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Recommended Citation
Smith, Joan A. and Nelson, Michael L., "Tools for a Preservation-Ready Web" (2008). *Computer Science Presentations*. 25.
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Tools for a Preservation-Ready Web

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NDIIPP Digital Preservation Partners Meeting
July 9, 2008

What is Preservation?

- We will define preservation of a web site *W* to be:
  - refreshing
    - copying the bits from place to place
    - $R(W) = W_r$
  - migrating
    - converting the bits from format f_1 to format f_2
    - $M(W) = W_m$
  - emulation
    - simulating the original context for the bits
    - $E(W) = W_e$
  - putting it all together:
    - $E(M(R(W))) = W_{rme}$

Preservation Function *P*

- We define a preservation function *P*
  - P(W) = W_p

- Intuition is that P makes other functions easier:

  M(W_p) is easier to implement than M(W)

  E(W_p) is easier to implement than E(W)

  R(W_p) is probably easier to implement than R(W)

Web Site Preservation: 2 Problems

The counting problem

What are the members of W?

The representation problem

How do we define P(W)?

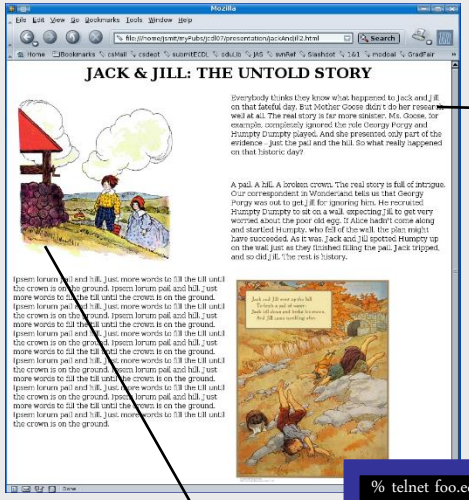
Preservation & the Counting Problem

- To preserve a site, we need to enumerate the full set of a web site's resources:

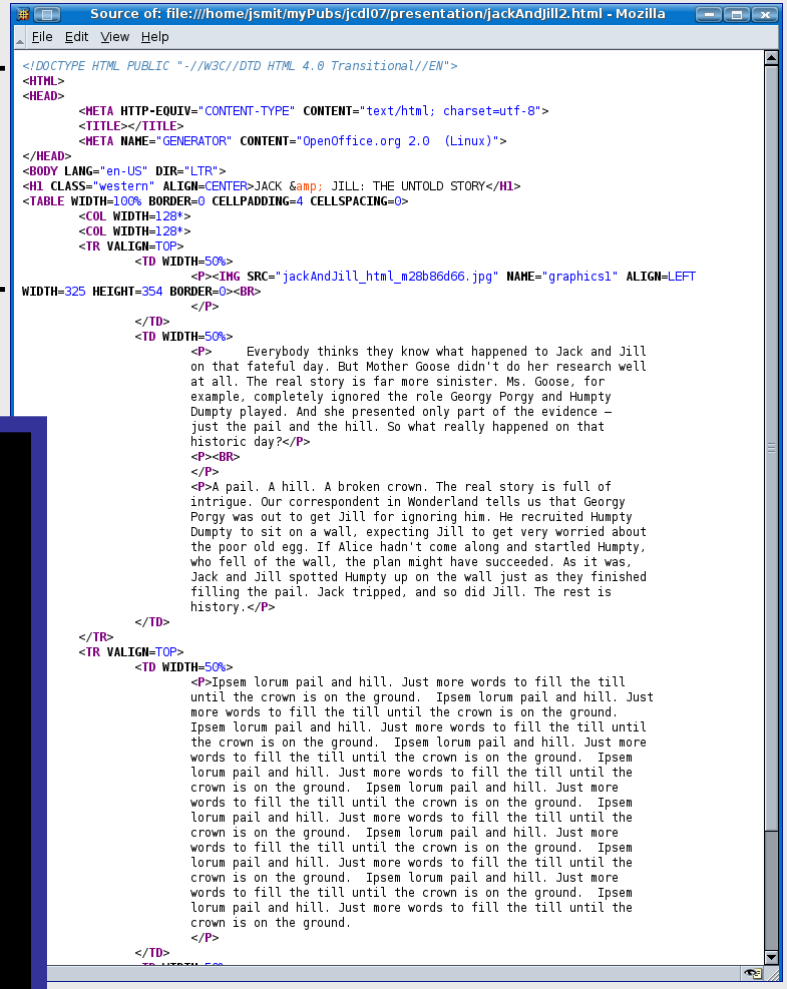
$$W = \{w_1, w_2, w_3, w_4 \ldots w_n\}$$

