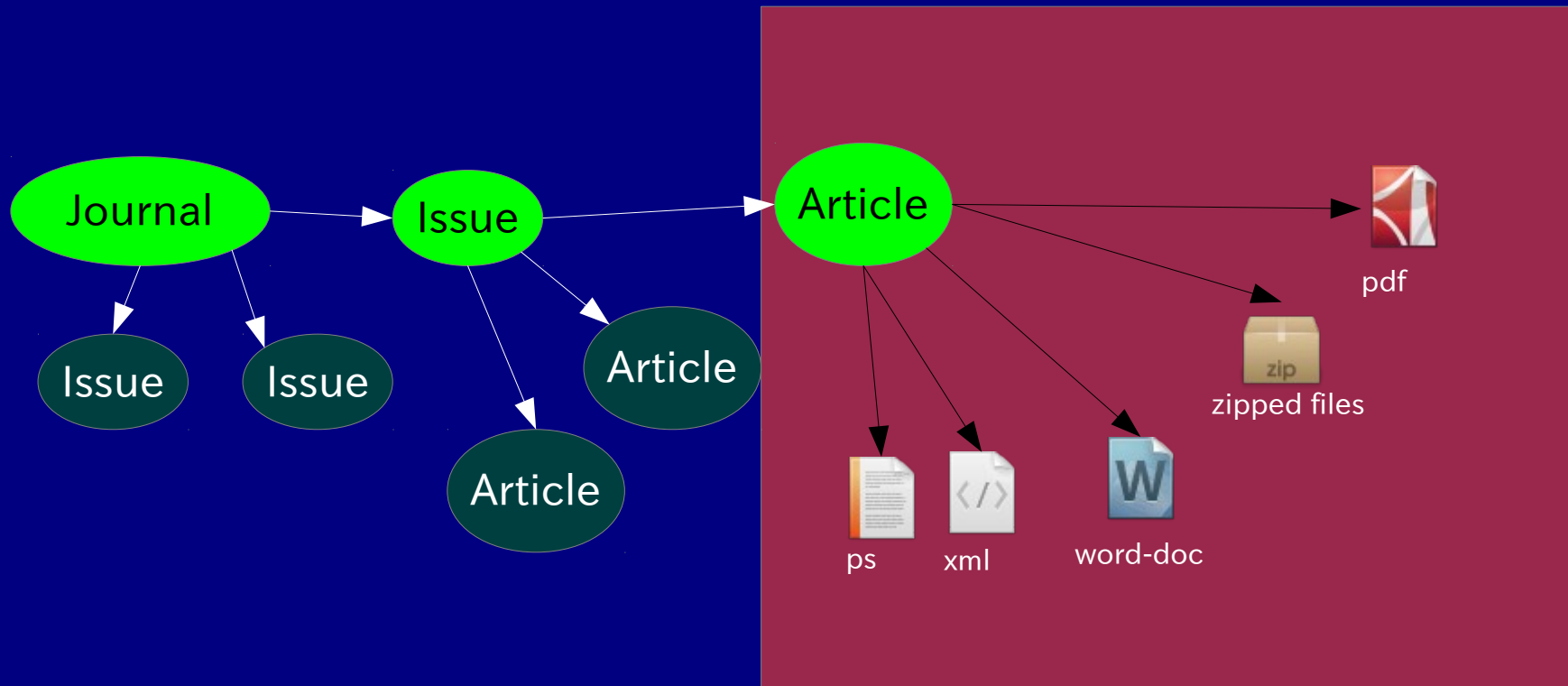
Structure of Journal, Issue, Article and Representations

- A **journal article** is a major example of OAI-ORE aggregation.



- We think that a journal article is also an example of Document.

A Question



Is it appropriate to describe an article as an **aggregation of its representations?**
(a **PDF as a part of document?**)

Document as an Aggregation

An article (or A Document) should be described as an Aggregation of **constituent resources**.

- Parts, Chapters, Sections, ...
- Embedded images
- Content (body text) of article

Constituents of a Wiki Page

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Taylor Expansion

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This is extension of TaylorExpansion for functions which are not holomorphic.

```
[[import TaylorTheorem]]
[[import ProofOfTaylorTheorem]]
For a function  $f(x)$ ,  $f$  is Taylor expandable when  $\lim_{n \rightarrow \infty} R_n(x) = 0$ 
[[import TaylorExpansion]]
Even if complex function  $f(z)$  is not holomorphic at a point  $c$ , if  $f$  is hol
 $f(z) = \sum_{n=0}^{\infty} a_n (z-c)^n$ 
where
 $a_n = \frac{1}{2\pi i} \int_{\gamma} \frac{f(z) dz}{(z-c)^{n+1}}$ 
and  $\gamma$  is a closed curve in the annulus (fig.annulus).
[[figure file:/2011/05/10/0 id=annulus]]
This is extension of [[TaylorExpansion]] for functions which are not holomorp
```



```
Let  $f$  be a function which is defined on the interval  $(a, b)$  and suppose the  $n$ th derivative
 $f^{(n)}$  exists on  $(a, b)$ . Then for all  $x$  and  $x_0$  in  $(a, b)$ ,
with  $\gamma$  strictly between  $x$  and  $x_0$  ( $\gamma$  depends on the choice of  $x$ ),  $R_n(x)$  is the  $n$ th
remainder of  $f$  for  $f$ .
[[import TaylorTheorem]]
[[import ProofOfTaylorTheorem]]
Let  $f(x)$ ,  $a < x < b$  be a real-valued,  $n$ -times differentiable function, and let  $a < x_0 < b$ 
be a fixed base-point. We will show that for all  $x \neq x_0$  in the domain of the function,
there exists a  $\xi$ , strictly between  $x_0$  and  $x$  such that
 $f(x) = \sum_{k=0}^{n-1} \frac{f^{(k)}(x_0)}{k!} (x-x_0)^k + \frac{f^{(n)}(\xi)}{n!} (x-x_0)^n$ 
Fix  $x \neq x_0$  and let  $R$  be the remainder defined by
 $f(x) = \sum_{k=0}^{n-1} \frac{f^{(k)}(x_0)}{k!} (x-x_0)^k + R \frac{(x-x_0)^n}{n!}$ 
Next, define
 $F(\xi) = \sum_{k=0}^{n-1} \frac{f^{(k)}(\xi)}{k!} (x-\xi)^k + R \frac{(x-\xi)^n}{n!}, \quad a < \xi < b.$ 
```

