Digital mathematics libraries: The good, the bad, the ugly

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7th International Conference on Mathematical Knowledge Management

Birmingham (UK), 28-30 July 2008

NUMDAM EuDML cedram

Outline

The mathematical literature
Specificities

- Mathematical litterature never becomes obsolete
- It's valid only as a *whole*, building a wide network of references
- It's useful to other sciences in an *asynchronous* fashion
- It must be carefully archived, indexed and preserved
- It must be accessible over the long term

The mathematical literature

Milestones

1665 Birth of scientific journals (*Journal des sçavans, Philosophical transactions*)

1800 About 200 journals where math articles are published

1810 First math-only journal (*Annales de mathématiques pures et appliquées*, aka *Annales de Gergonne*)

1850 About 1000 mathematical research articles published each year

1950 About 6000 mathematical research articles published each year

The mathematical literature

Milestones

1978-1986 TEX

1992 arXiv, math preprints (Physics: 1991)

1994 First non-specialized math-only electronic journal
it's free (*New York Journal of Mathematics*)

1995 JSTOR digitises 6 English speaking math journals
(400 000 pages)

2000 100 000 articles considered each year, 75 000 reviewed by
Math. Reviews or *Zentralblatt MATH*
600 cover-to-cover journals, 1500-2000 serials scanned

2008 10 million pages digitised? 65% of core journals available
digitally?

The mathematical literature

The impossible catalogue

1868 *Jahrbuch über die Fortschritte der Mathematik*

1894 *Répertoire bibliographique des sciences mathématiques* ("valuable" references from 19th century)

1931 *Zentralblatt für Mathematik und ihre Grenzgebiete*

1940 *Mathematical reviews* and AMS classification

1990 Electronic versions (MathSci Disc, CompactMath) and online access (telnet...)

1995 Web access (MathSciNet, ZMATH)

2000 Links to original texts

2002 Bibliographies, backward links

2004 mini-DML :-)

2009 EuDML?

The mathematical literature

Time scale

- Instant preprint circulation (labs, arXiv, email, home pages)
- Actual publication delayed 1-2 years
- About 50% citations in today's bibliographies are more than 10 years old
- About 25% citations in today's bibliographies are more than 20 years old
- Among the 100 most cited items in MR biblios, 96 are books (88 in NUMDAM biblios)

The mathematical E-literature

Interrogations

- How open archives and formal journals fit together?
- Reliability of digital libraries?
- Who pays for electronic-only free access journals?
- Does the author-pay model help improve the quality?
- Does the author-pay model help lower global costs?
- Will independent publishers survive?
- Who will maintain the files after their commercial life?

The mathematical E-literature

Wishes (IMU 2002, 2005)

- Free metadata and navigation
- Eventual open access (moving wall)
- No long-term economic, legal, technical barriers
- No dependance upon viability of any economic agent
- A universal reference digital mathematical library (DML)

The mathematical E-literature

Content providers

- Gallica retrodigitised, public domain (old), free, French speaking
- GDZ retrodigitised, free, not only German
- NUMDAM/CEDRAM retrodigitised/publishing platform, moving wall, not only French
- JSTOR retrodigitised, not-for-profit, English only, (expensive) subscription library service
- project Euclid retrodigitised and publishing platform, not-for-profit
- Oxford University Press retrodigitised/publishing platform, no moving wall, English only
- Elsevier publishing platform, retrodigitised content as one optionnal package
- Springer publishing platform, retrodigitised content as one optionnal package (English only)

The mathematical E-literature

Journal accessibility report

Acta math. ~~Mittag-Leffler (1882-2005)~~ ; Springer (1882-1997), Springer (1997-)

Ann. Math. ~~JSTOR (1884-2001), Euclid, Emis (2001-)~~
JSTOR (1884-2003), MSP (2008-) ?

Bull. LMS OUP (1865-)

CRAS Gallica (1835-1965) ; Elsevier (1997-)

Crelle GDZ (1826-1997) ; Walter de Gruyter (1999-)

Duke Math. J. Euclid (1935-1999), Euclid (2000-)

Liouville Gallica (1836-1935) ; Elsevier (1997-)

Math. Ann. GDZ (1869-1996) ; Springer (1869-1997), Springer (1997-)

Pacific J. Math. Euclid (1951-)

Théor. nombres Bordeaux Séminaire : GDZ (1972-1988) ; Journal : NUMDAM (1989-2005) ; ELibM (1994-2007) ; CEDRAM (1989-)

Digital Mathematical Library

The vision

"In light of mathematicians' reliance on their discipline's rich published heritage and the key role of mathematics in enabling other scientific disciplines, the Digital Mathematics Library strives to make the entirety of past mathematics scholarship available online, at reasonable cost, in the form of an authoritative and enduring digital collection, developed and curated by a network of institutions."