- For non trivial web sites:
  - The membership of W depends on who is asking
  - W is unknown (unknowable?)
  - W can only be approximated
- *There is no HTTP mechanism to define* W
- Sitemaps are a method to convey locally-held knowledge about W to web crawlers

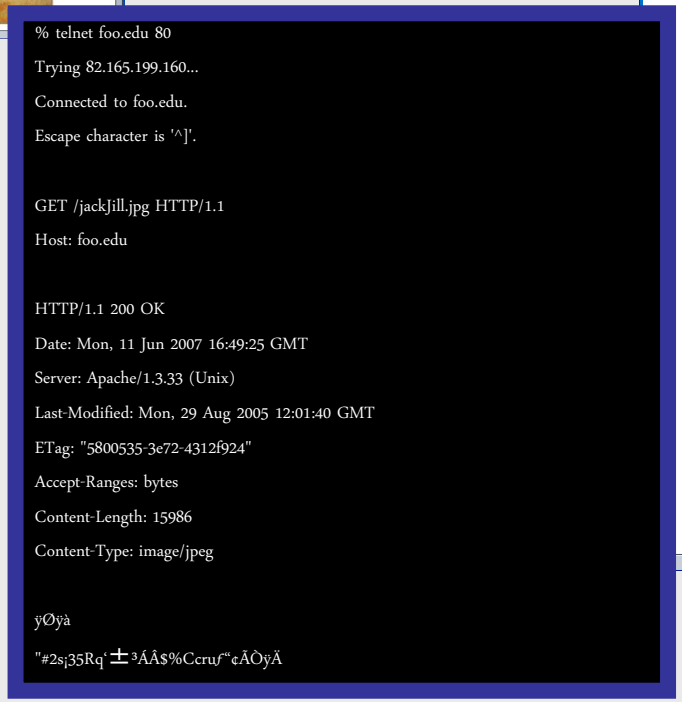
Preservation & the Representation Problem



HTML metadata



HTTP metadata



P(W) Involves the Output of Forensic Metadata Utilities

Standard HTTP Headers --

Last-Modified: Mon, 29 Aug 2005 12:01:40 GMT

ETag: "5800535-3e72-4312f924"

Content-Length: 15986

Content-Type: image/jpeg

EXIF:

File Name	103_0315.JPG
Camera Model Name	Canon EOS DIGITAL REBEL
Date/Time Original	2003:09:30 13:37:51
Shooting Mode	Sports
Shutter Speed	1/2000
Aperture	7.1
Metering Mode	Evaluative
Exposure Compensation	0
ISO	400
Lens	75.0 - 300.0mm
Focal Length	300.0mm
Image Size	3072x2048
Quality	Normal
Flash	Off
White Balance	Auto
Focus Mode	AI Servo AF
Contrast	+1
Sharpness	+1
Saturation	+1
Color Tone	Normal
File Size	1606 kB
File Number	103-0315

MD5 Hash:

58a54e8638db432f4515eedf89f44505

File/Magic:

JPEG image data
JFIF standard 1.00
resolution (DPI)
"LEAD Technologies Inc. V1.01“
33 x 26

JHOVE:

Date: 2007-06-18 14:35:50 EDT RepresentationInformation: /home/crate/apache/htdocs/jackJill.jpg ReportingModule: JPEG-hul, Rel. 1.2 (2005-08-22) LastModified: 2007-01-16 23:09:07 EST Size: 27750 Format: JPEG Version: 1.00 Status: Well-Formed and valid SignatureMatches: JPEG-hul MIMEtype: image/jpeg Profile: JFIF JPEGMetadata: CompressionType: Huffman coding, Baseline DCT Images: Number: 1 Image: NisoImageMetadata: MIMEType: image/jpeg ByteOrder: big-endian CompressionScheme: JPEG ColorSpace: YCbCr SamplingFrequencyUnit: inch XSamplingFrequency: 33 YSamplingFrequency: 26 ImageWidth: 172 ImageLength: 146 BitsPerSample: 8, 8, 8 SamplesPerPixel: 3 Scans: 1 QuantizationTables: QuantizationTable: Precision: 8-bit DestinationIdentifier: 0 Comments: LEAD Technologies Inc. V1.01 ApplicationSegments: APP0