This Wiki Page is an Aggregation of wiki-source and imported Resources

Main Content of a Document

- The Wiki source file is a special member of the Document. This includes
 - Main **content** of Document
 - body text
 - **Indication of embedding** Resources
 - [[import TaylorTheorem]]
 - [[figure file/2011/5/10/0 id=annul]]

Main Content of a Document

mt:hasContent

rdf:subPropertyOf

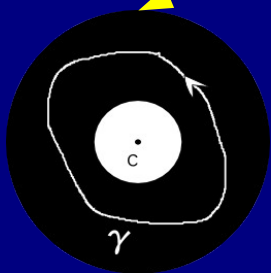
ore:aggregates

This screenshot shows the main content of a document, including sections for 'Laurent Series', 'Taylor Theorem', and 'Taylor Expansion'. It contains mathematical definitions and formulas, such as the Taylor series expansion $f(x) = \sum_{n=0}^{\infty} \frac{f^{(n)}(a)}{n!} (x-a)^n$.

mt:hasContent

This screenshot shows a document page with sections for 'Taylor Theorem' and 'Proof of Taylor Theorem'. It includes mathematical text and formulas, such as the Taylor series expansion $f(x) = \sum_{n=0}^{\infty} \frac{f^{(n)}(a)}{n!} (x-a)^n$.

ore:aggregates



This screenshot shows a document page with sections for 'Taylor Theorem' and 'Proof of Taylor Theorem'. It includes mathematical text and formulas, such as the Taylor series expansion $f(x) = \sum_{n=0}^{\infty} \frac{f^{(n)}(a)}{n!} (x-a)^n$.

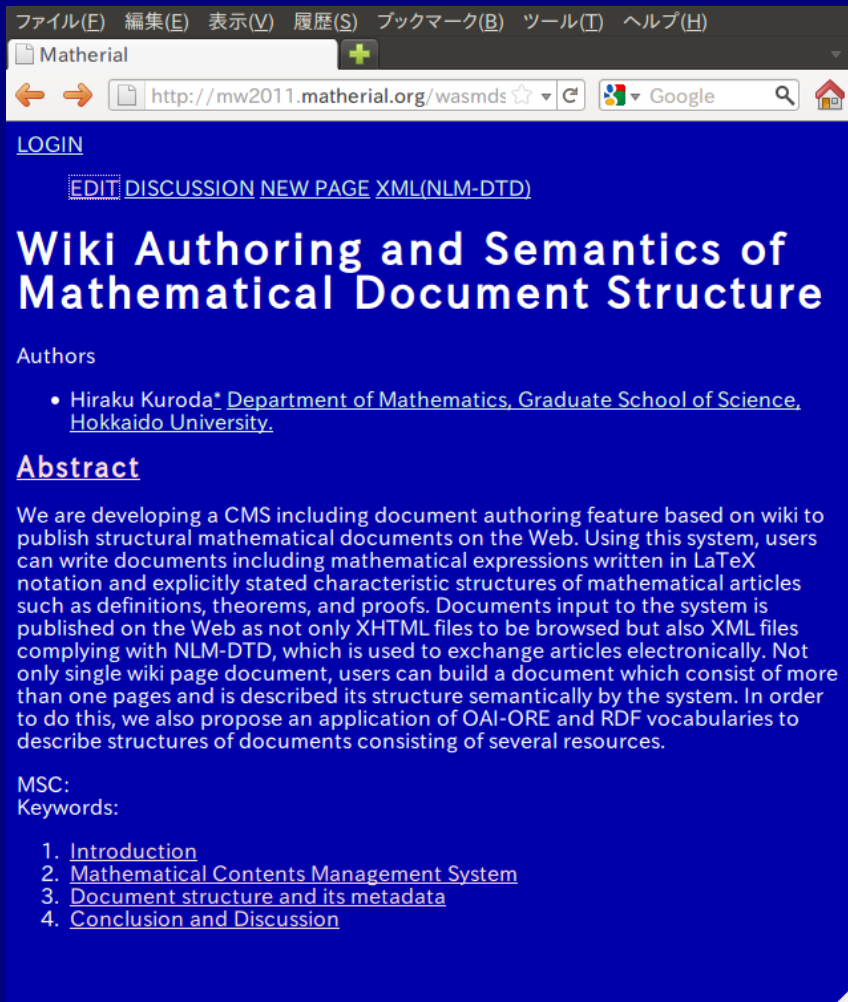
mt (<http://www.mathmaterial.org/terms/>) is for our new terms of RDF.