(Cornell NSF project 2002,
endorsed by IMU 2006)

A digital library?
Context

- Libraries buy and store publisher's (paper) production
- They preserve it and provide access to their patrons
- Why should this change because of a format move?
- Will the mathematical knowledge remain part of our common, freely accessible heritage?
- Or is it going to be confiscated by private interests?

A digital library?

Traditional components—digital counterparts

Selection	Selecting collections by subject, document type. . .
Acquisition	Retrospective digitisation *and* ingesting current production
Cataloguing	Capture, produce, import, enhance metadata
Archiving	Collections, file names, identifiers
Preservation	Hardware maintenance, emulation, management. . .
Access	Easy access, file conversions, interfaces maintenance

Suggested implementation

"The Digital Mathematics Library strives to make

- ~~the entirety of past mathematics scholarship~~
- available online, *and preserved offline*
- at reasonable cost,
- in the form of an authoritative and enduring digital collection,
- developed and curated by a network of institutions."

\+ updated continuously with publisher supplied new content

\+ with sophisticated interoperability, discovery and retrieval services

Cellule MathDoc
Missions

- The *Cellule de coordination documentaire nationale pour les mathématiques* (MathDoc) is a small unit of CNRS-UJF located in Grenoble since 1995
- Missions

  1995 National coordination for mathematical documentation
  - Technological support for librarians
  - Collaboration with *Zentralblatt-MATH*

  2000 Digitisation of main French serials

  2005 Technological support for academic publishers

Cellule MathDoc
Projects

- Small team of about 3 computer scientists, 3 information specialists, 2 mathematicians
- Main projects
  - 1996 CFPM : French union catalogue of math. depts
  - 1997 EDBM : Web interface to the ZMATH database
  - 2002 NUMDAM Pilot digitisation of 5 serials
  - 2005 CEDRAM, v. 1 : Electronic edition of 3 journals
    - LiNuM, mini-DML, Gallica-Math ;
  - 2007 CEDRAM, v. 2 : 5 journals, 3 seminars, MathML/TEX.

NUMDAM
A survey

Digitisation programme for archiving and providing access to the backrun of academic mathematical journals

Archiving: Integral scanning from the first page up to the last one of each volume

Delivery: One multipage image file per article

Free search and navigation at www.numdam.org

NUMDAM
Goals

- Preserve the “French” mathematical patrimony
- Enhance its visibility and accessibility
- Provide a power tool to researchers worldwide
- Support independent and society publishers
- Take part in the definition of the DML standards
- Support French as an international idiom

NUMDAM

Collections

2000-2004 Phase I

6 serials (4 main journals in pure maths, 1 memoirs series, 1 proceedings series)

7 500 articles, 210 000 p.

2004-2007 Phase II

17 journals (from mathematical physics to statistics, and from Nîmes in 1810
to Amsterdam, Pisa, 21th century. . .)

28 seminars (among which: Bourbaki [I.H.P.], Cartan [É.N.S.], Leray [Collège de France], . . .)

+ 20 000 articles, + 375 000 p.

2007- Phase III

Older journals, Doctoral theses 1918-1940, SMAI/EDP Sciences journals. . .

Already **+ 9 600 articles, + 75 000 p.**

NUMDAM

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(New)

Collections access

Quick search

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Browse 21 journals - 28 seminars

List by title

Informations

The **NUMDAM** web site (Numérisation de documents anciens mathématiques) offers an open access to the metadata and articles published in mathematical journals.

For each journal, all the volumes published up to year 2000 have been retro-digitized. To date, 560 000 digitized pages and 27 000 articles are shown on the web site.

The articles themselves are available for online consultation after a period of time called moving wall. During this period (generally 5 years), they are reserved for journal subscribers only.

Access to articles can be done in 2 differents ways :

News items

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- Nouvelles Annales de Mathématiques
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Search and download archives of mathematical journals

Article search

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Deligne, Pierre
Théorie de Hodge : III. *Publications Mathématiques de l'IHÉS*, 44 (1974), p. 5-77
Full text (djvu) | (pdf) | Reviews MR 58 #16653b | Zbl 0237.14003 | 45 citations in Numdam

stable URL: http://www.numdam.org/item?id=PMIHES_1974__44__5_0

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CEDRAM
A survey

"Center for dissemination of academic mathematical journals"

Support: Tools for better production and management of independent research math journals

Hosting: High quality electronic edition servers

Archiving Transfer of the user files to NUMDAM for long-term access, of production files in a preservation archive

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[Nom] [Prénom]