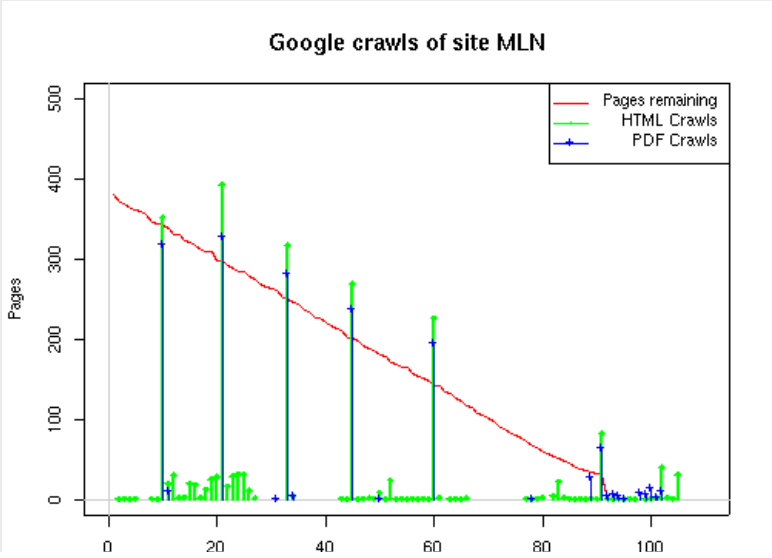
Experiments & Evaluation

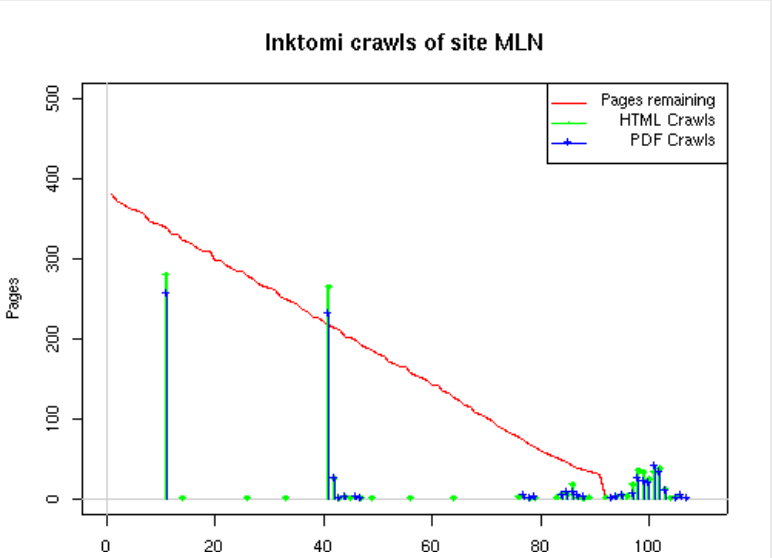
- Counting problem
  - Web crawler behavior on decaying web sites (D-Lib 2006)
  - Web crawler behavior on deep and wide web sites (D-Lib 2008)
  - Defining W on a departmental web site (unpublished)
- Representation problem
  - Dissemination time preservation metadata (JCDL 2007, IWAW 2007, D-Lib 2008)
  - Performance evaluation of metadata utilities (ECDL 2008)

- Reference implementation: mod_oai, an Apache module
  - uses Sitemaps, OAI-PMH resource harvesting for counting problem
  - uses “CRATE” -- base64’d resource + metadata output as the OAI-PMH metadataPrefix for representation problem