Wiki page as Aggregation

- A Document which has its own content is an Aggregation of
 - Document Content
 - Wiki-source, HTML, XML, Plain text, ...
 - Embedded (Transcluded) Resources
 - Image file, other Document and any objects

about an Aggregation of Documents

An Aggregation of Wiki pages



ファイル(E) 編集(E) 表示(V) 履歴(S) ブックマーク(B) ツール(T) ヘルプ(H)

Matherial

http://mw2011.matherial.org/wasmds

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[EDIT](#) [DISCUSSION](#) [NEW PAGE](#) [XML\(NLM-DTD\)](#)

Wiki Authoring and Semantics of Mathematical Document Structure

Authors

- Hiraku Kuroda* [Department of Mathematics, Graduate School of Science, Hokkaido University.](#)

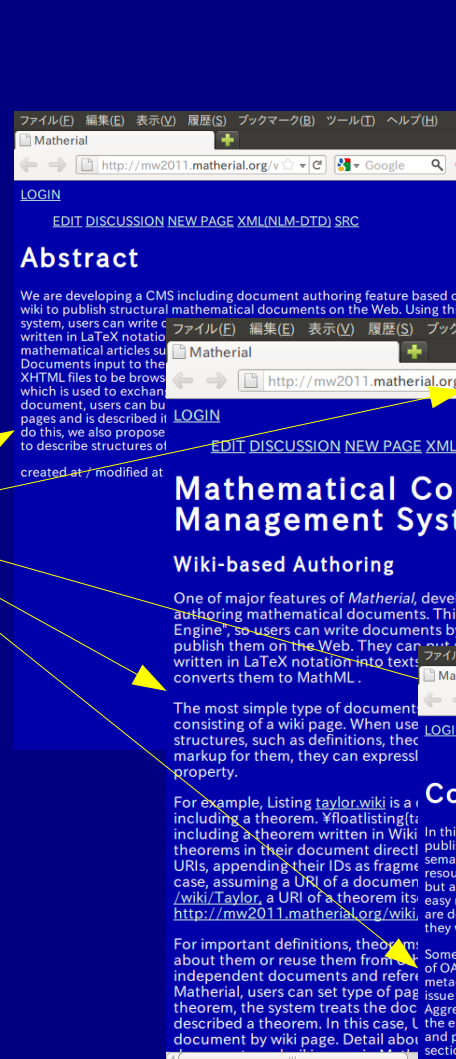
Abstract

We are developing a CMS including document authoring feature based on wiki to publish structural mathematical documents on the Web. Using this system, users can write documents including mathematical expressions written in LaTeX notation and explicitly stated characteristic structures of mathematical articles such as definitions, theorems, and proofs. Documents input to the system is published on the Web as not only XHTML files to be browsed but also XML files complying with NLM-DTD, which is used to exchange articles electronically. Not only single wiki page document, users can build a document which consist of more than one pages and is described its structure semantically by the system. In order to do this, we also propose an application of OAI-ORE and RDF vocabularies to describe structures of documents consisting of several resources.

MSC:

Keywords:

- [Introduction](#)
- [Mathematical Contents Management System](#)
- [Document structure and its metadata](#)
- [Conclusion and Discussion](#)



ファイル(E) 編集(E) 表示(V) 履歴(S) ブックマーク(B) ツール(T) ヘルプ(H)

Matherial

http://mw2011.matherial.org/v

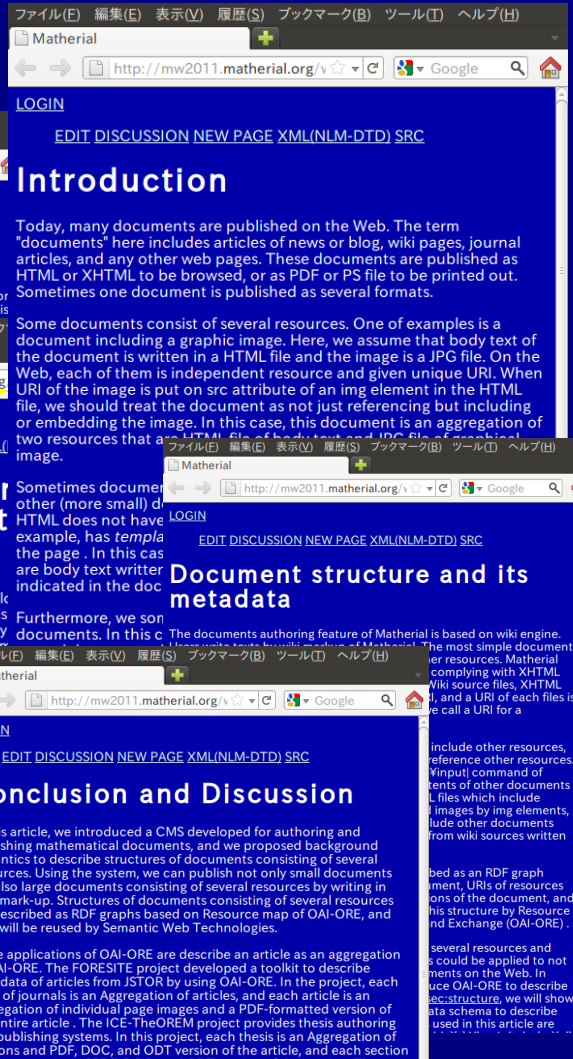
LOGIN

[EDIT](#) [DISCUSSION](#) [NEW PAGE](#) [XML\(NLM-DTD\)](#) [SRC](#)