Résolution rationnelle des fibrations

Journal de Théorie des nombres de Bordeaux, 1 (2010), p. 147-182

article PDF | Auteurs (0) | Citer

Résumé - Abstract

Le calcul de Galois fournit des exposants pour certaines sommes arithmétiques, comme les nombres premiers et les nombres premiers jumeaux. Dans dimensions au théorème de semi-stable X^{n+1}-X^n pour les exposants de ce type. Comme applications arithmétiques, nous considérons l'estimation des sommes d'exponentielles sur les d-uplets premiers. Soient $a_1, \ldots, a_d$ et $b_1, \ldots, b_d$ les entiers premiers. Un pour $N \geq \cdots + \sum_{i=1}^{d} a_i \log b_i$, où E est l'ensemble des $n \in \mathbb{N}$ tels que tous les nombres $a_1 n + b_1, \ldots, a_d n + b_d$ sont premiers. Nous obtenons des bornes supérieures pour $|S(\alpha, \beta; N)|$, qui vont au rapprochent la valeur de la conjecture de Hardy et Littlewood sur le d-uplet premiers d'ordre de grandeur attendu. Cette autre application est de nature. Elle s'obtient par théorème des Chinois et de Weil et de « passage de quantificateurs » à notre dimensions qui à montrer une solubilité de leurs arithmétiques $p_1 \times p_2 \times p_3$ de nombres premiers, tandis que chacun $p_i + 2$ est premier ne se produit en trois entiers premiers.

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ANNALES
DE
L'INSTITUT FOURIER

Frédéric Mangolte

Real Hodge structure of affine hypersurfaces
[Structures de Hodge réelles d'hypersurfaces affines]

Annales de l'Institut Fourier, 57 no. 3 (2007), p. 779-801
Article (PDF)
Class. Math. : 14D05, 32S35
Mots clés : problème d'approximation, théorie de polynômes, courant résidu, sommation intégrale

Résumé - Abstract

Dans cet article nous donnons un algorithme qui produit une base de même groupe de cohomologie de Gel'fand de l'hypersurface affine lisse $f^{-1}(t)$ compatible avec la structure de Hodge mixte, où f est un polynôme en $n+1$ variables et satisfait des conditions de régularité à l'infini (en particulier, il a des singularités isolées). Comme application nous montrons que la fibre générique de f est difféomorphe à une fibre régulière de f tout en calculant les intégrales de certaines n-formes polynomiales dans $\mathbb{C}^{n+1}$ sur des n-cycles topologiquement dans ces fibres de f. Puisque l'homologie de degré n d'une fibre régulière est engendrée par les cycles évanescents, cela conduit à étudier des intégrales abéliennes (définies en intégrant sur n-cycles). Notre résultat généralise et utilise les arguments de J. Dieudonné pour les polynômes quasi-homogènes.

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Article | MR 1838660 | Zbl 1020.32022

Jean-Pierre Serre

Prolongement de faisceaux analytiques cohérents

Annales de l'institut Fourier, 16 no. 1 (1966), p. 363-374
Article PDF | Reviews MR 35 #5660 | Zbl 0144.08003

Résumé - Abstract

Soit X un espace analytique complexe normal, soit S un sous-ensemble analytique fermé de X, de codimension ≥ 2, et soit **F** un faisceau analytique cohérent sans torsion sur $X - S$. On démontre l'équivalence des trois propriétés suivantes :

(i) L'image directe de **F** par l'injection $X - S \to X$ est un faisceau cohérent sur X.

(ii) Il existe un faisceau analytique cohérent sur X qui prolonge **F**.

(iii) Pour tout $x \in S$, il existe un voisinage ouvert U de x tel que la restriction de **F** à $U - S \cap U$ soit engendrée par ses sections (sur $U - S \cap U$).

Les implications (i) $\to$ (ii) $\to$ (iii) sont triviales. L'implication (iii) $\to$ (i) utilise le théorème de Remmert-Stein sur le prolongement des sous-variétés.

Lorsque X est une variété projective, les conditions (i), (ii) et (iii) équivalent à dire que le faisceau **F** est "algébrique".

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Cedram | MR 34 #2940 | Zbl 0146.31103
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Numdam | MR 25 #4552 | Zbl 0082.37702
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Article | MR 15,615e | Zbl 0051.06303
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Article | MR 31 #768 | Zbl 0136.20704
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Cedram | MR 18,511a | Zbl 0075.30401

ANNALES DE LA FACULTÉ DES SCIENCES DE TOULOUSE Mathématiques

[illegible]

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Christer Borell

Minkowski sums and Brownian exit times

Annales de la faculté des sciences de Toulouse Sér. 6, 16 no. 1 (2007), p. 37-47
Article PDF

Résumé - Abstract

Si C est un domaine de $\mathbb{R}^n$, le temps de sortie brownien de C est noté T_C. Etant donné deux domaines C et D de $\mathbb{R}^n$ cet article montre une borne supérieure pour la fonction de répartition de T_{C+D} quand les fonctions de répartition de T_C et T_D sont connues. En plus l'article établit une généralisation de l'inégalité d'Ehrhard.