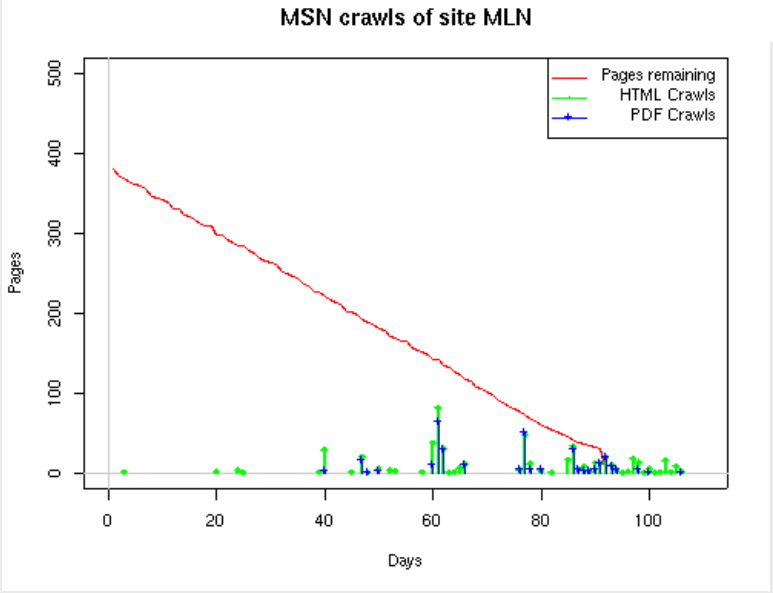
Decaying Web Sites

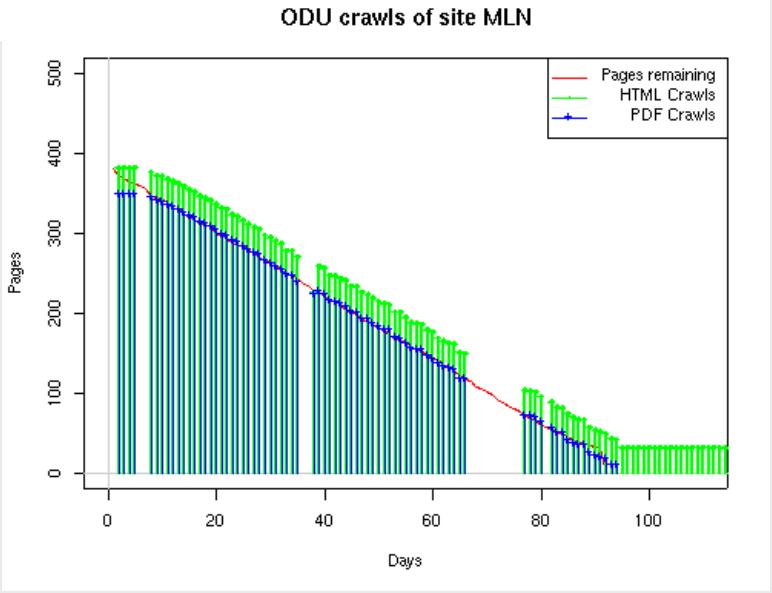
(D-Lib 2006)





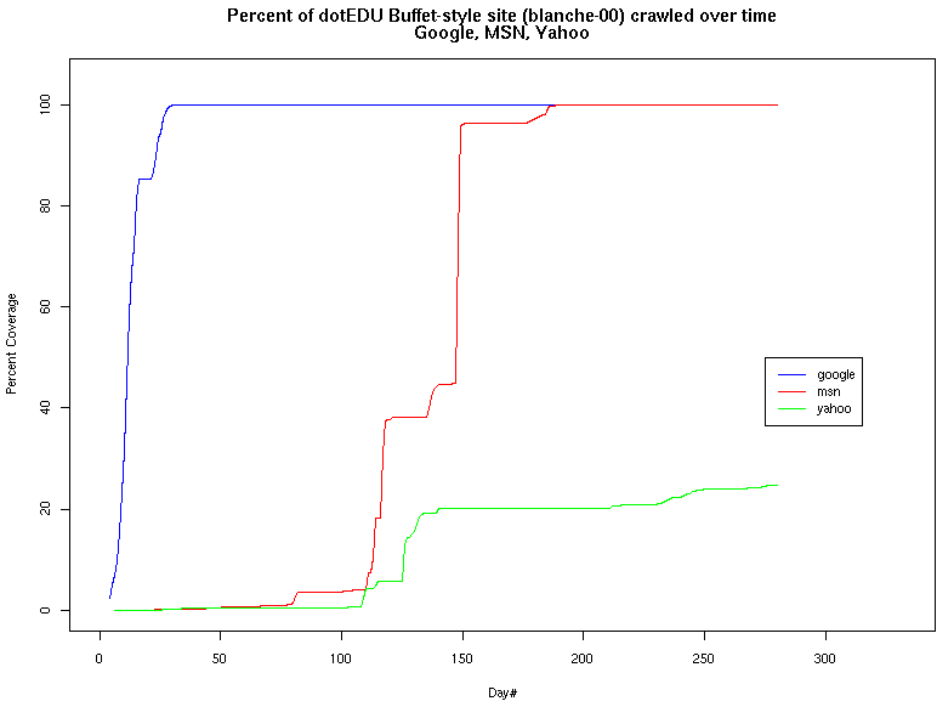
- Lots of pages die in between crawler visits
- IA never came in 3+ months