Abstract

We are developing a CMS including document authoring feature based on wiki to publish structural mathematical documents on the Web. Using this system, users can write documents including mathematical expressions written in LaTeX notation and explicitly stated characteristic structures of mathematical articles such as definitions, theorems, and proofs. Documents input to the system is published on the Web as not only XHTML files to be browsed but also XML files complying with NLM-DTD, which is used to exchange articles electronically. Not only single wiki page document, users can build a document which consist of more than one pages and is described its structure semantically by the system. In order to do this, we also propose an application of OAI-ORE and RDF vocabularies to describe structures of documents consisting of several resources.

created at / modified at



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Matherial

http://mw2011.matherial.org/v

LOGIN

[EDIT](#) [DISCUSSION](#) [NEW PAGE](#) [XML\(NLM-DTD\)](#) [SRC](#)

Introduction

Today, many documents are published on the Web. The term "documents" here includes articles of news or blog, wiki pages, journal articles, and any other web pages. These documents are published as HTML or XHTML to be browsed, or as PDF or PS file to be printed out. Sometimes one document is published as several formats.

Some documents consist of several resources. One of examples is a document including a graphic image. Here, we assume that body text of the document is written in a HTML file and the image is a JPG file. On the Web, each of them is independent resource and given unique URI. When URI of the image is put on src attribute of an img element in the HTML file, we should treat the document as not just referencing but including or embedding the image. In this case, this document is an aggregation of two resources that a HTML file and a image.

Sometimes documents consist of other (more small) documents. For example, has template page. In this case, the body text writer indicated in the document.

Furthermore, in this case, the documents authoring feature of Matherial is based on wiki engine. The most simple document structure complying with XHTML, XML, and a URI of each files is called a URI for a document.

The documents authoring feature of Matherial is based on wiki engine. The most simple document structure complying with XHTML, XML, and a URI of each files is called a URI for a document.

include other resources, reference other resources. `<input type="text" value="URI of other documents" />` files which include images by img elements, include other documents from wiki sources written

bed as an RDF graph element, URIs of resources of the document, and its structure by Resource and Exchange (OAI-ORE).

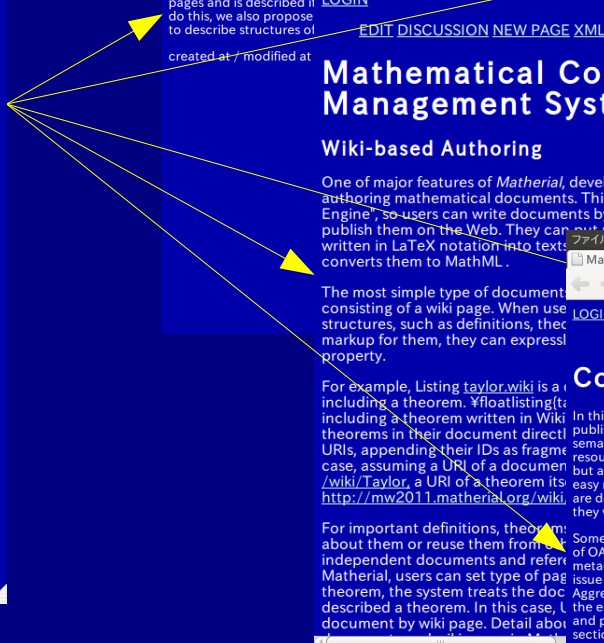
several resources and could be applied to not documents on the Web. In use OAI-ORE to describe structure, we will show a schema to describe used in this article are

Conclusion and Discussion

In this article, we introduced a CMS developed for authoring and publishing mathematical documents, and we proposed background semantics to describe structures of documents consisting of several resources. Using the system, we can publish not only small documents but also large documents consisting of several resources by writing in easy mark-up. Structures of documents consisting of several resources are described as RDF graphs based on Resource map of OAI-ORE, and they will be reused by Semantic Web Technologies.

Some applications of OAI-ORE are describe an article as an aggregation of OAI-ORE. The FORESITE project developed a toolkit to describe metadata of articles from JSTOR by using OAI-ORE. In the project, each issue of journals is an Aggregation of articles, and each article is an Aggregation of individual page images and a PDF-formatted version of the entire article. The ICE-TheOREM project provides thesis authoring and publishing systems. In this project, each thesis is an Aggregation of sections and PDF, DOC, and ODT version of the article, and each section is an Aggregation of PDF, DOC, and ODT version of the section. These applications treats each article as an Aggregation of parts of it and its Representations. On the other hand, in this article, we describe a Document as an Aggregation of parts of it, and we use another property for relationships between a Document and its Representations.

The OMDoc format is a content markup scheme for mathematical documents. This format is designed for the Mathematical Knowledge Base. SWIM is a semantic wiki for Mathematical Knowledge Management using OMDoc and OpenMath. While these are aimed at building the Mathematical Knowledge Base, the Matherial is aimed at publishing mathematical documents by using simple notation for authoring and only presentation markups for outputting. OMDoc also provides a document ontology. RDF classes i.e. Definition, Theorem (and so on), Proof, and Formula and RDF properties i.e. proves and provedBy are defined, but a class for general mathematical expression is not defined. These classes of OMDoc ontology are subclass of MathKnowledgeItem.



An Aggregation of Wiki pages

This Document is an Aggregation of

- <http://.../wasmds/Abstract>
- <http://.../wasmds/ConclusionAndDiscussion>
- <http://.../wasmds/Introduction>
- <http://.../wasmds/Matherial>
- <http://.../wasmds/StructureAndMetadata>

(This list is sorted into alphabetical order)

What **order** do we read them?