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Journées Équations aux dérivées partielles

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Terence Tao
Geometric renormalization of large energy wave maps
Journées équations aux dérivées partielles (2004), Art. No. 11, 32 p.
Article PDF | Analyses MR [illegible] | Zbl [illegible]
Class. Math.: 35L10

Résumé - Abstract

There has been much progress in recent years in understanding the existence problem for wave maps with small critical Sobolev norm (in particular for two-dimensional wave maps with small energy); a key aspect in that theory has been a renormalization procedure (either a geometric Coulomb gauge, or a microlocal gauge) which converts the nonlinear term into one closer to that of a semilinear wave equation. However, both of these renormalization procedures encounter difficulty if the energy of the solution is large. In this report we present a different renormalization, based on the harmonic map heat flow, which works for large energy wave maps from two dimensions to hyperbolic spaces. We also observe an intriguing estimate of ``non-concentration'' type, which asserts roughly speaking that if the energy of a wave map concentrates at a point, then it becomes asymptotically self-similar.

Bibliographie

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The pieces of the French DML

Special archives

Archives Nicolas Bourbaki Private documents and manuscripts from this famous mathematician, scanned by the CNRS unit « Archives de la création mathématique ». Online at http://portail.mathdoc.fr/archives-bourbaki/

Archives Laurent Schwartz Personal documents and manuscripts from this famous mathematician, scanned by the Polytechnique library (in progress)

Collected works of Laurent Schwartz Currently digitised for an edition on book with CD-ROM (SMF/X/CMD), but also online.

Doctoral theses from French universities 1918-1940

Videos Videotaped EHESS conferences (project)

The pieces of the French DML
Registries

Gallica-Math Frontend to Gallica's mathematical collections, providing article-level access

LiNum Catalogue of mathematical digitised books (Gallica, Michigan U, Cornell, Göttingen, etc.)

mini-DML Catalogue of mathematical digitised articles

The pieces of the French DML
Acquisition in NUMDAM

Since summer 2007, the NUMDAM website holds also born digital content supplied by two publishing platforms

CEDRAM content which was produced with CEDRICS and BibTEX bilios has been transfered

Science Direct transfered PDF and XML metadata for the 3 NUMDAM journals they produce

Additionnally, before the end of this year, we will transfer the 2007 volumes from the above sources, extend it to all CEDRAM published material, and welcome two new partners

Springer-SBM exports PDFs and XML metadata for the *Publications mathématiques de l'IHES*

EDP Sciences provides the full sources of all its applied mathematics journals

Gluing pieces together
mini-DML

- MathDoc provides and harvests OAI metadata
- *Service providers:* http://www.numdam.org/oai, http://www.cedram.org/oai
- *Harvester:* mini-DML 251 877 articles, 9 sources : arXiv, Euclid (Cornell), DigiZeitschriften (Göttingen), Kobe U, BN Portugal, ICM (Varsovie), MathDoc (NUMDAM, CEDRAM, Gallica-MATH).
- Simple one-stop search over all these corpus
- Bibliographical reference matching: $\simeq$ 20% article links in NUMDAM bibliographies

WDML?

Is there *one resource* that we could call WDML?

- To work like a web, it would need a bit of organisation...
- Some is already working pretty well...
- This needs a central registry and good matching algorithms

This has almost nothing to do with maths!

Math-aware mining?

So far, DML justifies its ‘M’ only through content selection

- Discovery tools are purely based on text strings (probably less efficient on math content)

  (Except for MSC, but it applies to a restricted time span, and is not even constant)
- Fuzzy matching works pretty well on strings with an expected structure (like bibliographical references)
- It doesn’t work at large when you don’t have a way to restrict the query to a mathematical context
- Imagine I search a reference for the prime number theorem. . .
- Matching and links could be a way to aggregate metadata?

Math-aware mining?

- The mathematical content is very symbolic, highly formalised

  But with very open notational system, same constructs for different concepts

  And a range of different notations for the same concepts at different places in time, space, or scientific landscape...
- By using formulas, new links could be established between items in the DML bearing at least some formal similarity (beyond text similarity)
- Possibly yielding new scientific links between distant texts

Conclusions

- Mathematicians are waiting for a reference digital library
- It should be a distributed collection of physical archives
- It has to be a public service (at least not-for-profit)
- Lasting for ever
- But it should keep current!
- Immediate free access is *not* mandatory
- Eventual open access *is* mandatory
- The DML idea is *good*!
- Some of its current components are *not so bad*
- Having some of them work *together* would be already *good*
- This is a hard job because the available metadata might be inexistent
- Interlinking support is *good*, but standardisation is still rather *bad*
- Math-aware mining is absent from the current efforts, which is *bad*
- Hacks to circumvent this tend to look *ugly*!