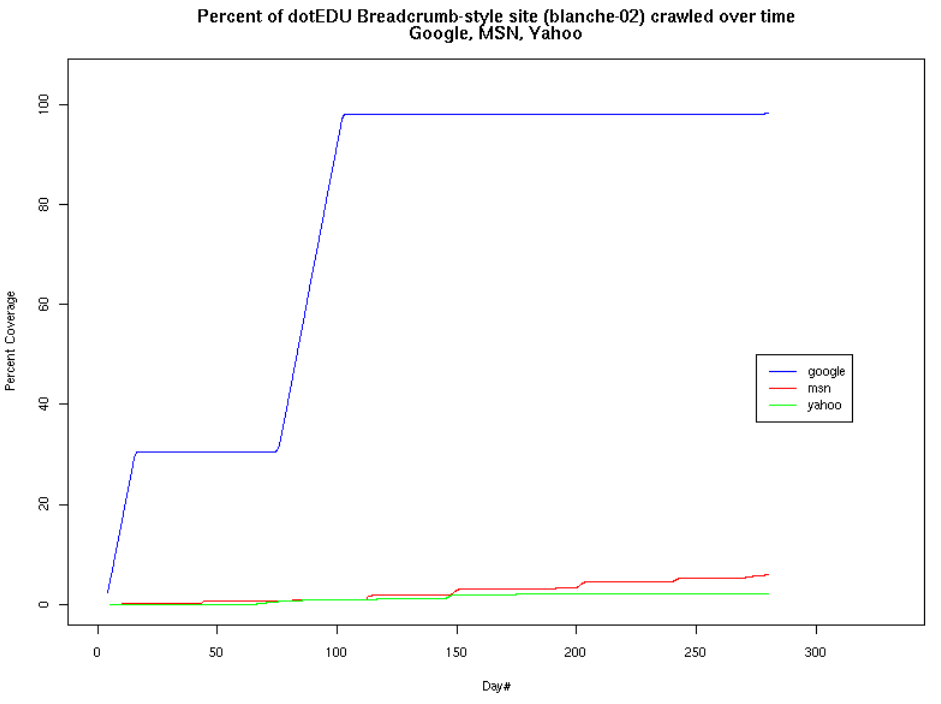




Deep & Wide Web Sites

(D-Lib 2008)

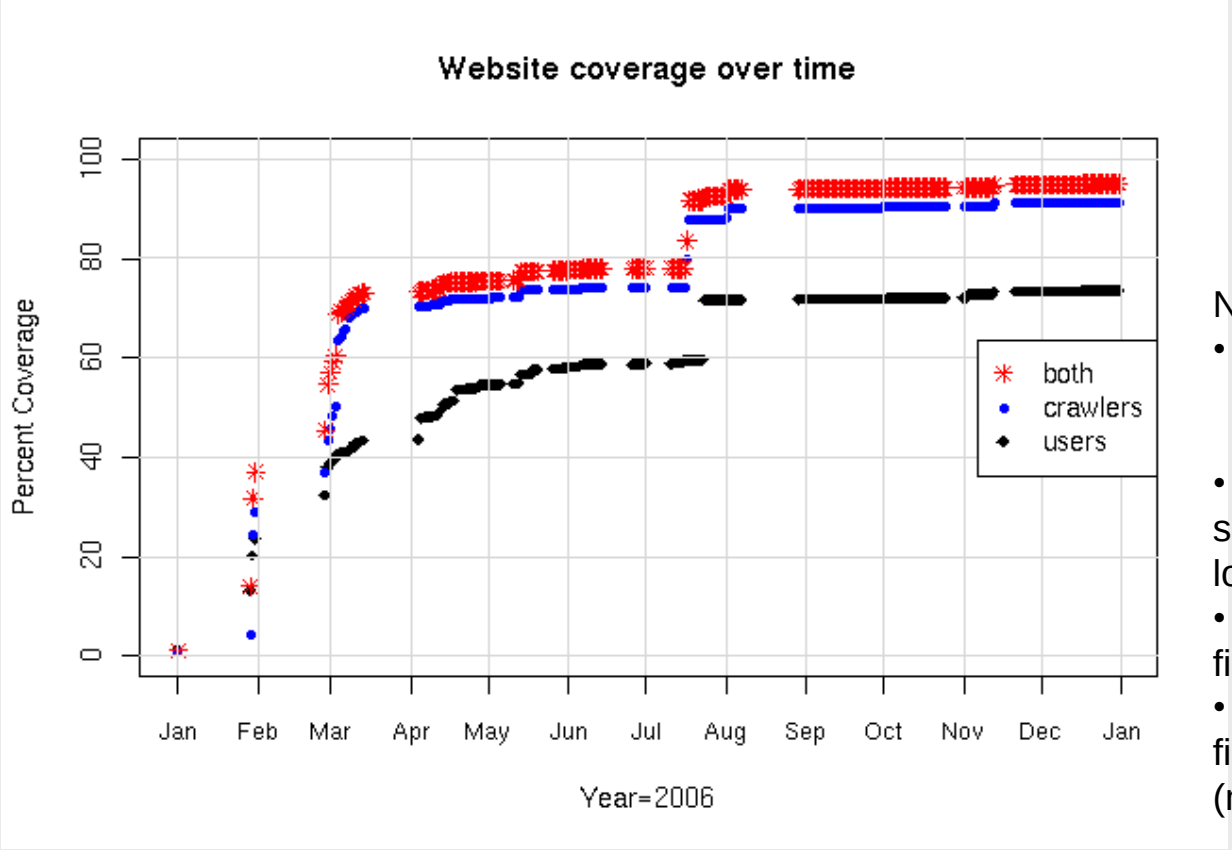




"Buffet" = Level 1 links to levels 2, 3, 4 … n

"Bread Crumb" = Level 1 links to level 2, level 2 links to level 3, etc.