Order of Members

mt:hasNext $\xrightarrow{\text{Rdfs:subPropertyOf}}$ dcterms:relation

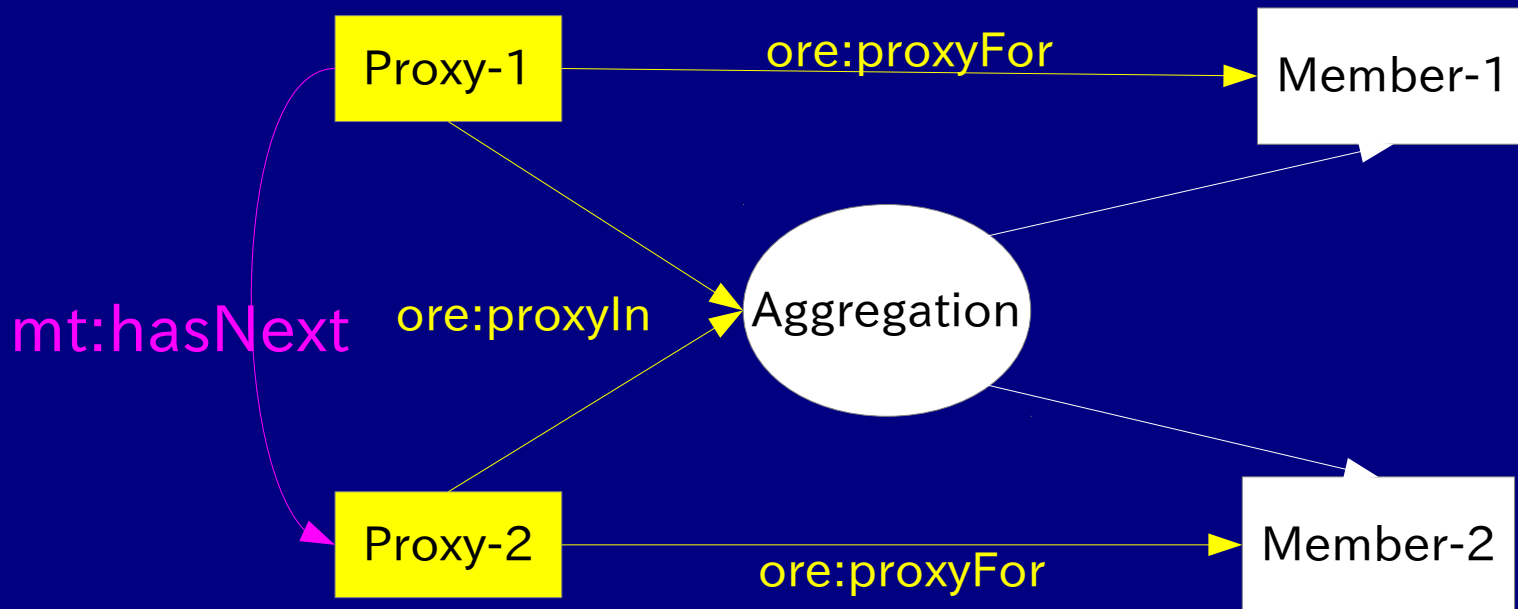
- We define a new term to describe order of members
- Order relationships should not be described between members directly.

Order of Members



We should not **directly describe a property** between members when the **property is valid only in an Aggregation.**

Proxy of ORE



Proxy of ORE is provided to describe a property which is **valid only in an aggregation**.

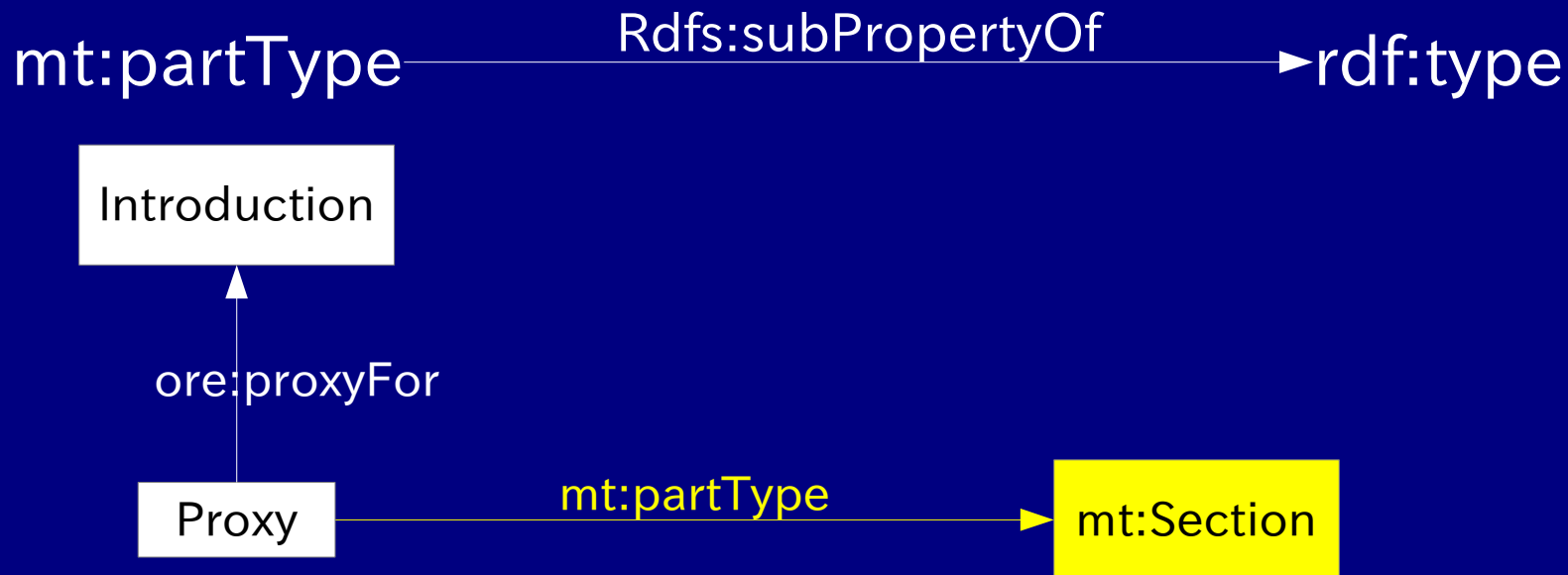
“Member-1 **hasNext** Member-2 in the **Aggregation**.”