Coverage of www.cs.odu.edu



Notes:
- Departmental snapshot (no ~user URLs; CGI files removed; spotty http logs)
- Google Python Sitemap script crashed on ill-formed log data
- 100% defined in terms of file system count
- Results written in a Sitemap file for mod_oai processing (more later)

Source	Files	URLs
Self-Crawl	406	538
External Crawl	406	761
File System	*2,052*	*2,052**

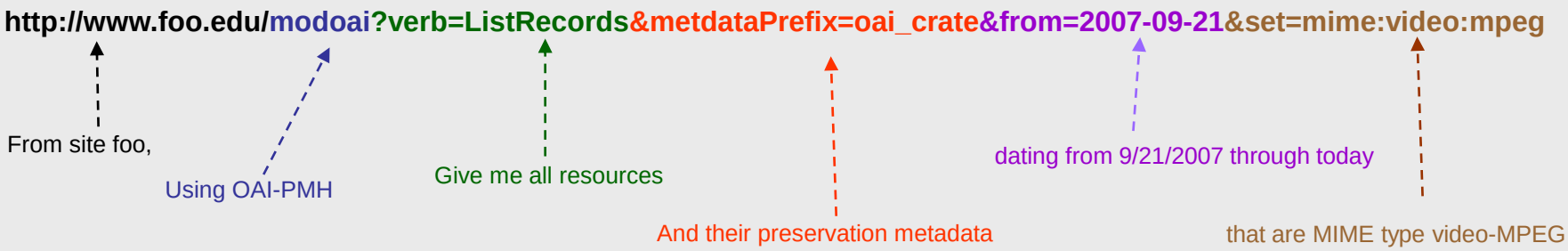
mod_oai implementation

(JCDL 2007, IWAW 2007, D-Lib 2008)

Integrate OAI-PMH functionality into the web server itself…

1. Use **mod_oai**
   - an Apache 2.0 module
   - automatically answers OAI-PMH requests for an http server
   - written in C
   - *respects values in .htaccess, httpd.conf*
2. Install mod_oai on http://www.foo.edu/
3. Define baseURL: http://www.foo.edu/modoai

→ **Result: web harvesting with OAI-PMH semantics (e.g., from, until, sets)**



Uses a public (or private) Sitemap for the definition of W (used to be dynamic file system inspection); create the Sitemap as the union of multiple tools

CRATE

<crate>
<http request headers> Accept: text/xml,application/xml,application/xhtml+xml,text/html;q=0.9,text/plain;q=0.8,image/png,*/*;q=0.5
Accept-Language: en-us,en;q=0.5
…
<http response headers> Content-Length: 101702
Content-Type: image/jpeg
…
<metadata>
<name>
<version>
<output>
</metadata>

File/Magic:
JPEG image data
JFIF standard 1.00
resolution (DPI)
"LEAD Technologies Inc. V1.00
33 x 26

<metadata>
<name>
<version>
<output>
</metadata>

EXIFTOOL:

File Name	
Camera Model Name	Canon EOS DIGITAL REBEL
Date/Time Original	2003:09:30 13:37:51
Shooting Mode	Sports
Shutter Speed	1/2000
Aperture	7.1
Metering Mode	Evaluative
Exposure Compensation	0
ISO	400
Lens	75.0 - 300.0mm
Focal Length	300.0mm
Image Size	3072x2048
Quality	Normal
Flash	Off
White Balance	Auto
Focus Mode	AI Servo AF
Contrast	+1
Sharpness	+1
Saturation	+1
Color Tone	Normal
File Size	1606kB
File Number	103-0315