about *hasNext*

- *hasNext* is used in documents of OAI-ORE.
 - x:hasNext
 - That is only for example and not defined formally.
- We need to describe order of members of Document which doesn't have its own content.

Therefore we define mt:hasNext.

Type of a Member



- The term `mt:partType` is a property to describe a type or a role of members in an Aggregation
- `mt:part` takes sub classes of `mt:PartType` for object of a triple.
 - `mt:Part`, `mt:Chapter` and so on

about A Document and
its Representations

A Document and its Representations

The screenshot shows a web browser window with the address bar displaying `http://mw2011.matherial.org/LaurentSeries`. The page content includes a navigation menu with links for LOGIN, EDIT, DISCUSSION, NEW PAGE, XML(NLM-DTD), and SRC. The main heading is 'Laurent Series'. The text begins with 'We begin with Taylor's theorem and its proof.' followed by a section titled 'Taylor Theorem'. The text states: 'Let f be a function which is defined on the interval (a, b) and suppose the n th derivative $f^{(n)}$ exists on (a, b) . Then for all x and x_0 in (a, b) ,

$$R_n(x) = \frac{f^{(n)}(y)}{n!} (x - x_0)^n$$

with y strictly between x and x_0 (y depends on the choice of x). $R_n(x)$ is the n th remainder of the Taylor series for $f(x)$.

(Original text is <http://planetmath.org/encyclopedia/TaylorTheorem.html>, retrieved at 2011.05.08)

Proof of Taylor Theorem

Let $f(x)$, $a < x < b$ be a real-valued, n -times differentiable function, and let $a < x_0 < b$ be a fixed base-point. We will show that for all $x \neq x_0$ in the domain of the function, there exists a ξ , strictly between x_0 and x such that

$$f(x) = \sum_{k=0}^{n-1} f^{(k)}(x_0) \frac{(x - x_0)^k}{k!} + f^{(n)}(\xi) \frac{(x - x_0)^n}{n!}.$$

Fix $x \neq x_0$ and let R be the remainder defined by

$$f(x) = \sum_{k=0}^{n-1} f^{(k)}(x_0) \frac{(x - x_0)^k}{k!} + R \frac{(x - x_0)^n}{n!}.$$

Next, define

This Document has **three Representations.**

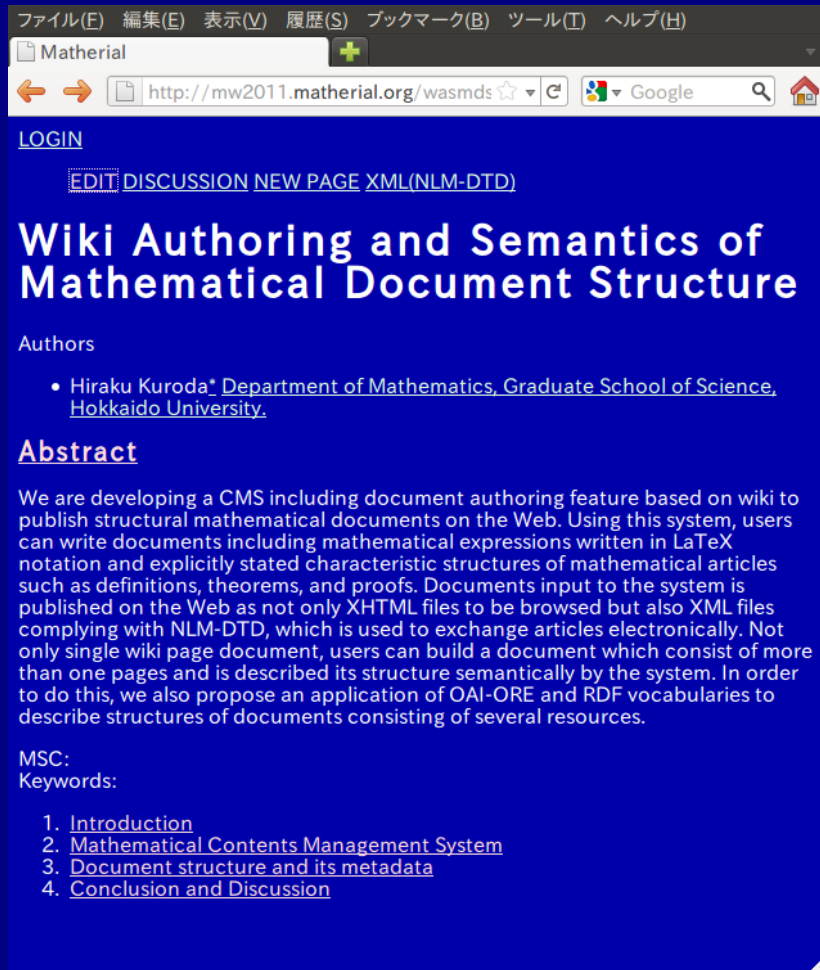
Wiki-SRC

- Document Content (Member of Aggregation)
- and the simplest Representation of this Document

XHTML

NLM-DTD

Aggregation of Wiki Page



- This Document does not have its own Content
- Each member Document has their own Document Content.