<metadata>
<name>
<version>
<output>
</metadata>

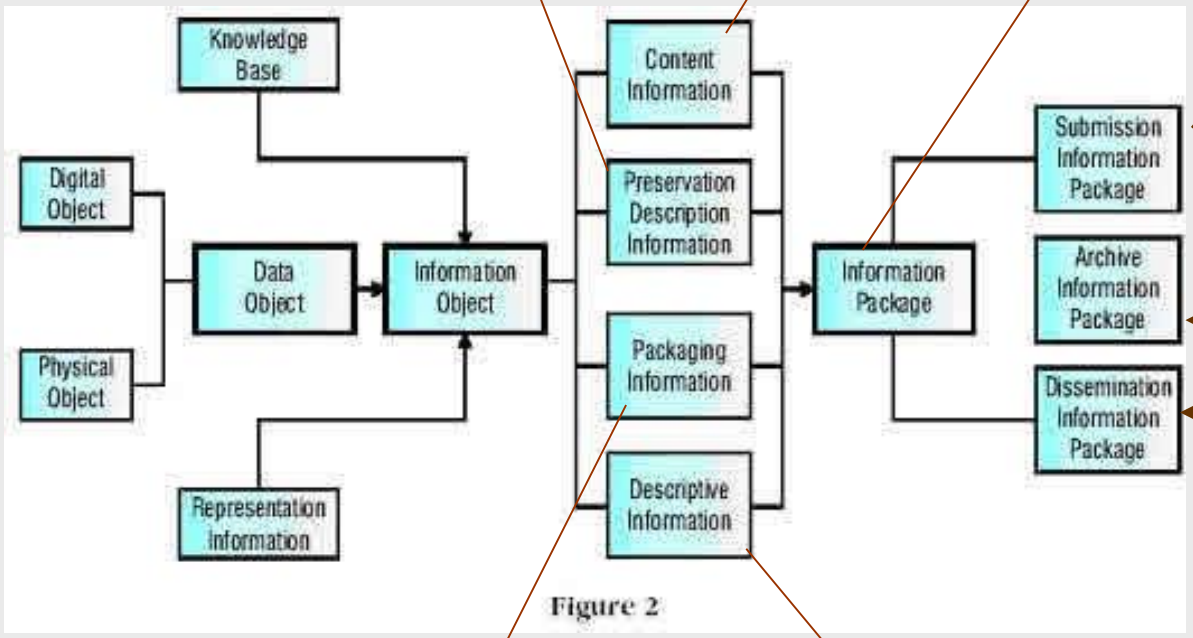
JHOVE TOOL:
Date: 2007-06-18 14:35:50 EDT RepresentationInformation: /home/crate/apache/htdocs/jackJ.jpg
ReportingModule: JPEG-hul, Rel. 1.2 (2005-08-22) LastModified: 2007-01-16 23:09:07 EST Size: 27750
Format: JPEG Version: 1.00 Status: Well-Formed and valid SignatureMatches: JPEG-hul
MIMEtype: image/jpeg Profile: JFIF JPEG Metadata CompressionType: Huffman coding, Baseline DCT
Images: Number: 1 Image: NisoImageMetadata MIMEType: image/jpeg ByteOrder: big-endian
Co… …CbCr SamplingFrequencyUnit: inch XSamplingFrequency: 33
YS… …2 ImageLength: 146 BitsPerSample: 8, 8, 8 SamplesPerPixel: 3
Sca… …nTable Precision: 8-bit DestinationIdentifier: 0
Co… …1 ApplicationSegments: APP0

<base64'd resource> …KNiAwIG9iago8PC9MZW5ndGgg….

</crate>

- If you like to look at lots of XML, go to: http://www.cratemodel.org/modoai/?verb=ListRecords&metadataPrefix=oai_crate
- Intuition: now is the best time to describe a file, and the local user has a good idea as to what should be said (does not preclude further analysis by harvester)

CRATE and the OAIS Information Model



Metadata from plug-ins: Summary, index, format analysis…

Base64-encoded resource

CRATE

OAI-PMH MPEG-21 DIDL Metadata Format

MIME / GDFR Type Copyright Originator Description

SIP: original web resource as it exists on the web site

AIP: resource processed by mod_oai for metadata &

DIP: disseminated to crawler; to other repositories; to an information archeologist for research/extraction