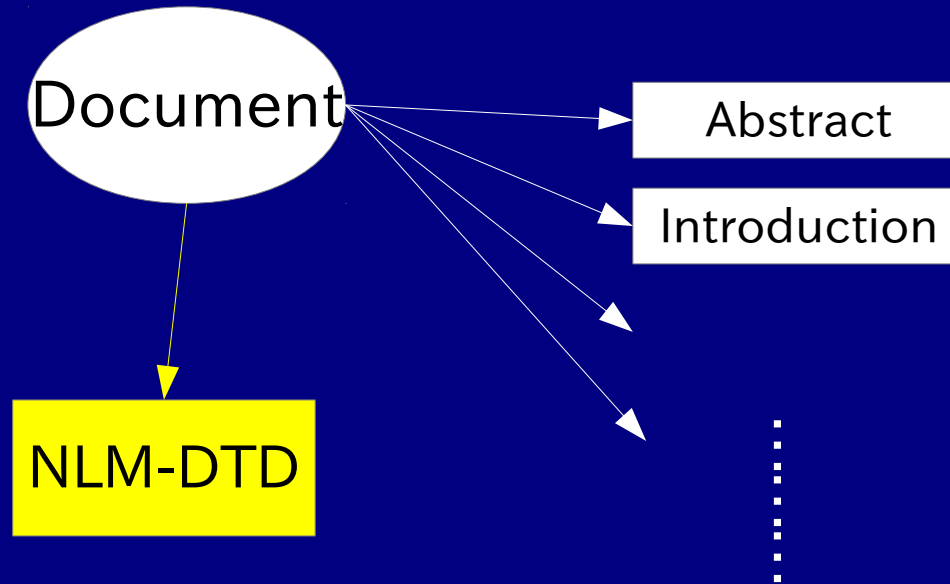
(This page is one of Representations, but not content of the Document)

Aggregation of Wiki Page

has NLM-DTD version of **Representation**, which **includes ALL text** of the Document.

```
ファイル(E) 編集(E) 表示(V) 履歴(S) ブックマーク(B) ツール(T) ヘルプ(H)
http://mw201...document/nlm
http://mw2011.matherial.org/wasmds/document/nlm
コンソール HTML CSS スクリプト DOM ネット
編集 front < article
<!DOCTYPE article PUBLIC "-//NLM//DTD Journal Archiving and Interchange DTD v3.0 20080202//EN" "http://mw2011.matherial.org/wasmds/document/nlm/nlm.dtd">
<article>
  <front>
    <article-meta>
      <title-group>
        <article-title>Wiki Authoring and Semantics of Mathematical Document Structure</article-title>
      </title-group>
      <contrib-group>
        <contrib>
          <name>
            </contrib>
        </contrib-group>
      <pub-date>
        <self-uri xmlns:xlink="http://www.w3.org/1999/xlink" xlink:href="http://mw2011.matherial.org/wasmds/document/nlm"></self-uri>
      </pub-date>
      <abstract>
        <p>We are developing a CMS including document authoring feature based on wiki to publish structural mathematical documents on the Web. Using this system, users can write documents including mathematical expressions written in LaTeX notation and explicitly stated characteristic structures of mathematical articles such as definitions, theorems, and proofs. Documents input to the system is published on the Web as not only XHTML files to be browsed but also XML files complying with NLM-DTD, which is used to exchange articles electronically. Not only single wiki page document, users can build a document which consist of more than one pages and is described its structure semantically by the system. In order to do this, we also propose an application of OAI-ORE and RDF vocabularies to describe structures of documents consisting of several resources.</p>
      </abstract>
    </article-meta>
  </front>
  <body>
    <sec>
      <title>
        <p>Today, many documents are published on the Web. The term "documents" here includes articles of news or blog, wiki pages, journal articles, and any other web pages. These documents are published as HTML or XHTML to be browsed, or as PDF or PS file to be printed out. Sometimes one document is published as several formats.</p>
        <p>Some documents consist of several resources. One of examples is a document including a graphic image. Here, we assume that body text of the document is written in a HTML file and the image is a JPG file. On the Web, each of them is independent resource and given unique URI. When URI of the image is put on src attribute of an img element in the HTML file, we should treat the document as not just referencing but including or embedding the image. In this case, this document is an aggregation of several resources.</p>
      </title>
    </sec>
  </body>
</article>
```

A Document and its Representations



The document is an aggregation of 5 sections, not aggregation of Representation(s).

We need **different way** to describe between **Document and Representations**.