CRATE: Apache Configuration File

```
        <Location /modoai>                          ← Apply these rules to http://foo.edu/modoai
          SetHandler modoai-handler                 ← Use modoai to process these requests

on a    modoai_plugin                               ← plugin element: one utility per element
single      "jhove"                                 ← each has a label, used as a metadata "ID tag"
text        "/opt/jhove/jhove -m jpeg-hul %s"       ← the command-line or script to call the utility
line        "/opt/jhove/jhove --v"                  ← include the version number of the installed utility
            "image/jpeg"                            ← which MIME types should be analyzed (any jpeg)


                                                    ← EOL here
         modoai_plugin
            "ots"                                   Open Text Summarizer
            "/usr/local/bin ots –summary %s"        ← "%s" means substitute resource name here
            "/usr/local/bin ots -v"
            "text/*"                                ← Use on all text (plain, HTML, XML, etc.) resources

        modoai_plugin
            "jhove"                                 ← Another invocation of the JHOVE utility
            "/opt/jhove/jhove -m pdf-hul %s"        ← Note the different hul used here
            "/opt/jhove/jhove --v"                  ← report the version
            "application/pdf"                       ← Use on all PDF resources (only)

        modoai_plugin
            "pronom"                                ← the PRONOM DROID tool
            "java -jar DROID.jar -L%s –SsigFile.xml"
            "java -jar DROID.jar -v"                ← report the version
            "*/*"                                   ← Use this utility on every resource

        </Location /modoai>
```

Tested CRATE Plug-Ins for mod_oai

Name	Description
Exif	Image/video metadata extractor
Jhove	Image analysis
DC	dcTag html extactor
Droid	Pronom registry info
MetaX	Meta-extractor
OTS	Open Text Summarizer
wc	unix word count utility
file	unix file utility (magic cookie)
md5, sha	unix md5sum, shasum utilities

Quantitative Evaluation of Using MODOAI to Build a CRATE

- Created "typical" website
  - 1084 resources – PDF, HTML, Applications, Images
  - Complete Sitemap file
- Tested in commercial environment (Kronos, Inc)
- Installed metadata utilities
  - Some Java
  - Some OS-Native
  - Some locally compiled
- Collected CPU performance data using Jmeter
- Compared CRATE with simple crawl
  - Time to complete crawl
  - Size of response
  - Response time by load variation
  - Impact on non-Crate requests
- Compared time for individual utilities
  - Response time by load factor
  - Response size by utility

Time Required to CRATE Web Site

(ECDL 2008)

Server response time to other web requests: < 2% throughput delta

Request Parameters	Active Utilities	Response Time in Min:Sec By Server Load			Response Size (Bytes)
		0 %	50 %	100%	
wget (full crawl)	None	00:27.16s	00:28.55s	00:28.89s	77,982,064
ListIdentifiers:oai_dc	None	00:00.14s	00:00.46s	00:00.20s	130,357
ListRecords:oai_dc	None	00:00.34s	00:00.37s	00:00.37s	756,555
ListRecords:oai_crate	None	00:02.47s	00:08.34s	00:03.38s	106,148,676
ListRecords:oai_crate	File	00:09.56s	00:09.72s	00:09.50s	106,429,668
ListRecords:oai_crate	MD5sum	00:04.55s	00:04.52s	00:04.40s	106,278,907
ListRecords:oai_crate	SHA	00:19.36s	00:19.70s	00:19.96s	106,190,722
ListRecords:oai_crate	SHA-1	00:04.57s	00:04.49s	00:05.37s	106,316,236
ListRecords:oai_crate	WC	00:06.14s	00:06.11s	00:05.92s	106,419,750
ListRecords:oai_crate	Exif	00:04.60s	00:04.79s	00:04.51s	106,163,645
ListRecords:oai_crate	DC	00:31.13s	00:29.47s	00:28.66s	106,612,082
ListRecords:oai_crate	OTS	00:35.81s	00:36.43s	00:35.83s	106,285,422
ListRecords:oai_crate	MetaX	01:13.71s	01:15.99s	01:13.96s	106,257,162
ListRecords:oai_crate	Jhove	00:54.74s	00:54.99s	00:54.84s	106,297,738
ListRecords:oai_crate	Droid	44:14.01s	45:29.76s	47:23.29s	106,649,382
ListRecords:oai_crate	All *but Droid*	03:34.58s	03:38.84s	03:42.60s	107,906,032
ListRecords:oai_crate	All	47:42.45s	48:53.97s	50:09.76s	108,407,266

Future Work

- OAI-ORE support
  - CRATEs as Resource Maps
- Defining CRATEs as an http encoding format
  - like gzip, zip, etc.
  - can return a CRATE in response to a regular http request with appropriate q values (not just OAI-PMH harvest request)
- Third party metadata
  - how can my web server use your installation of Jhove?
- Tighter http log / Sitemap integration:
  - “Sitemap strict” -- don’t serve a file unless it appears in a Sitemap
  - “Sitemap synch” -- in real-time, add/delete entries in Sitemap based on 200 / 404 responses

For more information

- More info, code:

  http://www.modoai.org/

  http://code.google.com/p/modoai/

- A joint research project between:
  - Old Dominion University and
  - LANL Digital Library Research & Prototyping Team
- Research supported by the Andrew Mellon Foundation & the Library of Congress