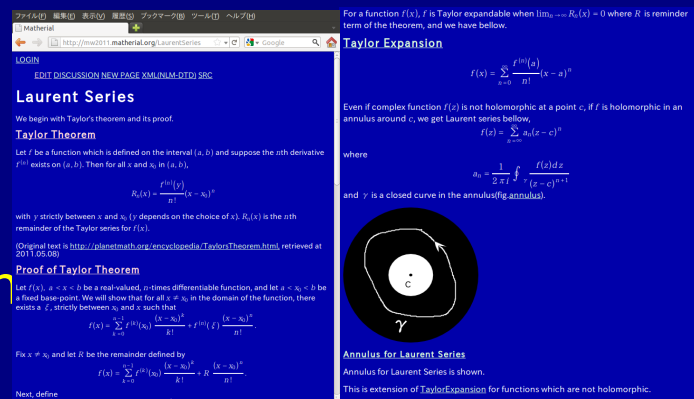
Representations of a Document

mt:hasRepresentation $\xrightarrow{\text{Rdfs:subPropertyOf}}$ dct:relation

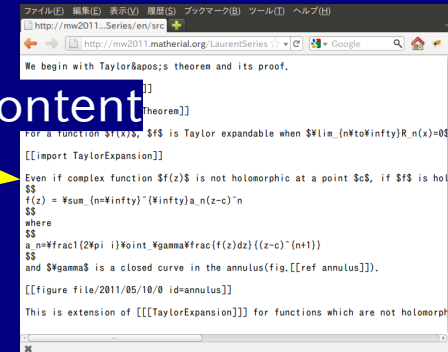
Document

mt:hasRepresentation

NLM-DTD



mt:hasContent



mt:hasRepresentation

- The term mt:hasRepresentation is a property to describe relationships between a Document and its Representations.
- A Document-Content member of the Document can be a Representation of the Document.

about Document Types for Mathematics

Document Types for Mathematics

File Edit View History Bookmarks Tools Help
Material
http://mw2011.material.org/TaylorThe

LOGIN
EDIT DISCUSSION NEW PAGE XML(NLM-DTD) SRC

Taylor Theorem

Let f be a function which is defined on the interval (a, b) and suppose the n th derivative $f^{(n)}$ exists on (a, b) . Then for all x and x_0 in (a, b) ,

$$R_n(x) = \frac{f^{(n)}(y)}{n!}(x - x_0)^n$$

with y strictly between x and x_0 (y depends on the choice of x). $R_n(x)$ is the n th remainder of the Taylor series for $f(x)$.

(Original text is <http://planetmath.org/encyclopedia/TaylorTheorem.html>, retrieved at 2011.05.08)
created at / modified at Sun May 29 07:12:16 +0900 2011

mt:proofOf

File Edit View History Bookmarks Tools Help
Material
http://mw2011.material.org/ProofOfT

LOGIN
EDIT DISCUSSION NEW PAGE XML(NLM-DTD) SRC

Proof of Taylor Theorem

Let $f(x)$, $a < x < b$ be a real-valued, n -times differentiable function, and let $a < x_0 < b$ be a fixed base-point. We will show that for all $x \neq x_0$ in the domain of the function, there exists a ξ , strictly between x_0 and x such that

$$f(x) = \sum_{k=0}^{n-1} f^{(k)}(x_0) \frac{(x - x_0)^k}{k!} + f^{(n)}(\xi) \frac{(x - x_0)^n}{n!}.$$

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$$f(x) = \sum_{k=0}^{n-1} f^{(k)}(x_0) \frac{(x - x_0)^k}{k!} + R \frac{(x - x_0)^n}{n!}.$$

Next, define

$$F(\xi) = \sum_{k=0}^{n-1} f^{(k)}(\xi) \frac{(x - \xi)^k}{k!} + R \frac{(x - \xi)^n}{n!}, \quad a < \xi < b.$$

rdf:type

mt:Theorem

rdf:type

mt:Proof

Document Types for Mathematics

- Mathematical Resource Type
mt:MathematicalObject
 - mt:Expression, mt:Definition, mt:Theorem
and mt:Proof
- A Relationship between a theorem and its
proof

mt:proofOf $\xrightarrow{\text{Rdfs:subPropertyOf}}$ dcterms:relation

Overlapping with OMDoc Ontology

- OMDoc Ontology provides similar vocabulary
 - RDF classes i.e. Definition, Theorem, Proof and so on.
 - Each class is sub class of *MathKnowledgeItem*
 - *Any mathematical knowledge item that can be expressed in OMDoc*
(<http://omdoc.org/ontology>)
 - If a document is a MathKnowledgeItem, the document may be **expected to be represented in OMDoc.**

Overlapping with OMDoc Ontology

- Matherial focuses to publish Documents using by **presentation markups** and not support OMDoc.
 - Mathematical Documents on Matherial is **not represented in OMDoc**
- This is because we define similar terms in our namespace.

Conclusion

Conclusion

- Matherial, CMS for mathematical documents
 - Authoring two types of document that **consist of several Resources.**
 - A Wiki Page type of Document
 - An Aggregation of Wiki Pages.
 - Mathematical expressions in LaTeX notation
 - Type of a Mathematical document
 - Publishing full-text documents into several Representations with their metadata.
 - XHTML + MathML and RDFa
 - NLM-DTD

Conclusion

- Semantics of Mathematical Document Structure
 - We defined new terms to describe Structure of Documents.
 - **mt:hasContent** to describe that an aggregating document has its own content resource.
 - **mt:hasNext** and **mt:partType** to describe properties of member-document of the aggregating document.
 - **mt:hasRepresentation** to describe relationships between the Document and its Representations

Conclusion

- Semantics of Mathematical Document Structure
 - We defined terms
 - `mt:Defintion`, `mt:Theorem`, `mt:Proof`, `mt:proofOf` and so on to describe type and relationship of mathematical documents which are **represented in presentation markup**, but not content markup.